

Minnesota Attorney General: Administrative Rules Proceedings

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August 20, 2018

211

MINNESOTA STATE REGULATIONS

Notice of filing by the Commissioner of Administration

We have received on this date, stamped and filed 2 copies of Rules and Regulations pertaining to the Minnesota Department of Health
(Agency or Board)

Regulation No. MHD 441-445 Chapter 26

Subject: Implementation of the Minnesota Indoor Clean air act.

Department of Administration
Publication, Central Services Division
Documents Section
140 Centennial Office Building
St. Paul, Minnesota 55155
Telephone: (612) 296-2874

FILED
RICHARD L. BRUBACHER
Commissioner of Administration

APR 2 1976

BY [signature]
AUTH. SIGNATURE 4:15 PM

Stamped and filed with the Secretary of State 4-2-76 4:00 PM

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Attorney General

Terry P. O'Brien
Special Assistant
Attorney General

March 30, 1976

4692

Michael B. Miller
Special Assistant
Attorney General

Department of Health Rules MHD 441-445

The above-captioned rules are returned herewith so that the Findings of Fact can be made more specific.

MBM/mb

Enclosure

RULES AS ADOPTED FOR THE IMPLEMENTATION
OF THE MINNESOTA CLEAN INDOOR AIR ACT

MINNESOTA DEPARTMENT OF HEALTH RULES
CHAPTER TWENTY-SIX

		Page
MHD 441	Authority, Scope and Purpose	1
MHD 442	Definitions	
	(a) Acceptable Smoke-free Area	1
	(b) Act	2
	(c) Bar	2
	(d) Educational Facilities	2
	(e) Factory, Warehouse or Similar Place of Work.	2
	(f) Health Care Facilities	2
	(g) Meals	2
	(h) Office	3
	(i) One Side of the Room	3
	(j) Other Person in Charge	3
	(k) Place of Work	3
	(l) Private Social Function	3
	(m) Proprietor	3
	(n) Public Conveyance	3
	(o) Responsible Person	4
	(p) Restaurant	4
	(q) Room	4
MHD 443	General Provisions	
	(a) General Prohibition	4
	(b) Smoking-Permitted Area	4
	(c) Single Room	5
	(d) Signs	5
	(e) Acceptable Smoke-free Area	6
MHD 444	Categories of Affected Places	
	(a) Applicability	6
	(b) Places of Work	7
	(c) Offices	7
	(d) Restaurant	7
	(e) Public Conveyance	8
	(f) Educational Facility	8
	(g) Health Care Facilities	8
	(h) Hotels, Motels and Resorts	8
MHD 445	Application for Waiver of the Law	9
MHD 446-450	Reserved for Future Use	

MHD 441. Authority, Scope and Purpose.

(a) These rules are promulgated pursuant to authority granted to the State Board of Health in Minnesota Statutes §144.417, Subd. 1, relating to prohibition of smoking in public places and at public meetings.

(b) These rules apply to "public places" and "public meetings," as defined in Minnesota Statute §144.413, Subdivisions 2 and 3. "Public place" includes all enclosed, indoor areas used by the general public or serving as a place of work, regardless of type of ownership of the area. Restrictions and prohibitions on smoking in "factories, warehouses and similar places of work" shall be regulated under rules of the Department of Labor and Industry.

(c) Nothing in these rules shall be construed to in any way affect smoking prohibitions imposed by the fire marshal or other laws, ordinances or regulations.

(d) It is the purpose of these rules to provide clarification of certain provisions of the Minnesota Clean Indoor Air Act and to maintain the same public policy position as the Act.

MHD 442. Definitions. All terms which are defined in Minnesota Statute §144.411-§144.417 shall have the meanings attributed to them therein. For the purpose of these rules the terms defined herein shall have the meanings given to them.

(a) "Acceptable Smoke-free Area" means:

(1) A contiguous portion of the public place or public meeting including seating arrangements, where smoking is prohibited and,

(2) At least one of the following conditions exist:

(aa) There is a continuous, physical barrier such as a wall, partition or furnishing, of at least 56 inches (1.42 meters) in height to separate the smoking-permitted and no-smoking areas. The barrier may contain doors or portals for exit and entry.

(bb) There is a space of at least four feet (1.22 meters) in width to separate the smoking-permitted and no-smoking areas. This space may be either an unoccupied area or a section of seating area acting as a buffer zone in which smoking is not permitted, but which itself is not part of the "acceptable smoke-free area."

(cc) The ventilation system in the room containing both a smoking-permitted and no-smoking area has total air circulation (recirculated plus outside air) of not less than six air changes per hour including supply of tempered outside air determined according to Regulation of the Department of Administration, Minnesota Building Code, Minn. Reg. SBC 6007(c)(3).

(dd) The concentration of carbon monoxide in the no-smoking area shall at no time exceed concentration of carbon monoxide in outside air within 12 feet (3.7 meters) of the building by more than 10 milligrams per cubic meter (9 parts per million).

(b) "Act" means the Minnesota Clean Indoor Air Act of 1975, Minnesota Laws 1975, Chapter 211, Minnesota Statutes §144.411-§144.417.

(c) "Bar" shall mean any establishment or portion of an establishment where one can purchase and consume alcoholic beverages, but excluding any such establishment or portion of the establishment having table and seating facilities for serving of meals to more than fifty people at one time, and where, in consideration of payment, meals are served at tables to the public.

(d) "Educational facilities" means any location used for instruction of enrolled students, including but not limited to, day care centers, nursery schools, elementary schools, middle schools, junior and senior high schools, vocational schools, colleges and universities. This classification shall include all areas supportive of instruction which are under the responsibility of the school administration, including but not limited to classrooms, lounges, study area and libraries.

(e) "Factory, warehouse or similar place of work" means the indoor area of any facility of an enterprise used principally to manufacture or assemble goods, products or merchandise not for the purpose of direct retail sale, and shall include those areas incidental but related to the primary operation.

(f) "Health care facilities" means any institution, place, building or agency which is required to be licensed under Minnesota Statute §§144.50 to 144.58, including but not limited to, hospitals, nursing homes, boarding care homes, supervised living facilities and surgical centers.

(g) "Meals" shall mean any foods made available to be consumed on the premises except foods which are prepackaged when served to the patron and foods which are served as snacks or appetizers.

(h) "Office" means any building, structure or area which is used by the general public or serves as a place of work at which the principal activities consist of professional, clerical or administrative services. This classification shall include professional offices, financial institutions, business offices and government offices.

(i) "One side of the room" shall mean a contiguous portion of the room, including any seating arrangements.

(j) "Other person in charge" shall mean the agent of the proprietor authorized to perform administrative direction to and general supervision of the activities within the public place at any given time.

(k) "Place of work" shall mean any location at which two or more individuals perform any type of a service for consideration of payment under any type of employment relationship, including but not limited to such employment relationship with or for a private corporation, partnership, individual, or government agency. This term shall also include any locations wherein two or more individuals gratuitously perform services for which individuals are ordinarily paid.

(l) "Private social function" shall mean any function for which all the following conditions are met:

(1) The function is a specific social or recreational event for which an entire room or hall has been reserved for the purpose of entertainment or pleasure and not for the principal purpose of education, sales or business.

(2) The function is limited in attendance to people who have been specifically designated and their guests.

(3) Seating arrangements for the function, if any, are under control of the sponsor of the function and not of the person otherwise responsible for the public place.

(m) "Proprietor" means the party, regardless of whether he is owner or lessee of the public place, who ultimately controls, governs or directs the activities within the public place. The term does not mean the owner of the property unless he ultimately controls, governs or directs the activities within the public place. The term proprietor may apply to a corporation as well as an individual.

(n) "Public Conveyance" means any air, land or water vehicle used for the transportation of persons for compensation, including but not limited to airplanes, trains, buses, boats, and taxis.

(o) "Responsible person" means the proprietor or other person in charge as herein defined.

(p) "Restaurant" means any building, structure, or area used as, maintained as, or advertised as, or held out to the public to be an enclosure where meals, for consideration of payment, are made available to be consumed on the premises. For the purpose of these rules, the term "restaurant" shall not depend upon licensure as such under Minnesota Statute, Chapter 157.

(q) "Room" means any indoor area which is bordered on all sides by a wall or partition of at least 56 inches (1.42 meters). Such sides shall be continuous and solid except for door portals for entry and exit.

MHD 443. General Provisions.

(a) General Prohibition

Smoking shall be prohibited in all sections of public places or public meetings except in areas designated as smoking-permitted areas.

(b) Smoking Permitted Area

(1) If smoking is to be permitted in an area of a public place or public meeting, the responsible person shall designate such area as "smoking permitted." One and only one smoking-permitted area shall be designated per room. However, rooms containing at least 20,000 square feet (1,858 square meters) in total floor space may designate more than one smoking-permitted area and shall otherwise comply with these Rules.

(2) In a public place which contains two or more rooms which are used for the same activity, the responsible person may designate one entire room as smoking permitted as long as at least a portion of one other comparable room has been designated as a no-smoking area.

(3) Entry or exit areas, ticket areas, registration areas, common traffic areas or similar sections of public places shall not be designated in their entirety as a smoking-permitted area if non-smokers would be required to use the area to participate in activities for which the public place is intended. This Rule shall not be construed to prevent designation of a smoking-permitted area in a portion of the establishment which non-smokers must briefly cross to reach the intended activity.

(4) The size of the designated smoking-permitted area shall not be more than proportionate to the preference of users of that location for a smoking-permitted

area, as can be demonstrated by the responsible person. The proportional preference of users of a smoking-permitted area in that location may be demonstrated by the responsible person by evidence of any of the following:

(aa) the percentage of users of the location who express a preference for a smoking-permitted area when the responsible person asks all users for their preference, or

(bb) the percentage of users of the location who request or select a smoking-permitted area when the responsible person does not ask all users for their preference, or

(cc) the percentage of users who are determined by the proprietor to prefer a smoking-permitted area by an alternate method which reasonably indicates the user's preference.

(c) Single Room

In the case of a public place consisting of a single room in which a smoking-permitted area is designated, the responsible person shall be responsible for reserving and clearly designating a no-smoking area on one side of the room.

(d) Signs

(1) All signs which are used to identify a bar that has been designated as a smoking area in its entirety shall use the statement, "This establishment is a smoking area in its entirety," or a similar statement. The sign shall be conspicuously posted either on all outside entrances or in a position clearly visible on entry into the establishment.

(2) All signs which are used to identify a location where the responsible person prohibits smoking in an entire public place or public meeting shall use the statement, "No smoking is permitted in this entire establishment," or a similar statement. The sign shall be conspicuously posted either on all outside entrances or in a position within the establishment.

(3) All signs which are used to identify a smoking-permitted area shall use the words "smoking permitted" and all signs which are used to identify a no-smoking area shall use the words "no smoking." Additional words and symbols, including the international smoking symbol, may be used, but the additional printing shall not obscure the basic words "smoking permitted" or "no smoking."

(4) All signs which are used to identify smoking-permitted and no-smoking areas shall be placed at a height and location easily seen by a person in the establishment and not obscured in any way. "Smoking-permitted"

and "no-smoking" signs, except signs on tables or seats, shall be in printed letters of not less than 1.5 inches (3.8 centimeters) in height. The boundary between a no-smoking area and smoking-permitted area shall be clearly designated so that persons may differentiate between the two areas.

(5) All signs which are used on tables or seats to designate no-smoking and smoking-permitted areas shall use printed letters of not less than 0.5 inches (1.3 centimeters) in height. When such signs are used, the responsible person shall conspicuously post at least one "no smoking" sign and one "smoking permitted" sign either at the boundary between the two areas or on the walls adjacent to the no-smoking and smoking-permitted areas.

(6) The size of lettering on signs reading "smoking permitted" shall not exceed the size of lettering on signs reading "no smoking" in the same public place.

(7) To advise patrons of existence of "no-smoking" and "smoking-permitted" areas, the statement, "In accordance with the Minnesota Clean Indoor Air Act, smoking is prohibited except in designated smoking areas," may be conspicuously posted at the entry to the establishment.

(8) In lieu of sign provisions specified in MHD 443(d)(3) and (4), a responsible person shall be in compliance with the law if all persons are asked their preference for a smoking-permitted or a no-smoking area and all persons are then directed to the appropriate area. Furthermore, at least one sign advising the public of this mechanism shall be conspicuously posted at all entrances normally used by the public.

(e) Acceptable Smoke-free Area

The responsible person shall make arrangements for an acceptable smoke-free area as defined in MHD 442(a). The size and location of any smoking-permitted area shall be determined such that toxic effects of smoking are minimized in the adjacent no-smoking area.

MHD 444. Categories of Affected Places

(a) Absent irreconcilable conflict, the responsible person shall be expected to comply with Minn. Reg. MHD 443 and the specific provisions governing that public place in Minn. Reg. MHD 444. If the provisions of the rules governing specific affected places conflict with or are inconsistent with a general provision of Minn. Reg. MHD 443, the specific portion of Minn. Reg. MHD 444 shall prevail over the general. The public places specified in this Rule shall be expected to comply with applicable provisions according to

functional activities taking place in a public area and not according to the nature of a controlling establishment.*

(b) Places of Work

(1) As an alternative to Minn. Reg. MHD 443(b)(1) requiring one and only one smoking-permitted area per room, a place of work which is not customarily frequented by the general public may contain several, separate no-smoking and smoking-permitted areas within the same room provided each no-smoking area is at least 200 square feet (18.2 square meters) in area. Such no-smoking areas must comply with the requirements for an acceptable smoke-free area as defined in Minn. Reg. MHD 442(a). Under this alternative for places of work which are not customarily frequented by the general public, the responsible person shall not be required to comply with sign provisions of Minn. Reg. MHD 443(d), but the responsible person must conspicuously post at least one sign on each floor which states, "Smoking is prohibited except in designated smoking areas."

(2) These Rules shall not apply to a private residence when the residence is not customarily used as a "place of work."

(3) Any "factory, warehouse or similar place of work," as defined in MHD 442(e), shall be regulated by Rules of the Department of Labor and Industry.

(c) Offices

When a public place which is a factory, warehouse or similar place of work contains an office which is incidental but related to the primary operation, such office shall for the purposes of this Act, be regulated under Rules of the Department of Labor and Industry.

(d) Restaurant

(1) During hours of operation when a facility which may otherwise be considered a restaurant does not serve food but does serve alcoholic beverages, the facility shall be considered a "bar."

(2) When a public place which is a factory, warehouse or similar place of work contains a restaurant which is intended as an employee eating area and which is incidental to the primary operation, such restaurant shall, for the purposes of this Act, be regulated under Rules of the Department of Labor and Industry.

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* For example, different Rules may apply to component areas of a medical center according to the actual functional activities of each area, such as a restaurant, office or health care facility.

(e) Public Conveyance

(1) No person is permitted to smoke in a public conveyance except in designated smoking areas. Smoking-permitted sections may be designated in any public conveyance with a capacity of ten or more persons including the driver.

(2) A public conveyance with a capacity of less than ten persons may be considered to be a smoking area in its entirety if the driver and all passengers expressly consent.

(f) Educational Facility

Smoking-permitted areas in educational facilities shall not be located in areas normally used by persons under 18 years of age.

(g) Health Care Facilities

(1) The requirement for posting of appropriate signs in Minn. Reg. MHD 443 shall be satisfied in patient or resident rooms if there is at least one sign at the entrance to each floor and wing which states: "Smoking is prohibited except in designated smoking areas."

(2) One of the following procedures shall be used in patient or resident rooms:

(aa) The responsible person shall ask all prospective patients or resident or a person authorized to represent the patient or resident whether a smoking-permitted or no-smoking area is preferred. The responsible person then shall assign rooms according to this preference when space is available. When space is not available in a no-smoking room and a person is admitted to a room originally designated for smoking, smoking shall be prohibited in that room unless expressly permitted by the non-smoker.

(bb) If the responsible person does not assign patient or resident rooms according to the smoking preference of the patient or resident, smoking shall be prohibited in all such rooms except rooms occupied exclusively by persons who smoke or persons who have expressed permission for smoking.

(3) Visitors and staff shall be prohibited from smoking in patient or resident rooms unless the occupants expressly permit.

(h) Hotels, Motels and Resorts

No person may smoke in hotels, motels and resorts except in designated smoking areas. This prohibition does not apply to sleeping rooms which are rented to a guest.

MHD 445. Application for Waiver of the Law.

(a) To apply for a waiver of the Act, the responsible person for a public place or public meeting shall submit a written application to the State Board of Health stating the grounds for the waiver. The Board has the right to request any other information reasonably necessary to determine the merits of the waiver application. Failure to submit such requested information may result in denial of the waiver application.

(b) An applicant for waiver shall have the burden to provide clear and convincing evidence to demonstrate that both:

(1) Compelling reasons exist to necessitate a waiver. Such compelling reasons may consist of evidence that implementation of the Act and these Rules would endanger the ability of the public place to produce sufficient income to meet its operating expenses. Acceptable evidence of such compelling reasons shall consist of financial records and/or projections, based upon demonstrable proof, reasonably showing changes of income and/or expenses which are directly attributable to the Act or these Rules.

(2) Even with waiver of the Act and these Rules the concentration of carbon monoxide in all sections of the public place shall at no time exceed the concentration of carbon monoxide in outside air within 12 feet (3.7 meters) of the building by more than 10 milligrams per cubic meter (9 parts per million).

(c) In making determination of the eligibility of an applicant for a waiver, the State Board of Health shall:

(1) Consider information supplied by the responsible person in the application for waiver.

(2) Consider prevailing smoking restrictions and other practices relating to similar public places in the community.

(3) Consider other relevant information consistent with the public policy expressed in the Act.

(d) After the Board has reviewed the information required in Minn. Reg. MHD 445(c), the Board shall make the final decision on the waiver application and shall respond in writing to the applicant indicating that the waiver request has been denied or approved and reasons therefor.

APPROVED AS TO FORM AND LEGALITY
APR 2 1976 19
WARREN SPANNAUS, ATTORNEY GENERAL
BY /s/ Michael B. Miller
SPECIAL ASSISTANT ATTORNEY GENERAL

STATE OF MINNESOTA
DEPARTMENT OF STATE
FILED
APR 2 - 1976 - 4:00 pm
Joan Anderson Growe
Secretary of State

FILED
RICHARD L. BRUBACHER
Commissioner of Administration
APR 2 1976
BY Edy Standerwick
AUTH. SIGNATURE
PS 4:15 PM

ADMIN 1000

STATE OF MINNESOTA

DEPARTMENT ATTORNEY GENERAL

Office Memorandum

TO : Michael Miller
Special Assistant
Attorney General
Department of Administration

DATE: April 2, 1976

FROM : Terry P. O'Brien
Special Assistant
Attorney General

PHONE:

SUBJECT: In the Matter of the Proposed (Rules) (Amendments) Relating to the Implementation of the Minnesota Clean Indoor Air Act of 1975

Enclosed for your review is a revised Findings of Fact relating to the above-referenced rules. Specific reference to portions of the record, either the Justification, Transcript or letters, are included in Findings 4-34 to support the Findings.

Sorry about the delay, but we had to send them to Rochester to have them signed. When the rules are filed would you please so inform me.

Thanks.

TPO:ss
enclosure

ADMIN 1000

STATE OF MINNESOTA

DEPARTMENT ATTORNEY GENERAL

Office Memorandum

TO : Michael Miller
Special Assistant Attorney General
Department of Administration

DATE: March 9, 1976

FROM : Terry P. O'Brien
Special Assistant Attorney General

PHONE: 5371

SUBJECT: Board of Health adoption of rules relating to implementation of the Minnesota Clean Indoor Air Act.

Enclosed for your review are three files containing the necessary documentation in support of the above referenced rules.

An initial interpretative problem arose with regard to the respective jurisdictional authority of the Board of Health and the Department of Labor and Industry. Minn. Stat. § 144.417 subd. 1 (Supp. 1975) states the Board of Health shall adopt rules to implement the Act "except as provided for in section 144.414." Minn. Stat. § 144.414 (Supp. 1975) indicates that the prohibitions contained in the Clean Indoor Air Act shall not apply to "factories, warehouses and similar places of work" but that Labor and Industry will promulgate rules to prohibit smoking in work places where close proximity of workers or inadequate ventilation causes prohibition. Jon Murphy and I agreed Labor and Industry would develop rules for places of work similar to factories and warehouses. Since Minn. Stat. § 144.413, subd. 2 (Supp. 1975) specifically includes "offices and other commercial establishments" as public places, the Board of Health would develop rules for all other places of work.

Further, it would appear the use of the term "public place" in Minn. Stat. § 144.413, subd. 2 (Supp. 1975) is a misnomer inasmuch as the definition includes categories such as offices not commonly thought of as public places.

The rules did give rise to controversy. However, many of the letters received and some of the remarks made at hearing consisted of reactions to the enabling statute itself rather than any specific rules. Those members of the public who commented on the rules usually fell within one of two groups: those who felt the rules were too lax and those who felt the rules were too stringent. Generally, the Board steered a compromise course by requiring certain results but permitting optional methods to achieve those results. For instance, MHD 443(d) requires a responsible person to arrange for an "acceptable smoke-free area" but permits him to implement any one of four optional methods in MHD 442(a)(2) to arrange an "acceptable smoke-free" area.

Minn. Stat. § 144.413, subd. 2 defines those places subject to the Act "as any indoor area used by the public" including restaurants. Minn. Stat. § 144.415 specifically permits bars to be designated as smoking areas in their entirety. Thus, the definition of "bar" in MHD 442(c) is important. In my opinion, page 10 of the justification adequately addresses the rationale behind the definition contained in the rule. Findings of Fact numbers 12 and 13 also deal with this definition.

If you have any questions please don't hesitate to contact me.

When the rules are filed, would you please return to me files Numbered 1 and 2. Thanks.

MHD 441. Authority, Scope and Purpose.

(a) These rules are promulgated pursuant to authority granted to the State Board of Health in Minnesota Statute § 144.417, Subdivision 1, relating to prohibition of smoking in public places and at public meetings.

(b) These rules apply to "public places" and "public meetings," as defined in Minnesota Statute § 144.413, Subdivisions 2 and 3. "Public place" includes all enclosed, indoor areas used by the general public or serving as a place of work, regardless of type of ownership of the area. Restrictions and prohibitions on smoking in "factories, warehouses and similar places of work" shall be regulated under rules of the Department of Labor and Industry.

(c) Nothing in these rules shall be construed to in any way affect smoking prohibitions imposed by the fire marshal or other laws, ordinances or regulations.

(d) It is the purpose of these rules to provide clarification of certain provisions of the Minnesota Clean Indoor Air Act and to maintain the same public policy position as the Act.

MINNESOTA DEPARTMENT OF HEALTH RULES

CHAPTER TWENTY-SIX

Proposed Rules for Implementation
of Minnesota Clean Indoor Air Act

		Page
MHD 441	Authority, Scope and Purpose	1
MHD 442	Definitions	
	(a) Acceptable Smoke-free Area	2
	(b) Act	3
	(c) Bar	3
	(d) Educational facilities	3
	(e) Health care facilities	4
	(f) Meals	4
	(g) Office	4
	(h) One side of the room	4
	(i) Other person in charge	4
	(j) Place of work	4
	(k) Private social function	5
	(l) Proprietor	5
	(m) Public Conveyance	6
	(n) Responsible person	6
	(o) Restaurant	6
	(p) Room	6
MHD 443	General Provisions	
	(a) Smoking Permitted Area	7
	(b) Single Room	8
	(c) Signs	8
	(d) Acceptable Smoke-free Area	10
	(e) Responsibility of Responsible Person	10
MHD 444	Categories of Affected Places	
	(a) Applicability	11
	(b) Places of Work	11
	(c) Offices	12
	(d) Restaurant	12
	(e) Public Conveyance	12
	(f) Educational Facility	13
	(g) Health Care Facilities	13
	(h) Hotels, Motels and Resorts	14
MHD 445	Application for Waiver of the Law	15
MHD 446-450	Reserved for Future Use	

MHD 442. Definitions. *All terms which are defined in Minnesota Statute § 144.411 - 144.417 shall have the meanings attributed to them therein. For the purpose of these rules the terms defined herein shall have the meanings given to them.*

(a) "Acceptable Smoke-free Area" means:

(1) A contiguous portion of the public place or public meeting including seating arrangements, where smoking is prohibited and,

(2) At least one of the following conditions exist:

(aa) There is a continuous, physical barrier such as a wall, partition or furnishing, of at least 56 inches (1.42 meters) in height to separate the smoking permitted and no smoking areas.

(bb) There is a space of at least four feet (1.22 meters) in width to separate the smoking permitted and no smoking areas.

(cc) The ventilation system in the room containing both a smoking permitted and no smoking area has total air circulation (recirculated plus outside air) of not less than six air changes per hour including supply of tempered outside air of not less than 7.5 cubic feet (2.29 cubic meters) per minute per person according to standard occupancy classifications in Regulation of the

Department of Administration, Minnesota Building Code, Minn. Reg. SBC 7705.

(dd) The concentration of carbon monoxide in the no smoking area shall at no time exceed concentration of carbon monoxide in outside air within 12 feet (3.7 meters) of the building by more than 10 milligrams per cubic meter (9 parts per million).

(b) "Act" means the Minnesota Clean Indoor Air Act of 1975, Minnesota Laws 1975, Chapter 211, Minnesota Statutes § 144.411 to 144.417.

(c) "Bar" shall mean any establishment where one can purchase and consume alcoholic beverages, but excluding any such establishment having table and seating facilities for serving of meals to more than fifty people at one time, and where, in consideration of payment, meals are served at tables to the public.

(d) "Educational facilities" means any location used for instruction of enrolled students, including but not limited to, day care centers, nursery schools, elementary schools, middle schools, junior and senior high schools, vocational schools, colleges and universities. This classification shall include all areas supportive of instruction which are under the responsibility of the school administration, including but not limited to classrooms, lounges, study area and libraries.

(e) "Health care facilities" means any institution, place, building or agency which is required to be licensed under Minnesota Statute §§ 144.50 to 144.58, including but not limited to, hospitals, nursing homes, boarding care homes, supervised living facilities and surgical centers.

(f) "Meals" shall mean any foods made available to be consumed on the premises except foods which are prepackaged when served to the patron and foods which are served as snacks or appetizers.

(g) "Office" means any building, structure or area which is used by the general public or serves as a place of work at which the principal activities consist of professional, clerical or administrative services. This classification shall include professional offices, financial institutions, business offices and government offices.

(h) "One side of the room" shall mean a contiguous portion of the room, including any seating arrangements.

(i) "Other person in charge" shall mean the agent of the proprietor authorized to perform administrative direction to and general supervision of the activities within the public place at any given time.

(j) "Place of work" shall mean any location at which two or more individuals perform any type of a service for consideration of payment under any type of employment relationship, including but not limited to such employment relationship with or for a private corporation, partnership, individual, or government agency. This term shall also include any locations wherein two or more individuals gratuitously

perform services for which individuals are ordinarily paid. Any place of work which is used principally to manufacture or assemble goods, products or merchandise for sale, or to store goods, products or merchandise not for the purpose of retail sale shall be included in a category of "factories, warehouses and similar places of work" and shall be regulated under Rules of the Minnesota Department of Labor and Industry.

(k) "Private social function" shall mean any function for which all the following conditions are met:

(1) The function is a specific social event for which an entire room or hall has been reserved.

(2) The function is limited in attendance to people who have been specifically designated and their guests.

(3) Seating arrangements for the function are under control of the sponsor of the function and not of the person otherwise responsible for the public place.

(l) "Proprietor" means the party, regardless of whether he is owner or lessee of the public place, who ultimately controls, governs or directs the activities within the public place. The term does not mean the owner of the property unless he ultimately controls, governs or directs the activities within the public place. The term proprietor may apply to a corporation as well as an individual.

(m) "Public Conveyance" means any air, land or water vehicle used for the transportation of persons for compensation, including but not limited to airplanes, trains, buses, boats and taxis.

(n) "Responsible person" means the proprietor or other person in charge as herein defined.

(o) "Restaurant" means any building, structure, or area used as, maintained as, or advertised as, or held out to the public to be an enclosure where meals, for consideration of payment, are made available to be consumed on the premises. For the purpose of these rules, the term "restaurant" shall not depend upon licensure as such under Minnesota Statute Chapter 157.

(p) "Room" means any indoor area which is bordered on all sides by a wall or partition of at least 56 inches (1.42 meters). Such sides shall be continuous and solid except for doors, openings or similar such spaces for entry and exit.

MHD 443. General Provisions.

(a) Smoking Permitted Area

(1) If smoking is to be permitted in an area of a public place or public meeting, the responsible person shall designate such area as "smoking permitted." One and only one smoking permitted area shall be designated per room. However, rooms containing at least 20,000 square feet (6,096 square meters) in total floor space may designate more than one smoking permitted area and shall otherwise comply with these Rules.

(2) In a public place which contains two or more rooms which are used for the same activity, the responsible person may designate one entire room as smoking permitted as long as at least one other comparable room has been designated as a no-smoking area.

(3) A smoking permitted area shall not be located in a complete section which non-smokers would be required to use to participate in activities for which the public place is intended. This provision shall include, but not be limited to, entry or exit areas, ticket areas, registration areas, common traffic areas, elevators or similar sections of public places which must be used by non-smokers.

(4) The size of the designated smoking permitted area shall not be more than proportionate to the preference of patrons of that location for a smoking permitted area, as can be demonstrated by the responsible person.

(b) Single Room.

(1) In the case of a public place consisting of a single room in which a smoking permitted area is designated, the responsible person shall be responsible for reserving and clearly designating a no smoking area on one side of the room.

(2) The size of the no smoking area shall be at least proportionate to the preference of patrons of that location for a no smoking area, as can be demonstrated by the responsible person.

(c) Signs.

(1) All signs which are used to identify a bar that has been designated as a smoking area in its entirety shall use the statement, "This establishment is a smoking area in its entirety," or a similar statement. The sign shall be conspicuously posted either on all outside entrances or in a position clearly visible on entry into the establishment.

(2) All signs which are used to identify a location where the responsible person prohibits smoking in an entire public place or public meeting shall use the statement, "No smoking

is permitted in this entire establishment," or a similar statement. The sign shall be conspicuously posted either on all outside entrances or in a position within the establishment.

(3) All signs which are used to identify a smoking permitted area shall use the words "smoking permitted" and all signs which are used to identify a no smoking area shall use the words "no smoking." Additional words and symbols, including the international smoking symbol, may be used, but the additional printing shall not obscure the basic words "smoking permitted" or "no smoking."

(4) All signs which are used to identify smoking permitted and no smoking areas shall be placed at a height and location easily seen by a person in the establishment and not obscured in any way. Such signs shall be in printed letters of not less than 1.5 inches (3.8 centimeters) in height. The boundary between a no smoking area and smoking permitted area shall be clearly designated so that persons may differentiate between the two areas.

(5) All signs which are used on tables or seats to designate no smoking and smoking permitted areas shall use printed letters of not less than 0.5 inches (1.3 centimeters) in height. When such signs are used, the responsible person shall conspicuously post at least one "no smoking" sign and one "smoking permitted" sign either at the boundary between the two areas or on the walls adjacent to the no smoking and smoking permitted areas.

(6) The size of lettering on signs reading "Smoking Permitted" shall not exceed the size of lettering on signs reading "No Smoking" in the same public place.

(7) To advise patrons of existence of "no smoking" and "smoking permitted" areas, the statement, "In accordance with the Minnesota Clean Indoor Air Act, smoking is prohibited except in designated smoking areas," may be conspicuously posted at the entry to the establishment.

(d) Acceptable Smoke-free Area.

The responsible person shall make arrangements for an acceptable smoke-free area as defined in MHD 442 (a). The size and location of any smoking permitted area shall be determined such that toxic effects of smoking are minimized in the adjacent no smoking area.

(e) Responsibility of Responsible Person.

It shall be considered to be a reasonable effort by the responsible person to prevent smoking in a public place if all persons are asked upon entry into the public place their preference for a smoking permitted or a no smoking area and all persons are then directed to the appropriate area. Furthermore, at least one sign advising the public of this mechanism shall be conspicuously posted at all entrances normally used by the public.

MHD 444. Categories of Affected Places.

*(a) Absent irreconcilable conflict, the responsible person shall be expected to comply with Minn. Reg. MHD 443 and the specific provisions governing that public place in Minn. Reg. MHD 444. If the provisions of the rules governing specific affected places conflict with or are inconsistent with a general provision of Minn. Reg. MHD 443, the specific regulation of Minn. Reg. MHD 444 shall prevail over the general. The public places specified in this Rule shall be expected to comply with applicable provisions according to functional activities taking place in a public area and not according to the nature of a controlling establishment.**

(b) Places of Work.

As an alternative to Minn. Reg. MHD 443 (a) (1) requiring one and only one smoking permitted area per room, a place of work which is not customarily frequented by the general public may contain several, separate no smoking and smoking permitted areas within the same room provided the no smoking areas are at least 200 square feet (70 square meters) in area. Such no smoking areas must comply with the requirements for an acceptable smoke-free area as defined in Minn. Reg. MHD 442 (a). Under this alternative for places of work which are not customarily frequented by the general public, the responsible person shall not be required to comply with sign provisions of Minn. Reg. MHD 443 (c), but

**For example, different Rules may apply to component areas of a medical center according to the actual functional activities of each area, such as a restaurant, office or health care facility.*

the responsible person must conspicuously post at least one sign on each floor which states, "Smoking is prohibited except in designated smoking areas."

(c) Offices.

When a public place contains an office which supports activities which are principally to manufacture or assemble goods, products or merchandise for sale, or to store goods, products or merchandise not for the purpose of retail sale, then the office shall be regulated under rules of the Department of Labor and Industry.

(d) Restaurant.

(1) During hours of operation when a facility which may otherwise be considered a restaurant does not serve food but does serve alcoholic beverages, the facility shall be considered a "bar."

(2) When a public place contains a restaurant which supports activities which are principally to manufacture or assemble goods, products or merchandise for sale, or to store goods, products or merchandise not for the purpose of retail sale, then the restaurant shall be regulated under rules of the Department of Labor and Industry.

(e) Public Conveyance.

(1) No person is permitted to smoke in a public conveyance except in designated smoking areas. Smoking permitted sections may be designated in any public conveyance with a capacity of ten or more persons including the driver.

(2) A public conveyance with a capacity of less than ten persons may be considered to be a smoking area in its entirety if the driver and passengers expressly consent.

(f) Educational Facility.

Smoking permitted areas in educational facilities shall not be located in areas normally used by persons under 18 years of age.

(g) Health Care Facilities.

(1) The requirement for posting of appropriate signs in Minn. Reg. MHD 443 shall be satisfied in patient or resident rooms if there is at least one sign at the entrance to each floor and wing which states: "Smoking is prohibited except in designated smoking areas."

(2) One of the following procedures shall be used in patient or resident rooms:

(aa) The responsible person shall ask all prospective patients or resident or a person authorized to represent the patient or resident whether a smoking permitted or no smoking area is preferred. The responsible person then shall assign rooms according to this preference when space is available. When space is not available in a no smoking room and a person is admitted to a room originally designated for smoking, smoking

shall be prohibited in that room unless expressly permitted by the non-smoker.

(bb) If the responsible person does not assign patient or resident rooms according to the smoking preference of the patient or resident, smoking shall be prohibited in all such rooms except rooms occupied exclusively by persons who smoke or persons who have expressed permission for smoking.

(3) Visitors and staff shall be prohibited from smoking in patient or resident rooms unless the occupants expressly permit.

(h) Hotels, Motels and Resorts.

(1) No person may smoke in hotels, motels and resorts except in designated smoking areas. This prohibition does not apply to sleeping rooms which are rented to a guest.

(2) Smoking permitted areas may not be located in common traffic areas such as registration areas, hallways, elevators or other areas which would be required to be used by non-smokers. However, a portion of the seating area of a lobby or lounge may be designated as smoking permitted.

MHD 445. Application for Waiver of the Law.

(a) To apply for a waiver of the Act, the responsible person for a public place or public meeting shall submit a written application to the State Board of Health stating the grounds for the waiver. The Board has the right to request any other information reasonably necessary to determine the merits of the waiver application. Failure to submit such requested information may result in denial of the waiver application.

(b) An applicant for waiver shall have the burden to provide clear and convincing evidence to demonstrate that both:

(1) Compelling reasons exist to necessitate a waiver. Such compelling reasons may consist of evidence that implementation of the Act and these Rules would endanger the ability of the public place to meet its costs of operation.

(2) Even with waiver of the Act and these Rules the concentration of carbon monoxide in all sections of the public place shall at no time exceed the concentration of carbon monoxide in outside air within 12 feet (3.7 meters) of the building by more than 10 milligrams per cubic meter (9 parts per million).

(c) In making determination of the eligibility of an applicant for a waiver, the State Board of Health shall:

(1) Consider information supplied by the responsible person in the application for waiver.

(2) Consider prevailing smoking restrictions and other practices relating to similar public places in the community.

(3) Consider other relevant information consistent with the public policy expressed in the Minnesota Clean Indoor Air Act of 1975.

(d) After the Board has reviewed the information required in Minn. Reg. MHD 445 (c), the Board shall make the final decision on the waiver application and shall respond in writing to the applicant indicating that the waiver request has been denied or approved and reasons therefor.

STATE OF MINNESOTA

COUNTY OF HENNEPIN

BEFORE THE MINNESOTA

BOARD OF HEALTH

In the Matter of Proposed
Rules Relating to the Implementation
of the Minnesota Clean Indoor Air
Act of 1975

ORDER FOR HEARING

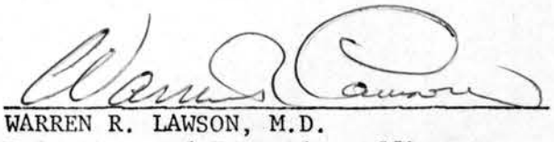
To effectively implement Minn. Laws 1975, ch. 211, the Minnesota Board of Health deems it necessary to consider adoption of of the proposed rules captioned above pursuant to the authority vested in it by the above-referenced statute.

NOW, THEREFORE, IT IS ORDERED this 23rd day of October, 1975, that a public hearing on the proposed rules captioned above be held in the Board Room, Minnesota Health Department Building, 717 Delaware Street S.E., Minneapolis, Minnesota, on December 2, 1975, commencing at 9:30 A.M., and continuing until all representatives of associations or other interested groups or persons have had an opportunity to be heard.

IT IS FURTHER ORDERED, that notice of said hearing be given to all representatives of associations or other interested groups or persons who have registered their names with the Secretary of State for that purpose and all persons who are presently members of the Minnesota Legislature.

STATE OF MINNESOTA

BOARD OF HEALTH



WARREN R. LAWSON, M.D.
Secretary and Executive Officer

STATE OF MINNESOTA

COUNTY OF HENNEPIN

BEFORE THE MINNESOTA

STATE BOARD OF HEALTH

In the Matter of Proposed Rules
Relating to the Implementation of
the Minnesota Clean Indoor Air Act
of 1975

NOTICE OF HEARING

Notice is hereby given that a public hearing will be held pursuant to Minn. Stat. § 15.0412 subd. 4 (1974), as amended by Minn. Laws 1975, ch. 380 § 2, in the above-entitled matter, in the Board Room, Minnesota Department of Health Building, 717 Delaware Street S.E., Minneapolis, Minnesota, on Tuesday, December 2, 1975, commencing at 9:30 A.M., and continuing until all representatives or other interested groups of persons have had an opportunity to be heard concerning adoption of the proposed rules captioned above by submitting either oral or written data, statements, or arguments. Statements or briefs may be submitted without appearing at the hearing.

Under Minn. Stat. § 10A.01 subd. 11 (1974), any individual representing persons or associations attempting to influence administrative action, such as promulgation of the proposed rules, must register with the State Ethics Commission as a lobbyist within five days of the commencement of such activity by the individual. The State Ethics Commission is located at 410 State Office Building, St. Paul, Minnesota 55155.

A copy of the rules proposed by the State Board of Health is attached and made a part hereof.

Copies of the proposed rules and Minn. Reg. Admin. SBC 7705 which is incorporated by reference into the proposed rules are now available and may be obtained by writing to Mr. Kent Peterson of the Minnesota Department of Health, 717 Delaware Street S.E., Minneapolis,

Minnesota 55440. Additional copies will be available at the door on the date of the hearing.

A copy of the procedural rules for the hearing is attached and made a part hereof.

Testimony or other evidence to be submitted for consideration should be pertinent to the matter at hand and may be presented either orally or in writing at the public hearing or by mailing a statement to the Secretary and Executive Officer of the Board at the Department of Health Building, address as above. If the person submitting a statement cannot be present to read his statement at the time of the hearing, the statement will be entered into the record. For those wishing to submit written statements or exhibits, it is requested that at least three (3) copies of such statement, exhibit or summary be furnished at the hearing. The record will remain open for receipt of briefs or other written material relative to the proposed rules for twenty (20) days subsequent to the public hearing.

It is suggested that to save time and avoid duplication, those organizations or associations having a common viewpoint or interest in these proceedings join together where possible and present a single statement in behalf of such interests.

To save time and avoid duplication, testimony regarding the rules will initially be received as each section of the rules is reviewed at the hearing. Following a section by section analysis, general comments will be received.

This hearing conducted by the State Board of Health will be held immediately preceding a hearing conducted by the Department of Labor and Industry on the same date and location as described hereinabove. The Department of Labor and Industry is conducting a hearing for the purpose of considering that Department's proposed rules governing smoking in factories, warehouses and similar places of work.

Dated: October 27th, 1975

STATE OF MINNESOTA

BOARD OF HEALTH

WARREN R. LAWSON, M.D.
Secretary and Executive Officer

MINNESOTA STATE BOARD OF HEALTH

PROCEDURAL RULES FOR HEARING

The purpose of the hearing is to allow interested parties to express their views and present facts bearing upon the proposed regulations. So as to provide for an orderly presentation of evidence, the following rules will be in effect during the hearing specified in the attached Notice of Hearing:

1. Anyone wishing to be heard should indicate by signing the speaking sheet, listing his name, address, and the group which he represents. The speaking sheet will be available at the main entrance to the hearing room. It is requested that each group select one speaker only to present its views.

2. The first time the witness makes a statement he should spell his name and identify the group he is representing. Prior to making any subsequent statements he should state his name and the group which he represents. He may be sworn upon his request but it is not required. If he elects not to be sworn, that may be considered in determining the weight to be given to his testimony.

3. By giving testimony, a witness, including one who may also be a member of the panel, subjects himself to questioning by the panel. However, he is subject to cross-examination by non-members of the panel only if he affirmatively consents to being so examined. A refusal to be cross-examined may be considered in determining the weight to be given to his testimony.

4. All parties interested in introducing any written matter may do so by having it marked as an exhibit and then introduced for the record. Unsworn written matter may be received, but the fact that it is unsworn may be considered in determining the weight to be given it.

CERTIFICATE OF BOARD'S

AUTHORIZING RESOLUTION

I, Warren R. Lawson, M.D., do hereby certify that I am the Secretary and Executive Officer of the Minnesota State Board of Health, a board duly authorized under the laws of the State of Minnesota, and that the following is a true, complete, and correct copy of a resolution adopted at a meeting of the said Board of Health duly and properly called and held on the 9th day of October, 1975, that a quorum was present at said meeting; that a majority of those present voted for the resolution; that said resolution is set forth in the minutes of said meeting and has not been rescinded or modified.

> "RESOLVED, that Warren R. Lawson, M.D., Secretary and Executive Officer of the Minnesota State Board of Health, be and he hereby is granted the authority and directed to call a hearing for the purpose of promulgating rules of the Board of Health relating to the implementation of the Minnesota Clean Indoor Air Act of 1975 as well as perform any and all acts incidental thereto, including but without being limited thereto, signing an order for hearing and notice of hearing as well as acting as or appointing a presiding officer at all hearings."

IN WITNESS WHEREOF, I have hereunto subscribed my name this 5th day of March, 1976.

STATE OF MINNESOTA

BOARD OF HEALTH

Warren R. Lawson

WARREN R. LAWSON, M.D.
Secretary and Executive Officer

STATE OF MINNESOTA

COUNTY OF RAMSEY

In the Matter of the Proposed
Rules Relating to the Implementation
of the Minnesota Clean Indoor Air
Act of 1975.

CERTIFICATE

I hereby certify that the 441 general labels, ~~and~~ 1 Smoking list and 2 lists for the Minnesota Department of Health all of which are attached and made a part hereof, constitute the complete lists of persons, associations, and other interested groups who as of 1:30 o'clock P.M., this 27th day of October, 1975, have requested pursuant to Minn. Stat. § 15.0412 subd. 4 (1971), that their names be placed on file with the Secretary of State for the purpose of receiving notice of public hearing on proposed rules on the subject captioned above.

Joan Anderson Growe
SECRETARY OF STATE

JOAN ANDERSON GROWE

By Neil Dion

STATE OF MINNESOTA

COUNTY OF HENNEPIN

In the Matter of the Proposed
Rules Relating to the Implementation
of the Minnesota Clean Indoor Air
Act of 1975.

AFFIDAVIT OF MAILING

Lora L. Erickson, being first duly sworn, deposes and says:

That on the 31 day of October, 1975, at the City of Minneapolis, County of Hennepin, State of Minnesota, she served the attached Notice of Hearing by depositing in the United States mail at said City of Minneapolis, a true and correct copy thereof, properly enveloped, with postage prepaid, to all persons and associations at the addresses listed on the Certificate of the Secretary of State attached and made a part hereof as Exhibit A, to all persons and associations at the addresses listed on Exhibit B, attached and made a part hereof, as well as to all members of the Minnesota Legislature as of the date of mailing.

Lora L. Erickson

Subscribed and sworn to before
me this 31st day of October, 1975.

Marie B. Tromiczak

MARIE B. TROMICZAK
NOTARY PUBLIC - MINNESOTA
HENNEPIN COUNTY
My Commission Expires Oct. 9, 1980

EXHIBIT A

WALTCKA ROBERT
3228 SO 17TH AVE
MPLS MN
55407

WALTERS TPLS H
4910 W 77TH ST STE 235
MPLS MN
55435

WANGDIST ALLEN
RM 252 FEDERAL BLDG
ST PAUL MN
55101

WECK C V NORTHERN STATES
414 NICOLLET MALL
MPLS MN
55401

WELLINGTON R R SKELLY OIL
PO BOX 1650
TULSA OK
75102

WESTIN CHAS N
220 MEDICAL ARTS BLDG
DULUTH MN
55802

WHITING RALPH
555 WABASHA SUITE 204
ST PAUL MN
55102

WHITLOCK A G
ECON LAB OSBORN BLDG
ST PAUL MN
55102

WILCOX J PATRICK
1220 NORTHERN FED BLDG
ST PAUL MN
55102

WM.MITCHEL COLLEGE LAW LIB.
2100 SUMMIT AVE.
ST.PAUL MN
55105

WILEY ENTERPRISES
101 5TH AVE SE
OSSEO MN
55369

WILSON R GARY PPG INDUST
1 GATEWAY CENTER
PITTSBURGH PA
15222

WIS FEEDER PIG MARKET CO-OP

FRANCIS CREEK WI

WOLKERSTORFER THEODORE
676 17TH AVE NW
NEW BRIGHTON MN
55112

WOZNIAK D D
401 FIRST FED BLDG
ST PAUL MN
55101

WYANT CLINTON W ATTY

ATKIN MN
56431

ALBERT,AA CALDER CORP
366 JACKSON ST
ST PAUL MN
55101

ALLENDORF MARSHALL
220 GRAIN EX 400 S 4TH
MPLS MN
55415

ALTMAN MILTON H
707 DEGREE OF HONOR BLD
ST PAUL MN
55101

AM CAMPING ASSN MRS LEACOCK
1235 BRIGHTON SQ
NEW BRIGHTON MN
55112

AM INST PROF GEOLOGISTS
2201 PRINCETON AVE
ST PAUL MN
55105

ANCHOR BLOCK COMPANY
PO BOX 3360
ST PAUL MN
55165

ANDERSON GRAHAM
951 E HENN
MPLS MN
55414

ANDERSON HERBERT
418 8TH ST. SO.
VIRGINIA MN
55792

ANDERSON HAROLD
BOX 3047
MANKATO MN
56001

ANDERSON JAMES
7703 NORMANDALE RD
MPLS MN
55435

ANDERSON STANFORD P
14600 MINNETONKA BLVD
MINNETONKA MN
55343

ANTHONY DICK WDSM RADIO
230 E SUPR ST
DULUTH MN
55102

APPELO ROBERT MESPA
41 SHERBURNE
ST PAUL MN
55103

ARROWHEAD REGIONAL DEV COMM
900 ALWORTH BLDG
DULUTH MN
55802

ARVER JOHN A
2467 COHANCY
ST PAUL MN
55113

ASMUSSEN,DENNIS,MPIRG
3036 UNIV AVE SE
MPLS MN
55414

ASSOCIATED GEN CONTRCR MN
48 E 8TH STREET
ST PAUL MN
55101

ASSOCIATED INDUST OF MPLS
NATIONAL BLDG
MPLS MN
55402

ASSN OF MINN COUNTIES
55 SHERBURNE AVE #203
ST PAUL MN
55103

ASSN RESIDENCES FOR RETARDED
459 RICE SUITE 301
ST PAUL MN
55103

AUTOMOBILE MFRS ASSN INC
55 SHERBURNE AVE
ST PAUL MN
55103

BABCOCK LOCHER NELSON ET
118 E MAIN ST
ANOKA MN
55303

BADALICH JOHN P
2025 THOMPSON AVE
SO ST PAUL MN
55075

BARRETT FRED
ST LOUIS CO COURT HOUSE
DULUTH MN

BARTHOLOW HAROLD E FIRE CHF
2600 109 AVE N W
COON RAPIDS MN
55433

BECK PAT
953 HYACINTH AVE
ST PAUL MN
55106

BECKLIN ROBERT C
447 N W 4TH
CAMBRIDGE MN
55008

BEECHER EVERETT
10 10 1ST ST SC
HOPKINS MN

BEMIDJI STATE COLLEGE
PLACEMENT BUR.J.C.BRADY
BEMIDJI MN
56601

BENSONI PETER USW OF AM
609 PROVIDENCE BLDG.
DULUTH MN

BERGERUD ALF
300 ROANOKE BLDG
MPLS MN
55402

BERGSETH THOMAS
1011 NICOLLET MALL
MPLS MN
55403

BEST FLANAGAN ET AL
4040 IDS CENTER
MPLS MN
55402

BEUTEL ROBERT
2200 SILVER LAKE RD
NEW BRIGHTON MN
55112

BLOMQUIST BARRY L

NORTH BRANCH MN
55056

BLOOMINGTON CITY CLERK
2215 W OLD SHAKOPEE RD
BLOOMINGTON MN
55431

BREHL JAMES W
332 HAMM BLDG
ST PAUL MN
55102

BRIGGS & MORGAN - B F FRI
2200 W 1ST NATL BK BLDG
ST PAUL MN
55101

BRIGHAM E M III
RR4
RED WING MN
55066

BROKER JOHN
2850METRO DR. SUITE 504
BLOOMINGTON MN
55420

BROOKS WILLIAM F JR
854 MIDLAND BK BLDG
MPLS MN
55401

BROWN D M GOODRIDGE PUB S
IND DIST #561
GOODRIDGE MN
56725

BROWN H C
4961 KINGSBERRY LANE
MINNETONKA MN
55343

BRUEACHER RICHARD COMM ACM
208 ADM BLDG
ST PAUL MN
55101

BRUNING C.R.DEPT.CLINIC.EXP.
BURTON HALL
MPLS. MN
55455

BUCHHOLTZ CHARLES
5044 BRENT AVE E
INV GRV HTS MN
55075

BURGER ALBERT
600 DEGREE OF HONOR BLD
ST PAUL MN
55101

BUR.ENGR.IND.DIV. MR.KIBIGER
219 N. 2ND ST.
MPLS. MN

BUR NATL AFFAIRS INC
1231 25TH ST NW
WASHINGTON DC
20037

BUSCH NOEL
3131 FERNBROOK LANE N
MPLS MN
55441

CAIN RUTH
730 E 38TH ST
MPLS MN
55407

CAIRNS JOHN A
47TH FLR IDS CENTER
MPLS MN
55402

CARLSON CARL L
7516 80TH ST S
COTTAGE GROVE MN
55016

CARLSON VERNE E
BOX 755 CITY HALL
WILLMAR MN
56201

CARRISON DALE K
MANKATO STATE COLLEGE
MANKATO MN
56001

CENTRAL BUSINESS DATA
BENSON RADIO ARCADE BLD
BENSON MN
56215

CENTRAL MN REGIONAL DEV C
1139 FRANKLIN AVE
SAUK RAPIDS MN
56379

CHAMBER OF COMMERCE
30 SO 1ST AVE EAST
ELY MN
55731

CHAMBERLAIN JOHN L
PO BOX 241
MPLS MN
55440

CHERCHES CHRIS CITY MGR
5005 MTKA BLVD
ST LOUIS PARK MN
55416

CHRISTIAN SCI COMM ON PUB
1821 UNIV AVE SUITE 271
ST PAUL MN
55104

RM 505 CAPITOL SQ BLDG
ST PAUL MN
55155

2104 STEVENS AVE S
MPLS MN
55404

366 CITY HALL
ST PAUL MN
55102

530 SYNDICATE BLDG
MPLS MN
55402

CLARKSON J.B.
2350 I.D.S. CENTER
MINNEAPOLIS MN
55402

CLAUSEN PHILLIP
2307 STANDISH ST
ST PAUL MN
55108

COLEMAN NICHOLAS D
700 LINWOOD AVE
ST PAUL MN
55105

COLLIN LAURENCE
RT 2
ISANTI MN
55040

COMMUNITY DESIGN CENTER
118 E 26TH ST
MPLS MN
55404

CONCORDIA COLLEGE
DEAN
MOORHEAD MN
56560

CONSUMER SERVICES DEPT COMM
5TH FLR METRO SQ BLDG
ST PAUL MN
55101

COUNTY ATTYS COUNCIL
95 SHERBURNE AVE S203
ST PAUL MN
55103

COX AND KING
600 BUILDERS EXCH
MPLS MN
55402

CRAVEN NORMAN
10637 THOMAS AVE S
BLOOMINGTON MN
55431

CROW WING CO PLANNING & ADV
COURT HOUSE
BRAINERD MN
56401

CUSHMAN J S DAYTON HUDSON
700 NICOLLET MALL
MPLS MN
55402

DAILEY THOMAS ECONOMICS LAB
370 WABASHA ST
ST PAUL MN
55102

DANKERS,KENNETH
1200 WEST FOURTH STREET
RED WING MN
55066

DANIELSON RODNEY L
418 AUDITORIUM
ST PAUL MN
55102

DAYTON CHAS SIERRA CLUB
800 MIDLAND BANK BLDG
MPLS MN
55401

DEVELOP DISABILITIES PROGRAM
STATE PLAN 101 CAP SQ
ST PAUL MN
55155

DICKINSON MRS JOANNE
BOX 1065
MARSHALL MN
56258

DIEHL JOHN
26 KENWOOD PKWY
ST PAUL MN
55105

DISPATCH PIONEER PRESS
PRESS RM STATE CAPITOL
ST PAUL MN
55101

DORSEY MARQUART
2400 1ST NATL BANK BLDG
MPLS MN
55402

DOUGLASS BELL
525 OSBORN BLDG
ST PAUL MN
55102

DOW CHEMICAL
47 BLDG
MIDLAND MI
48640

DOYTON MAURICE, MET SEWER BD
350 METRO SQ BLDG
ST PAUL MN
55101

DUDLEY E F
RT 7 BOX 122
EXCELSIOR MN
55331

DUNN OLIVER PLUMBERS LOC 15
706 SO 10TH ST
MPLS MN
55404

DZUGAN KEN ST PAUL PLANNI
421 WABASHA ST
ST PAUL MN
55102

EBELING EDWARD H.
161 W. MAIN
PERHAM MN
56573

ELDER DR JAMES B
11140 WASHBURN AVE SO
BLOOMINGTON MN
55431

ELDRED R W ARMOUR & CO
UNION STOCK YARDS
SO ST PAUL MN
55075

ELMER EDWIN W
2901 PLEASANT AVE
MPLS MN
55408

EMERICK RICHARD A
1506 IDS CENTER
MPLS MN
55402

ENNIS A F BOISE CASCADE
PO BOX 713
INTL FALLS MN
56649

ENV SERV-GEN RESOURCE COR
6340 INDUSTRIAL DR
HOPKINS MN
55343

ERDMAN ROGER TENNANT CO
701 N LILAC DR
MPLS MN
55441

ERNEST K LEHMAN & ASSOC.
1405 WILLOW ST.
MPLS MN
55403

ESSE KENNETH
4801 W 50TH ST
EDINA MN
55424

ETHICS COMM
RM 410 STATE OFF BLDG
ST PAUL MN
55155

EVANS CHAS.L. PRENTICE-HALL
ENGELWOOD CLIFFS
NEW JERSEY

EVERETT JERRY NW PETRO ASSN
512 NICOLLET MALL RM917
MPLS MN
55402

EWALD DOUGLAS MINN HOSP ASSN
2333 UNIV AVE SE
MPLS MN
55414

EWING MRS WM
42 ASTAR RD
BABBITT MN
55706

FAEGRE & BENSON ATTN LIBR
1300 NW BANK BLDG
MPLS MN
55402

FARMERS ELEVATOR ASSN
852 GRAIN EXCH BLDG
MPLS MN
55415

FARRELL FRANK BUR NOR
RM 1180 176 E 5TH ST
ST PAUL MN
55101

FELHABER R S
W 1ST NATL BANK BLDG
ST PAUL MN
55101

FINLEY JAMES F
920 MINN BLDG
ST PAUL MN
55101

FINNEGAN J.R.
55 E. 4TH
ST.PAUL MN
55101

FLADLAND CLINTON MN L&P B
796 RAYMOND AVE
ST PAUL MN
55114

FLEMING FREDERICK A
1860 HIGHLAND PARKWAY
ST PAUL MN
55116

FITZGERALD DR BOB
3007 LYNDALE AVE SO
MPLS MN
55408

FORBES GORDON MINN RRS ASSN
203 HANOVER 460 CEDAR
ST PAUL MN
55101

FORSBERG AGR SERV
518 SUMMIT AVE
NEW ULM MN
56073

FOX W.E. LINDQUIST & VENNUM
4200 IDSCTR 80 S.8TH ST
MINNEAPOLIS MN
55402

FRANKLIN ROBERT B MPLS TRIB
426 PORTLAND
MPLS MN
55415

FRECIN CONRAD M
811 FIRST NATL BK BLDG
DULUTH MN
55802

FREDRIKSON BYRON ET AL
47TH FLR IDS CENTER M
PLS MN
55402

FURLONG DR JOHN
RT 1
ROVEY MN
55709

F W WOOLWORTH CO
3316 W 66TH ST
EDINA MN
55424

GALVIN M J JR
#2162 1ST NATL BK BLDG
ST PAUL MN
55101

GARDNER HOW - R A JOHNSON
515 WASHINGTON AVE N
MPLS MN
55401

GEBERT K L
220 GRAIN EXCH
MPLS MN
55415

GEO A HORMEL & CO LAW DEPT
PO BOX 800
AUSTIN MN
55912

GEORGE K GRANSE CO
1477 SELBY AVE
ST PAUL MN
55104

GIEL DAVID
RM B-28 STATE CAPITOL
ST PAUL MN
55155

GLEESON MICHAEL
SCS SOC SC BLDG U OF M
MPLS MN
55455

GLEN. HILLS HOSP.R.VAN HAUER
3901 GOLDEN VALLEY RD.
MPLS. MN
55422

GODIN RALPH J
3824 47TH AVE SO
MPLS MN
55406

GRAHAM THOS H
854 MIDLAND BK BLDG
MPLS MN
55401

GRANATH MARVIN -HONEYWELL
2701 4TH AVE SO
MPLS MN
55408

GREATER MET AREA HOSPITALITY
5152 CEDAR AVE S
MPLS MN
55417

GREEN DEL CITY MGR
BLOOMINGTON CITY HALL
BLOOMINGTON MN
55431

GREEN GARY J
41 SHERBURNE AVE
ST PAUL MN
55102

GREEN JANET
5773 N SHORE DR
DLUTH MN
55804

GUSTAFSON DAN-LABOR TEMPLE
312 CENTRAL
MPLS MN
55414

GUSTAFSON WALLACE
BOX 567
WILLMAR MN
56201

H B FULLER CO
2400 KASOTA AVE
ST PAUL MN
55108

HANFT PHILIP M
1200 ALWORTH BLDG
DULUTH MN
55802

HANSON ETHEL
2813 85TH AVE N
MPLS MN
55444

HAROLD J WESTIN CONSTRUCTORS
45 E 8TH ST
ST PAUL MN
55101

HARVEY MICHAEL
1350 W M PARA PKWY
MPLS MN
55405

HALLBERG LEE & MCCABE
4927 34TH AVE S
MPLS MN
55417

HAUN DR J W GEN MILLS
PO BOX 1113
MPLS MN
55440

HAYES,THOMAS W
700 SELLWOOD BLG
DULUTH MN
55812

HEALTH MANPOWER C LARSON
717 DELAWARE ST SE
MPLS MN
55440

HENTHORN GARY WOODSTOCK
7365 LANDAU DR
BLOOMINGTON MN
55438

HART PATRICK V
112 E LIBERTY BOX 3271
MANKATO MN
56001

HARTFIELD WILL
434 FARM BLDG
ST PAUL MN
55102

HEISENFELT WM
BOX 516
BEMIDJI MN
56601

HOLCAHL SCOTT
380 N BLDG GRAIN EXCH
MPLS MN
55415

HORNER WALDORF - KAZIUKEWICZ
PO BOX 3260
ST PAUL MN
55165

HOUSE RESEARCH
RM 17 STATE CAPITOL
ST PAUL MN
55155

HUNT JAMES P JR
11470 GALTIER DR
BURNSVILLE MN
55378

ILLINGWORTH ROBT C
6750 FRANCE AVE S
MPLS MN
55435

INTERSTATE POWER RW STEELE
1000 MAIN ST
DUBUQUE IA
52001

HEAE & TREFA
1007 SOO LINE BLDG
MPLS MN
55402

HICHINGER-PARK PLANNING
421 WABASHA ST
ST PAUL MN
55102

HCLEY GEO AERONAUTICS
DOWNTOWN AIRPORT
ST PAUL MN
55107

HCLLE MELVIN
661 W HWY 96
SHOREVIEW MN
55112

HULSTRAND ANDERSON & LARSON
PO BOX 130
WILLMAR MN
56201

HUTCHISON R.M. ANOKA CO.COMP
COURT HOUSE
ANOKA MN
55303

INGEBRIGTSEN DR K H
23 SE 4TH ST
MPLS MN
55414

IUOE LOC 49 CHAS SWENSON
2500 UNIV AVE
ST PAUL MN
55101

JACKMAN DONALD G
4023 E LAKE ST
MPLS MN
55406

JOHNSON & SANDERSON
ST MARYS HOSPITAL
ROCHESTER MN
55901

JOHNSON LANCE J
265 S LAFAYETTE RD
ST PAUL MN
55107

KEABLE MIKE
505 6TH AVE N
ST CLOUD MN
56301

HEIM PAUL
1320 SOO LINE BLDG
MPLS MN
55402

HILL JIM ASSOC.MILK PROD.
7850 METRO PARKWAY
MINNEAPOLIS MN
55420

HOLMES EUSTIS ET AL
4610 IDS CENTER
MPLS MN
55402

HOUSE APPROPRIATIONS COMM
RM 109 STATE CAPITOL
ST PAUL MN
55101

HULTMAN WARREN R
C/O BARBAROSSA R3
OSSEO MN
55369

HYLAND DEAN
1501 W 50TH ST
MPLS MN
55419

INGVALSON VERN MN.FARM BUR.
3110 WOODDALE DR PO 337
OST PAUL MN
55165

IVERSON DR JOS DEPT ED
ST CLAF COLLEGE
NORTHFIELD MN
55057

JAIN NIRMAL . ENIV PROCESS
1220 GLENWOOD AVE
MPLS MN
55405

JOHNSON CLARENCE IBEW LU 292
3615 37TH AVE S
MPLS MN
55406

KEENAN RICHARD J
4444 IDS BLDG
MPLS MN
55402

HEINTZ MARY ELLEN
PO BOX 599
CINCINNATI OH
45201

HINRICHSEN PATRICK
MANKATO FREE PRESS
MANKATO MN
56001

HOPKINS WM.B. DIR.MISCCA
3915 GOLDEN VALLEY ROAD
GOLDEN VALLEY MN
55422

HOUSE ED STANDING SUB COM
RM 109 STATE CAPITOL
ST PAUL MN
55101

HUMAN RIGHTS
200 CAPITOL SQ BLDG
ST PAUL MN
55101

INS FED OF MINN
902 SOO LINE BLDG
MPLS MN
55402

IZAAK WALTON LEAGUE MN DI
106 TIMES BLDG 57 S 4TH
MPLS MN
55401

JENOS INC
525 LAKE AVE SO
DULUTH MN
55801

JOHNSON LEROY
9939 BLUEBIRD ST NW
COON RAPIDS MN
55433

KABLE RICHARD W

BETHEL MN
55006

KEILY DANILE
3549 V2 PLEASANT AVE
MPLS MN
55408

KIMBALL ROBERT
647 CAPITOL SQ BLDG
ST PAUL MN
55101

KLESTER MARION PEAVEY CO
730 2ND AVE S
MPLS MN
55402

KLOZ STEVEN J
1910 1ST NATL BK BLDG
MPLS MN
55402

KNOPP TIMOTHY
COLLEGE FORESTRY U OF M
ST PAUL MN
55108

KNUTSEN DR KEITH,BIOLOGY DPT
ST CLOUD STATE
ST CLOUD MN
56301

KNUTSEN R N GRANNIS ETAL
F J SCHULT BLDG
ST ST PAUL MN
55075

KNUDSEN POBT
4375 BROWNDALE AVE
MPLS MN
55424

KOLLER MR & MRS ERWIN A
1568 DULUTH ST
ST PAUL MN
55106

KOPP MRS VERNON
2050 65TH ST E
INVER GR HGHT MN
55075

KRAMER ERNEST H
717 DELAWARE ST SE
MPLS MN
55440

KRONLOKKEN J E
10048 NORD RD
BLOOMINGTON MN
55437

LAKE SUPERIOR INDUSTRIAL BUR
828 FIRST AM. BK. BLDG.
DULUTH MN
55802

LANAHAN E F - SIBLEY CO
184 E 6TH ST
ST PAUL MN
55101

LANGVIN DAVID
7500 80TH ST S
COTTAGE GROVE MN
55016

LANSING & OAKES
400 SIBLEY ST
ST PAUL MN
55101

LAPP LAZAR LAURIE ET AL
1200 BUILDERS EXCHANGE
MINNEAPOLIS MN
55402

LARSEN C L
2600 MINNEHAHA AVE SO
MPLS MN
55406

LARSON HANS P DIV HOSP SERV
717 DELAWARE ST SE
MPLS MN
55440

LEAGUE MN MUNIC
300 HANOVER 480 CEDAR
ST PAUL MN
55101

LEAGUE WOMEN VOTERS OF MINN
555 WABASHA
ST PAUL MN
55102

LIEBEY LEONARD
BOX 17011 NORMIS STA
MPLS MN
55417

LINDALL & JONATHAN DEVELOP.
VILLAGE ONE CENTER
CHASKA MN
55318

LOCKNER GARY
R R 1 BOX 23
BAUDETTE MN
56623

LOOS CALVIN J
6809 LYNDALE AVE SO
MPLS MN
55423

LOWE DOUG
2701 N LEXINGTON AVE
ROSEVILLE MN
55113

LYNCH DONALD SIBLEY CO
184 E 6TH ST
ST PAUL MN
55102

MCDONALD PHILIP M
2077 SELBY AVE
ST PAUL MN
55104

MCFADDEN G H DISPATCH-PRESS
55 E 4TH ST
ST PAUL MN
55101

MCKIBBON MRS SHIRLEY
11 EVERGREEN LN
BALBITT MN
55706

MCLELLAN LARKIN
215 ADM BLDG ST CAPITOL
ST PAUL MN
55101

MALONE E I COMM LABOR & INDU
444 LAFAYETTE RD 5TH FL
ST PAUL MN
55101

MANKATO STAT STUDENT SENATE
CENTENNIAL STUDENT UN
MANKATO MN
56001

MANKATO STATE STUDENT AS
BOX 58 MANKATO COLLEGE
MANKATO MN
56001

MANTHEY T J PICKANDS MATHER
1100 SUPERIOR AVE
CLEVELAND OH
44114

MASTOR & MATTSON LTD
315 PEAVEY BLDG
MPLS MN
55402

MAUL WARREN E
320 S 4TH ST
MPLS MN
55415

MAYO FOUNDATION G ORWOLL
200 FIRST AVE NW
ROCHESTER MN
55901

MECCA
867 GRAND AVE
ST PAUL MN
55105

MEIEROTTO, JOAN
1754 SO LEXINGTON
ST PAUL MN
55118

MERRITT GRANT POLLUTION CONT
1935 W CO RD 32
ROSEVILLE MN
55113

MET TFR MEN ASSN A ROSENT
1821 UNIV AVE
ST PAUL MN
55104

METROPOLITAN COUNCIL LIBRARY
300 METRO SQUARE
ST PAUL MN
55155

MIDLAND GLASS- HD SPURLING
PO BOX 69
SHAKOPEE MN
55379

MILLER RICHARD A
1020 PLYMOUTH BLDG
MPLS MN
55402

MILLER TOM
2311 PILLSBURY AVE S
MPLS MN
55404

MPLS CHAMBER COMM TRANSP DPT
15 S 5TH ST
MPLS MN
55402

MPLS CITY ATTORNEY
225M CITY HALL
MPLS MN
55415

MPLS STAR PRESS ROOM
STATE CAPITOL
ST PAUL MN
55101

MPLS TRIBUNE CITY DESK
425 PORTLAND AVE
MPLS MN
55415

MIDLAND GLASS-HD SPURLING
PO BOX 69
SHAKOPEE MN
55379

MILLER PAUL J PHARMACY SERV
ST MARYS HOSP
ROCHESTER MN
55901

MINN APT ASSN
GRIGGS-MIDWAY BLDG
ST PAUL MN
55104

MN. ASN.COIND H.O.PETERSO
480 CEDAR ST.
ST.PAUL MN
55101

MINN AFL-CIO, L O LA SHOMB
414 AUDITORIUM ST
ST PAUL MN
55102

MINN ASPHALT PAVEMENT ASSN
555 WABASHA RM 209
ST PAUL MN
55102

MINN ASSN COOPERATIVES
55 SHERBURNE AVE
ST PAUL MN
55103

MINN ASSN ELEC COOPERATIV
4901 W 77TH ST
MPLS MN
55435

MINN. ASSN. PET RETAILERS
1115 2ND AVE. SO.
MINNEAPOLIS MN
55403

MINN ASSN WATERSHED DIST'S

ADA MN
56510

MINN AUTOMOBILE DEALERS ASSN
GRIGGS MIDWAY BLDG
ST PAUL MN
55104

MINN COMM FOR HANDICAPPED
METRO SQ 492 7TH & ROBT
ST PAUL MN
55101

MINN COMMUNITY DEVELOP SERV
512 ROSSMOR BLDG
ST PAUL MN
55101

MINN COUNCIL STATE EMP NO 6
475 RICE ST
ST PAUL MN
55103

MINN DEPT HEALTH J C MCKASY
717 DELAWARE S E
MPLS MN
55440

MINN DENTAL HYGIENISTS
5041 YVONNE TERRACE
MPLS MN
55436

MINN ELECTRICAL ASSN INC
525 SO 7TH
MPLS MN
55415

MINN ENV LAW INST INC
PO BOX 15C76 COMM STA
MPLS MN
55415

MINN FARMERS UNION PRES OFF
1275 UNIV AVE
ST PAUL MN
55104

MINN FOOD RETAILERS ASSN
555 WABASHA
ST PAUL MN
55101

MINN HEREFORD-LJ SCHAFER

BUFFALO LAKE MN
55314

MINN. HOTEL & MTR. ASSN
2001 UNIVERSITY AVE
ST PAUL MN

MINN HOUSING INST N T CARTER
7801 METRO PKWY
MPLS MN
55420

MINN HWYS MANAGEMENT SERV
407 HWY BLDG
ST PAUL MN
55101

MINN LAND USE COMMITTEE
4344 IDS CENTER
MPLS MN
55402

MINN LP GAS ASSN
7515 WAYZATA BLVD 106
MPLS MN
55426

MINNE MINE CREDIT UNION
3000 HUDSON PK S 100
ST PAUL MN
55119

MINN.MTR.TRANSP. .J.N.O
1821 UNIV.
ST.PAUL MN
55104

MINN PETROLEUM COUNCIL
1020 NORTHERN FED BLDG
ST PAUL MN
55102

MINN POULTRY & HATCHERY ASSN
BOX 156
MADELIA MN
56062

MN REP STATE CENTRAL COMM
555 WABASHA AVE
ST PAUL MN
55102

MINN RESTAURANT ASSN
2001 UNIVERSITY AVE.
ST PAUL MN 55
104

MINN RETAIL FEDERATION
7600 PARKLAWN STE 457
MPLS MN
55435

MINN RETAIL HARDWARE ASSN
3033 EXCELSIOR BLVD 313
MPLS MN
55416

MINN SOCIETY ARCHITECTS AIA
NW NATL BK BLDG
ST PAUL MN
55101

MINN SOC CERTIFIED PUB AC
1102 WESLEY TEMPLE BLDG
MPLS MN
55403

MINN STATE BAR ASSN
100 MINN FED BLDG
MPLS MN
55402

MINN STATE BD PHARMACY
717 DELAWARE ST SE #351
MPLS MN
55414

MINN STATE CAPITOL EMP UNION
PO BOX 3215
ST PAUL MN
55165

MINN STATE MED ASSN
375 JACKSON ST
ST PAUL MN
55101

MINN STATE RETIREMENT SYSTEM
529 JACKSON ST
ST PAUL MN
55101

MINN TEAMSTERS CREDIT UNION
2021 HENN AVE E
MPLS MN
55413

MINN TBR PRODUCERS ASSN
200 CHRISTIE BLDG
DULUTH MN
55802

MINN.TURKEY GROWERS ASSN
2383 UNIV AVE
ST PAUL MN
55114

MINN VETERANS MED ASSN
2175 W HWY 36
ROSEVILLE MN
55113

MINN WATER RESOURCES BD
RM 206 555 WABASHA ST
ST PAUL MN
55102

MINN-RISC BOUNDARY AREA COMM
600 2ND ST
HUDSON WI
54016

MN PUB INT RESEARCH GROUP
3036 UNIV AVE SE
MPLS MN
55414

MOFFITT R C
RM 301 M MPLS CITYHALL
MPLS MN
55415

MOOD R BLOOMINGTON HLTH DEPT
1020 PENN SO
BLOOMINGTON MN
55431

MOONEY, MICHAEL A.
BOX 903, ST.JOHN'S UNIV
COLLEGEVILLE MN
56321

MORTON BUILDINGS INC
R #1
FOLEY MN
56329

MPIRG
BOX 45 ST MARYS COLLEGE
WINONA MN
55987

MUCK TROS R
160 STATE OFF BLDG
ST PAUL MN
55155

MUELLER SHIRLEY A
787 W COTTAGE AVE
ST PAUL MN
55117

NASS GEO V HENN CO GEN HOSP
5TH AND PORTLAND AVE
MPLS MN
55415

NATL CAR RENTAL ATT D MITZEL
5501 GREEN VALLEY DR
MPLS MN
55437

NATL COUNCIL JEWISH WOMEN
4330 CEDAR LK RD
MPLS MN
55416

NATL FAMILY INS CO
2147 UNIV AVE
ST PAUL MN
55114

NAT'L SOLID WASTES-R. GRASSO
1730 RHODE ISLAND AV.NW
WASHINGTON DC
20036

NCEC INC C/O DR DAHLBERG
CONCORDIA COLLEGE
MOORHEAD MN
56560

NEDELL HAROLD - MEINEKE
6300 W LOOP S SUITE 200
BELLAIRE TX
77401

NEREN MADONNA
376 NEAL AVE S
AFTON MN
55001

NESBITT JOHN
7851 METRO PKWY S 118
MPLS MN
55420

NEUMAN RALPH W
RT 2 BOX 125
EMBARRASS MN
55732

NIELSEN STOCK & BLACKBURN
415 730 BLDG
MPLS MN

NO SUB MONTESSORI-S SADDL
2487 HELEN COURT
NO ST PAUL MN
55109

NORTH CENTRAL ELEC ASSN
PO BOX 202
BATTLE LAKE MN
56515

NW COUNTRY ELEVATOR ASSN
802 GRAIN EXCH BLDG
MPLS MN
55415

NURSING HOME ADMRS BD EXAMRS
RM 340 717 DELAWARE SE
MPLS MN
55414

NUTTER JULIA
743 W MONTANA
ST PAUL MN
55117

NW BELL TEL CO LEGAL DEPT
224 S 5TH ST RM 2000
MPLS MN
55402

NYQUIST DEAN A
3707 53RD PL N
BROOKLYN CTR MN
55429

O'BRIEN J.DENNIS
1100 1ST NATL.BANK BLDG
MINNEAPOLIS MN
55402

OFFICE OF THE GOVERNOR
130 STATE CAPITOL
ST PAUL MN
55101

OLD COLONY GAS & OIL COMPANY
17TH AVE N AT 2ND ST
MPLS MN
55411

OLSEN ARTHUR MBO & MAINC
527 SOO LINE BLDG
MPLS MN
55402

OSTRUM DONALD E
PO BOX 33163
COON RAPIDS MN
55433

OTTER TAIL POWER CO.
215 S. CASCADE ST.
FERGUS FALLS MN
56537

PATTISON CRVIS
BOX 645
WILLMAR MN
56201

PAYNE COL ALVIN

DEGRAFF MN
56233

PAYNE WM B
2400 FIRST NATL BK BLDG
MPLS MN
55402

PETERSON JOHN W
510 NW BK BLDG
ST PAUL MN
55101

PETERSON GARY
854 MIDLAND BK BLDG
MPLS MN
55401

PFEIFER AND SHULTZ, INC
1433 UTICA AVE S
MPLS MN
55416

PHAR MFGRS ASSN WM D PATT
1155 15TH ST NW
WASHINGTON DC DC
20005

PHILLIPS LEGISLATIVE SERVICE
459 RICE ST
ST PAUL MN
55103

PINNETTI NICK M HALEY & ASS.
40 CENTRAL PARK S
NEW YORK NY
10019

POPOVICH PETER S
314 MINN BLDG
ST PAUL MN
55101

PORTER LYLE D

TRACY MN
56175

PORT AUTH CITY OF ST PAUL
330 MINNESOTA BLDG
ST PAUL MN
55101

PORTER DAVID
2212 LONGFELLOW AVE S
MPLS MN
55407

POSS DONALD G
6301 SHINGLE CREEK PKWY
BROOKLYN CTR MN
55430

POYZER ROBT
BOX 675
FERGUS FALLS MN
56537

PRAUSE JOS.C.
2220 105TH AVE.N.W.
COON RAPIDS MN
55433

PROCTOR&GAMBLE L THECHARCUS
INCRYCALE TECH CENTER
CINCINNATI OH
45217

PULSCHER RBT SPRINGSTED INC
813 OSBORN BLDG
ST PAUL MN
55102

RADMAN RICHARD-LABOR TEMPLE
416 AUDITORIUM
ST PAUL MN
55102

RANALLO CLARENCE
800 CENTRAL AVE N E
MPLS MN
55413

RAMSEY CO MEDICAL SOCIETY
1500 LOWRY MEDICAL BLDG
ST PAUL MN
55102

RAUENHORST CORP-C ANDERSON
7900 XERXES S. S-2200
MPLS MN
55431

REAGAN MICHAEL
% MINN LEARNING CTR
BRAINERD MN
56401

RED OWL STORES INC
215 E EXCELSIOR AVE
HOPKINS MN
55343

REID DAVID H
5633 WASHBURN AVE S
MPLS MN
55410

REINO O LAINE 3M COMPANY
3M CENTER
ST PAUL MN
55101

RENNER R.H. ST PAUL AREA CC
300 OSBORN BLDG.
ST PAUL MN
55102

RENQUIST ARTHUR NSP CO
414 NICOLLET MALL
MPLS MN
55401

RICHARDSON THOS
7851 METRO PKWY S 103
MPLS MN
55420

RICHARDS MONTGOMERY ET AL
1430 RAND TOWER
MPLS MN
55402

RICE DAVID
175 ALPORA
ST PAUL MN
55103

ROBBIE JOSEPH
904 CARGILL BLDG NO CTR
MPLS MN
55402

ROBERTS DAVID E
1260 NW NATL BK BLDG
ST PAUL MN
55101

ROSS ALFRED
6356 WARE RD
LINO LAKES MN
55014

RUDY FLOYD
118 AVE C
CLOQUET MN
55720

SAN SIMEON DEVELOP CORP
OLD 1ST STATE BK BLDG
PAYNESVILLE MN

SANFORD S M
7000 PORTLAND AVE
RICHFIELD MN
55423

SATHRE, HARVEY
375 MARION STREET
ST PAUL MN
55103

SAX COVE & STENSON
310 ENDICOTT BLDG
ST PAUL MN
55101

ST PAUL ASSN PLBG HTG MEC
614 AM NATL BK
ST PAUL MN

ST PAUL BUR HLTH DR P COX
555 CEDAR ST
ST PAUL MN
55101

ST PAUL FOOD RETAILERS ASSN
1220 ARCADE
ST PAUL MN
55106

SCARBOROUGH WILLIAM
DIV.ED. U.M.
MORRIS MN
56267

SCHLICHT REV ROBT
611 W MAIN ST
BELLE PLAINE MN
56011

SCHMIDT C R MN ASSN REALTORS
6101 WAYZATA BLVD
MPLS MN
55416

SCHMIDT H & TCHRS RETIREMENT
302 CAPITOL SQ BLDG
ST PAUL MN
55101

SCHMIDT LARRY WCCO-TV NEWS
50 S 9TH ST
MPLS MN
55402

SCHNEIDER MAHLON
GREEN GIANT
LESUEUR MN
56058

SCHUTZ LINDA
RM 328 CAPITOL BLDG
ST PAUL MN
55155

SCHWARTAU MEAL METH MGSP
201 N CENTER ST
ROCHESTER MN
55901

SCHWERMAN EARL JR
1535 8TH AVE SE
ROCHESTER MN
55901

SCHWINN ROBT.P.
1400 SOO LINE BLDG.
MPLS. MN
55402

SCHNEIDER & NEESER
706 1ST ST SO PO BX 676
WILLMAR MN
56201

SCHROEDER ALFRED H
2172 CARROLL AVE
ST PAUL MN
55104

SENATE COUN OFF ROOM 24
STATE CAPITOL
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STATE OF MINNESOTA

COUNTY OF HENNEPIN

BEFORE THE MINNESOTA

BOARD OF HEALTH

In the Matter of Proposed Rules
Relating to the Implementation of
the Minnesota Clean Indoor Air Act
of 1975.

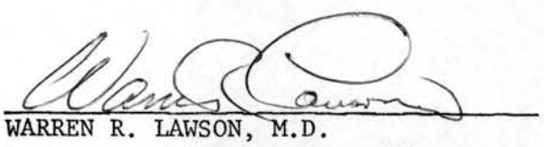
STATEMENT OF NEED

The above-captioned rules are not amendments to existing rules of the Board of Health.

The need to adopt these rules arises because of the legislative mandate contained in Minn. Laws 1975, ch. 211, § 7. The legislature, having stated the policy, prohibitions, and responsibilities under the Act, commands that the "state board of health shall adopt rules and regulations necessary and reasonable to implement the provisions of this act, ..." The rules are needed to comply with the legislature's mandate.

STATE OF MINNESOTA

BOARD OF HEALTH



WARREN R. LAWSON, M.D.
Secretary and Executive Officer

STATE OF MINNESOTA

COUNTY OF HENNEPIN

BEFORE THE MINNESOTA

STATE BOARD OF HEALTH

In the Matter of the Proposed (Rules) (Amendments) Relating to the Implementation of the Minnesota Clean Indoor Air Act of 1975.

FINDINGS OF FACT

The above-entitled matter came on for hearing before the Minnesota State Board of Health on the 2nd day of December, 1975, at 9:30 A.M., in the Board Room, Minnesota Department of Health Building, 717 Delaware Street S.E., Minneapolis, Minnesota 55440, after proper notice required by Minn. Stat. § 15.0412 (Supp. 1975) was served upon all persons, associations and other interested groups registered with the Secretary of State for that purpose and also upon other persons, associations and groups of which the State Board of Health was aware of as possibly having an interest in the above-captioned rules.

After affording interested persons an opportunity to present written and oral data, statements and arguments, and having heard and considered all of the testimony and evidence adduced and upon the records, files and proceedings herein, the Board makes and enters the following findings:

1. Authority to adopt regulations pertaining to implementation of the Clean Indoor Air Act is contained in Minn. Stat. § 144.417 (Supp. 1975). This statute states in relevant part that the ". . . board of health shall adopt rules and regulations necessary and reasonable to implement the provisions of sections 144.411 to 144.417 [the Minnesota Clean Indoor Air Act] . . . ." These regulations are within this legislative grant of authority given to the Board of Health.

2. There is a need for these regulations. The legislature, having stated the policy prohibitions and responsibilities under the Act, mandated that the Board of Health adopt reasonable and necessary regulations to implement the Act. These rules are needed to comply with the legislative mandate, to clarify the Act as it relates to specific public places, and to provide a detailed description of rights and duties under the Act. The Board finds that these regulations, as adopted, are reasonable and necessary to carry out its duties under the Act.

3. MHD 442(a) is an attempt to define "smoke-free area" as used in Minn. Stat. § 144.416(b) (Supp. 1975). The Board finds that the term "acceptable smoke-free area" is appropriate to use in the rules inasmuch as the law permits designated smoking areas within public places and imposes "reasonable" efforts on proprietors to comply with the law. Thus, the Board recognizes that the law does not necessarily require 100% smoke-free conditions, but consistent with Minn. Stat. § 144.415 (Supp. 1975), does require a minimization of the toxic effect of smoke in no smoking areas in those establishments wherein smoking is permitted.

4. Since the law in Minn. Stat. § 144.416(b) (Supp. 1975) requires that proprietors provide a smoke-free area and in Minn. Stat. § 144.415 (Supp. 1975) requires that proprietors use existing physical barriers and ventilation to minimize the toxic effects of smoke, MHD 442(a) merely clarifies the optional conditions available to proprietors to maintain a "smoke-free area." Based upon the rationale contained on pp. 3 - 10 of the Justification, accepted into the record as Exhibit 11 at the public hearing relating to the adoption of these rules, held on December 2, 1975, in the Minnesota Department of Health Building [hereinafter Hearing], MHD 442(a) is found to be necessary and proper.

5. MHD 442(a)(2)(aa) states that a continuous physical barrier of at least 56 inches in height separating smoking permitted from no smoking areas provides an acceptable smoke-free

area. The Board finds that while the adjective "continuous" is necessary to provide for uninterrupted horizontal air flow, such term was never meant to prohibit barrier openings for purposes of exit and entry. Testimony at the Hearing indicated some confusion and ambiguity regarding the meaning of the term "continuous." See, e.g. p. 16, lines 25 - 30 of the Transcript of the Hearing. Further, the Board finds the openings referred to in the rule to mean only openings used for exits and entry. See, e.g. p. 56, lines 26 - 30 of the Transcript of the Hearing. To clarify its meaning, MHD 442(a)(2)(aa) specifically authorizes doors, openings or similar portals for exit and entry within such barriers.

6. The Board finds that the barrier of 56 inches indicated in MHD 442(a)(2)(aa) is sufficient to completely interrupt the direct flow of smoke from seated persons and to provide deterrence from indirect shifting of smoke. Based upon testimony received at the Hearing, contained on p. 27, lines 10 - 20, and p. 68, lines 9 - 17, of the Transcript of the Hearing and in recognition that manufacturers provide free standing land-scaping screens from 56 inches to 80 inches, a 56 inch barrier is found to be a reasonable minimum. Further, the Board finds the rationale given on p. 4 of the Justification, accepted into evidence as Exhibit 11 at Hearing to be persuasive.

7. MHD 442(a)(2)(bb) states that a space of at least four feet in width separating a smoking permitted area from a no-smoking area will create an acceptable smoke-free area. The Board accepts the reasons given on p. 4 of the Justification, accepted into evidence as Exhibit 11 at the Hearing and finds that four feet is an accepted distance of common aisle space which is used in establishments and is of sufficient distance to minimize toxic effects of smoke.

8. Based upon a letter from Representative Phyllis Kahn dated December 18, 1975, and contained in the record, MHD 442(a)(2)(bb) has been clarified to specify that the four foot zone

need not be unoccupied or unused space so long as smoking is prohibited in the zone, and the zone is not included as part of the acceptable smoke-free area. The Board finds that the rule is not intended to require an unused or unoccupied four foot space.

9. MHD 442(a)(2)(cc) relates to a minimum ventilation system which could be used to demonstrate an acceptable smoke-free condition. The Board finds that such a system will minimize the toxic effects of smoke and thereby alleviate its health hazard. Based upon the reasons given on pp. 4 - 5 of the Justification, Exhibit 11 accepted at the Hearing, the Board finds that no modification of existing ventilation systems is necessary to comply with the rules if another authorized method within the rules is implemented.

10. Whereas MHD 442(a)(2)(cc) initially permitted compliance with Minn. Reg. SBC 7705 to demonstrate a smoke-free area, the rule as adopted permits compliance with Minn. Reg. SBC 6607(c)(3) to demonstrate a smoke-free area. The Board finds that while there is little practical difference between the requirements of SBC 7705 and 6607(c)(3), the latter provides more flexibility in terms of cubic feet per minute per person based upon the amount of tobacco smoke likely to be present within different categories of public places. While proprietors are presented with more flexibility in utilizing an acceptable ventilation system, the Board finds the health benefits the rules are designed to provide will not be compromised under SBC 6607(c)(3). Furthermore, based upon letters in the records received subsequent to the Hearing, and upon testimony received at the Hearing, (see, e.g. p. 18, lines 21 - 26 and p. 21, lines 3 - 10) the Board recognizes and accepts the energy conservation elements contained in SBC 6607(c)(3). Since responsible persons must comply with SBC 6607(c)(3) in any event, the Board finds that in order to prevent placing an undue burden upon responsible persons by forcing them to comply with inconsistent standards,

the substitution of SBC 6607(c)(3) for SBC 7706 is both reasonable and necessary.

11. MHD 442(a)(2)(dd) permits a proprietor to control smoke by means other than aisle space, ventilation or barriers if a level of 10 milligrams per cubic meter of carbon monoxide is not exceeded. The Board accepts the analysis and authorities cited to support the analysis contained on pp. 6 - 10 in Exhibit 11 accepted into the record at the Hearing, as justifying the adoption of this standard. The Board finds that only trace concentrations of background carbon monoxide is produced inside a public place from non-tobacco sources. As exterior levels of carbon monoxide is considered in the definition, it is reasonable that any increased variance of 10 milligrams within an establishment will not constitute an acceptable smoke-free area under the option provided in this subsection.

12. Various witnesses gave testimony in relation to MHD 442(c) which defines a "bar" for purposes of the rules. Some witnesses stated that bars should not be exempted from the law while others felt the definition should encompass all establishments which serve alcohol without further limitation. Minn. Stat. § 144.415 (Supp. 1975) permits no public place other than a "bar" to be designated in its entirety as a smoking area. Minn. Stat. § 144.413 subd. 2 (Supp. 1975) specifically defines a public place to include "restaurants." In order to give both sections of the law effect, the Board finds it reasonable and necessary to define a bar, not only as a public place at which people purchase and consume alcoholic beverages, but so as to exclude the category of public places at which people may also purchase and consume meals such as restaurants. The Board finds the reasoning and evidence contained on pp. 10 and 11 of the Justification, accepted as Exhibit 11 at the Hearing, to be persuasive and consistent with the public policy stated in Minn. Stat. § 144.412 (Supp. 1975).

13. Testimony at the Hearing indicated some confusion

as to the status of a bar within an establishment and its relationship with the rest of the establishment. See, e.g. Transcript of the Hearing, p. 34, lines 26 - 30. MHD 442(c) which defines "bar" was never intended to exclude a separately designated room of an establishment in which alcohol is served but in which meals are not served. Thus, a portion of an establishment which functions solely as a bar within these rules may be considered a bar for only that portion regardless of activities conducted in the remainder of the establishment.

14. MHD 442(g) defines meal so as to distinguish such a food serving from that type commonly served in a bar. The Board finds that snacks and appetizers served in a bar are merely a supplement and compliment to the primary activity of consuming alcoholic beverages. Thus, pursuant to the rationale contained on pp. 11 and 12 of the Justification, accepted as Exhibit 11 at the Hearing, the mere serving of such foods will not convert what is otherwise a bar under these rules into a restaurant.

15. The Board finds MHD 442(h) which defines "office" is to be reasonable and necessary and adopts the rationale contained on p. 12 of the Justification, accepted as Exhibit 11 at the Hearing.

16. MHD 442(i) defines "one side of a room" as a continuous portion of a room. While the Board considered definitions incorporating concepts of adjacent walls and minimum percentages of floor space, the Board finds that incorporating such concepts into this definition would not be reasonable and proper for all public places. Recognizing the need to permit the responsible person the opportunity to exercise good faith judgment based upon the geography and use of each public place, and consistent with the need to protect the health and comfort of non-smokers, the Board finds a flexible definition is in order. Based upon the above, and upon the reasons stated on p. 12 of the Justification, accepted as Exhibit 11 at the Hearing,

the Board finds the definition to be reasonable.

17. MHD 442(1)(1) specifies one of the necessary elements for an event to qualify as a "private social function." Minn. Stat. § 144.414 (Supp. 1975) provides an exemption for certain social events from operation of the Act. The Board accepts the reasons stated on pp. 13 - 14 of the Justification, accepted as Exhibit 11 at the Hearing, as supportive of this definition. The Board further finds it reasonable to require that such an event be held for purposes of pleasure, entertainment or recreation in order to fall within the exemption. The testimony at the Hearing indicated there may be some ambiguity as to what is or is not a "social" event. See, e.g. Transcript of the Hearing, p. 59, lines 1 - 22, p. 60, p. 61, lines 1 - 13, p. 62, p. 63 through line 12, p. 65, lines 9 - 20. Thus, the addition of the phrase "and not for the principle purpose of education, sales or business" provides further clarity to the rule.

18. MHD 442(1)(3) relates to seating arrangements at "private social functions." Based upon remarks made at the Hearing, found in the Transcript of the Hearing at p. 66, lines 4 - 21, the Board finds that it is necessary to clarify that seating arrangements, "if any", are under the control of the sponsor inasmuch as all social functions do not have or require "seating arrangements." The lack of seating arrangments will not automatically exclude a function from falling within the definition of a private social function.

19. MHD 442(p) specifically indicates that the definition of "restaurant" for purposes of these rules shall not depend upon licensure under Chapter 157 of Minnesota Statutes. As these rules are designed to implement the Clean Indoor Air Act and protect the public health, comfort and environment with regard to tobacco smoke, the Board accepts the rationale contained on p. 15 of the Justification, accepted as Exhibit 11 at the Hearing, and finds that the purpose of these rules and the

means used to fulfill that purpose are dissimilar from the purpose served by restaurant licensing statutes.

20. MHD 443(a) states the general statutory prohibition contained in Minn. Stat. § 144.414 (Supp. 1975). The Board finds that as this statutory prohibition is the central statement of the law, its specific inclusion into the rules will provide additional clarity.

21. MHD 443(b)(1) permits an exception from the requirement of one and only one smoking permitted area per room for areas of at least 20,000 square feet in total floor space. Based upon the rationale contained on pp. 16 - 17 of the Justification, accepted as Exhibit 11 at the Hearing, the Board recognizes that in extremely large rooms, health considerations will not be compromised by permitting more than one smoking permitted area within such large areas.

22. MHD 443(b)(2) states that if a public place contains two or more rooms which are used for the same activity, one room may be designated in its entirety as a smoking permitted area so long as a portion of one other comparable room is designated as a no-smoking area. The Board, based upon the rationale contained on p. 17 of the Justification, accepted as Exhibit 11 at the Hearing, finds it necessary to clarify that a proprietor may not designate one room within an establishment as a smoking permitted area unless a no-smoking area is designated in a comparable room. This rule is meant to give force and effect to both Minn. Stat. § 144.415 (Supp. 1975) which gives the proprietor the right to designate smoking areas and Minn. Stat. § 144.416(b) requiring the proprietor to attempt to arrange seating so as to provide a smoke-free area. The Board intends to prevent designation of no-smoking areas in substandard rooms by use of the term "comparable."

23. MHD 443(b)(3) states that a smoking permitted area may not encompass an entire area which non-smokers would be required to use to participate in activities for which the

public place is intended. The Board accepts the rationale contained on p. 17 of the Justification, accepted as Exhibit 11 at the Hearing, and finds that this rule is necessary to conform with the intent of Minn. Stat. § § 144.416(b) and 144.412 (Supp. 1975) in that non-smokers should have access to the activities conducted within the public place without being subjected to the harmful effects of tobacco smoke.

24. MHD 443(b)(3) limits application of its provision by providing that a smoking permitted area may be designated in a location which non-smokers may briefly cross to reach an intended activity. Based upon remarks made at the Hearing, see e.g. Transcript of the Hearing, pp. 69, 70 and 71 and pp. 83 - 84, the Board finds that such qualification is necessary inasmuch as many establishments would have to undertake extensive re-construction or remodeling to be in strict compliance with the rule if this limited qualification was not incorporated into the rule. As worded, the rule will conform with the intent of the law without placing an undue burden on proprietors.

25. MHD 443(b)(4) requires that the smoking permitted area shall not be more than proportionate to the preference of users of the location for smoking permitted areas. While the Board considered adopting such standards as absolute minimum percentages or minimum square footage, the Board finds that such criteria may not be reasonable and proper for all public places. The Board recognizes the variables of activity, use, need and population in each public place at any given time and therefore finds that fluctuating boundaries based upon demonstrable preference is consistent with the need to protect the health and comfort of non-smokers. Based upon favorable comments received at the Hearing (see, e.g. p. 85 of the Transcript of the Hearing) and upon a review of p. 19 of the Justification, accepted as Exhibit 11 at the Hearing, the Board finds the standard as adopted to be reasonable and necessary.

26. Based upon testimony received at the Hearing, specifically found on p. 86, lines 2 -20 and p. 105 - 107 of the Transcript of the Hearing, and Exhibit 21, the ANSR policy

statement received at the Hearing, MHD 443(b)(4) provides some guidance as to methods by which the proportionate preference of users of smoking permitted areas may be demonstrated. While such methods are not mandatory, the Board finds that clarification by example is in order.

27. The Board finds that the inclusion of MHD 443(d) relating to signs is necessary to permit a uniform interpretation of Minn. Stat. § 144.416(a) which states that the proprietor or other person in charge is responsible for making reasonable efforts to prevent smoking in a public place which may include "posting appropriate signs." Pursuant to the rationale contained on pp. 19 and 20 of the Justification, accepted as Exhibit 11 at the Hearing, this rule is found to describe and clarify what signs shall be considered to be appropriate.

28. MHD 443(d)(4) requires that "smoking permitted" and "no smoking signs" shall be printed in letters of not less than 1.5 inches in height. Based upon the reasons stated on p. 20 of the Justification, accepted as Exhibit 11 at the Hearing, the Board finds that this letter height is reasonable inasmuch as such height provides adequate readability to a viewer with normal vision at a distance of 60 feet with normal lighting conditions. This rule also specifies that the boundary separating smoking from non-smoking areas must be clearly designated. The Board finds that while this rule clearly requires that a clear designation of separate areas must be made, it does not require the posting of signs as the only acceptable method of designation but permits flexibility.

29. MHD 443(d)(8) relating to inquiries of all users as to their preference for placement was initially proposed in another section. However, based upon testimony received at the Hearing contained on pp. 120 - 121 of the Transcript of the Hearing, the Board finds that its inclusion in MHD 443(d) relating to signs is appropriate inasmuch as this rule permits an alternative to posting several signs.

30. MHD 444(b) relating to places of work is designed to provide the employer a flexible method to comply with the rules while protecting non-smoking employees from the toxic effect of smoke. The Board recognizes that employees are frequently separated into work areas according to their functional activities and cannot easily be divided and shifted without adverse economic effect to the employer. Thus, "checkerboarding" of no-smoking and smoking areas may be allowed for certain places of work. The Board further finds that a 200 square foot area is the minimal space necessary to maintain an acceptably smoke-free environment for an employee and is supported by the evidence contained on pp. 22 and 23 of the Justification, accepted as Exhibit 11 at the Hearing.

31. MHD 444(b) dealing with places of work specifically exempts private residences not customarily used as a place of work from its operative application. This specific exclusion is found to be necessary based on the testimony received at the Hearing contained on p. 53, lines 12 - 29 of the Transcript of the Hearing. The Board finds that since the inclusion of private residences was not contemplated in the rule as initially proposed, clarifying language is in order.

32. MHD 444(c) and (d)(2) relating to offices and restaurants to be regulated by the Department of Labor and Industry has been rephrased to conform with rules of the Department of Labor and Industry. Based upon a letter received from a representative of the Department of Labor and Industry dated December 8, 1975, and included as part of the record, the Board finds this change was necessary to make the rules from the different departments consistent and to provide for uniform enforcement and understanding.

33. Pursuant to the rationale contained on pp. 23 and 24 of the Justification, accepted as Exhibit 11 at the Hearing, the Board finds MHD 444(d) to be necessary and reasonable.

34. MHD 445(b)(1) more clearly defines what kind of

evidence is necessary to demonstrate "compelling reasons" which would justify waiver. Based upon testimony received at the Hearing, contained on pp. 148 - 149 of the Transcript of the Hearing, the Board finds that the rule, as originally proposed, may not have provided regulatees a sufficiently clear guideline as to what type of evidence would constitute a demonstration of financial hardships justifying waiver under the rules.

35. Other provisions of the rules not specifically referred to herein are found to be supported by all evidence in the record.

36. Many comments were made at the hearing and letters received both prior and subsequent to the hearing. Based thereon, modifications were made but in no instance has the substance of the regulation as presented at the public hearing been changed.

37. These rules are in keeping and will help fulfill the policy of the State as expressed in Minn. Stat. § § 144.411 - 417 (Supp. 1975).

Dated: April 1, 1976

STATE OF MINNESOTA

BOARD OF HEALTH

Robert G. Willmarth

ROBERT WILLMARTH
President

MDH Ex. II
12/2/75 RKH

STATE OF MINNESOTA

COUNTY OF HENNEPIN

BEFORE THE MINNESOTA

STATE BOARD OF HEALTH

In the Matter of Proposed Rules
Relating to the Implementation of
the Minnesota Clean Indoor Air Act
of 1975

Justification

MHD 441. AUTHORITY, SCOPE AND PURPOSE.

This proposed rule provides an introductory explanation of the Act and rules. The subjects, discussed below, are needed to give the reader broad knowledge of the context in which these rules shall be interpreted. The Board is authorized by Minn. Stat. § 144.417, Subdivision 1, to adopt rules necessary and reasonable to implement the provisions of the Minnesota Clean Indoor Air Act of 1975, and these rules fall within this authority.

MHD 441(a) states the authority under which the State Board of Health bases its actions to implement the Minnesota Clean Indoor Air Act of 1975. Minn. Stat. § 144.417, Subdivision 1, states:

> "The State Board of Health shall adopt rules and regulations necessary and reasonable to implement the provisions of this act, except as provided for in section 4."

Minn. Stat. § 144.414 contains the general prohibition for any person to smoke in a public place or at a public meeting except in designated smoking areas. The exception in the authority of the State Board of Health is in application to "factories, warehouses and similar places of work not usually frequented by the general public." Such exemption to the authority of the State Board of Health is described in proposed MHD 441(b).

MHD 441(b) describes the scope of these rules. The Act and rules applies to "public places" and "public meetings" as defined in the Act:

> "Minn. Stat. § 144.413, Subdivision 2. 'Public place' means any enclosed, indoor area used by the general public or serving as a place of work, including, but not limited to, restaurants, retail stores, offices and other commercial establishments, public conveyances, educational facilities, hospitals, nursing homes, auditoriums, arenas and meeting rooms, but excluding private, enclosed offices occupied exclusively by smokers even though such offices may be visited by nonsmokers."

"Minn. Stat. § 144.413, Subdivision 3. 'Public meeting' includes all meetings open to the public pursuant to Minnesota Statutes, Section 471.705, Subdivision 1."

The description of the scope of these rules elaborates on the statutory definition of "public places" by stating that the term applies to all enclosed, indoor areas used by the general public or serving as a place of work, regardless of type of ownership of the area. This supplementary language is felt to be necessary to avoid uncertainty among some persons who are responsible for areas which are operated by a single private corporation, partnership or individual ownership. The intent of the law and the language of the law applies to places operated by non-governmental proprietors as well as governmental operations. No enclosed, indoor area is excluded due to any variety of ownership.

As we mentioned above, Minn. Stat. § 144.414 takes a portion of the public places, factories, warehouse and similar places of work out of the general prohibition clause and requires the Department of Labor and Industry to establish rules to restrict or prohibit smoking in those places of work. This division of responsibility affects the scope of these rules, and therefore, it is considered to be reasonable and proper to state that rules of the Department of Labor and Industry exist.

MHD 441(c) is an elaboration of Minn. Stat. § 144.415 which states that a designated smoking permitted area may not be located in places where smoking is prohibited by the fire marshall or by other law, ordinance or regulation. To clarify the scope of these rules, it is reasonable and necessary to make such a statement about existing smoking prohibition restrictions.

MHD 441(d) gives the general purposes of these rules as called for in Minn. Stat. § 144.417, Subdivision 1. That statute requires the Board to adopt rules and regulations necessary and reasonable to implement the provisions of the Minnesota Clean Indoor Air Act. Clarification of certain provisions is necessary for implementation of the Act. It is required by Minn. Stat. §§ 15.0411-15.0413 for the administrative agency to maintain the same general public policy as language and intent of the Act.

MHD 442. DEFINITIONS.

This proposed rule deals with sixteen separate terms used in the Act and in these rules. These definitional provisions, discussed individually below, are necessary to effect a uniform interpretation of the Act and these rules and to avoid uncertainty and ambiguity in dealing with the Act and rules. The Board is authorized under Minn. Stat. § 144.417, Subdivision 1, to adopt rules necessary and reasonable to carry out the Act, and these definitional rule provisions fall within this authority.

MHD 442(a). "Acceptable Smoke-free Area."

This definition implements Minn. Stat. § 144.416 which requires the proprietor or other person in charge of a public place to make a reasonable effort to prevent smoking in the public place by, among other methods, "arranging seating to provide a smoke-free area." It is felt that the term "acceptable smoke-free area" is more appropriate to use in regulations because only "reasonable" efforts are necessary and designation of a smoking permitted area is allowable. Therefore, the law does not necessarily expect 100% "smoke-free" conditions and "acceptability" of the no-smoking area is the real question.

This definition furthermore implements Minn. Stat. § 144.415 which requires the following:

> "Where smoking areas are designated, existing physical barriers and ventilation systems shall be used to minimize the toxic effect of smoke in adjacent no-smoking areas."

The term "acceptable smoke-free area" is used in MHD 443(d) as one of the operative provisions of the Rules. It is reasonable and necessary to have this specific definition so that there is a clear standard for differentiation of a no-smoking area from a smoking permitted area.

In proposed rule MHD 442(a)(1), the proposed definition of "acceptable smoke-free area" requires that the area be a "contiguous portion" of the public place or public meeting "including seating arrangements." The definition also states that "smoking is prohibited" in such an area.

The term "contiguous" is necessary and reasonable to indicate that the area must be "connecting or compacted" and not broken down into "checkerboard" type sections. Furthermore, the phrase "including seating arrangements" elaborates on the description of an "acceptable smoke-free area." It is necessary to state that seating arrangements must be included so that a proprietor does not designate non-seating portions of the public places as the only no-smoking area. The clause "where smoking is prohibited" is necessary to eliminate any chance for uncertainty about smoking in an area that is considered as an "acceptable smoke-free area."

The second portion of the definition of "acceptable smoke-free area" requires the proprietor or other person in charge to use at least one of four conditions to demonstrate that reasonable efforts have been made to "provide a smoke-free area" (Minn. Stat. § 144.416(b)) and that "existing physical barriers and ventilation systems are being used to minimize the toxic effects of smoke in adjacent non-smoking areas" (Minn. Stat. § 144.415).

MHD 442(a)(2)(aa) describes a standard related to a barrier which may optionally be used to demonstrate that an area is "acceptably smoke-free." The terms "continuous" and "physical" are used to modify "barrier" in order to clarify and specify the types of barriers which are acceptable. Physical barriers which are not "continous" were considered but rejected because a sufficient degree of interrupted horizontal air flow could not be assured. Examples of these acceptable barriers are "a wall, partition or furnishing."

The height of at least 56 inches, or in metric measurements 1.42 meters, was selected because 56 inches or more is sufficient to completely interrupt the direct flow of smoke from seated persons and to provide partial deterence of the smoke from indirect drifting of smoke. Furthermore, according to sources who submitted suggestions for rules, standard heights of free standing "landscaping" screens from major manufacturers are 56 inches, 62 inches, 72 inches and 80 inches. All of these commercially available physical barriers would be of sufficient height. It is therefore felt that MHD 442(a)(2)(aa) is necessary and reasonable to implement the Minnesota Clean Indoor Air Act.

The second optional condition for demonstration of an "acceptable smoke-free area" is proposed MHD 442(a)(2)(bb) "a space of at least four feet (1.22 meters) in width to separate the smoking permitted and no-smoking areas." Four feet is a standard,accepted distance of comfortable aisle space which is used in commercial establishments. This standard can apply to all public places and meetings as a minimum acceptable width between the functional units in the smoking permitted and no-smoking area. The area in the four foot (or greater) "aisle space" is a neutral zone and would be covered by Minn. Stat. § 144.413, Subdivision 4, which requires that carrying of lighted smoking equipment is prohibited except in designated smoking permitted areas. Widths greater than four feet were considered but these were rejected because of a possible adverse economic effect on commercial establishments which would keep an unusually wide "aisle space" to be in compliance with the Act and these rules. We therefore feel that the standard of four feet space is necessary and proper to carry out the Act and these rules.

Proposed MHD 442(a)(2)(cc) relates to a minimum ventilation system which could be used to demonstrate an "acceptable smoke-free" condition. As in the options for barriers and space above, the ventilation option is not required and no modification of the ventilation system is necessary to comply with the law if another means for providing an acceptable smoke-free area is implemented.

An adequate ventilation system in a public place or public meeting would recirculate smoky air and provide for a certain level of tempered outside air in exchange for inside air. With an adequate ventilation system in use the level of toxic products

from smoking would not exceed low concentrations and it is reasonable that no health danger would result. While there may be minor discomfort among the people most allergic to smoke, this discomfort would be minimal if the non-smokers are separated from smokers in some manner.

The next issue considered in proposed MHD 442(a)(2)(cc) is: What number of air changes per hour and quantity of outside air should be added to the inside air which would be minimally necessary to accomplish reasonably clean air? This rule proposes that in such rooms where smoking is permitted in a portion of the room, it would be reasonable that there should be total air circulation of not less than six air changes per hour and a supply of not less than 7.5 cubic feet, or equivalent 2.29 cubic meters, of tempered outside air per minute per person. This number of exchanges and quantity of outside air is consistent with the general requirements of the current Minnesota State Building Codes, titled as Minn. Reg. Admin. Chapter Eleven: SBC 7706.

> "SBC 7706 (2). Air Movements. The total air circulation (recirculated plus outside air) for all occupancies in this classification shall not be less than 6 air changes per hour unless otherwise provided by this code."
>
> "SBC 7706 (3). Outside Air Supply. The outside air supply during occupancy shall not be less than 7½ cubic feet per minute per occupant and an equal amount shall be exhausted unless otherwise exempted by this code. See SBC 7705 for method used in determination of capacity."

Recommendations from the professional society of building engineers also point out the need for quantity of outside air supply to be at least 7½ cubic feet per minute per person when there is smoking permitted in the room. The attached reference table shows "outside air requirements" to be a minimum of under 7½ CFM per person only when smoking is prohibited. See reference for department stores, five and ten cent stores, and theaters.

On the other hand, the air supply requirement is a minimum of 7½ CFM or more per person in every other type of building listed. Recommended air supply exceeds the minimum requirements in each case. In these situations, buildings with smoking permitted areas have recommended air supply of 10 to 50 CFM per person. This quantity is at least 33% greater than the proposed quantity of air supply in MHD 442(a)(2)(cc) of 7½ CFM per person.

Therefore, the proposed six air changes per hour is standard, accepted ventilation procedure as recommended by building engineers and as required in the 1972 revision of the Minnesota State Building Code, Minn. Reg. SBC 7706. Additionally, the proposed 7.5 cubic feet per minute per person quantity of outside air supply is equal to or less than standard, accepted procedure in

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Make-up air

Table 3-21

Infiltration Through Windows

(cfh per ft)*

TYPE OF WINDOW	DESCRIPTION OF WINDOW	WIND VELOCITY, MPH	
		7½	15
DOUBLE-HUNG WOOD SASH (UNLOCKED)	TOTAL FOR AVERAGE WINDOW, NONWEATHERSTRIPPED, 1/16 IN. CRACK AND 3/64 IN. CLEARANCE	14	39
	DITTO, WEATHERSTRIPPED	8	24
	TOTAL FOR POORLY FITTED WINDOW, NONWEATHERSTRIPPED, 3/32 IN. CRACK AND 3/32 IN. CLEARANCE	43	111
	DITTO, WEATHERSTRIPPED	13	34
DOUBLE-HUNG METAL SASH	NONWEATHERSTRIPPED, LOCKED	33	70
	NONWEATHERSTRIPPED, UNLOCKED	34	74
	WEATHERSTRIPPED, UNLOCKED	13	32
ROLLED SECTION STEEL SASH	INDUSTRIAL PIVOTED, 1/16 IN. CRACK	60	176
	ARCHITECTURAL PROJECTED, 3/64 IN. CRACK	36	88
	RESIDENTIAL CASEMENT, 1/32 IN. CRACK	23	53
	HEAVY CASEMENT SECTION, PROJECTED, 1/32 IN. CRACK	16	38

* Cubic feet of air per hour per lineal foot of crack.

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Table 3-22

Outdoor Air Requirements[1]

APPLICATION	SMOKING	CFM PER PERSON[2]		CFM PER SQ[7] FT OF FLOOR
		RECOMMENDED	MINIMUM[3]	MINIMUM[3]
APARTMENT				
AVERAGE	SOME	20	10	.....
DELUXE	SOME	20	10	.....
BANKING SPACE	OCCASIONAL	10	7½	.....
BARBER SHOPS	CONSIDERABLE	15	10	.....
BEAUTY PARLORS	OCCASIONAL	10	7½	.....
BROKERS' BOARD ROOMS	VERY HEAVY	50	20	.....
COCKTAIL BARS	.....	40	25	.....
CORRIDORS (SUPPLY OR EXHAUST)	.....	.....	.....	0.25
DEPARTMENT STORES	NONE	7½	5	0.05
DIRECTORS' ROOMS	EXTREME	50	30	.....
DRUG STORES[5]	CONSIDERABLE	10	7½	.....
FACTORIES[4,6]	NONE	10	7½	0.10
FIVE AND TEN CENT STORES	NONE	7½	5	.....
FUNERAL PARLORS	NONE	10	7½	.....
GARAGES[4]	.....	.....	.....	1.0
HOSPITALS				
OPERATING ROOMS[4,7]	NONE	.....	.....	2.0
PRIVATE ROOMS	NONE	30	25	0.33
WARDS	NONE	20	10	.....
HOTEL ROOMS	HEAVY	30	25	0.33
KITCHENS				
RESTAURANT	.....	.....	.....	4.2
RESIDENCE	.....	.....	.....	2.0
LABORATORIES[5]	SOME	20	15	.....
MEETING ROOMS	VERY HEAVY	50	30	1.25
OFFICES				
GENERAL	SOME	15	10	.....
PRIVATE	NONE	25	15	0.25
PRIVATE	CONSIDERABLE	30	25	0.25
RESTAURANTS				
CAFETERIA[5]	CONSIDERABLE	12	10	.....
DINING ROOM[5]	CONSIDERABLE	15	12	.....
SCHOOLROOMS[4]	NONE	.....	.....	.....
SHOP, RETAIL	NONE	10	7½	.....
THEATER[4]	NONE	7½	5	.....
THEATER	SOME	15	10	.....
TOILETS[4] (EXHAUST)	.....	.....	.....	2.0

[1] Taken from present-day practice.
[2] This is contaminant-free air.
[3] When minimum is used, take the larger of the two.
[4] See local codes which may govern.
[5] May be governed by exhaust.
[6] May be governed by special sources of contamination or local codes.
[7] All outside air recommended to overcome explosion hazard of anesthetics.

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Ventilation is understood to relate with volume of room air movement per unit of time as regard "Air Changes".

F.J. Fale 10/6

rooms where smoking is permitted and is required by Minnesota State Building Code, Minn. Reg. SBC 7706.

Seven and one-half CFM per person is the lowest of the recommended air supply standard in smoking permitted rooms. This low standard was selected for the proposed rule because of recent energy conservation efforts. For example, the "Design and Evaluation Criteria for Energy Conservation in New Buildings, Additions and Remodeled Elements of Buildings" (Minn. Reg. Admin. SBC 6001-6013) was promulgated to create more effective utilization of energy, including utilization of energy in ventilation systems. Minn. Reg. Admin. SBC 6007(c)(3) calls for basing outdoor air quantities on not more than 33% of the maximum recommended ventilation rating of the ASHRAE Standard (see Requirements reference above). Therefore, the proposed 7.5 CFM per person, being at least 33% below the ASHRAE Standard, is reasonable and necessary to implement the Minnesota Clean Indoor Air Act. This will be consistent with energy conservation efforts and still accomplish air filtration in smoking permitted rooms.

The occupancy classifications from which the number of square feet per person is determined is variable and there is a variety of considerations in determining capacity. It was determined to be reasonable for the proposed rule to be based upon the same minimum, standard occupancy classifications as the current Minnesota State Building Code, Minn. Reg. Admin. SBC 7705. These occupancy classifications were developed according to the type of use of the category, typical amount of seating space and typical ceiling height. For example, the Code specifies the following considerations for capacity:

Cafeterias	15 sq. ft. per person
Dining Rooms	15 sq. ft. per person
Brokerage Boardrooms	7 sq. ft. per person
Barber Shops	20 sq. ft. per person
Beauty Parlors	20 sq. ft. per person
Restaurants	15 sq. ft. per person
Retail Establishments	60 sq. ft. per person

It is felt that these standard occupancy classifications will create uniformity of implementation with the State Building Code and are necessary to implement the Act.

Proposed Minn. Reg. 442(a)(2)(dd) creates an objective limit of carbon monoxide exposure for an area to be considered acceptably smoke-free. This proposed rule makes it permissable for a proprietor to control smoke by means other than barriers, aisle space or ventilation, but only if the objective level of 10 milligrams per cubic meter (9 parts per million) of carbon monoxide is not exceeded.

This proposed rule relates to Minn. Stat. §§ 144.415 and 144.416. The former section describes the designation of a

smoking area and the latter describes responsibilities of the proprietors.

Although tobacco smoke consists of several hundred substances, both gases and particles, carbon monoxide was selected as the chemical to be measured for determination of relative smoke-free conditions because equipment is readily available to measure the level in air and carbon monoxide is one of the most dangerous absorbed gases in tobacco smoke.* Carbon monoxide enters the bloodstream of persons from the lung and associates with the hemoglobin in the blood to form carboxyhemoglobin(COHb) in the blood. The presence of COHb in the blood means that there is a corresponding reduction of the amount of oxygen transported by the bloodstream. It also means that the oxygen is less easily transferred from the blood to the tissues.

Experimental studies which are listed later in this document have shown that an increased COHb level will give rise to arteriosclerosis found among people exposed to tobacco smoke.

Some of the other substances in tobacco smoke, other than carbon monoxide are: tar, nicotine, benzo(a)pyrene (carcinogenic), pyrene, phenols, cadmium, ammonia, carbon dioxide, nitrogen dioxide, acrolein, hydrogen cyanide, and other nitrous oxides.

One of the chief references which was used to develop this standard was "Health Consequences of Smoking; A Report of the Surgeon General: 1972," Chapter 8, Public Exposure to Air Pollution from Tobacco Smoke. (Attached as Appendix A). In that chapter are reviewed not only the data on carbon monoxide and its harmful effects on human health, particularly in those who have compromised cardiac or pulmonary function, but the significant discomfort and symptoms experienced by both allergic and non-allergic individuals to the irritants within tobacco smoke. Allergic individuals are particularly susceptible to the multiple irritant components of cigarette smoke.

The 1972 Surgeon General's Report concluded that the presence of low levels of carbon monoxide in rooms filled with tobacco smoke may be sufficient to be harmful to the health of an exposed person. This would be particularly significant for people who are already suffering from chronic bronchopulmonary disease and coronary health disease.

The evidence concerning the effect of low levels of carbon monoxide has been reviewed and evaluated by the National Air Quality Criteria Committee of the National Air Pollution Control Administration. The following is taken from the published conclusions of the Advisory Committee:

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*Ramstrom, L.M., et al., "A National Smoking Control Programme," Swedish National Smoking and Health Association, Stockholm, Sweden, September, 1973.

"Experimental exposure of nonsmokers to 58 mg/m^3 (50 ppm) for 90 minutes has been associated with impairment in time-interval discrimination . . . This exposure will produce an increase of about 2 percent COHb in the blood. This same increase in blood COHb will occur with continuous exposure to 10 to 17 mg/m^3 (10 to 15 ppm) for 8 or more hours . . .

"Experimental exposure to CO concentrations sufficient to produce blood COHb levels of about 5 percent (a level producible by exposure to about 35 mg/m^3 for 8 or more hours) has provided in some instances evidence of impaired performance on certain other psychomotor tests, and an impairment in visual discrimination . . .

"Experimental exposure to CO concentrations sufficient to produce blood COHb levels above 5 percent (a level producible by exposure to 35 mg/m^3 or more for 8 or more hours) has provided evidence of physiologic stress in patients with heart disease . . . "

The levels of carbon monoxide found to be present in "smoked" rooms (20 to 80 ppm) are similar to the levels (30 to 50 ppm) which the Advisory Committee has concluded are associated with adverse health effects:

"An exposure of 8 or more hours to a carbon monoxide concentration of 10 to 17 mg/m^3 (10 to 15 ppm) will produce a blood carboxyhemoglobin level of 2.0 to 2.5 percent in nonsmokers. This level of blood carboxyhemoglobin has been associated with adverse health effects as manifested by impaired time interval discrimination. Evidence also indicates that an exposure of 8 or more hours to a CO concentration of 35 mg/m^3 (30 ppm) will produce blood carboxyhemoglobin levels of about 5 percent in nonsmokers. Adverse health effects as manifested by impaired performance on certain other psychomotor tests have been associated with this blood carboxyhemoglobin level, and above this level there is evidence of physiologic stress in patients with heart disease."

Additional references used for this rule are attached and identified as Appendix B, C, and D, respectively.

Ayres, S. M., H. S. Mueller, J. J. Gregory, S. Gianelli, Jr., and J. L. Penny. Systemic and Myocardial Hemodynamic Responses to Relatively Small Concentrations of Carboxyhemoglobin (COHb), Arch. Environ. Health, Vol. 18, pp. 699-704, 1969.

Bartlett, Jr. D. Pathophysiology of Exposure to Low Concentrations of Carbon Monoxide, Arch. Environ. Health, Vol. 16, pp. 719-727, 1968.

Beard, R. R. and G. Wertheim. Behavioral Impairment Associated with Small Doses of Carbon Monoxide, Am. J. Pub. Health, Vol 57, pp. 2012-2022, 1967.

The above references and the 61 additional references listed in the bibliography of the Report of the Surgeon General are part of the data utilized by the Federal Environmental Protection Agency (EPA) to promulgate national primary and secondary air quality standards under provisions of the Federal Clean Air Act (PL 91-604). These primary and secondary standards for CO are:

"(a) 10 milligrams per cubic meter (9 parts per million) -- maximum eight-hour concentration not to be exceeded more than once per year.

(b) 40 milligrams per cubic meter (35 parts per million) -- maximum one-hour concentration not to be exceeded more than once per year."

The preponderance of research literature and other regulations indicates there is need for protection against the occurrence of carboxyhemoglobin blood levels above 2 percent. Research indicates that 2% COHb levels can be obtained from human exposure to 10 to 17 mg per cubic meter (10 to 15 ppm) of CO in the air for 8 hours. It has been the judgment of the Federal Environmental Protection Agency that national standards for carbon monoxide of not more than 10 milligrams per cubic meter is needed to provide an adequate safety margin for protection of public health and will protect against known and anticipated adverse effects on public welfare.

Therefore, it is the conclusion of the Board that the chemical definition of "acceptable smoke-free air" can be considered to be 10 milligrams per cubic meter of carbon monoxide and that exposure of person to more than this concentration of carbon monoxide could be harmful to the health and comfort of an individual.

This standard is reasonable and necessary for implementation of the Clean Indoor Air Act and is consistent with the intent of the legislation to provide for a reasonably smoke-free area in virtually all "public places." This law applies to places of work where people may be exposed to smoke contaminated air for at least 8 hours and it is felt that low concentrations of smoke pollutants are intended in the Act. Therefore, the standard of 10 milligrams per cubic meter of carbon monoxide is a reasonable level for compliance with this Act.

Comparison of the inside carbon monoxide standard to outside air concentration of carbon monoxide is made with consideration of a background CO level from sources other than tobacco smoke. There are only trace concentrations of carbon monoxide produced inside a

public place from non-smoking sources. However, there may be greater levels of carbon monoxide produced on the outside by motor vehicles. Outside CO pollution will not be a consideration in determining the inside concentration which is "acceptable smoke-free."

The distance of "within 12 feet of the building" was chosen to provide a specific distance for the background measurement. Twelve feet is the standard width of a sidewalk in the central city area of Minneapolis, according to the City of Minneapolis Public Works Department. This will provide a reasonable and proper distance for background measurement.

MHD 442(b). "Act."

This definition allows a shorthand reference to the statute which is identified in Minnesota Statutes § 144.411 as the "Minnesota Clean Indoor Air Act," the same reference used herein.

MHD 442(c). "Bar."

This definition relates to implementation of Minn. Stat. §§ 144.415 and 144.413, Subd. 2. The former section permits no public place other than a "bar" to designate itself as a smoking area in its entirety. The latter section defines the term "public place" and this definition specifically includes the category of "restaurants."

Therefore, to develop a definition of the term "bar" it was necessary to not only develop a reasonable description of the category of public place at which people purchase and consume alcoholic beverages, but also it was necessary to exclude the category of public places at which people eat meals in consideration of payment and are commonly known to the public as a "restaurant."

Minn. Stat. § 340.07 subd. 14 relating to intoxicating liquor provides an analogous situation where restaurants are distinguished from places where alcoholic beverages are sold and consumed. In that statute the term "restaurant" is defined as "any establishment . . . having appropriate facilities for the serving of meals, and where, in consideration of payment therefore, meals are regularly served at tables to the general public, and which employs an adequate staff to provide the usual and suitable service to its guests. In cities of the first class such establishments shall have facilities for seating not less than 50 guests at one time; in cities of the second and third class and statutory cities of over 10,000 population, such establishments shall have facilities for seating not less than 30 guests at one time or such greater number as a municipality shall determine; and in cities of the fourth class and statutory cities of 10,000 population or less, in such matter as a municipality shall determine; and in any unincorporated or unorganized area of a county such establishments shall have facilities for seating not less than 100 guests at one time or such greater number as the county board may determine."

In consideration of the language of the statute which requires inclusion of restaurants and permission for a "bar" to acquire itself as a smoking area in its entirety, the proposed definition was established. In the broad sense this definition includes all places where alcoholic beverages are purchased and consumed. At the same time an exclusion is made for any such establishment which generally conforms to the restaurant definition cited above in Minn. Stat. § 340.07, Subd. 14.

It is felt that such an exclusion is reasonable and necessary to implement the letter and the spirit of the Minnesota Clean Indoor Air Act. These "non-bar" establishments have table and seating facilities for the serving of "meals," which is defined in Minn. Reg. MHD 442(f), to a substantial number of people, more than 50 people at one time. These meals are served in consideration of payment at tables to the public.

MHD 442(d). "Educational Facilities."

This regulation defines one of the categories of public places which is specifically included in the definition of "public place" in Minn. Stat. § 144.413, Subd. 2. This definition is used in an operative provision in Minn. Reg. MHD 444(f). This definition includes the broad category of any location which is used for instruction of enrolled students and a classification includes all areas which are also supportive of such instruction if such area is under the responsibility of the school administration. This definition limits application of this category to location where students are not enrolled.

MHD 442(e). "Health Care Facilities."

This definition relates to one of the categories mentioned under the definition of "public place" in Minn. Stat. § 144.413, Subd. 2. Five categories of public places which are generally known as "health care facilities" are licensed in the State of Minnesota. These categories are hospitals, nursing homes, boarding care homes, supervised living facilities and surgical centers. This definition relates only to those specific health care facilities and other locations which are used in matters of health care and would be covered under other categories of this act. It is reasonable and necessary to establish a direct association with the licensure of these facilities for the purposes of implementation of this act by the Minnesota Department of Health.

MHD 442(f). "Meals."

This definition is necessary to clarify the meaning of the word "meals" as it is used in Minn. Reg. MHD 444(c), the term "bar." It is reasonable to define meals as any food made available to be consumed on the premises but it was necessary to exclude certain categories of foods as it applies to the situation of a "bar."

The excluded categories of foods are those of a prepackaged variety and foods which are served as snacks or appetizers. Prepackaged foods are commonly served in a "bar" as a supplement to the primary activity of the place, that of purchasing and consuming alcoholic beverages. Similarly, snacks and appetizers are commonly served as a complement to the alcoholic beverages. When such prepackaged foods, snacks or appetizers are the only type of food that is served in the establishment and alcoholic beverages are purchased and consumed in the establishment, it is reasonable that the foods not be considered to be a meal for the purposes of that location. We feel that this definition is consistent with the intent of Minn. Stat. § 144.415 and that the public will be adequately protected by the implementation of this rule.

MHD 442(g). "Office."

This definition relates to another category of public place which is included in the MHD § 144.413, Subd. 2. The term "office" is specifically included as a "public place" and it is necessary to provide a definition of the term to avoid confusion and implementation of the act and the regulations.

A proposed definition of the term "office" was selected to describe the principle activities which are performed in an office. These activities are customarily professional, clerical or administrative in nature. This definition is therefore analogous to that definition used for "office" in the Minnesota Occupational Safety and Health Act, Laws of Minnesota 1973, Chapter 732. As examples of the categories of offices which are included in this definition classification, this rule lists professional offices, financial institutions, business offices and government offices.

MHD 442(h). "One Side of the Room."

This phrase is defined so as to clarify the meaning of the language of Minn. Stat. § 144.415 regarding the provision for a public place consisting of a single room. This definition was selected to provide reasonable implementation of the law in public places which consist of a single room and therefore have less flexibility to separate smoking and nonsmoking areas. In this situation a connecting portion of a room including any seating arrangements, which have been set aside from the remainder of the room shall be considered to be "one side of the room." The alternative for defining this term as a particular percentage of the room or as a portion of the room which is adjacent to one or more complete side walls of the location was considered but rejected because it would not be reasonable for all public places. It is felt that this definition will provide adequate protection of the public's health and will provide a mechanism for the responsible persons in a public place to arrange seating consistent with the act and these rules.

MHD 442(i). "Other Person in Charge."

This definitional provision is necessary to clarify those portions of the statute and rules which make reference to the "other person in charge" of a public place or public meeting. It is felt that the legislation intends that such other person in charge be an agent of the proprietor who has been authorized to perform duties for the proprietor in his absence. It is reasonable to describe such duties as administrative direction to and general supervision of the activities within the public place. This agent of the proprietor is the most reasonable person to implement the Minnesota Clean Indoor Air Act in that location and therefore these rules place the obligations for compliance on such person.

MHD 442(j). "Place of Work."

This definition relates to the phrase within the statutory definition of "public place" as found in Minn. Stat. § 144.413, Subd. 2. This regulation is necessary to establish a single reference to what is considered to be a place of work which shall be regulated under the Clean Indoor Air Act. It is the intent of this act to protect the health of the public in all enclosed indoor areas which serve as a place of work and therefore the definition is developed to include all such places.

The definition states that two or more individuals must perform such services and that such services must be performed in consideration of payment. This definition then applies to any two individuals under working conditions in which case it is reasonable to expect that either one of these such persons could be a smoker or nonsmoker.

It is reasonable and necessary to state that this definition applies to any type of employment relationship for which individuals are paid and that the term also applies to locations where individuals perform services gratuitously when individuals are ordinarily paid for such services.

To provide clarity in the separation of responsibilities between the Department of Health and the Department of Labor and Industry, this definition describes the situations in which places of work are regulated under rules of the Minnesota Department of Labor and Industry. Such application to the rules of the Minnesota Department of Labor and Industry are called for in Minn. Stat. § 144.414 in relation to the category of "factories, warehouses and similar places of work."

MHD 442(k). "Private Social Functions."

This definition relates directly to Minn. Stat. § 144.414, which states that the general prohibition of smoking in a public place except in designated areas does not apply at a "private social function." Nevertheless, the law requires certain conditions to be met in order for the function to be considered such a "private social function." Three such conditions are listed in this definition. The first

condition which must be met is that the function must be a specific social event for which the entire room has been reserved. This condition is drawn from Minn. Stat. § 144.414 where it states that this exception applies "in cases in which an entire room or hall is used." It is further reasonable that such function be a specific social event and not merely a customary social gathering for which the person in charge could reasonably be prepared to provide a smoking and nonsmoking area. This act is intended to protect the environment of individuals who may be regular members of an establishment and in cases where the regular operator of the establishment is in charge it is proper that the act should apply.

The second condition in the definition is necessary to clarify the word "private" and to make it certain that attendance at such function is limited to "specifically designated" people and their guests. This is a reasonable interpretation of the word "private" and is consistent with common usage by the general public.

The third condition in this definition is that seating arrangements for this function be under the control of the sponsor of the function and not of the person otherwise responsible for the public place. This condition is drawn from Minn. Stat. § 144.414, where it is stated that an exception is permitted for private social functions where "seating arrangements are under the control of the sponsor of the function and not of the proprietor or person in charge of the place." Even though such terminology is stated directly in the act, we feel that it provides more clarity to include all conditions in the definition developed for these rules.

MHD 442(l). "Proprietor."

This definition is necessary to clarify those portions of the statute and rules which make reference to the "proprietor" of a public place or a public meeting. Without this definition there may be ambiguity as to who is responsible for enforcement of the act.

Minn. Stat. § 144.416 describes responsibility of "proprietors". Such responsibilities are posting of signs, arranging of seating, asking smokers to refrain from smoking, and other means which may be appropriate. These activities are appropriate for the person who ultimately controls, governs or directs the activities within the public place and would not be appropriate for the owner of the property if he is not the person who ultimately controls, governs or directs the activities. Nevertheless, there may be situations where the actual owner of the property actually does operate such property and in such case this person would be the "proprietor."

MHD 442(m). "Public Conveyance."

This provision is necessary to clarify any possible ambiquities which would occur from the use of the term "public conveyance" in Minn. Stat. § 144.413, subd. 2 or MHD 444(e). The definition was derived from the definition of "bus" in highway traffic regulations Minn. Stat. § 169.01, subd. 50. Such definition of the term "bus" means every motor vehicle designed for carrying more

then ten persons and used for the transportation of persons, and every motor vehicle other than a taxi cab designed and used for the transportation of persons for compensation.

This definition includes all such air, land or water vehicles used for the transportation of persons for compensation and includes all of the vehicles which would commonly be considered for such purposes.

In the operative provision for this term, MHD 444(e), the rules take up the matter of a more flexible requirement for public conveyances with a capacity of less then ten persons. Such differentiation of public conveyances is consistent with the highway traffic regulations cited above.

MHD 442 (n). "Responsible Person."

This definition is necessary to allow a shorter reference to the terms "proprietor or other person in charge" as it is used throughout M.S. §144.414 through 144.417. The term "responsible person" is an accurate description of the substitive intent of the terms "proprietor or other person in charge" and will provide for easier reading of the rules.

MHD 442 (o). "Restaurant."

This definition relates to another category of public places which is included in Minn. Stat. § 144.413, Subd. 2 and MHD 444(d). The term "restaurant" is specifically included as a "public place" and it is necessary to provide a definition of the term to avoid ambiguity in application of the act and these rules.

Under the Minnesota Clean Indoor Air Act, the term "restaurant" does not necessarily refer to the same establishments which are licensed as such under Minn. Stat. § 157.01. The intent of the licensing definition of "restaurant" is to maintain environmental standards in any places which serve, or prepare for service elsewhere, any type of food. However, the Clean Indoor Air Act is directed to the functional activity for the public and we feel that it is reasonable to not include establishments where food is not actually consumed in this definition. Establishments which prepare food but do not make it available to the public to be consumed on the premise are covered under the general provisions of the Clean Indoor Air Act as a "place of work," unless they are also a "bar," as defined in MHD 442(c).

The definition includes any area advertised as or held out to be a place where meals may be consumed by the public. That statement is necessary to provide clarity to the public; however, the operative provision, MHD 444(d) permits the place to consider itself a "bar" at times of the day when alcoholic beverages, but no meals, are being served and consumed.

MHD 442(p). "Room."

This definitional provision is necessary to clarify those portions of the statute and rules which make reference to a "room." The rule permits a uniform interpretation of the term which has varying common reference within the public.

This definition states that the room shall be bordered on all sides by a wall or partition of at least 56 inches in height. This distance is consistent with the height used in MHD 442(a) and is reasonable and necessary to provide adequate but not burdensome separation of one area from another. This definition furthermore states that the sides must be continuous and solid except for doors, openings or similar such spaces for entry or exit. In this situation it is reasonable that the openings or spaces for entry or exit are present but otherwise there shall be no air transfer in and out of the "room" below the height of at least 56 inches.

MHD 443. GENERAL PROVISIONS.

This section of the rules provides a description of the regulatory concepts which shall apply to all public places which are regulated under Minn. Stat. § 144. These subjects are needed to give the reader broad knowledge of the general application of these rules and the following concepts:

(a) Description of a proper smoking permitted area.
(b) Description of such area when it is in a single room.
(c) Acceptable signs.
(d) Acceptable smoke free area.
(e) Responsibility of responsible person.

The concept of each of these general provision subjects originate in the language of the Minnesota Clean Indoor Air Act and are necessary and reasonable to implement the provisions of the act. These proposals are all consistent with the scope of the authority given to the State Board of Health in Minn. Stat. § 144.417, subd. 1.

MHD 443(a). "Smoking Permitted Area."

This proposed rule deals with four separate subjects related to the concept of placement and size of the smoking permitted area, if such area is designated by the responsible person. These subjects, discussed individually below, are necessary to avoid uncertainty and ambiguity in dealing with the act and rules.

MHD 443(a)(1) clarifies that the responsible person has the authority to designate an area as "smoking permitted." Such area is permissible but not mandatory within a public place or public meeting. This section of the rules is a clarification of

Minn. Stat. § 144.4[redacted] where the basic authorit[redacted] to designate a smoking permitted area is given.

To remain consistent with the intent of the legislation and to help assure an acceptable smoke free area in the public place, this rule requires that there be one and only one smoking permitted area per room. The only exception to this rule shall be in rooms which have at least 20,000 square feet in total floor space in which case more than one smoking permitted area may be permitted. This exception is permitted in recognition that it would be reasonable for the smoker to walk a distance of no more than approximately 5,000 feet to find a smoking permitted area. Assuming approximately square dimensions of a room, the room containing at least 20,000 square feet in total floor space is the type of room which would apply to this concept. For example, the Minneapolis/St. Paul Municipal Airport Terminal is a single room of more than 20,000 square feet. It should be possible for that facility to have more than one smoking permitted area. Therefore, for airport terminals and other extremely large rooms, it is reasonable for this section to be included.

The next rule, MHD 443(a)(2) is a rule which explains that a public place containing two or more rooms which are used for the same activity may be divided up by the responsible person such that one entire room is used as smoking permitted so long as at least one other comparable room has been designated as a no smoking area. In this situation the responsible person is not required to use this method for designation of smoking permitted areas, but if one room is entirely designated as smoking permitted then there is responsibility to have at least one other comparable room with a no smoking area. The term "comparable" is used to prevent abuse of the law in which a substandard room could be designated as a no smoking area. This rule is in clarification of Minn. Stat. §§144.415 and 144.416(b).

MHD 443(a)(3) is also an elaboration of Minn. Stat. § 144.415 and 144.416(b) where the designation of smoking permitted areas are described. We feel it would be contrary to the basic intent of this legislation to have smoking permitted areas which would be located in complete areas that non-smokers would be required to use to participate in activities for which the public place is intended. It is necessary to have a specific prohibition against designating such complete sections for smoking permitted. The basic public policy for this act, stated in Minn. Stat. § 144.412, requires prohibition of smoking in public places and public meetings except in designated smoking areas and it is felt that these designated smoking permitted areas shall be arranged to provide smoke free access to the activities which are conducted in the public place.

MHD 443(a)(4) describes the general method in which the proprietor should decide the size for designation of a smoking permitted area in a public place if such an area is provided. For consistency with the intent of the legislation and to provide for a reasonable method for implementation of the act the provision for a size of a designated smoking permitted area is made "not more than proportionate to the preference of patrons of that location for a smoking permitted area." Furthermore, it is required that the responsible person in the public place must

demonstrate that the size used in the area is reasonable for the patrons of that location. Other size standards such as an absolute minimum percentage or a mimimum square footage were considered. However, due to difficulty in enforcement of such standards by the Minnesota Department of Health and because of lack of ability to find a percentage or square footage which would be reasonable and proper for all public places, this alternative was rejected.

This rule places the responsibility for determination of the size of the smoking permitted section on the responsible person, for that person's own location. This is the most practical method for such determination and as long as the method is consistent with the Law and these rules, any reasonable method may be used by the responsible person. Methods for size determination could be a combination of either surveys of customers and/or recording of the number of people who ask for smoking permitted areas in some period of time. For example, the following methods would be acceptable:

(1) The proprietor could start with designation of 50% of the facility as a smoking permitted area and the remainder no smoking. Then the proprietor could observe whether or not the size of those areas are adequate or excessive for customer demands. Then changes could be made in response to those demands.

(2) For a limited period of time all customers could be asked their preference for smoking or no smoking areas. These numbers could be recorded and the seating designated accordingly.

The proprietor's designation would be acceptable by health department inspectors as long as the method of designation is reasonable and there are not a significant number of citizen complaints that the size has not been adequate.

MHD 443(b). "Single Room."

This rule specifies parallel requirements for a public place consisting of a single room as that concept is described in Minn. Stat. § 144.415. This provision of the law states that the proprietor shall be deemed in compliance if one side of the room is reserved and posted as a no smoking area.

Posting a portion of the room as "no smoking area" is the reversed concept from the general prohibition within this law in Minn. Stat. § 144.414 where smoking is prohibited in the entire public place except in designated smoking permitted areas. Therefore, it is considered to be reasonable and necessary to promulgate a rule bringing this exception into as much continuity with MHD 443(a) as possible.

MHD 443(b)(1) is intended to parallel MHD 443(a)(1) which states that the responsible person for a public place shall have the responsibility for reserving and clearly designating a no smoking area.

MHD 443(b)(2) deals with the size of the no smoking area which would be required in a public place consisting of a single room. As in the above general designation of a smoking permitted area, the responsible person has the burden to demonstrate that the size of the no smoking area shall be at least proportionate to the preferences of patrons of that establishment for a no smoking area. We have not been able to find a proposal which provides more consistency with the general prohibition and we feel that this proposed rule is reasonable and necessary to implement the act.

MHD 443(c). "Signs."

This proposed rule deals with seven separate provisions related to the signs necessary to implement the act. The provisions are necessary to effect a uniform interpretation of Minn. Stat. § 144.416(a), which states that it is the responsibility of the proprietor or other person in charge to make reasonable efforts to prevent smoking in a public place which may include "posting appropriate signs." This rule therefore describes what shall be considered to be appropriate and is consistent with the scope of the rule making authority given to the State Board of Health in Minn. Stat. § 144.417, subd. 1.

MHD 443(c)(1) clarifies the statutory provision in Minn. Stat. § 144.415. That section of the act provides the following requirement for a "bar":

> "No public place other than a bar shall be designated as a smoking area in its entirety. If a bar is designated as a smoking area in its entirety, this designation shall be posted conspicuously on all entrances normally used by the public."

This rule maintains the same basic terminology of the statute and additionally explains that being posted on all entrances shall include posting either on all outside entrances or in a position clearly visible on entry into the establishment.

MHD 443(c)(2) is necessary to provide clarity for locations where smoking is prohibited in the entire public place. It is reasonable and necessary for such locations to be deemed in compliance if they have posted a statement "no smoking is prohibited in this entire establishment" on all outside entrances or in a position within the establishment.

MHD 443(c)(3) provides clarification of Minn. Stat. §§ 144.414, 144.415 and 144.416 by stating the words which must be used on signs which identify smoking permitted or no smoking areas. The words "smoking permitted" and "no smoking" were chosen as a standard, understandable wording which are considered to be minimally necessary to provide adequate notification to the public. In this rule it is stated that additional words and symbols may be used as long as the additional printing does not obscure the basic words.

MHD 443(c)(4) again describes the system for designation of a smoking permitted area as found in the above statutory citations. This rule states that the height and location must be "easily

seen by a person in the establishment" and that such signs shall be "not obscured in any way."

It is further stated in MHD 443(c)(4) that the signs shall be in printed letters of not less than 1.5 inches in height. This height was selected because printed letters of 1½ inches in height provides adequate readability at a distance of 60 feet in normal lighting conditions and with normal vision. Printed letters of 1 inch or less are not visible within 50 feet of the sign and we feel are not reasonable to provide adequate posting of the sign.

The boundary between no smoking and smoking permitted areas is another subject of MHD 443(c)(4). The boundary must be "clearly designated so that persons may differentiate between the two areas." This rule provides flexibility in the method for posting of the boundary area but it leaves no doubt that there must be clear designation of the area and that the public must be advised of the availability of the no smoking area. For example, the boundary could be designated by a wall sign between the no-smoking and smoking permitted areas, by table signs, by different colored tablecloths, by aisle space between the two areas or by fixtures or physical barriers between the two areas.

MHD 443(c)(5) provides a parallel set of regulations for signs which are used on tables or seats to designate smoking permitted and no smoking areas. In this case the posting of "appropriate" signs shall mean printed letters of not less than ½ inch in height. This rule provides more flexibility for the proprietor and, at the same time, the letter and the intent of the law is maintained by the requirement that the responsible person conspicuously post at least one no smoking sign and one smoking permitted sign either on the boundary between the two areas or on the walls adjacent to the no smoking and smoking permitted areas.

To prevent the size of lettering on signs reading smoking permitted to exceed the size of lettering reading "no smoking", MHD 443(c)(6) provides for a clear prohibition against this practice. This rule is consistent with the intent of the law and the authority granted to the Board in Minn. Stat. § 144.417, subd. 1.

As a permissive rule intended to encourage public education and awareness of the existence of smoking prohibition, MHD 443(c)(7) advises that an explanatory statement on the concept of the Minnesota Clean Indoor Air Act may be conspicuously posted on the entry to any establishment. It is reasonable for establishments to use such signs and would be advisable for as many establishments as possible to help advance the purposes of the act.

MHD 443(d). "Acceptable Smoke Free Area."

This rule clarifies the intent of Minn. Stat. § 144.416, which explains the responsibilities of proprietors and other persons in charge of a public place. The term "acceptable smoke free area" is defined in detail in MHD 442(a) and this rule is necessary to describe the acceptable smoke free area with an operative provision.

The portion of Minn. Stat. §§ 144.416 which is ambiguous is the statement which reads that the proprietor is responsible for "arranging seating to provide a smoke free area." As we stated in the justification for MHD 442(a) it would be reasonable to expect that the proprietor would provide only an "acceptable" smoke free area.

This rule further clarifies the intent of Minn. Stat. § 144.415 which states the following:

> "Where smoking areas are designated, existing physical barriers and ventilation systems shall be used to minimize the toxic effects of smoke in adjacent non smoking areas."

The above section of the statute gives the Department of Health authority to require that the size and location of any smoking permitted area shall be determined such that the toxic effects of smoke are minimized in the adjacent no smoking area. While the proprietor still has general flexibility to designate a smoking permitted area as the business operation dictates, there must be a certain over-riding concern for the toxic effects of smoking which could be minimized more effectively in a better ventilated portion of the room or portion of the room with more physical barriers. Additionally, depending upon the capacity of people, ventilation systems and physical barriers, certain rooms will be able to tolerate a larger size of a smoking permitted area than other rooms and still maintain an air quality which would be satisfactory to the health and comfort of the general public.

MHD 443(e). "Responsibility of Responsible Person."

Minn. Stat. § 144.416 requires that the proprietor or the person in charge shall make reasonable effort to prevent smoking in a public place by doing certain required actions or alternatively, "any other means which may be appropriate." This rule therefore defines what additional methods the State Board of Health shall deem to be appropriate and to be in compliance with this statute.

It is reasonable to believe that as an alternative to posting signs, arranging seating and asking smokers to refrain from smoking, the responsible person could be expected to ask all persons upon entry into the public place their preference for smoking or non smoking areas and that all persons are then directed to the appropriate area. This method would be particularly satisfactory for restaurants which currently use a host or hostess to direct people to seating and no further cost in personnel or changes in the seating arrangements of the facility would be required.

Nevertheless, so that all members of the general public know of this system for assuring the availability of a smoke free environment, at least one sign advising the public of this mechanism should be posted conspicuously at all entrances normally used by the public. Additional signs on tables or on the walls around the tables would not be necessary if all persons were asked their preference, but it is reasonable and necessary to expect at least one sign so that the general public is advised of the mechanism.

MHD 444. CATEGORIES OF AFFECTED PLACES.

MHD 444(a). "Applicability."

This rule explains the concept under which the rules in MHD 443 and MHD 444 apply for particular public places. This rule is necessary to explain the relationship between general provisions and specific categories of affected places and the applicability of each of these rules.

This rule furthermore explains the concept under which public places are designated into categories. The concept is for designation of functional areas, in contrast to the nature of a controlling establishment. For example, for a manufacturing corporation which operates a general office in a separate building, the offices would be categorized according to the functional activities and not the general nature of the activities of the controlling industrial corporation.

MHD 444(b). "Places of Work."

This rule is necessary to provide additional flexibility to places of work as included under the definition of "public place" in Minn. Stat. § 144.413, subd. 2. While the general provisions of MHD 443 apply except where there is irreconcilable conflict, there is need for permitting more than one smoking permitted area per room in a place of work due to the separation of employees according to activities within many work locations, the long period of time which both smoking and non smoking employees spend at the place of work, and the adverse economic effect which could be created by excess time off for smoking breaks or by separation of people doing related activities.

Therefore, under the authority granted to the Board of Health in Minn. Stat. § 144.417, subd. 1, this rule permits several, separate no smoking and smoking permitted areas within the same room, provided the no smoking areas are at least 200 square feet in area. The size of 200 square feet in area is determined on the basis of the standard, accepted square footage per person in commercial business offices being 150 square feet per person. This number was obtained from Minneapolis and St. Paul owners and managers.

In consideration of the 150 square feet per person standard, it was decided to require all no smoking areas to be a minimum area greater than 150 square feet. Hence, 200 square feet was selected as proper to maintain minimum space for a "smoke-free" environment.

"Checkerboarding" of no smoking and smoking permitted areas is herein allowed for places of work not customarily frequented by the general public because such places generally have working areas assigned by functional activities within the place of work. Alternation of such working locations, beyond a small distance to conform to 200 square feet no-smoking areas, would not be economically feasible for employers. Employers are still required to provide an "acceptable smoke-free area," as defined in MHD 442(a). With the 200 square foot minimum and "acceptable smoke-free" standards, it is felt that the health and comfort of non-smoking employees will be improved.

Since this rule applies only when the place of work is not customarily frequented by the general public and the people who are there would be expected to understand that smoking restrictions exist within the place of work, it would not be necessary to have all the sign provisions which are required in MHD 443(c). Nevertheless, it is reasonable and proper for the responsible person to be required to post at least one sign on each floor advising the employees and the infrequent visitor to the place of work that smoking is prohibited except in designated smoking areas. The responsible person would be expected to make a policy statement to all employees that smoking designated areas have been assigned.

MHD 444(c). "Offices."

To clarify the relationship between the Department of Health rules and rules promulgated by the Department of Labor and Industry, this rule is determined as necessary. Minn. Stat. § 144.414 states that the Department of Labor and Industry shall establish rules to restrict or prohibit smoking in "factories, warehouses and similar places of work."

With consultation from the Department of Labor and Industry, it was decided that the terminology "an office which supports activities which are principally to manufacture or assemble goods, products or merchandise for sale, or to store goods, products or merchandise not for the purpose of retail sale," was used to describe an office which supports a factory, warehouse or similar place of work. It is felt that for the purposes of clear and consistent regulatory authority between the various departments of state government, it is proper for only one agency to have regulatory authority in this situation. When an office is merely supportive of such a factory, warehouse or similar place of work, the Department of Health is willing to abdicate regulatory authority to the Department of Labor and Industry.

MHD 444(d). "Restaurant."

In addition to the general provisions dealt within MHD 443, this rule contains two concepts which clarify when a restaurant might be considered to be a "bar" or when the restaurant may be regulated under rules of the Department of Labor and Industry. The rule is necessary to prevent ambiguity in implementation of the act and to provide for uniform interpretation.

MHD 444(d)(1) states that during hours of operation when a facility does not serve food but does serve alcoholic beverages, then a facility may be considered to be a bar and may be considered under the section of the statute which deals with a "bar", Minn. Stat. § 144.415. It is common for a facility to not serve food throughout the entire business day and the clientele's purpose for coming to the establishment will vary considerably according to whether food is served or alcoholic beverages alone are served. Therefore, this rule will provide flexibility for certain operations and still provides adequate protection of the public's health.

Analogous to MHD 444(c) above, it is the purpose of MHD 444(d)(2) to clarify the relationship between the rules of the Department of Health and the Department of Labor and Industry which apply to the restaurants which are supportive of a "factory, warehouse or similar place of work." Minn. Stat. § 144.414 permits the Department of Labor and Industry to promulgate rules which apply to "factories, warehouses and similar places of work" and for regulatory consistency, the Department of Health feels that the restaurants which merely support such activity should be also regulated under rules of the Department of Labor and Industry.

MHD 444(e). "Public Conveyance."

The term "public conveyance", as defined in MHD 442(m), is a specifically listed "public place" in Minn. Stat. § 144.413, subd. 2. This rule states that the basic prohibition of Minn. Stat. § 144.414 does apply to a "public conveyance" and that smoking permitted sections may be designated in a public conveyance as long as the capacity is more than 10 persons including the driver.

Nevertheless, in smaller public conveyances, having a capacity of less than ten persons, it would not be reasonable to permit smoking in any portion of such public conveyance unless the driver and all passengers express their consent. Public conveyances of this size, commonly considered to be taxi cabs, have a low ceiling and a square footage of generally less than 60 square feet. We feel that it is not likely that a smoke free area could be maintained in such a public conveyance when there is any smoking permitted in the location. This concept for separate regulations of extremely small public conveyances is analogous with highway traffic regulations in Minn. Stat. §169.01, subd. 50.

The concept of permitting the driver and all passengers to express their consent for smoking permitted in the entire public conveyance is also analogous with the public policy created in Minn. Stat. § 144.413 for private, enclosed offices occupied exclusively by smokers.

MHD 444(f). "Educational Facility."

This rule is justified as a necessary clarification of Minn. Stat. § 144.413, subd. 2. Additionally, this rule is necessary due to the existence of Minn. Stat. § 609.685 which prohibits "use in any form of tobacco" by people under 18 years of age. This rule prevents ambiguity and permits clearer understanding of the combination of the prohibition against smoking of tobacco by minors and the provisions of the Minnesota Clean Indoor Air Act. Educational facilities are generally directed toward a specific age group of persons and this rule would therefore be practical to implement for individual educational facilities.

MHD 444(g). "Health Care Facilities."

This rule is necessary in consideration of the unique characteristics of residents of a health care facility in regard to both non smoking and smoking permitted practices. Patients of health care facilities are more likely to be suffering from a health condition which is adversely affected by toxic byproducts of cigarette smoke and therefore it is proper for these rules to have additional provisions for health care facilities beyond the general provisions of MHD 443.

Regarding the practice of posting of appropriate signs in MHD 443, there are many individual rooms in health care facilities. However, these rooms have largely similar uses and a consistent smoking restriction policy can apply to all these rooms. Therefore, to comply with Minn. Stat. § 144.416(a), which requires the proprietor to post "appropriate" signs, it is reasonable to require only one sign at the entrance to each floor or wing which states the policy for smoking prohibition on that floor or wing. Additional signs would not supply significantly greater information to the occupants of the building and additional cost for such signs could occur.

MHD 444(g)(2) provides for a choice of two procedures to implement the smoking prohibition or restriction in patient or resident rooms. This rule is reasonable and necessary to implement Minn. Stat. s 144.414, 144.415 and 144.416. The rooms of patients or residents are relatively small and any amount of smoking in such rooms could affect the health and comfort of non smoking patients. Therefore these alternatives for dealing with patient or resident rooms provide for maximum efforts to totally separate smokers from non smokers.

In the first alternative, MHD 444(g)(2)(aa), the responsible person for the health care facility must ask all prospective patients or residents or a person authorized to represent the patient or resident whehter a smoking permitted or no smoking area is preferred. When this procedure is accomplished, there is a satisfactory separation of smoking and non smoking patients with minimal administrative difficulty. When space is not available in a no smoking room and a person is admitted to a room originally designated for smoking, the right of the non smoker must prevail and smoking must be prohibited in that room. It is felt that this rule is consistent with the general intent of the Minnesota Clean Indoor Air Act and that the Board of Health is fully authorized to adopt this rule.

The second option for dealing with a resident or patient room in a health care facility is given in MHD 444(g)(2)(bb). This rule provides for the situation where the person responsible for the health care facility chooses not to use the above procedure for dealing with patient or resident rooms but instead chooses to designate rooms without asking the preference of patients or residents. In this case, due to the relatively small space in patient or resident rooms, the likely adverse effect of smoke on the health of people in the health care facility adn the general intent of the Minnesota Clean Indoor Air Act, smoking shall be prohibited in all such rooms except where occupied exclusively be people who smoke and persons who have expressed permission for smoking. This rule

clarifies the intent of Minn. Stat. 144.416(b) and is fully under the scope of the authority granted to the Board of Health in Minn. Stat. 144.417, subd. 1.

MHD 444(g)(3) is a rule that applies to visitors and staff of health care facilities. Visitors and staff are prohibited from smoking in patient or resident rooms unless the occupants expressly permit. As above, this rule considers the special health needs of residents or patients of health care facilities and visitors and staff should be discouraged from interfering with the rights of the patient or resident. This rule is authorized by Minn. Stat. § 144.414, the basic prohibition in Minn. Stat. § 144.416, the responsibility of proprietors to arrange seating (patient rooms) to provide a smoke free area.

MHD 444(h). "Hotels, Motels and Resorts."

This rule is necessary to clarify ambiguity which may occur in interpretation of portions of hotels, motels and resorts which are used for sleeping rooms rented to a guest. While the basic prohibition of Minn. Stat. § 144.414 does apply to this type of public place, it is felt that sleeping room which is rented to the guest is logically excluded from application of this law and that the prohibition does not apply to such accommodations. The concept of this exclusion is analygous with exception of a "private social function" in Minn. Stat. § 144.414.

MHD (h)(2) is a rule that applies to the common traffic areas in hotels, motels and resorts. This rule is consistent with the general provisions in MHD 443(a)(3), except that it is clearly stated that a portion of the seating area for a lobby or lounge may be designated as smoking permitted. This rule is necessary to avoid any ambiguity in consideration of lobbies or lounges in a hotel, motel or resort and is authorized under Minn. Stat. 144.414, 144.415 and 144.417.

MHD 445. APPLICATION FOR WAIVER OF THE LAW.

This rule specifies the procedure and the information that must be included in a request for waiver of the law. This is a clarification and an expansion of the authority given to the State Board of Health to grant such waivers in Minn. Stat. 144.417, subd. 1:

> "The State Board of Health may, upon request, waive the provisions of sections 144.411 to 144.417 if it determines there are compelling reasons to do so and waiver will not significantly affect the health and comfort of non smokers."

MHD 445(a) states that the responsible person for the public place or public meeting shall be required to submit a written application to the Board before consideration is made for a waiver. The procedure for waiver application is further made clearer by stating that any other information reasonably necessary to determine the merits of the waiver may be requested by the Board and a

failure to respond to such a request would cause inference or presumption by the Board that such information, if provided, would have been unfavorable to the applicant's position.

MHD 445(b) contains the basic requirements for the contents of an application for a waiver of the act. Minn. Stat. § 144.417, subd. 1, describes two basic types of evidence which must be provided by the applicant for a waiver. In order to protect the public health, comfort and environment as required in the Minnesota Clean Indoor Air Act, it is reasonable and proper for the Board of Health to demand that the evidence be "clear and convincing" in both of these subjects.

The first subject of evidence for a waiver request is "compelling reasons to necessitate a waiver." MHD 445(b)(1) deals with this particular requirement and specifies that endangering the ability of the public place to meet its cost of operation would be considered such a compelling reason. While this does not prohibit other mechanisms from being argued as a "compelling reason," this section does provide for more uniform interpretation of the statute and assistance in understanding the requirements for a waiver request.

Endangering the ability of the public place to meet its cost of operation is compelling because the statute was not intended to cause adverse economic effects or to cause termination of employment. That concept is found in Minn. Stat §144.415 where it is stated that no additional physical barriers or ventilation systems would be required to be installed. In consideration that the second subject of the waiver application requires protection of the public's health, it is reasonable that endangering economic viability should be considered a "compelling reason."

MHD 445(b)(2) relates to the second part of the statutory requirements for application for waiver of this law. This part of the law is ambiguous in its statement that the "waiver will not significantly effect the health and comfort of non smokers." This rule is therefore necessary to provide an objective, undisputable standard for the level of toxic byproducts of smoking which would be considered to be of effect to the health and comfort of non smokers.

The standard of 10 milligrams per cubic meter of carbon monoxide was selected for the reasons explained previously in MHD 442(a). In that justification of "acceptable smoke free area", the physiologic and pharmacologic effect on the non smoker is documented throughout the 1972 Report of the Surgeon General and numerous scientific references on carbon monoxide toxicity. Besides the greater risk for allergic individuals and people suffering from a cardiac or pulmonary malfunction, the dangers of carbon monoxide on the general public in smoking permitted areas is well documented. In view of the requirement that the waiver not significantly affect both the health and comfort of non-smokers, it is clearly reasonable and proper for this rule to state that the concentration of carbon monoxide in all sections of the public place shall not exceed the concentration of carbon monoxide in outside air by more than ten milligrams per cubic meter.

As stated in the justification for MHD 442(a), the concentration of carbon monoxide within the public place is compared to the outside air concentration of carbon monoxide within 12 feet of the building. This comparison is necessary due to the production of carbon monoxide from motor vehicles which could enter the public place via the ventilation system and therefore could contribute to a small portion of the carbon monoxide in the room. Other sources of carbon monoxide such as byproducts of kitchen equipment would be minimal and would not significantly contribute to the 10 milligrams per cubic meter of carbon monoxide.

MHD 445(c) relates to the standards that the Board of Health must apply in determining the eligibility of an applicant for a waiver. These details for determining eligibility of an applicant are not described in the statute and it is necessary to clarify the specific standards which would be used by the Board. This rule also is needed to give uniform consideration to all requests.

The first of three standards for determination of eligibility for an applicant for a waiver, MHD 445(c)(1), is the information actually supplied by the responsible person in the application for the waiver. This is a clearly understandable requirement for consideration by the Board and is listed merely to maintain consistency and to assure that all types of information are listed.

MHD 445(c)(2) is the second type of eligibility factor to be reviewed by the Board. The Board shall review the prevailing smoking restrictions and other practices related to similar public places in the community so that fairness is provided to all proprietors. It is proper for the Board to consider other examples and patterns for dealing with the Minnesota Clean Indoor Air Act in similar public places to see if there is a logical way for the applicant group to comply with the law without difficulty.

MHD 445(c)(3) is the third identified standard for the Board to apply in passing judgement on waiver requests. The public policy expressed in the Minnesota Clean Indoor Air Act is of utmost importance in dealing with efforts to waive the act and it is reasonable and proper for the Board to give broad consideration to the ramifications of waiver of the law.

The final rule related to application for a waiver of the law is MHD 445(d). This rule is necessary to clarify that the Board does make the final decision on waiver requests and that the applicant will be notified in writing of the decision on the request. This is a justified procedure, aimed at providing a prompt, clear decision on the matter and aimed at full information for the waiver applicant both on the nature of the decision and the reasoning used by the Board of Health in the matter.

Systemic and Myocardial Hemodynamic esponses to Relatively Small Concentrations of Carboxyhemoglobin (COHB)

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ARBON MONOXIDE was known to be extremely toxic gas long before Priest- s discovery of its chemical composition the late 18th century. The courageous lies of John Haldane,[1] performed upon self in 1895, clearly indicated the tionship between carboxyhemoglobin OHB) saturation and physiologic effect, also established the chemical basis for reactions between hemoglobin and car- monoxide.[2] Unfortunately, subsequent estigators interpreted Haldane's data as icating that COHB saturations below % to 20% were essentially harmless. A es of recent studies, however, have dem- trated that considerably lower concentra- s of COHB may produce definite altera- s in higher integrative activities of the tral nervous system and have raised the sibility that the levels of COHB found in blood of smokers and certain nonsmok- city dwellers may be sufficient to pro- e undesirable physiologic effects.

MacFarland and associates[3] were able to w a linear relationship between decrease visual discrimination and increase in COHB and observed significant impairment in discrimination with COHB levels as low as 4% saturation. Lilienthal and Fugitt[4] observed an impairment in flicker-fusion with COHB levels between 5% and 10% at 6,000 feet altitude, and Trouton and Eysenck[5] 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[6] before and after they breathed sufficient carbon monoxide to raise COHB levels to as high as 20.4%. Although significant correlations between pulse rate, blood pressure, or respiratory rate and COHB were not observed, Schulte was able to closely relate seven psychologic responses to COHB. COHB concentrations as low as 3% 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. Most recently, studies by Beard and associates[7] have demonstrated psychologic impairment at levels below 2% to 3% COHB.

Haldane,[1] Haggard,[8] and Chiodi and associates[9] observed significant cardiorespiratory responses when COHB concentrations were raised to 20% but lower concentrations generally failed to produce demonstrable effects. The effect of lower concentrations of COHB on cardiac function was seen in a recent study performed by Chevalier et al[10]

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rom the departments of medicine and surgery, St. cent's Hospital and Medical Center, New York.

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who observed a significant increase in the oxygen debt of exercise with COHB concentrations as low as 5%.

We have studied the physiologic effects of relatively small amounts of COHB by measuring acute cardiorespiratory changes following the inhalation of carbon monoxide in human subjects and in dogs.[11,12] This paper summarizes our findings on systemic hemodynamics and alveolar-capillary oxygen exchange, reviews certain aspects of myocardial metabolism, and presents an experimental model for the study of COHB and myocardial metabolism. Detailed studies on serial increases in COHB on five dogs are presented and data from 11 patients with lower levels of COHB discussed.

Theoretic Aspects

Changes in gas exchange following exposure to carbon monoxide are dictated by changes in the oxyhemoglobin dissociation curve in the presence of various concentrations of COHB as shown in Fig 1. The curve is shifted to the left so that if the same arteriovenous oxygen difference and therefore the same venous saturation is to be maintained, oxygen tension must decrease. This decrease in mixed venous oxygen tension is the major primary event; other hemodynamic changes must be considered secondary. The decrease in venous oxygen tension (and presumably in tissue oxygen tension) appears to initiate a series of stress responses which attempt to compensate for the decrease in oxygen tension. Data presented below suggest that the compensatory reaction resembles that seen with stimulation of the adrenergic nervous system.

Changes in coronary blood flow and myocardial oxygen extraction can best be appreciated by considering the differences between myocardial and systemic oxygen exchange. The coronary circulation differs markedly from the systemic circulation in its mode of adaptation to the increased oxygen requirements of stress. Peripheral tissues normally extract about 25% of the oxygen present in arterial blood and the remaining 75% serves as a reserve supply. Total oxygen uptake may be increased by increasing the amount of oxygen extracted from the perfusing blood and by increasing the rate of blood flow. In periods of stress, for example, mixed venous oxygen tension may drop from a normal of 40 mm Hg to below 20 mm Hg. In contrast, the exorbitant resting myocardial oxygen needs are met by extracting a much greater fraction of oxygen from the perfusing blood than the systemic tissues. Approximately 75% of oxygen is extracted from the coronary circulation at rest and coronary venous blood is about 25% saturated corresponding to an oxygen tension of 20 mm Hg. If increased myocardial oxygen needs were met by increasing oxygen extraction as in the peripheral circulation, coronary venous and myocardial cellular oxygen tension would fall to dangerously low levels. The coronary circulation avoids low oxygen tensions by increasing flow rate in response to increased oxygen demands rather than increasing oxygen extraction. Near maximal resting extraction and the ability to increase oxygen consumption by increasing flow allow performance of continuous contractile work at rest and also provide the ability to increase cardiac work with exercise. Coronary vascular disease may prevent an increase in local coronary blood flow in response to need. In this situation, the myocardium is forced to extract more oxygen but does this at the expense of a markedly reduced coronary venous and tissue oxygen tension.

Myocardial oxygen consumption, the product of coronary blood flow and the difference between arterial and coronary sinus oxygen content, is a complex function of external ventricular work, myocardial wall tension, and fiber length, rate of development of ventricular pressure, and heart beat rate.[13] Increasing oxygen requirements must be met by increasing oxygen consumption or myocardial ischemia and necrosis develop. If oxygen is plentiful, glucose and lactate are extracted from the coronary perfusate and metabolized to pyruvate in the glycolytic cycle. Pyruvate from this source together with directly extracted pyruvate and acetate fragments from fatty acid degradation are converted to acetyl coenzyme A and oxidized in the citric acid cycle liberating energy, carbon dioxide, and water. In periods of insufficient oxygen supply, the citric acid oxidative cycle is inactivated and pyruvate accumulates in the cytoplasm. A small

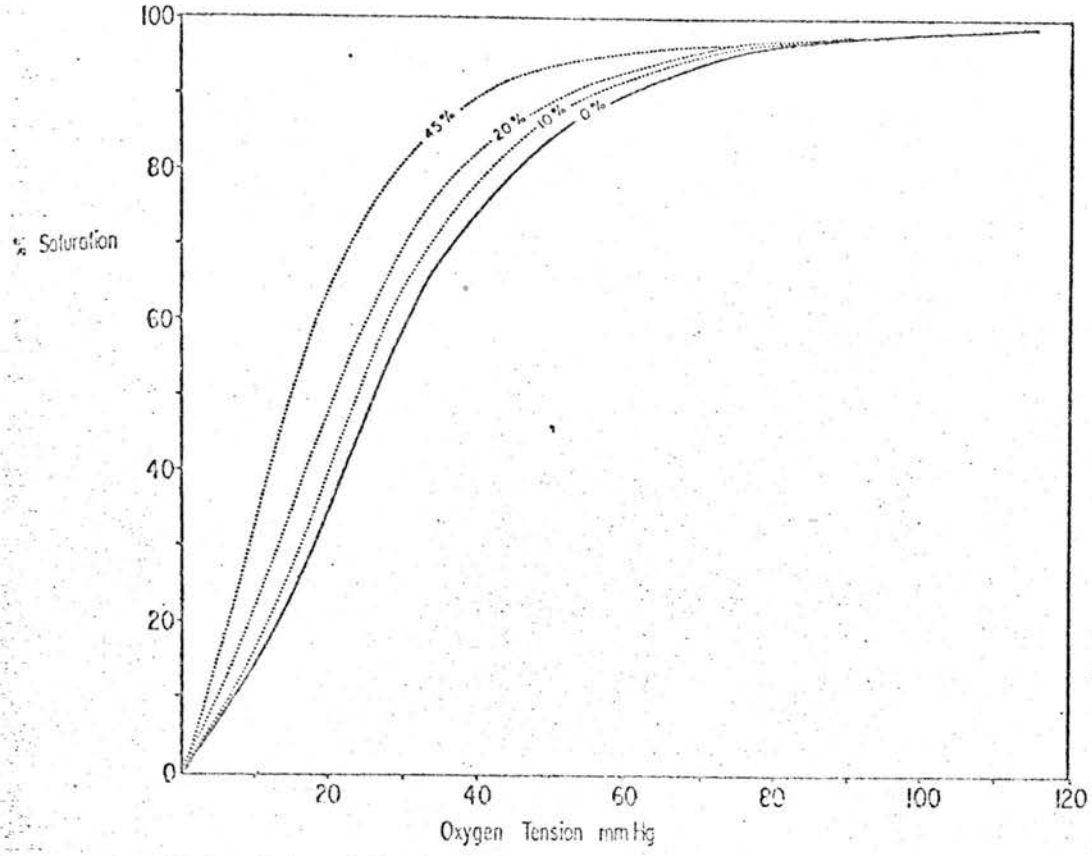


Fig 1.—Oxyhemoglobin dissociation curve in the presence of varying amounts of carboxyhemoglobin. Leftward shift of curve demonstrated by plotting oxyhemoglobin saturation of hemoglobin not combined with carbon monoxide against oxygen tension.

amount of energy is produced by glycolysis as the enzyme NAD (DPN in the older classification) oxidizes one of the glycolytic intermediates and produces high energy bonds. The cytoplasmic supply of NAD would soon be exhausted if a mechanism for its regeneration did not exist. Accumulating pyruvate is reduced to lactate by the reduced form of NAD (NADH) and, in the process, NADH is oxidized to NAD, permitting continued operation of the glycolytic cycle. In summary, inadequate oxygen decreases the utilization of pyruvate by the citric acid cycle, pyruvate accumulates in the cytoplasm and lactate is produced from the accumulating pyruvate.

Increasing cellular concentrations of lactate and pyruvate decrease the diffusion gradient between coronary perfusate and cytoplasm and decreases the extraction of these metabolites. Normally, arterial lactate and pyruvate concentrations determine the diffusion gradient so that the arteriovenous difference (or extraction) is a function of arterial lactate or pyruvate concentration. The extraction ratio of either lactate or pyruvate (the arteriocoronary sinus difference divided by arterial concentration) is a useful index for expressing extraction which is relatively independent of arterial concentration. Although increasing arterial concentrations may increase the extraction ratio slightly, the ratio does not decrease with decreasing arterial concentration so that a decrease in extraction ratio may be considered due to some intracellular alteration. The extraction ratio for both metabolites ranges from 15% to 30% when oxygen is plentiful. In periods of inadequate oxygenation, extraction decreases and lactate and pyruvate may actually be produced by the myocardium so that coronary sinus concentrations exceed arterial concentrations.

Huckabee[14] has pointed out that en-

hanced glycolysis or increased fatty acid degradation without oxygen lack may decrease lactate extraction. He has proposed calculation of "excess lactate" based on a rearrangement of the mass action equation and assuming that the lactate-pyruvate ratio is related to the intracellular redox relationships (NAHD/NAD ratio). Although theoretically attractive, recent observations have suggested that the extracellular lactate-pyruvate ratio may not be related to either cytoplasmic or mitochondrial NADH/NAD ratios and thus may not accurately reflect intracellular oxygen deficit.[15] For this reason we have preferred to concentrate on cellular extraction and this paper presents data on the myocardial extraction ratios of oxygen, lactate, and pyruvate. Detailed data on arterial lactate and pyruvate concentrations, excess lactate, and lactate-pyruvate ratios are included for the serial canine studies.

Methods

Studies were performed on 26 patients during routine diagnostic cardiac catheterization and in 31 dogs. The patients were studied in a cardiopulmonary laboratory following completion of diagnostic procedures. Catheters were placed in the ascending aorta and pulmonary artery. A Goodale-Lubin catheter was placed in the proximal coronary sinus in 11 of the human studies and in 16 of the canine studies. Mixed expired air, arterial, mixed venous and coronary sinus blood was obtained prior to administration of carbon monoxide. The subject was then switched to a mixture of 5% carbon monoxide in air for from 30 to 120 seconds, with continual electrocardiographic monitoring. Following a ten-minute period to permit washout of alveolar carbon monoxide, repeat blood samples and mixed expired air were collected while breathing room air. Coronary blood flow was measured immediately before and ten minutes after carbon monoxide breathing.

Oxygen and carbon dioxide tensions and pH were measured by previously described electrode techniques.[16] Oxygen and carbon dioxide contents were determined by the Van Slyke manometric method. Expired air was analyzed for oxygen and carbon dioxide in the Scholander microanalyzer. Cardiac output was calculated by the direct Fick principle. Blood carbon monoxide content was measured by a gas chromatographic technique[17] and total ligand capacity obtained by measuring both carbon monoxide and oxygen content of a sample of the subject's blood previously shaken with ambient air. Blood samples were analyzed in duplicate for lactate by the method of Barker and Summerson[18] and for pyruvate by the method of Friedemann and Haugan.[19] Coronary blood flow was measured by the method described by Krasnow and associates[20] which uses I-131 iodo-antipyrine as a diffusable indicator.

In addition to the experimental studies described above, chromatographic measurements of blood COHB concentration were made on an unselected group of subjects either residing or working in New York city. Studies were also made on an "exposed" group of subjects working as tunnel guards in a New York city tunnel.

Results

COHB Levels in New Yorkers.—Figure 2 shows the COHB concentrations for a series of unselected subjects grouped by smoking history. Mean values for each smoking group are indicated by the short horizontal lines. Significantly higher saturations were observed in a small number of studies performed in tunnel workers; higher saturations were observed for each smoking group.

Systemic Gas Exchange Studies.—Table 1 shows mean values for selected respiratory measurements in 26 subjects before and after carbon monoxide inhalation. Note that oxygen extraction did not significantly change but that the oxygen extraction ratio increased indicating more complete extraction of oxygen from perfusing arterial blood.

The decrease in venous oxygen tension could be correlated with an increase in COHB concentration:
($PO_{2_{CO}}/PO_2$ control $= -0.04$ $COHB_{co}/COHB$ control $+ 1.03$).

In the regression equation, changes in oxygen tension and COHB concentration are expressed as ratios, value obtained during carbon monoxide breathing divided by control value. The decrease in arterial oxygen tension was not correlated with increasing COHB concentration in the human studies but when a wider range of COHB concentrations was analyzed by including the canine data (not presented in this paper) a good correlation between COHB and arterial and oxygen tension was observed.

Myocardial Metabolic Studies.—Detailed data from five canine studies in which

Table 1.—*Systemic Cardiorespiratory Measurements in 26 Human Subjects Before and After CO Inhalation*

Measurements	Control Mean	CO Mean	F‡	P§
COHB, % saturation	0.98	8.96		
Arterial PO_2, mm Hg	81	76	22.1	<0.01
Venous PO_2, mm Hg	39	31	94.5	<0.001
Arterial PCO_2, mm Hg	40	38	4.2	<0.05
Ventilation, Liters/min	6.86	8.64	4.1	<0.05
Cardiac output, liters/min	5.01	5.56	4.4	<0.05
Oxygen extraction, ml/100 ml*	4.30	4.56	2.7	<0.20
Oxygen extraction ratio†	0.27	0.32	31.2	<0.01
Alveolar-arterial O_2 difference	20	29	7.0	<0.05

*Oxygen extraction, arteriovenous oxygen content difference.
†Oxygen extraction ratio, oxygen extraction divided by arterial oxygen content.
‡F, variance ratio calculated for paired data with interaction as denominator.
§P, probability that observed difference between control and carbon monoxide means are due to chance.

Fig 2.—Distribution of carboxyhemoglobin saturation in a group of New Yorkers grouped according to smoking history (solid circles). An exposed group of tunnel workers (X) is included for comparison. Arithmetic mean is indicated by the horizontal line.

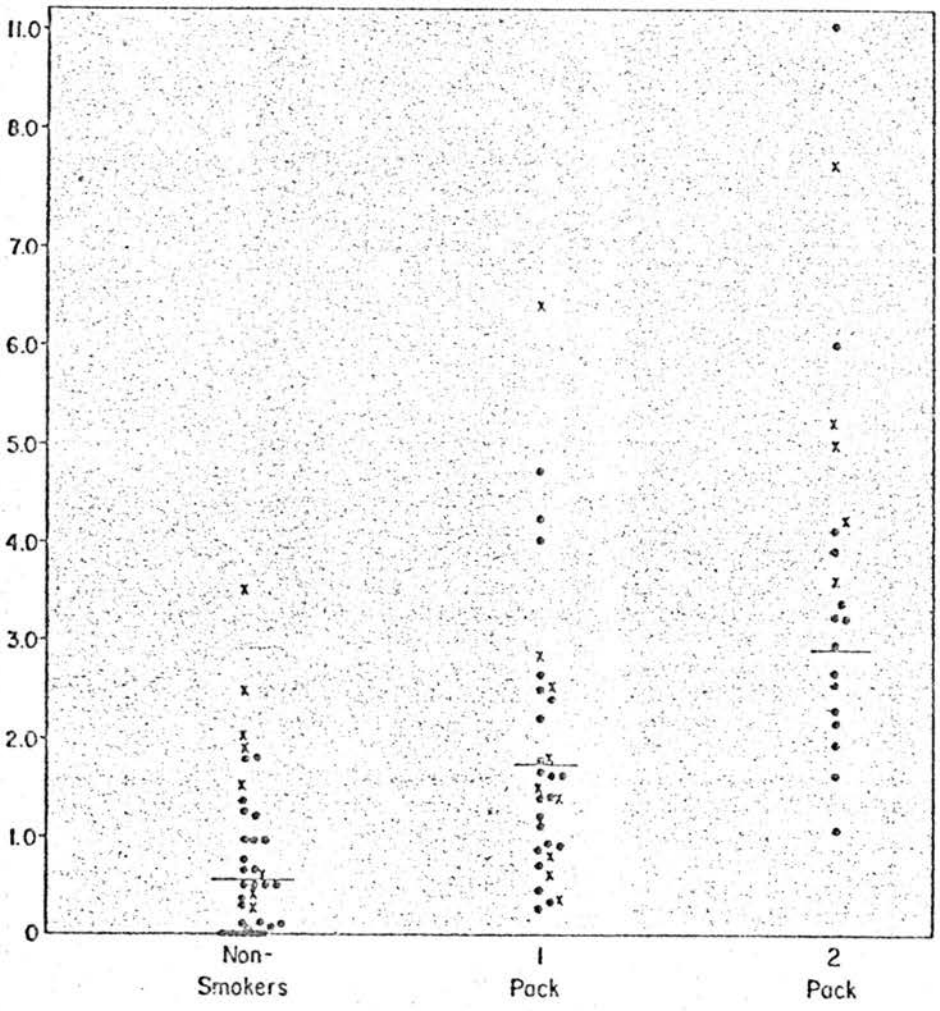


Table 2.—*Lactate and Pyruvate Metabolism, Oxygen Extraction, and Coronary Blood Flow in Five Dogs Before and After Serial Increases in COHB**

		Extraction Ratios†							
COHB	Q_M*	O_2	Lactate	Pyruvate	L_A‡	L/P Ratio§	XL‖	MVO_2¶	$PcsO_2$#
Control	131	0.83	0.42	0.28	0.87	8.66	—2.174	14.73	18
13	109	0.60	0.28	0.12	1.11	14.41	—0.180	8.35	19
50	512	0.36	—0.04	—0.03	1.24	17.14	—0.012	13.05	19
52	430	0.43	—0.82	0.10	3.64	60.00	3.401	10.22	7
Control	158	0.80	0.29	0.36	3.18	16.29	0.218	17.05	19
23	272	0.55	0.11	0.20	3.42	18.27	0.290	17.01	17
50	150	0.45	—0.10	—0.13	9.85	65.63	—0.295	3.68	10
63	D	0.21	—1.03	0.05	11.44	87.69	3.402	...	0
Control	123	0.69	0.61	0.49	1.40	13.46	—0.169	11.54	23
19	121	0.70	0.34	0.24	1.77	16.98	—0.231	8.56	13
33	396	0.38	0.11	0.17	2.70	21.77	0.145	11.90	14
42	...	0.45	—0.33	—0.61	3.23	31.15	—0.927	...	9
Control	75	0.77	0.42	0.16	1.31	17.25	—0.321	8.63	22
19	...	0.53	0.0	0.06	1.53	16.18	0.070	...	15
36	712	0.33	—0.43	—0.34	3.33	42.15	0.296	14.38	10
47	361	0.31	—0.23	0.12	8.26	85.42	2.935	2.77	3.2
Control	86	0.60	0.16	0.12	2.01	14.36	—0.086	6.12	28
29	103	0.56	0.19	0.33	3.91	20.90	0.218	6.59	16
45	338	0.49	0.07	0.17	4.66	16.26	0.475	13.05	11
57	D	0.59	—0.46	0.13	6.33	63.30	3.789	...	0

*Q_M, coronary blood flow in ml/100 gm/min (D, dog's death during sampling).
†Extraction ratios for O_2, lactate, and pyruvate are calculated as arterial-coronary sinus difference/arterial concentration. Negative sign denotes production by myocardium; positive sign, extraction.
‡L_A, arterial lactate in mM/liter.
§L/P, ratio of arterial lactate to arterial pyruvate.
‖XL, excess lactate (negative sign means absence of excess lactate).
¶MVO_2, myocardial oxygen consumption in ml/100 gm/min.
#$PcsO_2$, coronary sinus oxygen tension in mm Hg.

Table 3.—*Myocardial Metabolic Measurements in 11 Human Subjects Before and After Carbon Monoxide Inhalation**

Measurements	Control Mean	CO Mean	F	P
Group 1—Noncoronary Heart Disease (7 Patients)				
COHB, % saturation	0.95	9.00		
Q_M, ml/min/100 gm	129	196	6.5	<0.05
Oxygen extraction, ml/100 ml	11.84	8.89	52.7	<0.001
Oxygen extraction ratio	0.75	0.64	42.1	<0.001
MVO_2, ml/min/100 gm	14.3	15.9	0.4	NS
$PcsO_2$, mm Hg	21	17	2.9	<0.20
Lactate extraction ratio	—0.01	—0.19	0.7	NS
Pyruvate extraction ratio	0.28	0.24	0.3	NS
Group 2—Coronary Heart Disease (4 Patients)				
COHB, % saturation	0.66	8.69		
Q_M, ml/min/100 gm	102	127	0.5	NS
Oxygen extraction, ml/100 ml	12.71	8.82	34.7	<0.01
Oxygen extraction ratio	0.75	0.58	41.9	<0.01
MVO_2, ml/min/100 gm	12.9	11.3	0.5	NS
$PcsO_2$, mm Hg	19	17	12.9	<0.05
Lactate extraction ratio	0.12	—0.36	19.6	<0.05
Pyruvate extraction ratio	0.39	—0.07	25.6	<0.05

*Oxygen extraction = arterio-coronary sinus oxygen difference; oxygen, lactate, and pyruvate extraction ratios = respective extraction divided by arterial concentration. Other abbreviations as in Table 1 and 2. NS, not significant.

COHB was progressively increased is shown in Table 2 and Fig 3. Note the serial decreases in oxygen, lactate, and pyruvate extraction ratios and the marked increases in coronary blood flow. The asterisk in the final period of dogs 2 and 5 indicates the dogs' deaths during the period of sampling preventing measurement of coronary blood flow. In each instance, coronary sinus oxygen tension fell to zero and marked lactate production was observed. The changes in extraction ratios preceded the appearance of excess lactate.

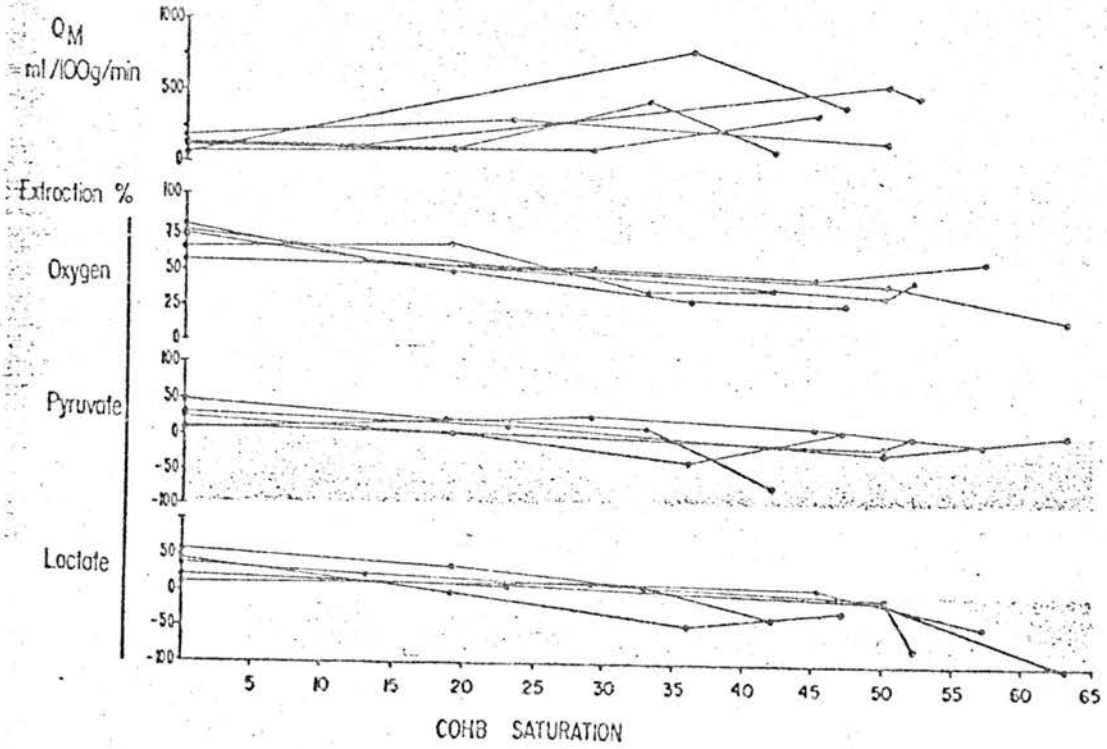
Table 3 lists mean data from seven patients with noncoronary heart disease and from four with arteriographically proven coronary artery disease. Oxygen extraction and extraction ratio decreased in each group and the decrease in oxygen extraction could be correlated with increasing COHB. Coronary blood flow increased significantly in the patients with noncoronary heart disease but not in those with coronary heart disease. Lactate extraction ratios changed to production in both groups but the change was statistically significant only for the patients with coronary artery disease.

Changes in three subjects, one with mitral stenosis, another with coronary artery disease, and a third with emphysema are shown in Fig 4. The patient with emphysema was hypoxemic with an arterial oxygen tension of 47 mm Hg. Extraction ratios, coronary sinus oxygen tension, and coronary blood flow are plotted on the vertical axis. The numerals on the horizontal axis refer to concentrations of COHB.

Comment

Inspection of the oxyhemoglobin dissociation curve in the presence of COHB suggests that venous oxygen tension must decrease if venous oxyhemoglobin saturation is unchanged. The data presented in this study confirm this prediction and demonstrate that raising COHB from a control level of 1% saturation to 9% produces about a 20%

Fig 3.—Coronary blood flow (Q_M) and myocardial extraction ratios for oxygen, pyruvate, and lactate plotted against increasing COHB saturation in five canine studies. Extraction ratios are calculated by dividing the arterial-coronary sinus difference by arterial content. A positive sign indicates myocardial extraction, a negative sign (crosshatched area) indicates myocardial production of a substance.



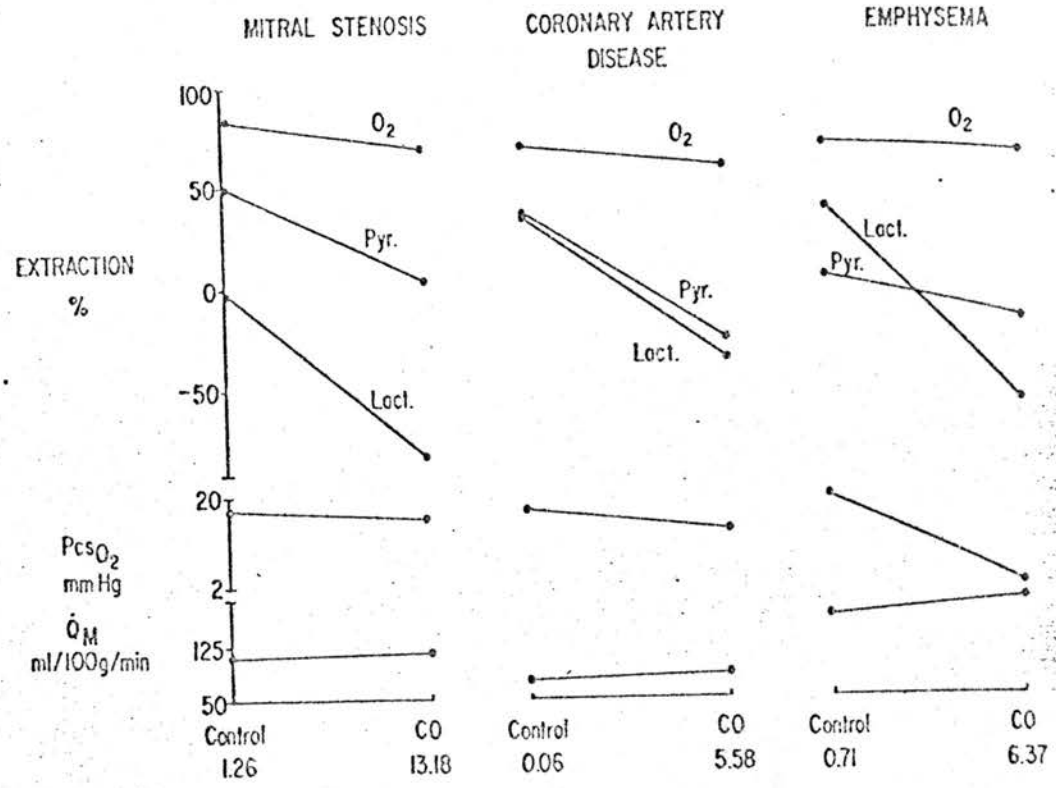


Fig 4.—Myocardial extraction ratios for oxygen, pyruvate, and lactate, coronary sinus oxygen tension (Pcs_{O_2}), and coronary blood flow ($\dot{Q}_M$) in three representative patients. Control and experimental concentrations of COHB are given on abcissa. Note consistent decline of extraction ratios.

decrease in mixed venous and presumably cellular oxygen tension. Since certain cells and their mitochondria are located at a critical distance from a capillary source of oxygen, a 20% decrease in oxygen tension might well inactivate certain oxidative enzyme systems and either decrease the energy production of that cell or lead to its death. These studies provide physiologic explanation for the observations of decreased psychologic function[3-7] and increase oxygen debt of exercise[10] following inhalation of low concentrations of carbon monoxide.

In order to facilitate the performance of these detailed physiologic studies both in a control state and following elevation of COHB to between 5% and 10% saturation, we administered an extremely high concentration of COHB for a short period of time. The breathing of 5% carbon monoxide, assuming normal alveolar-capillary diffusion, may be calculated to produce a maximum of 0.7% concentration in the alveolus. This would be high enough to almost completely saturate pulmonary venous blood so that the chemoreceptors in the aorta and carotid arteries would be exposed to an extremely low oxygen saturation, but a normal oxygen tension. The increases in minute ventilation and cardiac output might be due to this effect, although it has previously been thought that the chemoreceptors are responsive to oxygen tension rather than oxygen content. Transient exposure of the coronary vascular bed to high saturations of COHB would probably not produce a lasting effect. In order to develop an experimental model closely related to human exposures, additional studies following the breathing of 0.1% carbon monoxide for a longer period of time are now underway.

The extreme sensitivity of higher integrative functions to small concentrations of COHB is probably due to their great sensitivity to oxygen deprivation. Although in high concentrations carbon monoxide reversibly combines with cytochrome a_3[16] the affinity for the respiratory enzymes is much

less than that for hemoglobin so that death occurs from high concentrations of COHB long before significant inactivation of the respiratory chain occurs.[21]

Our finding that arterial oxygen tension decreased significantly following carbon monoxide inhalation was unexpected since the failure of arterial oxygen tension to fall has generally been considered to be characteristic of carbon monoxide poisoning. Several explanations for this observation may be advanced. The physiologic venoarterial shunt dilutes the arterial circulation by a variable quantity of venous blood. The oxygen tension drop caused by this saturation drop is magnified in the presence of COHB because of the shift of the curve to the left. Any increase in peripheral oxygen extraction enhances this decrease. Another possible explanation is the effect of COHB on the kinetics of oxygen uptake by hemoglobin in the pulmonary capillary.

The decrease in arterial and mixed venous oxygen tension appears to be a primary reaction which initiates a series of systemic compensations. Increasing cardiac output and minute ventilation are probably attempts to compensate for tissue hypoxia. They resemble the physiologic response to hypoxemia[22] and may be due to adrenergic sympathetic stimulation.

The coronary circulation responded to increasing amounts of COHB with relatively greater increases in blood flow than the systemic circulation. Most patients responded with some increase in coronary blood flow and exaggerated responses were seen in the canine studies where COHB was raised to above 50% saturation. The coronary blood flows of 819 and 1,180 ml/100 gm/min of heart tissue seem unphysiologic but were premortem and probably reflected massive dilatation of normal coronary vascular beds and opening of myocardial arteriovenous shunts.

The reason underlying the greater reactivity of the coronary vascular bed was discussed under theory. Oxygen extraction increased systemically so that increased oxygen consumption could be maintained with modest increases in cardiac output. The shift of the oxyhemoglobin dissociation curve and the maximal nature of myocardial oxygen extraction presented the myocardium with a homeostatic dilemma. An unchanged coronary sinus oxygen saturation would lead to an extremely low coronary sinus and tissue oxygen tension and subject many myocardial cells to near fatal conditions. Instead, myocardial oxygen extraction decreased allowing coronary sinus oxygen tension to remain almost normal. The critical response in this postulated chain of events is the coronary blood flow. A decrease in extraction must be balanced by an increase in coronary blood flow in order to maintain myocardial oxygen consumption. A normal coronary circulation could adequately increase coronary blood flow and keep tissue tensions within normal limits; a diseased vascular system might not be able to develop an adequate coronary blood flow response explaining the suspected sensitivity of patients with coronary artery disease to carbon monoxide.

The adequacy of myocardial oxygenation is a balance between oxygen demand and oxygen availability. While oxygen consumption may be readily measured, total work and heat production and thus total energy requirements cannot be easily determined. The measurement of myocardial lactate and pyruvate fluxes appears to be the best indicator of the balance between oxygen demand and availability although certain theoretic objections prevent unqualified acceptance of either extraction ratios or excess lactate. The canine studies showing that decreases in lactate extraction precede production of "excess lactate" partially validate the use of extraction ratios for the identification of anerobic myocardial metabolism. A further advantage of extraction ratios is their relative independence from arterial concentrations. This approach to the study of the human myocardium has also been emphasized by Cohen and associates.[23]

Figure 4 presents correlated events in three patients before and after acute elevation of COHB. In the patient with mitral stenosis, oxygen and pyruvate extraction decreased, lactate production developed, and a modest decrease in coronary sinus oxygen tension was observed. Similar changes were noted in the patient with coronary artery disease although pyruvate extraction shifted to production. In each patient the coronary blood flow response appeared inadequate.

Dramatic changes were observed in the patient with chronic obstructive lung disease who was hypoxemic at rest. Coronary blood flow was elevated at rest in response to chronic hypoxemia. A modest elevation of COHB to 6.37% saturation produced a decrease in oxygen extraction from 0.72 to 0.66. Both lactate and pyruvate extraction changed to production and the impact of the intervention on body oxygen exchange is emphasized by the drop in mixed venous and coronary sinus oxygen tension from 20 to 20 mm Hg, to 12 and 2 mm Hg, respectively. Had a myocardial oxygen tension of 22 mm Hg been sustained for a longer period of time serious consequences would have been a certainty.

Although the major effect of COHB on myocardial oxygenation appears to be the decrease in oxygen delivery and the need for increase in coronary blood flow, recent work suggests that COHB may also interfere with the diffusion of oxygen from capillary to mitochondria. Wittenberg has reviewed the physical diffusion of oxygen in cells[24] and proposed that myoglobin may facilitate the diffusion of oxygen in skeletal and cardiac muscle by reversibly combining with oxygen molecules, taking a short "random walk" and passing on the oxygen molecule to another uncombined myoglobin molecule. He has experimentally demonstrated that oxygen diffusion is much more rapid in myoglobin solutions compared to solutions of similar viscosity which do not bind oxygen. Should facilitated diffusion be shown to be a necessary process in cardiac muscle—and Wittenberg has postulated that it might account for from 50% to 90% of oxygen reaching the mitochondria during heavy work—carbon monoxide might well be found to exert a deleterious role by combining with myoglobin and intefering with facilitated oxygen diffusion. The reaction between carbon monoxide, oxygen, and myoglobin has an M value (affinity constant) about one sixth that for the reaction between carbon, oxygen, and hemoglobin. However, cellular oxygen tension is less than one fourth that of arterial oxygen tension so that a blood COHB of 10% saturation would be in equilibrium with 6% to 7% carboxymyoglobin. It is interesting to speculate on the effect of a 7% decrease in facilitated diffusion on mitochondrial oxygen tension in a normal subject during heavy exercise or in a patient with coronary artery disease at rest.

Summary

Cardiorespiratory measurements were made before and after acute elevation of COHB to an average of 8.96% saturation in 25 patients. Venous oxygen tension decreased from 39 to 31 mm Hg and significant increases in minute ventilation, cardiac output, peripheral oxygen extraction, oxygen consumption and the alveolar-arterial oxygen difference were observed. Coronary blood flow and myocardial extraction ratios for oxygen, lactate, and pyruvate were determined in a series of dogs and human subjects. Coronary blood flow increased and extraction ratios decreased following acute elevation of COHB. The decrease in myocardial oxygen extraction observed with increasing COHB contrasts with the increase in systemic oxygen extraction and constitutes an adaptive challenge to the coronary circulation.

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JAPAN'S YOUTH TOWER

The stature of Japanese youths has shown remarkable increase during the past decade. The age of maximal difference for boys was at 14 years (7.6 cm) and for girls at 11 years (6.6 cm). The increased stature is most marked in children born since the period of postwar shortages, who were thus less apt to have been exposed to handicaps during their critical preschool years. There is considerable evidence, both direct and indirect, that the increased growth rate in Japan has been stimulated by better nutrition. It seems evident that genetic factors could not have been responsible for the marked increases in stature of Japanese youth in one decade. For Japan as a whole, the total protein consumption has increased about 10% in the past decade, and the intake of animal protein has almost doubled. It may be pertinent to comment here that research workers have observed that protein as well as mineral malnutrition may greatly influence both the rate and character of bone growth.—Jackson, R.L.: Nutritional and Environmental Influences on Growth and Development, *J Amer Med Women's Assoc* 23:697-707 (Aug) 1968.

Appendix C

Review Article

Pathophysiology of Exposure to Low Concentrations of Carbon Monoxide

Donald Bartlett, Jr., MD, Cincinnati

THE BIOLOGY of carbon monoxide (CO) has been the subject of innumerable reports and reviews. The addition of this specialized review to the literature seems justified for three reasons. First, traditional studies of CO toxicology have rightly emphasized the dramatic effects of heavy exposures; remarkably little information is available about the consequences of exposure to the low concentrations found in polluted community air. Second, concern with environmental pollution is expanding rapidly, attracting the attention and participation of many persons not formally trained in biology; a summary of the somewhat complex biologic relationships of CO may be useful. Finally, quantitative comparisons of the effects of various hypoxic influences—CO, anemia, high altitude, and reduced blood flow—are presented in graphic form and discussed.

Basic Chemical Reactions

There is little doubt that the most important toxic properties of CO are attributable to its reactions with hemoproteins. The most important, and most thoroughly studied of these reactions is the reversible combination of CO with hemoglobin (Hb) to form carboxyhemoglobin (COHb), which for present purposes may be written as:

$$(1) \quad CO + Hb \rightleftharpoons COHb$$

Less important, but also of biologic significance, is the reaction of CO with myoglobin (Mb):

$$(2) \quad CO + Mb \rightleftharpoons COMb$$

Other proteins, including several enzymes, react in vitro with high concentrations of CO. Whether these reactions are significant in vivo is debated. Most evidence at present suggests that even if such reactions are of biologic significance, they occur only with CO tensions considerably above the range of community air pollution.[1]

Reactions (1) and (2), in their biologic settings, are discussed in more detail below. The alterations in steady state gas exchange resulting from equilibration with low partial pressures of CO are considered first, followed by a brief review of dynamic aspects of CO uptake and excretion.

Equilibrium Relationships (COHb)

When a person breathes air containing a certain concentration of CO for several hours, he reaches a state of equilibrium with respect to the gas in which the partial pressure of CO (P_{CO}) in the blood in the pulmonary capillaries is equal to that in the alveolar and ambient air. As long as the individual continues to breathe air with the same P_{CO}, no net uptake or excretion of CO occurs. (Strictly speaking this statement is inaccurate, as it neglects the endogenous production of CO and its metabolic conversion to CO_2.[2] Both of these processes are normally very slow, however, and may be neglected except under unusual circumstances.)

The equilibrium of reaction (1), meas-

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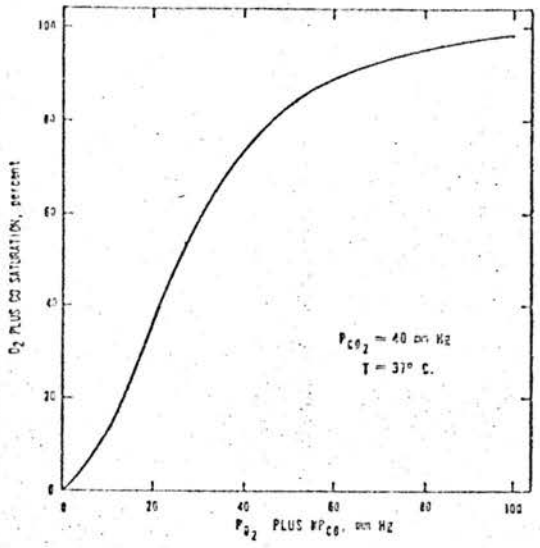


Fig 1.—Oxyhemoglobin and carboxyhemoglobin dissociation curve (After Rahn and Fenn[5]). The relative affinity constant (M) is numerically equal to 210.

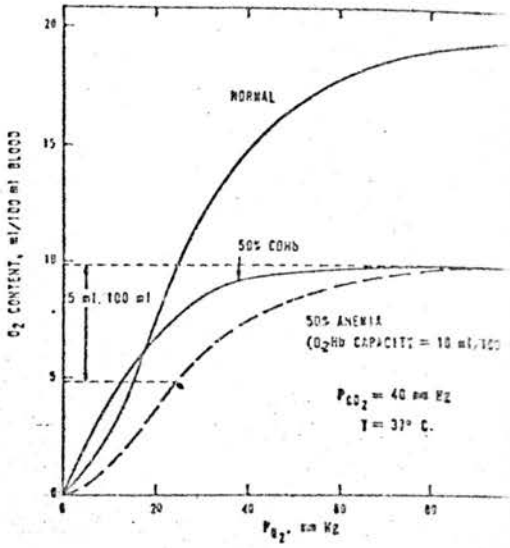


Fig 2.—Oxyhemoglobin dissociation curves of
mal human blood, of blood containing 50% carb
hemoglobin, and of blood containing 50% of the
mal amount of hemoglobin due to anemia. Note
the carboxyhemoglobin curve lies above and to the
of that of blood with an "equivalent" degree of ane

ured as the proportion of available hemoglobin combined with CO, depends not only on the partial pressure of CO, but on that of oxygen (O_2) as well, since the two gases compete for the same reactive sites on the hemoglobin molecule. This relationship is described by the Haldane equation:

$$(3) \qquad \frac{[COHb]}{[O_2Hb]} = M \times \frac{P_{CO}}{P_{O_2}}$$

where [COHb] and [O_2Hb] are the concentrations of the hemoglobin compounds expressed in any units (saturation percent, milliliters per 100 milliliters of blood, etc) and M is the relative affinity constant, numerically about 210 at physiologic temperature and pH. This equation has been repeatedly verified for cases in which the Pco and Po_2 together are sufficient to fully saturate the available hemoglobin. The relative affiinities of the two gases vary slightly when appreciable reduced hemoglobin is present.[3] Although this discrepancy is of considerable theoretical interest,[3,4] the variation in M with the degree of hemoglobin saturation is numerically small, and is therefore neglected in the following analysis.

The dissociation curve of COHb, in the absence of O_2, has the same sigmoid shape as that of O_2Hb and can be made to coincide with it by multiplying the Pco coordinates by M (Fig 1). From this curve and the Haldane equation, the absolute and relative concentrations of COHb and O_2 can be found if the Pco and Po_2 are kno Minor discrepancies between the curves CO and O_2 have been pointed out,[3] these may be neglected without introduc a quantitatively significant error.

Although the shape of the hemoglobin d sociation curve of either O_2 or CO alone sigmoid, the combination of part of available hemoglobin with CO shifts the dissociation curve for the remaining hem globin upward and to the left. Oxyhemog bin dissociation curves for human blood u der several conditions are shown in Fig These curves illustrate a point long est lished in the physiologic literature but oft neglected by industrial hygienists—that C interferes with O_2 transport by two mec anisms:

1. Displacement of O_2 from hemoglob in the arterial blood.

2. Interference with O_2 release in the t sues through alteration of the shape of t O_2Hb dissociation curve.

An example of the consequences of CO formation is shown by the two lower curv in Fig 2 which represent the blood of tw persons, one with 50% COHb, the oth with a 50% loss in O_2 capacity due to an mia. Both persons, breathing air, have a

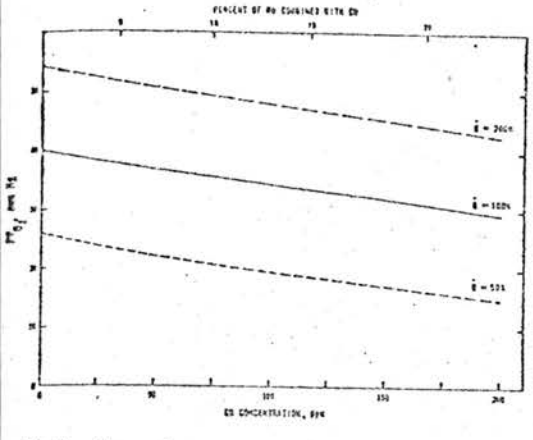


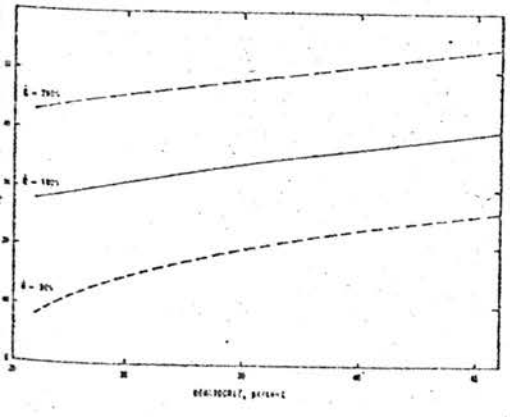
Fig 3.—Normal man at sea level: effect of CO on $P\bar{v}o_2$. Isopleths denote normal, half normal, and twice normal cardiac output ($\dot{Q}$) as defined in Table 1.

arterial O_2 content of about 9.8 ml/100 ml of blood. If metabolic demands require an arteriovenous O_2 difference of 5.0 ml/100 ml of blood, the mixed venous O_2 tension ($P\bar{v}o_2$) of the anemic person will be about 25 mm Hg, while that of the person with 50% COHb will be reduced to about 12 mm Hg—a level inconsistent with good tissue oxygenation. Although the COHb concentration in this example is far above those associated with community air pollution, the analysis illustrates the dual hypoxic effect of CO.

Theoretical Analysis of Hypoxia

A Theoretical Analysis of Hypoxia From Various Causes.—The ultimate expression of hypoxia resulting from any cause is in the body's peripheral tissues, where O_2 is consumed by cellular metabolism. Aerobic metabolic processes depend on maintaining tissue O_2 tension above a critical level, which varies among different tissues and in relation to other characteristics of the cellular environment, such as pH and temperature. Intracellular tissue gas tensions are difficult to measure directly, but changes in capillary Po_2 must reflect changes in tissue Po_2, barring large changes in capillary density or O_2 consumption.

Fig 4.—Effect of anemia on $P\bar{v}o_2$ in man at sea level.



In the absence of extensive arteriovenous shunting, the Po_2 of venous blood coming from a tissue is equal to the Po_2 at the venous end of its capillaries. Thus, venous Po_2 is a good indicator of the oxygenation of the tissue it represents. Mixed venous Po_2 is an indicator of the average tissue Po_2 of the whole body; individual organs and tissues may have higher or lower tissue and venous O_2 tensions, depending on their metabolic demands and blood supplies. Figures 3 to 8 represent a theoretical analysis of the degree of tissue hypoxia, reflected by the mixed venous O_2 tension, that may be expected under a variety of hypoxic stresses. To make the model applicable to the levels of CO associated with community air pollution, only fairly low concentrations are represented. Each curve in Fig 3, 4, 6, and 7 shows the $P\bar{v}o_2$ associated with the conditions specified.

The conditions of the model, unless otherwise noted, are those shown in Table 1. The blood nomogram of Dill, representing the combined O_2 and CO_2 dissociation curves of human blood, as revised by Rahn and Fenn,[5] is used throughout. The O_2 and CO in physical solution are neglected.

Figure 3 shows the effect on normal man of equilibration with various concentrations of CO at sea level. When cardiac output ($\dot{Q}$) is normal (100%), the $P\bar{v}o_2$ falls from a normal value of 40 mm Hg to less than 30 mm Hg after equilibration with 200 ppm CO. Curves for twice normal and half normal cardiac output are included for comparison. By the Fick principle, these may be used alternatively to represent half normal and twice normal rates of O_2 consumption, respectively. Figure 4 shows the effect of various degrees of anemia. Comparison with Fig 3 reveals, for example, that 75 ppm CO, which corresponds to about 10% COHb under these conditions, results in a mixed

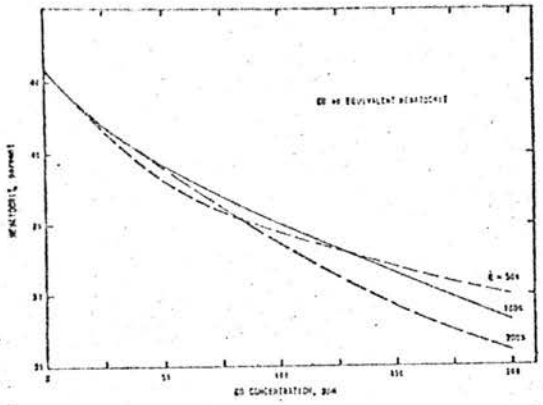


Fig 5.—Each curve shows CO concentrations and hematocrit values that are equivalent in terms of $P\bar{v}o_2$ for the cardiac output indicated.

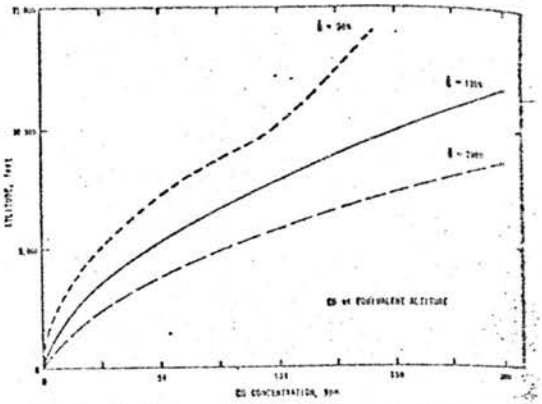


Fig 7.—Each curve shows CO concentrations and altitudes that are equivalent in terms of $P\bar{v}o_2$ for the cardiac output indicated.

venous Po_2 of 35 mm Hg; this is the $P\bar{v}o_2$ associated with a reduction in hematocrit value to 37%—nearly a 20% decrease from the normal value of 46%.

Figure 5 shows hematocrit and ambient CO values that are equivalent in terms of $P\bar{v}o_2$, determined as in the example above. Because of the peculiar shape of the O_2 dissociation curve, the relationship between CO levels and equivalent hematocrit values varies slightly with marked changes in cardiac output.

Figure 6 introduces another type of hypoxic stress—that of altitude. In calculating the mixed venous Po_2 for each altitude, the arterial Po_2 and Pco_2 used are those given by Rahn and Fenn for acute exposure[5]; after acclimatization, both arterial and venous O_2 tensions would be slightly higher.

Fig 7 shows altitudes and sea level ambient CO concentrations that are equivalent in terms of $P\bar{v}o_2$. Figure 8 shows equivalent altitudes and hematocrit values. By comparison with altitude, both anemia and CO have much greater effects on persons or tissues with reduced blood flow. For example, a man with normal cardiac output equilibrated with 100 ppm CO at sea level has a $P\bar{v}o_2$ of 34 mm Hg—that of a man at 7,800 feet. By contrast a man with half normal cardiac output under the same conditions has a $P\bar{v}o_2$ of 20 mm Hg—that of a similar man at 10,000 feet.

The Haldane equation, and thus the entire analysis presented above, describes the equilibrium state only. Kinetic aspects of COHb formation are discussed briefly later.

Effect of Smoking

Regular cigarette smokers have repeatedly been shown to have COHb concentrations

Fig 6.—Effect of altitude (acute exposure) on $P\bar{v}o_2$ in normal man.

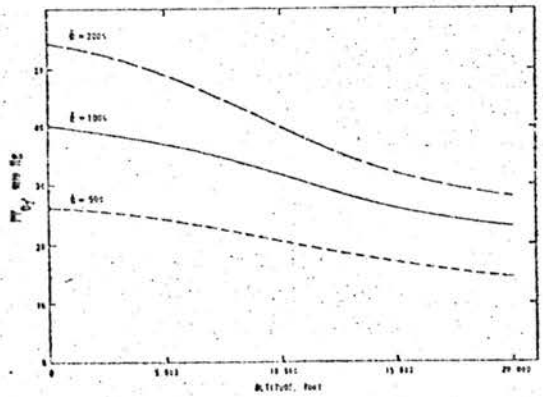


Fig 8.—Each curve shows hematocrit values and altitudes that are equivalent in terms of $P\bar{v}o_2$ for the cardiac output indicated.

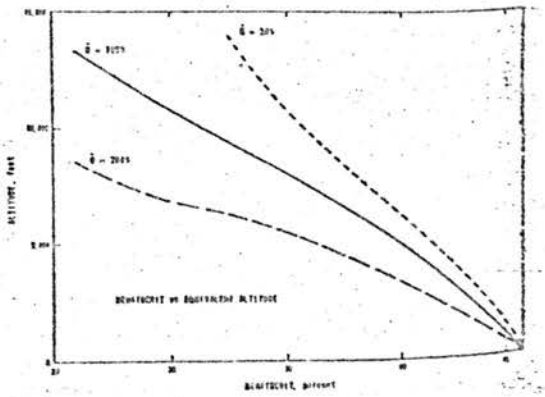


Table 1.—*Conditions of the Model of Steady State Gas Exchange Presented in Fig 3 to 8.*

Parameter	Assumed Value
Barometric pressure	760 mm Hg
Arterial P_{O_2}	100 mm Hg
Arterial P_{CO_2}	40 mm Hg
Arteriovenous O_2 content difference	5.0 ml/100 ml of blood when cardiac output ($\dot{Q}$) is normal (100%)
Normal O_2 capacity	20.0 ml/100 ml of blood
Normal hematocrit	46%
Respiratory exchange ratio (R)	0.8
M	210

in the 5% to 10% range.[6,7] Smokers of pipes and cigars have COHb levels that are somewhat lower than those of cigarette smokers, but higher than those of nonsmokers. These findings have led to the widespread error of supposing that smokers may be more susceptible to environmental CO than nonsmokers. Carbon monoxide from cigarette smoke and CO in the ambient air are not additive in their biologic effect. Carbon monoxide is absorbed only when the Pco in the ambient air exceeds that in the pulmonary capillary blood. Thus, persons with COHb levels of 5% from smoking do not absorb further CO from the environment unless the ambient CO concentration is 30 ppm or more; on the contrary, they excrete CO at a rate roughly proportional to the Pco gradient between their blood and the ambient air. This suggests that smokers may be among the least susceptible of persons exposed to low atmospheric concentrations of CO, since their COHb concentrations are not increased by the exposure. This conclusion is modified, however, by the fact that smokers' CO excretion between cigarettes is slower in a CO-polluted environment than in pure air. Thus, their long-term average COHb concentrations are slightly higher in the presence of environmental CO than in its absence.

Equilibrium Relationships (COMb)

The reaction of CO with myoglobin has been much less extensively studied than that with hemoglobin, but may be of considerable importance. Myoglobin accounts for about 20% of the body's CO capacity, hemoglobin accounting for nearly all of the remaining 80%.[2]

The equilibrium of reaction (2) may be expressed by a form of the Haldane equation:

$$(4) \qquad \frac{[COMb]}{[O_2Mb]} = K \times \frac{P_{co}}{P_{o_2}}$$

In this case, however, the relative affinity of the protein for CO over O_2 is less than for hemoglobin, the numerical value of K being about 40.[8]

The combination of O_2 or CO with myoglobin occurs without the formation of intermediate compounds, since only one heme group is present in each protein molecule. Accordingly, the dissociation curve of either gas with myoglobin is hyperbolic (Fig 9).

The biologic importance of myoglobin is uncertain. Situated in the sarcolemma of the muscle cell, between the capillaries and the mitochondria, it is usually thought of as an O_2 reservoir that can be tapped to supply mitochondrial needs during muscular contraction, when capillary blood flow is reduced. The very low P_{O_2} required for significant unloading of O_2 from myoglobin, however, casts some doubt on this hypothesis. An attractive, though unproven alternative is that sarcolemmal myoglobin serves as a matrix for facilitated diffusion of O_2, which has been demonstrated in vitro in myoglobin solutions.[9]

The role of CO in relation to myoglobin function is unknown. A person equilibrated with 100 ppm CO at sea level has an arterial Pco of 0.07 mm Hg, but the Pco in his capillary and venous blood is about 0.03 mm Hg—less than half the arterial value. The reason for this arteriovenous difference in Pco is apparent from consideration of the Haldane equation, which may be rewritten as

$$(5) \qquad P_{co} = \frac{[COHb] \times P_{o_2}}{[O_2Hb] \times M}.$$

As O_2 is extracted from the blood, P_{O_2} falls proportionally more than $[O_2Hb]$ because the upper part of the O_2Hb dissociation curve is fairly flat. Since CO does not exchange appreciably between blood and tissues, [COHb] is the same in venous and arterial blood. Under these conditions, blood Pco must fall as O_2 leaves the blood and enters the tissues. The proportion of COMb resulting from equilibration of myoglobin

with 0.03 mm Hg CO tension depends critically on P_{O_2} in the region. This can only be estimated, but it is clearly somewhat less than that of the local venous blood. For this example, [COMb] would be 5.1% if muscle P_{O_2} were 20 mm Hg, 13.8% if muscle P_{O_2} were 5 mm Hg, and 25.5% if muscle P_{O_2} were 1 mm Hg.

The extent to which COMb concentrations in this range are biologically meaningful is unknown. The facilitated diffusion of O_2 through hemoglobin and myoglobin solutions is impaired by high concentrations of CO,[10] but whether this effect is due to COMb formation and whether it occurs with low concentrations have not been determined. Elucidation of myoglobin function and its alteration by CO awaits further research.

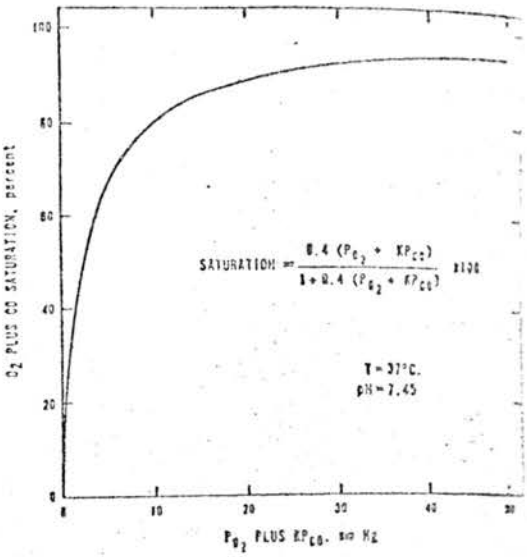


Fig 9.—Oxymyoglobin and carboxymyoglobin dissociation curve (After Rossi-Fanelli and Antonini[9]). The relative affinity constant (K) is numerically equal to 40.

Kinetic Aspects of CO Uptake and Excretion

In the absence of rapid endogenous production or metabolic removal of CO, both uptake and excretion of the gas are clearly nonsteady state processes. Several workers have found however, that, for practical purposes, the CO uptake rate is constant during the first hour or so of exposure.[11-13] This justified oversimplification has led to considerable confusion about the time course of CO absorption over longer periods, and no definitive study of the process has been reported.

The rate of CO uptake by the lung may be determined theoretically by a number of factors including ambient and pulmonary capillary Pco and P_{O_2}, alveolar ventilation, the diffusing characteristics of the lung, plasma, and red cell membrane, pulmonary capillary blood flow, and the kinetics of the reactions of CO and O_2 with hemoglobin. During the early phase of CO uptake, the ambient Pco and alveolar ventilation are the most important factors, but as equilibrium is approached, the Pco in the pulmonary capillary blood rises and slows pulmonary uptake. In the most complete study available,[11] equilibration with low concentrations (200 to 400 ppm) had a half time in terms of COHb formation of about two hours and was 90% or more complete after six hours in persons engaged in light activity. The data are not sufficiently complete to justify fitting a simple exponential equation, nor is it likely that such an expression would be appropriate in view of the many contributing factors.

The elimination of CO has been less definitively studied than its uptake. Like the latter process, it is most rapid early in its course, when the Pco gradient between blood and air is maximal, and slows as the pulmonary capillary Pco approaches that of the ambient air. Scattered observations suggest that the half time of excretion for subjects breathing air is in the range of 1½ to 4 hours.[14,15] The excretion rate is increased considerably by breathing O_2, particularly under hyperbaric conditions.

The kinetics of the chemical reactions of CO and O_2 with hemoglobin have been studied extensively by Roughton and reviewed by him recently.[16] The evidence suggests that, under some circumstances, pulmonary uptake and excretion of CO may be partially limited by the chemical reaction rates.

Effects on Health

The chief reason for studying the biologic effects of CO is to understand its influence on man's health and activities. This goal has been approached in the case of acute poisoning with high concentrations of the gas.

Table 2.—*Median Birth Weights and Percent of Babies Weighing 2,500 gm or Less**

	Population in Thousands				
	250+	50-250	10-50	2.5-10	Rural
White					
No. of births	148,230	87,837	109,537	66,153	246,538
Median birth weight (gm)	3,288	3,304	3,311	3,324	3,359
Percent ≤ 2,500 gm	7.46	7.20	7.10	7.07	6.61
Nonwhite					
No. of births	30,259	11,234	7,165	3,154	15,119
Median birth weight (gm)	3,127	3,154	3,173	3,173	3,215
Percent ≤ 2,500 gm	12.43	11.94	11.63	11.07	11.09

*Births attended by physician in hospital, United States, January-March, 1950 (by population of mother's place of residence).[30]

Some information is available about the effects of controlled exposures to low concentrations on specialized functions of the nervous system. Visual threshold,[17] flicker fusion frequency,[18] time perception,[19] and the performance of various psychomotor tasks[20] are altered by COHb concentrations in the 2% to 5% range. The significance of these findings in terms of man's health or usual activities is unknown.

Meaningful effects of exposure to the low concentrations of CO commonly found in community air have not been clearly identified. If such effects exist, it should be possible to predict them from our knowledge of CO pathophysiology and to design experimental or epidemiologic studies to demonstrate them. One approach to predicting such effects is to examine the effects of mild hypoxia from other causes such as anemia or reduced barometric pressure. Exercise tolerance is measurably impaired by exposure to simulated altitudes of as little as 7,000 feet. Maximal O_2 uptake is diminished by this degree of reduction in barometric pressure.[21] Equilibration with an equivalent concentration of CO (Fig 7) might be reasonably expected to induce similar changes. Pitts and Pace found that the pulse rate during exercise at sea level was unchanged with 6% COHb but increased with 13% COHb.[22] More recently Chevalier et al found an increased exercise O_2 debt with 4% COHb.[23] This finding must be interpreted with caution because the study did not include appropriate controls. More definitive studies of the effects of low levels of COHb on exercise are needed.

Chronic residence at high altitude leads to considerable symptomatic acclimatization or tolerance. This long-term acclimatization to hypoxia is associated with several alterations, including increases in the body's hemoglobin and myoglobin content, increase in the capillarity of tissues, and certain cellular and enzymatic adaptations.[24] Chronic or repeated exposure to CO also results in partial acclimatization to the gas.[25] Animals exposed to CO have been found to develop tolerance for exposure to simulated high altitudes, and vice-versa,[26] suggesting that common mechanisms are involved. The importance of tolerance in relation to health effects of CO has not been studied; it may be a significant factor in smokers and those chronically exposed.

Persons already subject to a degree of hypoxia from altitude, anemia, or reduced cardiac output, and those with supernormal O_2 needs due to pregnancy, hyperthyroidism, or fever may be particularly sensitive to the effects of CO or any additional hypoxic stress. The heart is doubly embarrassed by hypoxia, for it must increase its work to provide oxygen to peripheral tissues while its own oxygen supply is reduced. Thus, in theory, patients with heart disease may be expected to tolerate CO very poorly. Little specific information is available about the effects of mild CO exposure on such people, but the extensive epidemiologic studies of cigarette smoking provide data that may be applicable. The death rate from coronary heart disease is considerably higher for smokers than for nonsmokers.[27] The rate for exsmokers is no higher than for persons who have never smoked. This pattern implies that the smoking effect is completely reversible when an individual stops smoking. Thus, smoking must cause myocardial hypoxia by some acute, reversible process, probably unrelated to the formation of hard, irreversible, atherosclerotic lesions. Carbon monoxide fits this epidemiologic pattern quite well, but nicotine or other components of cigarette smoke may be responsible, and the question remains unsolved.

Another important effect of smoking that may be attributable to CO relates to fetal

development. Mothers who smoke during pregnancy have, on the average, smaller babies than those who do not smoke, regardless of smoking history prior to the pregnancy.[28] If this effect is due to hypoxia caused by CO, the average weight of babies born at high altitude should also be low. Data indicating that this is so have been presented by Grahn and Kratchman,[29] who found that babies born even at modest altitudes (2,000 to 4,000 feet) weigh less, on the average, than those born at sea level.

The question that follows logically from these observations is whether nonsmoking mothers exposed during pregnancy to CO in urban air have smaller babies than those not so exposed. Specific information about this question has not been obtained, but birth weight is inversely related to the population of the mother's place of residence[30] (Table 2). Apparently fetal development is influenced by some factor associated with urbanization; whether this factor is CO remains to be determined.

These examples of possible effects of low concentrations of CO are typical in being unresolved. Conclusive information about these and other questions is lacking, not because such information is unobtainable, but because, with few exceptions, it has not been looked for. Each problem mentioned in the preceding paragraphs can be studied by means of available experimental or epidemiologic techniques.

Carbon monoxide is unusual among community air pollutants in that we know enough about its biologic relationships to make fairly specific predictions of health effects. Applied research in this field should be concentrated increasingly on determining whether these predicted effects are in fact taking place in our cities.

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ERRATA

In the December 1967 issue of the ARCHIVES, an error was made in Molokhia and Smith's article, "Trace Elements in the Lung" (15:745-750 [Dec] 1967). Fig 1 and 2 (pp 748-749) should be transposed; the legend for Fig 1 should be matched with cut 2 and the legend for Fig 2 should be matched with cut 1. The erratum published in the April issue (p 595), hence, is incorrect.

In the March 1968 issue of the ARCHIVES, an error was made in Winkelstein et al's article, "The Relationship of Air Pollution and Economic Status to Total Mortality and Selected Respiratory System Mortality in Men" (16:401-405 [March] 1968). In column 2, page 401, lines 4 and 5 should read "economic status. No association between suspended. . . ."

In Baetjer's article, "Role of Environmental Temperature and Humidity in Susceptibility to Disease" (16:565-570 [April] 1968), in a recent issue of the ARCHIVES, an error was made on p 570. Lines 18 and 27 (column 1) should read "endogenous" and "exogenous," respectively.

Appendix D

In establishing improved standards of air quality, the effects of pollutants on human performance should be taken into account. For this reason, the effects of exposure to carbon monoxide were studied on a group of young adults. The results are reported.

BEHAVIORAL IMPAIRMENT ASSOCIATED WITH SMALL DOSES OF CARBON MONOXIDE

Rodney R. Beard, M.D., M.P.H., F.A.P.H.A., and George A. Wertheim, Ph.D.

THE rational development of the control of air pollution requires the establishment of identified, acceptable goals. Ultimately it must be results which count, not merely conformity to rules which set forth efforts to be made. Standards for quality of the air have been arrived at in several ways. In the United States and most of the world, technical feasibility and economic considerations set limits on the extent of air pollution control which can be included in the design of new facilities for any particular industrial or domestic process. The design determines the concentration and volume of pollutants emitted by the installation. This emission rate then becomes the standard of comparison for other installations which carry out similar processes.[1] Thus technical capabilities and economic values have determined the goals of air pollution control programs. In Russia and in some other countries, it is stated that everyone should be protected from the effects of any agent in the air which can produce any demonstrable physiological effect, even if the effect is not shown to be harmful. Hence, the air purity standard is set at a pollutant concentration lower than the threshold determined by the most sensitive test.[2,3]

It would appear logical to decide first upon our goals, to set standards according to these goals, and then to work toward their achievement. However, human communities do not always behave logically. For example, if air quality standards are too exacting and cannot be attained or closely approached, we are likely to relax our efforts and to ignore the standards. Hence, while we should not set standards which will permit harm to occur just because the public is not yet ready to welcome a safe standard, we need not go to extremes to discover and control relatively inconsequential effects of pollutants. Air quality standards must be fitted to the localities and populations which they serve, as Goldsmith[4] has explained so clearly.

There is always a risk that when one sets a standard at the highest readily attainable level, for no other reasons than the feasibility of that limit and the general notion that purity is desirable, the standard may become frozen into common usage. It then becomes exceedingly difficult to relax the requirement, although pressing practical and economic reasons might make such a change highly desirable. The beryllium standard is an example. A very exacting standard was set at a time when beryl-

lium was little used. The use of beryllium in rocket fuel would now make it convenient and economical if less restrictive controls could be applied but we know from years of experience that the existing limit is safe, and it will take a great deal of evidence to persuade any responsible health officer that he should approve less exacting precautions.

Sometimes doubts are raised about the applicability of economic factors in the setting of standards for air purity. Certainly economic considerations should play no part in developing quality standards designed for the prevention or aggravation of disease. Protection from annoyance or from physiological effects of uncertain significance must be weighed against other benefits which might be purchased by equivalent expenditures. It thus is evident that a single standard cannot be set; as in other fields of human enterprise, there are quality levels with differing price tags. It is the prerogative of the people to decide what quality they will pay for. It is up to the scientific community to define what the people can get for their money. In addition, scientists, in their roles as citizens, should do their utmost to combat the increase in air pollution.

We have entered an era in which air pollution controls will be based on air quality standards. The first principle recommended by the President's Science Advisory Committee says:

> "The public should come to recognize individual rights to quality of living, as expressed by the absence of pollution, as it has come to recognize rights to education, to economic advance, and to public recreation," and, "All concerned should recognize the quality of human life and the presence and growth of other living things as the major values currently damaged by pollution. While more subtle human effects are possible and should be sought for, demonstrable threats to human health constitute a small part of today's damage from pollution." The panel recommends that "efforts be increased to establish the scientific bases upon which standards of environmental quality can be set."[5]

Among the scientific criteria which ought to be considered in setting standards of environmental quality, of primary importance is evaluation of the effects of pollutants upon man's capacity to perform important tasks. The study of effects of toxic agents on conditioned reflexes and other patterns of behavior has been used by European workers, notably Horvath in Prague and Grandjean in Zurich. In our laboratory, we were impressed by the potential value of this approach, and have set forth on a program to develop it for application in our own country. This type of study may help us to understand the mechanisms of toxic action, as well as to provide data which may ultimately provide a basis for setting standards of air quality.

In reaching for an air quality standard for carbon monoxide, one is impressed by the paucity of data for the effects of concentrations below 100 parts per million (100 ppm), since it has often been stated that below this level there are no perceptible physiological effects. We have undertaken the exploration of this region, looking for subtle behavioral changes. It is our intent to investigate the effects of other environmental factors such as heat and noise in combination with carbon monoxide (CO).

We undertook a number of experiments with rats and monkeys to establish familiarity with the gross effects of CO, to become adept in handling the equipment, and to discover behavioral changes which might be most profitably investigated in human beings. We found that early in the course of CO exposure, the animals showed derangement of time sense: their response patterns became temporally irregular.

Following this lead, we devised a test of discrimination of time intervals for use with human subjects. This test took the form of comparison of paired presentations of pure tones with the second of the pair shorter, equal to, or longer than the first.

Equipment and Methods for Studies in Human Beings

A commercially built audiometer booth was used as a dynamic exposure chamber. It had a contained volume of three cubic meters (110 cubic feet) and was ventilated at a rate of 100 cubic feet per minute (design value) (2.83 cubic meters per min.). CO was metered from a pressure cylinder through a sensitive rotameter to the air inlet. A quietly operating fan in the chamber assured complete mixing of the air. A small pump provided a continuous flow from the chamber to a nondispersive infrared analyzer which was calibrated daily by use of standard CO-in-air mixtures. The concentration in the chamber was adjusted to the desired value by manipulation of a needle valve and was continuously recorded. The intended concentration could be built up within one minute and held within ten ppm or closer. The subject could adjust the temperature to his preference on cold days. Wet- and dry-bulb temperatures were recorded at about 20-minute intervals. The dry-bulb temperatures ranged from 67° F to 89° F with median values of 70° F to 88° F for the various sessions. Wet-bulb temperatures were from 57° F to 72° F with median values for individual sessions from 58° F to 68° F. The relative humidities were from 17 per cent to 64 per cent with median values for individual sessions from 19 per cent to 56 per cent. The performance data showed no significant differences correlated with temperature or humidity.

Tests were done between 11 A.M. and 6 P.M. Physical activity of the subjects was negligible during the tests and their activities prior to the tests did not include heavy exertion.

The subject and the experimenter could talk through a telephone system. A good light and a comfortable chair were provided. The subject could be observed through a window.

The subjects were young adult university students who were paid for their time. They were nonsmokers. The nature and purpose of the experiment were explained and honest answers were given to all questions raised, except whether CO was present during a test period. Blood samples were taken at the beginning and at the end of each experimental session. Regrettably, our determinations of carbon monoxide hemoglobin were inaccurate. Medical supervision was provided for all sessions.

The 1,000 hz tone signals were generated electronically. The durations were controlled by resistor-condenser circuits which were adjusted to the selected intervals by observation on a cathode-ray oscillograph. The signals were free of onset and offset clicks. The volume was adjusted to a comfortable level, well above the auditory threshold. The stimuli were presented by the psychophysical method of constant stimuli. On each trial, there were two presentations of the tone separated by a one-half-second interval. The first or "standard" signal was always one second in duration; the second or "variable" signal was varied in 18 steps between 0.675 seconds and 1.325 seconds. The subject was asked to judge whether the duration of the second signal was shorter, the same, or longer than the first, and to indicate this by pressing one of three levers. The subject received no indication of the correctness of response.

The comparison stimuli were presented in blocks of 25 trials with approximately 7.5 seconds between trials. In each block of 25 trials, eight of the comparison stimuli were identical to the standard, eight were longer, and nine were shorter; these were arranged in a nonsystematic sequence.

Each subject received a total of 600 trials in each four-hour session. After each set of 50 trials, a six- to seven-minute work period, there was a pause of about 13 minutes during which the

subject could read, sleep, or watch television. He stayed in the chamber throughout the session. A warning light and tone signalled the onset of each set of 50 trials.

The performance of the subjects was recorded in such a fashion as to preserve the real-time sequence of events. The Data Multiplexer, a small, special-purpose computer designed and constructed in our laboratory, translated the responses to digital symbols recorded on eight-channel punched paper tape. The results were then analyzed by electronic data-processing methods. Thus far, only the correctness-of-response data have been extensively analyzed. The real-time records will permit the future measurement of response latency and of sequential response patterns. The latter may be of considerable interest, judging from our work with lower animals.

Results in Human Subjects

Eighteen subjects were observed in at least 15 sessions each. CO was administered in concentrations of 0, 50, 100, 175, and 250 parts per million in the different sessions. None of the subjects experienced any discomfort attributed to

Figure 1—Mean per cent correct responses, ±1 s.d., by 18 human subjects, during the discrimination of two tones presented successively. Each point is the mean of three determinations per subject, at each CO dose, of performance during the second and third hours of the session, i.e., during 0.5-2.5 hours of CO exposure, since exposure began after the first 0.5 hour. Comparison of performance in sessions during and prior to CO revealed significant impairment (t-test) at all doses ($0.01 < p < 0.02$, at 50 ppm; $0.001 < p < 0.01$ at higher doses).

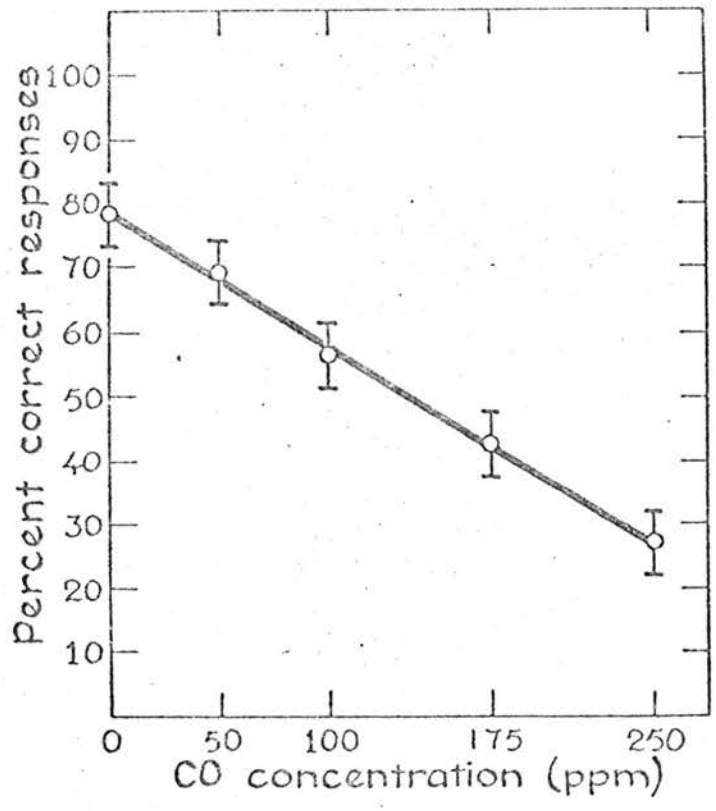
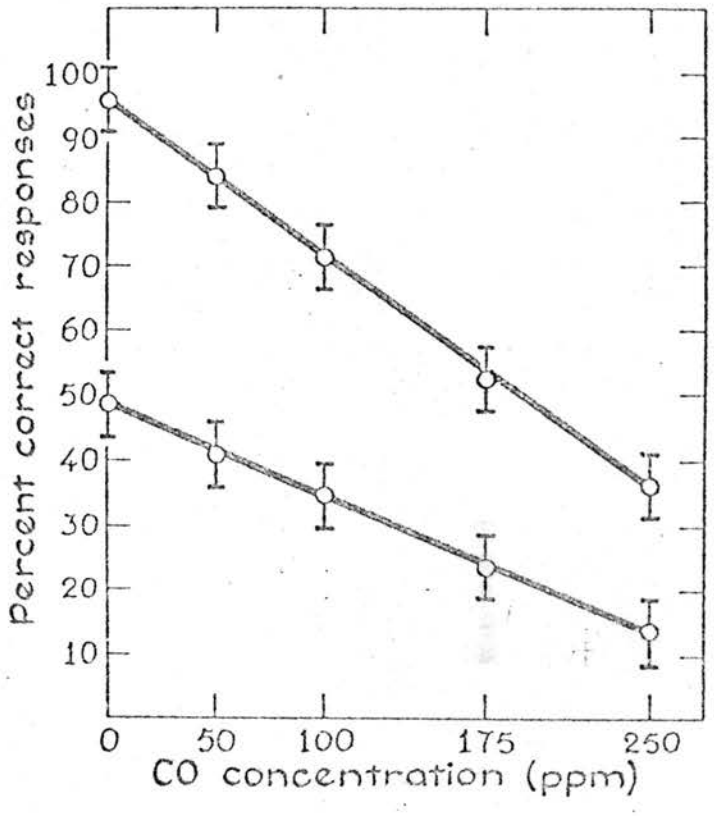


Figure 2—Mean per cent correct responses, ±1 s.d. (cf. Figure 1 caption), when the difference in tone duration was 325 msec (upper function), or 125 msec (lower function). Significant performance impairmen (t-test) occurred at all doses ($0.02<p<0.05$, at 50 ppm, 325 msec; $0.01<p<0.02$, at 50 ppm, 125 msec; $0.001<p<0.01$, at higher concentrations, both duration differences).



CO during the experiments, and none felt that he could reliably tell when CO was present. No changes in overt motor behavior were seen. However, a dose-related reduction of correct judgments of time intervals was clearly demonstrated. Figure 1 shows significant decrements of response for two and one-half hours of exposure to all concentrations from 50 parts per million upward. (The graph, as drawn, suggests that any degree of exposure would reduce performance in some measure, but further experimentation would be necessary to judge this conjecture.) Figure 2 shows that the decrement in precision of judgment associated with exposure to CO was similar, both for small and large differences in tone duration.

The rapidity of the onset of deterioration of time discrimination under the influence of small concentrations of CO is of particular interest. Using as a criterion a reduction in correct responses equal to two standard deviations from the mean performance in an uncontaminated atmosphere, 90 minutes were sufficient to produce a significant decrement in an atmosphere of 50 ppm, and much shorter times were needed for higher concentrations. These data are displayed in Figure 3.

The records of individual subjects show that not only did the proportion of

correct responses diminish in association with inhalation of CO, but that the perceptual behavior of the subjects became erratic. Figure 4 consists of records for seven sessions using three subjects. The graphs indicate the proportion of correct judgments in each block of 25 trials. The effect began to appear after 30 minutes to one hour in these sessions. We believe that analyses of sequential performance in these experiments will define the time of onset more precisely.

Studies in Rats

As mentioned earlier, the use of a time-discrimination test in human beings was suggested by previous observations in rats. We had begun by trying a variety of Skinnerian operant behavior schedules of reinforcement.[6]

In our studies, the animals were trained to press levers to obtain food pellets or water. The simplest pattern is one in which the animal receives one

Figure 3—Time after initial exposure to each CO dose that the mean per cent correct responses fell below 2 s.d. of mean performance without CO, during auditory-duration discrimination.

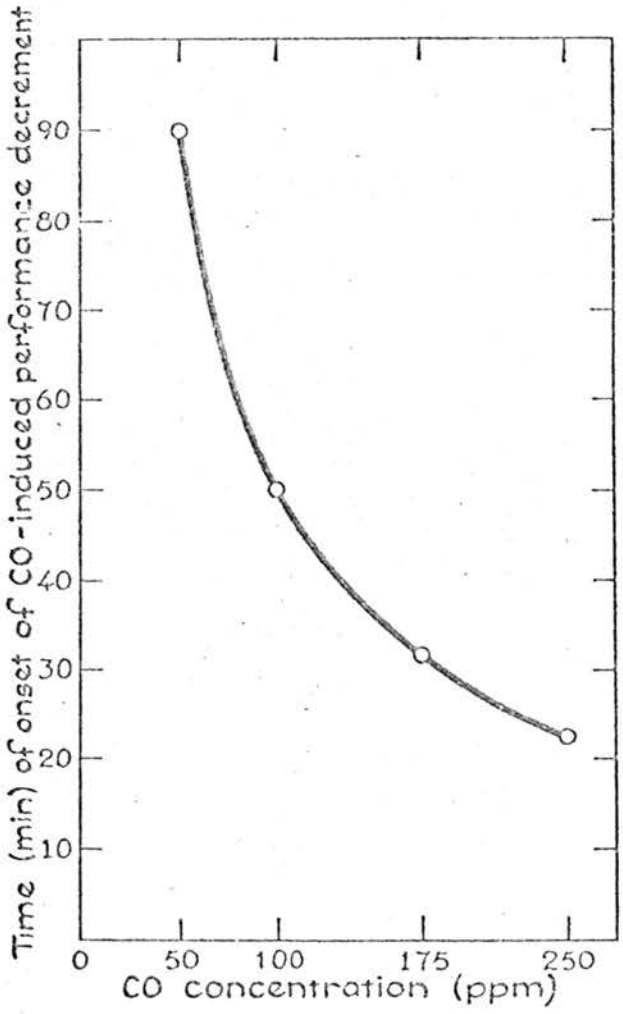
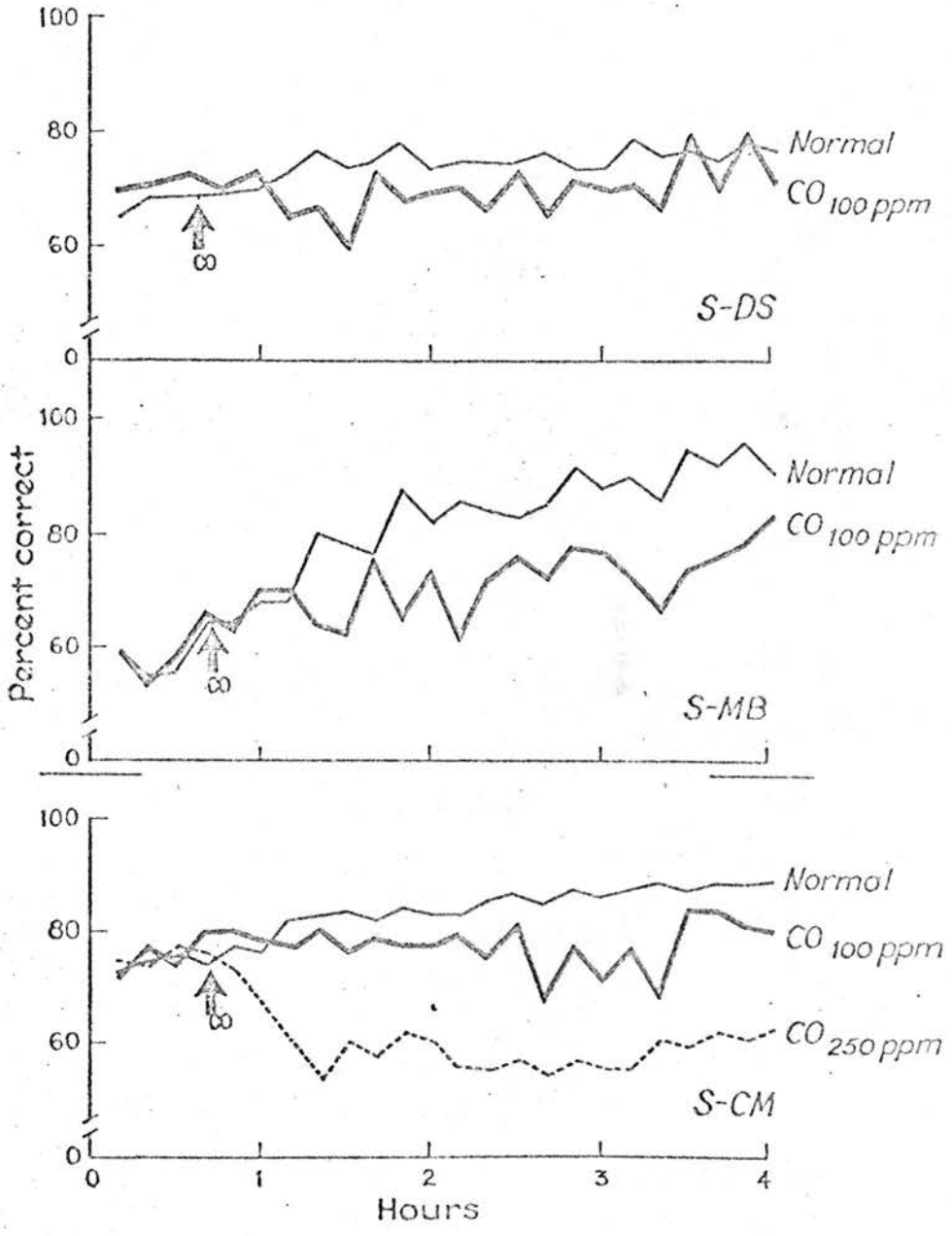


Figure 4—Mean per cent correct responses, for successive 25-trial blocks, during auditory-duration discrimination. Data are from individual four-hour sessions for each of three subjects; the arrows indicate gas exposure onset during CO sessions. "Normal" indicates a non-CO session.



such reward or "reinforcement" each time he presses the lever. Many ingenious variants have been devised by behavioral psychologists, including schedules in which one reinforcing stimulus is available only after a fixed number of responses have been emitted (fixed-ratio schedule, FR), or after a varying number of responses (variable-ratio, VR), or for the first response that occurs

after a specific lapse of time (fixed interval schedule, FI), or reinforcing responses after varying time intervals (variable-interval schedule, VI), and so forth.

Figure 5 shows an example of this kind of investigation. The rat was trained to work on a fixed interval schedule (FI) under which a food pellet was provided for the first response emitted three minutes after the previous pellet had been delivered. On each of the records in Figure 5, the pen of the cumulative recorder moved upward slightly for each response, and moved continuously to the right with the passage of time. A downward mark of the pen indicates each delivery of a pellet. The positive acceleration of the inter-reinforcement response pattern, evident in

Figure 5—Performance by one representative rat on a FI three-minute schedule. Note the greater response rate attenuation at 1,000 ppm than at 250 ppm.

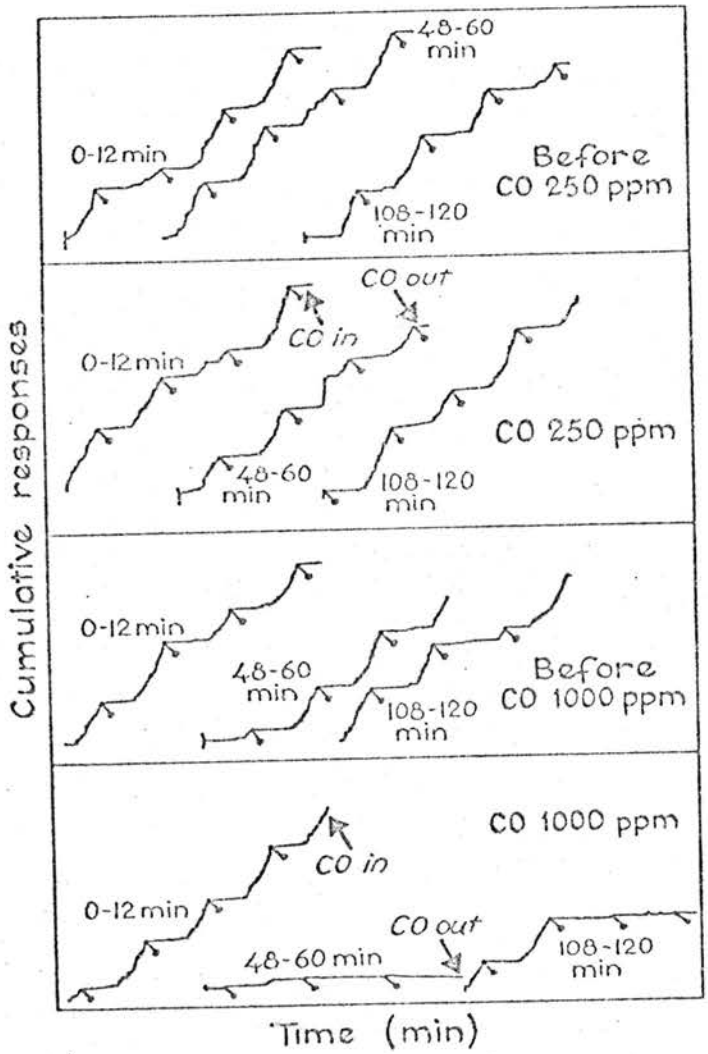
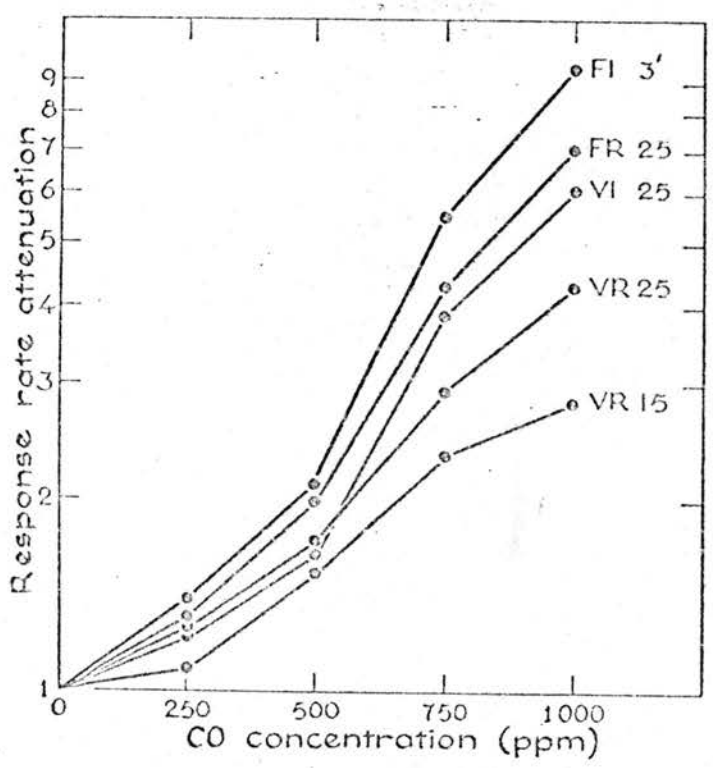


Figure 6—Response rate attenuation (RA), as a function of CO concentration, during performance by rats on several different schedules of reinforcement. RA is calculated by: RA=(c/d)/(a/b), where a is response rate during min. 0-12 on the pre-CO day, b is rate during min. 0-12 on the CO day, c is rate during min. 48-60 on the pre-CO day, and d is rate during min. 48-60 on the CO day. If a, b, and c were equal, RA would be the direct reciprocal of the reduction in response rate during CO exposure; RA is thus an index that takes into account fluctuations in the performance levels that serve as baselines against which the effects of CO are assessed.



these records, is characteristic of performance on FI schedules. One interpretation of the response pattern is that the animal has learned that responses made soon after reinforcement are useless. As the end of the fixed time interval approaches, there is a systematic increase in the rate of lever pressing until the next pellet is delivered.

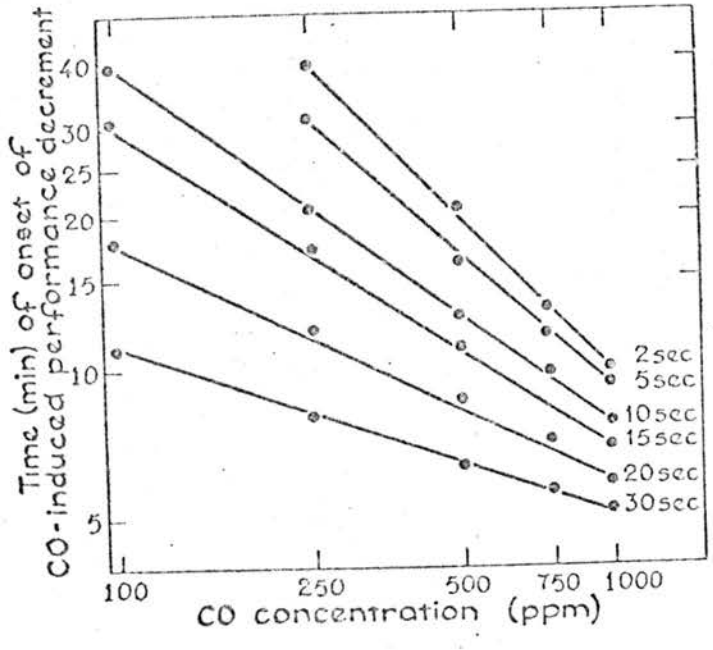
From the records in Figure 5, it may be noted that not only is the rate of responding slowed when CO is present, but also that the regularity of the inter-reinforcement response pattern is disrupted. This effect was regularly observed, and led to refinements of recording and analysis. A dose-response effect, apparent in these sample records, was worked out in detail in many experiments. We were also impressed by the rapid recovery rate of these animals: as may be seen in Figure 5, performance capability was regained about as quickly as it was lost; this suggests that the performance decrement is not directly related to the proportion of carbon monoxide hemoglobin in the blood, since the uptake of CO at low concentrations is linear and its excretion is exponential. We intend to investigate further these relations.

Figure 6 compares the sensitivity of several different reinforcement schedules to the effects of CO. These data suggest that time discrimination is readily susceptible to derangement by CO. This hypothesis was explored further by the use of a differential reinforcement of a low rate of response (DRL) schedule, during which the animal must refrain from pressing the lever for a predetermined fixed time in order to receive reinforcement. Rats can learn to make long inter-response delays with a high degree of reliability. This type of temporal discrimination is readily deranged by exposure to CO, as shown in Figure 7. These data also demonstrate that the more stringent discrimination tasks, i.e., longer delays, are more readily disrupted. Perceptible effects are observable after only 11 minutes of exposure to CO at 100 ppm, and increasing concentrations produce proportionately greater effects.

Discussion

We do not suggest the immediate application of these observations to the establishment of new air quality standards or threshold limit values. Much remains to be done before we understand the significance of performance decrements associated with low concentrations of CO. Other psychophysical and psychophysiologic measures must (and will) be obtained and evaluated. Our present intent is to bring attention to the applicability of particular experimental analyses of behavior to the study of air pollution effects. We believe that

Figure 7—Time after initial exposure to a given dose of CO that the mean DRL response rate fell below 2 s.d. of the rate during normal atmosphere conditions. Each point represents the mean of ten determinations from each of six rats at each dose. The number to the right of each curve indicates the required DRL delay duration. Exposure to CO never exceeded 43 minutes. All experimental sessions were of approximately two hours' duration.



information obtained from the detailed analysis of the impairment of "abstract" types of behavior induced by toxic agents and unfavorable environments will be increasingly useful in predicting functional limitations for important tasks.

Wherever possible, studies should be done in relation to activities which are important for man. It is tempting to try to simulate field conditions in the laboratory by the use of mock-ups of vehicle controls and related devices. However, it is exceedingly difficult to contrive simulators which experienced operators will accept as adequately resembling actual operative devices. Since the simulation is seldom convincing, it seems better to test the subject on various abstract tasks which are related to specific segments of real-life activities, and to do this in circumstances in which a large proportion of the extraneous variables are controlled. Such tests should culminate in field studies of various tasks under normal and abnormal operating conditions.

Summary

Improvement is needed in the methods of setting standards of air quality. In establishing such standards, the effects of various pollutants upon human performance should be considered. Toward this end, the effects of exposure to carbon monoxide upon the ability of 18 young adults to discriminate short intervals of time were studied. Deterioration of performance was observed. This occurred after 90 minutes at 50 ppm, and at proportionately shorter times after exposure to higher concentrations up to 250 ppm. Experiments with rats, using operant behavior schedules of reinforcement, showed rapid and marked disruption of the ability to judge time, with a significant decrement apparent after 11 minutes exposure to 100 ppm during performance on a DRL schedule. It is suggested that methods derived from experimental psychology can contribute materially to the evaluation and understanding of both gross and subtle effects of CO as an air pollutant and can thereby aid in the formulation of standards of air quality.

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This work was sponsored by the Commission on Environmental Hygiene, Armed Forces Epidemiological Board and was done, in part, under a contract with the US Army Medical Research and Development Command. The use of human volunteers was carried out in conformance with the policy standard of the Surgeon General, US Army.

In conducting this study the investigators adhered to the "Guide for Laboratory Animal Facilities and Care," as promulgated by the Committee on the Guide for Laboratory Animal Resources, National Academy of Sciences-National Research Council.

Appendix B

Systemic and Myocardial Hemodynamic Responses to Relatively Small Concentrations of Carboxyhemoglobin (COHB)

Stephen M. Ayres, MD; Hiltrud S. Mueller, MD; John J. Gregory, MD; Stanley Giannelli, Jr., MD; and John L. Penny, MD, New York

ARBON MONOXIDE was known to be extremely toxic gas long before Priest-'s discovery of its chemical composition the late 18th century. The courageous dies of John Haldane,[1] performed upon nself in 1895, clearly indicated the ationship between carboxyhemoglobin OHB) saturation and physiologic effect, l also established the chemical basis for reactions between hemoglobin and car-n monoxide.[2] Unfortunately, subsequent vestigators interpreted Haldane's data as dicating that COHB saturations below % to 20% were essentially harmless. A ies of recent studies, however, have dem-strated that considerably lower concentra-ns of COHB may produce definite altera-ns in higher integrative activities of the ntral nervous system and have raised the ssibility that the levels of COHB found in blood of smokers and certain nonsmok-g city dwellers may be sufficient to pro-ce undesirable physiologic effects.

MacFarland and associates[3] were able to ow a linear relationship between decrease visual discrimination and increase in COHB and observed significant impairment in discrimination with COHB levels as low as 4% saturation. Lilienthal and Fugitt[4] observed an impairment in flicker-fusion with COHB levels between 5% and 10% at 6,000 feet altitude, and Trouton and Eysenck[5] 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[6] before and after they breathed sufficient carbon monoxide to raise COHB levels to as high as 20.4%. Although significant correlations between pulse rate, blood pressure, or respiratory rate and COHB were not observed, Schulte was able to closely relate seven psychologic responses to COHB. COHB concentrations as low as 3% 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. Most recently, studies by Beard and associates[7] have demonstrated psychologic impairment at levels below 2% to 3% COHB.

Haldane,[1] Haggard,[8] and Chiodi and associates[9] observed significant cardiorespiratory responses when COHB concentrations were raised to 20% but lower concentrations generally failed to produce demonstrable effects. The effect of lower concentrations of COHB on cardiac function was seen in a recent study performed by Chevalier et al[10]

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who observed a significant increase in the oxygen debt of exercise with COHB concentrations as low as 5%.

We have studied the physiologic effects of relatively small amounts of COHB by measuring acute cardiorespiratory changes following the inhalation of carbon monoxide in human subjects and in dogs.[11,12] This paper summarizes our findings on systemic hemodynamics and alveolar-capillary oxygen exchange, reviews certain aspects of myocardial metabolism, and presents an experimental model for the study of COHB and myocardial metabolism. Detailed studies on serial increases in COHB on five dogs are presented and data from 11 patients with lower levels of COHB discussed.

Theoretic Aspects

Changes in gas exchange following exposure to carbon monoxide are dictated by changes in the oxyhemoglobin dissociation curve in the presence of various concentrations of COHB as shown in Fig 1. The curve is shifted to the left so that if the same arteriovenous oxygen difference and therefore the same venous saturation is to be maintained, oxygen tension must decrease. This decrease in mixed venous oxygen tension is the major primary event; other hemodynamic changes must be considered secondary. The decrease in venous oxygen tension (and presumably in tissue oxygen tension) appears to initiate a series of stress responses which attempt to compensate for the decrease in oxygen tension. Data presented below suggest that the compensatory reaction resembles that seen with stimulation of the adrenergic nervous system.

Changes in coronary blood flow and myocardial oxygen extraction can best be appreciated by considering the differences between myocardial and systemic oxygen exchange. The coronary circulation differs markedly from the systemic circulation in its mode of adaptation to the increased oxygen requirements of stress. Peripheral tissues normally extract about 25% of the oxygen present in arterial blood and the remaining 75% serves as a reserve supply. Total oxygen uptake may be increased by increasing the amount of oxygen extracted from the perfusing blood and by increasing the rate of blood flow. In periods of stress, for example, mixed venous oxygen tension may drop from a normal of 40 mm Hg to below 20 mm Hg. In contrast, the exorbitant resting myocardial oxygen needs are met by extracting a much greater fraction of oxygen from the perfusing blood than the systemic tissues. Approximately 75% of oxygen is extracted from the coronary circulation at rest and coronary venous blood is about 25% saturated corresponding to an oxygen tension of 20 mm Hg. If increased myocardial oxygen needs were met by increasing oxygen extraction as in the peripheral circulation, coronary venous and myocardial cellular oxygen tension would fall to dangerously low levels. The coronary circulation avoids low oxygen tensions by increasing flow rate in response to increased oxygen demands rather than increasing oxygen extraction. Near maximal resting extraction and the ability to increase oxygen consumption by increasing flow allow performance of continuous contractile work at rest and also provide the ability to increase cardiac work with exercise. Coronary vascular disease may prevent an increase in local coronary blood flow in response to need. In this situation, the myocardium is forced to extract more oxygen but does this at the expense of a markedly reduced coronary venous and tissue oxygen tension.

Myocardial oxygen consumption, the product of coronary blood flow and the difference between arterial and coronary sinus oxygen content, is a complex function of external ventricular work, myocardial wall tension, and fiber length, rate of development of ventricular pressure, and heart beat rate.[13] Increasing oxygen requirements must be met by increasing oxygen consumption or myocardial ischemia and necrosis develop. If oxygen is plentiful, glucose and lactate are extracted from the coronary perfusate and metabolized to pyruvate in the glycolytic cycle. Pyruvate from this source together with directly extracted pyruvate and acetate fragments from fatty acid degradation are converted to acetyl coenzyme A and oxidized in the citric acid cycle liberating energy, carbon dioxide, and water. In periods of insufficient oxygen supply, the citric acid oxidative cycle is inactivated and pyruvate accumulates in the cytoplasm. A small

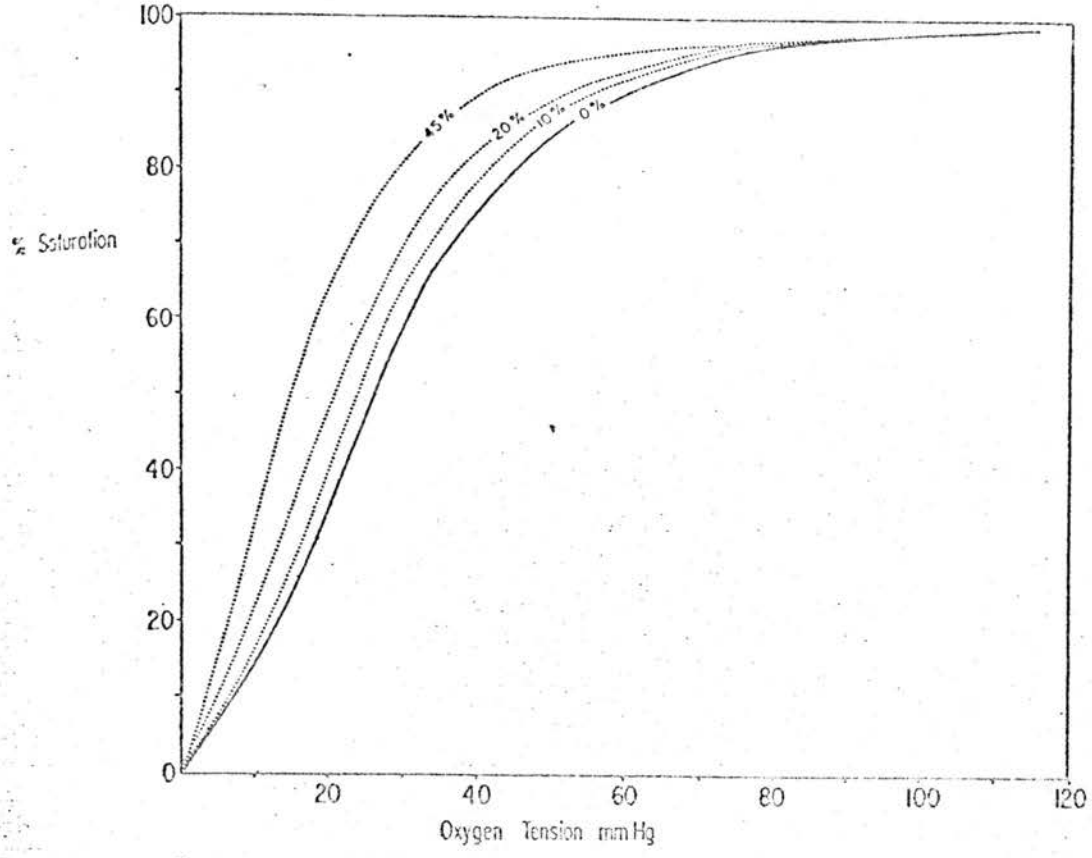


Fig 1.—Oxyhemoglobin dissociation curve in the presence of varying amounts of carboxyhemoglobin. Leftward shift of curve demonstrated by plotting oxyhemoglobin saturation of hemoglobin not combined with carbon monoxide against oxygen tension.

amount of energy is produced by glycolysis as the enzyme NAD (DPN in the older classification) oxidizes one of the glycolytic intermediates and produces high energy bonds. The cytoplasmic supply of NAD would soon be exhausted if a mechanism for its regeneration did not exist. Accumulating pyruvate is reduced to lactate by the reduced form of NAD (NADH) and, in the process, NADH is oxidized to NAD, permitting continued operation of the glycolytic cycle. In summary, inadequate oxygen decreases the utilization of pyruvate by the citric acid cycle, pyruvate accumulates in the cytoplasm and lactate is produced from the accumulating pyruvate.

Increasing cellular concentrations of lactate and pyruvate decrease the diffusion gradient between coronary perfusate and cytoplasm and decreases the extraction of these metabolites. Normally, arterial lactate and pyruvate concentrations determine the diffusion gradient so that the arteriovenous difference (or extraction) is a function of arterial lactate or pyruvate concentration. The extraction ratio of either lactate or pyruvate (the arteriocoronary sinus difference divided by arterial concentration) is a useful index for expressing extraction which is relatively independent of arterial concentration. Although increasing arterial concentrations may increase the extraction ratio slightly, the ratio does not decrease with decreasing arterial concentration so that a decrease in extraction ratio may be considered due to some intracellular alteration. The extraction ratio for both metabolites ranges from 15% to 30% when oxygen is plentiful. In periods of inadequate oxygenation, extraction decreases and lactate and pyruvate may actually be produced by the myocardium so that coronary sinus concentrations exceed arterial concentrations.

Huckabee[14] has pointed out that en-

hanced glycolysis or increased fatty acid degradation without oxygen lack may decrease lactate extraction. He has proposed calculation of "excess lactate" based on a rearrangement of the mass action equation and assuming that the lactate-pyruvate ratio is related to the intracellular redox relationships (NAHD/NAD ratio). Although theoretically attractive, recent observations have suggested that the extracellular lactate-pyruvate ratio may not be related to either cytoplasmic or mitochondrial NADH/NAD ratios and thus may not accurately reflect intracellular oxygen deficit.[15] For this reason we have preferred to concentrate on cellular extraction and this paper presents data on the myocardial extraction ratios of oxygen, lactate, and pyruvate. Detailed data on arterial lactate and pyruvate concentrations, excess lactate, and lactate-pyruvate ratios are included for the serial canine studies.

Methods

Studies were performed on 26 patients during routine diagnostic cardiac catheterization and in 31 dogs. The patients were studied in a cardiopulmonary laboratory following completion of diagnostic procedures. Catheters were placed in the ascending aorta and pulmonary artery. A Goodale-Lubin catheter was placed in the proximal coronary sinus in 11 of the human studies and in 16 of the canine studies. Mixed expired air, arterial, mixed venous and coronary sinus blood was obtained prior to administration of carbon monoxide. The subject was then switched to a mixture of 5% carbon monoxide in air for from 30 to 120 seconds, with continual electrocardiographic monitoring. Following a ten-minute period to permit washout of alveolar carbon monoxide, repeat blood samples and mixed expired air were collected while breathing room air. Coronary blood flow was measured immediately before and ten minutes after carbon monoxide breathing.

Oxygen and carbon dioxide tensions and pH were measured by previously described electrode techniques.[16] Oxygen and carbon dioxide contents were determined by the Van Slyke manometric method. Expired air was analyzed for oxygen and carbon dioxide in the Scholander microanalyzer. Cardiac output was calculated by the direct Fick principle. Blood carbon monoxide content was measured by a gas chromatographic technique[17] and total ligand capacity obtained by measuring both carbon monoxide and oxygen content of a sample of the subject's blood previously shaken with ambient air. Blood samples were analyzed in duplicate for lactate by the method of Barker and Summerson[18] and for pyruvate by the method of Friedemann and Haugan.[19] Coronary blood flow was measured by the method described by Krasnow and associates[20] which uses I-131 iodo-antipyrine as a diffusable indicator.

In addition to the experimental studies described above, chromatographic measurements of blood COHB concentration were made on an unselected group of subjects either residing or working in New York city. Studies were also made on an "exposed" group of subjects working as tunnel guards in a New York city tunnel.

Results

COHB Levels in New Yorkers.—Figure 2 shows the COHB concentrations for a series of unselected subjects grouped by smoking history. Mean values for each smoking group are indicated by the short horizontal lines. Significantly higher saturations were observed in a small number of studies performed in tunnel workers; higher saturations were observed for each smoking group.

Systemic Gas Exchange Studies.—Table 1 shows mean values for selected respiratory measurements in 23 subjects before and after carbon monoxide inhalation. Note that oxygen extraction did not significantly change but that the oxygen extraction ratio increased indicating more complete extraction of oxygen from perfusing arterial blood.

The decrease in venous oxygen tension could be correlated with an increase in COHB concentration:

$$(PO_{2_{CO}}/PO_2 \text{ control} = -0.04\ COHB_{co}/COHB \text{ control} + 1.03).$$

In the regression equation, changes in oxygen tension and COHB concentration are expressed as ratios, value obtained during carbon monoxide breathing divided by control value. The decrease in arterial oxygen tension was not correlated with increasing COHB concentration in the human studies but when a wider range of COHB concentrations was analyzed by including the canine data (not presented in this paper) a good correlation between COHB and arterial and oxygen tension was observed.

Myocardial Metabolic Studies.—Detailed data from five canine studies in which

Table 1.—*Systemic Cardiorespiratory Measurements in 26 Human Subjects Before and After CO Inhalation*

Measurements	Control Mean	CO Mean	F‡	P§
COHB, % saturation	0.98	8.96		
Arterial PO_2, mm Hg	81	76	22.1	<0.01
Venous PO_2, mm Hg	39	31	94.5	<0.001
Arterial PCO_2, mm Hg	40	38	4.2	<0.05
Ventilation, Liters/min	6.86	8.64	4.1	<0.05
Cardiac output, liters/min	5.01	5.56	4.4	<0.05
Oxygen extraction, ml/100 ml*	4.30	4.56	2.7	<0.20
Oxygen extraction ratio†	0.27	0.32	31.2	<0.01
Alveolar-arterial O_2 difference	20	29	7.0	<0.05

*Oxygen extraction, arteriovenous oxygen content difference.
†Oxygen extraction ratio, oxygen extraction divided by arterial oxygen content.
‡F, variance ratio calculated for paired data with interaction as denominator.
§P, probability that observed difference between control and carbon monoxide means are due to chance.

Fig 2.—Distribution of carboxyhemoglobin saturation in a group of New Yorkers grouped according to smoking history (solid circles). An exposed group of tunnel workers (X) is included for comparison. Arithmetic mean is indicated by the horizontal line.

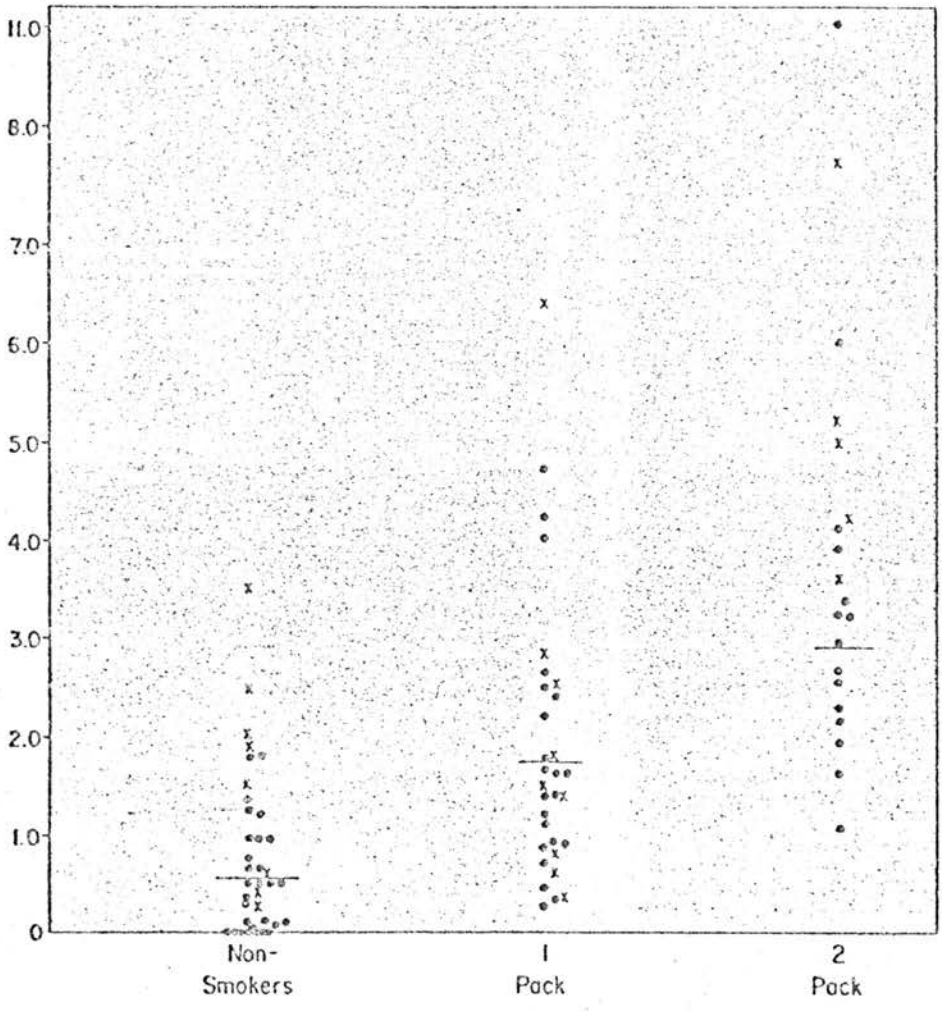


Table 2.—*Lactate and Pyruvate Metabolism, Oxygen Extraction, and Coronary Blood Flow in Five Dogs Before and After Serial Increases in COHB**

COHB	Q_M*	Extraction Ratios†			L_A‡	L/P Ratio§	XL‖	MVO_2¶	$PcsO_2$#
		O_2	Lactate	Pyruvate					
Control	131	0.83	0.42	0.28	0.87	8.66	—2.174	14.73	18
13	109	0.60	0.28	0.12	1.11	14.41	—0.180	8.35	19
50	512	0.36	—0.04	—0.05	1.24	17.14	—0.012	13.05	19
52	430	0.48	—0.82	0.10	3.64	60.00	3.401	10.22	7
Control	158	0.80	0.29	0.36	3.18	16.29	0.218	17.05	19
23	272	0.55	0.11	0.20	3.42	18.27	0.290	17.01	17
50	150	0.45	—0.10	—0.13	9.85	65.63	—0.295	3.68	10
63	D	0.21	—1.03	0.05	11.44	87.69	3.402	...	0
Control	123	0.69	0.61	0.49	1.40	13.46	—0.169	11.54	23
19	121	0.70	0.34	0.24	1.77	16.98	—0.231	8.56	13
33	396	0.38	0.11	0.17	2.70	21.77	0.145	11.90	14
42	...	0.45	—0.33	—0.61	3.23	31.15	—0.927	...	9
Control	75	0.77	0.42	0.16	1.31	17.25	—0.321	8.63	22
19	...	0.53	0.0	0.06	1.53	16.18	0.070	...	15
36	712	0.33	—0.43	—0.34	3.33	42.15	0.296	14.38	10
47	361	0.31	—0.23	0.12	8.26	85.42	2.935	2.77	3.2
Control	86	0.60	0.16	0.12	2.01	14.36	—0.086	6.12	28
29	103	0.56	0.19	0.33	3.91	20.90	0.218	6.59	16
45	338	0.49	0.07	0.17	4.56	16.26	0.475	13.05	11
57	D	0.59	—0.45	0.13	6.33	63.30	3.789	...	0

*Q_M, coronary blood flow in ml/100 gm/min (D, dog's death during sampling).
†Extraction ratios for O_2, lactate, and pyruvate are calculated as arterial-coronary sinus difference/arterial concentration. Negative sign denotes production by myocardium; positive sign, extraction.
‡L_A, arterial lactate in mM/liter.
§L/P, ratio of arterial lactate to arterial pyruvate.
‖XL, excess lactate (negative sign means absence of excess lactate).
¶MVO_2, myocardial oxygen consumption in ml/100 gm/min.
#$PcsO_2$, coronary sinus oxygen tension in mm Hg.

Table 3.—*Myocardial Metabolic Measurements in 11 Human Subjects Before and After Carbon Monoxide Inhalation**

Measurements	Control Mean	CO Mean	F	P
Group 1—Noncoronary Heart Disease (7 Patients)				
COHB, % saturation	0.95	9.00		
Q_M, ml/min/100 gm	129	186	6.5	<0.05
Oxygen extraction, ml/100 ml	11.84	8.89	52.7	<0.001
Oxygen extraction ratio	0.75	0.64	42.1	<0.001
MVO_2, ml/min/100 gm	14.3	15.9	0.4	NS
$PcsO_2$, mm Hg	21	17	2.9	<0.20
Lactate extraction ratio	—0.01	—0.19	0.7	NS
Pyruvate extraction ratio	0.28	0.24	0.3	NS
Group 2—Coronary Heart Disease (4 Patients)				
COHB, % saturation	0.66	8.69		
Q_M, ml/min/100 gm	102	127	0.5	NS
Oxygen extraction, ml/100 ml	12.71	8.82	34.7	<0.01
Oxygen extraction ratio	0.75	0.58	41.9	<0.01
MVO_2, ml/min/100 gm	12.9	11.3	0.5	NS
$PcsO_2$, mm Hg	19	17	12.9	<0.05
Lactate extraction ratio	0.12	—0.36	19.6	<0.05
Pyruvate extraction ratio	0.39	—0.07	25.6	<0.05

*Oxygen extraction = arterio-coronary sinus oxygen difference; oxygen, lactate, and pyruvate extraction ratios = respective extraction divided by arterial concentration. Other abbreviations as in Table 1 and 2. NS, not significant.

COHB was progressively increased is shown in Table 2 and Fig 3. Note the serial decreases in oxygen, lactate, and pyruvate extraction ratios and the marked increases in coronary blood flow. The asterisk in the final period of dogs 2 and 5 indicates the dogs' deaths during the period of sampling preventing measurement of coronary blood flow. In each instance, coronary sinus oxygen tension fell to zero and marked lactate production was observed. The changes in extraction ratios preceded the appearance of excess lactate.

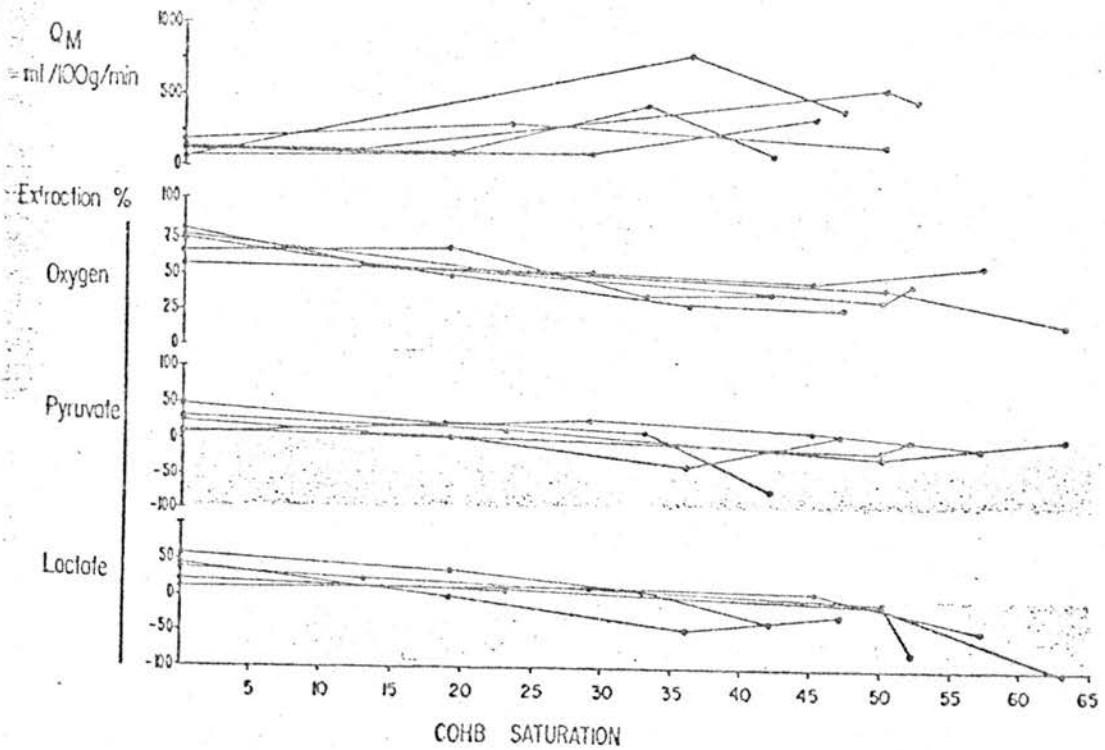
Table 3 lists mean data from seven patients with noncoronary heart disease and from four with arteriographically proven coronary artery disease. Oxygen extraction and extraction ratio decreased in each group and the decrease in oxygen extraction could be correlated with increasing COHB. Coronary blood flow increased significantly in the patients with noncoronary heart disease but not in those with coronary heart disease. Lactate extraction ratios changed to production in both groups but the change was statistically significant only for the patients with coronary artery disease.

Changes in three subjects, one with mitral stenosis, another with coronary artery disease, and a third with emphysema are shown in Fig 4. The patient with emphysema was hypoxemic with an arterial oxygen tension of 47 mm Hg. Extraction ratios, coronary sinus oxygen tension, and coronary blood flow are plotted on the vertical axis. The numerals on the horizontal axis refer to concentrations of COHB.

Comment

Inspection of the oxyhemoglobin dissociation curve in the presence of COHB suggests that venous oxygen tension must decrease if venous oxyhemoglobin saturation is unchanged. The data presented in this study confirm this prediction and demonstrate that raising COHB from a control level of 1% saturation to 9% produces about a 20%

Fig 3.—Coronary blood flow (Q_M) and myocardial extraction ratios for oxygen, pyruvate, and lactate plotted against increasing COHB saturation in five canine studies. Extraction ratios are calculated by dividing the arterial-coronary sinus difference by arterial content. A positive sign indicates myocardial extraction, a negative sign (crosshatched area) indicates myocardial production of a substance.



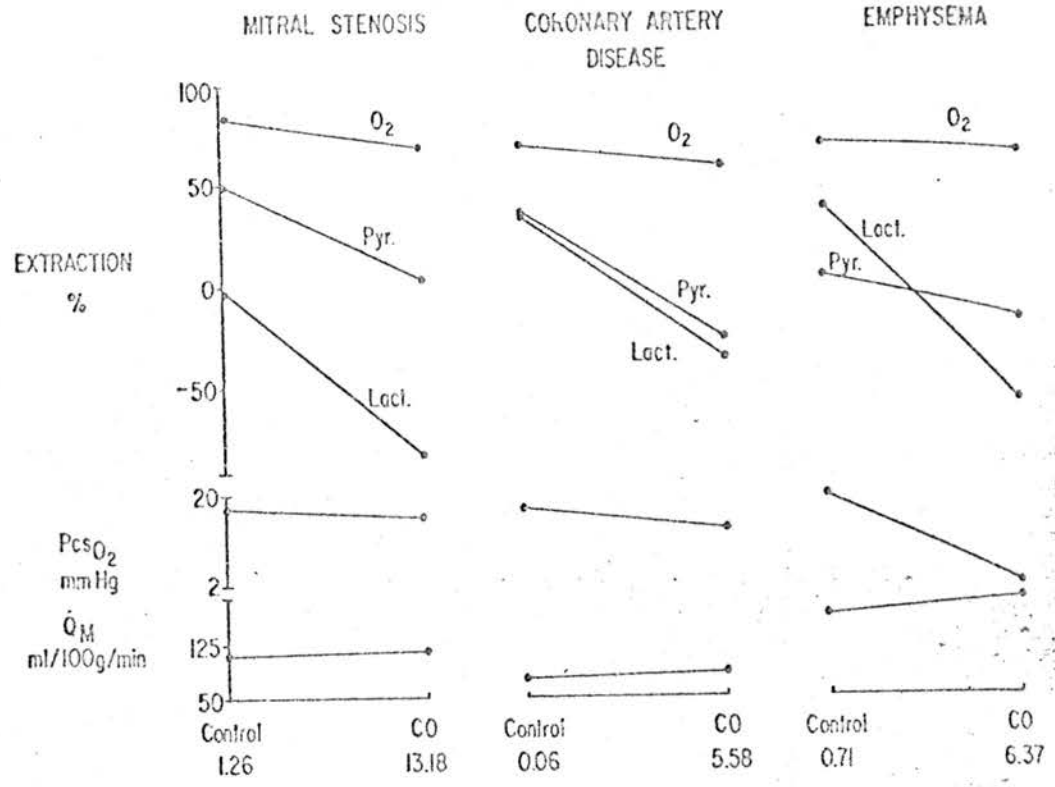


Fig 4.—Myocardial extraction ratios for oxygen, pyruvate, and lactate, coronary sinus oxygen tension (Pcs_{O_2}), and coronary blood flow ($\dot{Q}_M$) in three representative patients. Control and experimental concentrations of COHB are given on abcissa. Note consistent decline of extraction ratios.

decrease in mixed venous and presumably cellular oxygen tension. Since certain cells and their mitochondria are located at a critical distance from a capillary source of oxygen, a 20% decrease in oxygen tension might well inactivate certain oxidative enzyme systems and either decrease the energy production of that cell or lead to its death. These studies provide physiologic explanation for the observations of decreased psychologic function[3-7] and increase oxygen debt of exercise[10] following inhalation of low concentrations of carbon monoxide.

In order to facilitate the performance of these detailed physiologic studies both in a control state and following elevation of COHB to between 5% and 10% saturation, we administered an extremely high concentration of COHB for a short period of time. The breathing of 5% carbon monoxide, assuming normal alveolar-capillary diffusion, may be calculated to produce a maximum of 0.7% concentration in the alveolus. This would be high enough to almost completely saturate pulmonary venous blood so that the chemoreceptors in the aorta and carotid arteries would be exposed to an extremely low oxygen saturation, but a normal oxygen tension. The increases in minute ventilation and cardiac output might be due to this effect, although it has previously been thought that the chemoreceptors are responsive to oxygen tension rather than oxygen content. Transient exposure of the coronary vascular bed to high saturations of COHB would probably not produce a lasting effect. In order to develop an experimental model closely related to human exposures, additional studies following the breathing of 0.1% carbon monoxide for a longer period of time are now underway.

The extreme sensitivity of higher integrative functions to small concentrations of COHB is probably due to their great sensitivity to oxygen deprivation. Although in high concentrations carbon monoxide reversibly combines with cytochrome a_3[16] the affinity for the respiratory enzymes is much

less than that for hemoglobin so that death occurs from high concentrations of COHB long before significant inactivation of the respiratory chain occurs.[21]

Our finding that arterial oxygen tension decreased significantly following carbon monoxide inhalation was unexpected since the failure of arterial oxygen tension to fall has generally been considered to be characteristic of carbon monoxide poisoning. Several explanations for this observation may be advanced. The physiologic venoarterial shunt dilutes the arterial circulation by a variable quantity of venous blood. The oxygen tension drop caused by this saturation drop is magnified in the presence of COHB because of the shift of the curve to the left. Any increase in peripheral oxygen extraction enhances this decrease. Another possible explanation is the effect of COHB on the kinetics of oxygen uptake by hemoglobin in the pulmonary capillary.

The decrease in arterial and mixed venous oxygen tension appears to be a primary reaction which initiates a series of systemic compensations. Increasing cardiac output and minute ventilation are probably attempts to compensate for tissue hypoxia. They resemble the physiologic response to hypoxemia[22] and may be due to adrenergic sympathetic stimulation.

The coronary circulation responded to increasing amounts of COHB with relatively greater increases in blood flow than the systemic circulation. Most patients responded with some increase in coronary blood flow and exaggerated responses were seen in the canine studies where COHB was raised to above 50% saturation. The coronary blood flows of 819 and 1,180 ml/100 gm/min of heart tissue seem unphysiologic but were premortem and probably reflected massive dilatation of normal coronary vascular beds and opening of myocardial arteriovenous shunts.

The reason underlying the greater reactivity of the coronary vascular bed was discussed under theory. Oxygen extraction increased systemically so that increased oxygen consumption could be maintained with modest increases in cardiac output. The shift of the oxyhemoglobin dissociation curve and the maximal nature of myocardial oxygen extraction presented the myocardium with a homeostatic dilemma. An unchanged coronary sinus oxygen saturation would lead to an extremely low coronary sinus and tissue oxygen tension and subject many myocardial cells to near fatal conditions. Instead, myocardial oxygen extraction decreased allowing coronary sinus oxygen tension to remain almost normal. The critical response in this postulated chain of events is the coronary blood flow. A decrease in extraction must be balanced by an increase in coronary blood flow in order to maintain myocardial oxygen consumption. A normal coronary circulation could adequately increase coronary blood flow and keep tissue tensions within normal limits; a diseased vascular system might not be able to develop an adequate coronary blood flow response explaining the suspected sensitivity of patients with coronary artery disease to carbon monoxide.

The adequacy of myocardial oxygenation is a balance between oxygen demand and oxygen availability. While oxygen consumption may be readily measured, total work and heat production and thus total energy requirements cannot be easily determined. The measurement of myocardial lactate and pyruvate fluxes appears to be the best indicator of the balance between oxygen demand and availability although certain theoretic objections prevent unqualified acceptance of either extraction ratios or excess lactate. The canine studies showing that decreases in lactate extraction precede production of "excess lactate" partially validate the use of extraction ratios for the identification of anerobic myocardial metabolism. A further advantage of extraction ratios is their relative independence from arterial concentrations. This approach to the study of the human myocardium has also been emphasized by Cohen and associates.[23]

Figure 4 presents correlated events in three patients before and after acute elevation of COHB. In the patient with mitral stenosis, oxygen and pyruvate extraction decreased, lactate production developed, and a modest decrease in coronary sinus oxygen tension was observed. Similar changes were noted in the patient with coronary artery disease although pyruvate extraction shifted to production. In each patient the coronary blood flow response appeared inadequate.

Dramatic changes were observed in the patient with chronic obstructive lung disease who was hypoxemic at rest. Coronary blood flow was elevated at rest in response to chronic hypoxemia. A modest elevation of COHB to 6.37% saturation produced a decrease in oxygen extraction from 0.72 to 0.66. Both lactate and pyruvate extraction changed to production and the impact of the intervention on body oxygen exchange is emphasized by the drop in mixed venous and coronary sinus oxygen tension from 20 to 20 mm Hg, to 12 and 2 mm Hg, respectively. Had a myocardial oxygen tension of 22 mm Hg been sustained for a longer period of time serious consequences would have been a certainty.

Although the major effect of COHB on myocardial oxygenation appears to be the decrease in oxygen delivery and the need for increase in coronary blood flow, recent work suggests that COHB may also interfere with the diffusion of oxygen from capillary to mitochondria. Wittenberg has reviewed the physical diffusion of oxygen in cells[24] and proposed that myoglobin may facilitate the diffusion of oxygen in skeletal and cardiac muscle by reversibly combining with oxygen molecules, taking a short "random walk" and passing on the oxygen molecule to another uncombined myoglobin molecule. He has experimentally demonstrated that oxygen diffusion is much more rapid in myoglobin solutions compared to solutions of similar viscosity which do not bind oxygen. Should facilitated diffusion be shown to be a necessary process in cardiac muscle—and Wittenberg has postulated that it might account for from 50% to 90% of oxygen reaching the mitochondria during heavy work—carbon monoxide might well be found to exert a deleterious role by combining with myoglobin and intefering with facilitated oxygen diffusion. The reaction between carbon monoxide, oxygen, and myoglobin has an M value (affinity constant) about one sixth that for the reaction between carbon, oxygen, and hemoglobin. However, cellular oxygen tension is less than one fourth that of arterial oxygen tension so that a blood COHB of 10% saturation would be in equilibrium with 6% to 7% carboxymyoglobin. It is interesting to speculate on the effect of a 7% decrease in facilitated diffusion on mitochondrial oxygen tension in a normal subject during heavy exercise or in a patient with coronary artery disease at rest.

Summary

Cardiorespiratory measurements were made before and after acute elevation of COHB to an average of 8.96% saturation in 5 patients. Venous oxygen tension decreased from 39 to 31 mm Hg and significant increases in minute ventilation, cardiac output, peripheral oxygen extraction, oxygen consumption and the alveolar-arterial oxygen difference were observed. Coronary blood flow and myocardial extraction ratios for oxygen, lactate, and pyruvate were determined in a series of dogs and human subjects. Coronary blood flow increased and extraction ratios decreased following acute elevation of COHB. The decrease in myocardial oxygen extraction observed with increasing COHB contrasts with the increase in systemic oxygen extraction and constitutes an adaptive challenge to the coronary circulation.

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JAPAN'S YOUTH TOWER

The stature of Japanese youths has shown remarkable increase during the past decade. The age of maximal difference for boys was at 14 years (7.6 cm) and for girls at 11 years (6.6 cm). The increased stature is most marked in children born since the period of postwar shortages, who were thus less apt to have been exposed to handicaps during their critical preschool years. There is considerable evidence, both direct and indirect, that the increased growth rate in Japan has been stimulated by better nutrition. It seems evident that genetic factors could not have been responsible for the marked increases in stature of Japanese youth in one decade. For Japan as a whole, the total protein consumption has increased about 10% in the past decade, and the intake of animal protein has almost doubled. It may be pertinent to comment here that research workers have observed that protein as well as mineral malnutrition may greatly influence both the rate and character of bone growth.—Jackson, R.L.: Nutritional and Environmental Influences on Growth and Development, *J Amer Med Women's Assoc* 23:697-707 (Aug) 1968.

Appendix C
719

eview Article

Pathophysiology of Exposure to Low Concentrations of Carbon Monoxide

Donald Bartlett, Jr., MD, Cincinnati

HE BIOLOGY of carbon monoxide CO) has been the subject of innumerable ports and reviews. The addition of this ecialized review to the literature seems stified for three reasons. First, traditional udies of CO toxicology have rightly emasized the dramatic effects of heavy expores; remarkably little information is availle about the consequences of exposure to e low concentrations found in polluted mmunity air. Second, concern with envinmental pollution is expanding rapidly, tracting the attention and participation of any persons not formally trained in biolo; a summary of the somewhat complex ologic relationships of CO may be useful. nally, quantitative comparisons of the ects of various hypoxic influences—CO, emia, high altitude, and reduced blood w—are presented in graphic form and dissed.

Basic Chemical Reactions

There is little doubt that the most impornt toxic properties of CO are attributable its reactions with hemoproteins. The most portant, and most thoroughly studied of ese reactions is the reversible combination CO with hemoglobin (Hb) to form carxyhemoglobin (COHb), which for present rposes may be written as:

$$(1) \quad CO + Hb \rightleftharpoons COHb$$

Less important, but also of biologic significance, is the reaction of CO with myoglobin (Mb):

$$(2) \quad CO + Mb \rightleftharpoons COMb$$

Other proteins, including several enzymes, react in vitro with high concentrations of CO. Whether these reactions are significant in vivo is debated. Most evidence at present suggests that even if such reactions are of biologic significance, they occur only with CO tensions considerably above the range of community air pollution.[1]

Reactions (1) and (2), in their biologic settings, are discussed in more detail below. The alterations in steady state gas exchange resulting from equilibration with low partial pressures of CO are considered first, followed by a brief review of dynamic aspects of CO uptake and excretion.

Equilibrium Relationships (COHb)

When a person breathes air containing a certain concentration of CO for several hours, he reaches a state of equilibrium with respect to the gas in which the partial pressure of CO (Pco) in the blood in the pulmonary capillaries is equal to that in the alveolar and ambient air. As long as the individual continues to breathe air with the same Pco, no net uptake or excretion of CO occurs. (Strictly speaking this statement is inaccurate, as it neglects the endogenous production of CO and its metabolic conversion to CO_2.[2] Both of these processes are normally very slow, however, and may be neglected except under unusual circumstances.)

The equilibrium of reaction (1), meas-

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From the Medical Research Section, Health Efts Research Program, National Center for Air lution Control, Public Health Service, Cincinnati. eprint requests to 1055 Laidlaw Ave, Cincinnati 37.

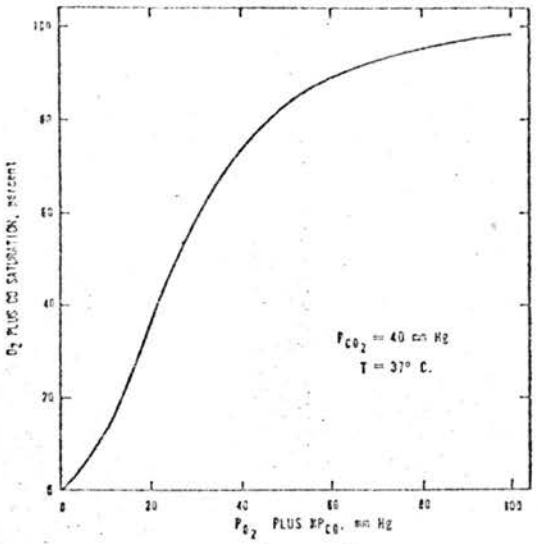


Fig 1.—Oxyhemoglobin and carboxyhemoglobin dissociation curve (After Rahn and Fenn[5]). The relative affinity constant (M) is numerically equal to 210.

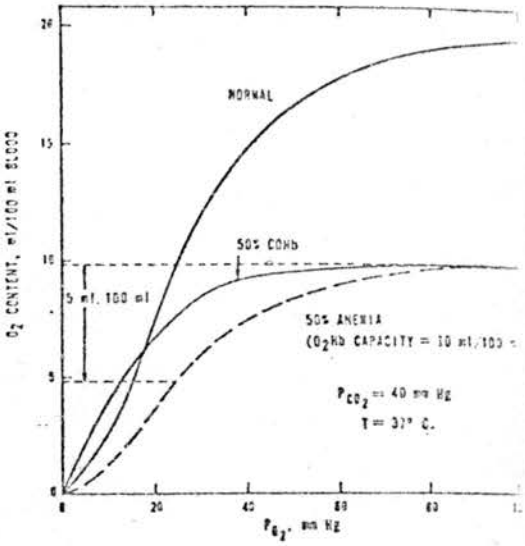


Fig 2.—Oxyhemoglobin dissociation curves of n mal human blood, of blood containing 50% carbo hemoglobin, and of blood containing 50% of the n mal amount of hemoglobin due to anemia. Note t the carboxyhemoglobin curve lies above and to the of that of blood with an "equivalent" degree of aner

ured as the proportion of available hemoglobin combined with CO, depends not only on the partial pressure of CO, but on that of oxygen (O_2) as well, since the two gases compete for the same reactive sites on the hemoglobin molecule. This relationship is described by the Haldane equation:

$$\frac{[COHb]}{[O_2Hb]} = M \times \frac{P_{co}}{P_{o_2}} \quad (3)$$

where [COHb] and [O_2Hb] are the concentrations of the hemoglobin compounds expressed in any units (saturation percent, milliliters per 100 milliliters of blood, etc) and M is the relative affinity constant, numerically about 210 at physiologic temperature and pH. This equation has been repeatedly verified for cases in which the Pco and Po_2 together are sufficient to fully saturate the available hemoglobin. The relative affinities of the two gases vary slightly when appreciable reduced hemoglobin is present.[3] Although this discrepancy is of considerable theoretical interest,[3,4] the variation in M with the degree of hemoglobin saturation is numerically small, and is therefore neglected in the following analysis.

The dissociation curve of COHb, in the absence of O_2, has the same sigmoid shape as that of O_2Hb and can be made to coincide with it by multiplying the Pco coordinates by M (Fig 1). From this curve and the Haldane equation, the absolute and relative concentrations of COHb and O_2H can be found if the Pco and Po_2 are know Minor discrepancies between the curves f CO and O_2 have been pointed out,[2] b these may be neglected without introduci a quantitatively significant error.

Although the shape of the hemoglobin di sociation curve of either O_2 or CO alone sigmoid, the combination of part of t available hemoglobin with CO shifts the dissociation curve for the remaining hem globin upward and to the left. Oxyhemogl bin dissociation curves for human blood u der several conditions are shown in Fig These curves illustrate a point long estal lished in the physiologic literature but oft neglected by industrial hygienists—that C interferes with O_2 transport by two mech anisms:

1. Displacement of O_2 from hemoglob in the arterial blood.

2. Interference with O_2 release in the ti sues through alteration of the shape of th O_2Hb dissociation curve.

An example of the consequences of COH formation is shown by the two lower curv in Fig 2 which represent the blood of tw persons, one with 50% COHb, the oth with a 50% loss in O_2 capacity due to an mia. Both persons, breathing air, have a

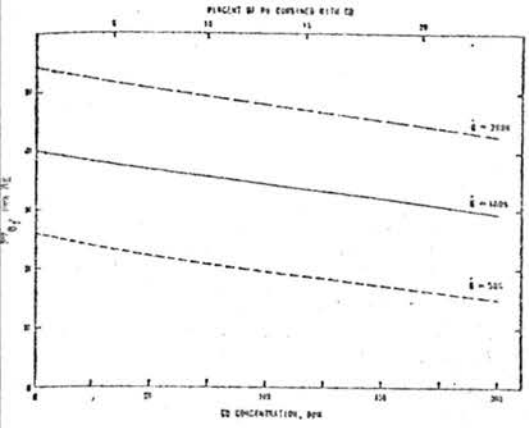


Fig 3.—Normal man at sea level: effect of CO on $P\bar{v}o_2$. Isopleths denote normal, half normal, and twice normal cardiac output ($\dot{Q}$) as defined in Table 1.

arterial O_2 content of about 9.8 ml/100 ml of blood. If metabolic demands require an arteriovenous O_2 difference of 5.0 ml/100 ml of blood, the mixed venous O_2 tension ($P\bar{v}o_2$) of the anemic person will be about 25 mm Hg, while that of the person with 50% COHb will be reduced to about 12 mm Hg—a level inconsistent with good tissue oxygenation. Although the COHb concentration in this example is far above those associated with community air pollution, the analysis illustrates the dual hypoxic effect of CO.

Theoretical Analysis of Hypoxia

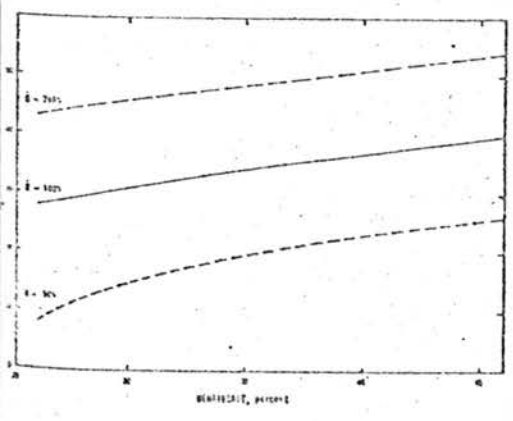
A Theoretical Analysis of Hypoxia From Various Causes.—The ultimate expression of hypoxia resulting from any cause is in the body's peripheral tissues, where O_2 is consumed by cellular metabolism. Aerobic metabolic processes depend on maintaining tissue O_2 tension above a critical level, which varies among different tissues and in relation to other characteristics of the cellular environment, such as pH and temperature. Intracellular tissue gas tensions are difficult to measure directly, but changes in capillary Po_2 must reflect changes in tissue Po_2, barring large changes in capillary density or O_2 consumption.

In the absence of extensive arteriovenous shunting, the Po_2 of venous blood coming from a tissue is equal to the Po_2 at the venous end of its capillaries. Thus, venous Po_2 is a good indicator of the oxygenation of the tissue it represents. Mixed venous Po_2 is an indicator of the average tissue Po_2 of the whole body; individual organs and tissues may have higher or lower tissue and venous O_2 tensions, depending on their metabolic demands and blood supplies. Figures 3 to 8 represent a theoretical analysis of the degree of tissue hypoxia, reflected by the mixed venous O_2 tension, that may be expected under a variety of hypoxic stresses. To make the model applicable to the levels of CO associated with community air pollution, only fairly low concentrations are represented. Each curve in Fig 3, 4, 6, and 7 shows the $P\bar{v}o_2$ associated with the conditions specified.

The conditions of the model, unless otherwise noted, are those shown in Table 1. The blood nomogram of Dill, representing the combined O_2 and CO_2 dissociation curves of human blood, as revised by Rahn and Fenn,[5] is used throughout. The O_2 and CO in physical solution are neglected.

Figure 3 shows the effect on normal man of equilibration with various concentrations of CO at sea level. When cardiac output ($\dot{Q}$) is normal (100%), the $P\bar{v}o_2$ falls from a normal value of 40 mm Hg to less than 30 mm Hg after equilibration with 200 ppm CO. Curves for twice normal and half normal cardiac output are included for comparison. By the Fick principle, these may be used alternatively to represent half normal and twice normal rates of O_2 consumption, respectively. Figure 4 shows the effect of various degrees of anemia. Comparison with Fig 3 reveals, for example, that 75 ppm CO, which corresponds to about 10% COHb under these conditions, results in a mixed

Fig 4.—Effect of anemia on $P\bar{v}o_2$ in man at sea level.



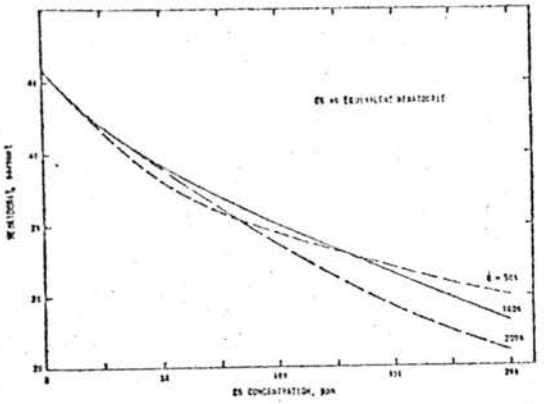


Fig 5.—Each curve shows CO concentrations and hematocrit values that are equivalent in terms of $P\bar{v}o_2$ for the cardiac output indicated.

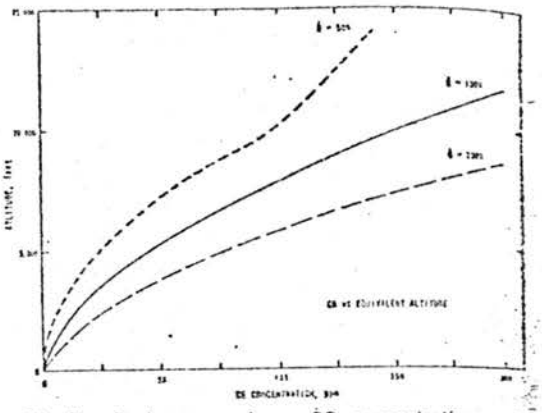


Fig 7.—Each curve shows CO concentrations and altitudes that are equivalent in terms of $P\bar{v}o_2$ for the cardiac output indicated.

venous Po_2 of 35 mm Hg; this is the $P\bar{v}o_2$ associated with a reduction in hematocrit value to 37%—nearly a 20% decrease from the normal value of 46%.

Figure 5 shows hematocrit and ambient CO values that are equivalent in terms of $P\bar{v}o_2$, determined as in the example above. Because of the peculiar shape of the O_2 dissociation curve, the relationship between CO levels and equivalent hematocrit values varies slightly with marked changes in cardiac output.

Figure 6 introduces another type of hypoxic stress—that of altitude. In calculating the mixed venous Po_2 for each altitude, the arterial Po_2 and Pco_2 used are those given by Rahn and Fenn for acute exposure[5]; after acclimatization, both arterial and venous O_2 tensions would be slightly higher.

Fig 7 shows altitudes and sea level ambient CO concentrations that are equivalent in terms of $P\bar{v}o_2$. Figure 8 shows equivalent altitudes and hematocrit values. By comparison with altitude, both anemia and CO have much greater effects on persons or tissues with reduced blood flow. For example, a man with normal cardiac output equilibrated with 100 ppm CO at sea level has a $P\bar{v}o_2$ of 34 mm Hg—that of a man at 7,800 feet. By contrast a man with half normal cardiac output under the same conditions has a $P\bar{v}o_2$ of 20 mm Hg—that of a similar man at 10,000 feet.

The Haldane equation, and thus the entire analysis presented above, describes the equilibrium state only. Kinetic aspects of COHb formation are discussed briefly later.

Effect of Smoking

Regular cigarette smokers have repeatedly been shown to have COHb concentrations

Fig 6.—Effect of altitude (acute exposure) on $P\bar{v}o_2$ in normal man.

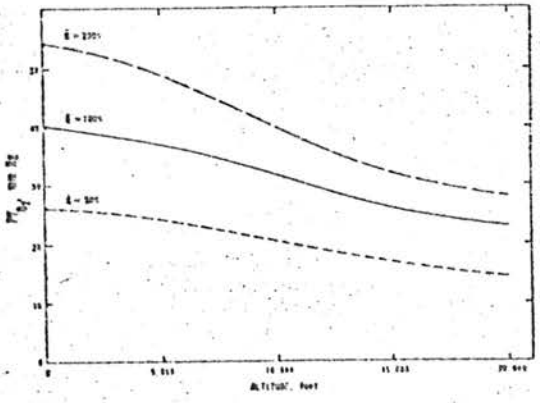


Fig 8.—Each curve shows hematocrit values and altitudes that are equivalent in terms of $P\bar{v}o_2$ for the cardiac output indicated.

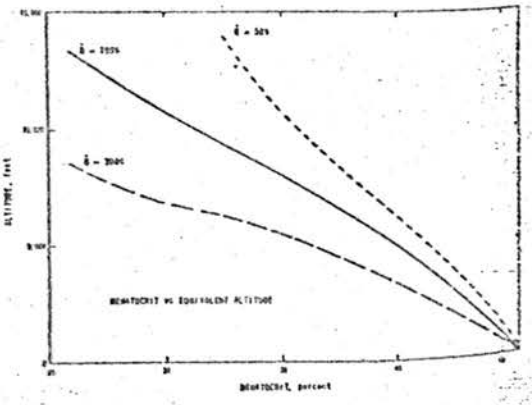


Table 1.—*Conditions of the Model of Steady State Gas Exchange Presented in Fig 3 to 8.*

Parameter	Assumed Value
Barometric pressure	760 mm Hg
Arterial P_{O_2}	100 mm Hg
Arterial P_{CO_2}	40 mm Hg
Arteriovenous O_2 content difference	5.0 ml/100 ml of blood when cardiac output ($\dot{Q}$) is normal (100%)
Normal O_2 capacity	20.0 ml/100 ml of blood
Normal hematocrit	46%
Respiratory exchange ratio (R)	0.8
M	210

in the 5% to 10% range.[6,7] Smokers of pipes and cigars have COHb levels that are somewhat lower than those of cigarette smokers, but higher than those of nonsmokers. These findings have led to the widespread error of supposing that smokers may be more susceptible to environmental CO than nonsmokers. Carbon monoxide from cigarette smoke and CO in the ambient air are not additive in their biologic effect. Carbon monoxide is absorbed only when the Pco in the ambient air exceeds that in the pulmonary capillary blood. Thus, persons with COHb levels of 5% from smoking do not absorb further CO from the environment unless the ambient CO concentration is 30 ppm or more; on the contrary, they excrete CO at a rate roughly proportional to the Pco gradient between their blood and the ambient air. This suggests that smokers may be among the least susceptible of persons exposed to low atmospheric concentrations of CO, since their COHb concentrations are not increased by the exposure. This conclusion is modified, however, by the fact that smokers' CO excretion between cigarettes is slower in a CO-polluted environment than in pure air. Thus, their long-term average COHb concentrations are slightly higher in the presence of environmental CO than in its absence.

Equilibrium Relationships (COMb)

The reaction of CO with myoglobin has been much less extensively studied than that with hemoglobin, but may be of considerable importance. Myoglobin accounts for about 20% of the body's CO capacity, hemoglobin accounting for nearly all of the remaining 80%.[2]

The equilibrium of reaction (2) may be expressed by a form of the Haldane equation:

$$(4) \qquad \frac{[COMb]}{[O_2Mb]} = K \times \frac{P_{co}}{P_{o_2}}$$

In this case, however, the relative affinity of the protein for CO over O_2 is less than for hemoglobin, the numerical value of K being about 40.[8]

The combination of O_2 or CO with myoglobin occurs without the formation of intermediate compounds, since only one heme group is present in each protein molecule. Accordingly, the dissociation curve of either gas with myoglobin is hyperbolic (Fig 9).

The biologic importance of myoglobin is uncertain. Situated in the sarcolemma of the muscle cell, between the capillaries and the mitochondria, it is usually thought of as an O_2 reservoir that can be tapped to supply mitochondrial needs during muscular contraction, when capillary blood flow is reduced. The very low P_{O_2} required for significant unloading of O_2 from myoglobin, however, casts some doubt on this hypothesis. An attractive, though unproven alternative is that sarcolemmal myoglobin serves as a matrix for facilitated diffusion of O_2, which has been demonstrated in vitro in myoglobin solutions.[9]

The role of CO in relation to myoglobin function is unknown. A person equilibrated with 100 ppm CO at sea level has an arterial Pco of 0.07 mm Hg, but the Pco in his capillary and venous blood is about 0.03 mm Hg—less than half the arterial value. The reason for this arteriovenous difference in Pco is apparent from consideration of the Haldane equation, which may be rewritten as

$$(5) \qquad P_{co} = \frac{[COHb] \times P_{o_2}}{[O_2Hb] \times M}.$$

As O_2 is extracted from the blood, P_{O_2} falls proportionally more than $[O_2Hb]$ because the upper part of the O_2Hb dissociation curve is fairly flat. Since CO does not exchange appreciably between blood and tissues, [COHb] is the same in venous and arterial blood. Under these conditions, blood Pco must fall as O_2 leaves the blood and enters the tissues. The proportion of COMb resulting from equilibration of myoglobin

with 0.03 mm Hg CO tension depends critically on Po_2 in the region. This can only be estimated, but it is clearly somewhat less than that of the local venous blood. For this example, [COMb] would be 5.1% if muscle Po_2 were 20 mm Hg, 13.8% if muscle Po_2 were 5 mm Hg, and 25.5% if muscle Po_2 were 1 mm Hg.

The extent to which COMb concentrations in this range are biologically meaningful is unknown. The facilitated diffusion of O_2 through hemoglobin and myoglobin solutions is impaired by high concentrations of CO,[10] but whether this effect is due to COMb formation and whether it occurs with low concentrations have not been determined. Elucidation of myoglobin function and its alteration by CO awaits further research.

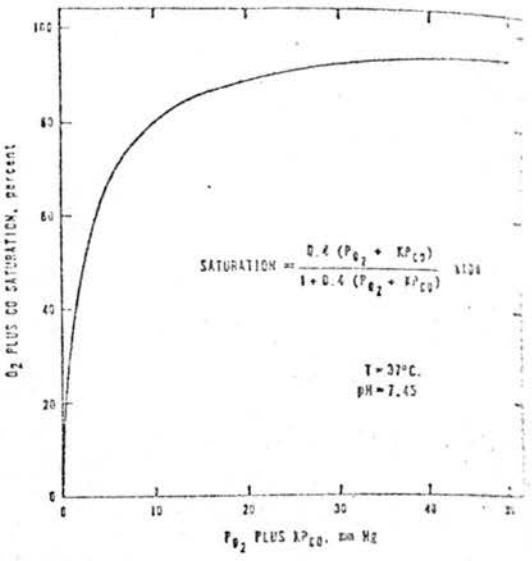


Fig 9.—Oxymyoglobin and carboxymyoglobin dissociation curve (After Rossi-Fanelli and Antonini[9]). The relative affinity constant (K) is numerically equal to 40.

Kinetic Aspects of CO Uptake and Excretion

In the absence of rapid endogenous production or metabolic removal of CO, both uptake and excretion of the gas are clearly nonsteady state processes. Several workers have found however, that, for practical purposes, the CO uptake rate is constant during the first hour or so of exposure.[11-13] This justified oversimplification has led to considerable confusion about the time course of CO absorption over longer periods, and no definitive study of the process has been reported.

The rate of CO uptake by the lung may be determined theoretically by a number of factors including ambient and pulmonary capillary Pco and Po_2, alveolar ventilation, the diffusing characteristics of the lung, plasma, and red cell membrane, pulmonary capillary blood flow, and the kinetics of the reactions of CO and O_2 with hemoglobin. During the early phase of CO uptake, the ambient Pco and alveolar ventilation are the most important factors, but as equilibrium is approached, the Pco in the pulmonary capillary blood rises and slows pulmonary uptake. In the most complete study available,[11] equilibration with low concentrations (200 to 400 ppm) had a half time in terms of COHb formation of about two hours and was 90% or more complete after six hours in persons engaged in light activity. The data are not sufficiently complete to justify fitting a simple exponential equation, nor is it likely that such an expression would be appropriate in view of the many contributing factors.

The elimination of CO has been less definitively studied than its uptake. Like the latter process, it is most rapid early in its course, when the Pco gradient between blood and air is maximal, and slows as the pulmonary capillary Pco approaches that of the ambient air. Scattered observations suggest that the half time of excretion for subjects breathing air is in the range of 1½ to 4 hours.[14,15] The excretion rate is increased considerably by breathing O_2, particularly under hyperbaric conditions.

The kinetics of the chemical reactions of CO and O_2 with hemoglobin have been studied extensively by Roughton and reviewed by him recently.[16] The evidence suggests that, under some circumstances, pulmonary uptake and excretion of CO may be partially limited by the chemical reaction rates.

Effects on Health

The chief reason for studying the biologic effects of CO is to understand its influence on man's health and activities. This goal has been approached in the case of acute poisoning with high concentrations of the gas

Table 2.—*Median Birth Weights and Percent of Babies Weighing 2,500 gm or Less**

	Population in Thousands				
	250+	50-250	10-50	2.5-10	Rural
of births	148,230	87,837	109,537	66,153	246,538
ian birth weight (gm)	3,288	3,304	3,311	3,324	3,359
ent ≦ 2,500 gm	7.46	7.20	7.10	7.07	6.61
hite					
of births	30,259	11,234	7,165	3,154	15,119
ian birth weight (gm)	3,127	3,154	3,173	3,173	3,215
ent ≦ 2,500 gm	12.43	11.94	11.63	11.07	11.09

ths attended by physician in hospital, United States, January-March, (by population of mother's place of residence).[30]

e information is available about the ts of controlled exposures to low con- rations on specialized functions of the ous system. Visual threshold,[17] flicker n frequency,[18] time perception,[19] and performance of various psychomotor s[20] are altered by COHb concentrations he 2% to 5% range. The significance of e findings in terms of man's health or al activities is unknown.

Meaningful effects of exposure to the low centrations of CO commonly found in mmunity air have not been clearly iden- d. If such effects exist, it should be possi- to predict them from our knowledge of pathophysiology and to design experi- ntal or epidemiologic studies to demon- ate them. One approach to predicting h effects is to examine the effects of mild oxia from other causes such as anemia or uced barometric pressure. Exercise toler- ce is measurably impaired by exposure to ulated altitudes of as little as 7,000 feet. ximal O_2 uptake is diminished by this de- e of reduction in barometric pressure.[21] uilibration with an equivalent concentra- n of CO (Fig 7) might be reasonably ex- cted to induce similar changes. Pitts and ce found that the pulse rate during exer- se at sea level was unchanged with 6% OHb but increased with 13% COHb.[22] ore recently Chevalier et al found an in- eased exercise O_2 debt with 4% COHb.[23] his finding must be interpreted with cau- on because the study did not include ap- opriate controls. More definitive studies of e effects of low levels of COHb on exercise e needed.

Chronic residence at high altitude leads to onsiderable symptomatic acclimatization or tolerance. This long-term acclimatization to hypoxia is associated with several alterations, including increases in the body's hemoglobin and myoglobin content, increase in the capillarity of tissues, and certain cellular and enzymatic adaptations.[24] Chronic or repeated exposure to CO also results in partial acclimatization to the gas.[25] Animals exposed to CO have been found to develop tolerance for exposure to simulated high altitudes, and vice-versa,[26] suggesting that common mechanisms are involved. The importance of tolerance in relation to health effects of CO has not been studied; it may be a significant factor in smokers and those chronically exposed.

Persons already subject to a degree of hypoxia from altitude, anemia, or reduced cardiac output, and those with supernormal O_2 needs due to pregnancy, hyperthyroidism, or fever may be particularly sensitive to the effects of CO or any additional hypoxic stress. The heart is doubly embarrassed by hypoxia, for it must increase its work to provide oxygen to peripheral tissues while its own oxygen supply is reduced. Thus, in theory, patients with heart disease may be expected to tolerate CO very poorly. Little specific information is available about the effects of mild CO exposure on such people, but the extensive epidemiologic studies of cigarette smoking provide data that may be applicable. The death rate from coronary heart disease is considerably higher for smokers than for nonsmokers.[27] The rate for exsmokers is no higher than for persons who have never smoked. This pattern implies that the smoking effect is completely reversible when an individual stops smoking. Thus, smoking must cause myocardial hypoxia by some acute, reversible process, probably unrelated to the formation of hard, irreversible, atherosclerotic lesions. Carbon monoxide fits this epidemiologic pattern quite well, but nicotine or other components of cigarette smoke may be responsible, and the question remains unsolved.

Another important effect of smoking that may be attributable to CO relates to fetal

development. Mothers who smoke during pregnancy have, on the average, smaller babies than those who do not smoke, regardless of smoking history prior to the pregnancy.[28] If this effect is due to hypoxia caused by CO, the average weight of babies born at high altitude should also be low. Data indicating that this is so have been presented by Gralın and Kratchman,[29] who found that babies born even at modest altitudes (2,000 to 4,000 feet) weigh less, on the average, than those born at sea level.

The question that follows logically from these observations is whether nonsmoking mothers exposed during pregnancy to CO in urban air have smaller babies than those not so exposed. Specific information about this question has not been obtained, but birth weight is inversely related to the population of the mother's place of residence[30] (Table 2). Apparently fetal development is influenced by some factor associated with urbanization; whether this factor is CO remains to be determined.

These examples of possible effects of low concentrations of CO are typical in being unresolved. Conclusive information about these and other questions is lacking, not because such information is unobtainable, but because, with few exceptions, it has not been looked for. Each problem mentioned in the preceding paragraphs can be studied by means of available experimental or epidemiologic techniques.

Carbon monoxide is unusual among community air pollutants in that we know enough about its biologic relationships to make fairly specific predictions of health effects. Applied research in this field should be concentrated increasingly on determining whether these predicted effects are in fact taking place in our cities.

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ERRATA

In the December 1967 issue of the ARCHIVES, an error was made in Molokhia and Smith's article, "Trace Elements in the Lung" (15:745-750 [Dec] 1967). Fig 1 and 2 (pp 748-749) should be transposed; the legend for Fig 1 should be matched with cut 2 and the legend for Fig 2 should be matched with cut 1. The erratum published in the April issue (p 595), hence, is incorrect.

In the March 1968 issue of the ARCHIVES, an error was made in Winkelstein et al's article, "The Relationship of Air Pollution and Economic Status to Total Mortality and Selected Respiratory System Mortality in Men" (16:401-405 [March] 1968). In column 2, page 401, lines 4 and 5 should read "economic status. No association between suspended. . . ."

In Baetjer's article, "Role of Environmental Temperature and Humidity in Susceptibility to Disease" (16:565-570 [April] 1968), in a recent issue of the ARCHIVES, an error was made on p 570. Lines 18 and 27 (column 1) should read "endogenous" and "exogenous," respectively.

Appendix D

In establishing improved standards of air quality, the effects of pollutants on human performance should be taken into account. For this reason, the effects of exposure to carbon monoxide were studied on a group of young adults. The results are reported.

BEHAVIORAL IMPAIRMENT ASSOCIATED WITH SMALL DOSES OF CARBON MONOXIDE

Rodney R. Beard, M.D., M.P.H., F.A.P.H.A., and George A. Wertheim, Ph.D.

THE rational development of the control of air pollution requires the establishment of identified, acceptable goals. Ultimately it must be results which count, not merely conformity to rules which set forth efforts to be made. Standards for quality of the air have been arrived at in several ways. In the United States and most of the world, technical feasibility and economic considerations set limits on the extent of air pollution control which can be included in the design of new facilities for any particular industrial or domestic process. The design determines the concentration and volume of pollutants emitted by the installation. This emission rate then becomes the standard of comparison for other installations which carry out similar processes.[1] Thus technical capabilities and economic values have determined the goals of air pollution control programs. In Russia and in some other countries, it is stated that everyone should be protected from the effects of any agent in the air which can produce any demonstrable physiological effect, even if the effect is not shown to be harmful. Hence, the air purity standard is set at a pollutant concentration lower than the threshold determined by the most sensitive test.[2,3]

It would appear logical to decide first upon our goals, to set standards according to these goals, and then to work toward their achievement. However, human communities do not always behave logically. For example, if air quality standards are too exacting and cannot be attained or closely approached, we are likely to relax our efforts and to ignore the standards. Hence, while we should not set standards which will permit harm to occur just because the public is not yet ready to welcome a safe standard, we need not go to extremes to discover and control relatively inconsequential effects of pollutants. Air quality standards must be fitted to the localities and populations which they serve, as Goldsmith[4] has explained so clearly.

There is always a risk that when one sets a standard at the highest readily attainable level, for no other reasons than the feasibility of that limit and the general notion that purity is desirable, the standard may become frozen into common usage. It then becomes exceedingly difficult to relax the requirement, although pressing practical and economic reasons might make such a change highly desirable. The beryllium standard is an example. A very exacting standard was set at a time when beryl-

lium was little used. The use of beryllium in rocket fuel would now make it convenient and economical if less restrictive controls could be applied but we know from years of experience that the existing limit is safe, and it will take a great deal of evidence to persuade any responsible health officer that he should approve less exacting precautions.

Sometimes doubts are raised about the applicability of economic factors in the setting of standards for air purity. Certainly economic considerations should play no part in developing quality standards designed for the prevention or aggravation of disease. Protection from annoyance or from physiological effects of uncertain significance must be weighed against other benefits which might be purchased by equivalent expenditures. It thus is evident that a single standard cannot be set; as in other fields of human enterprise, there are quality levels with differing price tags. It is the prerogative of the people to decide what quality they will pay for. It is up to the scientific community to define what the people can get for their money. In addition, scientists, in their roles as citizens, should do their utmost to combat the increase in air pollution.

We have entered an era in which air pollution controls will be based on air quality standards. The first principle recommended by the President's Science Advisory Committee says:

> "The public should come to recognize individual rights to quality of living, as expressed by the absence of pollution, as it has come to recognize rights to education, to economic advance, and to public recreation," and, "All concerned should recognize the quality of human life and the presence and growth of other living things as the major values currently damaged by pollution. While more subtle human effects are possible and should be sought for, demonstrable threats to human health constitute a small part of today's damage from pollution." The panel recommends that "efforts be increased to establish the scientific bases upon which standards of environmental quality can be set."[5]

Among the scientific criteria which ought to be considered in setting standards of environmental quality, of primary importance is evaluation of the effects of pollutants upon man's capacity to perform important tasks. The study of effects of toxic agents on conditioned reflexes and other patterns of behavior has been used by European workers, notably Horvath in Prague and Grandjean in Zurich. In our laboratory, we were impressed by the potential value of this approach, and have set forth on a program to develop it for application in our own country. This type of study may help us to understand the mechanisms of toxic action, as well as to provide data which may ultimately provide a basis for setting standards of air quality.

In reaching for an air quality standard for carbon monoxide, one is impressed by the paucity of data for the effects of concentrations below 100 parts per million (100 ppm), since it has often been stated that below this level there are no perceptible physiological effects. We have undertaken the exploration of this region, looking for subtle behavioral changes. It is our intent to investigate the effects of other environmental factors such as heat and noise in combination with carbon monoxide (CO).

We undertook a number of experiments with rats and monkeys to establish familiarity with the gross effects of CO, to become adept in handling the equipment, and to discover behavioral changes which might be most profitably investigated in human beings. We found that early in the course of CO exposure, the animals showed derangement of time sense: their response patterns became temporally irregular.

Following this lead, we devised a test of discrimination of time intervals for use with human subjects. This test took the form of comparison of paired presentations of pure tones with the second of the pair shorter, equal to, or longer than the first.

Equipment and Methods for Studies in Human Beings

A commercially built audiometer booth was used as a dynamic exposure chamber. It had a contained volume of three cubic meters (110 cubic feet) and was ventilated at a rate of 100 cubic feet per minute (design value) (2.83 cubic meters per min.). CO was metered from a pressure cylinder through a sensitive rotameter to the air inlet. A quietly operating fan in the chamber assured complete mixing of the air. A small pump provided a continuous flow from the chamber to a nondispersive infrared analyzer which was calibrated daily by use of standard CO-in-air mixtures. The concentration in the chamber was adjusted to the desired value by manipulation of a needle valve and was continuously recorded. The intended concentration could be built up within one miriute and held within ten ppm or closer. The subject could adjust the temperature to his preference on cold days. Wet- and dry-bulb temperatures were recorded at about 20-minute intervals. The dry-bulb temperatures ranged from 67° F to 89° F with median values of 70° F to 88° F for the various sessions. Wet-bulb temperatures were from 57° F to 72° F with median values for individual sessions from 58° F to 68° F. The relative humidities were from 17 per cent to 64 per cent with median values for individual sessions from 19 per cent to 56 per cent. The performance data showed no significant differences correlated with temperature or humidity.

Tests were done between 11 A.M. and 6 P.M. Physical activity of the subjects was negligible during the tests and their activities prior to the tests did not include heavy exertion.

The subject and the experimenter could talk through a telephone system. A good light and a comfortable chair were provided. The subject could be observed through a window.

The subjects were young adult university students who were paid for their time. They were nonsmokers. The nature and purpose of the experiment were explained and honest answers were given to all questions raised, except whether CO was present during a test period. Blood samples were taken at the beginning and at the end of each experimental session. Regrettably, our determinations of carbon monoxide hemoglobin were inaccurate. Medical supervision was provided for all sessions.

The 1,000 hz tone signals were generated electronically. The durations were controlled by resistor-condenser circuits which were adjusted to the selected intervals by observation on a cathode-ray oscillograph. The signals were free of onset and offset clicks. The volume was adjusted to a comfortable level, well above the auditory threshold. The stimuli were presented by the psychophysical method of constant stimuli. On each trial, there were two presentations of the tone separated by a one-half-second interval. The first or "standard" signal was always one second in duration; the second or "variable" signal was varied in 18 steps between 0.675 seconds and 1.325 seconds. The subject was asked to judge whether the duration of the second signal was shorter, the same, or longer than the first, and to indicate this by pressing one of three levers. The subject received no indication of the correctness of response.

The comparison stimuli were presented in blocks of 25 trials with approximately 7.5 seconds between trials. In each block of 25 trials, eight of the comparison stimuli were identical to the standard, eight were longer, and nine were shorter; these were arranged in a nonsystematic sequence.

Each subject received a total of 600 trials in each four-hour session. After each set of 50 trials, a six- to seven-minute work period, there was a pause of about 13 minutes during which the

subject could read, sleep, or watch television. He stayed in the chamber throughout the session. A warning light and tone signalled the onset of each set of 50 trials.

The performance of the subjects was recorded in such a fashion as to preserve the real-time sequence of events. The Data Multiplexer, a small, special-purpose computer designed and constructed in our laboratory, translated the responses to digital symbols recorded on eight-channel punched paper tape. The results were then analyzed by electronic data-processing methods. Thus far, only the correctness-of-response data have been extensively analyzed. The real-time records will permit the future measurement of response latency and of sequential response patterns. The latter may be of considerable interest, judging from our work with lower animals.

Results in Human Subjects

Eighteen subjects were observed in at least 15 sessions each. CO was administered in concentrations of 0, 50, 100, 175, and 250 parts per million in the different sessions. None of the subjects experienced any discomfort attributed to

Figure 1—Mean per cent correct responses, ±1 s.d., by 18 human subjects, during the discrimination of two tones presented successively. Each point is the mean of three determinations per subject, at each CO dose, of performance during the second and third hours of the session, i.e., during 0.5-2.5 hours of CO exposure, since exposure began after the first 0.5 hour. Comparison of performance in sessions during and prior to CO revealed significant impairment (t-test) at all doses ($0.01<p<0.02$, at 50 ppm; $0.001<p<0.01$ at higher doses).

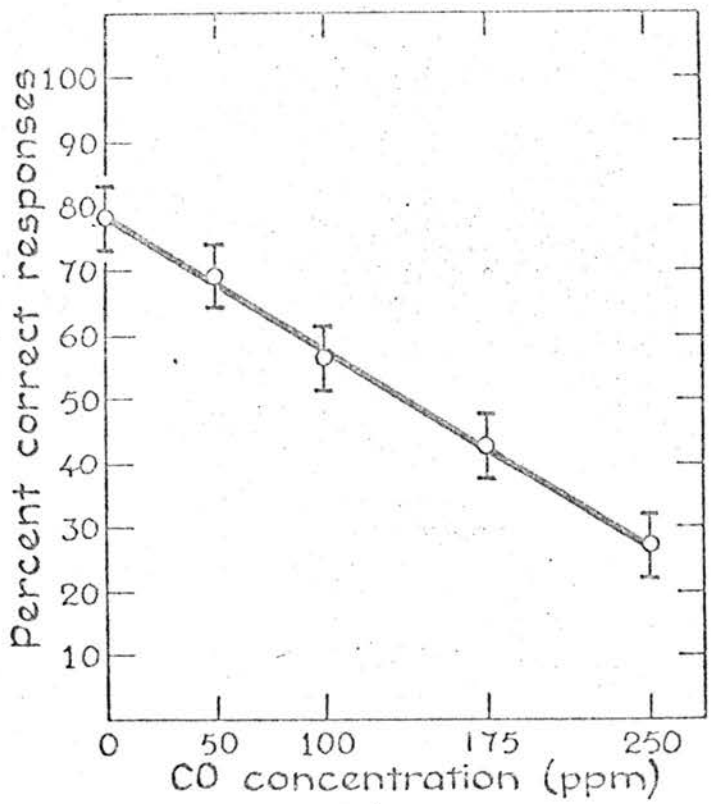
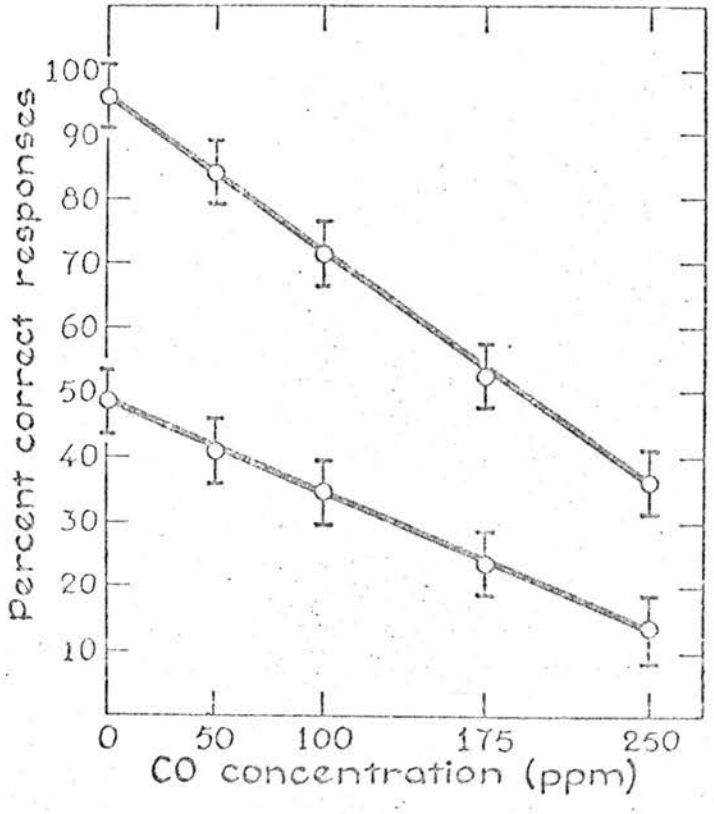


Figure 2.—Mean per cent correct responses, ±1 s.d. (cf. Figure 1 caption), when the difference in tone duration was 325 msec (upper function), or 125 msec (lower function). Significant performance impairmen (t-test) occurred at all doses ($0.02<p<0.05$, at 50 ppm, 325 msec; $0.01<p<0.02$, at 50 ppm, 125 msec; $0.001<p<0.01$, at higher concentrations, both duration differences).



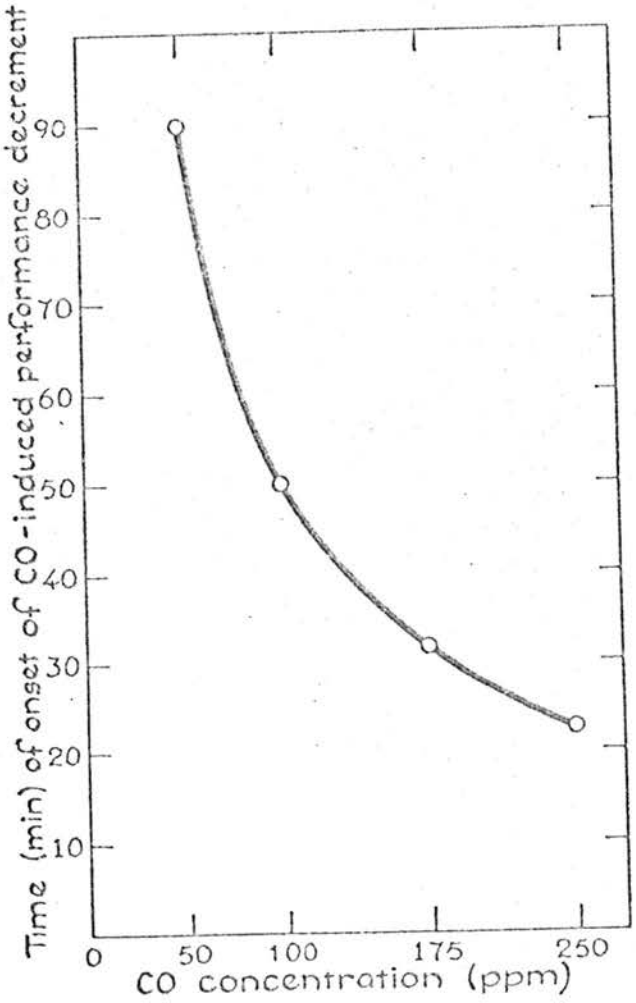
CO during the experiments, and none felt that he could reliably tell when CO was present. No changes in overt motor behavior were seen. However, a dose-related reduction of correct judgments of time intervals was clearly demonstrated. Figure 1 shows significant decrements of response for two and one-half hours of exposure to all concentrations from 50 parts per million upward. (The graph, as drawn, suggests that any degree of exposure would reduce performance in some measure, but further experimentation would be necessary to judge this conjecture.) Figure 2 shows that the decrement in precision of judgment associated with exposure to CO was similar, both for small and large differences in tone duration.

The rapidity of the onset of deterioration of time discrimination under the influence of small concentrations of CO is of particular interest. Using as a criterion a reduction in correct responses equal to two standard deviations from the mean performance in an uncontaminated atmosphere, 90 minutes were sufficient to produce a significant decrement in an atmosphere of 50 ppm, and much shorter times were needed for higher concentrations. These data are displayed in Figure 3.

The records of individual subjects show that not only did the proportion of

correct responses diminish in association with inhalation of CO, but that the perceptual behavior of the subjects became erratic. Figure 4 consists of records for seven sessions using three subjects. The graphs indicate the proportion of correct judgments in each block of 25 trials. The effect began to appear after 30 minutes to one hour in these sessions. We believe that analyses of sequential performance in these experiments will define the time of onset more precisely.

Figure 3—Time after initial exposure to each CO dose that the mean per cent correct responses fell below 2 s.d. of mean performance without CO, during auditory-duration discrimination.

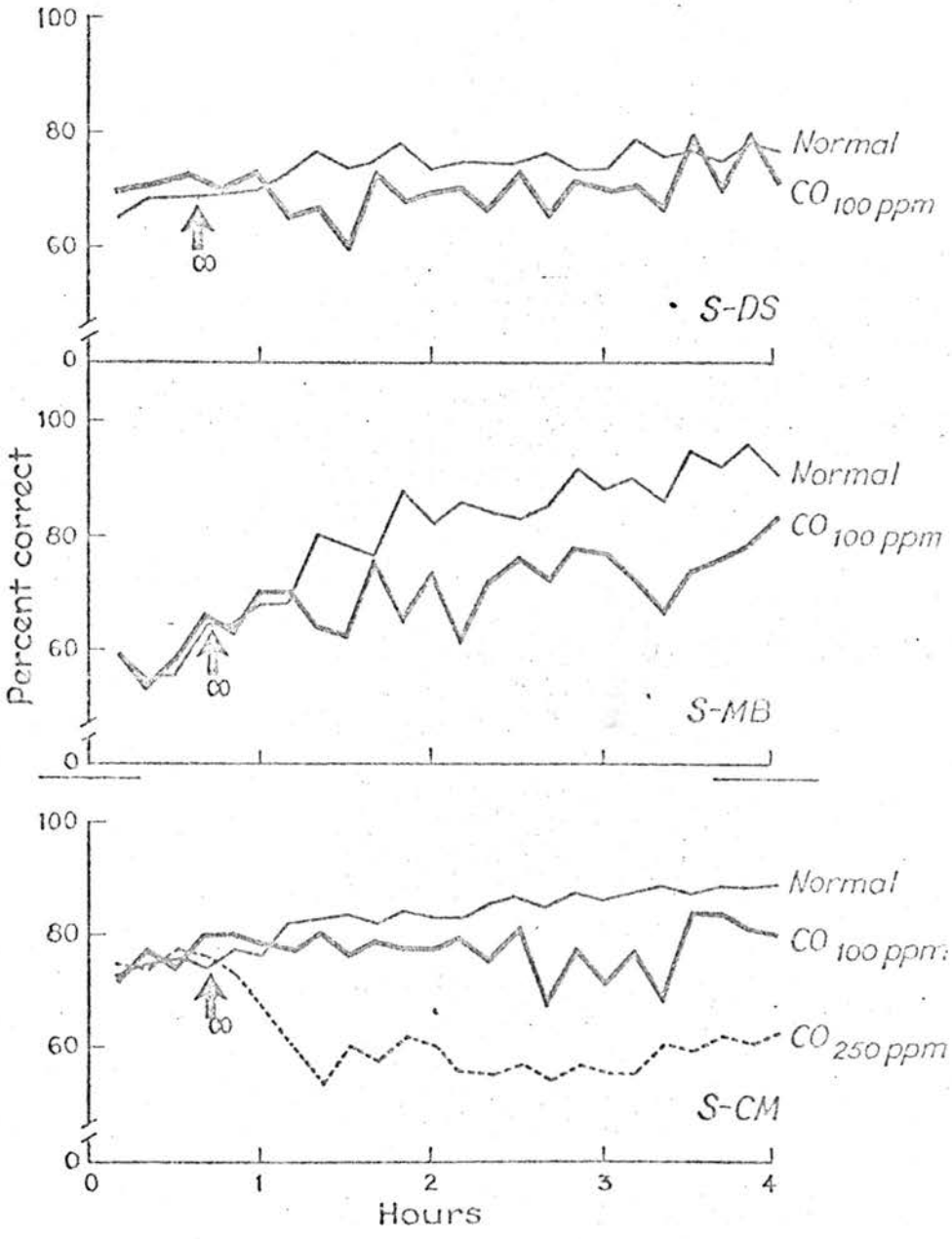


Studies in Rats

As mentioned earlier, the use of a time-discrimination test in human beings was suggested by previous observations in rats. We had begun by trying a variety of Skinnerian operant behavior schedules of reinforcement.[6]

In our studies, the animals were trained to press levers to obtain food pellets or water. The simplest pattern is one in which the animal receives one

Figure 4—Mean per cent correct responses, for successive 25-trial blocks, during auditory-duration discrimination. Data are from individual four-hour sessions for each of three subjects; the arrows indicate gas exposure onset during CO sessions. "Normal" indicates a non-CO session.



such reward or "reinforcement" each time he presses the lever. Many ingenious variants have been devised by behavioral psychologists, including schedules in which one reinforcing stimulus is available only after a fixed number of responses have been emitted (fixed-ratio schedule, FR), or after a varying number of responses (variable-ratio, VR), or for the first response that occurs

after a specific lapse of time (fixed interval schedule, FI), or reinforcing responses after varying time intervals (variable-interval schedule, VI), and so forth.

Figure 5 shows an example of this kind of investigation. The rat was trained to work on a fixed interval schedule (FI) under which a food pellet was provided for the first response emitted three minutes after the previous pellet had been delivered. On each of the records in Figure 5, the pen of the cumulative recorder moved upward slightly for each response, and moved continuously to the right with the passage of time. A downward mark of the pen indicates each delivery of a pellet. The positive acceleration of the inter-reinforcement response pattern, evident in

Figure 5—Performance by one representative rat on a FI three-minute schedule. Note the greater response rate attenuation at 1,000 ppm than at 250 ppm.

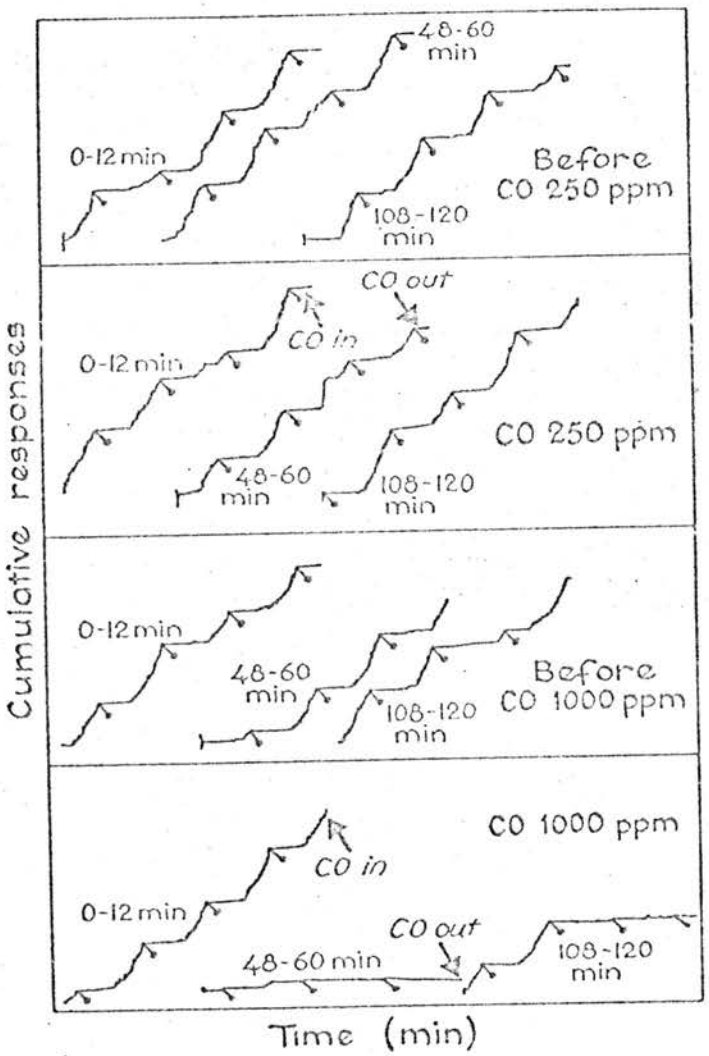
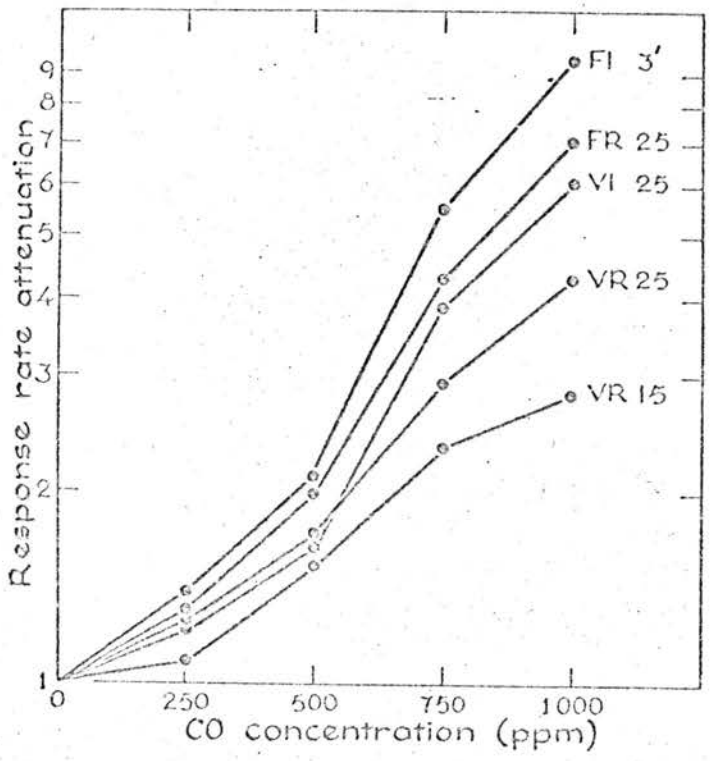


Figure 6—Response rate attenuation (RA), as a function of CO concentration, during performance by rats on several different schedules of reinforcement. RA is calculated by: RA=(c/d)/(a/b), where a is response rate during min. 0-12 on the pre-CO day, b is rate during min. 0-12 on the CO day, c is rate during min. 48-60 on the pre-CO day, and d is rate during min. 48-60 on the CO day. If a, b, and c were equal, RA would be the direct reciprocal of the reduction in response rate during CO exposure; RA is thus an index that takes into account fluctuations in the performance levels that serve as baselines against which the effects of CO are assessed.



these records, is characteristic of performance on FI schedules. One interpretation of the response pattern is that the animal has learned that responses made soon after reinforcement are useless. As the end of the fixed time interval approaches, there is a systematic increase in the rate of lever pressing until the next pellet is delivered.

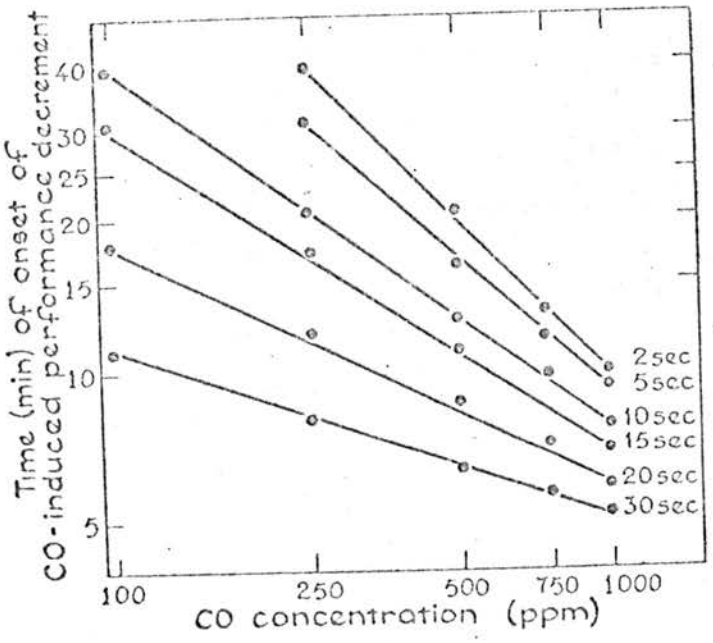
From the records in Figure 5, it may be noted that not only is the rate of responding slowed when CO is present, but also that the regularity of the inter-reinforcement response pattern is disrupted. This effect was regularly observed, and led to refinements of recording and analysis. A dose-response effect, apparent in these sample records, was worked out in detail in many experiments. We were also impressed by the rapid recovery rate of these animals: as may be seen in Figure 5, performance capability was regained about as quickly as it was lost; this suggests that the performance decrement is not directly related to the proportion of carbon monoxide hemoglobin in the blood, since the uptake of CO at low concentrations is linear and its excretion is exponential. We intend to investigate further these relations.

Figure 6 compares the sensitivity of several different reinforcement schedules to the effects of CO. These data suggest that time discrimination is readily susceptible to derangement by CO. This hypothesis was explored further by the use of a differential reinforcement of a low rate of response (DRL) schedule, during which the animal must refrain from pressing the lever for a predetermined fixed time in order to receive reinforcement. Rats can learn to make long inter-response delays with a high degree of reliability. This type of temporal discrimination is readily deranged by exposure to CO, as shown in Figure 7. These data also demonstrate that the more stringent discrimination tasks, i.e., longer delays, are more readily disrupted. Perceptible effects are observable after only 11 minutes of exposure to CO at 100 ppm, and increasing concentrations produce proportionately greater effects.

Discussion

We do not suggest the immediate application of these observations to the establishment of new air quality standards or threshold limit values. Much remains to be done before we understand the significance of performance decrements associated with low concentrations of CO. Other psychophysical and psychophysiologic measures must (and will) be obtained and evaluated. Our present intent is to bring attention to the applicability of particular experimental analyses of behavior to the study of air pollution effects. We believe that

Figure 7—Time after initial exposure to a given dose of CO that the mean DRL response rate fell below 2 s.d. of the rate during normal atmosphere conditions. Each point represents the mean of ten determinations from each of six rats at each dose. The number to the right of each curve indicates the required DRL delay duration. Exposure to CO never exceeded 48 minutes. All experimental sessions were of approximately two hours' duration.



information obtained from the detailed analysis of the impairment of "abstract" types of behavior induced by toxic agents and unfavorable environments will be increasingly useful in predicting functional limitations for important tasks.

Wherever possible, studies should be done in relation to activities which are important for man. It is tempting to try to simulate field conditions in the laboratory by the use of mock-ups of vehicle controls and related devices. However, it is exceedingly difficult to contrive simulators which experienced operators will accept as adequately resembling actual operative devices. Since the simulation is seldom convincing, it seems better to test the subject on various abstract tasks which are related to specific segments of real-life activities, and to do this in circumstances in which a large proportion of the extraneous variables are controlled. Such tests should culminate in field studies of various tasks under normal and abnormal operating conditions.

Summary

Improvement is needed in the methods of setting standards of air quality. In establishing such standards, the effects of various pollutants upon human performance should be considered. Toward this end, the effects of exposure to carbon monoxide upon the ability of 18 young adults to discriminate short intervals of time were studied. Deterioration of performance was observed. This occurred after 90 minutes at 50 ppm, and at proportionately shorter times after exposure to higher concentrations up to 250 ppm. Experiments with rats, using operant behavior schedules of reinforcement, showed rapid and marked disruption of the ability to judge time, with a significant decrement apparent after 11 minutes exposure to 100 ppm during performance on a DRL schedule. It is suggested that methods derived from experimental psychology can contribute materially to the evaluation and understanding of both gross and subtle effects of CO as an air pollutant and can thereby aid in the formulation of standards of air quality.

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5. ————. Restoring the Quality of Our Environment. Report of the Environmental Pollution Panel of the President's Science Advisory Committee. The White House, Washington, D. C., 1965.
6. Ferster, C. B., and Skinner, B. F. Schedules of Reinforcement. New York: Appleton-Century-Crofts, 1957.

The authors are associated with the Department of Preventive Medicine, Stanford University School of Medicine, Palo Alto, Calif.

This paper was presented before the Occupational Health Section of the American Public Health Association at the Ninety-Fourth Annual Meeting in San Francisco, Calif., November 1, 1966.

This work was sponsored by the Commission on Environmental Hygiene, Armed Forces Epidemiological Board and was done, in part, under a contract with the US Army Medical Research and Development Command. The use of human volunteers was carried out in conformance with the policy standard of the Surgeon General, US Army.

In conducting this study the investigators adhered to the "Guide for Laboratory Animal Facilities and Care," as promulgated by the Committee on the Guide for Laboratory Animal Resources, National Academy of Sciences-National Research Council.

STATE OF MINNESOTA

COUNTY OF HENNEPIN

BEFORE THE MINNESOTA

BOARD OF HEALTH

In the Matter of Proposed Rules
Relating to the Implementation
of the Minnesota Clean Indoor
Air Act of 1975

APPOINTMENT

David Giese is hereby appointed to serve as hearing officer on behalf of the Minnesota Board of Health in the above-captioned matter, said hearing to be held on December 2, 1975, and continuing until all representatives of associations or other interested groups or persons have had an opportunity to be heard.

This appointment is made pursuant to the following authority: resolution of the Minnesota Board of Health adopted at its meeting on October 9, 1975.

STATE OF MINNESOTA

BOARD OF HEALTH

WARREN R. LAWSON, M.D.
Secretary and Executive Officer

Dated: 12-1-, 1975

STATE OF MINNESOTA

COUNTY OF HENNEPIN

BEFORE THE MINNESOTA

STATE BOARD OF HEALTH

In the Matter of the Proposed Rules Relating to the Implementation of the Minnesota Clean Indoor Air Act of 1975.

ORDER ADOPTING RULES

The above-entitled matter came on for hearing before the Minnesota State Board of Health on the 2nd day of December, 1975, at 9:30 a.m., in the Board Room, Minnesota Department of Health Building, 717 Delaware Street S.E., Minneapolis, Minnesota 55440, after proper notice required by Minn. Stat. § 15.0412 (Supp. 1975) was served upon all persons, associations and other interested groups registered with the Secretary of State for that purpose.

After affording interested persons an opportunity to present written and oral data, statements and arguments, and having heard and considered all of the testimony and evidence adduced and upon the records, files and proceedings herein, and applicable statutory standards or criteria, and having confirmed the need for the above-captioned rules.

NOW, THEREFORE, IT IS ORDERED that these rules identified as MHD 441-445 are adopted this 5th day of March, 1976, pursuant to authority vested in me by Minn. Stat. § 144.417 (Supp. 1975), and by resolution of the Minnesota State Board of Health duly adopted at a meeting of the said Board on the 19th day of February, 1976.

STATE OF MINNESOTA

BOARD OF HEALTH



WARREN R. LAWSON, M.D.
Secretary and Executive Officer

STATE OF MINNESOTA

COUNTY OF HENNEPIN

BEFORE THE MINNESOTA

STATE BOARD OF HEALTH

In the Matter of the Proposed (Rules) (Amendments) Relating to the Implementation of the Minnesota Clean Indoor Air Act of 1975.

FINDINGS OF FACT

The above-entitled matter came on for hearing before the Minnesota State Board of Health on the 2nd day of December, 1975, at 9:30 A.M., in the Board Room, Minnesota Department of Health Building, 717 Delaware Street S.E., Minneapolis, Minnesota 55440, after proper notice required by Minn. Stat. § 15.0412 (Supp. 1975) was served upon all persons, associations and other interested groups registered with the Secretary of State for that purpose and also upon other persons, associations and groups of which the State Board of Health was aware of as possibly having an interest in the above captioned rules.

After affording interested persons an opportunity to present written and oral data, statements and arguments, and having heard and considered all of the testimony and evidence adduced and upon the records, files and proceedings herein, the Board makes and enters the following findings:

1. Authority to adopt regulations pertaining to implementation of the Clean Indoor Air Act is contained in Minn. Stat. § 144.417 (Supp. 1975). This statute states in relevant part that the ". . . board of health shall adopt rules and regulations necessary and reasonable to implement the provisions of sections 144.411 to 144.417 [the Minnesota Clean Indoor Air Act] . . . ." These regulations are within this legislative grant of authority given to the Board of Health.

2. There is a need for these regulations. The legislature, having stated the policy prohibitions and responsibilities under the Act, mandated that the Board of Health adopt reasonable and necessary regulations to implement the Act. These rules are needed to comply with the legislative mandate, to clarify the Act as it relates to specific public places, and to provide a detailed description of rights and duties under the Act. The Board finds that these regulations, as adopted, are reasonable and necessary to carry out its duties under the Act.

3. MHD 442(a) is an attempt to define "smoke-free area" as used in Minn. Stat. § 144.416(b) (Supp. 1975). The Board finds that the term "acceptable smoke-free area" is appropriate to use in the rules inasmuch as the law permits designated smoking areas within public places and imposes "reasonable" efforts on proprietors to comply with the law. Thus, the Board recognizes that the law does not necessarily require 100% smoke-free conditions, but consistent with Minn. Stat. § 144.415 (Supp. 1975), does require a minimization of the toxic effect of smoke in no smoking areas in those establishments wherein smoking is permitted.

4. Since the law in Minn. Stat. § 144.416(b) (Supp. 1975) requires that proprietors provide a smoke-free area and in Minn. Stat. § 144.415 (Supp. 1975) requires that proprietors use existing physical barriers and ventilation to minimize the toxic effects of smoke, MHD 442(a) merely clarifies the optional conditions available to proprietors to maintain a "smoke-free area." It is therefore found to be necessary and proper.

5. MHD 442(a)(2)(aa) states that a continuous physical barrier of at least 56 inches in height separating smoking permitted from no smoking areas provides an acceptable smoke-free area. The Board finds that while the adjective "continuous" is

necessary to provide for uninterrupted horizontal air flow, such term was never meant to prohibit barrier openings for purposes of exit and entry. To clarify this, MHD 442(a)(2)(aa) specifically authorizes doors, openings or similar portals for exit and entry within such barriers.

6. The Board finds that the barrier of 56 inches indicated in MHD 442(a)(2)(aa) is sufficient to completely interrupt the direct flow of smoke from seated persons and to provide deterrence from indirect shifting of smoke. Since manufacturers provide free standing land-scaping screens from 56 inches to 80 inches, a 56 inch barrier is found to be a reasonable minimum.

7. MHD 442(a)(2)(bb) states that a space of at least four feet in width separating a smoking permitted area from a no-smoking area will create an acceptable smoke-free area. The Board finds that four feet is an accepted distance of common aisle space which is used in establishments and is of sufficient distance to minimize toxic effects of smoke.

8. MHD 442(a)(2)(bb) has been clarified to specify that the four foot zone need not be unoccupied or unused space so long as smoking is prohibited in the zone and the zone is not included as part of the acceptable smoke-free area. The Board finds that the rule is not intended to require an unused or unoccupied four foot space.

9. MHD 442(a)(2)(cc) relates to a minimum ventilation system which could be used to demonstrate an acceptable smoke-free condition. The Board finds that such a system will minimize the toxic effects of smoke and thereby alleviate its health hazard. The Board finds that no modification of existing ventilation systems is necessary to comply with the rules if another authorized method within the rules is implemented.

10. Whereas MHD 442(a)(2)(cc) initially permitted compliance with Minn. Reg. SBC 7705 to demonstrate a smoke-free

area, the rule as adopted permits compliance with Minn. Reg. SBC 6607(c)(3) to demonstrate a smoke-free area. The Board finds that while there is little practical difference between the requirements of SBC 7705 and 6607(c)(3), the latter provides more flexibility in terms of cubic feet per minute per person based upon the amount of tobacco smoke likely to be present within different categories of public places. While proprietors are presented with more flexibility in utilizing an acceptable ventilation system, the Board finds the health benefits the rules are designed to provide will not be compromised under SBC 6607(c)(3). Furthermore, the Board recognizes and accepts the energy conservation elements contained in SBC 6607(c)(3). Since responsible persons must comply with SBC 6607(c)(3) in any event, the Board finds that in order to prevent placing an undue burden upon responsible persons by forcing them to comply with inconsistent standards, the substitution of SBC 6607(c)(3) for SBC 7706 is both reasonable and necessary.

11. MHD 442(a)(2)(dd) permits a proprietor to control smoke by means other than aisle space, ventilation or barriers if a level of 10 milligrams per cubic meter of carbon monoxide is not exceeded. The Board finds that only trace concentrations of background carbon monoxide is produced inside a public place from non-tobacco sources. As exterior levels of carbon monoxide is considered in the definition, it is reasonable that any increased variance of 10 milligrams within an establishment will not constitute an acceptable smoke-free area under the option provided in this subsection.

12. Various witnesses gave testimony in relation to MHD 442(c) which defines a "bar" for purposes of the rules. Some witnesses stated that bars should not be exempted from the law while others felt the definition should encompass all

establishments which serve alcohol without further limitation. Minn. Stat. § 144.415 (Supp. 1975) permits no public place other than a "bar" to be designated in its entirety as a smoking area. Minn. Stat. § 144.413 subd. 2 (Supp. 1975) specifically defines a public place to include "restaurants." In order to give both sections of the law effect, the Board finds it reasonable and necessary to define a bar, not only as a public place at which people purchase and consume alcoholic beverages, but so as to exclude the category of public places at which people may also purchase and consume meals such as restaurants.

13. MHD 442(c) which defines "bar" was never intended to exclude a separately designated room of an establishment in which alcohol is served but in which meals are not served. Thus, a portion of an establishment which functions solely as a bar within these rules may be considered a bar for only that portion regardless of activities conducted in the remainder of the establishment.

14. MHD 442(g) defines meal so as to distinguish such a food serving from that type commonly served in a bar. The Board finds that snacks and appetizers served in a bar are merely a supplement and compliment to the primary activity of consuming alcoholic beverages. Thus, the mere serving of such foods will not convert what is otherwise a bar under these rules into a restaurant.

15. MHD 442(i) defines "one side of a room" as a continuous portion of a room. While the Board considered definitions incorporating concepts of adjacent walls and minimum percentages of floor space, the Board finds that incorporating such concepts into this definition would not be reasonable and proper for all public places. Recognizing the need to permit the responsible person the opportunity to exercise good faith judgment based upon the geography and use of each public place,

and consistent with the need to protect the health and comfort of non-smokers, the Board finds a flexible definition is in order.

16. MHD 442(1)(1) specifies one of the necessary elements for an event to qualify as a "private social function." Minn. Stat. § 144.414 (Supp. 1975) provides an exemption for certain social events from operation of the Act. The Board finds it reasonable to require that such an event be held for purposes of pleasure, entertainment or recreation in order to fall within the exemption. Since there may be some ambiguity as to what is or is not a "social" event, the addition of the phrase "and not for the principle purpose of education, sales or business" provides further clarity to the rule.

17. MHD 442(1)(3) relates to seating arrangements at "private social functions." The Board finds that it is necessary to clarify that seating arrangements, "if any", are under the control of the sponsor inasmuch as all social functions do not have or require "seating arrangements." The lack of seating arrangements will not automatically exclude a function from falling within the definition of a private social function.

18. MHD 442(p) specifically indicates that the definition of "restaurant" for purposes of these rules shall not depend upon licensure under Chapter 157 of Minnesota Statutes. As these rules are designed to implement the Clean Indoor Air Act and protect the public health, comfort and environment with regard to tobacco smoke, the Board finds that the purpose of these rules and the means used to fulfill that purpose are dissimilar from the purpose served by restaurant licensing statutes.

19. MHD 443(a) states the general statutory prohibition contained in Minn. Stat. § 144.414 (Supp. 1975). The Board finds that as this statutory prohibition is the central state-

ment of the law, its specific inclusion into the rules will provide additional clarity.

20. MHD 443(b)(1) permits an exception from the requirement of one and only one smoking permitted area per room for areas of at least 20,000 square feet in total floor space. The Board recognizes that in extremely large rooms, health considerations will not be compromised by permitting more than one smoking permitted area within such large areas.

21. MHD 443(b)(2) states that if a public place contains two or more rooms which are used for the same activity, one room may be designated in its entirety as a smoking permitted area so long as a portion of one other comparable room is designated as a no-smoking area. The Board finds it necessary to clarify that a proprietor may not designate one room within an establishment as a smoking permitted area unless a no-smoking area is designated in a comparable room. This rule is meant to give force and effect to both Minn. Stat. § 144.415 (Supp. 1975) which gives the proprietor the right to designate smoking areas and Minn. Stat. § 144.416(b) requiring the proprietor to attempt to arrange seating so as to provide a smoke-free area. The Board intends to prevent designation of no-smoking areas in substandard rooms by use of the term "comparable."

22. MHD 443(b)(3) states that a smoking permitted area may not encompass an entire area which non-smokers would be required to use to participate in activities for which the public place is intended. The Board finds that this rule is necessary to conform with the intent of Minn. Stat. § § 144.416(b) and 144.412 (Supp. 1975) in that non-smokers should have access to the activities conducted within the public place without being subjected to the harmful effects of tobacco smoke.

23. MHD 443(b)(3) limits application of its provision by providing that a smoking permitted area may be designated

in a location which non-smokers may briefly cross to reach an intended activity. The Board finds that such qualification is necessary inasmuch as many establishments would have to undertake extensive reconstruction or remodeling to be in strict compliance with the rule if this limited qualification was not incorporated into the rule. As worded, the rule will conform with the intent of the law without placing an undue burden on proprietors.

24. MHD 443(b)(4) requires that the smoking permitted area shall not be more than proportionate to the preference of users of the location for smoking permitted areas. While the Board considered adopting such standards as absolute minimum percentages or minimum square footage, the Board finds that such criteria may not be reasonable and proper for all public places. The Board recognizes the variables of activity, use, need and population in each public place at any given time and therefore finds that fluctuating boundaries based upon demonstrable preference is consistent with the need to protect the health and comfort of non-smokers.

25. MHD 443(b)(4) provides some guidance as to methods by which the proportionate preference of users of smoking permitted areas may be demonstrated. While such methods are not mandatory, the Board finds that clarification by example is in order.

26. The Board finds that the inclusion of MHD 443(d) relating to signs is necessary to permit a uniform interpretation of Minn. Stat. § 144.416(a) which states that the proprietor or other person in charge is responsible for making reasonable efforts to prevent smoking in a public place which may include "posting appropriate signs." This rule then, is intended to describe and clarify what signs shall be considered to be appropriate.

27. MHD 443(d)(4) requires that "smoking permitted" and "no smoking signs" shall be printed in letters of not less than 1.5 inches in height. The Board finds that this letter height is reasonable inasmuch as such height provides adequate readability to a viewer with normal vision at a distance of 60 feet with normal lighting conditions. This rule also specifies that the boundary separating smoking from non-smoking areas must be clearly designated. The Board finds that while this rule clearly requires that a clear designation of separate areas must be made, it does not require the posting of signs as the only acceptable method of designation but permits flexibility.

28. MHD 442(d)(8) relating to inquiries of all users as to their preference for placement was initially proposed in another section. The Board finds that its inclusion in MHD 442(d) relating to signs is appropriate inasmuch as this rule permits an alternative to posting several signs.

29. MHD 444(b) relating to places of work is designed to provide the employer a flexible method to comply with the rules while protecting non-smoking employees from the toxic affect of smoke. The Board recognizes that employees are frequently separated into work areas according to their functional activities and cannot easily be divided and shifted without adverse economic effect to the employer. Thus, "checkerboarding" of no-smoking and smoking areas is allowed for certain places of work. The Board further finds that a 200 square foot area is the minimal space necessary to maintain an acceptably smoke-free environment for an employee.

30. MHD 444(b) dealing with places of work specifically exempts private residences not customarily used as a place of work from its operative application. The Board finds that since the inclusion of private residences was not contemplated in the

rule as initially proposed, clarifying language is in order.

31. MHD 444(c) and (d)(2) relating to offices and restaurants to be regulated by the Department of Labor and Industry has been rephrased to conform with rules of the Department of Labor and Industry. The Board finds this change was necessary to make the rules from the different departments consistent and to provide for uniform enforcement and understanding.

32. MHD 445(b)(1) more clearly defines what kind of evidence is necessary to demonstrate "compelling reasons" which would justify waiver. The Board finds that the rule, as originally proposed, may not have provided regulatees a sufficiently clear guideline as to what type of evidence would constitute a demonstration of financial hardships justifying waiver under the rules.

33. Other provisions of the rules not specifically referred to herein are found to be supported by evidence in the record.

34. Many comments were made at the hearing and letters received both prior and subsequent to the hearing. Based thereon, modifications were made but in no instance has the substance of the regulation as presented at the public hearing been changed.

35. These rules are in keeping and will help fulfill the policy of the State as expressed in Minn. Stat. § § 144.411 - 417 (Supp. 1975).

Dated: March 3, 1976

STATE OF MINNESOTA

BOARD OF HEALTH

Robert A. Willmarth

ROBERT WILLMARTH
President

CERTIFICATE OF BOARD'S

ADOPTION OF RULES RESOLUTION

I, Warren R. Lawson, M.D., do hereby certify that I am the Secretary and Executive Officer of the Minnesota State Board of Health, a board duly authorized under the laws of the State of Minnesota, and that the following is a true, complete, and correct copy of a resolution adopted at a meeting of the said Board of Health duly and properly called and held on the 19th day of February, 1976; that a quorum was present at said meeting; that a majority of those present voted for the resolution; that said resolution is set forth in the minutes of said meeting and has not been rescinded or modified.

RESOLVED, that the rules relating to the implementation of the Clean Indoor Air Act identified as MHD 441-445 are found to be reasonable, necessary and supported by the evidence contained in the record, and are hereby approved and adopted pursuant to authority vested in us by Minn. Stat. § 144.417 (Supp. 1975) and that Warren R. Lawson, M.D., Secretary and Executive Officer of the Minnesota Board of Health be and hereby is authorized to sign an order adopting these rules.

IN WITNESS WHEREOF, I have hereunto subscribed my name this 5th day of March, 1976.

STATE OF MINNESOTA

BOARD OF HEALTH

WARREN R. LAWSON, M.D.
Secretary and Executive Officer

MDH Ex 1
12/2/75 RKH

STATE OF MINNESOTA

COUNTY OF HENNEPIN

In the Matter of the Proposed Adoption, Amendment, or Revision of the Rules of the Minnesota State Board of Health

AFFIDAVIT OF MAILING

Janis Broz, being first duly sworn, deposes and says:

That on the 29th day of August, 1975, at the City of Minneapolis, County of Hennepin, State of Minnesota, She served the attached Notice of Intent to Obtain Information on Proposed Rules from Non-Agency Sources by depositing in the United States mail at said City of Minneapolis, a true and correct copy thereof, properly enveloped, with postage prepaid, to all persons and associations at the addressess listed on the Certificate of the Secretary of State attached and made a part hereof as Exhibit A, as well as to all members of the Minnesota Legislature as of the date of mailing.

Janis Broz

Subscribed and sworn to before me this 29th day of August, 1975.

Marie B. Tromiczak

MARIE B. TROMICZAK
NOTARY PUBLIC - MINNESOTA
HENNEPIN COUNTY
My Commission Expires Oct. 9, 1980

STATE OF MINNESOTA

COUNTY OF HENNEPIN

BEFORE THE MINNESOTA

STATE BOARD OF HEALTH

In the Matter of the Proposed Adoption, Amendment or Revision of the Rules of the Minnesota State Board of Health.

NOTICE OF INTENT TO OBTAIN INFORMATION ON PROPOSED RULES FROM NON-AGENCY SOURCES

NOTICE IS HEREBY GIVEN, pursuant to the provisions of Minnesota Laws 1975, Chapter 380, section 2, subdivision 6, that the Minnesota State Board of Health will propose the adoption of new rules on the subjects noted below (items A through G) and the amendment and revision of the existing rules noted below (items H through K).

All interested parties desiring to submit data or views relating to the proposed adoption, amendment or revision of the rules noted below should address their comments (either written or oral) to the Minnesota Department of Health (717 Delaware Street S.E., Minneapolis, Minnesota 55440) by writing or calling the persons designated. Any evidence submitted for consideration should be pertinent to the matter at hand. Any written material received by the Department of Health will become part of the hearing record.

A. Rules implementing the provisions of Minnesota Laws 1975, Chapter 211, also known as the Minnesota Clean Indoor Air Act.

Contact: Kent Peterson
Phone: (612) 296-5365

B. Rules relating to the control and regulation of clinical laboratories.

Contact: Division of Medical Laboratories
Attn: Dr. Henry Bauer
Phone: (612) 296-5241

C. Rules relating to the transfer of patient's x-ray records.

Contact: Dr. Ellen Z. Fifer
Assistant Commissioner for Programs
Phone: (612) 296-5391

D. Rules relating to the distribution of monies to aid in the construction of water filtration and purification plants and systems for those communities using Lake Superior as a drinking water source under the state grant program established by Minn. Laws 1975, Chapter 437, Art. XI, §2, subd. 2.

Contact: Division of Environmental Health
Attn: Fred Heisel
Phone: (612) 296-5320

E. Rules implementing the provisions of Minnesota Laws 1975, Chapter 346, also known as the Maternal and Child Nutrition Act of 1975.

Contact: Division of Personal Health Services
Section of Maternal and Child Health
Attn: Dr. Ronald Campbell
Phone: (612) 296-5265

F. Rules relating to the approval of laboratories performing bacteriological examinations of water.

Contact: Division of Environmental Health
Analytical Services Section
Attn: Russell Frazier
Phone: (612) 296-5300

G. Rules relating to the establishment of application procedures for the credentialing of allied health manpower groups.

Contact: Section of Allied Health Manpower
Attn: Corrine Larson
Phone: (612) 296-5393

H. MHD 44-71, Rules of the Minnesota State Board of Health for the construction, equipment, maintenance, operation and licensing of nursing homes and boarding care homes, and for the establishment of levels of assessments for violations of the regulations.

Contact: Division of Health Facilities
Attn: H. Michael Tripple
Phone: (612) 296-5294

I. MHD 76-116, Rules of the Minnesota State Board of Health for the construction, equipment, maintenance, operation and licensing of hospitals, and for the establishment of levels of assessments for violations of the regulations.

Contact: Division of Health Facilities
Attn: Janet Brodahl
Phone: (612) 296-5440

J. MHD 21-35, Rules of the Minnesota State Board of Health relating to Morticians, Funeral Directors, and the Disposition of the Dead.

Contact: Mortuary Science Unit
Attn: Eugene Larson
Phone: (612) 296-5491

K. MHD 181, Rule of the Minnesota State Board of Health relating to the limitation of the use of x-ray machines in the screening for detection and evaluation of health conditions.

Contact: Division of Environmental Health
Attn: Alice Dolezal
Phone: (612) 296-5323

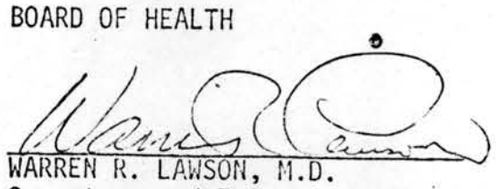
Any materials submitted shall be reviewed and considered by the Department of Health during the preparation of the proposed rules. Notice of the public hearing on the proposed rules shall be given to all interested parties in accordance with the provisions of the Administrative Procedures Act.

Under the provisions of Minn. Stat. § 10A.01, subd. 11 (1974), any individual representing persons or associations attempting to influence administrative action, such as the promulgation of these proposed rules, must register with the State Ethics Commission as a lobbyist within five days of the commencement of such activity by the individual. The State Ethics Commission is located at Room 401, State Office Building, Saint Paul, Minnesota 55155.

Dated: August 20th, 1975

STATE OF MINNESOTA

BOARD OF HEALTH



WARREN R. LAWSON, M.D.
Secretary and Executive Officer

Exhibit A

STATE OF MINNESOTA

COUNTY OF RAMSEY

In the Matter of the Proposed
Adoption, Amendment, or
Revision of the Rules of the
Minnesota State Board of Health.

CERTIFICATE

I hereby certify that the 437 general labels and 1 sheet list for the Minnesota State Health Department all of which are attached and made a part hereof, constitute the complete lists of persons, associations, and other interested groups who as of 11:30 O'clock A.M., this 25th day of August, 1975, have requested pursuant to Minn. Stat. ss 15.0412 subd. 4 (1971), that their names be placed on file with the Secretary of State for the purpose of receiving notice of public hearing on proposed rules on the subject captioned above.

Joan Anderson Growe
SECRETARY OF STATE

JOAN ANDERSON GROWE

By Cecil Dixon

ALBERT,AA CALDER CORP
366 JACKSON ST
ST PAUL MN
55101

ALLENDORF MARSHALL
220 GRAIN EX 400 S 4TH
MPLS MN
55415

ALTMAN MILTON H
707 DEGREE OF HONOR BLD
ST PAUL MN
55101

AM CAMPING ASSN MRS LEACOCK
1235 BRIGHTON SQ
NEW BRIGHTON MN
55112

AM INST PROF GEOLOGISTS
2201 PRINCETON AVE
ST PAUL MN
55105

ANCHOR BLOCK COMPANY
PO BOX 3360
ST PAUL MN
55165

ANDERSON GRAHAM
951 E HENN
MPLS MN
55414

ANDERSON HERBERT
415 5TH ST. SO.
VIRGINIA MN
55792

ANDERSON HAROLD
BOX 3047
MANKATO MN
56001

ANDERSON JAMES
7703 NORMANDALE RD
MPLS MN
55435

ANDERSON STANFORD P
14600 MINNETONKA BLVD
MINNETONKA MN
55343

ANTHONY DICK WDSM RADIO
230 E SUPR ST
DULUTH MN
55802

ARNOLD ROBERT MESPA
41 SHERBURNE
ST PAUL MN
55103

ARROWHEAD REGIONAL DEV COMM
900 ALWORTH BLDG
DULUTH MN
55802

ARVER JOHN A
2467 COHANCY
ST PAUL MN
55113

ASMUSSEN, DENNIS, MPIRG
3036 UNIV AVE SE
MPLS MN
55414

ASSOCIATED GEN CONTRUF MN
46 E 8TH STREET
ST PAUL MN
55101

ASSOCIATED INDUST OF MPLS
NATIONAL BLDG
MPLS MN
55402

ASSN OF MINN COUNTIES
55 SHERBURNE AVE #203
ST PAUL MN
55103

ASSN RESIDENCES FOR RETARDED
459 RICE SUITE 301
ST PAUL MN
55103

AUTOMOBILE MFRS ASSN INC
55 SHERBURNE AVE
ST PAUL MN
55103

BABCOCK LOCHER NELSON ET
118 E MAIN ST
ANOKA MN
55303

BADALICH JOHN P
2025 THOMPSON AVE
SO ST PAUL MN
55075

BARRETT FRED
ST LOUIS CO COURT HOUSE
DULUTH MN

BARKER KENT
8100 34TH AVE SO
MPLS MN
55420

BARTHOLOW HAROLD E FIRE C
2600 109 AVE N W
COON RAPIDS MN
55433

BECKLIN ROBERT C
447 N W 4TH
CAMBRIDGE MN
55008

BEECHER EVERETT
10 10 1ST ST SO
HOPKINS MN

BEMIDJI STATE COLLEGE
PLACEMENT BUR.J.C.BRADY
BEMIDJI MN
56601

BENSON PETER USW OF AM
609 PROVIDENCE BLDG.
DULUTH MN

BERGERUD ALF
300 ROANOKE BLDG
MPLS MN
55402

BERGSETH THOMAS
1011 NICOLLET MALL
MPLS MN
55403

BEST FLANAGAN ET AL
1ST NATL BANK BLDG
MPLS MN
55402

BEUTEL ROBERT
2200 SILVER LAKE RD
NEW BRIGHTON MN
55112

BLOMQUIST BARRY L

NORTH BRANCH MN
55056

BLOOMINGTON CITY CLERK
2215 W OLD SHAKOPEE RD
BLOOMINGTON MN
55431

BREHL JAMES W
332 HAMM BLDG
ST PAUL MN
55102

BRIGGS & MORGAN - B F FRI
2200 W 1ST NATL BK BLDG
ST PAUL MN
55101

BRIGHAM E M III
RR4
RED WING MN
55066

BROEKER JOHN
2850METRO DR. SUITE 504
BLOOMINGTON MN
55420

BROOKS WILLIAM F JR
854 MIDLAND BK BLDG
MPLS MN
55401

BROWN D M GOODRIDGE PUB S
ING DIST #561
GOODRIDGE MN
56725

BRUBACHER RICHARD COMM ADM
208 ADM BLDG
ST PAUL MN
55101

BRUNING C.R.DEPT.CLINIC.EXP.
BURTON HALL
MPLS. MN
55455

BUCHHOLTZ CHARLES
5044 BRENT AVE E
INV GRV HTS MN
55075

BURGER ALBERT
600 DEGREE OF HONOR BLD
ST PAUL MN
55101

BUR.INDUS.INL.DIV. MR.KIBIGER
219 N. 2ND ST.
MPLS. MN

BUR NAIL AFFAIRS INC
1231 25TH ST NW
WASHINGTON DC
20037

BUSCH NOEL
3131 FERNBROOK LANE N
MPLS MN
55441

CAIN RUTH
730 E 38TH ST
MPLS MN

CAIRNS JOHN A
47TH FLR IDS CENTER
MPLS MN

CARLSON CARL L
7916 80TH ST S
COTTAGE GROVE MN

CARLSON VERNE E
BOX 755 CITY HALL
WILLMAR MN

CARLSON DALE K
MANKATO STATE COLLEGE
MANKATO MN
56001

CHAMBERLAIN JOHN L
PO BOX 241
MPLS MN
55440

CITY CLERK
380 CITY HALL
ST PAUL MN
55102

COLEMAN NICHOLAS D
700 LINWOOD AVE
ST PAUL MN
55105

CONSUMER SERVICES DEPT COMM
5TH FLR METRO SQ BLDG
ST PAUL MN
55101

CROW WING CO PLANNING & ADV
COURT HOUSE
BRAINERD MN
56401

DANFORTH & ALLEN
731 NW BANK BLDG
MPLS MN
55402

DICKINSON MRS JOANNE
BOX 1065
MARSHALL MN
56258

DOUGLASS BELL
525 OSBORN BLDG
ST PAUL MN
55102

DUNN OLIVER PLUMBERS LOC 15
706 SO 10TH ST
MPLS MN
55404

ELDER DR JAMES B
11140 WASHBURN AVE SO
BLOOMINGTON MN
55431

ENNIS A F BOISE CASCADE

CENTRAL BUSINESS DATA
BENSON RADIO ARCADE BLD
BENSON MN
56215

CHERCHES CHRIS CITY MGR
5005 MTKA BLVD
ST LOUIS PARK MN
55416

CITIZENS LEAGUE
530 SYNDICATE BLDG
MPLS MN
55402

COLLIN LAURENCE
RT 2
ISANTI MN
55040

COUNTY ATTYS COUNCIL
95 SHERBURNE AVE S203
ST PAUL MN
55103

CUSHMAN J S DAYTON HUDSON
700 NICOLLET MALL
MPLS MN
55402

DANKERS,KENNETH
1200 WEST FOURTH STREET
RED WING MN
55066

DIEHL JOHN
26 KENWOOD PKWY
ST PAUL MN
55105

DOW CHEMICAL
47 BLDG
MIDLAND MI
48640

DZUGAN KEN ST PAUL PLANNING
421 WABASHA ST
ST PAUL MN
55102

ELDRED R W ARMOUR & CO
UNION STOCK YARDS
SO ST PAUL MN
55075

ENV SERV-GEN RESOURCE CORP

CENTRAL MN REGIONAL DEV COMM
1139 FRANKLIN AVE
SAUK RAPIDS MN
56379

CHRISTIAN SCI COMM ON PUB
1821 UNIV AVE SUITE 271
ST PAUL MN
55104

CLARKSON J.B.
2350 I.D.S. CENTER
MINNEAPOLIS MN
55402

COMMUNITY DESIGN CENTER
110 E 26TH ST
MPLS MN
55404

COX AND KING
600 BUILDERS EXCH
MPLS MN
55402

DANIELSON RODNEY L
418 AUDITORIUM
ST PAUL MN
55102

DISPATCH PIONEER PRESS
PRESS RM STATE CAPITOL
ST PAUL MN
55101

DOYTON MAURICE, MET SEWER BD
350 METRO SQ BLDG
ST PAUL MN
55101

ELMER EDWIN W
2901 PLEASANT AVE
MPLS MN
55408

ERDMAN ROGER TENNANT CO
701 N LILAC DR

CHAMBER OF COMMERCE
30 SO 1ST AVE EAST
ELY MN
55731

CHRISTIANSEN FREDRIK
RM 505 CAPITOL SQ BLDG
ST PAUL MN
55155

CLAUSEN PHILLIP
2307 STANDISH ST
ST PAUL MN
55108

CONCORDIA COLLEGE
DEAN
MOORHEAD MN
56560

CRAVEN NORMAN
10637 THOMAS AVE S
BLOOMINGTON MN
55431

DAILEY THOMAS ECONOMICS L
370 WABASHA ST
ST PAUL MN
55102

DAYTON CHAS SIERRA CLUB
800 MIDLAND BANK BLDG
MPLS MN
55401

DORSEY MARQUART
2400 1ST NATL BANK BLDG
MPLS MN
55402

DUDLEY E H
RT 7 BOX 122
EXCELSIOR MN
55331

EBELING EDWARD H.
161 W. MAIN
PERHAM MN
56573

EMERICK RICHARD A
1508 IDS CENTER
MPLS MN
55402

ERNEST K LEHMANN & ASSOC.
1409 WILLOW ST.

ESSE KENNETH
4601 W 50TH ST
EDINA MN
55424

EVANS CHAS.L. PRENTICE-HALL
ENGELWOOD CLIFFS
NEW JERSEY

EVERETT JERRY NW PETRO ASSN
512 NICOLLET MALL RM917
MPLS MN
55402

EWALD DOUGLAS MINN HOSP A
2333 UNIV AVE SE
MPLS MN
55414

EWING HAS WM
42 ASTAR RD
DABBITT MN
55706

FAEGRE & BENSON ATTN LIBR
1200 NW BANK BLDG
MPLS MN
55402

FARMERS ELEVATOR ASSN
852 GRAIN EXCH BLDG
MPLS MN
55415

FARRELL FRANK BUR NOR
RM 1160 176 E 5TH ST
ST PAUL MN
55101

FELHABER R S
W 1ST NATL BANK BLDG
ST PAUL MN
55101

FINLEY JAMES F
920 MINN BLDG
ST PAUL MN
55101

FINNEGAN J.R.
55 E. 4TH
ST.PAUL MN
55101

FLAGLAND CLINTON MN L&P BUR
796 RAYMOND AVE
ST PAUL MN
55114

FLEMING FREDERICK A
1866 HIGHLAND PARKWAY
ST PAUL MN
55116

FITZGERALD DR BOB
3007 LYNDALE AVE SO
MPLS MN
55408

FORBES GORDON MINN RRS AS
203 HANOVER 480 CEDAR
ST PAUL MN
55101

FORSBERG AGR SERV
518 SUMMIT AVE
NEW ULM MN
56073

FOX W.E. LINDQUIST & VENNUM
4200 IDSCTR 80 S.8TH ST
MINNEAPOLIS MN
55402

FRANKLIN ROBERT B MPLS TRIB
426 PORTLAND
MPLS MN
55415

FREDIN CONRAD M
811 FIRST NATL BK BLDG
DULUTH MN
55802

FREDRIKSON BYRON ET AL
47TH FLR ILS CENTER M
PLS MN
55402

FURLONG DR JOHN
RT 1
BOVEY MN
55709

F W WOOLWORTH CO
3316 W 66TH ST
EDINA MN
55424

GALVIN M J JR
W2162 1ST NATL BK BLDG
ST PAUL MN
55101

GARDNER HDW - R A JOHNSON
515 WASHINGTON AVE N
MPLS MN
55401

GEBERT K L
220 GRAIN EXCH
MPLS MN
55415

GEO A HORMEL & CO LAW DE
PO BOX 800
AUSTIN MN
55912

GEORGE K GRANSE CO
1477 SELBY AVE
ST PAUL MN
55104

GIEL DAVID
RM B-26 STATE CAPITOL
ST PAUL MN
55155

GLEESON MICHAEL
909 SCC SC BLDG U OF M
MPLS MN
55455

GLEN. HILLS HOSP.R.VAN HA
3901 GOLDEN VALLEY RD.
MPLS. MN
55422

GODIN RALPH J
3624 47TH AVE SO
MPLS MN
55406

GRAHAM THOS H
854 MIDLAND BK BLDG
MPLS MN
55401

GRANATH MARVIN -HONEYWELL
2701 4TH AVE SO
MPLS MN
55408

GREATER MET AREA HOSPITAL
5152 CEDAR AVE S
MPLS MN
55417

GREEN DEL CITY MGR
BLOOMINGTON CITY HALL
BLOOMINGTON MN
55431

GREEN GARY J
41 SHERBURNE AVE
ST PAUL MN
55102

GREEN JANET
9773 N SHORE DR
DULUTH MN
55804

GUSTAFSON DAN-LABOR TEMPL
312 CENTRAL
MPLS MN
55414

GUSTAFSON WALLACE
BOX 567
WILLMAR MN
56201

H B FULLER CO
2400 KASOTA AVE
ST PAUL MN
55108

HANFT PHILIP M
1200 ALWORTH BLDG
DULUTH MN
55802

HANSON ETHEL
2613 85TH AVE N
MPLS MN

HAROLD J WESTIN CONSTRUCTORS
45 E 8TH ST
ST PAUL MN

HARVEY MICHAEL
1390 W MINNEHAHA PKWY
MPLS MN

HALLBERG LEE & MCCABE
4927 34TH AVE S
MPLS MN

HAUK DR J W GEN MILLS
PO BOX 1113
MPLS MN
55440

HESS DONALD MIDWEST PLANNING
2101 HERM BLDG
MPLS MN
55405

HEIM PAUL
1320 SOO LINE BLDG
MPLS MN
55402

HILL JIM ASSOC.MILK PROD.
7690 METRO PARKWAY
MINNEAPOLIS MN
55420

HOLMES EUSTIS ET AL
4610 IDS CENTER
MPLS MN
55402

HOUSE APPROPRIATIONS COMM
RM 109 STATE CAPITOL
ST PAUL MN
55101

HUMAN RIGHTS
200 CAPITOL SQ BLDG
ST PAUL MN
55101

INTERSTATE POWER RM STEELE
1000 MAIN ST
DUBUQUE IA
52001

JENSEN CARL A
127 E MAIN ST
SLEEPY EYE MN
56085

JOHNSON M.C. FRUNDT & FRUNDT

HAYES, THOMAS W
700 SELLWOOD BLG
DULUTH MN
55812

HART PATRICK V
112 E LIBERTY BOX 3271
MANKATO MN
56001

HEINTZ MARY ELLEN
PO BOX 599
CINCINNATI OH
45201

HINRICHSEN PATRICK
MANKATO FREE PRESS
MANKATO MN
56001

HOPKINS WM.B. DIR.MISCCA
3915 GOLDEN VALLEY ROAD
GOLDEN VALLEY MN
55422

HOUSE ED STANDING SUB COMM
RM 109 STATE CAPITOL
ST PAUL MN
55101

HUNT JAMES P JR
11470 GALTIER DR
BURNSVILLE MN
55378

INGEBRIGTSEN DR K H
23 SE 4TH ST
MPLS MN
55414

IUOE LOC 49 CHAS SWENSON
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ST PAUL MN
55101

JACKMAN DONALD G
4023 E LAKE ST
MPLS MN
55406

JOHNSEN & SANDERSON
ST MARYS HOSPITAL
ROCHESTER MN
55901

JOHNSON LANCE J
265 S LAFAYETTE RD

HEALTH MANPOWER C LARSON
717 DELAWARE ST SE
MPLS MN
55440

HARTFELDT WILL
434 HAMM BLDG
ST PAUL MN
55102

HEISENFELT WM
BOX 516
BEMIDJI MN
56601

HOLDAHL SCOTT
380 N BLDG GRAIN EXCH
MPLS MN
55415

HORNER WALDORF - KAZIUKEWICZ
PO BOX 3260
ST PAUL MN
55165

HULSTRAND ANDERSON & LARSON
PO BOX 130
WILLMAR MN
56201

HUTCHISON R.M. ANOKA CO.COMP
COURT HOUSE
ANOKA MN
55303

INGVALSON VERN MN.FARM BUR.
3110 WOODDALE DR PO 337
OST PAUL MN
55165

IVERSON DR JOS DEPT ED
ST OLAF COLLEGE
NORTHFIELD MN
55057

JAIN NIRMAL ENIV PROCESS
1220 GLENWOOD AVE
MPLS MN
55405

JOHNSON CLARENCE IBEW LU 292
3015 37TH AVE S
MPLS MN
55406

HENTHORN GARY WOODSTOCK
7365 LANDAU DR
BLOOMINGTON MN
55438

HEAD & TRUHN
1007 SOO LINE BLDG
MPLS MN
55402

HICHINGER-MARK PLANNING
421 WABASHA ST
ST PAUL MN
55102

HOLEY GEO AERONAUTICS
DOWNTOWN AIRPORT
ST PAUL MN
55107

HOULE MELVIN
821 W HWY 96
SHOREVIEW MN
55112

HULTMAN WARREN R
C/O BARBAROSSA R3
OSSEO MN
55369

HYLAND DEAN
1501 W 50TH ST
MPLS MN
55419

INS FED OF MINN
902 SOO LINE BLDG
MPLS MN
55402

IZAAK WALTON LEAGUE MN DI
106 TIMES BLDG 57 S 4TH
MPLS MN
55401

JENUS INC
525 LAKE AVE SO
DULUTH MN
55801

JOHNSON LEROY
9939 BLUEBIRD ST NW
COON RAPIDS MN
55433

KABLE RICHARD W

KAVANEY RICHARD
1220 NORTHERN FED BLDG
ST PAUL MN
55102

KEABLE MIKE
509 6TH AVE N
ST CLOUD MN
56301

KEENAN RICHARD J
4444 IDS BLDG
MPLS MN
55402

KIMBALL ROBERT
647 CAPITOL SQ BLDG
ST PAUL MN
55101

KING, TIMOTHY
3333 OAKLAND AVE S
MPLS MN
55407

KLOSTER MARION PEAVEY CO
730 2ND AVE S
MPLS MN
55402

KLUZ STEVEN J
1910 1ST NATL BK BLDG
MPLS MN
55402

KNOPP TIMOTHY
COLLEGE FORESTRY U OF M
ST PAUL MN
55108

KNUTSON DR KEITH, BIOLOGY DPT
ST CLOUD STATE
ST CLOUD MN
56301

KNUTSON R A GRANNIS ETAL
F J SCHULT BLDG
ST ST PAUL MN
55075

KNUDSON ROBT
4375 BROWNDALE AVE
MPLS MN
55424

KOLLER MR & MRS ERWIN A
1568 DULUTH ST
ST PAUL MN
55108

KOPP MRS VERNON
2050 65TH ST E
INVER GR HGHT MN
55075

KRAMER ERNEST H
717 DELAWARE ST SE
MPLS MN
55440

KRUNLOKKEN J E
10048 NORD RD
BLOOMINGTON MN
55437

LAKE SUPERIOR INDUSTRIAL BUR
426 FIRST AM. BK. BLDG.
DULUTH MN
55802

LANAHAN E F - SIBLEY CO
184 E 6TH ST
ST PAUL MN
55101

LANGVIN DAVID
7500 80TH ST S
COTTAGE GROVE MN
55016

LANSING & OAKES
400 SIBLEY ST
ST PAUL MN
55101

LAPP LAZAR LAURIE ET AL
1200 BUILDERS EXCHANGE
MINNEAPOLIS MN
55402

LARSON C L
3800 MINNEHAHA AVE SO
MPLS MN
55406

LARSON HANS P DIV HOSP SERV
717 DELAWARE ST SE
MPLS MN
55440

LEAGUE MN MUNIC
300 HANOVER 400 CEDAR
ST PAUL MN
55101

LEAGUE WOMEN VOTERS OF MINN
555 WABASHA
ST PAUL MN
55102

LIBBEY LEONARD
BLK 17011 NOKOMIS STA
MPLS MN
55417

LINDALL & JONATHAN DEVELOP.
VILLAGE ONE CENTER
CHASKA MN
55318

LOCKNER GARY
R R 1 BOX 23
BAUDETTE MN
56623

LUCS CALVIN J
6809 LYNDALE AVE SO
MPLS MN
55423

LOWE DOUG
2701 N LEXINGTON AVE
ROSEVILLE MN
55113

LYNCH DONALD SIBLEY CO
184 E 6TH ST
ST PAUL MN
55102

MCDONALD PHILIP M
2077 SELBY AVE
ST PAUL MN
55104

MCFADDEN G H DISPATCH-PRESS
55 E 4TH ST
ST PAUL MN
55101

MCKIBBON MRS SHIRLEY
18 EVERGREEN LN
BASBITT MN
55706

MCLELLAN LARKIN
215 ADM BLDG ST CAPITOL
ST PAUL MN
55101

MALONE E I COMM LABOR & INDU
444 LAFAYETTE RD 5TH FL
ST PAUL MN
55101

MANKATO STAT STUDENT SENATE
CENTENNIAL STUDENT UN
MANKATO MN
56001

MANKATO STATE STUDENT AS
BOX 58 MANKATO COLLEGE
MANKATO MN
56001

MANTHEY T J PICKANDS MATHER
1100 SUPERIOR AVE
CLEVELAND OH
44114

MASTOR & MATTSON LTD
315 PEAVEY BLDG
MPLS MN
55402

MAUL WARREN E
320 S 4TH ST
MPLS MN
55415

MAYO FOUNDATION G ORHOLL
200 FIRST AVE NW
ROCHESTER MN
55901

MCCOA
867 GRAND AVE
ST PAUL MN

MEIEROTTO, JOAN
1754 SO LEXINGTON
ST PAUL MN

MERRITT GRANT POLLUTION CONT
1935 W CO RD 32
ROSEVILLE MN

MET TEA MEN ASSN A ROSENT
1621 UNIV AVE
ST PAUL MN

METROPOLITAN COUNCIL LIBRARY
300 METRO SQUARE
ST PAUL MN
55155

MIDLAND GLASS- HO SPURLING
PO BOX 69
SHAKOPEE MN
55379

MILLER RICHARD A
1020 PLYMOUTH BLDG
MPLS MN
55402

MILLER TOM
2311 PILLSBURY AVE S
MPLS MN
55404

MPLS CHAMBER COMM TRANSP DPT
15 S 5TH ST
MPLS MN
55402

MPLS CITY ATTORNEY
325M CITY HALL
MPLS MN
55415

MPLS STAR PRESS ROOM
STATE CAPITOL
ST PAUL MN
55101

MPLS TRIBUNE CITY DESK
425 PORTLAND AVE
MPLS MN
55415

MIDLAND GLASS-HO SPURLING
PO BOX 69
SHAKOPEE MN
55379

MILLER PAUL J PHARMACY SERV
ST MARYS HOSP
ROCHESTER MN
55901

MINN APT ASSN
GRIGGS-MIDWAY BLDG
ST PAUL MN
55104

MN. ASN.C&IND H.D.PETERSO
480 CEDAR ST.
ST.PAUL MN
55101

MINN AFL-CIO, L O LA SHOMB
414 AUDITORIUM ST
ST PAUL MN
55102

MINN ASPHALT PAVEMENT ASSN
555 WABASHA RM 209
ST PAUL MN
55102

MINN ASSN COOPERATIVES
55 SHERBURNE AVE
ST PAUL MN
55103

MINN ASSN ELEC COOPERATIV
4901 W 77TH ST
MPLS MN
55435

MINN. ASSN. PET RETAILERS
1115 2ND AVE. SO.
MINNEAPOLIS MN
55403

MINN ASSN WATERSHED DIST'S

ADA MN
56510

MINN AUTOMOBILE DEALERS ASSN
GRIGGS MIDWAY BLDG
ST PAUL MN
55104

MINN COMM FOR HANDICAPPED
METRO SQ 492 7TH & ROBT
ST PAUL MN
55101

MINN COMMUNITY DEVELOP SERV
312 RUSSMOR BLDG
ST PAUL MN
55101

MINN COUNCIL STATE EMP NO 6
475 RICE ST
ST PAUL MN
55103

MINN DEPT HEALTH J C MCKASY
717 DELAWARE S E
MPLS MN
55440

MINN DENTAL HYGIENISTS
5041 YVONNE TERRACE
MPLS MN
55436

MINN ELECTRICAL ASSN INC
525 SO 7TH
MPLS MN
55415

MINN ENV LAW INST INC
PO BOX 15076 COMM STA
MPLS MN
55415

MINN FARMERS UNION PRES OFF
1275 UNIV AVE
ST PAUL MN
55104

MINN FOOD RETAILERS ASSN
555 WABASHA
ST PAUL MN
55101

MINN HEREFORD-LJ SCHAFER

BUFFALO LAKE MN
55314

MINN. HOTEL & MTR. ASSN
2001 UNIVERSITY AVE
ST PAUL MN

MINN HOUSING INST N T CARTER
7601 METRO PKWY
MPLS MN
55420

MINN HWYS MANAGEMENT SERV
407 HWY BLDG
ST PAUL MN
55101

MINN LAND USE COMMITTEE
4344 IDS CENTER
MPLS MN
55402

MINN LP GAS ASSN
7515 WAYZATA BLVD 106
MPLS MN
55426

MINNE MINE CREDIT UNION
3000 HUDSON PK S 100
ST PAUL MN
55119

MINN.MTR.TRANSP. .J.N.D
1821 UNIV.
ST.PAUL MN
55104

MINN PETROLEUM COUNCIL
1020 NORTHERN FED BLDG
ST PAUL MN
55102

MINN POULTRY & HATCHERY ASSN
BOX 156
MADELIA MN
56062

MN REP STATE CENTRAL COMM
555 WABASHA AVE
ST PAUL MN
55102

MINN RESTAURANT ASSN
2001 UNIVERSITY AVE.
ST PAUL MN 55
104

MINN RETAIL FEDERATION
7600 PARKLAWN STE 457
MPLS MN
55435

MINN RETAIL HARDWARE ASSN
3033 EXCELSIOR BLVD 313
MPLS MN
55416

MINN SCH BUS OPERATORS ASSN

FARIBAULT MN
55021

MINN SOCIETY ARCHITECTS A
NW NATL BK BLDG
ST PAUL MN
55101

MINN SOC CERTIFIED PUB ACCTS
1102 WESLEY TEMPLE BLDG
MPLS MN

MINN STATE BAR ASSN
100 MINN FED BLDG
MPLS MN

MINN STATE BD PHARMACY
717 DELAWARE ST SE 4351
MPLS MN

MINN STATE CAPITOL EMP UN
PO BOX 3215
ST PAUL MN

MINN STATE MED ASSN
375 JACKSON ST
ST PAUL MN
55101

MINN STATE RETIREMENT SYSTEM
529 JACKSON ST
ST PAUL MN
55101

MINN TEAMSTERS CREDIT UNION
2021 HENN AVE E
MPLS MN
55413

MINN TBR PRODUCERS ASSN
200 CHRISTIE BLDG
DULUTH MN
55802

MINN.TURKEY GROWERS ASSN
2303 UNIV AVE
ST PAUL MN
55114

MINN VETERANS MED ASSN
2175 W HWY 36
ROSEVILLE MN
55113

MINN WATER RESOURCES BD
RM 206 555 WABASHA ST
ST PAUL MN
55102

MINN-WISC BOUNDARY AREA C
600 2ND ST
HUDSON WI
54016

MN PUB INT RESEARCH GROUP
3036 UNIV AVE SE
MPLS MN
55414

MOFFITT R.C. DIR.ENV.CONTROL
MPLS.CITY HALL RM 301M
MPLS MN
55415

MOOD R BLOOMINGTON HLTH DEPT
10200 PENN SO
BLOOMINGTON MN
55431

MOONEY, MICHAEL A.
BOX 903, ST.JOHN'S UNIV
COLLEGEVILLE MN
56321

MORTON BUILDINGS INC
R #1
FOLEY MN
56329

MPIRG
BOX 45 ST MARYS COLLEGE
WINONA MN
55987

MUELLER SHIRLEY A
787 W COTTAGE AVE
ST PAUL MN
55117

NISS GEO V HENN CO GEN HOSP
5TH AND PORTLAND AVE
MPLS MN
55415

NATL CAR RENTAL ATT D MITZEL
5501 GREEN VALLEY DR
MPLS MN
55437

NATL COUNCIL JEWISH WOMEN
4330 CEDAR LK RD
MPLS MN
55416

NATL FAMILY INS CO
2147 UNIV AVE
ST PAUL MN
55114

NAT'L SOLID WASTES-R. GRASSO
1730 RHODE ISLAND AV.NW
WASHINGTON DC
20036

NCEC INC C/O DR DAHLBERG
CONCORDIA COLLEGE
MOORHEAD MN
56560

NELSON DONALD E NSP CO
414 NICOLLET AVE
MPLS MN
55401

NEDELL HAROLD - MEINEKE
6300 W LOOP S SUITE 200
BELLAIRE TX
77401

NESBITT JOHN
7601 METRO PKWY S 118
MPLS MN
55420

NELMAN RALPH W
RT 2 BOX 125
EMBARRASS MN
55732

NIELSEN STOCK & BLACKBURN
415 730 BLDG
MPLS MN

NO SUB MONTESSORI-S SADUL
2487 HELEN COURT
NO ST PAUL MN
55109

NORTH CENTRAL ELEC ASSN
PO BOX 202
BATTLE LAKE MN
56515

NW COUNTRY ELEVATOR ASSN
602 GRAIN EXCH BLDG
MPLS MN
55415

NURSING HOME ADMRS BD EXAMRS
RM 340 717 DELAWARE SE
MPLS MN
55414

NUTTER JULIA
745 W MONTANA
ST PAUL MN
55117

NW BELL TEL CO LEGAL DEPT
224 S 5TH ST RM 2000
MPLS MN
55402

NYQUIST DEAN A
3707 53RD PL N
BROOKLYN CTR MN
55429

O'BRIEN J.DENNIS
1100 1ST NATL.BANK BLDG
MINNEAPOLIS MN
55402

OCONNOR GREEN THOMAS ET A
845 NW BANK BLDG
MPLS MN
55402

OFFICE OF THE GOVERNOR
130 STATE CAPITOL
ST PAUL MN
55101

OLD COLONY GAS & OIL COMPANY
17TH AVE N AT 2ND ST
MPLS MN
55411

OLOFSON ARTHUR M&O & MAINC
927 SOO LINE BLDG
MPLS MN
55402

OSTRUM DONALD E
PO BOX 33163
COON RAPIDS MN
55433

OTTER TAIL POWER CO.
215 S. CASCADE ST.
FERGUS FALLS MN
56537

PATTISON ORVIS
BOX 645
WILLMAR MN
56201

PAYNE COL ALVIN

DEGRAFF MN
56233

PAYNE WM J
2600 FIRST NATL BK BLDG

PETERSON JOHN W
510 NW BK BLDG

PETERSON GARY
854 MIDLAND BK BLDG

PFEIFER AND SHULTZ, INC
1433 UTICA AVE S

PHAR MFGRS ASSN WM C PATTON
1155 15TH ST NW
WASHINGTON DC DC
20005

PHILLIPS LEGISLATIVE SERVICE
459 RICE ST
ST PAUL MN
55103

PINNETTI NICK M HALEY & ASS.
40 CENTRAL PARK S
NEW YORK NY
10019

POPOVICH PETER S
314 MINN BLDG
ST PAUL MN
55101

PORTER LYLE O

TRACY MN
56175

PORT AUTH CITY OF ST PAUL
330 MINNESOTA BLDG
ST PAUL MN
55101

POSS DONALD G
6301 SHINGLE CREEK PKWY
BROOKLYN CTR MN
55430

POYZER ROBT
BOX 675
FERGUS FALLS MN
56357

PRAUSE JOS.C.
2220 105TH AVE.N.W.
COON RAPIDS MN
55433

PROCTOR&GAMBLE L THECHAROUS
IVORYDALE TECH CENTER
CINCINNATI OH
45217

PULSCHER R&T SPRINGSTED INC
813 OSBORN BLDG
ST PAUL MN
55102

QUINLIN E W
406 MNY BLDG
ST PAUL MN
55155

RADMAN RICHARD-LABOR TEMPLE
416 AUDITORIUM
ST PAUL MN
55102

RANALLO CLARENCE
800 CENTRAL AVE N E
MPLS MN
55413

RADENHORST CORP-C ANDERSON
7900 XERXES S. S-2200
MPLS MN
55431

RED OWL STORES INC
215 E EXCELSIOR AVE
HOPKINS MN
55343

REID DAVID H
5933 WASHBURN AVE S
MPLS MN
55410

RENNER R.H. ST PAUL AREA
300 OSBORN BLDG.
ST PAUL MN
55102

RAMSEY CO MEDICAL SOCIETY
1500 LOWRY MEDICAL BLDG
ST PAUL MN
55102

RICHARDSON THOS
7651 METRO PKWY S 103
MPLS MN
55420

RICHARDS MONTGOMERY ET AL
1430 RAND TOWER
MPLS MN
55402

ROE DAVID
175 AURORA
ST PAUL MN
55103

ROBBIE JOSEPH
904 CARGILL BLDG NO CTR
MPLS MN
55402

ROBERTS DAVID E
1260 AM NATL BK BLDG
ST PAUL MN
55101

ROSS ALFRED
6356 WAKE RD
LINO LAKES MN
55014

RUDY FLOYD
118 AVE C
CLOQUET MN
55720

SAN SIMEON DEVELOP CORP
OLD 1ST STATE BK BLDG
PAYNESVILLE MN

SANFORD S M
7000 PORTLAND AVE
RICHFIELD MN
55423

SATHRE, HARVEY
375 MARION STREET
ST PAUL MN
55103

SAX DOVE & STENSON
310 ENDICOTT BLDG
ST PAUL MN
55101

ST PAUL ASSN PLBG HTG MECH
614 AM NATL BK
ST PAUL MN

ST PAUL BUR HLTH DR P COX
555 CEDAR ST
ST PAUL MN
55101

ST PAUL FOOD RETAILERS AS
1220 ARCADE
ST PAUL MN
55106

SCARBOROUGH WILLIAM
DIV.ED. U.M.
MORRIS MN
56267

SCHLICHT REV ROBT
611 W MAIN ST
BELLE PLAINE MN
56011

SCHMIDT D R MN ASSN REALTORS
6101 WAYZATA BLVD
MPLS MN
55416

SCHMIDT H W TCHRS RETIREM
302 CAPITOL SQ BLDG
ST PAUL MN
55101

SCHMIDT LARRY WCCO-TV NEWS
90 S 9TH ST
MPLS MN
55402

SCHNEIDER MAHLON
GREEN GIANT
LESUEUR MN
56056

SCHUTZ LINDA
RM 328 CAPITOL BLDG
ST PAUL MN
55155

SCHWARTAU NEAL METH HOSP
201 W CENTER ST
ROCHESTER MN
55901

SCHWERMAN EARL JR
1535 6TH AVE SE
ROCHESTER MN

SCHWINN ROBT.P.
1400 SEC LINE BLDG.
MPLS. MN

SCHNEIDER & NEESER
700 1ST ST SO PO BX 876
WILLMAR MN

SCHROEDER ALFRED H
2172 CARROLL AVE

SENATE COUN OFF ROOM 24
STATE CAPITOL
ST PAUL MN
55101

SENATE FINANCE COMMITTEE
113 STATE CAPITOL
ST PAUL MN
55101

SENATE GOV OP COMM
RM 303 STATE CAPITOL
ST PAUL MN
55155

SHABATURA EUGENE H
2833 LAKE AVE SO
DULUTH MN
55811

SHARP BOB
4125 HIGHWOOD RD
ST LOUIS PK MN
55416

SHAW ROBERT M
616 MOBIL OIL BLDG
MPLS MN
55402

SHELL OIL CO. W.A. ROQUET
ONE SHELL PLAZA BX 2463
HOUSTON TX
77001

SITE ENGINEERS INC
900 REDWELL LANE
APPLE VALLEY MN
55124

SKELLY OIL CO R R WELLINGTON
PO BOX 436
KANSAS CITY MO

SLOCUM CHARLES A
1203 IDS TOWER
MPLS MN
55402

SMERIKA WM.
BOISE CASCADE PAPERS
INTL FALLS MN
56649

SMITH MICHAEL
1423 NEWTON AVE N
MPLS MN
55411

SNELL LYN
BOX 314
EDEN VALLEY MN
55329

SNYDER ROBERT W
248 CO B C OF M
ST PAUL MN
55101

SODERBERG HAROLD J
1500 MIDWEST PLAZA BLDG
MPLS MN
55402

SODERMAN ANTHONY
152 S PLAZA BLDG
MPLS MN
55416

STANSFIELD ARLENE LAND OLKS
PO BOX 116
MPLS MN
55440

STATE BD.BARBER EXAMINERS
555 WABASHA
ST PAUL MN
55102

STATE BD VETERINARY EXAMINER
C/O DR A C SPANNAUS DVM
WACONIA MN

STD AM LIFE & ANNUITY CO
3601 W 50TH ST
MPLS MN
55410

STEELWORKERS CREDIT UNION
BOX 250
BABBITT MN
55706

STENSLAND M.E. PRES. MVMA
203 NW 22ND ST.
AUSTIN MN
55912

STOLPESTAD BROWN & SMITH
1550 NW BK BLDG
ST PAUL MN
55101

STUPKA & MOREM
MIDTOWN BLDG
AUSTIN MN
55912

SULLIVAN J KIRK
PO BOX 200
BOISE ID
83701

SUMMIT NATL BANK D L MORRILL
205 AURORA AVE
ST PAUL MN
55103

SUSSEL CO.ATTN:TED SCHWENKER
1650 CUMO AVE.
ST PAUL MN
55108

SWANSON BURT E
W-2162 1ST NATL BK BLDG
ST PAUL MN
55101

SWANSON DALE
P O BOX 339
FOREST LAKE MN
55025

SWANSON GERALD H
212 CITY HALL
ROCHESTER MN
55901

SWEITZER R L HONEYWELL INC
2701 4TH AVE S
MPLS MN
55408

TATE VERN 3M CO
3M CENTER 220/6W
ST PAUL MN
55101

THOMPSON CONRAD
1107 23RD ST NW
ROCHESTER MN
55901

THOMPSON HESSIAN ET AL
1500 MIDWEST PLAZA BLDG
MPLS MN
55402

TIMESAVERS INC ATT R S VO
5270 HANSON COURT
MPLS MN
55422

TOUCHE ROSS & CO K H STUCKE
700 NORTHSTAR CNTR
MPLS MN
55402

TWIN CITY RETAIL DRUGGIST AS
2388 UNIV AVE
ST PAUL MN
55104

UNION STOCK YARDS
ATTN PRES
SO ST PAUL MN
55075

VAN CLEVE JOHN H
2101 HENN AVE
MPLS MN
55405

VAN DRAKE STEPHEN R
BOX 353
PELICAN RAPID MN
56572

VAN EVERA MUNDT ET AL
700 TORREY BLDG
DULUTH MN
55802

VERRILL JOHN E
DEPT SECONDARY ED UOF M
DULUTH MN

VILLAGE OF WOODBURY-F.STRONG
501 TOWER DRIVE
WOODBURY MN

VOLDNESS PERRY
105 6TH & MARQUETTE
MPLS MN

VOSS REV GORDON O
11120 NE 7TH ST
BLAINE MN

VERRILL JOHN E
DEPT SECONDARY ED UOF M
DULUTH MN
55812

VOS LEROY
2137 BURNS AVE
ST PAUL MN
55119

WALTERS THOS H
4910 W 77TH ST STE 235
MPLS MN
55435

WHITING RALPH
555 WABASHA SUITE 204
ST PAUL MN
55102

WILEY ENTERPRISES
101 5TH AVE SE
OSSEO MN
55369

WOZNIAK L D
401 FIRST FED BLDG
ST PAUL MN
55101

[illegible] MN
55[illegible]

VILLAGE OF WOODBURY-F.STRONG
561 TOWER DRIVE
NEWPORT MN
55055

WANGLIST ALLEN
RM 252 FEDERAL BLDG
ST PAUL MN
55101

WHITLOCK A G
ECON LAB OSBORN BLDG
ST PAUL MN
55102

WILSON R GARY PPG INDUSTR
1 GATEWAY CENTER
PITTSBURGH PA
15222

WYANT CLINTON W ATTY

ATKIN MN
56431

[illegible]
[illegible]

VOLDNESS PERRY
105 8TH & MARQUETTE
MPLS MN
55402

WALO JEAN
5746 SANDER DR
MPLS MN
55417

WELK G V NORTHERN STATES
414 NICOLLET MALL
MPLS MN
55401

WILCOX J PATRICK
1220 NORTHERN FED BLDG
ST PAUL MN
55102

WIS FEEDER PIG MARKET CO-OP

FRANCIS CREEK WI

VOSS REV GORDON O
11120 NE 7TH ST
BLAINE MN
55434

WALIGORA ROBERT
3228 SO 17TH AVE
MPLS MN
55407

WESTIN CHAS W
220 MEDICAL ARTS BLDG
DULUTH MN
55802

WM.MITCHEL COLLEGE LAW LI
2100 SUMMIT AVE.
ST.PAUL MN
55105

WOLKERSTORTER THEODORE
676 17TH AVE NW
NEW BRIGHTON MN
55112

NAME	ADDRESS	CITY	ZIP CODE
MOFFITT R C	RM 301 M MPLS CITY HALL	MPLS	MN 55415
RENQUIST ARTHUR DSR GO	9419 DIGGONET CIRCLE	MINN	MN 55343
BECK BAT	9453 HYACINTH AVE	ST. PAUL	MN 55119
BROWN H D	4961 WINDSBERRY LANE	MINNETONKA	MN 55343
NEREN MADONNA	3216 NEAL AVE S	HITON	MN 55001
REAGAN MICHAEL	C/O MINN LEARNING CTR	BRAINARD	MN 56401
HOUSE RESEARCH	RM 563 STATE CAPITOL	ST. PAUL	MN 55155

HEALTH

Abrahamson, Dr. Dean E., 243 Space Science Center, Minneapolis 55455

Booth Cold Storage Co., St.Peter & Kellogg, St. Paul
Branson, Lindley S., 300 Roanoke Bldg., Mpls. 55402
Bush, John T., Box 611, Mayo Bldg., U of M.,Mpls. 55455

Cassel, Dr. Carl V. E., Minn. State Dental Ass'n., 2236 Marshall Av.,St.Paul55104

Deephaven Montessori School, Inc.,188 So. Circle A Dr., Wayzata, Mn. 55391

Environment Reporter, 1231 25th St., N.W., Washington D. C.

Hawley, Lyle, Graco, PO Box 1441, Mpls. 55440

Houghton, Charles, Vendo, 7246 Troost Ave., Kansas City, Miss. 64131

Higgins, J.C.,Brotherhood Rwy. Clerks, 2317 W. 7th St., Duluth

Janke, John R., Burger Chef Systems,Inc.,250 No. St., White Plains, NewYork10625

Kurtz, Mrs.Kirsten,Mn. Nurses Ass'n.,1821 Univ.Ave., St.Paul 55104

Markham,B.B., 2250 IDS Center, 80 So. 8th St.,Mpls.55402

Merck & Co., Inc. Rahway, N.J., Attn; Off of Gen. Counsel

Minneapolis & Hennepin County Mental Health Clinic, 619 S. 5th St., Mpls.55415

Minn. Nurses Assn., Attn: Geraldine Wedel, 1821 Univ. Ave. Rm. 152,St.Paul 55104

Minn. State Pharmaceutical Ass'n., 2388 University Av.,St. Paul 55104

Parke, Davis & Company, P.O.Box 118, Detroit [illegible], Michigan 48120

Patrick, Peter, 101 Central Av., S.E.,Mpls.55414

Perso, E. R., 4411 Branson St.Mpls.55424

Planning and Advisory Comm. of Crow Wing County, Court House,Brainerd 56401

Roesler, Immanuel F., 6700 Portland Av.So., Richfield 55423

Schneider, Dorothy, StPaul Bur.Health, 555 Cedar St,St.Paul 55101

Walgreen, J.E.Krahulec, 4300 Peterson, Ave.Chicago,Ill.60646

DIV. OF ENVIRONMENTAL SANITATION

U.S. Soil Conservation Serv.,517 Red.Courts Bldg.,St.Paul (Swimming pools)

HOTELS, RESORTS, RESTAURANTS

U.S.Soil Conservation Serv., 517 Red.Courts Bldg.,St. Paul (trailer Parks,etc)

MINN. PLUMBING CODE ONLY

Hendricks, Manley, & Tyler Pipe Industries, Box 2027, Tyler, Texas 50701

Higgins, Robert G. - Room 300B, 1409 Willow St.,Mpls. 55403

Sharp, Richard H., 964 W. Cecil St.,Neenah, Wisc. 54956

CEMETERIES

Fox, Howard - 244 Dayton Ave.,St. Paul 55102

MOH Ex. 2
12/2/75 RJKH.

STATE OF MINNESOTA

COUNTY OF HENNEPIN

In the Matter of the Proposed Adoption, Amendment or Revision of the Rules of the Minnesota State Board of Health

AFFIDAVIT OF MAILING

H. Michael Tryple, being first duly sworn, deposes and says:

That on the 17th day of September, 1975, at the City of Minneapolis, County of Hennepin, State of Minnesota, he mailed the attached Press Release by depositing in the the United States mail at said City of Minneapolis, a true and correct copy thereof, properly enveloped, with postage prepaid, to all persons and associations at the addresses listed on Exhibit A, attached and made a part hereof.

H. Michael Tryple

Subscribed and sworn to before me this 15th day of ~~September~~ October, 1975.

John E. Diehl

JOHN E. DIEHL
Notary Public, Ramsey County, Mn.
My Commission Expires
September 22, 1978

YOUR HEALTH



NEWS RELEASE FROM THE MINNESOTA DEPARTMENT OF HEALTH

September 16, 1975 Contact: Bill Moore
FOR IMMEDIATE RELEASE (612) 296-5294

The State Board of Health has announced its intent to obtain the input of Minnesota residents as it considers the adoption of new rules in seven different subject areas and the amendment and revision of existing rules in five different areas.

Minnesotans interested in submitting data or views relating to the proposed adoption, amendment or revision of rules should address their written or oral comments to the Minnesota Department of Health, 717 S.E. Delaware St., Minneapolis 55440, through the contact persons listed below.

The proposed new rules relate to the following subjects:

* Implementing provisions of the Minnesota Clean Indoor Air Act; Kent Peterson, (612) 296-5365.

* Control and regulation of clinical laboratories; Dr. Henry Bauer, Division of Medical Laboratories, (612) 296-5241.

* Transfer of patient's x-ray records; Dr. Ellen Z. Fifer, Assistant Commissioner for Programs, (612) 296-5391.

* Distribution of monies to aid in construction of water filtration and purification plants and systems for communities using Lake Superior as a drinking water source; Frederick Heisel, Division of Environmental Health, (612) 296-5320.

* Implementing provisions of the Maternal and Child Nutrition Act of 1975; Dr. Ronald Campbell, Section of Maternal and Child Health, (612) 296-5265.

* Approval of laboratories performing bacteriological examinations of water; Russell Frazier, Analytical Services Section, (612) 296-5300.

- MORE -

* Establishment of application procedures for the credentialing of allied health manpower groups; Corrine Larson, Section of Allied Health Manpower, (612) 296-5393.

Amendments or revisions of existing rules are proposed in the following subject areas:

* Construction, equipment, maintenance, operation and licensing of nursing homes and boarding care homes, and the establishment of levels of assessments for violations of the regulations; H. Michael Tripple, Division of Health Facilities, (612) 296-5418 (effective Oct. 1).

* Construction, equipment, maintenance, operation and licensing of hospitals, and the establishment of levels of assessments for violations of the regulations; Janet Brodahl, Division of Health Facilities, (612) 296-5440.

* Morticians, funeral directors, and the disposition of the dead; Eugene Larson, Mortuary Science Unit, (612) 296-5491.

* Limitation of the use of x-ray machines in the screening for detection and evaluation of health conditions; Alice Dolezal, Division of Environmental Health, (612) 296-5323.

* Construction, equipment, maintenance, operation and licensure of supervised living facilities; Hans Larsen, Division of Health Facilities, (612) 296-5451.

Any materials submitted will be reviewed and considered by the Department of Health during the preparation of proposed rules, amendments or revisions. Notice of public hearings on proposed rules will be given to all interested parties, and any written materials submitted will become part of the hearing record.

Under state law, any individual representing persons or associations attempting to influence administrative action, such as the promulgation of these proposed rules, must register with the State Ethics Commission as a lobbyist within five days of the commencement of such activity.

Exhibit A

SWIFT COUNTY PHN SERVICE 72
COURTHOUSE
BENSON, MN 56215

STEVENS CO PHN SERVICE 72
STEVENS COUNTY COURT HOUSE
500 COLORADO, P.O. BOX 404
MORRIS, MN 56267

STEELE CO PHN SERVICE 72
COURTHOUSE
OWATONNA, MN 55060

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Radio Station WKLK
Cloquet, Minnesota

News Director 65
KLIZ
Brainerd, Minn.

News Director
Radio Station KLIZ
Brainerd, Minnesota

News Director 65
KBEW
Blue Earth, Minn.

News Director
KBMO
Benson, Minnesota 63

News Director
Radio Station KBUN
Bemidji, Minnesota

News Director 63
KQAQ
Austin, Minn.

News Director 72
Radio Station KAUS-TV
Box 577
Austin, MN 55912

News Director
Radio Station KAUS
Austin, Minnesota

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WDGY Radio Station
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Minneapolis, MN 55420

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WCCO-FM Radio Station
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Minneapolis, MN 55403

Public Service Director 74
WCCO Radio Station
625 Second Avenue South
Minneapolis, MN 55404

Public Service Director 74
KUOM Radio Station
2 Eddy Hall, U. Campus
Minneapolis, MN 55455

Public Service Director 74
KQRS Radio Station
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Minneapolis, MN 55422

Public Service Director 74
KTCR Radio Station
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Minneapolis, MN 55406

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KDAL Radio Station
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Newport, MN 55055 74

Public Service Director 74
KBEM Radio Station
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Minneapolis, MN 55415

Public Service Director 74
KANO Radio Station
Anoka, MN 55303

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Wahpeton, ND 58075

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Fargo, N.D. 58103

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Grand Forks, ND 58201

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Radio Station CKDR
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Fort Frances, Ontario
CANADA

News Director 71
Radio Station WDAY
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WAYN Radio Station
Stillwater, MN 55082

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KDWA Radio Station
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Hastings, MN 55033

Public Service Director 74
KSEM Radio Station
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Public Service Director 74
WWTC Radio Station
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Minneapolis, MN 55402

Public Service Director 74
WRCR Radio Station
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St. Paul, MN 55119

Public Service Director 74
KSTP Radio Station
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St. Paul, MN 55114

Public Service Director 74
KSJN Radio Station
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St. Paul, MN 55101

Public Service Director 74
KEEY Radio Station
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Public Service Director 74
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Public Service Director 74
KTIS Radio Station
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New Brighton, MN 55112

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Radio Station KVOD
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Fargo, ND 58102

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East Grand Forks, Minn.

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Radio Station KWOM
Worthington, Minnesota

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KWNO
Winona, Minnesota 60

News Director
KAGE
Winona, Minnesota 60

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KVNL
Sauk Rapids, Minn.

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KNSI
St. Peter, Minnesota 60

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Radio Station KNSR-TV
Sheraton Hotel
Rochester, MN 55901 70

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Radio Station KLGR
St. Cloud, Minnesota

News Director
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Redwood Falls, Minnesota

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St. Cloud, Minnesota

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KCUB
Red Wing, Minnesota 60

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KRSB
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Long Prairie, Minn.

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Radio Station KLTF
Little Falls, Minnesota

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KLFD
Litchfield, Minn.

News Director 65
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STATE OF MINNESOTA

Office Memorandum

DEPARTMENT HEALTH

TO : Addressograph Unit

DATE: Sept. 16, 1975

FROM : Section of Public Health Education

SUBJECT: News Release Additions

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53

STATEMENT OF COMPLIANCE WITH

MANUAL OF RULE MAKING PROCEDURES

I, Special Assistant Attorney General Terry P. O'Brien, do hereby declare that I have examined the proposed rules relating to implementation of the Minnesota Clean Indoor Air Act and all related documents and that, based on them and my personal familiarity with the applicable procedures, the Manual of Rule Making Procedures has been followed.

Dated: March 8th, 1976

TERRY P. O'BRIEN
Special Assistant
Attorney General