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HEATING, VENTILATION and AIR CONDITIONING CODE

INTRODUCTION

AUTHORITY

The Heating, Ventilation and Air Conditioning Code has been adopted by the Industrial Commission in discharge of its duties under Section 101.01 to 101.28, inclusive, of the Statutes of Wisconsin.

HISTORY

Prior to the adoption of the Heating and Ventilation Code by the Industrial Commission on July 6, 1923 the general requirements on ventilation of public buildings and places of employment in Wisconsin were enforced as a part of the Building Code and of the General Orders on Sanitation, issued by the Industrial Commission. The Building Code became effective on October 9, 1914, and the ventilation requirements therein were amended only in minor details prior to July 6, 1923.

The General Orders on Sanitation became effective on February 20, 1913. The ventilation requirements contained therein, Orders 2000 to 2017, inclusive, were amended in 1921, effective July 19, 1921. The revised general ventilation requirements were contained in Orders 2000, 2010, 2011, 2012 and 2020 to 2025, inclusive, and were in force until March 18, 1932 when they were repealed and superseded by the General Orders on Dusts, Fumes, Vapors and Gases. These orders are now in effect and apply to all places of employment and public buildings.

In the fall of 1922, the Industrial Commission appointed an Advisory Committee to assist in the preparation of a reasonable code of standards of heating and ventilation for public buildings and places of employment in Wisconsin. The personnel of this committee was as follows:


Dr. H. E. Dearholt, Milwaukee, Wisconsin. Representing the Wisconsin Anti-Tuberculosis Association.


Prof. G. L. Larson, College of Engineering, University of Wisconsin, Madison, Wisconsin.

Samuel R. Lewis, Consulting Engineer, Chicago, Illinois.
HEATING, VENTILATION and AIR CONDITIONING CODE

SECTION 1. SCOPE OF HEATING, VENTILATION AND AIR CONDITIONING CODE.

Order 5800. Scope of Code.


The provisions of this code shall apply to all buildings used, or to be used, as places of employment or as public buildings, as defined by statutes.

Note. "Place of employment" is defined in Section 101.01 of the statutes as, "every place, whether indoors or out or underground and the premises appurtenant thereto where either temporary or permanently any industry, trade or business is carried on, or where any process or operation, directly or indirectly related to any industry, trade or business, is carried on, and where any person is directly or indirectly employed by another for direct or indirect gain or profit, but shall not include any place where persons are employed in private domestic service or agricultural pursuits which do not involve the use of mechanical power."

The term "public building" is defined as "any structure used in whole or in part as a place of resort, assembly, lodging, trade, traffic, occupancy, or use by the public, or by three or more tenants."

(a) New Buildings. The provisions of this code shall apply to the heating, ventilation and air conditioning of all new buildings.

(b) Existing Buildings. The provisions of this code shall apply to all alterations or improvements, including the replacement of any major apparatus or device, in existing buildings, other than existing places of industrial employment.

Note. See General Orders on Dusts, Fumes, Vapors and Gases for requirements pertaining to existing places of industrial employment.

(c) Change in Use. The provisions of this code shall apply to every building, or portion of a building, devoted to new use for which the requirements under this code are in any way more stringent than the requirements covering the previous use.

SECTION 2. DEFINITIONS

Order 5810. Definitions.

1. Air supply is the supply and appropriate distribution of the air required for heating, ventilating and air conditioning.

2. Ventilation is the production and maintenance of atmospheric condi-
in intimate contact with flowing combustion gases on one side and water on the other side.

16. The term heating surface applied to furnaces and jacketed stoves, shall be understood to mean and include only the total area of air supply surface exposed to combustion of fuel or in intimate contact with flowing combustion gases on one side and flowing air supply on the other side.

17. An occupied area is any room, area or enclosure, the normal use of which involves actual or intended occupancy by one or more persons.

18. The term new building used in this code shall be understood to mean and include buildings, additions thereto, and alterations thereof, for which complete plans have not been approved by the Industrial Commission or construction is not in progress, prior to the effective date of this code.

19. The term existing building used in this code shall be understood to mean and include buildings, additions thereto, and alterations thereof, structurally completed, or for which complete plans have been approved by the Industrial Commission, or its authorized local representative, and construction is in progress, prior to the effective date of this code.

SECTION 3. GENERAL REQUIREMENTS

Order 5820. Plans, Specifications and Data.

1. Design and Preparation of Plans.

All plans and data for heating, ventilation and air conditioning, shall be designed and prepared by competent designers.

2. Approval of Plans and Specifications.

Complete plans, specifications and data sheets for heating, ventilation and air conditioning of all buildings and occupancies within the scope of this code shall be submitted to the Industrial Commission for approval. Approval shall be obtained before affected work is commenced and all work shall be executed according to the approved plans and specifications.

Exception. In cities where such plans are examined, and building permits are issued, in a manner approved by the Industrial Commission, this requirement does not apply.

3. Plans and Specifications Required in Duplicate.

All plans and specifications for heating, ventilation and air conditioning shall be submitted in duplicate.

Note. Extra copies of plans may be filed for approval stamp but they should accompany the duplicate plans.

4. Approval of Changes in Plans.

If, after having been approved by the Industrial Commission, building or heating and ventilation, or air conditioning plans or specifications are changed in any respect covered by this, or any other, code, such revised plans shall be submitted to the Industrial Commission for approval.

5. Approved Plans Kept at Building.

A complete set of approved plans and specifications showing identity of approval shall be kept at the building at all times.

The lines, data and information shown on plans for heating, ventilation and air conditioning systems submitted for approval shall be permanent, clear, legible and complete, and shall include all details and data necessary for review of installation, such as:

(a) Building; name, type, location, on each sheet.
(b) Owner; name, on each sheet.
(c) Architect; name, on title sheet.
(d) Engineer or Designer; name, on each sheet.
(e) North points on general plans.
(f) General plans, including attic and roof layouts.
(g) General plan dimensions and height of all rooms.
(h) Intended use of all rooms.
(i) Thickness of walls and type of construction.
(j) Thickness and type of insulation in walls, roofs, ceilings, floors, etc.
(k) Vertical sections and elevations necessary to show profiles of installation.
(l) Size and continuity of all ducts and flues.
(m) Location and type of all principal units of equipment.
(n) Chimney size, shape and height above primary grate of heater.
(o) Specifications shall be properly identified with and completely supplement the plans.

7. Data Required.

All plans or specifications submitted for approval shall be accompanied by data sheets giving the heat loss calculations in B. t. u. per hour calculated in accordance with the heat transmission factors of the current issue of the American Society of Heating and Ventilating Engineers' Guide, the amount of radiation calculated for each room on a direct radiation installation, amount of air and delivery temperature calculated for each room for all heating, ventilation and air conditioning systems, amount of indirect radiation, and other data needed to judge the capacity and performance of an installation. There shall also be furnished a statement of sizes and ratings of boilers, furnaces and other heating, fans and all other equipment.

Note. Heat loss calculations may be based on the standards of the Heating, Piping and Air Conditioning Contractors National Association, or the Standard Code of the National Warm Air Heating and Air Conditioning Association. However, in all cases the total heat loss calculations shall be shown in B.t.u.

8. Fundamental Data Required.

Fundamental data pertaining to design and operation of equipment shall be filed for approval with the Industrial Commission by manufacturers before such equipment is installed or used.

Order 5821. Accident Prevention and Fire Protection.

1. Guards.

All mechanical apparatus shall be guarded in compliance with General Orders on Safety issued by the Industrial Commission.

Order 5822. Design.

1. Adequacy.

All heating, ventilation and air conditioning installations shall be designed and installed to provide the service and results required by this code.

2. Capacity and Arrangement.

The calculated capacity and the arrangement of all installations for required heating, ventilation and air conditioning shall be based upon simultaneous service to all parts of the building, unless otherwise provided for in this code.

3. Bas's for Heating Calculations.

In the accompanying map, the state has been divided into three zones of coldest weather temperatures recorded for included localities by the U.S. Weather Bureau during a ten year period. Maximum heat losses for a heating system shall be calculated on the basis of cold weather temperature not more than 10 degrees Fahrenheit warmer than the zone average of the zone in which the installation is located.

4. Provision for Cleanliness.

All parts of installations and equipment which house or handle air used for ventilation purposes shall be designed so as to facilitate sanitary maintenance thereof.

Order 5823. Air Supply.

1. Uncontaminated Source.

The outside air shall be taken from a relatively uncontaminated source outside of the building.

2. Maximum Inlet Temperature.

The calculated room inlet temperature of air used for heating and ventilation purposes shall not exceed 120 degrees Fahrenheit unless approved in writing by the Industrial Commission.
INDUSTRIAL COMMISSION OF WISCONSIN

MAP OF WISCONSIN SHOWING COLDEST TEMPERATURE ZONES

ZONE AVERAGE OF COLDEST TEMPERATURE RECORDED FOR EACH ZONE ARE AS FOLLOWS:

ZONE 1: 40° BELOW ZERO F.
ZONE 2: 36° BELOW ZERO F.
ZONE 3: 34° BELOW ZERO F.

HEATING, VENTILATION AND AIR CONDITIONING CODE

3. Control.

Adequate control of temperature and other conditions and effects of heating, ventilation, and air conditioning shall be provided and maintained and operated for all heating, ventilation and air conditioning systems.

Note. See order 5841 for requirements pertaining to the installation of automatic controls.

4. Air Quantity.

The quantity of air used to ventilate the given space during occupancy shall always be sufficient to maintain the standards of air temperature, air quality, air motion and air distribution as herein required. Not less than 10 cubic feet per minute per occupant of the total air circulated to meet these requirements shall be taken from an outdoor source. Systems employing thermal control to admit at least 75 per cent outside air for the purpose of temperature reduction may supply a minimum of 7.5 cubic feet per minute of outside air per occupant.


1. Heating Systems Required.

Adequate and appropriate heating systems shall be provided, maintained and operated for all occupied areas within the scope of this code. The following winter inside dry bulb temperatures shall be considered as a minimum.

<table>
<thead>
<tr>
<th>Type of Building</th>
<th>Dog. Fahr.</th>
<th>Type of Building</th>
<th>Dog. Fahr.</th>
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<tbody>
<tr>
<td>Class Rooms</td>
<td>70-72</td>
<td>Seating Space</td>
<td>68-72</td>
</tr>
<tr>
<td>Assembly Rooms</td>
<td>68-72</td>
<td>Lounges</td>
<td>68-72</td>
</tr>
<tr>
<td>Gymnasiums</td>
<td>65-69</td>
<td>Toilets</td>
<td>68</td>
</tr>
<tr>
<td>Toilet Rooms</td>
<td>65</td>
<td>Wardrobe and Locker Rooms</td>
<td>65-68</td>
</tr>
<tr>
<td>Playrooms</td>
<td>60-65</td>
<td>Bathrooms and Baths</td>
<td>70</td>
</tr>
<tr>
<td>Patios and Bath Rooms</td>
<td>70</td>
<td>Dining Rooms</td>
<td>70</td>
</tr>
<tr>
<td>Kitchens and Laundries</td>
<td>68</td>
<td>Kitchens and Lasadries</td>
<td>68</td>
</tr>
<tr>
<td>Playrooms</td>
<td>60-65</td>
<td>Ballrooms</td>
<td>65-68</td>
</tr>
<tr>
<td>Bathrooms</td>
<td>65-69</td>
<td>Toilets and Service Rooms</td>
<td>68</td>
</tr>
<tr>
<td>Apartments</td>
<td>70-72</td>
<td>Restaurants</td>
<td>65-68</td>
</tr>
<tr>
<td>Offices</td>
<td>65-72</td>
<td>Garages</td>
<td>65</td>
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<tr>
<td>Stores</td>
<td>65-68</td>
<td>Factories and Machine Shops</td>
<td>60-70</td>
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<tr>
<td>Private Rooms</td>
<td>70-72</td>
<td>Foundries and Boiler Shops</td>
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<td>Operating Rooms</td>
<td>70-76</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wards</td>
<td>68</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kitchens and Laundries</td>
<td>65-69</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Toilets</td>
<td>68</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bath Rooms</td>
<td>70-80</td>
<td></td>
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</table>

Note. The most comfortable dry bulb temperature to be maintained depends on the relative humidity and air motion. These three factors considered together constitute what is termed the effective temperature.
2. Ventilation Systems Required.

Ventilation systems shall be provided, maintained and operated to accomplish required ventilation service for all occupied areas within the scope of this code.

Note. For requirements pertaining to all places of employment or occupancy where smoke, gas, dust, fumes, steam, vapor, industrial poisons, or other detrimental materials, are used, stored, handled or are present in the air in sufficient quantities to obstruct the vision, or to be irritating, or to be injurious to the health, safety or welfare of the employees or frequenters, see the General Orders on Ducts, Fumes, Vapors and Gases issued by the Industrial Commission.


Gravity direct-indirect systems shall not be considered permissible for installation under this code.

Note. This clause is intended to prohibit the use of so-called direct-indirect radiators whereby the room air supply is supposed to be admitted directly from the outside to the base, and to be delivered at the top of direct radiators placed in the rooms to be served, without mechanical assistance.

4. Exhaust Systems Required.

Exhaust systems shall be provided, maintained and operated for all occupied areas where machines, vats, tanks, furnaces, forges, salamanders, and any other equipment and processes in such areas produce or throw off dust or particles sufficiently light to float in the air, or which emit heat, odors, fumes, spray, gas or smoke, in such quantities as to be irritating or injurious to the health.

See the General Orders on Ducts, Fumes, Vapors and Gases issued by the Industrial Commission for requirements covering these systems.

5. Exhaust Systems, Clean Discharge.

Exhaust systems shall include adequate dust collectors, air washers, or other machines, contrivances or methods, whereby the discharge from the systems will be prevented from contaminating the breathing zone inside the building, or becoming a nuisance or hazard either inside or outside the building.

See the General Orders on Ducts, Fumes, Vapors and Gases issued by the Industrial Commission.


Where ventilation is secured by exhaust methods the air which enters to replace that exhausted from the room shall be appropriately tempered.

Note. Taking air out of a room is only part of the service required. This code requires that air exhausted from a room shall be replaced with an adequate supply of air properly warmed or treated before it is admitted to the room served.

7. No Contamination of Adjacent Area.

All equipment and systems serving rooms which house sources of odors, fumes, noxious gases, smoke, steam, dust, spray, or other contamination, shall be such as to prevent spreading of any such contamination to any other occupied parts of the building.

8. Final Test Required.

The performance of every heating, ventilation and air conditioning system shall be tested and balanced in place for compliance with the requirements of this code before being turned over to the owner.

Order 5825. Maintenance and Operation.

1. Maintenance.

All heating, ventilation, exhaust and air conditioning systems shall be maintained in good working order and shall be kept clean and sanitary.

2. Operation.

All heating, ventilation and exhaust systems shall be operated in accordance with the requirements of this code during all periods of occupancy.

3. Instructions.

Contractors shall thoroughly instruct the operators of heating, ventilation and air conditioning systems before leaving the job and shall post in a conspicuous place, printed instructions for the efficient and practical operation of the system and equipment.

SECTION 4. GENERAL REQUIREMENTS FOR CLASSIFIED OCCUPANCIES AND AREAS

Order 5840. Occupancy Classification.

The various occupancies to which the provisions of this code apply shall be classified as follows:

A. Require ventilation on an occupancy basis.
B. Require ventilation on an occupancy basis unless otherwise exempted.
C. Require exhaust.
D. Require ventilation on the basis of floor area.
E. Require tempered air supply only.

Note. By "ventilation" is meant a combination of supply and exhaust. See "Definitions, order 4819.

The following table indicates the individual classifications of occupancies within the scope of this code, together with the method to be used in establishing the number of persons for which ventilation is to be provided.
3. Outside Air Supply.
   - The total supply of outside air shall be the larger of the following:
     - 60 cubic feet per minute per person
     - 15 cubic feet per minute per 100 square feet of occupied area

4. Air Movement.
   - All air inlets shall be so located, shaped, and arranged to prevent drafts and intakes of dusts, fumes, and gases.

5. Mechanical Installations.
   - The design, installation, and operation of ventilation systems shall be such as to provide adequate circulation of the air and to eliminate drafty conditions.

6. Air Conditioning.
   - Air conditioning systems shall be designed and installed to provide appropriate conditions for the occupancy.

7. General.
   - All provisions of the code shall apply to all occupancies.

A and B Classifications.
- The total supply of outside air in any space shall not be less than 15 cubic feet per minute per person.
Gravity installations are not permitted in areas, armories, laboratories, skating rinks and theatre auditoriums, lobbies and lounges.

7. Inlet and Outlet Locations.
The locations of all room inlets and outlets as well as the locations of the outside air supply are required to be definitely shown on all plans.

8. Temperature Control.
Automatic temperature control shall be provided for all arenas, armories, assembly halls, banquet halls, gymnasiums, laboratories, lecture halls, library reading and stack rooms, school auditoriums, class, lecture, project and study rooms, swimming pools, theatre auditoriums, lobbies and lounges and vocational instruction rooms.

Approved air cleansing devices shall be installed in connection with all mechanical heating and ventilation systems, except in garage occupancies. This requirement applies to both outside and recirculated air.

10. Recirculation.
No air contaminated by other than human occupancy shall be used for general recirculation.

Order 5842. Places of Assembly.

1. Scope.
This classification shall be understood to include all occupancies such as arenas, armories, assembly halls, banquet halls, billiard rooms, bowling alleys, cafeterias, club rooms (for gatherings), dance halls, dining rooms, gymnasiums, lecture halls, lounge halls, playrooms, restaurants, school auditoriums, skating rinks and theaters, where persons gather for entertainment, instruction or dining purposes.

The air movement, supply and distribution for all occupancies under this classification shall conform to the requirements of order 5841, except that for auditoriums, gymnasiums and similar occupancies having a ceiling height in excess of 20 feet, the air supply shall be based on 6 air changes per hour; and except further, that for theaters having a ceiling height in excess of 20 feet the total air supply shall be not less than 20 cubic feet per minute per occupant.

3. Stages.
The stage in any theatre or assembly hall, for which a fire curtain is required, shall be supplied with sufficient air to equalize the air pressure thereof so as to avoid deflecting the curtain.

4. Playrooms—Rural Schools.
Occupancies in this classification where used exclusively as pupils' playrooms need only be provided with a positive exhaust directly from the occupied area.

5. Alternate Service and Capacity.
Heating and ventilation systems installed in so-called community buildings may be arranged for selective delivery of the entire service to either the first floor areas or to the basement floor areas, if approved in writing by the Industrial Commission.

Order 5843. Motion Picture Booths.

1. Scope.
This classification shall be understood to include all motion picture booths other than portable booths.

2. Exhaust Ventilation.
Fumes, gases and other harmful contamination shall be effectively removed by mechanical exhaust ventilation from their source, including projectors, spotlights, stereopticons and similar equipment, and discharged to the outside air or to an approved disposal system. A single exhaust system, including the exhaust unit, and connecting ducts, shall be arranged to serve all the sources of harmful contamination in a booth or area, and there shall not be more than one exhaust system in such booth or area. The pressure in the ducts within 12 inches of the exhaust hood shall be not less than 2 inches of water, as measured by a U-tube or equivalent device.

3. Air Supply.
In every booth or room which is required to have mechanical exhaust ventilation, provision shall be made for a supply of fresh tempered air to replace the vitiated air exhausted. The supply of air to a booth or room shall be accomplished in one of, or by a combination of, the following methods:

(a) The ventilation system for the building may be arranged to supply air for the booth or room if the inlet opening is protected with an approved shutter having quick acting fusible links, or other approved heat release devices, which will automatically and quickly close the inlet opening simultaneously with the openings in the front of the booth.

(b) A separate supply system, such as a unit ventilator, if the equipment is arranged so that the air supply will be stopped automatically and simultaneously with the closing of the openings in the front of the booth.

(c) Gravity intake, from a source of outside air, arranged so that the air will be properly tempered before it reaches the booth or room.

(d) Where approved in writing by the Industrial Commission, the air may be taken through openings in the booth walls, from the auditorium or other space adjoining the booth.

Note: For relief outlets in addition to exhaust ventilation, see order 5145 of the Building Code issued by the Industrial Commission.
Order 5844. Places of Assembly for Worship.

1. Scope.

This classification shall be understood to mean and include auditoriums, social assembly rooms, Sunday school rooms, and similar areas which are contained in churches or houses of worship. It shall also include chapels used in connection with funeral homes, as well as those in parochial schools, convents and similar occupancies.


The air movement, supply and distribution for all occupancies under this classification shall conform to the requirements of order 5841, except that no ventilation will be required where the total window sash area is more than 10 per cent of the floor area and the total outdoor openings there through are more than 2 per cent of the floor area of the occupancy to be served, except that for funeral homes the required window opening shall be more than 5 per cent of the floor area. Where such ventilation is not required, the window area and outdoor openings shall preferably be all above grade. No window or outdoor opening below grade will be considered unless there is a clear space outside of the windows having a width of at least 1 1/2 times the distance below grade at the bottom of the window.

Note. By width is meant the horizontal distance measured at right angles to the plane of the window.

3. Alternate Service and Capacity.

Heating and ventilation systems installed in occupied areas of this class may be arranged for selective delivery of the entire service to either the auditorium floor area or to the basement floor area.

Order 5845. Schools.

1. Scope.

This classification shall be understood to include class, recitation, study, lecture and project rooms in all school and college buildings, and similar areas used for educational purposes, as well as all library reading rooms. (See also order 5342.)

2. Air Movement and Supply.

The air movement and supply for all occupancies under this classification shall conform to the requirements of order 5841. For corridors and halls used in conjunction with occupied areas of this class, the air supply shall not be less than 10 cubic feet per minute per linear foot of corridor or hall.

3. Alternate Service and Capacity.

The capacity of heating and ventilation systems installed in school buildings having not more than 2 class rooms, may be based upon service to class room floors only; provided that where basement apparatus is used, appropriate arrangement shall be made for alternate service to basement areas if used for occupancy.


1. Scope.

This classification shall be understood to include all places of employment not classified elsewhere in this code.


The air movement, supply and distribution for all occupied areas under this classification shall conform to the requirements of order 5841:

(A) Where the available floor space is less than 75 square feet per normal occupant; or

(B) Where heat, smoke, gas, dust, spray, fumes, vapor, steam, or other contamination would otherwise be present in the air in sufficient quantities to obstruct the vision, or to be irritating or injurious to the health, safety or welfare of employees and frequencies; or

(C) Where industrial poisons are to be used, stored, or handled, or would otherwise be present in the breathing zone.

3. Special Exhaust Systems Required.

Special exhaust systems shall be provided and operated at all sources of harmful contamination in occupied areas of this class as required by the General Orders on Dusts, Fumes, Vapors and Gases, issued by the Industrial Commission.

Order 5854. Dormitories and Wards.

1. Scope.

This classification shall be understood to include rooms in hospitals, asylums, dormitory buildings and similar occupancies, equipped with more than two beds.


The air movement, supply and distribution for all occupancies under this classification shall conform to the requirements of order 5841 unless the window sash area is more than 30 per cent of the floor area and the outdoor opening there through is more than 5 per cent of the floor area. Where an outside air supply is not required the window area and outdoor opening shall preferably be all above grade. No window or outdoor opening below grade will be considered unless there is a clear space outside of the windows having a width of at least 1 1/2 times the distance below grade at the bottom of the window.

Note. By width is meant the horizontal distance measured at right angles to the plane of the window.

1. Scope.
This classification shall be understood to mean and include areas of compulsory occupancy, corridors and stair halls, in penal institutions, asylums and places of detention.

The air movement, supply and distribution for all occupancies under this classification shall be accomplished by mechanical means and shall conform to the requirements of order 5841. In general, exhaust ventilation shall be through the corridors.

3. Overnight Lock-Ups.
Where cells are provided for not more than 6 occupants for purposes of overnight detention only, ventilation will be accepted without a tempered fresh air supply, providing the window sash area direct to the cells is equal to, or greater than, 10 per cent of the floor area.

SECTION 5. HEATING AND VENTILATION EQUIPMENT.

Order 5860. Outside Air Intakes.

1. Location.
All outside air intakes shall be located as far as possible from chimneys and vent outlets, but this distance shall in no case be less than 20 feet. Fresh air intakes for all gravity heating systems and all gravity ventilation systems shall be located on the side, or sides, of the building exposed to the prevailing winds.

2. Height Above Grade.
All outside air intakes shall be located not less than 2 feet above the outside grade and above roofs and similar areas.

3. Screens.
All outside air intakes shall be suitably screened.

All outside air intakes shall be suitably protected against weather and water.

5. Accessibility and Cleanliness.
All outside air intakes shall be made and maintained easily accessible for cleaning, and shall be kept clean and sanitary in use throughout the circuit to the heater.

Consult order 5860 for allowable velocities to be used in the design of outside air intakes.

Order 5861. Air Purification Apparatus.

1. General.
The construction, design and control of all air purification apparatus shall be such as to insure consistent maintenance and operation.

2. Air Washers.
Dirty water shall not be recirculated through sprays affecting air used for ventilation purposes, and not less than 20 per cent of air washer water used shall be renewed during each day of operation exclusive of make-up water; and the reservoir shall be emptied and thoroughly cleaned and refilled with fresh water after each week of operation.

Order 5862. Heaters.

1. Arrangement.
Where more than one heater is required, or provided, for service to the same piping or duct system, or group of systems, they shall be set in battery form and shall be cross connected so that any one may be used alone, or any combination of them may be used simultaneously.

Order 5863. Boilers.

1. General.
The construction, equipment, connections, etc., of all boilers installed hereunder shall comply in every way with the Boiler Code issued by the Industrial Commission.

2. Rating.
All low pressure heating boilers shall be of capacities as required by the American Society of Heating and Ventilating Engineers' Boiler Code, or the Net Load Recommendations for Heating Boilers as issued by the Heating, Piping and Air Conditioning Contractors' National Association.

Order 5864. Furnaces.

1. Fan-Furnace Installations.
Draw through fans, except auxiliary fans, are not permitted in connection with any fan-furnace installation.

2. Gravity Systems.
All furnaces shall be located so that the air supply circuits leading to and from them will be as short and direct as practicable. The outside air inlets to furnace air-ways shall be such as will insure distribution of air to relatively unheated portions of the furnace proper and throughout the furnace air-ways. The top of such inlets shall not be higher than 2 inches below the top of the grates.
Order 5865. Jacketed Stoves.

1. Where Permitted.

The installation of jacketed stoves or cabinet heaters shall be considered permissible for schools having no basement or sub-floor heater spaces; also for portable schools and for other areas having a gross floor area not greater than 1300 square feet, and for temporary installations elsewhere, provided written permission for the latter is granted by the Industrial Commission.

2. Location.

All jacketed stoves and heaters shall be located in that portion of the schoolroom most exposed to cold weather, usually the northwestern portion. They shall be set well clear of any obstruction which may prevent the free and rapid distribution and circulation of heat and air.

3. Shields.

The casings or shields of jacketed stoves or heaters shall be constructed so as to shield adjacent occupants from undue radiant heat. The clear air space between shield and stove shall average 6 inches and the shields themselves are to extend well above and below all heat radiation surfaces of stoves, but in no case more than 12 inches clear of the floor.

4. Outside Air Intake.

(a) Every jacketed stove or heater shall have an outside air intake. The outside wall opening shall be properly and adequately protected from the weather and screened. The intake duct shall be joined to the heater casing and air-way to prevent cold air from spreading over the floor, and to insure proper contact of the air with heater surfaces. Under-floor ducts are not permitted.

(b) The area of the outside air duct shall not be less than 0.25 square inches per square foot of floor area.

5. Vents.

(a) Vent outlets in rooms served by jacketed stoves and heaters shall be located at the floor line and not less than 6 feet from the heater casing.

(b) The area of auxiliary metal vent flues used in connection with smoke pipes shall not be less than 150 square inches.

(c) Where suitable and effective devices for mixing smoke and vented air are used, the smoke flue and outlet duct may be combined, provided that the free area of the vent duct shall not be less than 144 square inches.

Order 5866. Stack Heaters.

1. Minimum Grate Area.

The grate areas of stack heaters shall be not less than 30 square inches for each 1000 cubic feet per minute air supply required for the rooms served, but in no case less than 50 square inches.

2. Location in Flue.

Stack heaters shall be located so that the vertical center lines of heaters and flues will coincide, wherever possible.

3. Diaphragm Required.

Where a single stack heater serves two or more vent circuits, the circuits shall be kept separate up to a point not less than 4 feet above the stack heater, such as by a tight diaphragm.

4. Accessibility.

Stack heaters shall be arranged conveniently accessible from the furnace firing space.

Order 5867. Chimneys.

1. Height and Effective Area.

Chimneys and smoke flues shall be of ample effective area and height for the calculated maximum duty, and shall include sufficient additional height to compensate for:

(A) horizontal length of breeching or smoke pipe;

(B) extraneous resistance of heater, or economizer;

(C) smoke flue heat losses, where smoke flues are used for aspirating effect in vent flues;

(D) such further heights as may be necessary to extend above high point of building served and as much higher as may be necessary to attain free wind action at top.

Note. Recommended actual sizes and heights of chimneys for hand firing are listed in the following table. For rectangular chimney areas divide circular area by 0.80. In rectangular chimney the long side of cross section should not be greater than 1.6 times the short side.

<table>
<thead>
<tr>
<th>Size Dia.</th>
<th>Height, Feet</th>
<th>Bldg. Loss B.t.u. per Hr.</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>10</td>
<td>116,000</td>
</tr>
<tr>
<td>12</td>
<td>15</td>
<td>122,000</td>
</tr>
<tr>
<td>16</td>
<td>40</td>
<td>354,000</td>
</tr>
<tr>
<td>18</td>
<td>45</td>
<td>469,000</td>
</tr>
<tr>
<td>20</td>
<td>50</td>
<td>514,000</td>
</tr>
<tr>
<td>22</td>
<td>65</td>
<td>854,000</td>
</tr>
<tr>
<td>24</td>
<td>60</td>
<td>1,099,000</td>
</tr>
<tr>
<td>26</td>
<td>66</td>
<td>1,144,000</td>
</tr>
<tr>
<td>28</td>
<td>65</td>
<td>1,224,000</td>
</tr>
<tr>
<td>30</td>
<td>70</td>
<td>1,304,000</td>
</tr>
<tr>
<td>32</td>
<td>70</td>
<td>1,312,000</td>
</tr>
<tr>
<td>34</td>
<td>70</td>
<td>3,072,000</td>
</tr>
<tr>
<td>36</td>
<td>70</td>
<td>3,543,000</td>
</tr>
<tr>
<td>38</td>
<td>70</td>
<td>4,032,000</td>
</tr>
<tr>
<td>40</td>
<td>100</td>
<td>5,000,000</td>
</tr>
</tbody>
</table>

For direct fired warm air furnaces the chimney capacity above may be reduced 25 per cent.

Chimney heights are measured from primary grate level.

Chimney sizes for oil, stoker and gas firing, also for sizes other than listed shall be in accordance with accepted standards.

Breeching Details. Smoke pipes should preferably slope upward at least one inch per foot; and should be made of not less than 16 gauge metal full.
size of total smoke collar areas connected thereto, with 20 per cent excess area for smoke pipes or breeching more than 10 feet long.

Chimney Height Allowances for Breathing Resistance. To offset friction and draft losses in smoke pipes or breechings, the normal chimney heights should be increased one foot for each 5 feet length of horizontal smoke pipe in excess of 10 feet, and 6 feet of chimney height for each 90 degree turn, horizontal or vertical, in smoke pipe or breeching between heater smoke collar and the chimney, but not including the turn where smoke pipe enters the chimney. These figures are intended for smoke pipe 20 per cent larger than the required area of chimney. If the smoke pipe is made equal to the required area of chimney, the foregoing figures should be increased 20 per cent.

2. Smooth Inside.

Chimneys shall be constructed substantially, true and plumb, and shall be tight and smooth inside.

Note. See also order 6218 of the Building Code, issued by the Industrial Commission, for general construction requirements.


All smoke flues used for the purpose of aspirating effect in vent flues, shall be securely stayed and supported at the centers of the vent flues, shall be made tight at all joints and shall extend not less than 8 inches above the vent flue. Where such flues are 12 inches or less in diameter, they shall be made of substantial cast iron. Where such flues are more than 12 inches in diameter they may be constructed of steel plate not less than 14 gauge in thickness.


All chimneys and flues shall be provided with substantial and adequate clean-out doors and frames readily accessible, and tight when closed.

Order 5889. Fans and Blowers.

1. Type and Capacity.

All fans and blowers shall be of appropriate type and size and shall be selected on a basis of performance against the resistance of the system as installed. All fans shall be rated in accordance with the latest standard test requirements for fans and blowers as adopted by the American Society of Heating and Ventilating Engineers.

2. Quiet Operation.

Fans and blowers installed in buildings where noisy operation would be objectionable, shall be located and set, and shall be of such type and outlet velocity in practical use, that reasonably quiet operation is assured.

Note. This order will be understood to prohibit the use of unit heaters and other equipment with a similar degree of noise in occupied areas where such noise would be objectionable.


Exposed engines and similar motive power and apparatus, except electric motors in self-contained ventilating units, shall be kept out of

Order 5869. Ducts.

1. Design.

All ducts shall be designed to promote the unrestricted flow of air, with long sweep or turning vanes. In gravity systems all ducts shall be as direct as possible and heat ducts shall have a rise of not less than one inch per foot in the direction of flow.

2. Air Velocities.

For the purpose of calculation and design the velocities in any airways shall not in general exceed the following limits; except that for mechanical systems these velocities may be exceeded where properly designed in accordance with the best accepted engineering practice and satisfactory data submitted thereon.

<table>
<thead>
<tr>
<th>Part of System</th>
<th>Mechanical System</th>
<th>Gravity System</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Intake Opening</td>
<td>1000 F. P. M.</td>
<td>300 F. P. M.</td>
</tr>
<tr>
<td>2. Blast Flues (Steam)</td>
<td>1000 F. P. M.</td>
<td></td>
</tr>
<tr>
<td>(Net free area)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Trunk Ducts</td>
<td>1200 F. P. M.</td>
<td>300 F. P. M.</td>
</tr>
<tr>
<td>4. Branch Ducts</td>
<td>750 F. P. M.</td>
<td>250 F. P. M.</td>
</tr>
<tr>
<td>5. Vertical Inlet Flues</td>
<td>500 F. P. M.</td>
<td>150 F. P. M.</td>
</tr>
<tr>
<td>6. Vertical Vent Flues</td>
<td>500 F. P. M.</td>
<td>250 F. P. M.</td>
</tr>
<tr>
<td>7. Return Air Flues</td>
<td>800 F. P. M.</td>
<td></td>
</tr>
<tr>
<td>8. Roof Ventilators</td>
<td>500 F. P. M.</td>
<td>300 F. P. M.</td>
</tr>
<tr>
<td>9. Inlets and Outlets</td>
<td>300 F. P. M.</td>
<td></td>
</tr>
</tbody>
</table>

3. Use.

All ducts and air-ways shall be used only for the transmission of air, and shall not be designed or used for any other purpose.


Underground ducts shall not be considered permissible for conveying air supply, including return and outside air, unless they are constructed and equipped as follows:

- Thoroughly waterproof;
- Provided with ample free drainage to a lower room of the building so that no water may stand anywhere in the ducts;
- Without direct sewer connections.
shall be at least one gauge heavier than the main duct, and the drainage pitch of the branch duct is not less than one inch in 8 feet toward the main duct; and

providing with appropriate access for inspection and cleaning service.

5. Construction.

All ducts shall be substantially made, with locked seams, and shall be made and maintained smooth on the inside and shall be substantially air tight. Ducts or air-ways of wood or other combustible or rough material shall be tightly lined on the inside with sheet metal.

No ducts shall be lined with any material which will support combustion or which will present a rough surface to the flow of air.

Note. For construction and protection of hot air pipes, registers, and hot air and ventilating ducts, see the Building Code issued by the Industrial Commission.


The gauges and construction of sheet metal ducts and flues shall be appropriate for their specific use and location. They shall be securely stayed and supported to insure permanence.

The following table of U. S. standard sheet metal gauges shall be considered the minimum for the construction of ducts and flues.

<table>
<thead>
<tr>
<th>Round Ducts Diam. in Inches</th>
<th>Gauge</th>
<th>Rectangular Ducts Width in Inches</th>
<th>Gauge</th>
</tr>
</thead>
<tbody>
<tr>
<td>1–2</td>
<td>25</td>
<td>4–18</td>
<td>26</td>
</tr>
<tr>
<td>20–29</td>
<td>24</td>
<td>19–30</td>
<td>24</td>
</tr>
<tr>
<td>30–39</td>
<td>23</td>
<td>31–40</td>
<td>23</td>
</tr>
<tr>
<td>40–49</td>
<td>22</td>
<td>41–50</td>
<td>22</td>
</tr>
<tr>
<td>50 &amp; above</td>
<td>18</td>
<td>51 &amp; above</td>
<td>18</td>
</tr>
</tbody>
</table>

For lining purposes, not less than 28 gauge

All rectangular ducts having one dimension over 18 inches shall be constructed with standing seams, or angles, not more than 33 inches on centers and shall be cross broken diagonally to stiffen the sheets. When this construction cannot be obtained the sheet metal in the ducts or flues shall be at least one gauge heavier than specified in the table above.

All ducts with one dimension over 90 inches shall be reinforced with angles of proper sizes.

Plenum chambers and fan rig housings shall be constructed of not less than 20 gauge metal and shall be reinforced with standing seams or angles.

Ducts used in connection with kitchen ranges, etc., where greasy fumes are exhausted shall be constructed of not less than 20 gauge metal and shall be provided with a damper arranged to close automatically in case of fire.

7. Gravity Outlet Ducts.

Outlet ducts for gravity systems shall be so located or heated that the required or calculated air currents will be reasonably assured.

8. Insulation of Ducts.

Where heat supply ducts are so located or exposed so as to be subject to excessive or undesirable heat losses, they shall be covered with not less than ½ inch of suitable insulating material.


Vent ducts shall not be combined anywhere between room vent openings, and gathering chambers or outside atmosphere unless direct-connected to an exhaust fan. However, gravity vent ducts serving similar occupancy classifications may be combined immediately below the point of final delivery to the outside atmosphere, such as at the base of a roof ventilator.

Note. Wherever exhaust or vent ducts are installed leading to the outside atmosphere, provision should be made for condensation.

10. Termination of Outlet Ducts.

Outlet ducts used in conjunction with mechanical ventilation system inlets may terminate in air tight incineralzable gathering chambers, which may be the general attic space if the attic floor is fireproof and smoothly finished. Such ducts shall terminate in incineralzable 90 degree elbows with horizontal outlets at least one diameter in length, not less than 2 inches above the attic floor.


Horizontal runs in vent ducts of gravity ventilation systems shall be avoided wherever possible, and maximum practicable inclination shall be provided in all cases. Where horizontal runs are unavoidable they shall be not less than 20 per cent larger in free area than the required area of the connected vertical runs. In no case, however, shall the horizontal run exceed 30 per cent of the vertical run, unless connected to an exhaust fan.

12. Vent Ducts Above Roof.

Final delivery of all vent circuits shall be protected from weather, and shall be so located and constructed as to prevent contamination of air supply for or in any occupied area. Gravity vent ducts shall extend not less than 3 feet above the high portion of the roof or parapet wall, and shall be surmounted with an approved type of siphon hood.

Order 5870. Volume Dampers and Deflectors.

Necessary volume dampers, splitters and deflectors, shall be provided for all ducts to permit accurate balancing of the system, and such dampers, splitters and deflectors shall be properly set according to metered tests of the system, and shall then be securely locked in place or otherwise made reasonably meddleproof.
Order 5871. Inlets and Outlets.

1. Number and Arrangements.

The capacity, number and arrangement of inlets and outlets shall be such as to insure a uniform distribution of air throughout the areas served during all periods of occupancy.

2. Elevator Shafts and Stair Wells.

Elevator and stair shafts shall not be considered or used for ventilation purposes nor shall they be allowed to interfere with the effectiveness of installations hereunder.

Note. See also Elevator Code issued by the Industrial Commission.

3. Inlets and Outlets for Gravity Systems.

Gravity inlets and outlets shall be suitably arranged in room walls in such a manner as to use every possible natural advantage to provide proper and effective air movement and distribution.

Where foot warmers are installed in the main heat flue wall, they are to be provided with suitable dampers which shall not obstruct more than 2/3 of the free area of the heat flue when fully open.

4. Inlet Grilles or Diffusers Required.

All inlets, except outdoor openings, shall be equipped with suitable grilles or devices, which promote uniform distribution of air.


Where ventilation involves removal of heat or smoke, or relatively light gas or odor, upward ventilation shall be provided wherever practicable. Where normal upward ventilation is impracticable appropriate auxiliary outlets shall be provided in, at, or near the ceiling. Where removal of relatively heavy air, gas, or odor, or other substances is similarly involved, the outlets therefor shall be at or near the floor.

6. Corridor Ventilation.

Air from occupied areas uncontaminated by other than human occupancy may be discharged into corridors and the latter vented through auxiliary spaces such as built-in lockers, toilet rooms, etc. Provided, however, that where the vent capacity of such auxiliary spaces is insufficient, additional direct vent flues shall be installed.

In cases of multiple story buildings each floor shall be independently vented.

Where lockers are installed in recessed walls and used for vesting purposes, they shall have a net free inlet and outlet area each, not less than 15 square inches per linear foot of locker width.

Order 5872. Direct Radiation.

1. Radiators Recessed or Elevated.

Direct radiation installed in gymnasiums, playrooms, auditoriums and similar occupied areas shall be fully recessed and protected, or elevated not less than 7 feet above the floor. Radiators in passageways and corridors shall not project into the minimum width required by the Building Code.

2. Shields Required.

Direct radiators and other sources of radiant heat, installed within 2½ feet of fixed seats shall be provided with suitable insulated shields constructed and arranged to prevent convective air currents and at the same time protect the adjacent occupants from direct radiant heat. In general, such shields shall be not less than 3 inches above the floor nor more than 4 inches further from the floor than the bottom of the radiator.

Order 5873. Humidifiers.

1. Location.

Where humidifiers are used, they shall be so located and arranged that they will effectively treat all the air handled by the ventilation system, unless otherwise permitted by the Industrial Commission.

2. Capacity.

Humidifiers shall be calculated and maintained on the basis of not less than 30 per cent relative humidity, measured at 70 degrees Fahrenheit for total air supply, unless otherwise approved by the Industrial Commission.

3. Automatic Control.

Where humidity is supplied, proper automatic control must be provided.

Note. Where evaporating pans in a furnace are used, constant level float devices are acceptable for this purpose.

Order 5874. Piping.

1. Pipe Sizes and Arrangement.

All steam and hot water supply and return piping, air line piping and auxiliary equipment shall be of appropriate sizes, elevations and arrangements in accordance with standard engineering practice to accomplish the calculated services in practical operation, without undue noise, stress or other detriment. They shall be adequately shown on plans submitted for approval.

2. Expansion and Contraction.

Appropriate anchors, expansion swings or joints, supports and similar trade essentials shall be provided in every piping system.

3. Pipe Insulation.

Where steam and hot water supply, and return piping pass through occupied areas where their heat emission might be objectionable or where such piping is subjected to the danger of freezing, it shall be.
I. "I\'nUSL\'RIAI1\'\'M I\'ESSION OU WISCONSIN

properly covered with not less than one inch of suitable insulating material.

See the Building Code issued by the Industrial Commission for additional requirements.

Order 5875. Refrigerants.

1. Scope.

This order covers the use of refrigerants in heat transfer apparatus for temperature reduction or dehumidification as a function of air conditioning of occupied areas.

Note. For regulations covering refrigerating machinery, condensers, pressure tests, machinery room enclosures, etc., see the Refrigeration Code and the Building Code issued by the Industrial Commission.

2. Classification of Refrigerants.

Refrigerants used in connection with this code shall be classified as follows:

Class I. Non-toxic and non-inflammable refrigerants. Included in this list are:

- Water or Water Vapor
- Carbon Dioxide
- Dichlorodifluoromethane
- Dichlorotetrafluoroethane

Class II. Relatively non-toxic and non-inflammable refrigerants having a sufficiently high boiling point to prevent rapid evaporation in event of release. Included in this list are:

- Dichloroethylene
- Methylene Chloride
- Monofluorotrichloromethane
- Trichlorotrifluoroethane

Class III. Irritant and flammable refrigerants. Included in this list are:

- Ammonia
- Methyl Chloride
- Ethyl Chloride
- Methyl Bromide
- Ethyl Bromide


Only the refrigerants included in Class I may be used for cooling air by direct expansion or circulation in coils or extended surface cooling apparatus.

Refrigerants included in Classes I and II may be used for the purpose of cooling water to be circulated through air washers.

Refrigerants included in Classes I, II and III may be used for the purpose of cooling brine or water in a closed system where such brine or water is not circulated directly through the air to be conditioned.

4. Refrigerants Prohibited.

The following toxic and inflammable refrigerants shall not be used for air conditioning purposes:

- Butane
- Iso Butane
- Propane
- Ethane
- Ethyl Chloride
- Methyl Bromide
- Methyl Formate
- Sulphur Dioxide
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