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Code for design of heating, ventilation and air conditioning

采暖通风与空气调节设计规范

GBJ 19－87

Beijing 1995

Preface

This book is the English translation of *Code for Design of heating, ventilation and air conditioning* GBJ 19 - 87. It is the official translation of the original in Chinese for general use as examined and approved by the Department of Standards and Norms, Ministry of Construction of the People's Republic of China.

In the event of any inconsistency between the Chinese-language text of the Standard and the present English-language text of the Standard, the Chinese-language text shall be taken as ruling.

Department of Standards and Norms, Ministry of
Construction of the People's Republic of China

State Planning Commission, P.R.China

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Notice on Promulgation of the National Standard, the Code for Design of Heating, Ventilation and Air Conditioning

In accordance with the Notice, issue No. (81) 546, issued by the former State Capital Construction Commission, the Code for Design of Heating, Ventilation and Air Conditioning in Industrial Enterprises TJ 19 – 75 has been revised by China National Non-ferrous Metals Industry Corporation in cooperation with other departments concerned and has been reviewed and approved by the authorities concerned. The revised Code for Design of Heating, Ventilation and Air Conditioning GBJ 19 – 87 now is approved as the new National Standard, and will come into effect in August 1st 1988, while the Code for Design of Heating, Ventilation and Air Conditioning in Industrial Enterprises TJ 19 – 75 will be abolished.

State Planning Commission of the People's Republic of China
December 30th 1987

China National Non-ferrous Metals Industry Corporation

December 1987

Explanation of Revision

This is the code prepared by revising the former Code for Design of Heating, Ventilation and Air Conditioning in Industrial Enterprises TJ19 - 75 by Beijing Central Engineering & Research Institute for Non-ferrous Metallurgical Industries in cooperation with 17 relevant designing, scientific research institutes and colleges and universities under the leadership of China National Non-ferrous Metals Industry Corporation and in accordance with the Notice, issue No. (81) 546, issued by former State Capital Construction Commission of the People's Republic of China.

During the revision, the revision group has made wide and deep investigation and study, summarized domestic practical experiences, taken relevant scientific research results of recent years, looked up a lot of foreign and domestic data, used the contents of foreign technology of the same kind which meet the practical conditions in China, solicited for many times the opinions from relevant units all over China and Hong Kong, and particularly studied and discussed some important questions repeatedly, and finally hold the National Reviewing Meeting and passed the final version in the presence of various departments concerned.

The code consists of eight chapters and thirteen appendixes covering General, Indoor and Outdoor Design Conditions, Heating, Ventilation, Air Conditioning, Refrigeration, Automatic Control, Sound Attenuation and Vibration Isolation, etc.

During the execution of the code, all units should give their mind to summarizing experience and collecting information, and mail the opinions and relevant information, if found somewhere needed to be corrected and supplemented, to the Management Office for Heating, Ventilation and Air Conditioning Design Code, the Beijing Central Engineering & Research Institute for Non-ferrous Metallurgical Industries (12 – Fuxing Avenue, Beijing) as reference for revising it in the future.

Main Symbols

A — Sound level; side length of rectangular air outlet

a — Factor for correction of temperature difference of envelope; turbulent coefficient

B — Distance; side length of rectangular air outlet

b — Index; factor; coefficient

C — Breezelessness; the ratio of effective thermal pressure difference to effective wind pressure difference; factor; coefficient

C_f — Wind pressure coefficient

CL — Hourly cooling load

C_p — Specific heat capacity at constant pressure of air

C_r — Thermal pressure coefficient

D — Thermal inertial index of building envelope; diameter

d_g — Width of working place

d — Humidity ratio

d_o — Diameter of air outlet

d_s — Width of air stream to the working place

E — East; east wind

F, f — Area

F_o — Effective cross section area of air outlet

F_j — Area of air intake

F_p — Area of exhaust outlet

G — Ventilation rate

G_j — Air intake rate

G_p — Air exhaust rate

g — Acceleration of gravity

H — Height; level

h — Height; elevation of center line for calculated door or window; height difference

h_j — Height difference between center of air intake and neutral level

h_p — Height difference between center of exhaust outlet and neutral level

h_z — Elevation of neutral level

I — Enthalpy

J — Total hourly solar irradiance

J_p — Mean daily value of total solar irradiance

K — Heat transfer coefficient; safety factor

L — Air volume; air flow rate

l — Calculated length of gaps of door or window

m — Effective factor of heat release; overall correction factor of cold air infiltration

m_1, m_2, m_3 — Coefficient

N — North; north wind

n — Number of storeys of building; orientation correction factor for cold air infiltration

P — Power of motor

P_z — Motor shaft power

$\triangle P$ — Total pressure drop of the system

$\triangle P_{min}$ — Pressure drop with control valve fully open

Q — Heat release; sensible heat; heat loss

Q_f — Radiation heat release

R_o — Heat transfer resistance of building envelope

$R_{o.min}$ — Minimum heat transfer resistance of building envelope

R_j — Thermal resistance of building envelope

R_n — Inner surface heat-transfer resistance of building envelope

R_w — External surface heat transfer resistance of building envelope

S — Pressure drop ratio; South; South wind

s — Net distance; Distance

t_o — Outlet air temperature of air outlet

t_d — Temperature under roof

t_g — Temperature of working place

t_l — Dew – point temperature

t_{lp} — Mean temperature of normal coldest month

t_{ls} — Mean design temperature of adjacent room

t_{max} — Normal extreme maximum temperature

t_n, t_n' — Indoor design temperature and shaft design temperature separately

t_{np} — Indoor mean temperature

t_p — Exhaust air temperature

$t_{p.min}$ — Mean temperature of normal coldest day

t_{rp} — Mean temperature of normal hottest month

t_{sh} — Outdoor design hourly temperature for air conditioning in summer

$t_{s.max}$ — Wet – bulb temperature corresponding to normal extreme maximum temperature and mean relative humidity of hottest month

$t_{s.rp}$— Wet－bulb temperature corresponding to mean temperature and mean relative humidity of normal hottest month

t_w— Outdoor design temperature of the calculated envelope

t_{wf}— Outdoor design temperatutre for summer ventilation

t_{wg}— Outdoor design dry－bulb temperature for summer air conditioning

t_{wk}— Outdoor design temperature for winter air conditioning

t_{wl}— Hourly design cooling load temperature

t_{wn}— Outdoor design temperature for heating

t_{wp}— Outdoor design mean daily temperature for summer air conditioning

t_{ws}— Outdoor design wet－bulb temperature for summer air conditioning

t_{zp}— Outdoor design average daily sol－air temperature for summer air conditioning

t_{zs}— Outdoor design hourly sol－air temperature for air conditioning in summer

$\triangle t_H$— Temperature gradient

$\triangle t_{ls}$— Difference between mean design temperature of adjacent room and outdoor design mean daily temperature for summer air conditioning

$\triangle t_r$— Mean outdoor design temperature daily range of summer

$\triangle t_y$— Allowed temperature difference between indoor design temperature and inner surface temperature of building envelope

V_o— Mean outdoor wind speed in winter; outlet air velocity

V_g— Mean air velocity in working place

W — West; west wind

Z — Distance

α — Coefficient; factor

α_n— The inner surface heat conductance of building envelope

α_w— External surface heat conductance of building envelope

β — Hourly variation coefficient of outdoor temperature

ζ_j— Local resistance coefficient of air inlet

ζ_p— Local resistance coefficient of air outlet

ρ — Absorptance for solar radiation of envelope external surface

ρ_{np}— Average density of indoor air

ρ_p— Air density under exhaust air temperature

ρ_{wf}— Air density under outdoor design temperature for ventilation

ρ_{wn}— Air density under outdoor design temperature for heating

Contents

1 General

1.0.1 This code is prepared to show the spirit of building up our country through arduous struggle, diligence and frugality, and pursue the current general and relevant policies of the country in the design of heating, ventilation and air conditioning in order to provide necessary conditions for safe production, improvement of living and working conditions, saving energy, protection of environment, ensuring product quality and increasing productivity.

1.0.2 The code is applied to the design of heating, ventilation, air conditioning and refrigeration used for civil buildings, plant buildings and auxiliary buildings of industrial enterprises in the newly – built, expansion and modification projects.

The code is not applied to the design of underground structures, buildings with special application, special cleaning and protection requirements and the temporary buildings.

1.0.3 The concept design of heating, ventilation and air conditioning and its refrigeration shall be determined through technical and economical comparisons and coordination with other specialities based on the application of building, process and usage requirements, outdoor meteorological conditions and power source conditions.

1.0.4 The equipment, components and materials in good quality used for heating, ventilation, air conditioning and refrigeration systems shall be selected in accordance with the existing production capacity and material supply availability of the country and construction regions. The local materials shall be used as much as possible.

The equipment used for the same project should be in same series, model and size.

1.0.5 In preparing the design documents, necessary specialized, operation and maintenance personnel as well as the relevant repairing and maintenance equipment, testing and measuring instrument shall be provided in accordance with quantity and complication of heating, ventilation, air conditioning and refrigerating facilities.

1.0.6 The necessary regulating, detecting and metering facilities for heating, ventilation, air conditioning and refrigerating systems shall be installed in the places convenient for operation and observation.

1.0.7 The necessary spaces shall be reserved for installation, operation and maintenance when arranging the equipment, pipelines and fittings. For the large – sized equipment and pipelines, the provided openings for installation and maintenance shall be given as required in the structure design, and the possibility of installation of lifting facilities shall be considered.

1.0.8 Necessary safety and protection measures shall be taken in the design if the equipment and pipeline for heating, ventilation, air conditioning and refrigeration may be dangerous for human body.

1.0.9 For the project in the earthquake area and in the collapsible loess area, necessary anti-seismic and draining measures shall be taken respectively as required in making arrangement for equipment and pipelines.

1.0.10 When the design for heating, ventilation, air conditioning and refrigeration is made based on this code, the prevailing relevant requirements in the national standards and codes shall be satisfied.

2 Indoor and outdoor air design conditions

2.1 Indoor air design conditions

2.1.1 In the design of central heating, the indoor design temperature in winter shall be determined in accordance with the following regulations and based on the usage of a building:

2.1.1.1 Main rooms in a civil building may be at the temperature of 16~20℃;

2.1.1.2 Work places in a plant building:

Light work	not lower than 15℃
Middle work	not lower than 12℃
Heavy work	not lower than 10℃

Note: a. For work classification, Sanitary Standard for Design of Industrial Enterprise in force shall be followed.

b. If each worker has larger area (50~100m^2), the temperature for light work may be as low as 10℃, for middle work as low as 7℃ and for heavy work as low as 5℃.

2.1.1.3 The temperature for auxiliary buildings and rooms shall not be lower than the following values:

Bath room	25℃
Changing room	23℃
Nursery, kindergarten and clinic	20℃
Office	16~18℃
Dining hall	14℃
Washing room and toilet	12℃

Note: The indoor temperature for various buildings may refer to relevant standards and regulations provide that a process or application conditions has special requirements.

2.1.2 The mean air velocity for occupied area or work area in a central heating building shall be consistent with the followings:

2.1.2.1 The air velocity for a civil building and an industrial auxiliary building should not be over 0.3m/s.

2.1.1.2 The air velocity for the area in a plant building should not be more than 0.3m/s if its indoor heat release is lower than 23W/m^3[20kcal/(m^3·h)] and it should not be over 0.5m/s if its indoor heat release is over or equal to 23W/m^3.

2.1.3 The indoor design conditions for winter air conditioning should be consistent with the following regulations:

2.1.3.1 Indoor design conditions for comfort air conditioning:

Temperature	18~22℃
Relative humidity	40%~60%
Air velocity	not more than 0.2m/s

Note: There may be no limitation for indoor relative humidity if no special requirements for usage conditions.

2.1.3.2 Indoor references and their allowed fluctuation of air temperature and relative humidity for industrial air conditioning shall be determined in accordance with the process requirements and the air velocity at work area should not be more than 0.3m/s.

Note: The conditions for installing air conditioning shall be in conformity with 5.1.1 in this code.

2.1.4 If no special requirements for industrial process, the temperature at work place of a plant building in summer shall be determined based on outdoor design temperature for summer ventilation and the allowed temperature difference between the temperature of outdoor and that of work place as given in Table 2.1.4.

Table 2.1.4 Spot temperature in summer (℃)

Outdoor design temperature for summer ventilation	≤22	23	24	25	26	27	28	29~32	≥33
Allowed temperature difference	10	9	8	7	6	5	4	3	2
Temperature at work place	≤32	32						32~35	35

Note: The allowed temperature difference may be 1~2℃ more if it can not meet the requirements in the above table due to the limitation of conditions after ventilation and cooling measures have been taken.

2.1.5 For a plant building with local relief, its allowed air velocity at indoor work place shall be determined in accordance with the relative requirements in 4.3.5 and 4.3.7 of this code.

2.1.6 The indoor design conditions for summer air conditioning shall be consistent with the following requirements:

2.1.6.1 Indoor design conditions for comfort air conditioning:

Temperature	24~28℃
Relative humidity	40%~65%
Air velocity	not more than 0.3m/s

2.1.6.2 Indoor references and their allowed fluctuation of temperature and relative humidity for industrial air conditioning shall be determined according to the demands of process with consideration of necessary hygiene conditions; the air velocity at work area should be 0.2~0.5m/s and it may be more than 0.5m/s if indoor temperature is over 30℃.

Note: The conditions for providing the air conditioning shall be in conformity with 5.1.1 herein.

2.2 Outdoor air design conditions

2.2.1 The outdoor design temperature for heating shall be determined by successive year mean daily temperature of five days of failure caused by outside temperature.

Note: "Days of failure" herein refers to the outdoor air temperature, and "the successive year mean days (hours) of failure" refers to the successive year mean value of the normal total days (hours) of failure.

2.2.2 The outdoor design temperature for winter ventilation shall be determined by the mean temperature of the normal coldest month.

2.2.3 The outdoor design temperature for summer ventilation shall be determined by the monthly mean temperature at 14 o'clock of the successive year hottest month.

2.2.4 The outdoor design relative humidity for summer ventilation shall be determined by the monthly mean relative humidity at 14 o'clock of the successive year hottest month.

2.2.5 The outdoor design temperature of winter air conditioning shall be determined by the successive year mean daily temperature of one day of failure caused by outside temperature.

2.2.6 The outdoor design relative humidity of winter air conditioning shall be determined by the mean relative humidity of normal coldest month.

2.2.7 The outdoor design dry-bulb temperature of summer air conditioning shall be determined by the successive year mean dry-bulb temperature of 50h of failure caused by outside temperature.

Note: In determining dry-bulb temperature, fixed time temperature record by local weather station four times a day may be adopted and a calculation should be carried out based on the temperature representing 6h of each record.

2.2.8 The outdoor design wet-bulb temperature of summer air conditioning shall be determined by the successive year mean wet-bulb temperature of 50h of failure.

2.2.9 The outdoor design mean daily temperature of summer air conditioning shall be determined by the successive year mean daily temperature of five days of failure caused by outside temperature.

2.2.10 The hourly outdoor design temperature for summer air conditioning should be determined using the following formula:

$$t_{sh} = t_{wp} + \beta \Delta t_r \qquad (2.2.10-1)$$

Where t_{sh}— Outdoor design hourly temperature (℃);

t_{wp}— Outdoor design mean daily temperature for summer air conditioning (℃) shall be determined in accordance with 2.2.9 herein.

β — Hourly variation coefficient of outdoor temperature should be determined in accordance with Table 2.2.10 herein.

Δt_r—Mean outdoor design temperature daily range of summer should be calculated using the following formula:

$$\Delta t_r = \frac{t_{wg} - t_{wp}}{0.52} \qquad (2.2.10-2)$$

Where t_{wg}— Outdoor design dry - bulb temperature for summer air conditioning (℃) should be determined in accordance with 2.2.7 herein;

Other symbols are the same as those in formula 2.2.10 - 1.

2.2.11 Another outdoor design temperature for air conditioning shall be determined when indoor temperature and humidity must be ensured for the whole year.

The air conditioning system working only some time a day may not follow 2.2.7 and 2.2.10 of this code.

Table 2.2.10 Hourly variation coefficient of outdoor temperature

Time	1	2	3	4	5	6
β	-0.35	-0.38	-0.42	-0.45	-0.47	-0.41
Time	7	8	9	10	11	12
β	-0.28	-0.12	0.03	0.16	0.29	0.40
Time	13	14	15	16	17	18
β	0.48	0.52	0.51	0.43	0.39	0.28
Time	19	20	21	22	23	24
β	0.14	0.00	-0.10	-0.17	-0.23	-0.26

2.2.12 The mean value of mean monthly wind speed of normal coldest 3 - month period shall be adopted as outdoor design mean wind speed for winter. The mean value of mean monthly wind speed for the dominant wind direction of normal coldest 3 -

month period (except breezelessness) shall be adopted as outdoor mean wind speed of dominant wind direction for winter.

The mean value of mean monthly wind speed of normal hottest 3 – month period shall be adopted as outdoor mean wind speed of summer.

2.2.13 The dominant wind direction and its mean frequency of normal coldest 3 – month period shall be adopted as the dominant wind direction and frequency of winter.

The dominant wind direction and its mean frequency of normal hottest 3 – month period shall be adopted as the dominant wind direction and frequency of summer.

The normal dominant wind direction and its mean frequency shall be adopted as normal dominant wind direction and frequency.

2.2.14 The mean value of mean monthly atmospheric pressure for normal coldest 3 – month period shall be used as outdoor atmospheric pressure of winter.

The mean value of mean monthly atmospheric pressure of normal hottest 3 – month period shall be employed as outdoor atmospheric pressure of summer.

2.2.15 The mean value of mean monthly percentage of possible sunshine of normal coldest 3 – month period shall be employed as winter percentage of possible sunshine.

2.2.16 The design days of heating period shall be determined based on days whose normal mean daily temperature is stably lower than or equal to the outdoor critical air temperature for heating.

5℃ **may be** adopted as the outdoor critical air temperature for heating for ordinary civil buildings and plant buildings as well as auxiliary buildings.

Note: "Normal mean daily temperature is stably lower or equal to outdoor critical air temperature for heating" means outdoor overlapping average temperature for five continuous days lower than or equal to outdoor critical temperature for heating.

2.2.17 The years for calculating outdoor design conditions should be from 1951 through 1980, thirty years, and in total for shorter than thirty years but not less than ten years, the real years should be adopted, if shorter than ten year number, the climatic data shall be revised.

2.2.18 Outdoor climatic conditions of mountain areas shall be determined in accordance with investigation and measurement in situ and the comparison with the climatic data of the weather station nearby which has the similar geographical and climatic conditions.

2.2.19 Outdoor climatic conditions of some main cities shall be determined in accordance with Appendix 2 herein.

For those cities and weather stations not listed in Appendix 2 herein, their conditions shall be determined according to the requirement in this clause. Various outdoor design temperatures for winter and summer should be determined by the simplified statistic method in Appendix 3 herein.

2.3 Solar irradiance in summer

2.3.1 Solar irradiance in summer shall be determined by the solar declination on July 21st in accordance with local geographic latitude, atmospheric transparency and atmospheric pressure.

2.3.2 Solar global irradiance on vertical and horizontal surfaces in various orientations for buildings may be taken from Appendix 4 herein.

2.3.3 Solar direct irradiance and sky irradiance through standard window glass on vertical and horizontal surfaces of buildings facing various orientations for buildings may be adopted from Appendix 5 herein.

2.3.4 While Appendices 4 and 5 are adopted, the local atmospheric transparency grades shall be taken from Table 2.3.4 in accordance with Appendix 6 herein and the atmospheric pressure in summer.

Table 2.3.4 Atmospheric transparency grades

Nominal transparency Grade in Appendix 6	Transparency grades under following atmos. press. (hPa) (mbar)							
	650	700	750	800	850	900	950	1000
1	1	1	1	1	1	1	1	1
2	1	1	1	1	1	2	2	2
3	1	2	2	2	2	3	3	3
4	2	2	3	3	3	4	4	4
5	3	3	4	4	4	4	5	5
6	4	4	4	5	5	5	6	6