The China Sustainable Energy Program

Promotion Project for the Implementation of the Standards for Building energy efficiency in Hot Summer and Warm Winter Zone in Shenzhen

THE CHINA SUSTAINABLE ENERGY PROGRAM

Toward a Sustainable Energy Future for the People's Republic of China

中国可持续能源项目

—迈向中国可持续能源的未来

The David and Lucile Packard Foundation

in partnership with The Energy Foundation

大卫与露西·派克德基金会
能源基金会
合盟

Achievement Summary of Pilot City for Building Energy Efficiency in Shenzhen

Name of Organization: Shenzhen Constrution Bureau

Shenzhen Institute of Building Research (SIBR)

License Number of the Project: G-0405-07386

Time Period of the Project: 08/01/2004 -07/31/2005

General Contents

First Part

General Report of First-stage of Project for the Implementation of the Standards for Buildings energy efficiency in Hot Summer and Warm Winter Zone in Shenzhen

I. Background Information

This project carried out eight parts of the work to promote the implementation of the Standards for Buildings Energy Efficiency in Hot Summer and Warm Winter Zone in Shenzhen. The first part: set up inspecting systems for buildings energy efficiency, including construction drawing design and final inspection; the second part: set up the implementing plan for buildings energy efficiency in Shenzhen; the third part: complete the management organization for buildings energy efficiency in Shenzhen and establish *Wall Material Retrofit and Buildings Energy Efficiency Joint Conference System in Shenzhen* Set up a long-term operating office for the Joint Conference System； the fourth part: build energy efficiency standards and Relative technical measures in Shenzhen; the fifth part: carry out training and public propagandism for buildings energy efficiency; the sixth part: build the demonstrating constructions for buildings energy efficiency and develop it into demonstrating project for energy efficiency of Ministry of Construction. The seventh part： start up the legislation for buildings energy efficiency in Shenzhen; the eighth part： release *Temporary Provision of Energy Efficiency Management for Operation and Maintenance of Air-conditioning System*. The last two items are added work.

II. Results up to the Present

▼ Project 1： Set up Inspecting System for Buildings Energy Efficiency Design in Shenzhen

Subproject 1：Establish Specialized Inspecting System for Shenzhen Buildings Energy Efficiency Design in Construction Drawing

1、Shenzhen government has released *Notification for Fully Developing the Inspection Systems for Shenzhen Buildings Energy Efficiency Design in Construction Drawing* in 2004 (Shenzhen Municipal Planning & Land Resources Bureau : File No. 31 (2004)). It is stated that from February 1st, 2004, Shenzhen will fully carry out the inspections for construction drawing design. The file in the inspection part clearly point out that it is necessary to inspect the forced standards & codes for fire protection, energy efficiency, environmental protection, seismic resistance, sanitation, etc. and for the projects applying for establishing buildings design in Shenzhen, it have to pass the inspection for construction drawing design before applying for *Buildings Planning Permission*.

2、Shenzhen Construction Bureau and Shenzhen Planning Bureau released a joint document *Notification for Fully Carrying out the Special Inspection for Shenzhen Residential Buildings Energy Efficiency Design* (Shenzhen Institute of Buildings Research No. 20 (2005)) in May 27th, 2005 and carried out the special inspection for buildings energy efficiency for one month. They comprehensively inspected the performance of the buildings design companies and construction drawing inspection systems for the forced items in buildings energy efficiency standards during the design and inspection process.

3、Presently Shenzhen Planning Bureau has compiled *Technical Standards for Construction Drawing Design Inspection of House buildings and municipal fundamental facilities* and the standards has brought the buildings energy efficiency into inspection area.

Subproject 2: Establish the Inspection Policy for the Construction of Energy Efficiency Buildings in Shenzhen

1、In November 11th ,2004, Shenzhen Construction Engineering Quality Supervision Headquarter put out *Temporary Method for buildings energy efficiency Inspection* (in 51th document of Shenzhen Construction Engineering Quality Supervision Headquarter), it regulate that inspecting the project item according to the national documents of buildings energy efficiency and national standard 、industry standard 、district standard and some related compulsion document in the process of inspecting construction drawing ,step of construction and final inspection .

2、In 2005, according to the practice situation of first period project item of ZhenYe city that is the demonstration in buildings energy efficiency of Ministry of Construction, the Bureau of Construction organized Shenzhen Construction Engineering Quality Supervision Headquarter and some of the construction units , supervise units , measurement units to set down *The implement method of first stage project item of ZhenYe city that is the demonstration in building energy efficiency*, and they also try to grope for the buildings energy efficiency implement way in construction ,supervising , final inspection and measurement during the implement of demonstration project in buildings energy efficiency ,all of these method are suitable for Shenzhen .

Subproject 3: Establish the Final Inspection and Documentation Policy for Energy Efficiency Buildings in Shenzhen

1. At present , the accomplishment of energy efficiency buildings in Shenzhen is rare , the checking and accepting work to the final inspection of energy efficiency buildings is spread by the demonstration project in buildings energy efficiency , Shenzhen Construction Engineering Quality Supervision Headquarter mostly checking and accepting at the final of construction according to *The implement method of first stage project item of ZhenYe city that is the demonstration in building energy efficiency* ,they accumulate the experience in practice and provide the experience of final inspection and document policy for energy efficiency buildings in Shenzhen .

2. Founded on the *Reply Letter of Shenzhen Finance Bureau about the Incomes and Expenses Plan of Wall Reform Fund in 2005* and the already approved the *Quality Control and Final Inspection rules of Energy Efficiency Construction Project*, this project aims to enactment control points of quality detection through experiment research, to insure the projects are inline with Energy Efficiency standards.

▼ Project Ⅱ: Set up Implementing Plan for Shenzhen Buildings Energy Efficiency Project

In May 17th ,2005, the Shenzhen Construction Bureau put out " *Notification about compiling 'the specialties programming for buildings energy efficiency in Shenzhen*" (the 18th documents ,2005,Shenzhen institute of buildings research) , and establish the leading group .At present ,the plan is been compiled now , and the first draft is finished , we plan to finish it in the end of the year.

In July 29th ,2005, the Shenzhen trade industry is associate with the Shenzhen Real Estate Bureau, the Shenzhen Construction Bureau to put out *Notification for releasing 'Temporary Provision of Energy Efficiency Management for Operation and Maintenance of Air-conditioning System'* (Bureau of Trade and Industry of Shenzhen Municipality No.36 ,2005), regulate the maintenance and management of center air-conditioning in energy efficiency and safety way.

▼ Project Ⅲ: Establishment, coordination and integration of the bureau that in charge of wall material retrofit and buildings energy efficiency

1、 In June,2005, Shenzhen wall material retrofit office submit instruction to senior leading office about changing the name "Shenzhen wall material retrofit office" into "Shenzhen wall material retrofit and buildings energy efficiency office" and increasing authorization

2.At present, according to the requirement of the work, Shenzhen Construction Bureau is providing filings to Shenzhen Authorized office to apply setting up a special institution namely Wall Materials Innovation & buildings energy efficiency office, which will manage all the affairs about buildings energy efficiency in Shenzhen.

▼ Project Ⅳ: Relative Standards and Technical Measures

Subproject 1: Compile Detail Rules for Implementation of Shenzhen Residential Buildings Energy Efficiency Design Code

1 The first meeting for Setting up the *Detail Rules for Implementation of Shenzhen Residential Buildings Energy Efficiency Design Code* was held at 2005 26th Jun. During this meeting the leading group, chief editors and assistant editors were selected and the general engineer of construction bureau was selected as president of the leading group.

2. In 2005 10th Aug., the first draft of *Detail Rules for Implementation of Shenzhen Residential Buildings Energy Efficiency Design Code* was finished and revising suggestions were also collected and discussed.

3. At present, *Detail Rules for Implementation of Shenzhen Residential Buildings Energy Efficiency Design Code* are still revising. Its edition for approving will be finished in Aug and put forward in middle ten days of Sept.

Subproject 2： Compile *Shenzhen Residential Buildings Energy Efficiency standard Picture Collections*

1. After comprehensive investigations about buildings exterior insulation systems, very extensive information was collected, and then the construction method about common nodes were gained.
2. Studies on wind pressure were carried through about exterior insulation systems.
3. Studies on thermal performance were carried through about exterior insulation systems.

4. Studies on economy and feasibility were carried through about exterior insulation systems.
5. Established demonstrative project of exterior insulation systems.
6. Collected comprehensive suggestions.
7. On August 24, 2005, these Picture collections were approved by expert panel.
8. At present, these picture collections are being revised after the evaluation of expert panel.

Subproject 3: Develop the Software for Energy Efficiency Design of Residential Buildings in Shenzhen

1 The mathematical model of ACDLP-1 software was set up and also finished compile the software.
2 Finished verification and consummate of ACDLP-1 software.
3 Presently the software is in the stage of review.

Subproject 4: Research of Testing Methods and Technologies of Fenestration Shading Coefficient in Residential Buildings

1 Four times of approval meetings were organized and finished compiling the Testing Methods and Technologies of Fenestration Shading Coefficient.
2 Finished collecting and design of shading devises
3 Finished construction of shading device testing software, and carry out testing and analysis.

Subproject 5: R&D of Shenzhen Residential Buildings Energy Efficiency Key Technology

Shenzhen Construction Bureau issued *The Notification of work arrangement of researching the shading devise testing cabin and the compiling buildings exterior shading device details of Shenzhen* (Shenzhen Institute of Buildings Research, No. 30, (2005)), and arranged the research work and the compile of details.

▼ ProjectⅤ: Training Technicians and Propagandizing Buildings Energy Efficiency

1. Compiled two volumes of training material, Propagandizing Material of *Design Code for Energy Efficiency in Shenzhen* and the Technique Training Material of *Energy Efficiency technology in Shenzhen*.
2. 21times of training of buildings energy efficiency, organized or lectured by SIBR, were finished,

and up to 2500 people attend those trainings. 1741people attended 13 of those trainings that we could offer the attendee′s list and anther 8 trainings without attendee′s list which up to 820 people attended these trainings.

The timetable and participants are shown in following table:

The Energy Efficiency Training Table

NO.	NAME of THE TRIANING	ORGNAZITION	TIME	PLACE	NUMBER of THE ATTENDEE	LECTURER
1	first stage of training	Shenzhen Institute of Buildings Research(SIBR),Shenzhen estate association	2004.9.26	The 5th floor of DESIGN BUILDING	55	Liu Junyue BO Zengwen Ma Xiaowen
	second stage of training	idem	2004.10.18	idem	74	idem
2	The Lecture of Buildings Design and Research Institute of Shenzhen	Buildings Design and Research Institute of Shenzhen	2005.4.26	Shenzhen	91	Ye Qing
3	The Training of Buildings Energy Efficiency at Dongwan	The Construction Bureau of Guangdong	2005.7.5	Dongwan	201	Ye Qing Ma Xiaowen
4	The Training of Buildings Energy Efficiency at Zhaoqing	The Construction Bureau of Guangdong	2005.7.7	Zhaoqing	126	BO Zengwen
5	The Training of Buildings Energy Efficiency at Maoming	The Construction Bureau of Guangdong	2005.7.19	Maoming	192	Liu Junyue BO Zengwen
6	The Training of Buildings Energy Efficiency at Zhanjiang	The Construction Bureau of Guangdong	2005.7.20	Zhanjiang	149	Liu Junyue BO Zengwen
7	The Training of Buildings Energy Efficiency at Zhanjiang	The Construction Bureau of Guangdong	2005.7.29	Chaozhou	172	Ma Xiaowen BO Zengwen
8	The Training of Buildings Energy Efficiency at Zhanjiang	The Construction Bureau of Guangdong	2005.7.28	Jieyang	127	Ma Xiaowen BO Zengwen

9	The Training of Buildings Energy Efficiency at Meizhou	The Construction Bureau of Guangdong	2005.8.4	Meizhou	123	Ma Xiaowen BO Zengwen
10	The Training of Buildings Energy Efficiency at Zhuhai	The Construction Bureau of Guangdong	2005.7.26	Zhuhai	137	Ma Xiaowen BO Zengwen
11	The Training of Buildings Energy Efficiency at Zhongshan	The Construction Bureau of Guangdong	2005.8.12	Zhoushan	236	Ma Xiaowen BO Zengwen
12	The Training of Buildings Energy Efficiency at SIBR	SIBR	2005.5.11 2005.8.1	Shanzhen	31	BO Zengwen Mao Hongwei
13	The Training of Buildings Energy Efficiency at Wanke estate	Wanke estate at Shenzhen	2005.5.13	Shenzhen	27	Ma Xiaowen
TOTAL					1741	
14	The Training of Buildings Energy Efficiency of Guangdong province	The Construction Bureau of Guangdong	2005.7.3	Guangzhou	About 150 person	Ye Qing Mao Hongwei
15	The Training of Buildings Energy Efficiency for registered architect of Guangdong province	The Committee of Registered Architect of Guangdong Province	2005.6.1	Guangzhou	About 120	Ye Qing
16	The Training of Buildings Energy Efficiency at Planning Bureau of Guangdong Province	The Construction Bureau of Guangdong The Construction Bureau of Shenzhen	2005.3.5	Shenzhen	About 60	Ye Qing
17	The Training of Buildings Energy Efficiency at Energy Efficiency Week	The Construction Bureau of Shenzhen	2005.6.5	Shenzhen	About 150	Ye Qing
18	The Training of Buildings Energy Efficiency during House Business Exhibition	Shenzhen Housing Department	2005.5.2	Shenzhen	About 70	Ye Qing
18	The Summit Forum of Real Estate around Pearl River Delta	The Construction Bureau of Guangdong	2005.6.15	Shenzhen	About 70	Ye Qing
20	The Training of Buildings Energy Efficiency at	Zhonghai Real Estate Corporation	2005.6.10	Shenzhen	About 50	Ye Qing

	Zhonghai Real Estate					
21	The Training of Buildings Energy Efficiency at China Construction design Corporation	China Construction design Corporation	2005.6.7	Shenzhen	About 150	Ye Qing

▼ Project VI: Energy Efficiency Demonstration Project

Help constructing the first energy efficient residential district-Zhenye Town I, Shenzhen, which was certificated as the Energy efficiency demonstration district by National Construction Ministry. The timetable is as follows:

Jun 2004—Sept 2004, Energy efficiency design for the residential buildingss.

3 Aug 2004, Passing the 3A-class residential pre-certificate by the National Construction Ministry

3 Aug 2004, the beginning of construction

1 Oct 2004, Virgin poses on the stage of the *autumn real estate fair, Shenzhen*

26 Dec 2004, the visiting of the Experts from National Construction Ministry.

21 Jan 2005, John Hogan, the scientists of Lawrence Berkeley National Laboratory and American Energy Fund visited the project

24 Feb 2005, being honored with the *energy efficiency demonstration district, China,* by the National Construction Ministry

1 May 2005, being the focus of *the autumn real estate fair, Shenzhen*

26 Jun 2005, the open quotation of Zhenye Town broke the record of total villa sale price in Shenzhen, which is about 200 million yuan.

Jun 2005, being honored with the *Shenzhen excellent energy efficiency design (reconstruction), South glass cup, 2004.*

Wu Yong， the vice manager of the Science and Technology Department in the National construction Ministry and several local governmental leaders visited the project.

Lang Xianpin ,a famous economist took a speech *,The direction of real estate economy of china in new situation* on the *New wealth & wit class Forum, Zhenye Town*

▼ Project VII: Start up the Legislation for Buildings Energy Efficiency in

Shenzhen

1. On October 21，2004，Shenzhen Legislation Bureau has taken *Shenzhen Buildings Energy Efficiency management Ordinance* into the lawmaking list. Shenzhen Construction Bureau is organizing relevant sides doing investigation and research, and as well as drafting the *Ordinance.*

2.On March 8，2005，Shenzhen Legislation Bureau released *Notification About establishing the work group for drafting Shenzhen Buildings Energy Efficiency management Ordinance*, and the work group was established.

3.On March 9，2005，the wok group hold the first meeting , The general requirement was proposed in this meeting ,and tasks were assigned.

4.On March 19，2005，the wok group hold the second meeting. In this meeting, inspecting *buildings construction drawing* was listed on the special censorship, as well as *energy efficiency project check and accept.*

5. March - April of 2005, the wok group carried through the research project about buildings energy efficiency in Beijing and Shanghai.

6.On April 8，2005，the wok group hold the third meeting. Summarized the research project, the clauses of Ordinance were discussed and modified in this meeting.

7.On April 20，2005，the wok group hold the 4th meeting. In this meeting, the first draft was discussed and modified.

8.On May 12，2005，the wok group hold the 5th meeting. In this meeting, the second draft was discussed and modified.

9.On June 3，2005，the wok group hold the 6th meeting. In this meeting, the third draft was discussed and modified.

10.On June 10，2005，the wok group hold the 7th meeting. In this meeting, the 4th draft was discussed and modified.

11.On June 23，2005，the wok group hold the 8th meeting. In this meeting, the 5th draft was discussed and modified.

12.On July 7，2005，the wok group hold the 9th meeting. In this meeting, the 6th draft was discussed and modified.

13.On July 8，2005，the wok group hold the 10th meeting. In this meeting, the 7th draft was discussed and modified.

14.On July 22，2005，the wok group hold the 11th meeting. In this meeting, the 8th draft was discussed and modified.

15.On July 25，2005，Office of Municipal Standing Committee of the National People's Congress released *2005 about printing and distributing Shenzhen Municipal Standing Committee of the National People's Congress Notice that the annual legislation plans* and bring *Shenzhen Buildings Energy Efficiency management Ordinance* into surveyed and studied the project in the legislative plan in 2005.

16.On August 25，2005，the wok group hold the 12th meeting. In this meeting, the 9th draft was discussed and modified.

▼ Project VIII:

On July 29，2005, Bureau of Trade and Industry of Shenzhen Municipality, Shenzhen Municipal Bureau of Land Resources and Housing Management, and Shenzhen Construction Bureau released jointly of *Temporary Provision of Energy Efficiency Management for Operation and Maintenance of Air-conditioning System*.

III. Subsequent Works

1. Complete the inspection and submission of *Technical Standards for Inspection of Shenzhen Residential Buildings Energy Efficiency Design*, standardize and regulate the inspection of construction drawings and strengthening inspection of energy efficiency design for buildingss.
2. Shenzhen Construction Bureau is in charge of establishing energy efficiency for buildingss construction inspection system.
3. According to the construction of an energy efficiency demonstration buildings in Shenzhen, explore suitable operation methods of energy efficiency for buildings in Shenzhen on construction, supervision, final inspection, measurements and so on. Comprehensively establish the supervision and inspection system of buildingss energy efficiency in Shenzhen based on the issued primary policies.
4. Compile *Shenzhen Buildings Energy Efficiency Special Plan* and supervise its detailed implementation.
5. Establish a buildingss energy efficiency organization which in charge of the management works of buildings energy efficiency altogether.
6. Assess and promulgate *Design Standards for Energy Efficiency of Residential Buildings in Shenzhen Detailed Rules for Application*.
7. Promulgate *Collective Drawings of Design Standard for External Insulation of External Walls in Shenzhen* and *Collective Drawings of Design Standard for Insulation Structure of XPS* .
8. Assess and promulgate a calculation program on standards for residential buildings energy efficiency in Shenzhen (ACDLP-1).

9. Compile *Collective Drawings of External Shading Devices for Residential Buildings,* and establish *Database of Shading Performance of External Shading Devices for Residential Buildings.*
10. Follow the first stage of Zhenye Town's operation which is the demonstration project of buildingss energy efficiency, and collecting its energy consumption data.

Second Part
Achievement Summary of Promotion Project for the Implementation of the Standards for Buildings energy efficiency in Hot Summer and Warm Winter Zone in Shenzhen

2.1 Submission form of the *Technical Standards for Inspection of Shenzhen Residential Buildings Energy efficiency Design*

Technical Standards for Inspection of Shenzhen Residential Buildings energy efficiency Design

Submission Form

August 28 2005

Contents

1. General Provisions

1.0.1 These standards are established in order to implement the national and local energy efficiency related laws and policies, ensure and enhance the design quality of energy efficiency, and improve the heat environment of civil buildingss

1.0.2 These standards are set up according to the *Design Standard for Energy efficiency of Residential Buildings in Hot Summer and Warm Winter Zone* (JGJ75-2003), the *Design Code for Energy efficiency of Residential buildings in Shenzhen* (SJG10-2003), and the *Design Standard for Energy efficiency of Public Buildings* (GB50189-2005)

1.0.3 These standards apply to the inspection of the energy efficiency design for new-built, rebuilt, and expanded civil buildingss.

1.0.4 In addition to the above standards, the inspection of the energy efficiency design should comply with the related existing national standards and regulations.

2. Terminology

2.0.1 Index of cool loss of buildings(q_c)

The cool loss in unit construction area and in unit time, which shall be provided by the air conditioning device, and computed based on the summer indoor heat environment design standard and the defined calculation conditions. The unit is W／㎡.

2.0.2 annual cooling electricity consumption(E_c)

The electricity consumption every year in unit construction area, which shall be provided by the air conditioning device, and is computed based on the summer indoor heat environment design standard and the defined calculation conditions. The unit is kWh／㎡

2.0.3 annual cooling electricity consumption factor(ECF_c)

A non dimension index which is to be used in the custom budget method, and its value is corresponding to the annual cooling electricity consumption.

2.0.4 indoor thermal environment

The generic term for all indoor environment factors which affect the heat sense of human body. And it is together represented by the indoor dry bulb temperature, air humidity, wind speed and average radiation temperature.

2.0.5 air exchange rate

The ratio between the air volume going through the room per hour and the room volume. The unit is times/hour.

2.0.6 (C)area ratio of window to wall(C)

The ratio between the window hollow area and the room vertical plane area (i.e., the area enclosed by the buildings story height and the bay position lines). It can also be computed by the ratio between the hollow area of the window facing the same direction and the external wall (including the window wall) area.

2.0.7 (C_M)mean ratio of window area to wall area(C_M)

The ratio between the window area on the external walls puls the total area of the transparent part of the balcony door, and the area of the external walls of the whole buildings.

2.0.8 buildings envelope trade-off option

When the construction design can not fully meet the thermal performance design requirement of the buildings envelope, calculate and compare the annual cooling energy consumptions of the reference buildings and the designed buildings, and decide that whether the overall thermal performance design requirement of the buildings envelope can meet the requirement of energy efficiency.

2.0.9 custom budget method

Compare the cooling energy consumption of the designed buildings with that of the reference buildings, and base on the result to decide whether the designed buildings can meet the standards of energy efficiency

2.0.10 reference buildings

A virtual buildings which meets the energy efficiency requirement and is used as a comparison object in the custom budget method

2.0.11 absolute data limitation method

Compare the cooling energy of the designed residential buildings with the specified cooling energy consumption limit, and base on the comparison result to determine whether the designed buildings can meet the standards of energy efficiency

2.0.12 thermal conductivity(λ)

In stable state heat transferring condition, the transferred heat in a unit time through 1 ㎡ area on the 1m thick material panel with 1℃ temperature difference between both sides. The unit is W / (m·K).

2.0.13 thermal resistance(R)

A physical quantity that characterize the heat transferring resistance ability of the whole enclosing construction or certain material layer, and it is the ratio between the material thick and the coefficient of heat conduction, with the unit as ㎡·K / W. Single-layer enclosing construction: $R=\delta / \lambda$, among which, δ is the thick of the material layer (m). multiple-layer enclosing construction: $R=\sum\delta / \lambda$.

2.0.14 heat store coefficient of material(S)

When a single material layer with certain thickness is affected by harmonic heat, the surface temperature will fluctuate under a same period. And this coefficient is the ratio between the wave amplitude of the heat flow and the wave amplitude of the surface temperature. If the value is bigger, then the heat stability of the material is greater.

2.0.15 overall heat transfer coefficient of buildings envelope(K)

It is the conducted heat amount in unit time passing through the unit area of the enclosing construction in stable condition, when the air temperature difference between the both sides of the buildings envelope is 1℃. The unit is W / (㎡·K).

2.0.16 index of thermal inertia(D)

A dimensionless index that characterizes the damping degree of the temperature wave on the buildings envelope. For single-layer buildings envelope: D=RS; For multiple-layer buildings envelope: D=∑RS, among which R is the heat resistance of the material of the buildings envelope, and S is the coefficient of heat accumulation of the material. If D is greater, then damping speed of temperature wave on the material will be faster, and the heat stability of the buildings envelope is greater.

2.0.17 outside shading coefficient of window(SD)

It is the ratio between the sun radiation heat passing into the room when there is sunshade on windows and that when there is no buildings external sunshade on windows, in the period with direct sunlight.

2.0.18 shading coefficient of window(SC)

It is the ratio between the sun radiation heat passing through external windows into the room and the sun radiation heat passing through windows into the room, in the period with direct sunlight. It can be roughly estimated by multiplying the product of the shading coefficient of window glass Se with the window glass area Ag and dividing with the total window area Aw, that is SC=Se×Ag /Aw=(0.8 ~ 0.7) Se.

2.0.19 overall shading coefficient of window(Sw)

A coefficient that characterizes the overall shading affects considering the window itself and the buildings external sunshade of the window. The value is equal to the product of the shading coefficient of window (SC) and the outside shading coefficient of window (SD), i.e., SW=SC×SD.

2.0.20 visible transmittance

The ratio between the visible light luminous flux passing through the transparent material and the visible light luminous flux casting on the surface.

2.0.21 integrated part load value(IPLV)

An efficient index of single value that represents the efficient of the cooling chilling unit for air conditioning under partial load. It is obtained based on the performance coefficient of the chilling unit under partial load, with consideration of the weight factors relating to the wording periods of the unit in different types of loads.

2.0.23 long-wavelength radiation

The electromagnetic wave radiation emitted by object and with wave length larger than 3μm. Since the temperatures of the ground, external furnaces of buildingss, and atmosphere is far lower than the surface temperature of the sun, the wave radiation emitted by them is larger than 3μm, and is long-wavelength radiation.

2.0.24 absorptions coefficient of solar radiation(ρ)

The ratio between the sun radiation heat absorbed by the surface and the sun radiation the surface can bear.

2.0.25 Typical Meteorological Year(TMY)

Based on the monthly average values of the latest 30 years, 12 months form the latest 10 years, of which values are most close to the average values of the 30 years, are selected as the typical meteorological year. Because these months are from different years, and the data is uncorrelated, inter-month processing is needed.

2.0.26 Predicted Mean Vote(PMV)

An evaluation index that characterizes the thermal reaction (cold and hot feeling) of human body, and represents the cold and hot feeling of most people in a same environment.

2.0.27 energy efficiency ratio(EER)

It is the ratio between the cooling amount provided by air conditioning equipment and the energy consumed by the equipment itself under rated condition. The energy efficiencies of same equipment under different operating conditions are different. So when talking with the energy efficiency, the related operating condition shall be specified.

2.0.28 Variable Refrigeration Volume

The air conditioning system is a type of air conditioning system in which the cooling medium evaporates directly. It uses the cooling medium as the transferring medium, and through controlling the cycling amount of the cooling medium and the cooling flow amount passing into different heat exchangers indoors, satisfy the requirement on change of the temperature controlling load. So it is an air conditioning system that can automatically adjusting according to the indoor loads.

2.0.29 lighting power density(LPD)

The lighting installation power on unit area (including light source, ballast, or transformer), and the unit is w/㎡.

2.0.30 luminance

The lightingof a single point on the surface is the quotient of the luminous flux on the region enclosing that point dΦ and the area of that region, i.e., E=Dφ/dA. The symbol of that value is E, and the unit is lx, 1lx=1lm/㎡.

2.0.31 unified glare rating(UGR)

It is the psychology parameter that characterizes the objective reaction of the discomfort able feeling caused by the light emitted by the luminous device in visual environment against human eyes. Its value can be calculated by the CIE unified glare value equation.

2.0.32 color rendering index

The measure that characterizes the compliance degree between the physiological physical color of the lighting object of the measured light source and the physiological physical color of same color sample illuminated by the reference light source, with the symbol is R.

3． Inspection Reference

3.0.1 *People's Republic of China Law on Energy efficiency*

3.0.2 *Management Regulation on Energy efficiency for Civil Buildings* (Ministry of Construction Order 76)

3.0.3 *Design Standards for Energy efficiency of Residential Buildings in Hot Summer and Warm Winter Zone* (JGJ75-2003)

3.0.4 *Design Code for Energy efficiency of Residential buildings in ShenZhen* (SJG10-2003)

3.0.5 *Design Standards for Energy efficiency of Public Buildings* (GB50189-2005)

3.0.6 *Standards for Lighting Design of Buildings* (GB50034-2004)

3.0.7 *Thermal Design Code for Civil Buildings* (GB50176-93)

3.0.8 *Notification of Reinforcing the Inspection Work of the Buildings Energy efficiency in Civil Buildings Project* (Construction Office 【2004】74)

4. Energy efficiency Design Document

4.0.1 Energy efficiency design for civil buildingss shall have special design for energy efficiency (energy efficiency special part)

4.0.2 Special design for energy efficiency (energy efficiency special part) shall include:

1. Energy efficiency design description
   - Overview of the engineering project
   - Design reference
   - Energy efficiency measures for buildings, air conditioning, electronics and illumination.
   - Thermal performance index of buildings envelope (can be illustrated with graph)
   - Energy consumption index (when the specifications of the buildings envelope can not meet the standards, energy consumption index shall be considered)

2 .Energy efficiency drawings
   - Detailed drawing or standard drawing index for the construction of the buildings envelope
   - Detailed drawing or standard drawing index for other energy efficiency facilities and components.

3 Energy efficiency calculation
   - Calculation of the window and wall area ratio C or the average window and wall area ratio C_m
   - Computation of the outside shading coefficient SD or the overall shading coefficient S_w
   - Computation of the average heat transfer coefficient of buildings envelope K_m and the average index of thermal inertia $D_{m.}$
   - Computation of the heat transfer coefficient of buildings roof K and the index of thermal inertia D.
   - Computation of the heat load of air conditioning and the cooling loads by objects and by time.
   - Computation of the delivery heads of the cold (hot) pumps of air conditioning and cooling tower
   - Computation of the transferring energy ratio (ER) of the cold (hot) pumps of air

conditioning and cooling tower.

- Computation of the resistance of the ventilation and air conditioning systems, and the power by unit wind amount of the wind machine (Ws).
- Computation of the energy consumption index (only calculated when the specifications of the buildings envelope can not meet the requirements)

5. Buildings Energy efficiency Design

5.1 Buildings orientation and distance

5.1.1 The buildings orientation should choose the south or north direction or close to south or north direction, rather than east or west direction. If the requirement can not be satisfied due to certain reasons, some effective measures should be considered to prevent the sunshine.

5.1.2 The buildings distance shall not only meet the requirement of fire separation, fir residential buildingss, the sunlight period requirement shall also be satisfied, and the sunshine analysis chart meeting the sunshine standards should be provided.

5.2 Natural lighting and ventilation

5.2.1 Residential buildingss shall adopts the “complete bright” (bright living room, bright bedroom, bright kitchen, bright toilet) design. For residential buildingss, the visible transmittance ratio between the external window and the transparent curtain wall should not be less than 0.6, and for public buildings, it should not be less than 0.4.

5.2.2 The overall design of civil buildings should adopt the layout format that facilitates the natural lighting to avoid the wind shadow area. Residential quarter with land area above 150 thousand ㎡ shall adopt the air simulation design.

5.2.3 Buildings unit design shall facilitates draught, and avoid single side wind.

5.2.4 The openable areas of the external windows and curtain walls of residential buildingss shall comply with the requirements in the item 5.3.2.1 in these standards. The openable areas of the external windows and curtain walls of public buildingss shall comply with the requirements in the item 5.3.9 in these standards.

5.3 Thermal performance of buildings envelope

5.3.1 Residential buildings

5.3.1.1 The heat conduction coefficient K and index of thermal inertia D of buildings envelope for residential buildings shall meet the requirement in table 5.1.1

Table 5.1.1 Limits for heat conduction coefficient K and index of thermal inertia D of buildings envelope for residential buildings

Part / Standard	Roof	External wall	External wall (including the transparent part of the balcony door)	Apartment partition and floor slab	Overhead line or buildings sheet	Apartment door
National standard	K≤1.0,D≥2.5	K≤2.0, D≥3.0 K≤1.5, D≥3.0 K≤1.0, D≥2.5	—	—	—	—
	K≤0.5	K≤0.7				
Shenzhen standard	K≤1.0, D≥3.0	K≤1.5, D≥3.0	K≤4.7	K≤2.0	K≤1.5	K≤3.0

Note 1. If the K values of the roof and the external wall reach the standard while the D values do not, then the heat shielding performance shall be examined.

2. The heat conduction coefficient and the index of thermal inertia D of the external wall shall consider the effect of the structural heat channel, and should take the average heat conduction coefficient K_m and the average index of thermal inertia D_m.

5.3.1.2 The overall shading coefficient of external window Sw and the openable area and air tightness q for residential buildings shall comply with the requirement of Table 5.3.1.2

		Average window and wall area Cm	External wall（ρ≤0.8）		
			K≤2.0，D≥3.0	K≤1.5，D≥3.0	K≤1.0，D≥2.5 Or K≤0.7
National standard	overall shading coefficient S_W	Cm≤0.25	≤0.6	≤0.8	≤0.9
		0.25＜Cm≤0.3	≤0.5	≤0.7	≤0.8
		0.3＜Cm≤0.35	≤0.4	≤0.6	≤0.7
		0.35＜Cm≤0.4	≤0.4	≤0.5	≤0.6
		0.4＜Cm≤0.45	≤0.3	≤0.4	≤0.5
	Openable area	≥8% floor area inside room or 45% of external window area			
	Air tightness q.（m³/m·h）	1～9 layer：q。≤2.5 m³/m·h（3 degree） ≥10 layer：q。≤1.5 m³/m·h（4 degree）			
Shenzhen standard	Shading coefficientS_W	S_W≤0.3			
	Openable area	≥10% floor area inside room			
	Air tightness q.（m³/m·h）	1～6 layer：q。≤2.5 m³/m·h（3 degree） ≥7 layer：q。≤1.5 m³/m·h（4 degree）			

Note: 1. External window includes the transparent part of the balcony door

2. ρ is the solar radiation absorbility of the external wall surface, and can be obtain through table

5.3.1.3 Roof window area, heat conduction, and shading coefficient for residential buildings shall comply with the requirement in Table 5.3.1.3.

Table 5.3.1.3 Limits for roof window area, heat conduction, and shading coefficient for residential buildings

Item / Standard	Roof window area	Heat conduction coefficient K（w/㎡·k）	Self shading coefficient SC
National standard	≤4% of total roof area	K≤4.0	SC≤0.5
Shenzhen standard	——	——	——

5.3.1.4 The window and wall area ratio for residential buildings shall comply with the requirement in Table 5.3.4

Table 5.3.4 limit for window and wall area ratio for residential buildings

	North	East and west	South	Average window and wall area ratio C_M
National standard	≤0.45	≤0.30	≤0.50	≤0.45
Shenzhen standard	——	——	——	——

5.3.2 Public buildings

5.3.2.1 The heat conduction coefficient and shading coefficient of buildings envelope for public buildings shall meet the requirement in table 5.3.2.1

Table 5.3.2.1 Limits for heat conduction coefficient and shading coefficient of buildings envelope for public buildings

Buildings envelope		heat conduction coefficient K（W/㎡·K）	
Roofing covering		≤0.90	
External wall (including nontransparent curtain wall)		≤1.5	
Overhead line or buildings sheet		≤1.5	
External wall (including transparent curtain wall)		heat conduction coefficient K（W/㎡·K）	Shading coefficient SC (east south west/north)
Single-direction external window (including transparent curtain wall)	Window and wall area ratio≤0.2	≤6.5	——
	0.2＜Window and wall area ratio ≤0.3	≤4.7	≤0.50/0.60
	0.3＜Window and wall area ratio ≤0.4	≤3.5	≤0.45/0.55
	0.4＜Window and wall area ratio ≤0.5	≤3.0	≤0.40/0.50
	0.5＜Window and wall area ratio ≤0.7	≤3.0	≤0.35/0.45
Transparent part of the roof		≤3.5	≤0.35
Note: 1. When there is external sunshade, shading coefficient=glass shading coefficient×external sunshade shading coefficient When there is no external sunshade, shading coefficient=glass shading coefficient 2. The heat conduction coefficient of external wall is the average heat conduction coefficient Km considering the buildings heat channel.			

5.3.2.2 The window and wall area ratio of external windows of every directions (including the transparent curtain wall and the transparent part of balcony wall) for public buildings should not exceed 0.7. If it is less than 0.40, then the visible transmittance ratio should not less than 0.40.

5.3.2.3 The area of the transparent (roof window) for public buildings should not be larger than 20% of total roof area.

5.3.2.4 The heat resistance R of the floor and the external wall of the basement for public buildings shall not be less than 1.0 ㎡·k/w.

Note: The floor heat resistance refers to the sum of the heat resistances of all the layers above the buildings basic supporting course.

The heat resistance of the external wall of the basement refers to the sum of the heat resistances of all the layers inside the earth.

5.3.2.5 The openable area and the air tightness of the external window and the transparent curtain wall for public buildings shall comply with the requirement in Table 5.3.2.5.

Table 5.3.2.5 Specifications for the openable area and the air tightness of the external window and the transparent curtain wall for public buildings

	openable area	Air tightness degree
External window	≥30% of window area	≥4 degree（$q_{。}$ ≤1.5 $m^3/m \cdot h$）
Transparent curtain wall	With openable part or ventilating device	≥3 degree（$q_{。}$ ≤2.5 $m^3/m \cdot h$）

5.4 Buildings energy consumption indicator

5.4.1 Residential buildings energy consumption indicator

5.4.1.1 When the residential buildings can not meet the criterion specified in 5.3.1.1, 5.3.1.2, 5.3.1.3 and 5.3.1.4, energy consumption indicator must be examined.

5.4.2.2 The checking calculation of energy consumption indicator can be conducted with one of the following three general evaluating indicators:

(1) Annual cooling electricity consumption index $ECF_C \leq ECF_{C\cdot ref}$

(2) Annual cooling electricity consumption $EC \leq EC_{ref}$,or $EC \leq 26.5$ KWh/ ㎡

(3) Index of cool loss of buildings

Among which,

ECF_C --- Annual cooling electricity consumption index of the designed buildings

$ECF_{C\cdot ref}$ --- Annual cooling electricity consumption index of the reference buildings

EC ---- Annual cooling electricity consumption of the designed buildings

EC_{ref} ---- Annual cooling electricity consumption index of the reference buildings

q_c ---- index of cool loss of the designed buildings

If the checking calculation of the energy consumption meets the above requirements, then it can be considered that the residential buildings meets the energy consumption criterion, and that energy efficiency design of that buildings is qualified, and can be approved.

5.4.2 Residential buildings energy consumption indicator

5.4.2.1 When the residential buildings can not fully meet the criterion specified in 6.1.2, 6.2.2, 6.2.4, and 6.2.6, it shall be evaluated that if the general thermal performance of the buildings envelope can meet the energy efficiency requirement. If the total energy consumption of the public buildings is less than or equal to that of the reference buildings, then it can be considered that the designed public buildings meets the criterion of energy efficiency design, and the energy efficiency design can be approved.

5.5 Buildings energy efficiency calculation

5.5.1 The design parameters or the energy efficiency calculation shall be complete, accurate, and the calculation methods shall be appropriate. The calculation results shall be right without mistakes.

5.5.2 The annual cooling electricity consumption index of the residential buildings ECF_C can be calculated with the method mentioned in the appendix B in the *Design Standard for Energy efficiency of Residential Buildings in Hot Summer and Warm Winter Zone*. The annual cooling electricity consumption of the residential buildings EC or the index of cool loss of buildings q_c should be calculated using the dynamic energy consumption calculation software. The energy consumption of public buildings should also be calculated using dynamic energy consumption calculation software

5.5.3 The thermal performance indicator of buildings external buildings envelope shall be calculated according to the calculating equation mentioned in Appendix II in the *Thermal Design Code for Civil Buildings*

5.5.4 All the design parameters and performance indicators of the reference buildings for the residential buildings energy consumption calculation shall comply with the requirement in item 5.0.2 in the *Design Standard for Energy efficiency of Residential Buildings in Hot Summer and Warm Winter Zone*. And the calculation condition for energy consumption checking calculation shall comply with the requirements in 5.0.3

5.5.5 The every consumption of public buildings (trade-off calculation of the thermal performance of buildings envelope) shall comply with the parameters and the calculation conditions specified in Appendix B in the *Design Standard for Energy efficiency of Public Buildings.*

5.6 Buildings energy efficiency products, materials, and technologies

5.6.1 The products, materials, technologies, and structures adopted in the energy efficiency design should comply with the requirements of the energy efficiency standards. The national or local forbidden products, materials, and technologies can not be adopted.

5.6.2 Buildings energy efficiency design shall preferentially adopt the new products, new materials, and new technologies. The adopted new products, new materials, and new technologies should meet the requirements of energy efficiency and environment protection, and should be developed, safe and reliable.

5.6.3 The roof should adopt the converted form of roof. The climbing roof shall adopt the solid structure, not hollow structure. The external wall shall adopt the external temperature conservation design. External windows (including transparent curtain wall) shall adopt heat insulation hollow glass, LOW-e glass, or heat rejecting glass. And external sunshade shall be equipped.

5.6.4 The heat insulation material of the roof and external wall shall adopt hydrophobic or low water absorption (<3%) and highly thermal preservative material, and can not adopt epispastics or loose lowly thermal preservative material.

5.6.5 The external surface of buildings envelope shall adopt light color facing layer.

5.6.6 The glass (or other materials) adopted in external window and transparent curtain wall should meet the requirements in respect of thermal preservation and sun shading, and also meet the requirements of natural lighting. The visible transmittance of the glass (or other transparent materials) should not be less than 0.40.

5.6.7 For the standard drawings for the buildings energy efficiency design, the thermal performance should meet the requirements of energy efficiency standards. The construction should comply with the climate characteristics of Shenzhen city, and at the same time be safe and reliable.

5.6.8 Use of new technologies, new materials, and new products for energy efficiency without engineering proofing shall be approved by professionals organized by government administrative department.

6. Energy efficiency Design for Air Conditioning and Ventilation

6.1 Indoor thermal environment and design calculation parameters

6.1.1 Energy efficiency design for civil buildings in Shenzhen should consider cooling in summer, but not central heating in winter.

6.1.2 For residential buildings, when air conditioning is used, the indoor thermal environment quality shall meet the satisfying criterion, and also meet the requirement for sanitation and ventilation.

Table 6.1.2 the indoor thermal environment quality and air change rate

Index name	Comfort ability level	habitability level
Composite index（*PMV*）	≤0.7	——
Main index (dry bulb temperature)	24~28℃	Daily average value≤29℃
air change rate	1.5 times/hour	1.5 times/hour
Air relative humidity	≤70％	——

6.1.3 Air conditioning indoor calculation parameters for public buildings shall meet the requirements in Table 6.1.3

Table 6.1.3 Air conditioning system indoor calculation parameters

Parameter		Winter	Summer
Temperature（℃）	Normal room	20	25
	hall, passage hall	18	Indoor and outdoor temperature difference≤10
（υ）（m/s） wind speed		0.10≤ υ ≤0.20	0.15≤ υ ≤0.30
Relative humidity（%）		30-60	40-65

Note: Air conditioning for winter only applies to special places like star hotels, hospitals, and kindergartens.

6.1.4 Minimum fresh air volumes required in main spaces of public buildings are specified in Table 6.1.4.

Table 6.1.4 Designed fresh air volumes required in main spaces of public buildings

Buildings type and room name			fresh wind amount [m3/(h • p)]
Tourist hotel	guest room	5 star	50
		4 star	40
		3 star	30
	dining hall, balling hall, multifunctional hall	5 star	30
		4 star	25

		3 star	20
		2 star	15
	main hall, four-season hall	4-5 star	10
	business, service	4- 5 star	20
		2-3 star	10
	beautification, hairdressing, entertainment facilities		30
Hostel	guest room	1, 3 class	30
		4 class	20
Culture and entertainment	theater, music hall, VCD hall		20
	Entertainment hall, dance hall, (including karaoke)		30
	pub, tea restaurant, coffee house		10
gymnasium			20
Shopping mall (shop), book shop			20
restaurant (dinning hall)			20
office			30
school	classroom	primary school	11
		junior middle school	14
		senior middle school	17

6.2 Energy efficiency design for air conditioning for residential buildings

6.2.1 Air conditioning method and the relative equipments adopted in residential buildings shall preferentially consider the energy efficiency, and should be decided based on technical economy analysis and environment evaluation.

6.2.2 For the residential buildings adopting the central air conditioning, devices for room temperature control and room cooling amount meter should be provided.

6.2.3 For the residential buildings adopting the separate air conditioning, energy efficiency of air conditioning device should comply with the requirements in Table 6.2.3

Table 6.2.3 Evaluating indicators of energy efficiency of room air conditioning equipment

Type	Rating cooling amount（CC）W	Energy efficient ratio（EER）W/W	
		Cold wind type	Heat pump type
Solid type	CC≤4500	2.35	2.30
	CC>4500	-	-
Separate type	CC≤2500	2.85	2.75
	2500＜CC≤4500	2.70	2.60
	CC>4500	2.55	2.45

6.2.4 For the residential buildings adopting the separate air conditioning, the installation position of outdoor equipment should not only matching the structure of the buildings, but also consider the following:

1. heat dissipation for the air conditioning equipment
2. cleaning and maintenance of the outdoor heat exchanger
3. to avoid the interference of the air flows of several close outdoor machines.
4. chimney effect of high buildings to the outdoor air conditioning machines of higher position.
5. Thermal pollution and noise pollution produced by the outdoor air conditioning machines to the residents.

6.2.5 If condition permits, the residential buildings should adopt air conditioning technologies which is using renewable energy, like solar energy, geothermal energy, ocean energy.

6.2.6 6.2.6 For the living quarter adopting the central air conditioning, the energy efficiency design for air conditioning system should comply with the requirements in 6.3 of this chapter, and be examined according to 6.4.

6.3 Energy efficiency design for air conditioning for public buildings

6.3.1 Air conditioning areas with different requirements on time, temperature, humidity, shall not be partitioned into a same air conditioning system.

6.3.1 For those air conditioning areas where the room areas or spaces are large, people amount is big, or central temperature and humidity control is necessary, the air conditioning system should adopt air-only air conditioning system, not fan coil system.

6.3.3 If there is no special requirements for the design of air-only air conditioning system, single air pipe supplying manner should be adopted.

6.3.4 In the following conditions, air-only air conditioning system should adopt the volume-variant air conditioning system:

1. In the same air conditioning system, cooling and heating loads differences in different areas are large, changing is great, and the low-loaded working period is long, and it is necessary to control the temperatures in different areas separately.
2. Cooling wind is needed to be supplied all the year.

6.3.5 In the design of volume-variant air-only air conditioning system, air processing machine should adopt the frequency-conversion kind which can automatically adjust the rotation of the wind machine. When frequency conversion is adopted for the end device, measure to protect the electricity network against the electromagnetic pollution should be devised. And according to the minimum fresh air volume requirements, mark the minimum fresh air volumes for every volume-variant end device on the design documents.

6.3.6 For the public place that adopts the design of air-only air conditioning system, measure to realize the full fresh air working or adjust the fresh air ratio should be provided. And corresponding air discharging system should also be provided. And the positive pressure values indoors should be ensured. The control of fresh volume and the transformation of working condition should adopt the enthalpy control measure of the fresh air and cycling air.

6.3.7 When a single air conditioning system is working for several using areas, the fresh air of the system should be calculated by the following equation:

$$Y=X/(1+X-Z)$$
$$Y=V_{ot}/V_{st}$$
$$X=V_{on}/V_{st}$$
$$Z=V_{oc}/V_{sc}$$

Among which: Y—pasentage of the fresh wind amount of the rectified system in the supplying wind amount

V_{ot}—the total fresh wind amount of the rectified system (m^3/h)

V_{st}—Total supplying wind amount(m^3/h)

X—pasentage of the fresh wind amount of the unrectified system in the supplying wind amount

V_{on}—the total fresh wind amount of all the rooms of the rectified system (m^3/h) (m^3/h)

Z—the fresh wind ratio of the rooms with greatest demand

V_{oc}—the fresh wind amount of the rooms with greatest demand (m^3/h)

V_{sc}—the total supplying wind amount of all the rooms (m^3/h)

6.3.8 In the space with great population density and large change, the fresh air control should base on the CO_2 concentration indoors, and to make the CO_2 concentration remain in the limit for hygienic standard. And at the same time, the air discharge amount should change according to the change of the fresh air volume to maintain the positive pressure indoors.

6.3.9 When using manual cooling or heating source to conduct precooling or preheating to the air conditioning area, the fresh air system should be able to shut down. When using the outdoor air for precooling, the fresh air system should try to be used.

6.3.10 The division of the internal and external air conditioning areas of the buildings should be preferably based on the depth, separation, orientation, floor, and buildings envelope. For internal and external areas, separate air conditioning systems should be devised.

6.3.11 For the office and commercial buildingss where there is relatively large internal area, and there is stable large amount of residue heat all through the year, water-cycling heat-pump air conditioning system should be adopted.

6.3.12 When designing the fan coil system together with the fresh air system, the fresh air should be directly supplied into every air conditioning areas, and not pass through the fan coil system first.

6.3.13 If there is large amount of heat produced in the buildings roof or the suspended ceiling, or the suspended ceiling space is relatively high (the height between the suspended ceiling and the buildings base exceeds 1.0 m), it is not suitable to cycle the air from the suspended ceiling.

6.3.14 When there devises the central air discharge system in one of the following conditions, air-exhaust heat recycling device should be equipped. The heat recycling efficiency of the heat recycling device (full heat or sensible heat) should be not less than 60%.

1. DC air conditioning system with air volume larger than or equal to 3000m^3 /h, and the temperature difference between the fresh air and the exhausted air is larger than or equal to 8℃
2. Air conditioning system with air volume larger than or equal to 4000m^3 /h, and the temperature difference between the fresh air and the exhausted air is larger than or equal to 8℃
3. The system with independent fresh air and exhausted air

6.3.15 For the air conditioning space (room) where there is human staying for long period (normally referring to continuous use of over 3h), and there is no fresh air and air exhaust systems, dual-direction air changing system with heat recycling function should be equipped in every air conditioning space (room)

6.3.16 The selection of air filter should meet the following requirements:

1. Initial resistance of the low-effect filter should be less than or equal to 50Pa (grain size larger than or equal to 5.0μm, and efficiency: 80% > E≥20%), and the resistance less than or equal to 100 Pa.
2. Initial resistance of the filter should be less than or equal to 80Pa (grain size larger than or equal to 1.0μm, and efficiency: 70% > E≥20%), and the resistance less than or equal to 160 Pa.
3. The filter of the air-only air conditioning system shall meet the requirement for complete fresh air working.

6.3.17 For air conditioning system, earth wind channel can not act as the wind supply channel for the air conditioning system or the fresh air supply channel after the cooling or heating processing. If earth wind channel must be used, measures should be devised to prevent air leakage and heat loss.

6.3.18 The design of air conditioning cooling, heating water system should comply with the following requirements:

1. Closed circulation water system should be adopted.
2. For the air conditioning system only required to provide cooling and heating transformation based on seasons, dual-pipe water system should be adopted.
3. When in the buildings, there is some areas that requiring cool water supply all the year, and other areas that requiring both cool water and hot water supply, separate dual-pipe water system should be adopted.
4. For the air conditioning system which is required to switching between cooling and heating conditions, or supplying cooling and heating functions at the same time during the year, four-pipe water system should be adopted.
5. If the system is relatively small or difference among every circulation channel in terms of load characteristics or pressure loss is small, one-circulation pump system should be adopted. And speed-variant adjusting mode can be adopted for one-time pump system after the technical inspection relating to the compatibility of the equipment, the control

system scheme, ensuring safe and reliable working condition of the system, and basing on advantages of energy efficiency and economical profits.

6. If the system is relatively big, and the resistance is relatively great, and the difference among every circulation channel in terms of load characteristics or pressure loss is large, two-circulation pump system should be adopted. And the two-circulation pump system should adopt the speed-variant volume-variant adjusting mode according to the change of demand.

7. The design temperature difference for cold water supplying and cycling design of water chilling unit should be no less than 5℃. Based on the premise of meeting the technical reliability and economic resonality, the cold water supplying and cycling temperature difference should tried to be enlarged.

8. The pressure and expansion of the air conditioning water system should adopt the type of high-positioned expansion water tank.

6.3.19 When selecting the cycling pump for the two-pipe air conditioning water system, the cold water cycling pump and the hot water cycling pump should be selected separately.

6.3.20 The design of the air conditioning cooling water system should comply with the following requirements:

1. Should provide with water processing functions including filtering, corrosion mitigation, encrustation mitigation, sterilization, algo destroying.
2. The cooling tower should be equipped in the space where the air circulation is good.
3. The water compensation general pipe of the cooling tower should be equipped with flow meter device.

6.3.21 The wind supply temperature difference of the air conditioning system should be calculated according to the air processing process indicated in the enthalpy-humidity chart (h-d). When the air conditioning system adopts the upper supplying flow organization method, big summer design supplying temperature difference should be adopted, and should meet the following requirements:

1. When the wind supplying height is less than or equal to 5m time, the supplying temperature difference should be lower than 5℃
2. When the wind supplying height is larger than 5m time, the supplying temperature difference should be lower than 10℃

3. When displacing ventilation measure is adopted, no limit is posed.

6.3.22 When the buildings space height is larger than or equal to 10m, and the volume is larger than $10000m^3$, layer-separated air conditioning or displacing air conditioning system should be adopted. That is, only lower part of the space (2 ~ 3m from the floor) should be air conditioned.

6.3.23 When conditions allow, air conditioning should adopt the ventilation supplying measure with high ventilation efficiency and short air age. For large space, the displacing ventilation can save 20% ~ 50% of the energy consumption than mixed ventilation mode.

6.3.24 Except for special circumstances, in a same air processing system, heating and cooling process should not be working at the same time.

6.3.25 In ventilation, air conditioning system, if the length of air pipe is longer than 30m, then the system resistance and the power consumption per unit air volume (W_s) of the selected air machine should be calculated. And the action radius of the air conditioning system should not be too large. the power consumption per unit air volume (W_s) of the selected air machine can be calculated according to the following equation, and should not be larger than the limit specified in Table 6.3.25.

$W_s = p/(3600\eta t)$ (6.2.2.25)

Among which W_3-----power consumption per unit wind amount [W/（m^3/h）]；

P-----wind machine full pressure value（Pa）；

η_1--------Total efficiency including wind machine, electric machine, and transmission efficiency（%）

wind machine power consumption per unit wind amount [W/（m^3/h）]

System type	Office buildings		Business, hotel buildings	
Two-pipe fixed-volume system	0.42	0.48	0.46	0.52
four-pipe fixed-volume system	0.47	0.53	0.51	0.58
Two-pipe variant-volume system	0.58	0.64	0.62	0.68
four -pipe	0.63	0.69	0.67	0.74

variant - volume system				
Normal mechanical system	0.32			
Note: 1. The normal mechanical ventilation system does not include the systems in the rooms like kitchen which requires special filtering device. 2. When preheating coil pipe is installed for cold area, the power consumption per unit wind amount can be increased by 0.035[W/（m^3/h）] 3. When the wet-membrance moisturing method is employed in the air conditioning unit, the power consumption per unit wind amount can be increased by 0.053[W/（m^3/h）]				

On the equipment list of the drawing should be marked with the full pressure of the air machine adopted in the air conditioning unit and the required minimum total efficiency of the air machine.

6.3.26 The delivery heads of the cold (hot) water pump and cooling water pump should be calculated, and the supplying energy efficiency（ER） of the cold (hot) water system, cooling water system should also be calculated. The supplying energy efficiency（ER） of the cold (hot) water system, cooling water system should be calculated according to the following equation, and the values should not be larger than the limits specified in Table 6.3.26.

$$ER=0.002342H/(\Delta T\cdot\eta)$$

In which H——design delivery head of the water pump（m）；

△ *T——temperature difference between supplying and returning water（℃）；*

η ——efficiency on the working spot of the pump（%）。

Table Maximum transferring energy efficient ratio of the air conditioning cold & hot water system

Pipe type	two-pipe hot water pipe			four-pipe hot water pipe	air conditioning cold water pipe
	cold area	cold area/ summer-hot winter-warm area mer	summer-hot winter-warm area		
ER	0.00577	0.00433	0.00865	0.00673	0.0241

Note: The transferring energy efficient ratio of two-pipe hot water pipe can not apply to the air conditioning hot water system which adopts the directly burnt cold and hot water unit as heat source.

The total distance of the longest circle of the piping should be controlled within 500m, and the delivery heads of the water pumps are determined through computation.

6.3.27 The heat insulation thickness of the cold/hot water pipe for air conditioning should be calculated based on the economic thickness and the thickness against surface sweating specified in the *Guide for design of low-temperature insulation of equipments and pipe* GB/T15586.

6.3.28 The cold/hot water pipe for air conditioning inside buildings can also be selected according to Table 6.3.27.

Table 6.3.27 Economic heat insulation thickness for cold/hot water pipe for air conditioning inside buildings

heat insulation material / pipe type	centrifugal glass wool		flexible foam plastic	
	nominal pipe diameter （mm）	thickness （mm）	nominal pipe diameter （mm）	thickness （mm）
Single cold pipe (inside medium temperature 7ºC-normal temperature)		25	checking calculation of anti-dew	
		30		
		35		
Hot or cold/hot pipe (inside medium temperature 5-60ºC)				25
				28
				32
Hot or cold/hot pipe (inside medium temperature 0-95ºC)		50	Not suitable for use	
		60		
		70		

Note：1. heat conduction coefficient of the heat insulation material:

centrifugal glass wool:λ=0.033+0.00023t_m[W/（mK）]

flexible foam plastic: λ-0.03375+0.0001375 t_m[W/（mK）]

among which t_m——average temperature of the insulation layer (ºC)

2. Single cold pipe and flexible foam plastic cold keeping pipe should perform the checking calculation of anti-dew.

If the actual pipe length exceeds 500m, the design personnel should stick to the principle that the energy loss inside the air conditioning pipe shall not be larger than 6%, i.e., total temperature rise of the medium inside the pipe can not exceed 6% of the temperature difference between supplying and cycling water.

6.3.28 The minimum heat resistance of the heat insulation layer of air conditioning air pipe should comply with Table 6.3.28

Table 6.3.28 The minimum heat resistance of the heat insulation layer of air conditioning air pipe

Pipe type	Minimum heat resistance (㎡ k/w)
Normal air conditioning pipe	0.74
Low-temperature air conditioning pipe	1.08

Applicable conditions: 1. environment temperature: 26℃ of summer and 32℃ for winter

2. air temperature inside the pipe: higher than 15℃ in summer, and lower than 32℃in winter.

The temperature inside the pipe for low-temperature air conditioning should be higher than 5℃in summer.

Notice: 1. If the heat insulation pipe is equipped outdoors, it should be calculated according to economic thickness for outdoor environment

2. When the supplying temperature in summer is lower than 5℃In summer, or the supplying temperature in winter is higher than 32℃, the economic thickness of the insulation layer of the pipe should be calculated again.

6.3.29 Besides the insulation layer, the pipes in air conditioning system should also equip with vapor insulation layer and protection layer.

6.4 Cooling and heating sources of the air conditioning system in public buildings

6.4.1 The Cooling and heating sources of the air conditioning system should adopt the central setting cooling (heating) water unit or heat supplying, heat exchanging equipment. The selection of machine unit or equipment should be determined according to the buildings scale, using features, energy structure of the city, price policy, environment regulations, and through synthesis analysis based on the following principles:

1. After the supplying of natural gas service, it should be promoted with the distributed heat electricity cooling combined supplying and burning gas air conditioning technologies, to realize the peak-clipping channel filling policy for electricity and natural gas, so as to improve the compound utility of energy use.
2. In area with multiple types of energies (heat, electricity, and fuel gas), compound energy cooling and heating technology should be employed.

3. If the natural water resource or geothermal source is available, it is suitable to employ water (geothermal) energy pump cooling and heating technologies.

6.4.2 Unless in one of the following circumstances, electric heated boiler, electric water heater can not be used as the heat source for heating and air conditioning system.

1. Buildings in area where there is sufficient electricity supply, electricity supply policy support, and preferential electricity price.
2. Mainly cooling supply, and small heating demands, and unable to utilize the heat pump as heat source.
3. Without central heat supplying source and fuel gas source, and use of coal and oil as fuel is forbidden by the environment or fire protection policies.
4. In evening low burdened electricity can be used to store heat, and the heat storage furnace will not work in the daytime when the electricity demand is high.
5. Buildings in area where renewable energy is used.
6. Buildings in which the volume-variant systems in internal and external areas are integrated and need to supply heat to partial external area.

6.4.2 The rated heat efficiency of the furnace should meet the specification in Table 6.4.3

Table 6.4.3 The rated heat efficiency of the furnace

Furnace type	heat efficiency（%）
coal (II gas coal) vapor, hot water furnace	78
fuel oil, fuel gas vapor, hot water furnace	89

6.4.3 In rated cooling working condition and specified conditions, the performance indicator (cop) of the engine-driven vapour compressed cycling cold water (hot pump) unit shall not be lower than the requirements in Table 6.4.4

Table 6.4.4 performance indicator (cop) of the engine-driven vapour compressed cycling cold water (hot pump) unit

Type		Rating cooling amount（KW）	performance coefficient（W/W）
	piston type/ vortex type		
	screw type		
	centrifugal type		
wind-cooling or vapor cooling	piston type/ vortex type		
	screw type		

6.4.5 The load performance indicator of the engine-driven vapour compressed cycling cold water (hot pump) unit (IPLV) shall not be lower than the requirements in Table 6.4.5

Table 6.4.5 The load performance indicator of the engine-driven vapour compressed cycling cold water (hot pump) unit

Type		Rating cooling amount（KW）	Overal performance coefficient under partial load（W/W）
Water cooling	screw type		
	centrifugal type		
Note: IPLV value is base on the working condition of the single main machine			

6.4.6 The load performance indicator of the water-cooling electric vapour compressed cycling cold water (hot pump) unit (IPLV) should be calculated according to the following equation and be examined according to the following condition:

IPLV=2.3% X A+41.5% X B+46.1% X C+10.1% X D

Among which

A——performance coefficient under 100% load (W/W). Cooling water supplying temperature is 30 ºC

B——performance coefficient under 75% load (W/W). Cooling water supplying temperature is 26 ºC

C——performance coefficient under 50% load (W/W). Cooling water supplying temperature is 23 ºC

D——performance coefficient under 25% load (W/W). Cooling water supplying temperature is 19 ºC

The performance indicators of every loading part can be obtained according to the ARI500/590-1988 standards, and then the efficiency-load graph should be made out. And the performance indicators in every loading point can be obtained by interpolation method in the graph, but it is not appropriate to extend the line.

6.4.4 When the nominate cooling capacity is larger than 7100w, and it adopts the unit-type air conditioning machine, air-pipe supplying type and roof-type air conditioning unit with electric-driven compressor, under the specified condition in nominal cooling working condition, the energy efficiency ratio (EER) should not be less than the requirement in

Table 6.4.7.

Table 6.4.7 Unit-type unit energy efficiency ratio

<table>
<tr><th colspan="2">Type</th><th>Energy efficient ratio（EER）
W/W</th></tr>
<tr><td rowspan="2">Wind cooling mode</td><td>Without wind pipe</td><td>2.60</td></tr>
<tr><td>With wind pipe</td><td>2.30</td></tr>
<tr><td rowspan="2">Water cooling mode</td><td>Without wind pipe</td><td>3.00</td></tr>
<tr><td>With wind pipe</td><td>2.70</td></tr>
</table>

6.4.5 For vapour or hot water type lithium bromide absorption type cold water unit and direct-burning lithium bromide adsorption type cold (warm) water unit, it shall adopts the machine type with high precise and reliable energy adjusting device. In nominal working condition the performance indicator should meet the specification in Table 6.4.8.

Table 6.4.8 Performance indicator for lithium bromide absorption type unit

<table>
<tr><th>machine type</th><th colspan="3">nominal working condition</th><th colspan="3">performance coefficient</th></tr>
<tr><td rowspan="2"></td><td rowspan="2">cold (warm) water in/out temperature（℃）</td><td rowspan="2">cooling water in/out temperature</td><td rowspan="2">Vapor pressure（Mpa）</td><td rowspan="2">Unit cooling amount Vapor consumption [Kg（Kw • h）]</td><td colspan="2">performanc factor（W/W）</td></tr>
<tr><td>cooling</td><td>heating</td></tr>
<tr><td rowspan="4">vapor dual-effect</td><td>18/13</td><td rowspan="4">30/35</td><td>0.25</td><td rowspan="2">≤1.40</td><td></td><td></td></tr>
<tr><td rowspan="3">12/7</td><td>0.4</td><td></td><td></td></tr>
<tr><td>0.6</td><td>≤1.31</td><td></td><td></td></tr>
<tr><td>0.8</td><td>≤1.28</td><td></td><td></td></tr>
<tr><td rowspan="2">direct burning</td><td>cool supply 12/7</td><td>30/35</td><td></td><td></td><td>≥1.10</td><td></td></tr>
<tr><td>heat supply outlet 60</td><td></td><td></td><td></td><td></td><td>≥0.90</td></tr>
<tr><td colspan="7">Note: performanc factor of direct-burning machine is: cooling supply (heat supply)/[heating source consumption (as low-position heat value) + electricity consumption (as one-time energy)]</td></tr>
</table>

6.4.9 The selection of air-source heat-pump cold or heat water unit should be determined according to the functions of the buildings.

6.5 Energy efficiency design for ventilation

6.5.1 The ventilation design for living and public buildingss should well handle with the indoor air flow organization, in order to improve the ventilation efficiency.

6.5.2 When the outdoor air temperature is not higher than 28℃, it shall first employ the air ventilation to improve the indoor thermal environment. In high temperature in summer time, it should prevent large amount of hot wind from passing inside.

1. Residential buildings should first consider natural ventilation. When in summer evening, if the air changing rate can not reach 20 time/hour, mechanical ventilation can be employed.
2. The configuration of ventilation system should ensure that the air pressure in higher populated areas is larger than other spaces like aisles, toilets. In kitchens and toilets mechanical ventilation devices should be installed.

6.5.3 The exhausting of air should pass through the non-air conditioning areas like the aisles, kitchens, or toilets. The cooling amount in the exhausted air shall try to be utilized.

6.6 Inspection and control

6.6.1 For centralized air conditioning system, inspection and control should be employed. The contents should include parameter inspection, parameter and equipment status displaying, automatically adjustment and control, working condition switching, energy measuring, and centralized inspection and management. The actual contents should be determined according to the functions of the buildings, relative standards, system type, etc., and based on technical economic comparison.

6.6.2 For the air conditioning system of intermittent working periods, it should be equipped with auto control device. The control device should provide the time-predefined prioritized running function.

6.6.3 for the full-rounded air conditioning buildings with buildings area larger than 20000 ㎡, when the condition allows, the air conditioning system, ventilation system, and the cooling and heating source systems should adopt direct digital control system.

6.6.4 The control of cooling and heating source systems should comply with the following requirements:

1. To monitor the instantaneous value and accumulative value of the system cooling and heating amount. The cooling water unit should preferentially adopt the measure that controls the working machine amount according to the cooling capacity.
2. The cold water unit or heat exchanger, water pump, cooling tower can be controlled interlocked.
3. To control and monitor the temperature difference and pressure difference between the supplying and cycling water.
4. To inspect the working status of equipments and be able to send failure alarm.
5. When technology is reliable, the supplying water temperature of the cold water unit should be optimized and defined.

6.6.5 For large scale engineering cooling and heating source machine rooms with relatively large installed gross capacity and large amount, it should employ the unit group control mode.

6.6.6 The cold water system of the air conditioning system should meet the following control requirements:

1.When the cold water unit is running, the minimum cycling water temperature should be controlled.
2.Control of the amount of cooling tower wind machines in working or the control of the rotation speed of the wind machines
3.Control of the water supplying temperature when cooling tower is used to supplying cold water for air conditioning.
4.Control of pollution discharge

6.6.7The air conditioning system (including the air conditioning unit) should meet the following control requirements:

1.Inspection and control of the air temperature and humidity
2.When volume-fixed air-only conditioning system is employed, it should adopt the variant fresh air ratio specific enthalpy control measure.
3.When volume-variant system is employed, it should adopt the speed-variant control measure.
4.Inspection and failure alarm of the equipment working status.
5.Over-pressure alarming and displaying of the filter

6.6.8 When two-circulation pump system is employed, auto speed-variant control measure should be employed.

The rotation of the two-circulation pump can be controlled by the fixed pressure difference method. With reliable technology, variant pressure difference method can be employed. But it should be noticed that even the two-circulation pump employed the speed-variant controlling based on the pressure difference between supplying and cycling water, it is also necessary to equip the bypath electric valve in the general pipes of supplying and cycling water.

6.6.9 For the fan coil pipe of the end volume-variant system, it should employ the electric temperature control valve and three-phrase wind speed combined control method.

6.6.10 For ventilation system in underground carpark, it is suitable to employ timing control of the ventilation machine according to the using conditions or automatic control according to the CO density.

For air (smoke) exhausting system in underground carpark, every system should adopt 2 wind machines in parallel operation, or adopt the frequency controlled wind machine, in order to reduce the air exhaust capacity when the amount of parking cars is small, so as to realize energy efficiency.

6.6.11 For public buildings utilizing centralized air conditioning system, separate cooling, heating measuring devices should be equipped in every floor, room, or different user area. In a buildings group, every public buildings and cooling and heating source station room should be equipped with separate cooling and heating measuring device.

6.6.12 The centralized air conditioning system in public buildings should be equipped with separate electric meter.

1. Cooling, heating source equipment system for air conditioning (including cold (hot) water unit, cold water cycling pump, cooling water pump, hot water cycling pump, cooling tower) should be equipped with separated electric meter.
2. End equipments in air conditioning system should be equipped with separated electric meters in every area or every floor.

7 Energy efficiency Design for Electric System

7.1 Power density, unified glare value, and color rendering index of buildings lighting system

7.1.1 The energy efficiency design for buildings lighting system should comply with lighting power density specified in 6.1.2～6.1.7 in GB50034-2004 and the UGR and $R_v$alues of the corresponding room specified in 5.2.2,5.2.3,5.2.5,5.2.6,5.2.7,5.3.1. See the Table 7.1.1.

Table 7.1.1 Power density, unified glare value, and color rendering index of buildings lighting system

	Room or place	Lighting power density（w/㎡）		lighting standard（LX）	Unified glare value UGR	color rendering index Ra
		Present value	Objective value			
Office buildings	Normal office	11	9	300	19	80
	High-class office, design room	18	15	500	19	80
	Meeting room	11	9	300	19	80
	Business hall	13	11	300	22	80
	Document processing, photocopy, issue room	11	9	300	——	80
	Document room	8	7	200	——	80
Business buildings	Business hall in normal shop	12	10	300	22	80
	Business hall in high-class shop	19	16	500	22	80
	Business hall in normal supermarket	13	11	300	22	80
	Business hall in high-class supermarket	20	17	500	22	80
Hotel buildings	Hotel room	15	13	——	——	80
	Chinese food restaurant	13	11	200	22	80
	Multi-function hall	18	15	300	22	80
	Corridor in hotel room floor	5	4	50	——	80
	Lobby	15	13	300	——	80
Hospital buildings	Treatment room, consulting room	11	9	300	19	80
	Testing laboratory	18	15	500	19	80
	Operation room	30	25	750	19	90
	Waiting room, register room	8	7	200	22	80
	Ward room	6	5	100	19	80
	Nurse station	11	9	300	——	80
	Pharmacy room	20	17	500	19	80
	ICU	11	9	300	19	80
School buildings	Classroom, reading room	11	9	300	19	80
	Laboratory	11	9	300	19	80
	artroom	18	15	500	19	80
	Multimedia classroom	11	9	300	19	80

Appendix

	Room or place		Lighting power density（w/m²）		lighting standard（LX）	Unified glare value UGR	color rendering index Ra
			Present value	Objective value			
Public equipment room	Transformer and distribution substation	Distribution compartment	8	7	200	——	60
		Transformer compartment	5	4	100	——	20
	Power source compartment, generator compartment		8	7	200	25	60
	Control room	Normal control room	11	9	300	22	80
		Main control room	18	15	500	19	80
	Telephone station, network center, computer station		18	15	500	19	80
	Driving force station	Wind machine room, air conditioning room	5	4	100	——	60
		Pump room	5	4	100	——	60
		Cooling plant	8	7	150	——	60
		Compressed air station	8	7	150	——	60
		Furnace room, operation layer of gas station,	6	5	100	——	60
carpark		Carpark compartment			75	——	60
		Repair compartment			200	25	60

Note: 1. The lighting power density in the table is the evaluating index. If it meets the specification in 4.1.3 in GB50034-2004, then the lighting can be improved by one class, if it meets 4.1.4, then the lighting can be degraded by one class.

2.The lighting illumination may have ±10% difference from the standard value.

7.2 Electric equipment installation power

7.2.1 For the installation powers of electric equipments in different types of rooms (not including the air conditioning equipments), if it can not be determined by the design documents, it can be obtained according to Table 7.2.1

Table 7.2.1 installation powers of electric equipments in different types of rooms

Note: This table is taken from the Appendix B.0.7-1 in Public Buildings Energy efficiency Design Standards (GB50189-2005)

Buildings type	room type	electric equipment power
office buildings	Normal office	20
	High-class office, design room	13
	Meeting room	5
	corridor	0
	other	5
hotel buildings	normal hotel room	20
	high-class hotel room	13
	meeting room, multi-function hall	5
	corridor	0
	other	5
shopping buildings	normal shop	13
	high-class shop	13

7.3 lighting source selection

7.3.1 The selection of lighting source should comply with the requirements specified in 3.2.3 in GB50034-2004.

7.3.1.1 For room with relatively low height, like office, classroom, meeting room, and instrument and electronic production plant, it should adopt the small-diameter straight-tube fluorescent lamp.

7.3.1.2 In business hall of shopping buildings, it should adopt the small-diameter straight-tube fluorescent lamp, compact-type fluorescent lamp, or low-power metal halide lamp.

7.3.1.3 For industrial plant with relatively large height, according to the production requirements, it should adopt the metal halide lamp or high-pressure sodium lamp, or the large-power small-diameter fluorescent lamp.

7.3.1.4 For normal lighting places, it should not adopt the fluorescent high-pressure mercury lamp, nor the self-ballasting fluorescent high-pressure mercury lamp.

7.3.1.5 In normal condition, indoor and outdoor lighting should not adopt normal lighting incandescent lamp. In special circumstance when it must be adopted, the rated power should not exceed 100w.

7.4 Selection of lighting ballast

7.4.1 The selection of lighting ballast should comply with the requirements specified in 3.3.5 in GB50034-2004

7.4.1.1 Self-ballasting fluorescent lamp should be equipped with electric ballast.

7.4.1.2 Straight fluorescent lamp should be equipped with electric ballast or Energy efficiency electric-inductive ballast.

7.4.1.3 High-pressure sodium lamp, metal halide lamp should be equipped with Energy efficiency electric-inductive ballast. In spaces where the voltage deviation is large, constant power ballast should be employed. If the power is relatively low, then electric ballast can be employed.

7.4.1.5 The selection of ballast should comply with national energy efficiency standard for this kink of product.

7.5 Lighting system control

7.5.1 In public areas of residential buildings, artificial lighting should be installed. Except in the elevator lobby in high residential buildings and for emergency usage, it should all adopt Energy efficiency switch.

7.5.2 The lighting system control should comply with the requirements in item 7.4 in GB50034-2004

7.5.2.1 The lighting in corridor, stair hall, lobby in public buildingss and industrial buildingss, should adopt centralize control, and employ the sub-area, sub-group control measures according to the using condition and natural lighting condition.

7.5.2.2 In public places like gymnasium, theater, plane departure hall, bus departure hall, it should employ the centralized control, and employ control measures to adjust the lightingaccording to requirement.

7.5.2.3 In every room of the hotel, it should provide general switch to for Energy efficiency controlling.

7.5.2.4 In stair hall, corridor with natural lighting in residential buildings, except for emergency lighting, it should employ Energy efficiency self-shutting switch.

7.5.2.5 The amount of lighting sources controlled by each lighting switch should not be too large. The amount of switches in every room should not be less than 2 (except when only 1 lighting source installed).

7.5.2.6 When 2 or more lamps are installed inside a room or place, the following group controlling method should be employed:

(1) The controlled lamp row is parallel to the side window.

(2) Places like audio visual classroom, meeting room, multi-function hall, report room, etc, and the lamps should be grouped according to the distance from the platform.

7.5.2.7 In places where condition allows, following control method should be employed:

(1) In places with good natural lighting, control the lamp or the lighting automatically according to the lamination.

(2) For personal used office, control the switch of the lamp according to human sensing or movement sensing.

(3) In lobby, elevator lobby, and corridor on residence floor of a hotel, it should employ the auto lighting adjusting device which can reduce the lightingin evening.

(4) In middle and large scale buildings, base on actual conditions to determine whether it should employ the centralized or separate, multi-function or single-function automatic control system

2.2 Temporary Method for buildings energy efficiency Inspection

Documents of Shenzhen Construction Engineering Quality Supervision Headquarter

Reference No., SJZJ 2004-51

Dated: November 11 2004

Temporary Method for buildings energy efficiency Inspection

This Temporary Method for buildings energy efficiency Inspection is stipulated according to the state standard *Thermal Design Code for Civil Buildings* GB50176-93, industrial standard *Design Standards for Energy efficiency of Residential Buildings in Hot Summer and Warm Winter Zone* JGJ 75-2003, J275-2003, and the municipal standard of Shenzhen *Design Code for Energy efficiency of Residential buildings in ShenZhen* SJG10-2003.

1. According to the relative documents of the state standard, industrial standard, local standard and the compelling statute (refer to the attachment), perform the inspection in the courses of drawings examination, construction and completion acceptance.
2. Drawings examination
   Check whether the economic conservation has been passed through in construction drawings examination, whether it has been reported to municipal economic conservation office for filing and proposes the opinion and relevant content of economic conservation in pertinence.
3. Examine the relative materials, structure and accessories in construction, the spot inspection should be executed if necessary. The important construction position of economic conservation should be inspected specially, such as the encircle structure (wall, house roof, doors and windows) and air condition system, to determine the employ status of new material of wall, the insulation of house roof, the pyrological features of doors and windows, the efficiency of heating and cooling and insulation of pipeline.
4. The following 3 items should be the stress of daily inspection
   I. The airproof requirement of outside windows;
   II. The area requirement when outside windows open;
   III. The ratio requirement of the outside window against the wall;
   Ⅳ. The index requirements of the diathermanous coefficient of outside wall of the house roof and the heat inertia.

5. A inspection record of economic conservation in construction should be prepared in completion acceptance of subsidiary (or below) construction, unit (subsidiary unit). The inspection information and opinion of the economic conservation in construction should be contained in the record; the relative record and document should be kept in file accordingly.

6. Any breach of relative policies and statute of economic conservation in construction cause by any party should produce the fault behavior record and report to civil construction authority according to <The Fault record and Publicizing Rules of Principals and the Practitioner of Shenzhen Construction Market> and result in fine according to t<The Sanction and Investigation Information Relegating Procedure > issued by Administration Division of Shenzhen Construction Bureau.

Attachment:
Relative criterions and the document issued by the Ministry of Construction

2.3 Submission form of *Detail Rules for Implementation of Shenzhen Residential Buildings Energy efficiency Design Code*

Detailed rules for application in Shenzhen area of

Design standard for energy efficiency of residential buildingss

in hot summer and warm winter zone and

Design code for Energy efficiency of residential Buildings in Shenzhen

(Submission Form)

September 2005

Contents

Appendix C Common thermal performance indices of external window (omitted)

Appendix D Classification standards of air tightness, water tightness, wind resistance, heat insulation, sound insulation, light absorbility of buildings external window (omitted)

Appendix E Simplified computation method for buildings annual cooling electricity consumption index (omitted)

Appendix F: Computation of heat coefficient and average index of thermal inertia of external wall (omitted)

Appendix G: Common computation parameters for buildings thermal performance design (omitted)

Appendix H: Common buildings envelope form and thermal performance factors (omitted)

Appendix I: Simplified computation method for heat insulation of roof and external wall (omitted)

Vocabulary description in this rules (omitted).

1. General Provisions

1.0.1These standards are established in order to implement the national and local energy efficiency and environment protection related laws and policies, improve the energy utility efficiency during the utilizing process of residential buildingss. These standards are set up according to *Design Standard for Energy efficiency of Residential Buildings in Hot Summer and Warm Winter Zone* (JGJ75-2003) and *Design Code for Energy efficiency of Residential buildingss in Shenzhen* (SJG10-2003)

This detail rules are set up by integration with *Design Standard for Energy efficiency of Residential Buildings in Hot Summer and Warm Winter Zone* (JGJ75-2003) and *Design Code for Energy efficiency of Residential buildingss in Shenzhen* (SJG10-2003). The establishment principle is that this detail rules must satisfy *Design Standard for Energy efficiency of Residential Buildings in Hot Summer and Warm Winter Zone*, and upon this premise, parts of the regulation in *Design Code for Energy efficiency of Residential buildingss in Shenzhen* are selected as reference.

1.0.2 This detail rules apples to the energy efficiency design for new-built, rebuilt, and expanded residential buildingss.

Residential buildingss mainly include house buildingss (about 92%) and corporate dormitories, hostels, hotels, and kindergartens, etc.

1.0.3 The energy efficiency design for residential buildingss in Shenzhen should take measures in various aspects including planning, construction, thermal works, air conditioning, lighting, etc, so as to control the energy consumption within specified scope while ensuring comfortable indoor thermal environment.

1.0.4 Housing estate in Shenzhen should try to employ ecological design, natural ventilation design to improve the thermal environment and air quality. The residential buildings should employ measures like improving the thermal performance of the buildings envelope and improving the energy efficiency of the air conditioning equipments, to save 50% of energy consumption compared to previous condition without these measures while reaching the same indoor thermal environment quality and hygiene air changing indicators.

The energy efficiency design for residential buildingss in Shenzhen should comply with the relative existed national standards and regulations, besides these detail rules.

2. Terminology

2.0.1 index of cool loss of buildings（q_c）

The cool loss in unit construction area and in unit time, which shall be provided by the air conditioning device, and is computed based on the summer indoor heat environment design standard and the defined calculation conditions. The unit is W / ㎡.

2.0.2 annual cooling electricity consumption（E_C）

The electricity consumption every year in unit construction area, which shall be provided by the air conditioning device, and is computed based on the summer indoor heat environment design standard and the defined calculation conditions. The unit is kWh / ㎡

2.0.3 annual cooling electricity consumption factor（ECF_C）

A non dimension index which is to be used in the custom budget method, and its value is corresponding to the annual cooling electricity consumption.

2.0.4 indoor thermal environment

The generic term for all the indoor environment factors to affect the heat sense of human body. And it is together represented by the indoor dry bulb temperature, air humidity, wind speed and average radiation temperature.

2.0.5 air exchange rate

The ratio between the air volume going through the room per hour and the room volume. The unit is times/hour.

2.0. 6 area ratio of window to wall

The ratio between the window hollow area and the room vertical plane area (i.e., the area enclosed by the buildings story height and the bay position lines). It can also be computed by the ratio between the hollow area of the window facing the same direction and the external wall (including the window wall) area.

2.0.7 mean ratio of window area to wall area （C_M）

The ratio between the area of the window area on the external walls and the transparent part of the balcony door, and the area of the external walls of the whole buildings.

2.0.8 shape coefficient of buildings

The ratio between the surface area of the buildings that directly contacts with the atmosphere and the volume enclosed by it.

2.0.9 custom budget method

Compare the cooling energy consumption of the designed buildings with that of the reference buildings, and base on the result to decide whether the designed buildings can meet the standards of energy efficiency

2.0.10 reference buildings

A virtual buildings which meets the energy efficiency requirement and is used as a comparison object in the custom budget method

2.0.11 absolute data limitation method

Compare the cooling energy of the designed residential buildings with the specified cooling energy consumption limit, and base on the comparison result to determine whether the designed buildings can meet the standards of energy efficiency

2.0.12 thermal conductivity(λ)

In stable state heat transferring condition, the transferred heat in a unit time through 1 m^2 area on the 1m thick material panel with 1℃ temperature difference between both sides. The unit is W / (m·K).

2.0.13 thermal resistance

A physical quantity that characterize the heat transferring resistance ability of the whole enclosing construction or certain material layer, and it is the ratio between the material thick and the coefficient of heat conduction, with the unit as m^2·K / W. Single-layer enclosing construction: $R=\delta/\lambda$, among which, δ is the thick of the material layer (m). multiple-layer enclosing construction: $R=\sum\delta/\lambda$.

2.0.14 heat store coefficient

When a single material layer with certain thickness is affected by harmonic heat, the surface temperature will fluctuate under a same period. And this coefficient is the ratio between the wave amplitude of the heat flow and the wave amplitude of the surface temperature. If the value is bigger, then the heat stability of the material is greater. The unit is W/(m^2·K).

2.0.15 heat transfer coefficient

It is the conducted heat amount in unit time passing through the unit area of the enclosing construction in stable condition, when the air temperature difference between the both sides of the buildings envelope is 1℃. The unit is W / (㎡·K).

The heat transfer coefficient of multi-layer buildings envelope:

$$K = 1/\left(R_i + R_1 + R_2 + \text{L} + R_e\right)$$

Among which: R_i ——internal surface heat exchange resistance, taken as 0.11 m^2·K/W

R_e ——internal surface heat exchange resistance, taken as 0.05 m^2·K/W

$$R_i = \frac{d_i}{\lambda_i}$$

Among which: d_i——thickness of single layer of material

λ_i——coefficient of heat conductivity of single layer of material

The heat transfer coefficient of single-layer buildings envelope:

$$K = 1/(R + 0.16)$$

Among which:

d——thickness of single layer of material

λ——coefficient of heat conductivity of single layer of material

2.0.16 index of thermal inertia

A dimensionless index that characterizes the damping degree of the temperature wave on the buildings envelope. If D is greater, then damping speed of temperature wave on the material will be faster, and the heat stability of the buildings envelope is greater.

For single-layer buildings envelope

D=RS

For multiple-layer buildings envelope:

D=∑RS

Among which: R ——the heat resistance of the material of the buildings envelope

S ——coefficient of heat accumulation of the material.

2.0.17 average heat transfer coefficient

Average value of all the heat transfer coefficients of different buildings envelopes in the whole buildings weighted by self buildings envelope area.

2.0.18 \average index of thermal inertia（D_m）

Average value of all the index of thermal inertias of different buildings envelopes in the whole buildings, weighted by self buildings envelope area.

2.0.19 outside shading coefficient of window

It is the ratio between the sun radiation heat passing into the room when there is sunshade on windows and that when there is no buildings external sunshade on windows, in the period with direct sunlight.

The SD calculation for the three basic types of sunshade: horizontal sunshade, vertical sunshade, and baffle plate sunshade is based on Appendix B of this detail rules

2.0.20shading coefficient of window

It is the ratio between the sun radiation heat passing through external windows into the room and the sun radiation heat passing through windows into the room, in the period with direct sunlight. It can be roughly estimated by multiplying the product of the shading coefficient of window glass *Se* with the window glass area *Ag* and dividing with the total window area *Aw*, that is $SC=Se\times A_{玻}/A_{窗}$.

2.0.21 overall shading coefficient of window(*Sw*)

A coefficient that characterizes the overall shading affect considering the window itself and the buildings external sunshade of the window. The value is equal to the product of the shading coefficient of window (SC) and the outside shading coefficient of window (SD), i.e., SW=SC×SD.

The average overall shading coefficient of window of certain direction is: the Average value of all the overall shading coefficient of all the windows of that direction, weighted by window areas, that is:

$$S_W = \frac{\sum_i A_i \cdot S_{W,i}}{\sum_i A_i}$$

Among which: A_i——area of single window

$S_{W,i}$——overall shading coefficient of a single window

The average overall shading coefficient of the whole buildings is: the Average value of all the overall shading coefficient of all the windows of every direction weighted by window areas of every direction and the weighting parameter of every direction. the weighting parameter of every direction is like this: for south and north is 0.9, for east and west is 1.25. that is:

$$S_W = \frac{1.25A_E \cdot S_{W,E} + 0.9A_S \cdot S_{W,S} + 1.25A_W \cdot S_{W,W} + 0.9A_N \cdot S_{W,N}}{1.25A_E + 0.9A_S + 1.25A_W + 0.9A_N}$$

Among which: A_E、A_S,A_W,A_N——window areas of east, south, west, north directions.

$S_{W,E}$,$S_{W,S}$,$S_{W,W}$,$S_{W,N}$——overall shading coefficients of east, south, west, north directions

2.0.22 cross ventilation

Under the wind pressure, the outdoor air passes from one side of the buildings into the internal part, and passes out from the other side. This natural ventilation process is called cross ventilation.

2.0.23 one-side ventilation

A ventilation type that uses external doors or windows on the same side to exchange air between indoor and outdoor areas.

2.0.24 air-dynamical coefficient

The ratio between the pressure on certain point of the buildings surface caused the wind and the dynamic pressure of the wind (before the interference by the buildings).

2.0.25 solar radiation

The heat energy emitted from the surface of the sun to the aerospace in form of electromagnetic wave.

2.0.26 short-wavelength radiation

The electromagnetic wave radiation emitted by object and with wave length less than 3μm. Since the wave radiation emitted by the sun is much shorter, usually within 0.3~3μm, so the radiation of sun is short-wavelength radiation.

2.0.27 long-wavelength radiation

The electromagnetic wave radiation emitted by object and with wave length larger than 3μm. Since the temperatures of the ground, external surfaces of buildingss, and atmosphere is far lower than the surface temperature of the sun, the wave radiation emitted by them is larger than 3μm, and is long-wavelength radiation.

2.0.28 absorbility coefficient of solar radiation（ρ）

The ratio between the sun radiation heat absorbed by the surface and the sun radiation the surface can bear.

2.0.29 Typical Meteorological Year（*TMY*）

Based on the monthly average values of the latest 30 years, 12 months form the latest 10 years, of which values are most close to the average values of the 30 years, are selected as the typical meteorological year. Because these months are from different years, and the data is uncorrelated, inter-month processing is needed.

2.0.30（*PMV*） Predicted Mean Vote （*PMV*）

An evaluation index that characterizes the thermal reaction (cold and hot feeling) of human body, and represents the cold and hot feeling of most people in a same environment.

2.0.31 energy efficiency ratio

It is the ratio between the cooling amount provided by air conditioning equipment and the energy consumed by the equipment itself under rated condition. The energy efficiencies of same equipment under different operating conditions are different. So when talking with the energy efficiency, the related operating condition shall be specified.

3. Computation indices for indoor thermal environment and buildings energy efficiency design

3.0.1 Energy efficiency design for residential buildings in Shenzhen should consider cooling in summer, may not consider heating in winter.

3.0.2 For residential buildings, the indoor thermal environment quality and air change rate shall meet the requirements specified in Table 3.0.2. when air conditioning is used, it shall meet the satisfying criterion, and when ventilation is utilized, it shall meet the living criterion.

Table 3.0.2 the indoor thermal environment quality and air change rate

Index name	Comfortability level	habitability level
Composite index	≤0.7	——
Main index (dry bulb temperature)	24~28℃	Daily average value≤29℃
air change rate	1.5 times/hour	1.5 times/hour
Air relative humidity	≤70％	——

3.0.3 The calculation index for summer air conditioning indoor design should be taken as the following:

1. The dry bulb temperature for bedroom and living room should be 26℃
2. The computing air changing rate is 1.5 times/hour

2.3 The air relative humidity in bedroom and living room should be ≤70％

3.0.4 The calculation index for summer evening air ventilation indoor thermal environment design should be taken as the following:

The dry bulb temperature for bedroom ≤30℃

4. Zone Planning and Thermal Energy efficiency Design of Buildings

4.1 Buildings layout and orientation design

4.1.1 The layout planning of the buildingss in housing quarter should adopt the layout that can facilitate the natural ventilation among buildingss in summer.

1. It should adopt the layout formats of stagger form, diagonal form, and free form based on the lineament, etc.
2. It should try to employ the south-low north-high design principle.

4.1.2 It should try to adopt the central green land and grouping green land combined mode, in order to fully utilize the original lineament, land feature, and all the other utilizable conditions in the housing quarter to ensure compound greening.

It should better plan for adequate amount of woods, green lands and suitable water areas. It is not appropriate to plan large area of drip tight hard ground. And the hard ground should try to employ the water permeable structure like fastener bricks.

4.1.3 The orientation of the buildings should better be within the range from south by east 15°to south by west 15°, and try not to exceed south by east 45°and south by west 45°

1. In the layout design of the buildings, it is not suitable to orient the bedroom and living room to right east, right west, or northwest.
2. It is not suitable to design glass door or window or glass curtain wall in the right east, right west, and west northwest, east northwest directions in the buildings.
3. The buildings which takes the best orientation (right south) can obtain 5%~10% of energy efficiency compared to that which takes the worst orientation (right west)

4.2 Natural ventilation design

4.14.2.1 The overall planning of the residential quarter and the design of the layout, facade, and profile of the residential buildingss should facilitate natural ventilation to avoid counter-flow area in the quarter. Residential quarter with land area above 150 thousand ㎡ shall adopt the air simulation design.

1. the air simulation design can be conducted by using the natural ventilation simulation software. The method is to first conduct the natural ventilation simulation for the initial design of the quarter planning, then adjust the planning based on the simulation result, so as to make the planning of the residential quarter facilitate the natural ventilation. When employing the natural ventilation simulation, it should be careful with the selection of the natural boundary conditions. The principle for the selection of the natural boundary conditions is: to facilitate the natural ventilation in summer, and to avoid the penetration of the cold air flow.

2. When deciding the relative positions of the buildingss, it should try to make the buildingss to be outside of the air flow vortex of other buildingss.

3. It should try to make the buildingss in the quarter facing the leading wind direction of summer, or to attract the leading wind direction to the main facades of the buildingss. The purpose is to facilitate the natural ventilation, and to produce a wind pressure difference between the front and the back of the buildingss, so as to form a good condition inside the buildings to facilitate natural ventilation.

4.14.2.2 The unit buildings design should facilitate natural ventilation. The design for natural ventilation should focus on the summer time, with main consideration on the ventilation in evening.

1. It could use the natural ventilation simulation software to conduct the natural ventilation simulation for the apartment layout of the buildings. The main point is to simulate the ventilation condition in summer evening. And then based on the simulation results, perform adjustments to the window position, window size, inside layout of the buildingss, in order to make the design to facilitate the natural ventilation.

2. the natural ventilation simulation of single buildings should be conducted based on the completing of the natural ventilation simulation of the living quarter, taking the pressure difference between the front and back side of the buildingss in the quarter or the wind speed as input.

4. 14.2.3 Passing-through ventilation should be employed, rather than single-side ventilation.

1. When employing the passing-through ventilation, the inlet window should face the lead wind direction, and the outlet window should face the opposite side of the wind direction.

2. When there are two or more rooms together to form the passing-through ventilation, the area in the room for the passing of the air flow should be larger than the area of the inlet and outlet windows.

3. When an apartment forms the passing-through ventilation, it is better to use the bedroom and living room as the wind inlet rooms, and the kitchen, toilet as the outlet rooms.

4. When single-ventilation is employed, the included angle between the outside wall of the wind inlet window and the leading wind direction should be within 40°~65°. By the

design of the window and aperture, it should design a lower inlet part and upper outlet part of close area in the same window, and by increasing the window height to increase the air dynamic coefficient difference between the inlet and outlet areas.

5. When single-ventilation is employed, the design of the window should facilitate the inlet air flow to penetrate into the room.

6. When single-ventilation is employed, the design of the window should try to the outlet air flow to pass into this room

4. 14.2.4 The openable area of the external windows (including balcony door) of the residential buildings should not be less than 10% of the floor area of the room in which the external windows are located.

1. The ratio of the openable area of the external windows of bedrooms and living rooms and the floor area of these rooms should be calculated.

2. The lowest limit of this value should be 10%.

4.14.2.5 When performing natural ventilation design of the living quarter and residential buildingss, the air change rate of the living space of the buildingss should be no less than 20 times/hour, that is, the average air age indoors in living space should not be larger than 3 minutes.

1. Qualified natural ventilation design of the living quarter and residential buildingss may cause 20% ~ 30% energy efficiency.

2. The simplified evaluating method of the energy efficiency rate of the natural ventilation of the living quarter is:

the energy efficiency rate of the natural ventilation of the living quarter=the total area inside the quarter in which the average air age is less than 3 minutes / the total construction area of all the buildingss inside the quarter X 20%

3. Likewise, the simplified evaluating method of the energy efficiency rate of the natural ventilation of a single residential buildings is

the energy efficiency rate of the natural ventilation of the residential buildings= the total area inside the buildings in which the average air age is less than 3 minutes / the total construction area of the buildings X 20%

4. The indoor average air age can be obtained by the natural ventilation simulation software. The method is to first perform natural ventilation simulation for the living quarter, and then based on the results of the air pressure difference between the front and the back of

the buildings and the wind speed, to perform the indoor natural ventilation simulation.

4.3 Performance design of the buildings envelope

4.4.3.1 The area of the external windows in residential buildings should not be too large. For the window-wall area ratio of different directions, north should not be larger than 0.45, and east, west should not be larger than 0.30, south should not be larger than 0.50. When the external windows of designed buildings could not meet the above requirements, the cooling electricity consumption index (electricity consumption amount) should be no more than that of the reference buildings.

1. The orientation of the facade:

North: north by west 30° ~ north by east 45°

South: south by west 30° ~ south by east 45°

West: west by north 60° ~ west by south 60°(including west by north 60°and west by south 60°)

east: east by north 60° ~ east by south 60°(including east by north 60°and east by south 60°)

2. The orientation of the concavo-convex facade wall: based on the practical orientation of the concavo-convex facade

3. The external wall and external window in the stair lobby and elevator lobby should be considered in the calculation.

4. The side wall of the bay window: the side wall of the bay window should base on the area of the external wall in calculation, and the orientation should take the real orientation.

5. The translucidus part of the external window: 1) for the external window on the external wall, the window area should be the area of the window hold, and the orientation is as the same orientation of the external window. 2) for the convex window on the external window, if the side of the convex window is the opacitas structure, the window area should be the area of the window hold, and the orientation is as the same orientation of the external wall. If the side of the convex window is also the translucidus window, the translucidus side of the convex window should take the real area and the real orientation, and the upper translucidus side should take as the roof window, and the lower translucidus side should take the real area and the orientation of the external stand window.

6. The slopping roof: when the slope of the slopping roof is less than or equal to 75°, it should be calculated with the real area as level roof, and the roof window with the same slope of the roof should be also calculated as level roof window. When the slope of the slopping roof is larger than 75°, it should be calculated as the stand external wall against the orientation, and the roof window should be also calculated as stand side window.

4.4.3.2 The area of the roof windows for residential buildings should be no more than 4% of the total roof area. And the heat conduction coefficient should be less than 4.0 W/(m2•K), and the self shading coefficient should be less than 0.a5. When the roof widows of the designed buildings do not meet the above requirements, the annual cooling electricity consumption index (electricity consumption amount) should be no more than that of the reference buildings.

4.34.3.3 The heat conduction coefficients and the indices of thermal inertia of the roof, external walls, Apartment partition, floor panel, overhead plate and apartment doors should meet the requirements in Table 4.3.3. If not, the annual cooling electricity consumption index (electricity consumption amount) should be no more than that of the reference buildings.

Table 4.3.3 The heat conduction coefficients *K* [W/(m^2.K) and the indices of thermal inertia *D* of the roof, external walls, Apartment partition, floor panel, overhead plate and apartment doors

roof	external wall	dividing wall and floor panel	base natural ventilated overhead plate	apartment door
$K≤1.0$，$D≥2.5$ or $K≤0.5$	$K≤1.5$，$D≥3.0$ or $K≤1.0$，$D≥2.5$ or $K≤0.7$	$K≤2.0$	$K≤1.5$	$K≤3.0$
Note: 1. For light roof and external wall with $D<2.5$, it should also comply with heat insulation requirement specified in 5.1.1 in the *Civil Buildings Thermal Performance Design Guideline* (GB50176-93), or the checking calculation in the Appendix I. 2. If the heat conduction coefficient of the roof and the external wall meet the energy efficiency standard, but the index of thermal inertia does not meet the energy efficiency standard, it should be checked with the heat insulation requirements specified in Appendix I.				

1. When the external wall and the roof employ different construction, the average heat condition coefficient of external wall and the roof should be averaged weighted by each area of different structure.

$$K = \frac{\sum_i A_i \cdot K_i}{\sum_i A_i}$$

2. When the thermal performance of used construction material can not be determined, the design value should be taken from the examination value by the legal examination institutes.

4.4.3.4 The heat conduction coefficient of external window (including the transparent area of the balcony door) should be less than 4.7 W/(m^2•K). When different window-wall area ratios are used, the shading coefficient should meet the requirements specified in Table 4.3.4-1. When the external widows of the designed buildings do not meet the above requirements, the annual cooling electricity consumption index (electricity consumption amount) should be no more than that of the reference buildings.

1. The overall shading coefficient of external window $S_w=SC\cdot SD$, SC is the shading coefficient of the self external window, SD is the shading coefficient of the sunshade of the buildings. When there is no sunshade, $SD = 1$, $S_W = SC$

2 SC=Se×Ag /Aw=(0.8～0.7) Se，*Se* is the shading coefficient of the window glass, and Ag is the area of the window glass, Aw is the area of the window hole. When calculating, for aluminum window, Ag /Aw=0.8 , for plastic and steel window Ag /Aw=0.7. The common shading coefficient of external window is listed in Appendix Table C.0.2, or can be referred to the product catalogue of the producer.

3. The shading coefficient of buildings sunshade SD can be calculated by the method in Appendix B in this regulation. Shading coefficient of typical buildings sunshade can be obtained in the Table 4.3.4-2

4. The balcony or gabarite of the upper floor over the window or the balcony door can also be considered as the shading plates.

5. When calculating average window-wall area ratio, the area of the external window and external window should be calculated according to the method in 4.3.1.

6 The external wall and external window in stair lobby and elevator lobby should be included into the calculation of the window-wall area ratio. However, the design of the external window in stair lobby and elevator lobby does not necessarily consider the limitation of the shading coefficient.

Table 4.3.4-1 limits for composite shading coefficient of external window

External wall（$\rho\leq0.8$）	composite shading coefficient of external window S_W				
	average window-wall area ratio $C_M\leq0.25$	average window-wall area ratio $0.25<C_M\leq0.3$	average window-wall area ratio $0.3<C_M\leq0.35$	average window-wall area ratio $0.35<C_M\leq0.4$	average window-wall area ratio $0.4<C_M\leq0.45$
$K\leq1.5, D\geq3.0$	≤0.8	≤0.7	≤0.6	≤0.5	≤0.4
$K\leq1.0, D\geq2.5$ Or $K\leq0.7$	≤0.9	≤0.8	≤0.7	≤0.6	≤0.5

Note: 1 the external window mentioned here includes the transparent part of the balcony door
2. ρ the sun radiation absorbility of the external wall surface, and can be obtain through table

Table 4.3.4-2 Outside shading coefficients of typical forms

Sunshade form	*SD*
Fixed shutter, fixed riser pallet, sunshade plate which can completely screen out sunlight	0.5
Fixed shutter, fixed riser pallet, sunshade plate which can basically screen out sunlight	0.7
Rather dense grate	0.7
Nontransparent active shutter or roller shutter	0.6

4.4.3.5 The external windows of residential buildings, especially the windows facing east or west, should employ active or fixed buildings external sunshade facility.

1. Active external sunshade facility should facilitate operation and maintenance, and shall be able to bear the wind force in clear days in summer, so as to make the sunshade keep the position. And it should be able to ensure the safety of the sunshade facility when rainstorm comes.

2. The sunshade facilities of the buildings external windows should not interfere with the natural ventilation, and should try to prevent the sun radiate heat absorbed by the sunshade facilities from being brought into the buildings by the inlet air flow.

3. The sunshade facilities of the buildings external windows should be in concordance with the construction of the external facade of the buildings.

4.4.3.6 The air tightness class of the external windows and the balcony doors of the first to six floors of residential buildingss should not be less than 3 class (under pressure difference of 10Pa, the air amount passing through every meter of clearance every hour should not be larger than 2.5 m^3, and the air amount passing through every square meter of area every hour should not be larger than 7.5 m^3) defined in the present national standards *the Graduation and test method for air permeability performance of windows* (GB/T7107-2002). The air tightness class of the external windows and the balcony doors of the seven floor and above should not be less than 4 class (under pressure difference of 10Pa, the air amount passing through every meter of clearance every hour should not be larger than 1.5 m^3, and the air amount passing through every square meter of area every hour should not be larger than 4.5 m^3)

For the air tightness performance of windows and doors, there should be inspection report by relative inspection institutes with relative qualification as the design basis.

4.4.3.7 The roof and external window of residential buildings should employ the following measures of energy efficiency.

1. light-color smooth facing (like light-color rendering, coating, and facing brick, etc)

2. Close air layer inside roof with aluminum foil

3. Coating of moisture porous material

4. Roof covering water accumulation

5. Roof covering sunshade

6. Roof with-earth or without earth planting

7. East and west external walls employ grate structure or liana as sunshades

In the calculation or total heat resistance of the roof and external walls, the equivalent additional heat resistances for the above energy efficiency measures can be obtained in Table 4.3.7.

Table 4.3.7 Equivalent additional heat resistances for heat insulation measures

Roof or external walls employing energy efficiency measures	Equivalent additional heat resistances (m2·K/W)
Light-color external facing （ρ<0.6）	0.2
Close air layer inside roof with aluminum foil	0.5
Coating of moisture porous material	0.45
Roof covering water accumulation	0.4
Roof covering sunshade	0.3
Roof with-earth or without earth planting	0.5
east and west external walls employ grate structure or liana as sunshades	0.3
Note: ρ is the solar radiation absorbility factor of the external surface of roof or external walls.	

4.4 Construction and buildings thermal energy efficiency design process

4.4.1 For residential quarter and single buildings with land use less than 150,000 m^2, qualitative or quantitative natural ventilation design should be performed. For residential quarter and single buildings with land use less than 150,000 m^2, quantitative natural air flow simulation design should be performed.

4.4.2 Calculate the window-wall area ratio and area of roof windows of every directions, and thermal performance, and examine whether the results meet the requirements in 4.3.1 and 4.3.2. If not, adjust the design parameters until the specifications are met or conduct the energy efficiency composite evaluation method described in Chapter 5.

4.4.3 Calculate the heat conduction coefficients K and the indices of thermal inertia D of the roof, external walls, Apartment partition, floor panel, overhead plate and apartment doors. For external wall, the average heat conduction coefficient K_m and average indices of thermal inertia D_m should be calculated. And the results should meet the requirements in Table 4.3.3. If not, adjust the design parameters until the specifications are met or conduct the energy efficiency composite evaluation method described in Chapter 5.

4.4.4 Calculate the average window-wall area ratio C_M, and based on the average window-wall area ratio C_M and the K, D of external wall, using the Table 4.3.4-1, obtain the composite shading coefficient S_W, and then calculate the self shading coefficient of external window SC. Examine that whether the shading coefficient of external window SC and the heat conduction coefficient K meet the requirements specified in 4.3.4. If not, adjust the design parameters until the specifications are met or conduct the energy efficiency composite evaluation method described in Chapter 5.

4.4.5 Examine whether the openable area of external windows meets the requirements specified in 4.2.4. If not, adjust the design parameters until the specifications are met or conduct the energy efficiency composite evaluation method described in Chapter 5.

4.4.6 Based on the position of the external windows in the construction drawing and the requirements specified in 4.3.6, select the suitable window structure, and mark the requirements of air tightness of external windows in the general description of the design.

5. Overall evaluation of buildings energy efficiency design

5.0.1 The energy efficiency design can adopt the "custom budget method", or can adopt the "absolute data limitation method" to make comprehensive assessment.

5.1 Custom budget method

5.1.1 When the custom budget method is adopted, the comprehensive evaluation index may adopt the cooling electricity consumption index, or directly take the cooling electricity consumption amount, according to the following specifications:

1. When taking the cooling electricity consumption index as the comprehensive evaluation index, the annual cooling electricity consumption index of the designed buildings should not be larger than that of the reference buildings, and satisfy the following specification:

$$ECF_C \leq ECF_{C\,ref} \qquad (5.1.1\text{-}1)$$

Among which: ECF_C ——the cooling electricity consumption index of the designed buildings

ECF_{Cref}——the cooling electricity consumption index of the reference buildings

2. When taking the cooling electricity consumption amount as the comprehensive evaluation index, under the same calculation condition, the annual cooling electricity consumption amount of the designed buildings should not be larger than that of the reference buildings, and satisfy the following specification:

$$E_C \leq E_{C\,ref} \qquad (5.1.1\text{-}2)$$

Among which: E_C ——the cooling electricity consumption amount of the designed buildings（kWh/m^2）

E_{Cref}——the cooling electricity consumption amount of the reference buildings（kWh/m^2）

3. For the buildings undertaking the overall evaluation of the energy efficiency design, the shading coefficient and heat conduction coefficient of the roof window, the heat conduction coefficient of the roof, and the heat conduction coefficient of external wall of which the index of thermal inertia less than 2.5 should also satisfy the requirements specified

in 4.3.2 and 4.3.3.

5.1.2 The reference buildings should be determined based on the following principles:

1. The construction shape, size, and orientation of the reference buildings should be exactly the same as the designed buildings.

2. Every orientation of the reference buildings and the window area of the roof should be the same as the designed buildings. But if the area of widows of certain orientation (including the roof windows) exceeds the specifications in 4.3.1 and 4.3.2, then the area of windows of that orientation (or roof) should be reduced to meet the specification in 4.3.1 and 4.3.2.

3. Every performance factors of the buildings envelope of the reference buildings should meet the requirements specified in 4.3.2, 4.3.3 and 4.3.4. The solar radiation absorbility factor of the external surface of the roof should be taken as 0.7. When the thermal inertia index of the external wall of the designed buildings is larger than 2.5, then the heat conduction of the external wall should take 1.5W/(m^2·K), and the heat conduction of the roof should take 1.0W/(m^2·K). When the thermal inertia index of the external wall of the designed buildings is less than 2.5, then the heat conduction of the external wall should take 0.7W/(m^2·K), and the heat conduction of the roof should take 0.5W/(m^2·K).

5.1.3 The annual cooling electricity consumption amount of the buildings should be calculated using dynamic simulation method. And the annual cooling electricity consumption index of the buildings should be calculated using the method specified in Appendix E in this detail rules.

1. When calculating the buildings annual cooling electricity consumption amount, the calculation software may use the American DOE-2 software as the calculation tool, and use the input/output program developed by the China Construction Science Research Institution as the input/output tool.

2. The buildings annual cooling electricity consumption index can be calculated by hands, or employ the *Standards for Residential Buildings Energy efficiency in Hot Summer and Warm Winter Zone* energy efficiency design composite evaluation software as the calculation tool.

5.1.4 The calculation of the composite evaluating factors of the “custom budget method” should meet the following specifications:

1. Outdoor calculating atmosphere parameters are taken from typical meteorological year.

2. Indoor computing temperature for rooms with air conditioning takes 26℃

3. Air change rate takes 1.5 times/hour.

4. Cooling rating energy efficiency takes 2.7

5. In indoor environment, heat produced by lighting and other internal sources should not be considered.

6. The construction area is calculated as the total area which is encircled by external boundary lines on all floors. The construction volume is calculated as the total volume encompassed by the external surfaces of the buildings and the base ground. The external surface area is calculated as the total area of external walls and roof. The area of the floor panel on the lower surface that contacts the atmosphere is not concluded into the area of external surface.

5.2 Absolute data limitation method

5.2.1 When the custom budget method is adopted, the comprehensive evaluation index may adopt the cooling electricity consumption amount, or take the average index of cool loss of the hottest month. The cooling electricity consumption amount and the average index of cool loss of the hottest month of the buildings should not exceed the limits specified in Table 5.2.1.

Table 5.2.1 Limits for energy efficiency composite evaluation for residential buildings

cooling electricity consumption amount E_C （kWh/m^2）	26.5
average index of cool loss of the hottest month q_c （W/m^2）	27.5

5.2.2 The cooling electricity consumption amount and the average index of cool loss of the hottest month of the buildings can be calculated by using the dynamic temporal simulation methods.

The calculation software may use the American DOE-2 software as the calculation tool, and use the input/output program developed by the China Construction Science Research Institution as the input/output tool.

5.2.3 The calculating of the composite evaluating factors of “absolute data limitation method” is same as 5.1.4.

6 Energy Efficiency design for air conditioning and ventilation

6.1 Energy Efficiency design for air conditioning

6.1.1 Air conditioning method and the relative equipments adopted in residential buildings shall preferentially consider the energy efficiency, and should be decided based on technical economy analysis and environment evaluation.

6.1.2 For the residential buildings adopting the central air conditioning, devices for room temperature control and room cooling amount meter should be provided.

1. For refrigerating unit in central air conditioning system, the energy efficient (performance factors) should meet the specifications of present relative product standards, and preferably choose the products with relatively high energy efficient.

2. The energy efficient of unit air conditioning unit should satisfy the “energy efficiency evaluation values“ specified in Item 5.2 in the *Energy Efficient Limits and Energy Efficient Class for Unit Air Conditioning Unit* GB19576-2004.

Table 6.1.2-1 energy efficiency evaluation values for unit air conditioning unit

Type		Energy efficient ratio（EER）W/W	
		1class	2class
Wind cooling mode	Without wind pipe	3.20	3.00
	With wind pipe	2.90	2.70
Water cooling mode	Without wind pipe	3.60	3.40
	With wind pipe	3.30	3.10

3. The energy efficient of vapour-compress cycling cold water (hot pump) unit should satisfy the “energy efficiency evaluation values“ specified in Item 5.2 in the *Energy Efficient Limits and Energy Efficient Class for Cold Water Unit* GB19576-2004.

Table 6.1.2-2 energy efficiency evaluation values for vapour-compress cycling cold water (hot pump) unit

Type	Rating cooling amount（CC）kW	Performance factor（*COP*）W/W	
		1class	2 class
Wind-cooling or vapour-cooling	CC≤50	3.20	3.00
	CC＞50	3.40	3.20
Water cooling	CC≤528	5.00	4.70
	528＜CC≤1163	5.50	5.10
	CC＞1163	6.10	5.60

4. If the system is relatively small or difference among every circulation channel in terms of load characteristics or pressure loss is small, one-circulation pump system should be adopted. And speed-variant adjusting mode can be adopted for one-time pump system after the technical inspection relating to the compatibility of the equipment, the control system scheme, ensuring safe and reliable working condition of the system, and basing on advantages of energy efficiency and economical profits.

5. When user-type air conditioning and central air conditioning system are used, it should focus on the analysis and comparison of the energy efficient ratio under partial load.

6.1.3 For the living buildings adopting the separate air conditioning, energy efficiency of air conditioning device should comply with the “energy evaluating values” specified in Item 6 in the *Energy Efficient Limit and Energy Efficient Value for Air Conditioner Inside Rooms* the GB12021.3-2004.

Table 6.1.3 Energy evaluation values for air conditioner inside rooms

Type	Rating cooling amount （CC） W	Energy efficient ratio（EER） W/W	
		1class	2class
Solid type		3.10	2.90
Separate type	CC≤4500	3.40	3.20
	4500＜CC≤7100	3.30	3.10
	7100＜CC≤14000	3.20	3.00

6.1.4 The layout and facade design of the residential buildings should consider the installation position of the air conditioning devices, and try to not affect the façade view of the buildings, and to facilitate the heat removal of the air conditioning devices in summer time, and make the cleaning and maintenance of the heat exchangers convenient.

1. It should consider the installation position of the separate air conditioner with the construction of the shelf.

2. The design of the installation position should try to avoid the interference of the air flows from several outdoor machines and the chimney effect of high buildings to the outdoor air conditioning machines of higher position.

3. It should consider the discharge of the condensation water.

4. It should consider the thermal pollution and noise pollution produced by the outdoor air conditioning machines to the residents.

5. The construction design of shelf should facilitate the absorbing and discharging of air

flow by the outdoor machines.

6. For the buildings in which the solid-type (window-type) air conditioner should preserve space for the installation.

6.1.5 The air conditioner in residential buildingss can discharge heat to atmosphere, waters, and ground. And the heat discharging objects for air conditioners should be determined based on the analysis of energy efficiency, environment effect, technical economy, etc.

1. If there is water source condition liked ground water resource (like river, see water, etc), or suitable waste water, the cooling source of air conditioner can discharge heat to the water body. During the discharge of heat to water body, it should be ensured that the water resource will not be destroyed, or polluted.

2. For those residential buildings requiring high-level of outside environment, like villa, villa quarter, high-class residential quarter, etc, of when there is no condition for discharging heat to atmosphere or water body, then air conditioner should adopt berried-pipe earth heat exchanger to discharge heat to the ground.

6.1.6 When it is necessary to abstract groundwater as the cooling water for air conditioning, it should be approved by relative management government department, and the extracted water should be able to be recharged to the ground.

6.1.7 When condition allows, the living quarter should preferably adopt the central air conditioning. If condition permits, the residential buildings should adopt air conditioning technologies which is using renewable energy, like solar energy, geothermal energy, ocean energy.

6.2 Energy efficiency design for ventilation

6.2.1 The ventilation design for living and public buildingss should well handle with the indoor air flow organization, in order to improve the ventilation efficiency.

6.2.2 When the outdoor air temperature is not higher than 28℃, it shall first employ the air ventilation to improve the indoor thermal environment. In high temperature in summer time, it should prevent large amount of hot wind from passing inside.

1. Residential buildings should first consider natural ventilation. When in summer evening, if the air changing rate can not reach 20 time/hour, mechanical ventilation can be

employed.

2. The configuration of ventilation system should ensure that the air pressure in living rooms is larger than other spaces like kitchens and toilets. In kitchens and toilets mechanical ventilation devices should be installed.

6.2.3 For buildingss which adopt central air conditioning or apartment central air conditioning, cooling or heating recycling devices could be installed between the fresh air system and the air discharge system. If there is no air discharge system, it can use the discharged air to reduce the cooling and heating consumption. The discharged air in air conditioned rooms should be discharged through the rooms without air conditioning like kitchens and toilets, in order to completely utilize the cooling amount.

6.2.4 The ventilation facilities like the external window of the buildings should be equipped with switch adjusting device, in order to satisfy the different requirements under different weathers.

6.2.5 In the ventilation design for residential buildingss, the mechanical facilities should preferably adopt the energy efficiency equipments and products which meet the existed national standards.

The air discharge fan should choose the products meeting the standards （GB10080， ZBJ-72046，ZBJ-72047，ZBJ72048, etc）, and should preferably adopt the machines with high energy efficiency and low noise.

7 Energy efficiency design for other construction facilities

7.0.1 Indoor lighting for residential buildings should adopt the lighting sources with lighting efficiency not less than 60lm, color rendering index (Ra) no less than 80, and with electric rectifier.

7.0.2 Multiple-floor residential buildings should adopt solar energy technology for supplying hot water. The installation of solar water heating system should be coordinate with the buildings.

7.0.3 Residential buildingss may adopt matured and reliable heat pump technology for supplying hot water.

7.0.4 The water supplying system for residential buildings should adopt transducer constant-voltage system.

7.0.5 For residential buildingss with central cooling, heat pump unit with heat recycling device should be adopted, to supply living hot water for residential buildingss.

8 Documentation for buildings energy efficiency design

8.0.1 The residential buildings design shall have special design for energy efficiency.

8.0.2 Special design for energy efficiency (energy efficiency special part) shall include:

1. Energy efficiency design description

   1) Overview of the engineering project

   2) Design reference for buildings energy efficiency design

   3) Buildings energy efficiency design parameter list (Table 8.0.2 in this regulation)

2. Energy conservation design drawings

Detailed drawing or standard drawing indexs for energy efficiency design of buildings envelope, other energy efficiency accessories drawings （e.g., external sunshade) or standard drawing index.

3. Energy efficiency computation

   1) Computation of the average heat transfer coefficient of buildings envelope *Km* and the average index of thermal inertia *Dm*

   2) Computation of the heat transfer coefficient of buildings roof K and the index of thermal inertia D.

   3) Computation of the heat transfer coefficients of Apartment partitions, floor panels, overhead or external floor panels.

   4) Calculation of the window-wall area ratio of every direction or the average window and wall area ratio C_m

   5) Computation of the ratio of the roof window area and the roof area.

   6) Computation of the outside shading coefficient SD or the overall shading coefficient *Sw*

   7) Computation of the ratio between the openable area of living space including living rooms and bedrooms and the area of the ground of these rooms.

   8) The computation of buildings energy consumption index (when any item relating the external buildings envelope design does not meet the requirements specified in 4.3.1, 4.3.2, 4.3.3, or 4.3.4, the energy consumption index should be computed). The computation of the

energy consumption index should include: input boundary condition, adopted simulation software, output results, output result analysis, etc.

Table 8.0.2 Energy efficiency design parameters for residential buildings

Project profile	Buildings area （m^2）		Floor number （Aboveground /underground）		Height （m）		Structure form
Material selection and thermal performance for buildings external envelop	Roof	Material and structure					
		Heat transfer coefficient K[W/(m^2.K)]					
		Heat inertia D					
	External wall	Material and structure					
		Heat transfer coefficient K[W/(m^2.K)]					
		Heat inertiaD					
	Separated wall	Material and structure					
		Heat transfer coefficient K[W/(m^2.K)]					
	Floor panel	Material and structure					
		Heat transfer coefficient K[W/(m^2.K)]					
	Aerial or external floor panel	Material and structure					
		Heat transfer coefficient K[W/(m^2.K)]					
	Door	Material and structure					
		Heat transfer coefficient K[W/(m^2.K)]					
	Area rate of window wall	Area rate of each directional window wall	North				
			East				
			West				
			South				
		Average area rate of window wall					
	Skylight	Material and structure					
		Skylight area/roof area（%）					
		Heat transfer coefficient K[W/(m^2.K)]					
		Adumbral coefficient SC					
	External window	Type of external window					
		Heat transfer coefficient K[W/(m^2.K)]					

	（including transparent part of balcony door）	Comprehensive adumbral coefficient S_W					
		Rate of open area and room area（%）					
		Gas sealing	1-6 floor				
			7 floor and over 7 floor				
Air-condition design	Distributed air-condition device	Energy efficiency rate（performance coefficient）					
	Centralized air-condition device	Whether room(house) temperature control and room cooling measure facility is deployed					
	Water source heating pump	Whether water source is destroyed or polluted (environmenbt protection measure)					
Light design	Light power density for each door（W/m^2）						
	Light source						
	Light control						
Energy savig measure for other buildingss							
Energy consumption index	Annual air-conditioner power consumption index ECFc			Reference buildings		Design buildings	
	Annual air-condition consumed power Ec（kWh/m^2）						
	Hottest monthly average cooling index q *c*						

9 Inspection of buildings energy efficiency design

9.0.1 On the design drawing of the construction drawings of the construction unit, it shall be filled in with the “Submission Form of Residential buildings Energy efficiency Design” (Table 9.0.1-1 or Table 9.0.1-2 in this detail rules)

9.1 Perform inspection of the energy efficiency design based on the specified indices

9.1.1 Inspect whether the plane, façade, profile design of the residential quarter and single buildings meet the requirements specified in 4.2.1 and 4.2.2.

9.1.2 Inspect whether the heat condition coefficient and index of thermal inertia of roof, external wall, Apartment partition, floor panel, overhead plate with bottom natural ventilation, and apartment door meet the requirements specified in 4.3.3.

9.1.3 Inspect whether window-wall area ratio of every direction meets the requirements specified in 43.1.

9.1.4 Inspect whether the area of the roof window, the heat condition coefficient and shading coefficient of the roof window meets the requirements specified in 4.3.2.

9.1.5 Inspect whether the heat conduction coefficient and shading coefficient of the selected external window meets the requirements specified in 4.3.4.

9.1.6 Inspect whether the openable area of the external windows meets the requirements specified in 4.2.4.

9.1.7 Inspect whether the air tightness of external windows meets the requirements specified in 4.3.6.

9.1.8 Inspect whether the selection of air conditioning, ventilation and lighting devices meet the requirements specified in 6.1.2, 6.1.3.6.1.6, and 7.0.1.

9.1.9 If all of the above-mentioned inspection items are passed, then the inspection of energy efficiency design can be approved.

Table 9.0.1-1 Submission Form of Residential Buildings Energy efficiency Design (Based on specified indices)

Project name: Project No: Buildings name: Floor count: Floor height: Construction area:

No	Inspection content			Checking standards	Design or computation value	Energy efficiency measure	Energy efficiency satisfying standard (filled by inspector)
1	Whether the overall planning of the residential quarter and the single design of the residential buildings considers the natural ventilation			If the land use<150,000 m^2, quantitative or qualitative design. If the land use≥150,000 m^2, air flow simulation design			
2	Roof	Heat conduction coefficient K [W/(m^2·K)]		K≤1.0，D≥2.5 or K≤0.5（light material）			
		Index of thermal inertia D					
3	External wall	Heat conduction coefficient K [W/(m^2·K)]		K≤1.5, D≥3.0 or K≤1.0, D≥2.5 or K≤0.7（light material）			
		Index of thermal inertia D					
4	Apartment partition	Heat conduction coefficient K [W/(m^2·K)]		K≤2.0			
5	Floor panel	Heat conduction coefficient K [W/(m^2·K)]		K≤2.0			
6	Floor panel with overhead bottom	Heat conduction coefficient K [W/(m^2·K)]		K≤1.5			
7	Apartment Door	Heat conduction coefficient K [W/(m^2·K)]		K≤3.0			
8	Window-wall area ratio	Window-wall area ratio of different direction	north	≤0.45			
			east	≤0.30			
			west	≤0.30			
			south	≤0.50			
		Average window-wall area ratio		≤0.45			
9	Roof window	Area ratio of roof window and roof		≤4%			
		Heat conduction coefficient K [W/(m^2·K)]		≤4.0 W/(m^2·K)			
		Shading coefficient SC		≤0.5			
10	External window (including the transparent part of balcony door)	Heat conduction coefficient K [W/(m^2·K)]		≤4.7 W/(m^2·K)			
		Overall shading coefficient S_W		Obtained in table 4.3.4-1 in this regulation			
		Openable area		No less than 10% of the floor area inside the room			
		Air tightness		1-6 floors：≤2.5 m^3/（m·h）and ≤7.5 m^3/（m^2·h）			

			7 floor and above: ≤1.5 m^3/（m·h）且≤4.5 m^3/（m^2·h）			
11	Air conditioning device	Distributed air conditioning device	Energy efficient ratio (performance factor) should meet the requirements in GB12021.3			
		Central air conditioning device	Install cooling measuring device for every room (apartment)			
		Water source heat pump	Water resource not destroyed, not polluted, and can be effectively recharged.			
12	Lighting device		Adopt the lighting sources with lighting efficiency not less than 60lm, color rendering index (Ra) no less than 80, and with electric rectifier.			
13	Other buildings energy efficiency measures					

Name of design unit		Designer		Date	year month day
		Auditor		date	year month day
Opinion of design inspector					
Name of design inspector unit		inspector		Date	year month day

9.2 Perform inspection of the energy efficiency design based on the performance indices

9.2.1 Inspect whether the plane, façade, profile design of the residential quarter and single buildings meet the requirements specified in 4.2.1 and 4.2.2.

9.2.2 Inspect whether the heat conduction coefficient of the roof meet the requirements specified in 4.3.3.

9.2.3 Inspect whether the index of thermal inertia of external wall is less than 2.5. If it is, then decide whether it is less than or equal to 0.7. If not, there is no need to decide.

9.2.4 Inspect whether the heat conduction coefficient and shading coefficient of the roof window meets the requirements specified in 4.3.2.

9.2.5 Inspect whether the openable area of the external windows meets the requirements specified in 4.2.4.

9.2.6 Inspect whether the air tightness of external windows meets the requirements specified in 4.3.6.

9.2.7 When performing the computation of the energy efficiency composite evaluating index, it should also examine whether it meets the requirements of performance indices.

9.2.8 Inspect whether the selection of air conditioning, ventilation and lighting devices meet the requirements specified in 6.1.2, 6.1.3.6.1.6, and 7.0.1.

9.2.9 If all of the above-mentioned inspection items are passed, then the inspection of energy efficiency design can be approved.

Table **9.0.1－2** Energy efficiency design table of residential buildingss reporting for approval (according to the performance index)

Project name：_____Project number：_____Buildings name：_______floor number：___floor height：____ construction area：

No.	Examine the content		Assessment criteria	Design or calculation number	Energy efficiency measure	Judge whether or not comply with Energy efficiency
1	The general plan of residential community and the single design of residential buildings whether have		Land area<150,000m^2，qualitative or quantitative design；Land area≥150,000m^2,should carry on air simulated design			
2	Rooftop	Heat transfer coefficient K [W/(m^2 • K)]	K≤1.0，D≥2.5 or K≤0.5（light material）			
		Heat inertia index D				
3	Out walls	Heat inertia index D	D≥2.5 or D<2.5，K≤0.7			
		Heat transfer coefficient K [W/(m^2 • K)]				
4	skylight	Heat transfer coefficient K [W/(m^2 • K)]	≤4.0 W/(m^2 • K)			
		Shading Coefficient SC	≤0.5			
5	ExternalExternal windows（including the transparent part of balcony	Available open area	No smaller than 10% floor area of the externalexternal window room			
		Air tightness	Floor 1-6: ≤2.5 m^3/（m·h）and≤7.5 m^3/（m^2·h）			
			Floor 7 and above：≤1.5 m^3/（m·h）and≤4.5 m^3/（m^2·h）			

6	Integrated appraisal of energy efficiency of buildings	Reference buildings	①Provide corresponding computing book； ②Annual cooling electricity consumption index： $ECF_C \le ECF_{C\,ref}$ Or annual cooling electricity consumption： $E_C \le E_{C\,ref}$ Or annual cooling electricity consumption： $E_C \leqslant 26.5$ kWh/m^2 Or the hottest month average cooling consumption index： $q_C \leqslant 27.5$ W/m^2			
		Design buildings				
7	Air-condition system	Distributed air-condition system	Energy efficiency ratio(the performance coefficient) should comply with GB12021.3			
		Centralizing air-condition system	Should set up each room(each door) temperature controlling and each door cooling calculating system			
		Water Source Heat Pump	Water resources can't be destroyed, polluted and effectively return to irrigate			
8	Lighting system		Adopt light source with light-emitting efficiency no lower than 60 lumen/watt,Ra-color rendering index no lower than 80 and have electronic rectifier			
9	Other energy efficiency measures of buildings					

Name of designing unit		Designer		Date	month day year
		Proofreader		Date	month day year
Suggestion to design inspection					
Name of design inspection unit		Examinator		Date	month day year

10 Supervision and Acceptance for energy efficiency of buildingss

10.0.1 Supervision and acceptance of project should comply with shop drawing, and check the implementing status of this project about ventilating, shading and water permeability etc. within inside scope of red lines.

10.0.2 Construction unit should send roof insulation material to test heat transfer coefficient before construction. Supervision unit should supervise construction unit to record each roof floor of the concealed project. Acceptance unit should inspect concealed project record of roof structure and submitted report of insulation material during inspecting.

10.0.3 Before construction of insulation material of external or padding material, construction unit should send out wall insulation material or wall-padding material to test heat transfer coefficient. Supervision unit should supervise construction unit to do well concealed project record of each external wall layer structure. Acceptance unit should inspect concealed project record of external wall structure and inspection report of insulation material, fill-wall material during inspecting. If adopting new type of wall material or compound wall material, acceptance unit must inspect heat transfer coefficient of out wall.

10.0.4 Construction unit should send external wall paint material or external decorative material to test reflectivity before construction. Supervision unit should supervise construction unit to keep well project record of external facing of external wall. Acceptance unit should inspect the inspection report of out surface material of external-wall.

10.0.5 Construction unit should send insulation material and wall material of apartment partition to test heat transfer coefficient before construction. Supervision unit should supervise construction unit to keep well concealed project record of each floor structure of apartment partition. Acceptance unit should inspect concealed project record of apartment partition structure and inspection report of insulation material, wall material during inspection.

10.0.6 Construction unit should send insulation material or floor slab material of floor slab, aerial floor slab or external floor slab to test heat transfer coefficient before construction. Supervision unit should supervise construction unit to keep well concealed project record of each floor structure of floor slab, aerial floor slab or external floor slab. Acceptance unit should inspect concealed project record of each floor structure of floor slab, aerial floor slab or external floor slab and inspection report of insulation material, floor slab material during inspection.

10.0.7 Construction unit should send door to test heat transfer coefficient before construction. Supervision unit should supervise construction unit to do well project record of door. Acceptance unit should inspect the inspection report of door during inspecting.

10.0.8 Construction unit should send skylight to test heat transfer coefficient, and send special glass (except ordinary flat glass) used by skylight to test shading coefficient before construction. Supervision unit should supervise construction unit to do well project record of skylight installation. Acceptance unit should inspect the area ratio of skylight and roof according to shop drawings, and the inspection report of skylight structure and special kind of glass during inspecting.

10.0.9 Acceptance unit should inspect the each direction area ratio of window and wall according to shop drawings, and inspect open area of external window during inspecting.

10.0.10 Construction unit should send external window to test heat transfer coefficient, and send special glass (except ordinary flat glass) used by external window to test shading coefficient before construction. Supervision unit should supervise construction unit to do well project record of installing external window. Acceptance unit should inspect the inspection report of external window structure and special kind of glass during inspecting.

10.0.11 Supervision and acceptance unit should inspect the inspection report of physical capability of external window, according to requirement of air tight capability of shop drawings.

10.0.12 Supervision unit should supervise construction unit to do well project record of air-condition, ventilation and lighting. Acceptance unit should inspect the project record of air-condition, ventilation and lighting according to this detailed rules.

10.0.13 If the quality of buildings inspected by supervisor matches the designing requirement, construction can enter into the next working procedure. When the above-mentioned inspecting items all comply with the designing requirement, the project is qualified.

2.4 First page of submission form of *Shenzhen Buildings Insulation Structure Design Drawing Collection*

Chart set No.: Shen J/T-01

Standard design for Shenzhen buildings
Insulation Structure for Buildings (one)
(Extruded panel inversion roof, the externalexternal insulation of external wall)

Shenzhen Construction Bureau 2005

Insulation Structure for Buildings(one) **(Extruded panel inversion type roof,** **the external insulation of external wall)** Chief editing unit: Shenzhen Institute of Building Research chart number: Shen J/T-01 Editing unit: Nanjin Owens Kening Extruded Panel Corporation Publishing unit: **Shenzhen Construction Bureau** Implementing date:10/1/2005	Principal of chief editing unit: Ye qing Technology principal of chief editing unit: Chen zeguang Technology approver of chief editing unit : Liu junyue Technology approver of participating unit: Zhang yanhong Design principal: Pu zengwen

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Insulation Structure for Buildings(two) **(polystyrene panel, the external insulation of external wall)** Chief editing unit: Shenzhen Institute of Building Research chart number: Shen J/T-01 Editing unit: Nanjin Owens Kening Extruded Panel Corporation Publishing unit: **Shenzhen Construction Bureau** Implementing date:10/1/2005	Principal of chief editing unit: Ye qing Technology principal of chief editing unit: Chen zeguang Technology approver of chief editing unit : Liu junyue Technology approver of participating unit: Zhang yanhong Design principal: Pu zengwen

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Drawing Set No.: Shen J/T-01

Standard Design for Shenzhen Buildings

Insulation Structure for Buildings (2)

(External insulation of **polystyrene** panel external wall)

Shenzhen Construction Bureau

2005

2.5 *"Use manual for Standard computing program for energy efficiency of residential buildings"*

Standard Computing Program for energy efficiency of Residential Buildings

Use Manual

Shenzhen Institute of Building Research

August,2005

Chapter 1 System Summary

1.1Brief introduction to system

The database is the data Input system for Simulation Computing Programming of Buildings Air-condition Energy efficiency . It is a sub-system of data input for Simulation Computing Programming of Buildings Air-condition Energy efficiency. The database uses the most common Access database system of Microsoft Office. It is small, flexible and easy to operate. It uses the Visual Basic language same to the main program , and can realize seamless connection with main program and is developed simply. It can exchange data with office automated softwares such as Word, Excel , simplify the analysis of result and report and the editing of research report ,it has the remarkably excellent. Before you use the database or you are using it, you may learn some knowledge about database, especial the knowledge of Access database.

1.2 Component of database and the name and content of label

The buildings database consist of many data tables and input interface(window). The names of the tables are shown in figure 1.1. The content of each table is shown in table1.1.

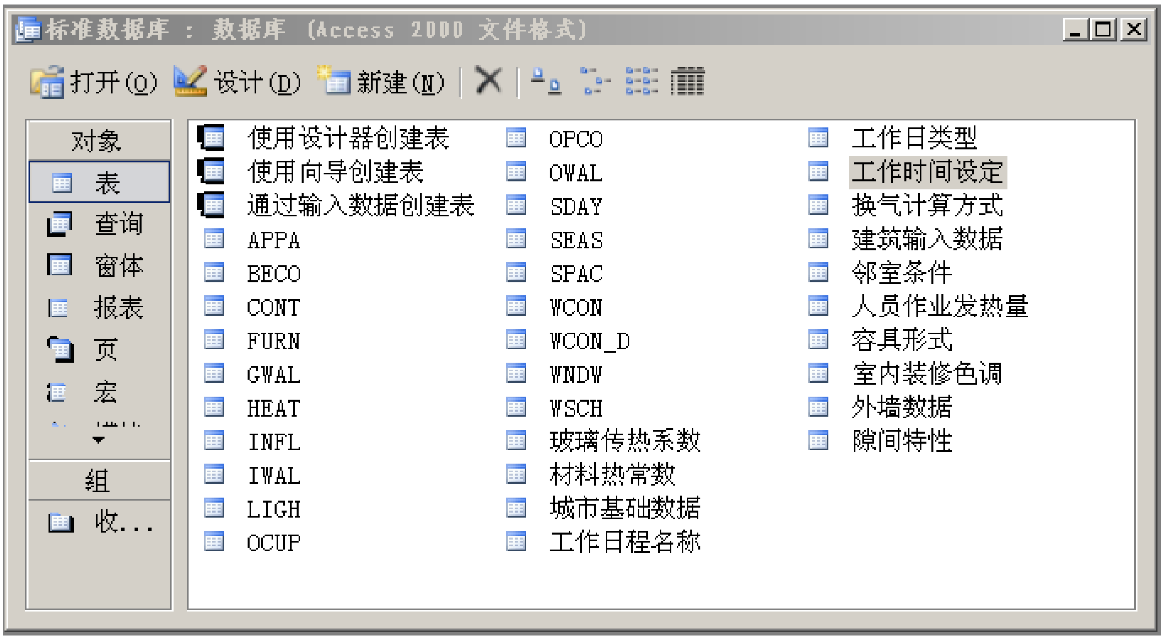


Figure 1.1: name of data table

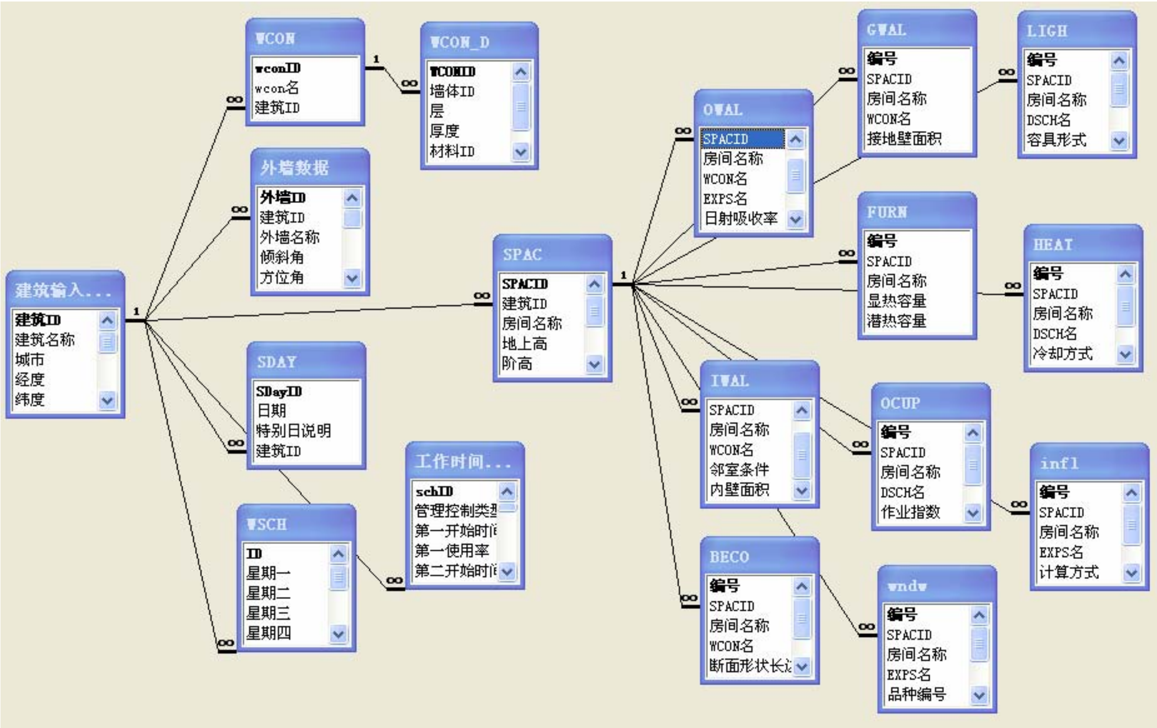
Table 1.1 content of data table

General data of architecture (Input person can operate)		The interior data of room (Input person can operate)		Basis data (The system administrator can login and edit)	
Table's	Stored content	Table's	Stored content	Table's name	Stored content

name		name			
Buildings's input data	Buildings's place ,temperature and humidity setting and so on.	BECO	Heterogenous component data	Heat coefficient of material	Diathermanous characteristic value of general buildings's material
External wall data	External wall's location direction and adjacent buildingss' situation	FURN	Room's thermal capacity	City's base data	Countrywide cities' name, longitude and latitude
OPCO	Air-condition device capacity, running start time and room's temperature and humidity setting of each season	GWAL	Grounding wall's data	Working schedule's name	Every kind of working schedule's name
APPA	Setting for stop time of running, the device's maximal heat elimination	HEAT	Inner heat capacity data	Workday's type	Name of full workday ,half working, full holiday
SEAN	Season setting of air-conditioner	INFL	Penetrative wind's data	Room decoration hue	Decoration's light and shade level
WCON	Name of wall body	IWAL	Internal room partition	Computing mode of air exchange change	Computing method's name of Clark's process or change times
WCON_D	Buildings wall's structure and material	LIGH	Light capacity	Clearance characteristic	Clearance characteristic description of buildings
WSCH	One week's work schedule	OCUP	Indoor personnel heat capacity	Diathermanous coefficient of glass	All kinds of diathermanous characteristics value of glass
Working time setting	One day's work schedule of device, light, personnel	WNDN	Window and window glass data	Personnel work's heat capacity	The description of working state and heat degree
SDAY	Special holiday's appointment in one year			Container's form	Light tool's category and installation style data
SPAC	Name, floor height, light control of room			Adjacent room's condition	Whether adjacent room has air-conditioner, room temperature or not

1.3 Relationship of each table

The relationship between tables uses “Relation” of the related database to connect. Its



Fiugre1.2 Mutual relation for each table

mutual relation is shown in figure 1.2. From figure 1.2, the total buildings data table has the highest level. It has the one-to-many relation with the other total buildings data and room table. And the room table has the one-to-many relation with the other room buildings component, personnel and devices. These one-to-many relations ensure “Integrality reference”,” Level linkage update relation” and “Level linkage deletion relation” of each table and record, namely, If you delete or update any record or field at higher level, then record and field of all correspond down records will be automatically deleted or updated. For example, if the buildings name of total buildings data is deleted, then all data records will be deleted and the database is empty. Similarly, if a room is deleted or the name is changed, then the corresponding room data will be deleted or the name be changed.

1.4 Composition of input interface

Shown in figure 1.3, a input interface consists of three big parts: header, main and record display:

Page header: consist of a decoration pattern and a title, no operation button.

Main body: the data input part of interface, can input or edit the data by the below explanation. When the operation is adding a new record, the main body ‘s background color will change to be light and sky-blue and “record browsing “indication word will change to “input new record”.

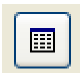
Record operation indication: located in the bottom of window, is made up of record location and display .These operations belong to the general knowledge of database operation, please refer to the operation manual of database. Using these buttons can move the edit operation to the record you want.

Record operation: consist of four buttons for record operation.

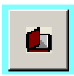
1）  Button for deleting record , delete the current record;

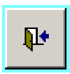
2）  Button for adding record , add a new record;

Figure 1.3 Input interface of room data

3）  Button for displaying record, pop up a table and display all records ,convenient for the reference of operation;

4）  Button for saving record , save the result of record's editing.

5）  Open help file.

6）  Exit, close window.

Chapter 2 System main interface

2.1 Main interface

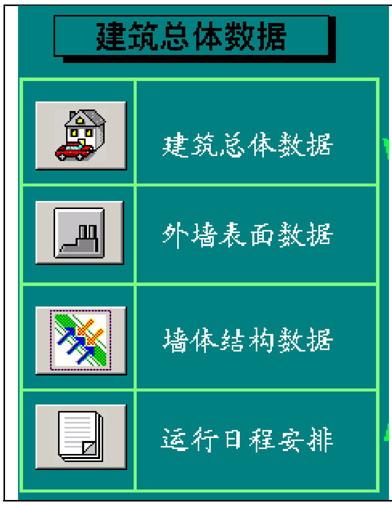
System main interface is shown as in Fig. 2.1, which will pop up as soon as the system

Fig. 2.1 System main interface.

starts up. System structure is the tree type. And the interface is divided into four parts: part of buildings general data, part of room data, part of components and equipments inside room, and part of air condition system equipments. Each part has several subsystems. And each subsystem corresponds to one or several data tables. All data can be inputted via this interface. When being familiar with Access database, you can input data through directly operating tables. But it is recommended to use these window interfaces in order to reduce input errors because many uniqueness and defaults are set via these window interfaces.

2.2 Part of buildings general data

Icons set of "Buildings general data", which are in the right part of the interface, include four input sub-interfaces: "buildings outline data", "external wall surface data", "wall body structure data", and "running schedule arrangement". When click on these icons, sub- interface will pop up and then input operation can be carried out.



	Accident occurring when click on the icon.
	Enter the buildings general data input interface.
	Enter the buildings external wall surface data input interface.
	Enter the wall body structure data input interface.
	Enter the schedule arrangement interface.

Fig. 2.2 The buildings general data interface

2.3 Part of air-condition system equipments setting

Settings on capacity of air-condition system and running conditions include three parts: “air-condition system running parameter set”, “equipment capacity set”, and “air-condition seasonal set”. The setting method and interface in details can be seen in the introduction of Chapter 4 “**Air-condition system equipment settings**”.

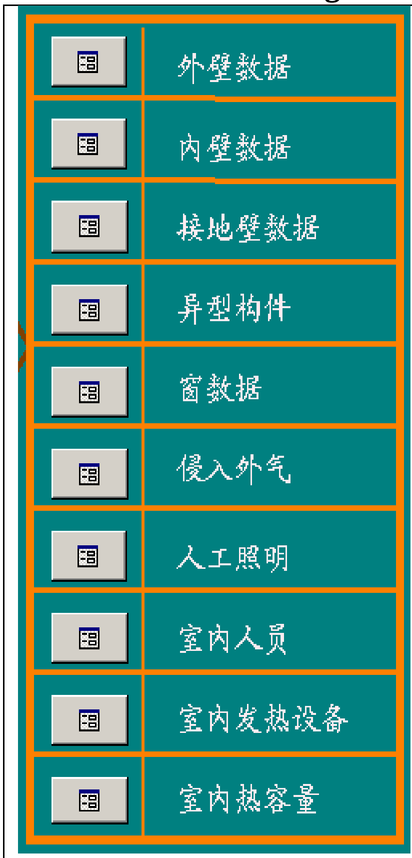
Air-condition system running parameter setting	Equipment capacity setting	Air-condition seasonal setting	Open the help files	Exit and close the interface

Fig. 2.3 Air-condition system equipment setting.

2.4 Part of room data management

Graphical interface	Operations and functions
	When click on the position of “select room”, the data interface, which describes the room, will pop up.
	Room name column. When double click the “room data input interface” corresponding to a room, one may edit the room data, and may also input a new room. Double click the line with “*” label to enter the “room data input interface” and input a new room.
	Recorder operation column. Check room recorders.

2.5 Room inner factor setting



Click the icon on the left side to enter the room external wall data input interface.
Click the icon on the left side to enter the room inner wall data input interface.
Click the icon on the left side to enter the room grounded wall data input interface.
Click the icon on the left side to enter the room special form components data input interface.
Click the icon on the left side to enter the room window data input interface.
Click the icon on the left side to enter the room invading outside air data input interface.
Click the icon on the left side to enter the room manual lightingdata input interface.
Click the icon on the left side to enter the indoor person data input interface.
Click the icon on the left side to enter the indoor heating equipment data input interface.
Click the icon on the left side to enter the indoor thermal capacity data input interface.

Fig. 2.5 **Room inner factor setting interface.**

Chapter3 Total data of buildings

3.1 Summary data of buildings

Calculate the indispensable data that totally describes the target buildings. Input interface as fig.3.1 shows, input data including: the name of buildings, located city, the height of buildings, surface reflectivity, the upper-limit heat of operating curtain, calculating method of run up, calculating date of run up, begin date of calculation, end date of calculation, design of indoor temperature, design of indoor humidity etc.. The date stored in "input data of buildings" table.

Figure 3.1: General data input UI for buildings

<u>Buildings name</u>: calculate the located city. select in pull-down menu of the item. City data stored in data sheet: 'essential data of city', including city name, longitude, latitude etc. after selecting city, longitude and latitude will automatically display in the item. When adding city in table 'essential data of city', you are able to operate after logging in with the status of 'system administrator'.

<u>Unit</u>: set system unit. International unit: W/M^2 and engineering unit $Kcal/M^2.h$, two kinds of setting. When you choose a certain unit, it will turn into corresponding unit in thermal

unit items of all interfaces, at the same time, the material value table of thermal constant will change correspondingly too, so you should pay attention to unit selection while inputting. $1W/M^2$=4.1816/3.6 $Kcal/M^2$.h.

The height of buildings: height from ground to summit of the buildings, the unit is meter.

Surface reflectivity: the reflecting intensity to sunlight of the environment around buildings , the unit is percentage. If the surrounding environment is coverings, such as surface of water, white snow, etc., this value is relatively high, on the contrary it is low, experienced value is 10, that is to say, the setting value to concrete pavement and general urban ground surface with certain green proportion.

The upper-limit heat of operating curtain: when the receiving value of heating is under the setting value, and there are occupants in room, the curtain will automatically establish the state of opening by the computer procedure. When the receiving value of heat is exceeding the setting value, the curtain will close automatically.

Calculating method of run up: calculate the computing method of the stable state of heat transfer, the value is 1~4, the higher this value is, the larger the heat storage of the room has. Default setting is 1, generally don't need set.

Calculating days of run up: set up in order to make heat transfer into heat stable state and improve calculation precision. The default setting of calculation days of run up in program is 10 days.

Begin date of calculation: it's the calculation begin date. Clicking the small triangle on the right of the column, the calendar will pop up automatically, then choose date, or input date directly in column, but should accord with the form of yyyy-mm-dd.

End date of calculation: it's the calculation end date, it is bigger than begin date. Clicking the small triangle on the right of the column, the calendar will pop up automatically, then choose date, or input date directly in column, but should accord with the form of yyyy-mm-dd.

Design of indoor temperature: the upper limit of basic temperature of air conditioner in summer, default setting is 24, the unit is ℃.

Design of indoor humidity: the upper limit of basic temperature of air conditioner in summer, default setting is 50, the unit is %. In main calculation program, use the design of indoor temperature and indoor humidity as basic index of receiving value of buildings and load of air conditioner, it's different from the temperature and humidity setting of the operating parameter of air conditioning, the former calculate basic temperature and humidity setting point, it is the receiving heat and load that cannot be disturbed by air conditioning, and the latter is the operating temperature and humidity for controlling air conditioning, their difference as shown in fig.3.2

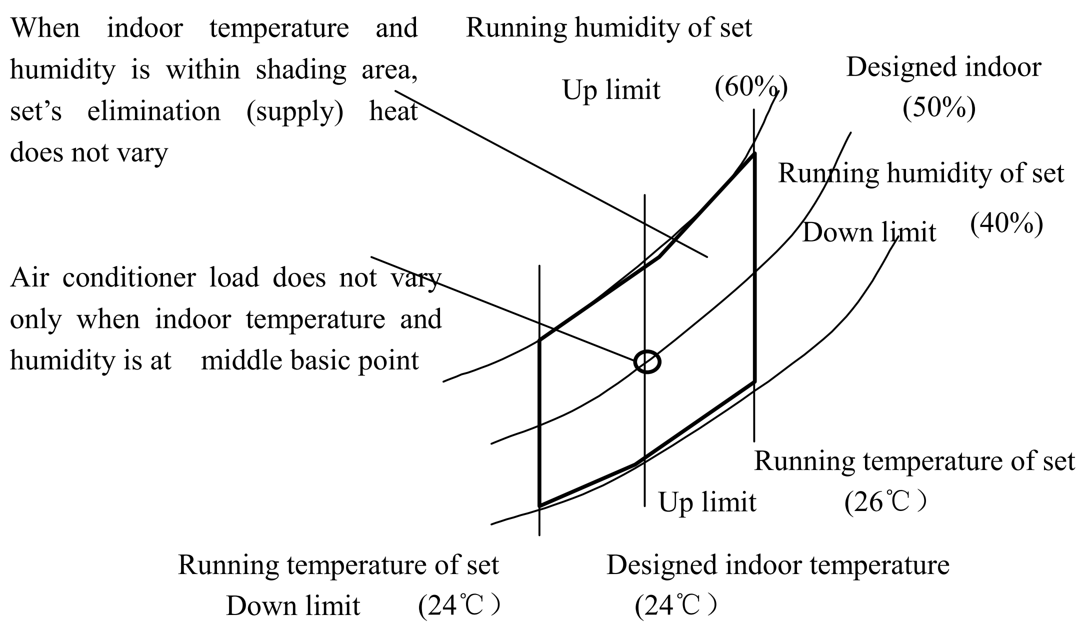


Figure 3.2 Different between designed indoor temperature and humidity and set's

3.2 Exterior wall surface

The inputting interface of exterior wall surface data as shown in fig.3.2.1, it is divided into three data field: relative position and distance of bordering buildings, sunshade parameter of window, azimuth and angle of inclination of exterior wall, etc. data stored in table: ‘exterior wall data’.

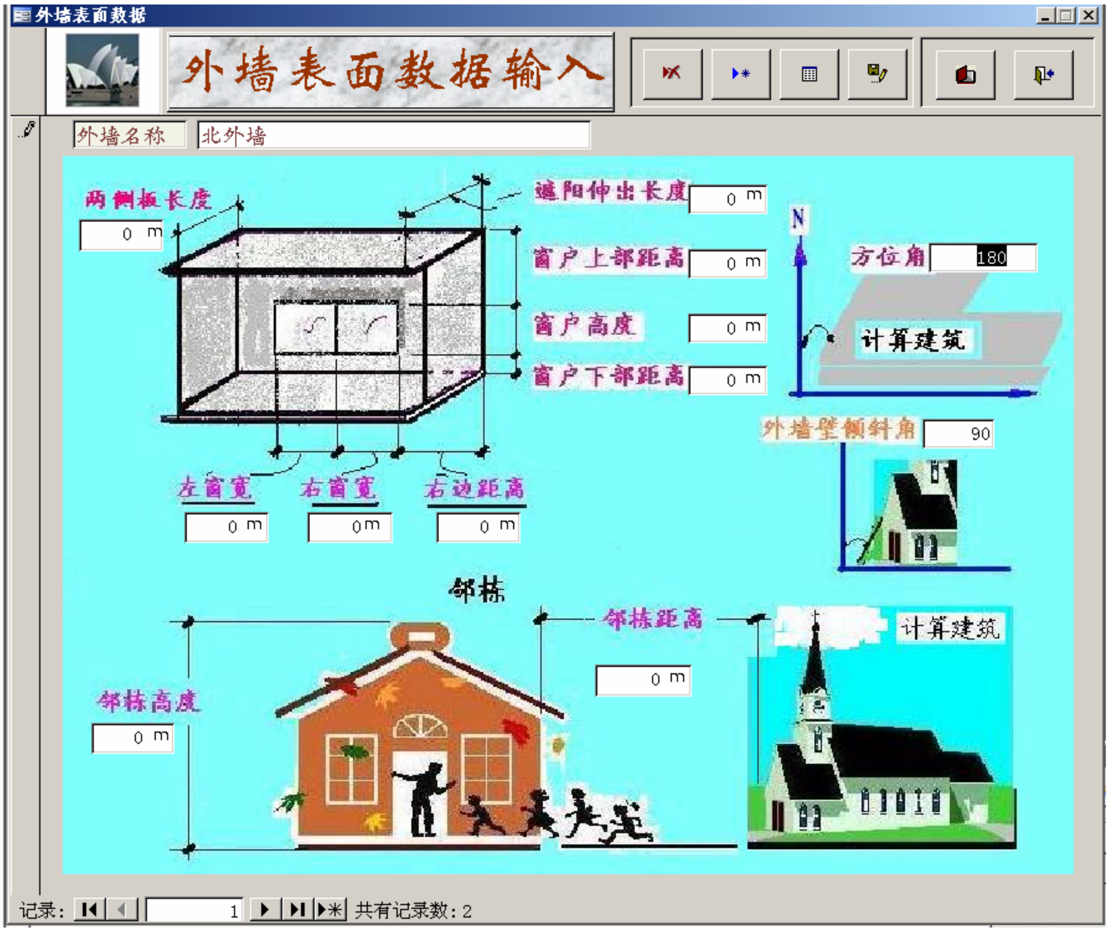


Figure 3.2.1 Data input UI of buildings external protection structure surface

3.2.1 Relative position and distance of the adjacent buildings

The existence of neighboured buildings has influence on the receiving heat of long wave radiation of sun, so it must input the height and distance of neighboured buildings correctly. It there is no neighboured buildings, the data is 0, the unit is meter.

3.2.2 Shading panelpanel data of window

Stretching length of shading panelpanel: the width from exterior of the top Shading panelpanel of the window to wall surface, the unit is meter.
Top distance of window: the distance from window frame to under Shading panelpanel, the unit is meter.
Height of window: the height of window frame, the unit is meter.

Distance of under part of the window: the distance from under part of window frame to the floor of the buildings, the unit is meter.
The length of both sides panel: the width of both sides of sun-shading panel, the width is 0 when no side panel, the unit is meter.
Right distance: the distance from right side of window to right side of wall, the unit is meter.
The width of right window: the width of right side window, the unit is meter.
The width of left window: the width of left side window, the unit is meter.

3.2.3 Azimuth and angle of inclination of exterior wall

Azimuth of exterior wall: take direction of north as 0°; the angle of inclination of exterior wall take direction of plumb as 0°, both take counter-clockwise as positive direction.

3.3 Structure of wall

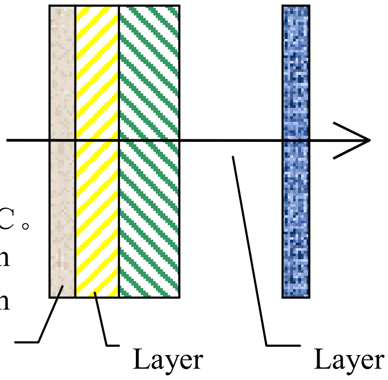
The structure of wall is the important factor of heat transfer of buildings. All structure of wall used in calculating should be inputted in this interface, and be quoted by room structure component. The data of wall name stored in table: 'WCON'. The interface of wall structure as fig. 3.31 shown, a wall structure includes two plates of 'wall name' and 'wall layer edit':

Figure 3.3.1 Input UI of wall body structure

Wall name: made up of ten English words, can input Chinese and symbol. Using operating record button at the bottom of inputting interface window can stir the wall record, edit the existing wall or increase new wall, or delete the existing wall.

Wall layer edit: the middle sub-window is inputting interface, including three items of 'layer', 'thickness', 'material', all records of wall layer is stored in the table: 'WCON-D'. Moving the mouse to the record of layer directly, or making use of the operating record button at the bottom of sub-window of wall layer can edit the existing wall layer or increase the new wall layer, or delete the existing wall layer.

$$K = \frac{1}{\frac{1}{\alpha_i} + \frac{\sigma_1}{\lambda_1} + \frac{\sigma_2}{\lambda_2} + \cdots + \frac{\sigma_r}{\lambda_r} + \frac{1}{\alpha_o}}$$



For equation:

K: Total heat conduction coefficient of wall body: W/m^2℃。

α_i: Indoor heat exchange coefficient, take 9.1 W/m^2℃。

α_o: Outdoor heat exchange coefficient, 20 W/m^2℃。

λ: Heat conduction coefficient of material W/m ℃

σ: Material layer thickness, unit:mm

1, 2, n Subscript label means layer serial number of material

Figure 3.3.2 Layer of wall body structure

Layer: does not need to input by hand, the system will record automatically according to the order.

Thickness: must input it, the unit is millimeter.

Material: it can only be chosen from pull-down menu. If you want to increase new material, you must logging in with the status of 'system administrator', then operating the table: 'thermal constant of material' to increase or edit.

Heat transfer coefficient: database calculate the total heat transfer coefficient of wall automatically, and display on interface. The calculating definition and calculating formula of heat transfer coefficient please refer to the fig. 3.3.2.

1) Exterior wall and interior wall: both start from the interior surface of room, as shown in fig.3.3.2, Input materials of every layer in turn;
2) Ground wall: the so-called ground wall, as shown in fig. 3.3.3, refer to those wall connected with ground, generally quoted by 'ground wall' of room data. Inputting method is: from top (ground level) to down, input materials data of every layer in turn, then up to the domain basic soil, at last input the data of soil, but don't require the thickness of soil.

3) Heterogenous component: the so-called heterogenous component refers to the structure of girder and column, etc. The inputting method is shown in fig.3.3.4; from the surface of component to the core, input in turn, the thickness of the core is not required.

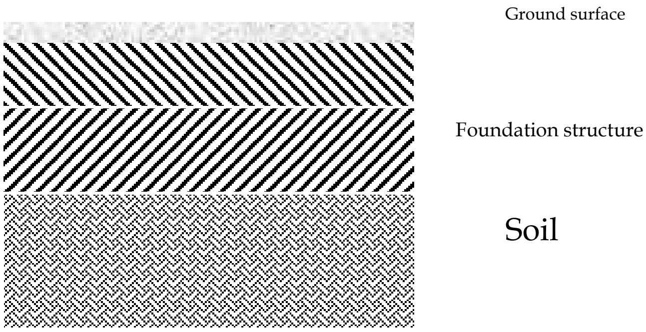


Figure 3.3.3 Representation of

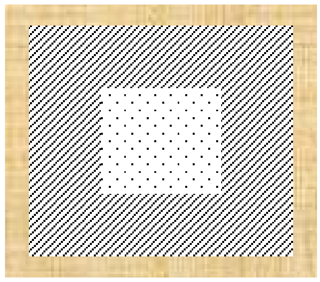


Figure 3.3.4 Representation of heterogenous

3.4 Schedule

The use of buildings and operation of air condition change with occupant's life, this interface can set every kinds of schedule which influences the load. The interface is shown in fig.3.4, it is composed of 'week schedule', 'special festival' and 'setting of every kinds of working time', etc, its purpose and setting methods is following:

3.4.1 Week schedule

The sub-window of 'Week schedule' lies in the left of interface, it can set three kinds of 'whole working day', 'half working day' and 'whole rest day' from Monday to Sunday, festival and special day. It is operated by pull-down menu. The beginning and the ending of 24 hours of 'whole working day' and 'half working day' are decided by the sub-window---'setting of every kinds of working time', which is under right of the inputting interface. 'Rest pf whole rest day' shows that nobody works in 24 hours of the day, air condition does not work.

3.4.2 Special festival

Setting sub-window of 'Special festival' lies up left of the inputting interface, it can help customers to set several legal holiday and holiday of the enterprise own. The working time mode of 'special festival' follows the setting of 'week schedule', contains three kinds of 'whole working day', 'half working day' and 'whole rest day'.

3.4.3 Setting of every kinds of working time

Setting sub-window of ‘every kinds of working time’ lies under left of the inputting interface, it can set every kinds of working time with people and equipments by eight period of time, the setting value is integral percentage. The time can set to minute, but the data of the standard weather parameter of main program which is used to calculate the load is separated by 1 hour. Therefore, the time set here such as
8:35 will follow the round principle. That is to say, when the time is longer than 30 minutes, it goes to the last hour, on the contrary, it goes to the next hour to deal with. For example, 8:30 will be displayed as 9:00. if the air conditioner is working all day, it will be divided into two stage: the first beginning time is 0:00, the other beginning time is the time which is bigger than 23:30, the usage rate of the two stage are both 100%.

Figure 3.4 Data input UI of workday schedule

Chapter Four Setting of air conditioning system

The settings of capacity and operating conditions of air conditioning system comprise: “Operating parameter setting of air conditioning system”, “Capacity setting of system”, “Season setting of air conditioning”. Their positions and icons in the general data interface of buildings are shown as follows:

Operating parameter setting of air conditionin g system	Capacity setting of system	Season setting of air conditionin g	Open help documents	Exit and close interface

[空调系统操作设定]——Operation setting of air condition system

4.1 Operating parameter setting of air conditioning system

[Fig 4.1: 空调系统运行参数设定：Operating parameter setting of air conditioning system；空调系统运行参数界面 Operating parameter interface of air conditioning system；房间名称：room name；系统整体设定 system integrated setting；提示：attention；单击此处创建或编辑“系统整体设定”：Click here to create or edit “system integrated setting”；夏季运行参数：operation parameters of summer；过渡季运行参数：operation parameters of transition season；冬季运行参数：operation parameters of winter；运行开始时间：Operation start time；干球温度上限：Upper limit of dry-bulb temperature；干球温度下限：Lower limit of dry-bulb temperature；相对湿度上限：Upper limit of relative humidity；相对湿度下限：Lower limit of relative humidity；记录：Records；共有记录数：Total number of records]

In order to set various kinds of air conditioning systems flexibly, the program was designed to enable not only to set the operation of central air-condition system as a whole, but also to set units of various rooms such as fan-coil individually. The settings include such items as room name, bound of dry- and wet-bulb temperatures in room of winter, summer, and transition seasons, and so on. And the interface is shown in Figure 4.1.

Room Name: Select individual room or system integrated parameter which is to be set from pull down menu. The program has set air condition system parameters of the integrated system with default values in advance. When a new buildings calculation project is set, and the interface is opened for the first time, the default values of the system integrated setting will be shown. You can also change these settings according to your needs. However, it is commended to adopt these standard settings. Press “prompt button” on the right, then you will return to the position of system integrated setting. “System integrated settings ” will not be deleted. When you attempt to delete the records, a prompting dialog box will pop up to stop such operation.

The lower part of interface is divided into three sections of winter, summer, and transition season (The season setting refers to “season setting” interface), where operating time, dry- and wet-bulb temperatures are set individually.

Operation start time: The time when the air condition system is started up.

Upper limit of dry-bulb temperature: When dry-bulb temperature in room is lower than or equal to this temperature limit, the sensible heat removed or supplied by equipments of

Figure 4.1 Parameter setting interface of air conditioning system

the system is the sensible heat at the temperature.

Lower limit of dry-bulb temperature: When dry-bulb temperature in room is higher than or equal to this temperature limit, the sensible heat removed or supplied by equipments of the system is the sensible heat at the temperature.

Upper limit of wet-bulb temperature: When wet-bulb temperature in room is lower than or equal to this temperature limit, the latent heat removed or supplied by equipments of the system is the latent heat at the temperature.

Lower limit of wet-bulb temperature: When wet-bulb temperature in room is higher than or equal to this temperature limit, the latent heat removed or supplied by equipments of the system is the latent heat at the temperature.

4.2 Capacity setting of air condition system

[Fig 4.2：装置容量参数界面：Interface of system's capacity parameters；房间名称：room name；系统整体设定 system integrated setting；提示：attention；单击此处创建或编辑“系统整体设定”：Click here to create or edit “system integrated setting”；使用开始时间：Operation start time；平日运行停止时间 Operation stopped time of mean day；半日运行停止时间 Operation stopped time of half day；装置最大除去显热量：Maximum sensible heat removal capacity of the equipments；装置最大除去潜热量：Maximum latent heat removal capacity of the equipments；装置最大供给显热量：Maximum sensible heat supplying capacity of the equipments；装置最大供给潜热量：Maximum latent heat supplying capacity of the equipments；记录：Records；共有记录数：Total number of records]

In this interface, various parameters of the whole system, or air-condition equipments of individual is set. The interface is shown in Figure 4.2, and the settings include such

Figure 4.2 Setting interface of system’s capacity parameters

items:

Room Name: Select individual room or whole system which is to be set from pull down menu. The program has set capacity parameters of air condition equipments of the integrated system with default values in advance. When a new buildings calculation project is set, and the interface is opened for the first time, the default values of the integrated system will be shown. You can change these settings according to your needs. However, it is commended to adopt these standard settings. Press “prompt button” on the upside, then you will return to the position of integrated system setting. “System integrated settings ” will not be deleted. When you attempt to delete the records, a prompting dialog box will pop up to stop such operation.

Operation start time: The time when the air condition equipments in the room are started up. The default is 8:00.

Operation stopped time of mean day: the time when the air-condition system in room is stopped at mean-day. The default is 18:00.

Operation stopped time of half day: the time when the air-condition system in room is stopped at half mean-day. The default is 13:00.

Maximum sensible heat removal capacity of the equipments: Refrigerating unit capacity of the air-condition system in room removing sensible heat in room.

Maximum latent heat removal capacity of the equipments: Refrigerating unit capacity of the air-condition system in room removing latent heat in room.

Maximum sensible heat supplying capacity of the equipments: Heating unit capacity of the air-condition system in room supplying sensible heat.

Maximum latent heat supplying capacity of the equipments: Heating unit capacity of the air-condition system in room supplying latent heat.

The above four item is set depending on “International unit” or “Engineering unit” set in “general inputting interface of buildings”. When the column is blank, the capacity of equipments is infinite, i.e. the temperature and humidity in room will be adjusted to the set values as soon as the air condition system is started up.

4.3 Season setting of air conditioning

[Fig 4.3：季节设置界面：Season setting interface；单击此处回到标准设置：Click here, it will return to standard setting；一月：January；二月：February；三月：March；四月：April；五月：May；六月：June；七月：July；八月：August；九月：September；十月：October；十一月：November；十二月：December；冬季：Winter；过渡季：Transition；夏季：Summer]

The interface where the seasons of months in a year, from January to December, are set is shown in Figure 4.3. The standard settings of system are: winter comprises four months, namely December, January, February, March; transition season comprises April, May, October, November; summer comprises June, July, August, September. You can reset the seasons of various months via pull-down menu, for example the calculated object is located in such southern hemisphere country as Australia. However, it is commended to adopt these standard settings. Click the header, then the seasons will be set as standard default.

Figure 4.3 Season setting interface

Chapter Five Room Settings

Room is the elementary calculating unit in this program. In general, the buildings of calculated object is composed of many rooms. The room names are listed in main interface as shown in Figure 5.1. Every room comprises ten data blocks of structure and equipments: external wall, internal wall, grounded wall, heterotypic components, windows, invading air, artificial illumination, indoor personnel, indoor heating equipments, and indoor thermal capacity.

<table>
<tr><th>Picture of interface</th><th>Operations and functions</th></tr>
<tr><td rowspan="3">

选定房间 selected room
主卧室 master bedroom
房间名称 room name
客厅 living room
工作室 workroom
书房 study room
卫生间 toilet
餐厅 dining-room
临时来客室 temporary reception room</td><td>Click “select room”, then a data interface will pop up describing this room.</td></tr>
<tr><td>Room name column. Doulbe-click the column, then “Room data inputting interface” of corresponding room will pop up. Now data of the room can be edited. A new room can also be inputted here. Double-click the line with symbol “*”, you will enter “Room data inputting interface”, where new room can be inputted.</td></tr>
<tr><td>Record operating column. Room records can be reviewed here.</td></tr>
</table>

5.1 Room integrated data inputting interface

When you double click room column, “Room integrated data inputting interface” will pop up immediately as picture shown in Figure 5.2. You can add or delete room via this interface, and can also edit and change the room integrated data.

After the integrated data of buildings is inputted, room data should be inputted immediately. Room data is stored in “SPAC” table, which is composed of such items as room name, room height, floor height, ceiling height, shading of decoration, room area, and so on. Meanings and data formats are as follows:

Room name: It is composed of letters not more than 30 or Chinese characters not more than 15, and it have to be inputted.

Controlled values	Lighting control	Indoor decoration tune
0	No control	Needn’t fill
1	Control	Light
2	Control	Middle
3	Control	Shady;

[Fig 5.2：房间数据输入界面：Room data inputting interface；房间名称：room name；主卧室：master bedroom；顶棚：ceiling；楼层高：floor height；顶棚高：Ceiling height；地板：floorpanel；房间地面距建筑平面的高：Height between room floor and buildings plane；装修明暗：Shading of decoration；不利用昼光：Free of applying daylight；熄灯范围：Range of lights out；地板面积：Area of floorpanel；记录：records；共有记录数：Total number of records]

Height between room floor and buildings plane: The distance between floor and the local level of the buildings. The unit is meter.

Floor height: Room’s height of structural floor, i.e. the height between floor of the

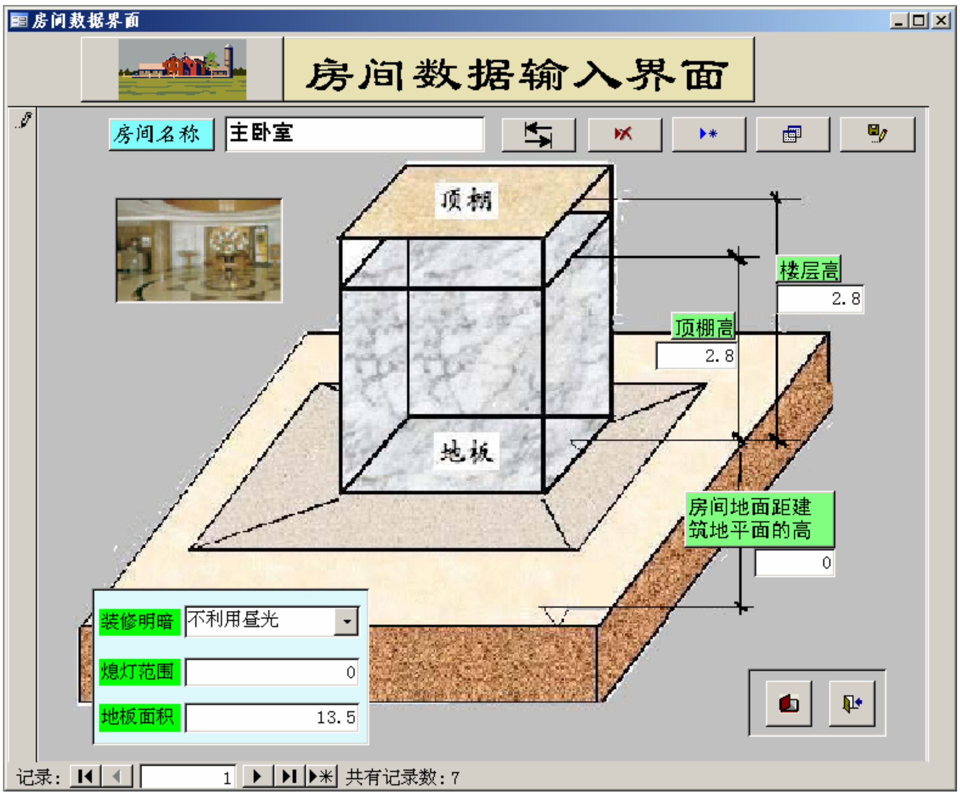


Figure 5.2 Room data-inputting interface

calculated room and floor of the above room. The unit is meter.

Ceiling height: Height between ceiling panel and floorpanel. The unit is meter.

Shading of decoration: The settings in the case of lighting control using daylight. Relations between the set values and interior finish is shown in the right table.

Range of lights out: The range interval of light out in case that lighting control using daylight is adopted, from window to the center in room. The unit is meter.

Area of floorpanel: Buildings area of room.

5.2 Icon of "Select room"

[Fig 5.3：房间整体数据 Room integrated data；房间名称 room name；距地面标高 height above ground；层高 Floor height；顶棚高 Ceiling height；昼光利用照明控制 lighting control using daylight；熄灯范围 Range of lights out；房间面积 area of room]

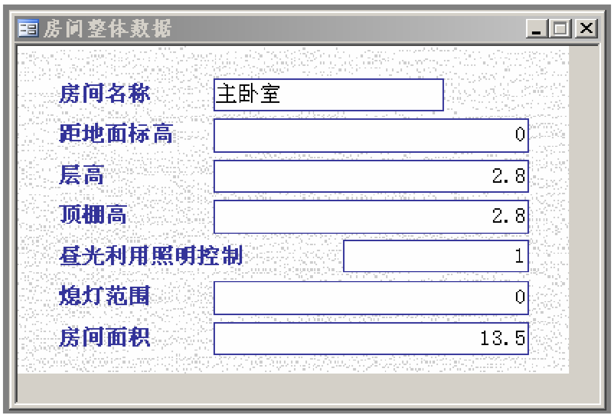


Figure 5.3 Display of room integrated data

Click text box of "Select room" in the above figure, the interface shown in 5.3 where "Room integrated data" is selected will pop up. You can edit room data in this interface.

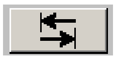
5.3 Function of copying room

[Fig 5.4：复制房间：copy room；窗体：windows；复制房间全体数据：copy all the data of room；复制房间数据的步骤：procedures of copying room data；选定左边的"源房间"：Select "source room" on the left；选定右边的"目标房间"：Select "objective room" on the right；点击图标执行操作：Click iron to perform operations；源房间：source room；目标房间：objective room；房屋名称：room name；餐厅：dining-room；工作室：workroom；客厅：living room；临时来客室：temporary reception room；书房：study room；卫生间：toilet；主卧室：master bedroom]

Figure 5.4 Copying of room integrated data

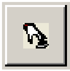
In order to reduce inputting work, the program provide a function of copying room. When you click the icon  in Room data inputting interface shown in Figure 5.2, the interface to copy room data will pop up immediately as shown in Figure 5.4. The procedures of copying room are as follows:

1）Create a new room via “Room data inputting interface” shown in Figure 5.2.

2）Click  in Room data inputting interface, interface of “Copy room data” shown in Figure 5.4 will be entered.

3）Select the room of data source to be copied from “source room”.

4）Select the room of copying object from “target room”.

5）Click iron  to carry out copying.

After these procedures, the ten data blocks of “source room ”, external wall, internal wall, grounded wall, heterotypic components, windows, invading air, artificial illumination, indoor personnel, indoor heating equipments, and indoor thermal capacity, then is added to “target room”.

Chapter Six Room interior data inputting interface

A room is composed of such parts as various structural components, equipments and personnel. Every component comprises various items. These items are all inputted via "Room interior data interface". Windows of Room interior data inputting interface are all

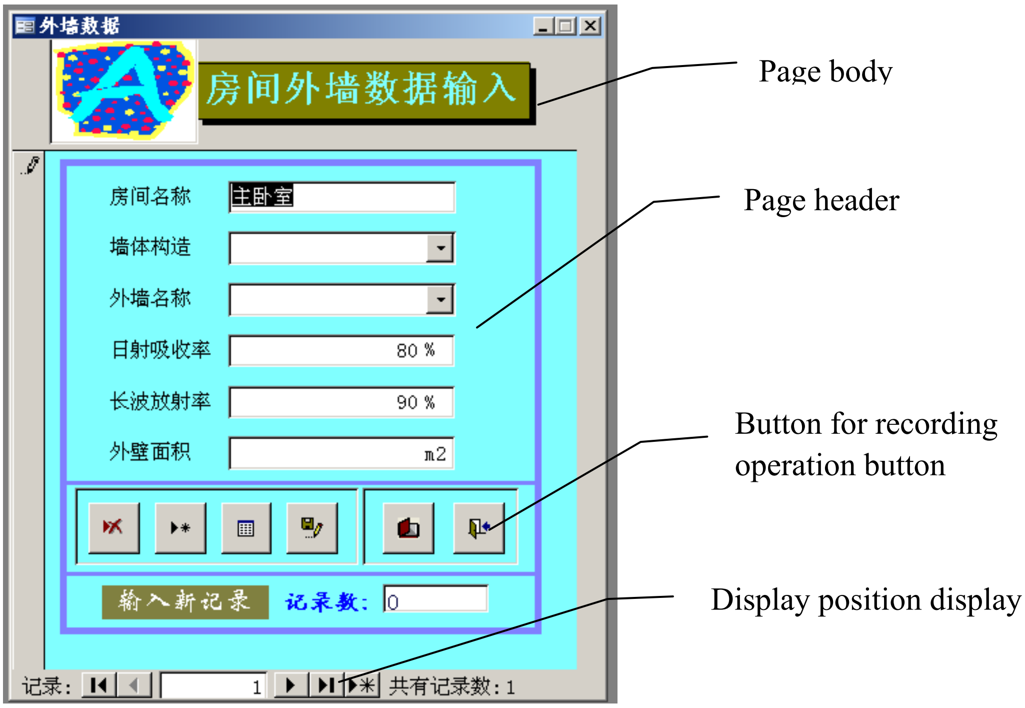


Figure 6.1 Data inputting interface

in the same form, which is illustrated taking external wall data inputting interface shown in Figure 6.1 for instance:

6.1 External wall data

A room can have several external walls, every external wall with one record. All the records are memorized in the "OWAL" table. External wall data inputting interface is shown in Figure 6.1, meanings and inputting methods of various items in which are as follows:

Figure 6.2 Internal wall data-inputting interface

Room name: It is brought from main interface, which cannot be changed.

Walling structure: It is selected from pull-down menu. Walling in the list of pull-down menu is defined by “walling structure” of general data of buildings.

Name of external wall: It is selected from pull-down menu. External wall in the list of pull-down menu is defined by “external wall surface” of general data of buildings.

Insolation absorption ratio: solar radiation absorptivity of external wall. In general, the empirical value of buildings walling work is about 80%.

Long-wave reflectance ratio: long-wave radiation reflectivity of external wall. In general, the empirical value of buildings walling work is about 90%.

Area of external wall: It must be filled, and cannot be 0. The unit is square meter.

Figure 6.3 Grounded wall data inputting interface

[Fig 6.1 页眉：page header；页面主体：principal part of page；纪录操作按钮：button of record operation；纪录位置显示：showing record position；房间外墙数据输入：Room external wall data inputting；房间名称：room name；主卧室：master bedroom；墙体构造：Walling structure；外墙名称：Name of external wall；日射吸收率：Insolation absorption ratio；长波吸收率：Long-wave reflectance ratio；外壁面积：Area of external wall；输入新记录：inputting new record；记录数：number of records；记录：records；共有记录数： Total number of records]

6.2 Internal wall data inputting interface

Fig 6.2：内壁数据：Internal wall data；内壁条件输入：internal wall conditions inputting；房间名称：room name；墙体构造：Walling structure；邻室条件：Conditions of next room；内壁面积：area if interior wall；输入新记录：inputting new record；记录数：number of records；记录：records；共有记录数：Total number of records]

Internal wall refers to interior walls and partitions that are not exposed externally. Its inputting interface is shown in Figure 6.2, and its data comprises four items: room name, walling structure, conditions of next room, and area of internal wall. Meanings and inputting methods of various items are as follows:

Room name: It is brought from main interface, which cannot be changed.

Walling structure: It is selected from pull-down menu. Walling in the list of pull-down menu is defined by “walling structure” of general data of buildings.

Conditions of next room: It is selected from pull-down menu. There are only two options: =0 means that conditions of the calculated room are the same as conditions of the next room, =1 means that room temperature of the next room = (outdoor air temperature + designed room temperature) / 2. These calculations are automatically set in main program, and needn’t be designated by programmer.

Area of internal wall: It must be filled, and cannot be 0. The unit is square meter.

[Fig 6.3：接地墙壁：Grounded wall；接地壁数据输入：Grounded wall data inputting；房间名称：room name；餐厅：dinning room；墙体构造：Walling structure；接地壁面积：Area of grounded wall；输入新记录：inputting new record；记录数：number of records；记录：records；共有记录数：Total number of records]

6.3 Grounded wall data inputting interface

Grounded wall describes the features of the walls contacting with natural ground surface. Its inputting interface is shown in Figure 6.3, and its data comprises three items: room name, walling structure, and area of grounded wall. Meanings and inputting methods of various items are as follows:

Room name: It is brought from main interface, which cannot be changed.

Walling structure: It is selected from pull-down menu. Walling in the list of pull-down menu is defined by “walling structure” of general data of buildings.

Area of grounded wall: It must be filled, and cannot be 0. The unit is square meter.

6.4 Heterotypic components

[Fig 6.4：异型构件：Heterotypic components；异型构件数据输入：Data inputting of heterotypic components；房间名称：room name；餐厅：dinning room；墙体构造：Walling structure；断面长边；Long-side of cross section；断面短边：short-side of cross section；构件长度：length of component；输入新记录：inputting new record；记录数：number of records；记录：records；共有记录数：Total number number of records]

Figure 6.4 Heterotypic component data inputting interface

Heterotypic components refer to indoor structure components of buildings such as beam column and so on. Its inputting interface is shown in Figure 6.4. And its data comprises five items: room name, long-side length of cross section, short-side length of cross section, and peripheral length of component. Meanings and inputting methods of various items are as follows:

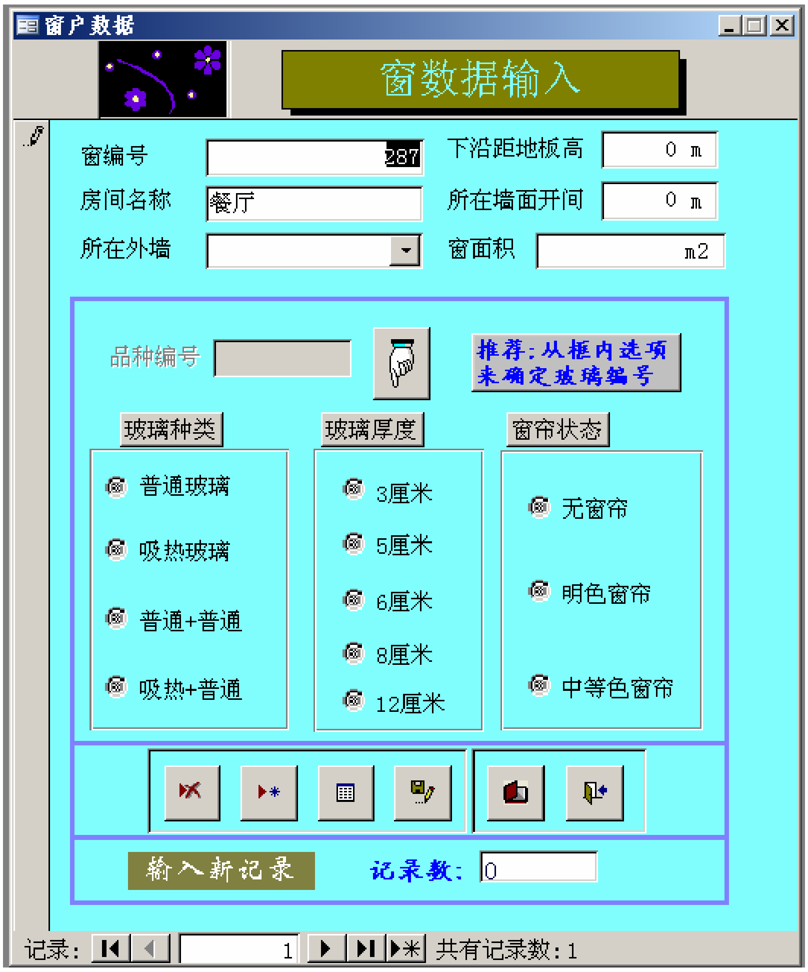


Figure 6.5 Window glass data-inputting interface

Room name: It is brought from main interface, which cannot be changed.

Walling structure: It is selected from pull-down menu. Walling in the list of pull-down menu is defined by “walling structure” of general data of buildings.

Long-side length of cross section: long-side length of cross section of beam column. It must be filled, and cannot be 0. The unit is meter.

Short-side length of cross section: short-side length of cross section of beam column. It must be filled, and cannot be 0. The unit is meter.

Peripheral length of component: length of beam column. It must be filled, and cannot be 0. The unit is meter.

[Fig 6.5：窗户数据：Window data；窗数据输入：Window data inputting；窗编号：serial number of window；房间名称：room name；所在外墙：window-located external wall；下沿距地板高：height between lower side and floorpanel；所在墙面开间：bay of window-located wall；窗面积：area of window；品种编号：serial number of kind；推荐：commending；从框内选项来确定玻璃编号：the serial number of glass is determined via items within box；玻璃种类：kind of glass；普通玻璃：simple glass；吸热玻璃：antisolar glass；普通+普通：double-layered simple glass；吸热+普通：simple + antisolar glass；玻璃厚度：thickness of glass；厘米：centimeter；窗帘状态：state of curtain；无窗帘：colorless curtain；明色窗帘：tint curtain；中等色窗

帘：medium shade curtain；输入新记录：inputting new record；记录数：number of records；记录：records；共有记录数：Total number of records]

6.5 Window data inputting interface

Window data refers to various characteristic values of window to be inputted. Its inputting interface is shown in Figure 6.5, and the data comprises two parts: one, architectural positions and sizes of windows, including such five items as serial number of window, room name, window-located external wall, height between lower side and floorpanel, bay of window-located wall, and area of window; the other, glass of windows, including such items as serial number of glass, kind of glass, thickness of glass, state of curtain, and so on. Meanings and inputting methods of various items are as follows:

Serial number of window: a automatic serial number assigned by system when data is created. It cannot be inputted or changed.

Room name: It is brought from main interface, which cannot be changed.

Window-located external wall: It is selected from pull-down menu. External wall in the list of pull-down menu is defined by “external wall surface” of general data of buildings.

Height between lower side and floorpanel: height between lower side of window and floorpanel of calculated room. The unit is meter.

Bay of window-located wall: Height of the wall on which window is located. The unit is meter.

Area of window: Inner frame area of window. It must be filled, and cannot be 0. The unit is square meter.

Glass of windows:

Serial number of glass type: serial number of glass type in “Table of glass heat transmission coeffcient”. These data can be inputted directly according to the table. However, for the purpose of accuracy and convenience, it is commended to use the under inputting interface, where the serial number is determined depending on kind of glass, thickness, and state of curtain. When the following items are selected, click the icon of downward finger, system will find the serial number of glass type automatically depending on kind of glass, thickness, and state of curtain, and show it in the column of serial number of type.

Kind of glass: including four kinds, simple glass, antisolar glass, double-layered simple glass, and simple + antisolar glass. The options can be selected using selecting button.

Thickness of glass: There are five options from 3 to 12 mm. You can choose anyone among them.

State of curtain: There are three options including colorless, tint, and medium shade. You can choose anyone among them.

6.6 Invading air data inputting interface

[Fig 6.6：侵入外气：Invading air；侵入外气输入：Invading air inputting；房间名称：room name；餐厅：dinning room；外墙名称：external wall name；计算方式；calculation method；缝隙特性法：gap feature method；缝隙特性：gap feature；缝隙长度：length of gap；换气次数：ventilation rate；输入新记录：inputting new record；记录数：number of records；记录：records；共有记录数：Total number of records]

Figure 6.6 Invading air data-inputting interface

Gap feature		
Grade	Fixed size	**Description**
1	.2	With air-tight fitting
2	.9	Single-leaf doors or sash windows with sealing strip, or wooden upper and lower doors and windows with decorative strips
3	3.2	With sealing strip and can open from both right and left side, or high-quality wooden doors and windows
4	12.9	Without air-tight sealing strip, or mid or low-quality wooden doors and windows

Features of air pervading from the outdoor to the indoor due to differential pressure are inputted via this interface. The inputting interface is shown in Figure 6.6. And the data comprises such three items as room name, name of external wall, and calculating method, which are memorized in “INFL” table. Meanings and inputting methods of various items are as follows:

Room name: It is brought from main interface, which cannot be changed.

Name of external wall: It is selected from pull-down menu. External wall in the list of pull-down menu is defined by “external wall surface” of general data of buildings.

Calculating method: including two methods, Clarke method and ventilation rate method. You can choose either from pull-down menu. Then corresponding coefficient inputting column on the right will turn into inputting-ready state with highlight automatically.

While Clarke method is selected, length of gap needn't be inputted. The gap features will be selected by system automatically referring to the following table. The table is memorized in "Gap feature" table. Gap feature table can be edited by system administrator after its entry.

While ventilation rate method is selected, the calculation of pervading air is performed in main program, and the formula is: ventilation volume = ventilation rate×room volume (room area × ceiling height). If you consider that external pressure is negative, the inputting value should be 0. Length of gap needn't be inputted.

6.7 Artificial lighting data inputting interface

[Fig 6.7：人工照明：Artificial lighting；人工照明数据输入：Artificial lightingdata inputting；房间名称：room name；餐厅：dinning room；室内照度：Indoor illuminance；开启操作时间设定：Start-up of operation time setting；电器容量：Capacity of electric appliances；器具种类安装形式：Instrument kinds and installing forms；照明控制时间：lighting control time；单位：unit；输入新记录：inputting new record；记录数：number of records；记录：records；共有记录数：Total number of records]

Various characteristic values of artificial lighting are inputted here. The inputting interface is shown in Figure 6.7. And the data comprises six items: room name, start-up of operation time setting, instrument kinds and installing forms, indoor illuminance, capacity of electric appliances, and units. Meanings and inputting methods of various items are as follows:

Room name: It is brought from main interface, which cannot be changed.

Start-up of operation time setting: It is selected from pull-down menu. Data in the list of pull-down menu is defined by "working hours setting" of general data of buildings.

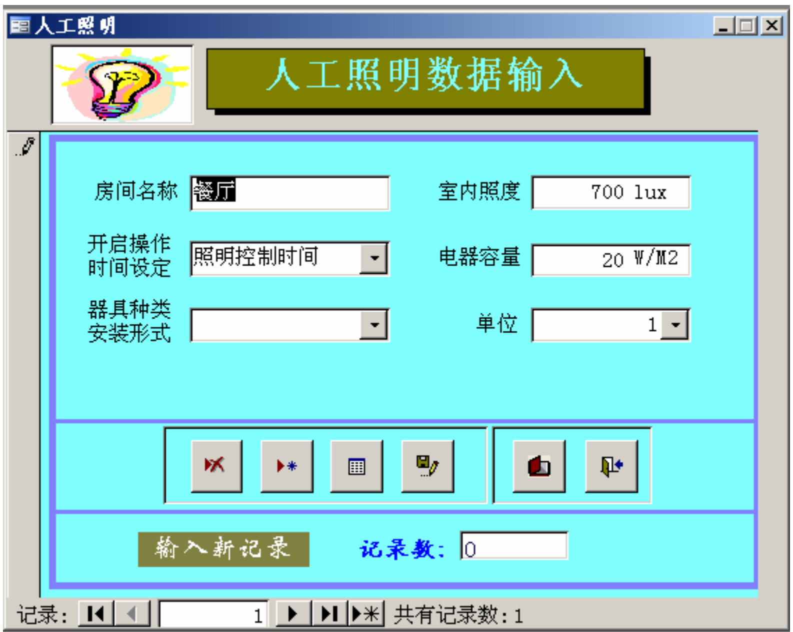


Figure 6.7 Artificial lightingdata inputting interface

Instrument kinds and installing forms: It is selected from pull-down menu. Installing forms in the list of pull-down menu is defined by "Table of instrument kinds" of basic table in database. Here "lighting control time " is selected in general.

Indoor illuminance: designed lumen value of indoor illuminance. The empirical value of general office setting ranges from 500 to 700.

Capacity of electric appliances: output power of light fitting. The unit is determined by the following item "Units".

Units: There are two options, W/m^2 and KW.

Figure 6.8 Indoor personnel data inputting interface

[Fig 6.8 室内人员：Indoor personnel；在室人员数据输入：Indoor personnel data inputting；房间名称：room name；作业状态：Operating state；在室人数：number of indoor person；开启操作时间设定：start-up of operation time setting；员工休息时间：rest time of personnel；单位：unit；输入新记录：inputting new record；记录数：number of records；记录：records；共有记录数：Total number of records]

Operation heating value of personnel			
Intensity index	**Operating state**	**Complete thermal value**	**Scope**
1	Sitting still	79	Theater
2	Light work	91	School
3	Office work, light movement	102	Office, Hotel
4	Alternating among sitting, standing and moving	113	Bank
5	Light work in sitting form	125	Restaurant
6	Medium work in sitting form	170	Light work in plant
7	Medium-intensity dancing	194	Ballroom
8	Pacing with speed of 4.8KM/H	227	Heavy work in plant
9	Playing bowling	329	Alley

6.8 Indoor personnel data inputting interface

Various characteristic values of indoor personnel are inputted via this interface. The inputting interface is shown in Figure 6.8. And the data comprises five items: room name, operating state, start-up of operation time setting, number of indoor persons, and units. Meanings and inputting methods of various items are as follows:

Room name: It is brought from main interface, which cannot be changed.

Operating state: It is selected from pull-down menu. Data in the list of pull-down menu is defined by "operation heating value of personnel" of basic table in database.

Start-up of operation time setting: It is selected from pull-down menu. Data in the list of pull-down menu is defined by "working hours setting" table of general data of buildings. Here "personnel timetable" is selected in general.

Number of indoor persons: amount of indoor personnel. The empirical value of general office setting is 0.2 person/m^2.

Units: There are two options, person/m^2 and person.

Figure 6.9 Data inputting interface of indoor heating equipments

6.9 Data inputting interface of indoor heating equipments

Various characteristic values of indoor heating equipments are inputted via this interface. The inputting interface is shown in Figure 6.9. And the data comprises five items: room name, start-up of operation time setting, cooling method, quantity of sensible heat, and quantity of latent heat. Meanings and inputting methods of various items are as follows:

Room name: It is brought from main interface, which cannot be changed.

Start-up of operation time setting: It is selected from pull-down menu. Data in the list of pull-down menu is defined by "Table of working hours setting" of database. Here "Startup-stop time of internal equipments" is selected in general.

Cooling method: It is selected from pull-down menu, options including natural cooling and forced cooling.

Quantity of sensible heat: quantity of sensible heat spreading in room. Here empirical value is applied. The unit is kcal/h.

Quantity of latent heat: quantity of latent heat spreading in room. Here empirical value is applied. The unit is kcal/h.

[Fig 6.9 室内发热设备：Indoor heating equipments；室内发热器械数据输入：Data inputting of indoor heating equipments；房间名称：room name；餐厅：dinning room；开启操作时间设定：Start-up of operation time setting；内部设备开停时间：

Startup-stop time of internal equipments； 显热量： sensible heat； 潜热量： latent heat； 冷却方式： cooling methods； 输入新记录： inputting new record； 记录数： number of records； 记录： records； 共有记录数： Total number of records]

6.10 Data inputting interface of indoor thermal capacity

[Fig6.10 室内热容数据:Indoor thermal capacity； 室内热容量数据输入： Data inputtingof indoor thermal capacity； 房间名称： room name； 显热容量； capacity of sensible heat； 潜热容量： capacity of latent heat； 餐厅： dinning room； 输入新记录： inputting new record； 记录数： number of records； 记录： records； 共有记录数： Total number of records]

Thermal characteristic values of fitments with thermal capacity, such as indoor floorpanel, sofa, and so on, are inputted via this interface. The inputting interface is shown in Figure 6.10. And the data comprises three items: room name, quantity of sensible heat, and quantity of latent heat. Meanings and inputting methods of various items are as follows:

Room name: It is brought from main interface, which cannot be changed.

Quantity of sensible heat: quantity of sensible heat spreading in room. Here empirical value is applied. The unit is kcal/m^2.h.℃ or W/m^2.K.

Quantity of latent heat: quantity of latent heat spreading in room. Here empirical value is applied. The unit is kcal/m^2.h.℃ or W/m^2.K.

Figure 6.10 Data inputting interface of indoor thermal capacity

2.6 《Test Method of Shading Performance》

Test Method of Shading Performance

I. Solar position and radiation

Regions with different latitudes on the earth can receive different solar radiation intensities. Although regions have the same latitude, they also perhaps have different sunrise and sunset times owing to their different longitude, which results from the different relative positions of the earth and the sun.

Because the solar position is variable at any time everyday, the formed shadow shape and size of external shading structural members on window are variable at any moment. The data of solar position at that time must be obtained to make certain the area of solar facula and shadow on window at any time. However, time-varying positions of the sun at any day in one year are regular, so the variation of solar positions can be obtained approximately.

Among the solar radiations permeating aerosphere to the earth, the radiation directions of one part of them are unchanged, namely so called "solar straight radiation"; the other part of them have not special directions at the time of reaching the earth because they have been reflected by gas molecular, liquid or solid particles, namely so called "solar scattered radiation".

The summation of straight radiation and scattered radiation is called total solar radiation or solar radiation for short. In the case of fare weather, the solar scattered radiation received by vertical buildings external window without shading includes: sky scattered radiation I_{dV}, ground reflected radiation I_{RV} and atmosphere long-wave radiation I_B.

Ⅱ.Shading performance theoretical analysis of shading device

Because louver sun-shading panel is representative, the solar radiation model of single-piece horizontal sun-shading panel and vertical sun-shading panel can be readily solved as long as the solar radiation calculation model of louver sun-shading panel is obtained. Therefore, only the solar radiation calculation models of horizontal sun-shading panel and vertical sun-shading panel are given out at the following.

If the sun-shading panel is made of non-transparent substance, the solar radiation permeating sun-shading panel to window glass includes:

1) Straight and scattered radiation permeating from clearance of sun-shading panel;

2) For the solar radiation sheltered by panel, one part of them are absorbed by sun-shading panel to make its temperature increase, and then transfer the heat to the outside of glass window by thermal conduction and convection.

3) Solar straight radiation enters into the inside of sun-shading panel after being reflected as scattered radiation, but scattered radiation is still scattered radiation after being reflected and enters into the inside of sun-shading panel.

2.1 Analysis to solar straight radiation

For straight radiation, it can be considered that there three kind of ways to permeate louver sun-shading device to the exterior surface of glass:

1) Incident straight radiation directly permeates louver sun-shading panel and irradiates on the exterior surface of glass.

2) Incident straight radiation is reflected in the sun-shading panel, and then irradiates on the exterior surface of glass. The following assumptions are made:

- Sun-shading panel belongs to diffuse reflecting surface, and specular reflection need not be considered.
- Only primary reflection is considered.

3) Incident straight radiation is absorbed by sun-shading panel, and then reaches the exterior surface of glass by convection and radiation.

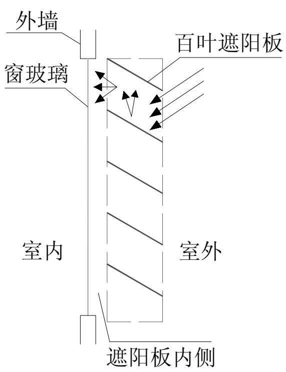


Figure 2-1 Effects of horizontal louver sun-shading panel on solar straight radiation (Sectional drawing)

[外墙：External wall; 窗玻璃：Window glass; 室内：Indoor; 遮阳板内侧：Inside of sun-shading panel; 室外：Outdoor; 百叶遮阳板：Louver sun-shading panel]

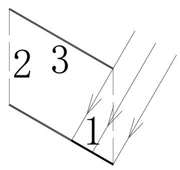


Figure 2-2 Partial enlarged drawing of horizontal louver sun-shading panel

At the time of i, the straight radiation being reflected as scattered radiation can be approximately calculated with the formula (2-1):

$$I^{r}_{D-d,i} = \rho \cdot \varphi_{12} \cdot I_{DV,i} \cdot (1 - x_{s,i}) \quad (2\text{-}1)$$

Where, $I^r_{D-d,i}$ --- At the time of i, the portion of straight radiation that is reflected as scattered radiation and reaches the exterior surface of glass, W/m^2;

ρ ——Reflectance ratio of sun-shading panel surface;

φ_{12} ——Angle coefficient of surface 1 to surface 2, and here surface 1 is actual radiation portion of direct light;

$I_{DV,i}$ ——At the time of i, solar straight radiation of vertical external window surface, W/㎡

3) Incident straight radiation is absorbed by sun-shading panel, and then reaches the exterior surface of glass by convection and radiation. This part of solar radiation can be approximately calculated with formula (2-2):

$$I^a_{D-d,i} = I_{D,i} \cdot (1 - x_{s,i}) \cdot \alpha \cdot \frac{\alpha_i}{\alpha_i + \alpha_o} \quad (2\text{-}2)$$

Where: $I^a_{D-d,i}$ ——At the time of i, solar straight radiation absorbed by horizontal louver sun-shading system and then sent to external surface of glass, W/㎡;

α ——Absorption ratio of sun-shading panel surface;

α_i ——Internal surface heat-transferring coefficient of louver sun-shading system, approximately is 8.7$W/m^2 \cdot k$;

α_o ——External surface heat-transferring coefficient of louver sun-shading system, approximately is 19.0$W/m^2 \cdot k$;

Therefore, the quantity of solar straight radiation permeating horizontal louver panel and radiating on the external surface of window glass is:

$$I^D_{T,i}{}' = I_{D,i} \cdot x_{s,i} + I^r_{D-d,i} + I^a_{D-d,i} \quad (2\text{-}3)$$

2.1.1 Effects of horizontal louver sun-shading panel on sky scattered radiation and ground reflected radiation

For sky scattered radiation and ground reflected radiation, it can be considered that there three kind of ways to permeate louver sun-shading device to the exterior surface of glass.

Sky scattered radiation and ground reflected radiation directly permeating the clearance of louver sun-shading panel can be approximately calculated with formula (2-4):

$$I^t_{d,i} = I_{dH,i} \cdot \varphi_{G-S}{}' + \rho_G \cdot I_{SH,i} \cdot \varphi_{G-G}{}' \quad (2\text{-}4)$$

Where, φ_{G-S}' ——Angle coefficient of glass to sky after installing louver sun-shading panel;

φ_{G-G}' ——Angle coefficient of glass to ground after installing louver sun-shading panel;

Considered that the calculation of above two angle coefficients is complicated, the following approximate treatment can be done:

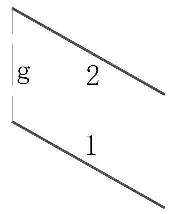


Figure 2-3 Angle coefficient of glass external surface to the other surface

There is following relation among angle coefficients of glass external surface g to space:

$$\varphi_{g-1} + \varphi_{g-2} + \varphi_{g-s} + \varphi_{g-g} = 1 \qquad (2\text{-}5)$$

Where: φ_{g-1} ——Angle coefficient of glass external surface to surface 1;

φ_{g-2} ——Angle coefficient of glass external surface to surface 2;

φ_{g-s} ——Angle coefficient of glass external surface to the sky;

φ_{g-g} ——Angle coefficient of glass external surface to the ground..

If the angle coefficients of glass surface g to surface 1and surface 2 (φ_{g-1} and φ_{g-2}) can be calculated, then the angle coefficients of glass surface to the sky and the ground can be obtained. In addition, it can be approximately considered that the angle coefficient of glass surface to the sky is equal to that to the ground.

By virtue of this simplified treatment, the quantity of scattered radiation permeating directly can be calculated with the formula (2-6):

$$I^{t}_{d,i} = (I_{dH,i} + \rho_G \cdot I_{SH,i}) \cdot \varphi_{G-O}/2 \qquad (2\text{-}6)$$

Where: φ_{G-O} ——Angel coefficient of window glass to environment, equal to $\varphi_{g-s} + \varphi_{g-g}$;

Then, the scattered radiation permeating ratio at the time of i can be expressed as:

$$\tau_{d,i} = \frac{I^{t}_{d,i}}{I_{dV,i} + I_{RV,i}} \qquad (2\text{-}7)$$

The quantity of sky scattered radiation and ground reflected radiation being reflected in sun-shading panel could be expressed as:

[外墙：External wall; 窗玻璃：Window glass; 百叶遮阳板：Louver sun-shading panel; 室内：Indoor; 遮阳板内侧：Inside of sun-shading panel; 室外：Outdoor]

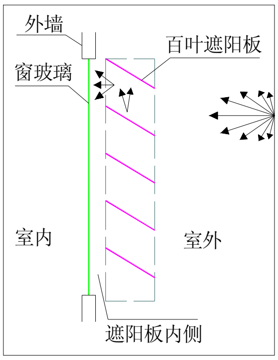


Figure 2-4 Effects of horizontal louver sun-shading panel on solar scattered radiation

$$I_{d,i}^{r} = I_{d,i} \cdot (1-\tau_{d,i}) \cdot \rho \cdot \varphi_{12} \quad (2\text{-}8)$$

Where, $I_{d,i} = I_{dV,i} + I_{RG,i}$ (2-9)

Incident scattered radiation is absorbed by sun-shading panel, and then reaches the exterior surface of glass by convection and radiation. This part of solar radiation can be approximately calculated with formula (2-8):

$$I_{d,i}^{a} = I_{d,i} \cdot (1-\tau_{d,i}) \cdot \alpha \cdot \frac{\alpha_i}{\alpha_i + \alpha_o} \quad (2\text{-}8)$$

Then, the total quantity of scattered radiation permeating louver sun-shading panel at the time of i is:

$$I_{T,i}^{d}{}' = I_{d,i}^{t} + I_{d,i}^{r} + I_{d,i}^{a} \quad (2\text{-}9)$$

Then, the total quantity of solar radiation permeating louver sun-shading panel at the time of i is:

$$I_{T,i}{}' = I_{T,i}^{d}{}' + I_{T,i}^{D}{}' \quad (2\text{-}10)$$

2.2 Vertical louver external sun-shading

The effect model of vertical louver external sun-shading on solar radiation intensity of window glass external surface is similar to that of the above horizontal louver sun-shading system. The difference is that the relative location of window glass to sun-shading panel is different, and so the corresponding calculations of angle coefficients between surfaces are different. The relative location of vertical louver sun-shading panel to window glass and the effect of the panel on solar straight radiation and scattered radiation are show in figure 2-5~6.

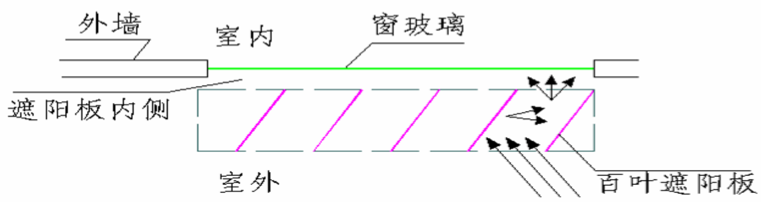


Figure 2-5 Effects of vertical louver sun-shading panel on solar straight radiation (Plain view drawing)

[外墙：External wall; 室内：Indoor; 遮阳板内侧：Inside of sun-shading panel; 室外：Outdoor; 窗玻璃：Window glass; 百叶遮阳板：Louver sun-shading panel]

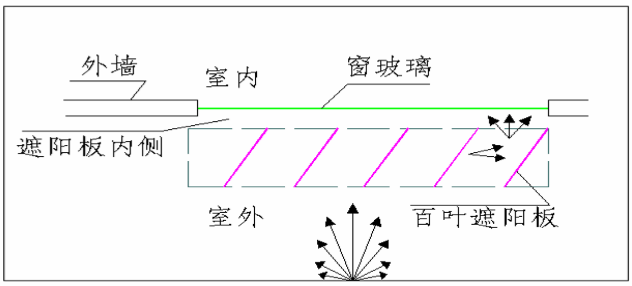


Figure 2-6 Effects of vertical louver sun-shading panel on solar scattered radiation (Plain view drawing)

III. Shading performance test method of shading device

3.1 Establishments of test parameters

The key problem during panelshading panel analysis is the effect of the material and structure of panel on external shading coefficient. The material and structure of panelpanel are different because of the different types and structures of modern buildings material. At the same time, the different buildings orientation and surrounding environment also bring a lot of difficulties about immediate measurement of solar position angle and analysis to sun-shading coefficient. Therefore, in this test method the average value of different orientations shall be calculated according to typical incidence angle of sunbeams. Table 1 shows that typical incidence angles of sunbeams with different orientations listed in ”Calculation method of buildings external shading coefficient M”. Shading coefficient of shading device can be divided into two types: winter-type and summer-type. Take four typical incidence angles of sunbeams in each orientation (they are different in winter and summer) and calculate the average value in this orientation after respective test.

Table1 Typical incidence angles of sunbeams （°）

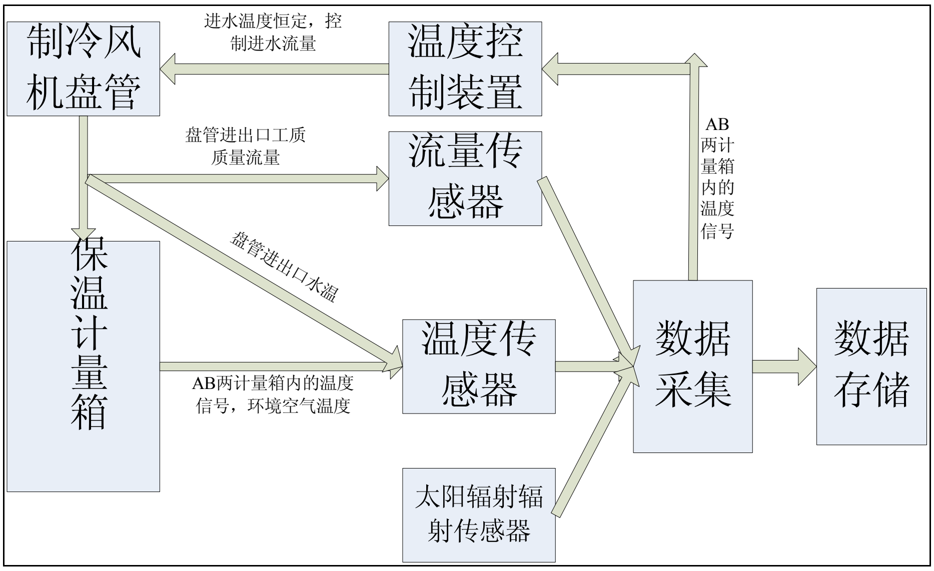
Window orientation	South	East or west	North

		group 1	group 2	group 3	group 4	group 1	group 2	group 3	group 4	group 1	group 2	group 3	group 4
Summer	Altitude angle	0	0	60	60	30	30	45	45	30	30	30	30
	Azimuth angle	0	45	0	45	75	90	75	90	180	180	135	-135
Winter	Altitude angle	0	0	45	45	30	30	45	45	30	30	30	45
	Azimuth angle	0	45	0	45	45	90	45	90	180	135	-135	180

3.2、 Test principle

3.2.1 Brief introduction of test system

The entire test system is composed with three parts: heat insulating and measuring box, data acquisition system and temperature control system. Figure 3-1 is the sketch of test system.



[制冷风机盘管：Refrigerating fan coil； 保温计量箱：Heat insulating and measuring box; 温度控制装置：Temperature control equipment; 流量传感器：Flow sensor; 温度传感器：Temperature sensor; 太阳辐射传感器：solar radiation sensor; 数据采集：Data acquisition; 数据存储：Date storage; 进水温度恒定，控制进水流量：The temperature of water supply constant, control the flow of water supply; 盘管进出口工质质量流量：Mass flow of substance at inlet and outlet of coil; 盘管进出口水温：Temperature of water at inlet and outlet of coil; AB 两计量箱内的温度信号，环境空气温度:Temperature signal in A and B measuring boxes, temperature of environmental air]

Figure 3-1 Sketch of test system

3.2.2 Instantaneous test method

Because of the effect of thermal capacity of heat insulating and measuring box, the quantity of heat taken by air-conditioning machine from heat-flow measuring box at the time of t is dependent on the quantity of heat obtained by heat-flow measuring box at the time of t and before t.

It can be expressed as the following formula:

$$q(t)=\int_0^{\infty} k(t')[SHGC\cdot G(t-t')+U\cdot \Delta T(t-t')]dt' \qquad (3\text{-}1)$$

Where: $\Delta T = T_i - T_a$;

$G(t-t')$ —Radiation intensity on the surface of sun-shading device within the time of $(t-t')$;

$\Delta T(t-t')$ —Temperature difference between inside and outside within the time of $(t-t')$;

U —Heat transmission coefficient of window;

$SHGC$ —Heat acquiring coefficient of solar radiation. This value is the common sun-shading coefficient of sun-shading device and window, namely comprehensive sun-shading coefficient.

$k(t')$ is a response function. It denotes the proportion of instantaneous heat-acquiring quantity at the time of t' before the calculation time t in instantaneous heat-acquiring quantity at the time of t. It has the following characters:

$$k(t')=0 \qquad t'>\tau_d \qquad (3\text{-}2)$$

Namely, if $t'>\tau_d$, the effect of heat-acquiring quantity at the time of t' on that at the time of t attenuates to zero.

$$\int_0^{\infty} k(t')dt' = \int_0^{\tau_d} k(t')dt' = 1 \qquad (3\text{-}3)$$

Where, $\tau_d = \dfrac{(MC)_{sys}}{mc_p}$ is the time when the quantity of heat taken by fan coil from heat-flow measuring box is equal to the quantity of heat stored in heat insulating and measuring box. It indicates the response time of test system to the variation of boundary condition. Equation (1) can be transformed into:

$$q(t)=\int_0^{\infty} k(t')[SHGC\cdot G(t-t')+U\cdot \Delta T(t-t')]dt'$$
$$=\int_0^{\tau_d} k(t')SHGC\cdot G(t-t')dt' + \int_0^{\tau_d} k(t')\cdot U\cdot \Delta T(t-t')dt' \qquad (3\text{-}4)$$

Provided that the temperature in thermal flow measuring box is constant, ΔT changes slowly. If the position of the sun has little change during testing, then equation (4) can be transformed into:

$$q(t)=\int_0^{\tau_d} k(t')SHGC\cdot G(t-t')dt'+\int_0^{\tau_d} k(t')U\cdot\Delta T(t-t')dt'$$
$$=SHGC\int_0^{\tau_d} k(t')\cdot G(t-t')dt'+(U/\tau_d)\int_0^{\tau_d}\Delta T dt' \qquad (3\text{-}5)$$

The following equation can be obtained by dividing time delay τ_d into N parts, discretizing equation (5) and substituting summation for integral:

$$q(j)=SHGC\cdot\sum_{n=1}^{N}k_n\cdot G_n(j)+U\cdot\overline{\Delta T}(j) \qquad (3\text{-}6)$$
$$j=1,\cdots\cdots J$$

Where: $\sum_{n=1}^{N}k_n=1$

$$\overline{\Delta T}(j)=\frac{1}{N}\sum_{n=1}^{N}\Delta T_n(j)$$

N in equation (3-6) is ascertained by $N\Delta t\geq\tau_d$. After N is ascertained, $q(j)$, $G_1(j),\cdots\cdots,G_n(j)$, $\overline{\Delta T}(j)$ in this equation are measurable values, and equation（3-6）is a linear equation including $N+1$ unknown parameters $[SHGC\cdot k(1),\cdots\cdots,SHGC\cdot k(n),U]$. Taking $J\geq N$， the values of above parameters are estimated by regression analysis. And then solar radiation heat-acquiring rate can be calculated with the following formula after obtaining the value of every parameter ($SHGC$):

$$SHGC=\sum_{n=1}^{N}SHGC\cdot k_n \qquad (3\text{-}7)$$

Shading coefficient is defined as: Take the total quantity of solar radiation permeating the window of common transparent glass with 3mm thickness under certain conditions as a base, compare the total quantity of solar radiation permeating other windows under the same conditions with the base, and then the obtained ratio is the shading coefficient of this window. At the same time that determines shading coefficient, the solar radiation heat-acquiring rate of transparent glass window (with 3mm thickness) without any shading devices should be tested.

$$Cs = \frac{\overline{SHGC_T}}{\overline{SHGC_B}} \qquad (3\text{-}8)$$

Cs —Sun-shading coefficient of sun-shading device

$\overline{SHGC_T}$ $\overline{SHGC_B}$ —Respectively are the average solar radiation heat-acquiring rates of the window having been installed sun-shading device and common window with white glass.

3.3 Instantaneous test method and steps

This test method includes two pars: Determination of response time τ_d and test of sun-shading performances.

3．3.1 Determination of response time τ_d

Choose period of time with strong solar radiation and keep water supply temperature T_i and mass flow m of fan coil be constant. Set constant temperature in measuring box and observe water-yielding temperature of fan coil T_o. After the system keeps balance, namely the outdoor conditions keep unchanged, water-yielding temperature of fan coil T_o reach steady state. Cover the window absolutely using non-transparent heat-keeping panel and at the same time observe the water-yielding temperature of fan coil T_o. It is defined that τ_d is the required time when T_o changes to 95% of initial value.

3.3.2 Testing of sun-shading performances

1) Testing conditions

a) Owing to the precision restriction of total solarimeter, solar radiation intensity shall be more than 300W/m^2.

b) Water supply temperature of fan coil can be kept constant, and fluctuation range with ±1K. Fluctuation range of mass flow shall be less than 1%.

c) Temperature in heat-flow measuring box shall be kept constant, and outdoor temperature changes slowly.

2) Operating conditions of testing

Choose four operating conditions within normal variation range of indoor temperature, and one of them shall be the same as the outdoor temperature at testing day.

3) Detecting period

The time interval of data acquisition ($\Delta t = 30s$) is ascertained according to national standard *"Service test method of flat-plate solar collector"*, and each period of time τ_d is divided into $N = \tau_d / \Delta t$ sections. If there are at least 60 acquisition points in every detecting period, then the length of detecting period is $60 \times \Delta t$ **4) Measured physical parameters**

a) Total solar radiation intensity， G ；

b) Environmental temperature, T_a ;

c) Temperature in measuring box, T_j ;

d) Water-supply and water-yielding temperatures of fan coil, T_i T_o ；

e) Mass flow of cooling medium, m 。

5) Instruments and their precisions

a) Total radiation meter, less than 5%

b) Long-wave meter, less than 5%

c) Air temperature sensor, ±0.5K

d) Cooling medium temperature sensor, ±0.1K

e) Flow sensor, ±1.0%

References

[1] Ma Jing-tao. Light transmission rate analysis of window external sun-shading device in Guang-zhou, Dissertation submitted to South China University of Technology for the degree of master, 2003: p26-27.

[2] Jian Yi-wen, Wang Su-ying, Jiang-yi. Sun-shading effect analysis of horizontal or vertical sun-shading types to the windows facing south and east in Beijing, Journal of Xi'an University of Architecture and Technology, 2001,9:p212～217.

[3] Zhang-lei. Light transmission rate analysis of window external sun-shading device in Guang-zhou, Dissertation submitted to South China University of Technology for the degree of master, 2003: p26-27.

2.7 “Testing equipment of Shading Performances”

Testing equipment of Shading Performances

I. Heat insulating and measuring box

1. The whole facility should be installed at open place, and any shelter shouldn’t be here during testing.
2. The whole housing of heat insulating and measuring box should be firm and with a defined bending resistance. Considered that rolled angle is used as framework, so heat-insulating panel should be fixed on rolled angle with bolts.
3. The heat insulating and measuring box is made of heat-insulating material with small heat transmission coefficient and large thermal inertia. Considered using sandwich polyphenyl panel with the thickness of 50mm. If fluctuation range of outdoor air temperature is 10 degrees, that of inner surface temperature only is 0.49 degree, see also attached drawing 1.
4. Heat-flow measuring box is shown in the table. A layer of light polyethylene foam is lined on the inner surface of heat insulating and measuring box, and a black coating is painted on the surface of polyethylene foam.
5. The external surface of protective housing should be light-colored to decrease radiation absorbability as best as possible.
6. Fan coil is installed in heat insulating and measuring box, and a baffle is used to seclude air inletting open and air circulating open to prevent airflow from short-circuit, prevent airflow from blowing glass wall surface straightly and make the temperature in measuring box be uniform.

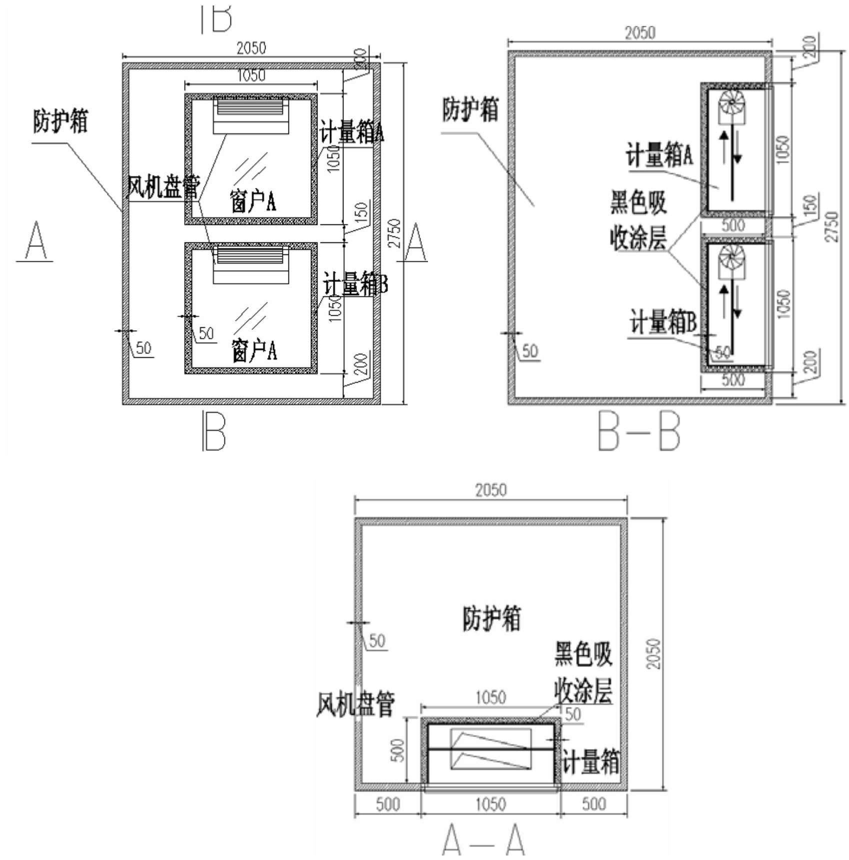


Figure 1-1 Housing drawing of testing equipment

II．Data acquisition system

Data acquisition system should have the following functions:

1 Time-interval between data acquisition and storage is adjustable. The minimum interval should be less than 30 seconds.

2 Synchronous data acquisition. The data of temperature, radiation and working medium flow can be acquired simultaneously at the same time.

3 Data acquisition system should have a considerable precision.

2.1 Measurement of solar radiation data

1. Measurement of total solar radiation

- □ First-level total solarimeter should be used to measure the total short-wave radiations from the sun and sky.
- □ The total solarimeter should be placed in testing environment for 30 minutes at least to meet temperature equilibrium.
- □ Proper measures should be taken to prevent the humidity from coagulating on total solarimeter.

- The total solarimeter sensor should keep parallel to the window surface, and parallelism tolerance of these two planes should be within ±1° . The window should not be sheltered by total solarimeter during the course of testing. The total solarimeter should be installed at the place where can receive the same quantity of solar straight radiation, diffused radiation and reflected radiation as the window.
- The total solarimeter should be installed at the middle position of testing equipment height. Data conducting wire of solarimeter should be protected to prevent from sun shining.
- Measurement of solar incidence angle: Direct incidence angle θ can be calculated by solar hour angle ω, tilt angle of testing equipment β, azimuth angle γ and latitude of testing location Φ. Calculation formula is as follows:

$$\cos\theta = (\sin\delta\sin\phi\cos\beta) - (\sin\delta\cos\phi\cos\gamma) + (\cos\delta\cos\phi\cos\beta\cos\omega) + (\cos\delta\sin\phi\sin\beta\cos\gamma\cos\omega) + (\cos\delta\sin\beta\sin\gamma\sin\omega) \qquad (2\text{-}1)$$

Where, solar angle between equator and Latitude δ of the Nth testing day in a year is calculated as follows:

$$\delta = 23.45\sin[360(284+n)/365] \qquad (2\text{-}2)$$

2 Measurement of scattered radiation

Scattered radiation meter is installed on a fixed bracket, and the long axis just faces southward. Latitude scale should be adjusted to local latitude, and the scale of angle degree between equator and Latitude is adjusted according to the solar operating rule everyday. Angle between equator and Latitude can be approximately calculated with the following formula:

$$\delta = 23.45 \cdot \sin(360 \cdot \frac{284+n}{365}) \qquad (2\text{-}3)$$

Where, n is the data serial number of calculated day in the whole year.

2.2 Measurement of long-wave thermal radiation intensity

- The long-wave radiation meter is installed at the middle position of testing equipment height and at the side of window to measure the long-wave thermal radiation irradiating on the window.
- Long-wave radiation has complicated relation with surrounding architecture environment. It is difficult to give out quantitative data when the surrounding

architecture is too many. Therefore, in this test green plants were planted around testing box to approximately neglect the effects of long-wave radiation.

2.3 Measurement of temperature

1) Measurement of In-and-out chilled water temperature of fan coil

- Temperature sensor should be installed within 200mm from inlet and outlet. Insulation treatment should be carried out for rear and front pipes of the sensor.
- Elbow union should be installed in front of the sensor to mix the flow.
- The sensor should be installed in the rising pipe of fluid and sensor gauge head should face the flow direction of liquid to avoid collecting of air around the sensor.

2 Measurement of air temperature

Measuring point of outdoor air temperature should be above 1m from the ground, and radiation-resistant and ventilated aluminum-platinum cap is needed.

2.4 Measurement of working medium flow

- Overall measurement accuracy of flow sensor and secondary instrument: The measurement accuracy of working medium flow should be within ±1%.
- The sensor should be installed on the straight-pipe section and full-cap fluidized state should be kept in the pipe, so the flow sensor should be installed on the rising-pipe section of working medium.

III. Refrigerating and environmental control system

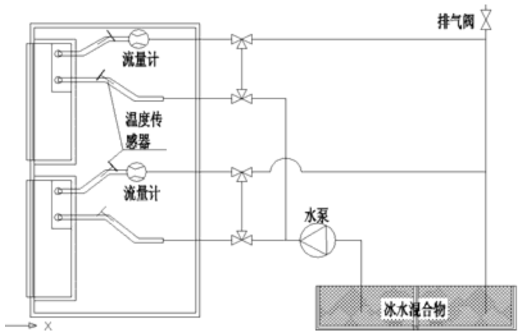
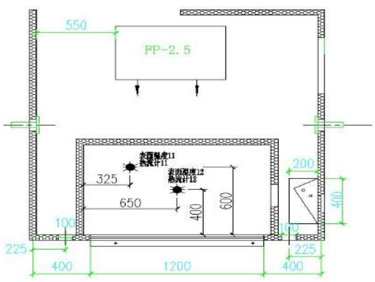


Figure 3-1 Diagrammatic sketch of refrigerating equipment

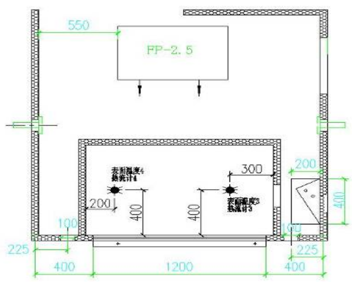
[流量计：Flow meter; 温度传感器：Temperature sensor; 水泵：Water pump; 排气阀：Exhaust valve; 冰水混合物：Ice water mixture]

- In-and-out chilled water flow of fan coil is adjusted by two temperature signals in heat-insulating box. The temperature in heat insulating and measuring box A is the same as that in box B.
- Air-condition can be installed in protective box to make the temperature in protective box is near to that in heat insulating box.
- The temperature in heat insulating and measuring box should be kept stable as best as possible during the course of testing, and the fluctuation range is within ±1.
- Ice bath is divided into two small bathes: Pre-cooling bath and thermostatic bath. The thermostatic bath should be kept constant. The water in pre-cooling ice bath should be agitated continuously during the course of testing to ensure that the water and ice cannot enter thermostatic bath until they are mixed absolutely.
- The pipeline from ice bath to fan coil should be as short as possible. All of pipes should be treated with heat protective measures, and sun-screening reflected coating should be painted on them.
- The pipeline from fan coil to flow meter uses PVC pipe, and the pipes after it uses flexible pipe.
- Pump and flow control equipment: Pump and flow control equipment should keep stable mass flow. The fluctuation range is within ±1%.

IV. Arrangement plan of measuring points



1#箱体底面热流温度布置



1#箱体顶面热流温度布置

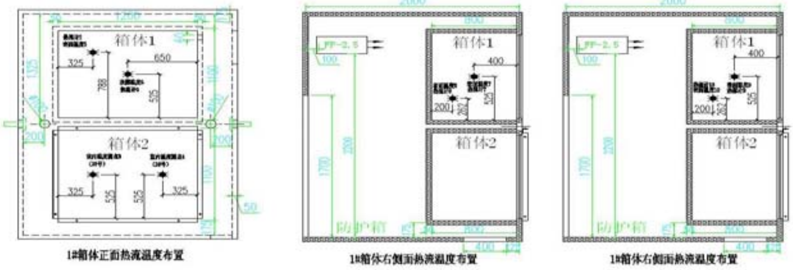


Figure 4-1 Arrangement plan of heat-flow measuring points for No.1 testing box

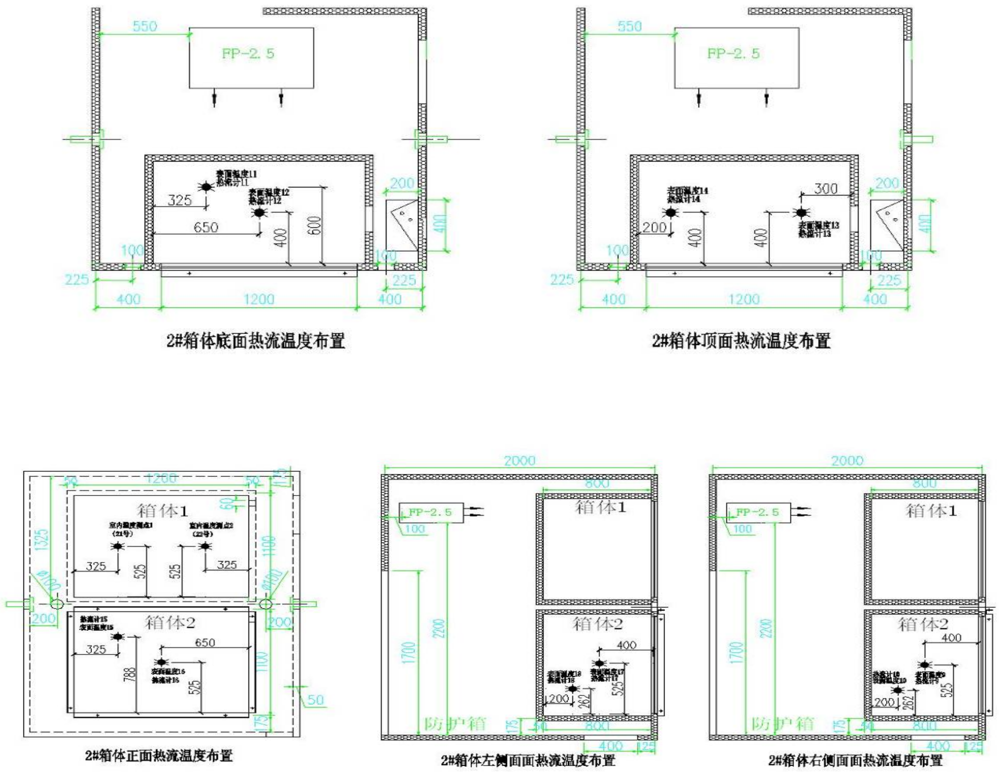


Figure 4-2 Arrangement plan of heat-flow measuring points for No.2 testing box

2.8 ”Optimization design for Energy efficiency of first-stage of Shen-zhen Zhen-ye Town”

Optimization Design for Energy efficiency of First-stage of Shen-zhen Zhen-ye Town

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Abstract: Taking *Energy efficiency design standard of residential buildings in hot-summer and cold-winner region* as a basis, special designs to natural ventilation and construction Energy efficiency are carried out for the first-stage project of Zhenye town during planning phase and residential construction documents design phase. The residential buildingss of the first-stage for this project reach the objective that saving 50% of energy. They provide a favorable indoor-outdoor thermal environment for residence’s people to the maximum limit.

Key words Architectural Energy efficiency Natural ventilation Thermal environment

1. General situation

Zhenye city lies at Liuyue of Henggang town, Longgang district, Shenzhen city. It is north to Shenhui road, south to Huanchengbeilu road, west to Wutong road, and east to Shengfeng road. It has 18km far away from the downtown area of Shenzhen. Its land use area is 416765.9 m^2, total buildings area is 634541m^2, architectural plot ratio is 1.3, architectural coverage percentage is 25% and green area percentage is 40%. The first-stage land use area of this project is 192500m^2 and total architectural area is 146460 m^2. thereinto area of residential architecture is 121239 m^2. The type of residential buildingss is given priority to row villas, and at the same time there are little quantity of multiple-story combined apartment buildingss.

For the first-stage project of Zhenye town, special designs to natural ventilation and construction Energy efficiency are carried out during planning phase and residential construction documents design phase. Objectives of construction Energy efficiency design are: Taking national related policies and “Energy efficiency design standard of residential architecture in hot-summer and cold-winner region " as a basis, make the best use of the climatic characters of Shenzhen and orographic characters of the town to meet architectural Energy efficiency design requirements and create a favorable indoor-outdoor thermal environment.

Construction documents of first-stage project of Zhenye town have been finished. At present the project stays at the stage of reporting for construction.

2. Building Energy efficiency design basis

The buildings Energy efficiency design basis is the trade standard of P.R.C. "Energy efficiency design standard of residential buildings in hot-summer and cold-winner region "(JGJ 75-2003) promulgated at October 1, 2003 (It is called "standard" briefly). The main design bases are one recommendatory clause and five mandatory clauses:

Clause 4.0.1 The panel and elevation design of general planning and residential buildings in residential area shall facilitate natural ventilation.

Clause 4.0.4 (mandatory) The area of external window shouldn't be too large. Window-wall area ratio in every orientation shall accord with the following regulations: that in north orientation doesn't be more than 0.45, that in west orientation shouldn't be more than 0.30 and that in south orientation shouldn't be more than 0.50.

Clause 4.0.5 (Mandatory) The skylight area of residential buildings shouldn't be more than 4％ that of total roofing area. Heat transmission coefficient shouldn't be more than 4.0 W/(m^2·K), and itself sun-shading coefficient shouldn't be more than 0.5.

Clause 4.0.6 (Mandatory): Heat transmission coefficients of residential architecture roof and external wall should accord with the regulations in table 4.0.6.

Table 4.0.6 Heat transmission coefficient of roof and external wall K 〔W/ (m^2·K)〕

Roof	External wall
K≤1.0，D≥2.5	**K≤2.0，D≥3.0 or K≤1.5，D≥3.0 or K≤1.0，D≥2.5**
K≤0.5	**K≤0.7**
Note: For light roof and external wall with D＜2.5, heat protecting requirements regulated in national standard 《Heat engineering design specifications of civil buildings》GB50176—93 should be met.	

Clause 4.0.7 (Mandatory): If different average window-wall area ratios are used for residential architecture, the heat transmission coefficient and comprehensive sun-shading coefficient of external window should accord with the regulations in table 4.0.7-1 and table

4.0.7-2.. Shenzhen city lies in the southern area of hot-summer and cold-winner region, so the buildingss within this area should be designed according to table 4.0.7-2.）

Table 4.0.7-2 Comprehensive sun-shading coefficient limit value of residential architecture external window in south area

External wall （$\rho \leqslant 0.8$）	Comprehensive sun-shading coefficient of external window S_W				
	Average area ratio of window to wall $C_M \leqslant 0.25$	Average area ratio of window to wall $0.25 < C_M \leqslant 0.3$	Average area ratio of window to wall $0.3 < C_M \leqslant 0.35$	Average area ratio of window to wall $0.35 < C_M \leqslant 0.4$	Average area ratio of window to wall $0.4 < C_M \leqslant 0.45$
$K \leqslant 2.0, D \geqslant 3.0$	≤0.6	≤0.5	≤0.4	≤0.4	≤0.3
$K \leqslant 1.5, D \geqslant 3.0$	≤0.8	≤0.7	≤0.6	≤0.5	≤0.4
$K \leqslant 1.0, D \geqslant 2.5$ or $K \leqslant 0.7$	≤0.9	≤0.8	≤0.7	≤0.6	≤0.5

Note: 1. The external window mentioned in this clause includes the transparent portion of balcony door.

2. Heat transmission coefficient of external window isn't regulated in Energy efficiency design of residential architecture in south area.

3. ρ is the solar radiation absorption coefficient of external surface of external window.

Clause 4.0.10 (Mandatory): The opening area of external window (Including balcony door) shouldn't be less than 8% of the ground area of its located room or 45% of external window area.

3 Energy efficiency design principle of buildings

Aiming at the climatic condition of Shenzhen and combining with its economic development actuality and characters of this project, the energy efficiency principle of first-stage Zhen-ye town are ascertained as follows:

(1) Using unified integral design strategies: Energy efficiency design is considered grounded on the whole course of general plan and buildings unit design.

(2) The proper energy efficiency techniques are chosen based on economical efficiency, locality and phases of buildings energy efficiency.

(3) Energy efficiency design principle adapting the climatic conditions: Passive design strategies giving priority to "natural ventilation+ batch air condition".

4 Natural ventilation design

4.1 Natural ventilation conditions of Shenzhen city

Table 1 shows the statistic analysis to weather data of Shenzhen. It can be seen from the table that: Shenzhen city has very good ventilation conditions. From May to September, there are more than ten days whose outdoor temperatures are lower than 28^{o}C. Thereinto the temperatures of more than 70% of days are lower than 28^{o}C in May. The city has the natural conditions adopting natural ventilation to decrease the temperature. The corresponding outdoor wind-speed is within the range of 2.8~3.2m/s and outdoor wind-speed is more larger.

Table 1 Shenzhen statistic table of outdoor weather data

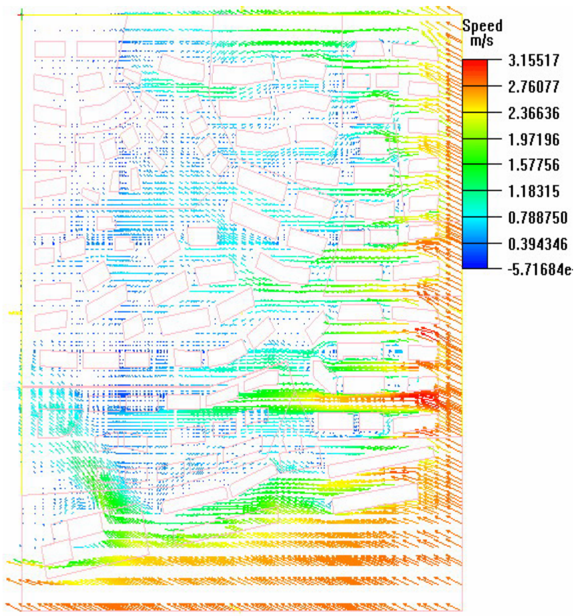
Month	May	June	July	August	Septembe r
Number of days when outdoor temperature is less than 28℃	24	14	11	11	11
Percentage of number of days when outdoor temperature is less than 28℃ to total number of days in the month	77.4%	46.7%	35.5%	35.5%	36.5%
Average wind speed of dominant wind	3.20	2.95	2.90	2.80	2.95

4.2 First-stage architectural natural ventilation design of Zhen-ye Town

4.2.1 Natural ventilation simulated design of town, groups

Besides that opening area of external window is designed according to the requirements in clause 4.0.10 in “standard”, natural ventilation simulated design to town, groups and house-style also are carried out for the first-stage plan of this project to make use of Shenzhen favorable natural ventilation conditions sufficiently on three levels: town air renewal, buildings air renewal and indoor air renewal.

The initial designs of the town are adjusted by us according to the natural ventilation simulated results. Figure 1~figure 4 respectively are natural ventilation simulated results of initial designs and the design after being adjusted.



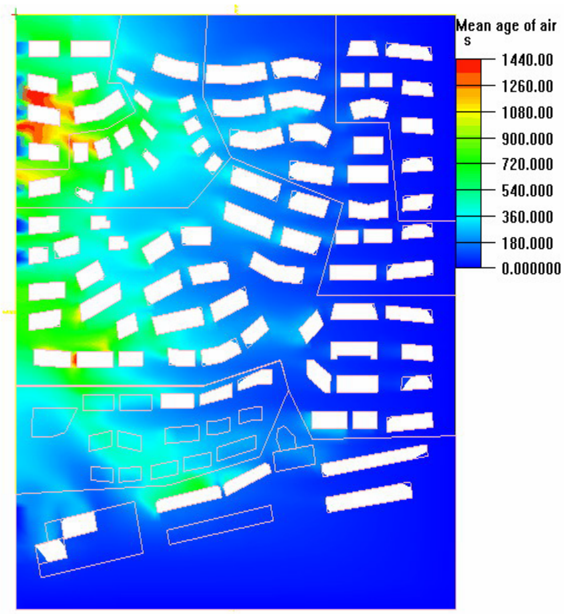
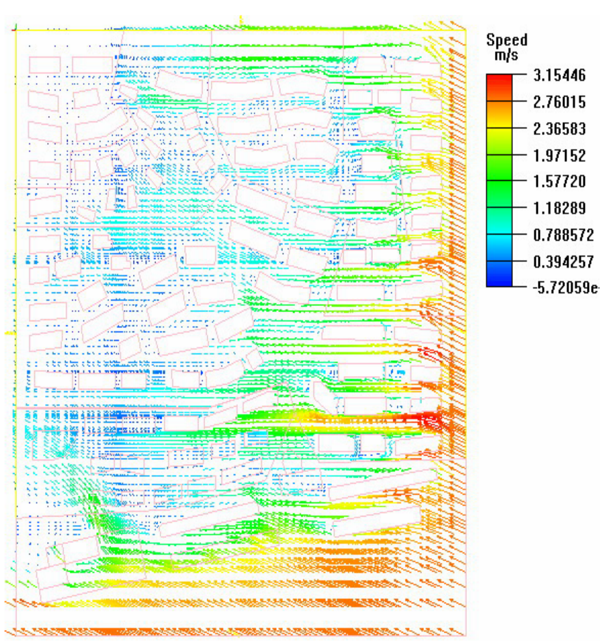


Figure 1 Wind speed drawing of the town before being adjusted   Figure 2 Air age map of the town before being adjusted



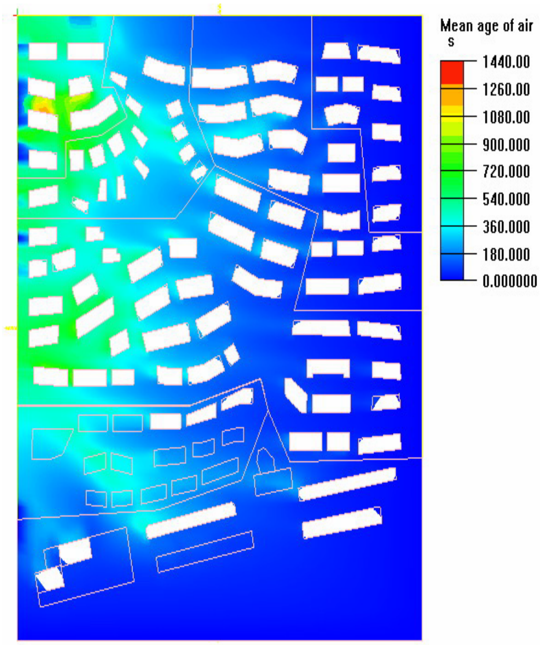
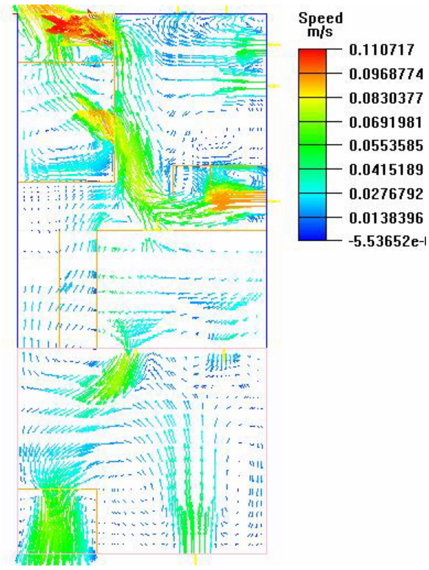


Figure 3 Wind-speed drawing of the town after being adjusted   Figure 4 Air age map of the town after being adjusted

Respectively comparing figure 1 with figure 3, figure 2 and figure 4, it can be seen that the outdoor air age around the buildings lying at the north-west corner of the town decreases obviously. Especially that several air-flow dead corners are eliminated and the natural ventilation environment around the buildings is improved.

4.2.2 Natural vitalization simulated design of the house-style

For the house-style without favorable natural ventilation, such factors as indoor division, external window position and opening area of external window in initial design are adjusted according to the natural ventilation simulated results of house-styles. Figure 5~figure 8 respectively are simulated results of one house-style in the town before and after being modified.



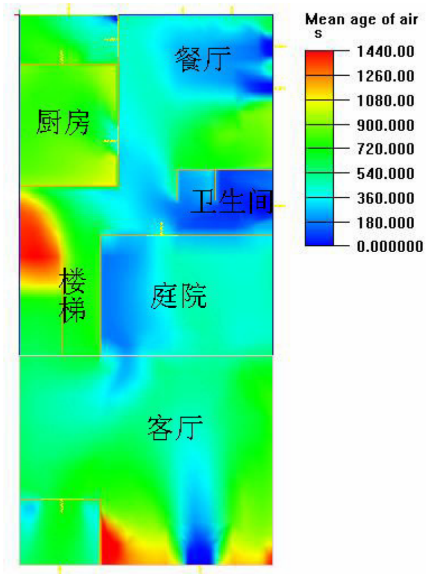
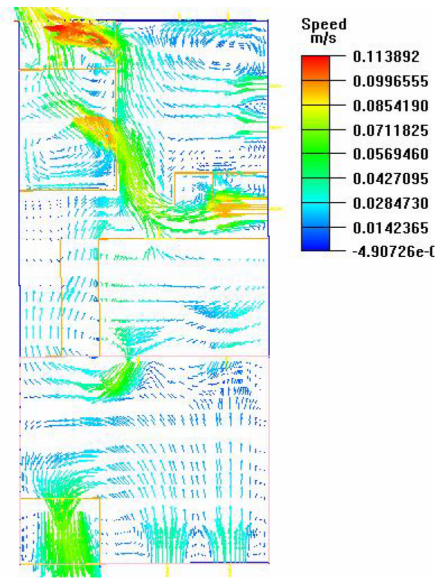


Figure 5 Wind-speed drawing of the house-style before being modified Figure 6 Air age map of the house-style before being modified



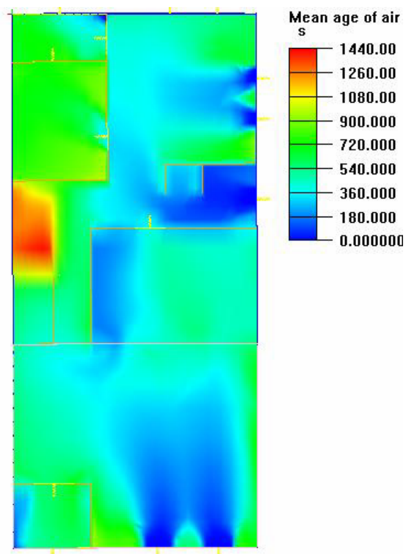


Figure 7 Wind-speed drawing of the house-style after being modified Figure 8 Air age map of the house-style after being modified

Respectively comparing figure 5 with figure 7, figure 6 and figure 8, it can be seen that the indoor air-flow of this house-style becomes more unobstructed and indoor air age decreases obviously by changing external window position and enlarging the opening area of external window. Especially that the indoor air fresh degrees in dining-room and living room are improved markedly.

5 Architecture and architectural thermo-technical Energy efficiency design

For the section of buildings and buildingstechnical energy efficiency design, we firstly examined the initial design according to clauses 4.0.4, 4.0.5, 4.0.6, 4.0.7 in “standard”, and then Energy efficiency approach was chosen according to technical and economic analysis. Finally the buildingsenergy efficiency design scheme was ascertained. Taking one residential buildings in this town as an example, the buildingsand buildingstechnical energy efficiency design in this town is explained at the following.

5.1 Energy efficiency examination and verification

(I) Area ratio of window to wall

Table 2 Statistical analysis table of window-wall area ratio in every buildings orientation

	North orientation	East orientation	South orientation	West orientation
1G4 buildings	0.21	0.475	0.37	0.10
Standard requirements	≤0.45	≤0.30	≤0.50	≤0.30
Whether accord with the standard requirements	**Yes**	**No**	**Yes**	**Yes**

II Skylight

Table 3 Statistical analysis tables of skylight area and construction

	Area ratio of skylight to roof	Heat transmission coefficient of skylight〔W/(m^2·K)〕	sun-shading coefficient of skylight
1G4 buildings	6.3%	5.6	0.9
Standard requirements	≤4%	≤4.0	≤0.5
Whether accord with the standard requirements	**No**	**No**	**No**

III External wall

Westward external wall: 190 hollow clay brick, using 40mm-thickness polyphenyl heat-protective panel on the outside of external wall （K=0.734，D=3.47）.

External walls in other orientations: 190 hollow clay brick, without heat-protective material（K=1.783，D=3.08）.

Average heat transmission coefficient of external wall: K=1.548，D>3.0 。

Standard requirements: D⩾3.0，K⩽1.5.

Conclusions: Thermo-technical performances of external wall doesn't meet the requirements in《standard》.

IV Roof

Roof heat protective system using 40mm-thickness air-sized panel （K=0.641，D=3.45）

Standard requirements: D⩾2.5，K⩽1.0.

Conclusions: Thermo-technical performances of roof can meet the requirements in 《standard》.

V Comprehensive shading coefficient of external window

Average window-wall area ratio of buildings: C_M=0.28.

Thermo-technical parameters of external wall: D⩾3.0，K=1.548.

From table 4.0.7-2 in ”standard”it can be found that: Comprehensive shading coefficient of external window should not be more than 0.5.

The initially designed external window is: common aluminium alloy single-glass window SC=0.9, without shading device.

Conclusions: Comprehensive shading coefficient of external window doesn't meet the requirements in ”standard”.

(VI) Auditing conclusions about energy efficiency design in initial scheme

The design indexes such as window-wall area ratio in east orientation, area and thermo-technical performances of skylight, thermo-technical performances of external wall and comprehensive sun-shading coefficient design of external window for this buildings are unqualified. Therefore, the energy efficiency design in initial design scheme needs to be modified.

5.2 Choices of approaches to meet the standard of energy efficiency

5.2.1 Energy efficiency design is carried out according to specified indexes

Because the energy efficiency design is carried out according to the specified indexes, these design parameters should be modified in comparison with those that don't accord with “standard” in above auditing conclusions to make them meet the requirements in “standard”.

By detailed analysis of technical economy, the scheme of energy efficiency design is established as:

(Ⅰ) Area ratio of window to wall

Area of the external window in east orientation is decreased to make the area ratio of window to wall less than 0.30.

Ⅱ Skylight

All of designs about skylights are abrogated.

III External wall

Aerated concrete blockworks are adopted for all of external wall of buildings. Its heat transmission coefficient K is 1.12 W/(m^2•K), and thermal inertia index D>3.0.

Ⅳ Roof

To optimize the design, the thickness of heat protective layer on roof is changed from 40mm to 30mm, namely the roof used 30mm-thickness air-sized panel roofing as heat protective system. Heat transmission coefficient of the roof K=0.786 W/(m^2•K), and thermal inertia index D>2.5.

v External wall (Including the transparent portion of balcony door)

Areas of the external windows in every orientation are decreased to make the average area ratio of window to wall of the whole buildings less than 0.30, namely $C_M \leqslant 0.30$. By looking for table 4.0.7-2 in “standard”, the limit value of comprehensive sun-shading coefficient of external window should not be more than 0.7, namely $S_W \leqslant 0.7$.

Therefore, in the case of choosing constructions of external windows: The external window in north orientation uses common glass window （SC=0.8）, and windows in other orientations use Low-E glass window （SC=0.5）. In addition, when the area of external window is ascertained the following equation should be met:

$$\frac{0.8\times\text{北向外窗面积总和}+0.5\times\text{其它朝向外窗面积总和}}{\text{整个建筑的总外窗面积}}\leq 0.7$$

5.2.2 Energy efficiency design is carried out according to performance indexes

To keep the initial design style that: (1) don’t decrease the area of external window in east orientation; (2) don’t decrease the area of skylight. Therefore, the initial design should be modified by analyzing energy-consumption

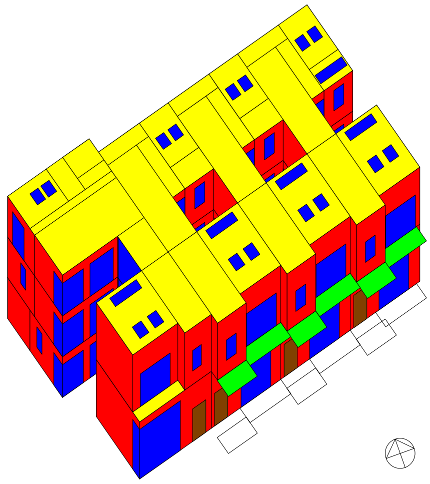


Figure 9 DOE-2 simulated diagram

according to performance indexes to make energy efficiency meet the requirements in "standard".

I Choice of calculation tools

DOE-2 dynamic energy-consumption calculation software developed by American Lawrence Berkeley National Laboratory is used as calculation tool. Figure 9 is DOE-2 simulated diagram of this buildings.

(II) Calculation of energy-consumption indexes of reference buildings

The reference buildings is established according to the principle of clause 5.0.2 in "standard".

For the reference buildings, annual power consumption of air condition on every buildings area calculated using DOE-2 is: 40.62 kWh/(m^2yr) .

(III) Calculation of comprehensive energy efficiency index of designed buildings

The input heat-insulating structures of exterior-protected construction are:

External wall: A: 190mm aerated concrete blockwork; B: Using 25mm XPS panel as the heat protective system of external wall.

Roof: A: Using 25mm XPS panel as the heat protective system of the roof; B: Using 40mm XPS panel as the heat protective system of the roof.

External window: A：K=4.5，SC=0.6；B：K=4.5，SC=0.5 (K is heat transmission coefficient, SC is sun-shading coefficient).

Calculation results of comprehensive energy efficiency index of designed buildings are shown in table 4.

Table 4 Calculation results of comprehensive energy efficiency index of designed buildings

Schemes				the designed architectural energy efficiency comprehensive index kWh/(m2yr)	Whether to meet the standard requirements
Serial number	**External wall**	**Roof**	**External window**		
1	A	A	A	41.32	No
2	A	A	B	39.01	Yes
3	A	B	A	40.24	Yes
4	A	B	B	37.97	Yes
5	B	A	A	40.13	Yes
6	B	A	B	37.89	Yes
7	B	B	A	39.03	Yes
8	B	B	B	36.81	Yes

Form the table 4 it can be seen that, if the appearance of initial designed buildings wants to be kept unchanged, the energy efficiency design of the buildings can meet the requirements in “standard” only the energy efficiency scheme of exterior-protected construction with the serial number of 2-8 are used. This buildings belongs to emery-saving buildings.

5.2.3 comparison between energy efficiency scheme of specified indexes and Energy efficiency scheme of performance indexes

Comparing energy efficiency scheme of specified indexes with Energy efficiency scheme of performance indexes, it can be known that:

(1) If the above energy efficiency scheme of specified indexes is adopted, a large quantity of external window areas can be decreased and the skylights can be cancelled. Therefore a large numbers of initial investments are saved.

(2) In the case of adopting the design depending on performance, the area of external window in east orientation and area of skylight mustn’t be decreased. The comprehensive sun-shading coefficient of external window can be increased to 0.6.

By the common technical and economic argumentation with construction organization and design unit, the first-stage engineering of Zhenye town adopts the design scheme according to specified indexes.

6 Summarization

By the special designs of natural ventilation and residential construction energy efficiency to town, groups and house-style, the first-stage engineering of Zhenye town meets the requirements in “standard” that saving 50% of energy. This project as a residential town fulfilling “energy efficiency design standard of residential architecture in hot-summer and cold-winner region” firstly, it plays an important popularizing role for people to understand new standard, use new standard and further realize the overall architectural energy efficiency.

References

[1] “energy efficiency design standard of residential architecture in hot-summer and cold-winner region “, JGJ 75-2003. China construction industry publishing house, 2003, Beijing.

[2] “Thermo-technical design specifications of civil architecture “, GB 50176-93. China planed publishing house, 1993, Beijing.

2.9 “Implementation Schemes of First-stage of Shen-zhen Zhen-ye Town for Buildings Energy efficiency Demonstration Project”

Implementation Schemes of First-stage of Shen-zhen Zhen-ye Town for Buildings Energy efficiency Demonstration Project

“First-stage Heng-gang Zhen-ye Town” project developed by Shen-zhen Zhen-ye Co. Ltd. has been listed as “Plans of architectural energy efficiency scientific and technical projects” by Ministry of Construction and Shenzhen Construction Bureau. According to the requirements of “Administrative regulations of architectural energy efficiency experimental demonstration project (subdistrict)” of Ministry of Construction and “Notice on setting up a leading group of operation of first-stage architectural energy efficiency demonstration project of Shen-zhen Zhen-ye Town”, Schemes of “Zhen-ye Town first-stage” architectural energy efficiency demonstration project are established as follows, so as to ensure that construction of the project accords with the requirements of architectural energy efficiency demonstration project:

1、Operational organization and its responsibilities

In order to complete operation schemes, operating group was established. Municipal central station of quality supervising, quality inspecting station of Long-gang district, Shen-zhen Zhen-ye (group) joint-stock Co. Ltd., Shen-zhen No. 1 architecture engineering Co. Ltd., and Shen-zhen Jian-ye architecture engineering Co. Ltd. are responsible for the project, Zhen-ye construction supervision company is member of operating group, and Municipal central station of quality supervising is the adjusting and leading organization. Responsibilities of the involved organizations are as follows:

(One) Supervising organizations: Municipal central station of quality supervising, Quality inspecting station of Long-gang district

1. Take charge of detailed supervising and managing jobs of architectural energy efficiency in the course of project construction.

2. Municipal central station of quality supervising shall report the development of demonstration project to leading group termly.

(Two) Construction organization: Shen-zhen Zhen-ye (group) joint-stock Co. Ltd.

Take charge of detailed operating jobs of architectural energy efficiency in the course of project construction all around, and provide necessary supports and assistance for demonstration project.

(Three) Construction organization: Shen-zhen No. 1 architecture engineering Co. Ltd., and Shen-zhen Jian-ye architecture engineering Co. Ltd.

1. Take charge of construction jobs of energy efficiency engineering.

2. Take charge of construction information.

3. Take charge of sending the energy efficiency materials and products to check and checking and accepting them before entering.

4. Other jobs concerned.

(Four) Inspecting and controlling organization: Zhen-ye construction supervision company

1. Take charge of supervision jobs of architectural energy efficiency engineering.

2. Take charge of supervision logs of energy efficiency engineering.

3. Jobs of sending to check and checking and accepting materials before entering that are related with energy efficiency.

4. Other jobs concerned.

Two. energy efficiency control project of engineering construction

In the project, the following items shall be controlled during such developing courses as construction, supervision, inspection, and completion acceptance, so as to ensure that the project accords to the requirements of relative architectural energy efficiency standards:

(One) External wall thermal properties of buildings

(Two) External wall shading properties of buildings

(Three) External wall sealing properties of buildings

(Four) Roof thermal properties of buildings

(Five) Solar heating water supplying system

(Six) Inorganic energy efficiency elevator

(Seven) Other architectural energy efficiency productions and systems

Three. Operation procedures of architectural energy efficiency demonstration project

(One) Design of subdistrict layout

(Two) Design of project construction documents

(Three) energy efficiency design of engineering construction

(Four) Application of architectural energy efficiency demonstration project

(Five) Construction of project

(Six) Completion acceptance of project

(Seven) Preparing information related with Shen-zhen inspection and acceptance for Ministry of construction.

Four. Operation of architectural energy efficiency demonstration project

(One) Construction of project

"Operating according to drawings" is strictly required during the construction course of the engineering project. The construction shall be performed canonically according to relative technical codes and standards, to ensure that the construction accords with designs and architectural energy efficiency requirements of standards.

1. Walling work

In this project the wall is filled with aerated concrete blocks, and built with M5 mixed mortar. In the course of construction, the relative codes and standards shall be strictly followed, to ensure that the external wall thermal properties meet the requirements of energy efficiency standards.

(1) Preparing stage:

Light aerated concrete block is chosen as block of walling material in this project. Besides the requirements of architectural and structural design, size, intensity grade, and dry density of blocks must also meet the requirements of Energy efficiency design. As a result, Mo-tian high-quality light aerated concrete block made in Dong-guan is selected since its average thermal transmission coefficient K=1.26W/（m2K）, and its thermal inertia factor D ＞3.0, which all meet the requirements of Energy efficiency design. When materials are entered, it shall be checked whether ex-factory conformity certificate and test sheets has supplied by manufacturer of blocks, and whether specification of block meet the requirements. Blocks with deformed edge or corner shall be eliminated.

(2) Matters related with energy efficiency that need attention in laying engineering

1) Mortar joint thickness of walling works shall be controlled strictly. It shall be controlled according to the minimum of code requirement, 15MM.

2) Quality of block materials shall be controlled strictly: it is forbidden to fill wall with broken bricks. The blocks shall be taken and put carefully in the course of transportation and conveying to avoid man-made damages. Filling minimize light aerated concrete block with deformed edge or corner in external wall shall be minimized as possible. And ex-factory time of light aerated concrete block shall be more than 28 day, or the block shall not be used.

3) Blocks shall be laid for three times: the wall shall be laid up to about 1.4 meters high for the first time. The second time, it is laid up to the level 180mm lower than structural beam after an interval of one day. The third time, the bricks of wagon top are laid after an interval of seven days. Thus the wall is avoided from cracking.

4) As the thermal resistance value of cement solid brick is less than that of light aerated concrete block, custom-made light aerated concrete block is selected as brick of wagon top here.

2. External windows and glass window of balcony door

Therefore, in the case of choosing constructions of external windows: The external window in north orientation uses common glass window （SC=0.8）, and windows in other orientations use Low-E glass window （SC=0.5）. In the course of construction, the relative codes and standards shall be strictly followed, to ensure that the external wall thermal properties meet the requirements of energy efficiency standards.

1. External windows and glass window of balcony door

After the incoming of external windows/balcony door, quality inspection and acceptance shall be carried out. Their sorts, specifications and performances shall accord with the requirements of designs and standards concerned. Besides the inspection of product qualification certificate and ex-factory test report, selective re-inspection shall be carried out in site to ensure the air-tightness accord with the requirements of designs and standards concerned.

2) Installation of external windows and glass window of balcony door

Before aluminum alloy door and window being installed, quality inspections to openings, doors and windows shall be carried out to ensure the door and window are without deformation and distortion. If the deviation of openings is more than 10mm, they shall be trimmed by civil engineering. Installation step includes paying off-frame installation—caulking. During installation measures should be taken to strictly control the air-tightness performance of external window and balcony door. After installation quality re-checks to smoothness and verticality, aluminum door and window frame must be caulked. And then make the surrounding of the frame clean and spray water to make the base layer wet. Caulking task is done with waterproof cement. The wooden wedges cannot be taken out gently until mortars around the aluminum frame reach a defined intensity. And then fill the interstice of wedges with waterproof cement.

For sliding door, owing to its longer slide track and larger deviation of level degree, sometimes the requirements cannot be met only by adjusting the pulley. At this time spigot and socket depth of upper-lower bridging beams and edges needs to be adjusted. So window sash of sliding window is rubberized in workshop, but sometimes that of sliding door is rubberized in site after being adjusted, not in the workshop. When leaf of jib door is installed with hinges, lift the door sash and make rotating shafts of sash hinge be enclosed into hinge shaft sleeve on doorframe. Respectively install tapered hardware fittings on door sash and doorframe to make their locations anastomosing and close state tight.

3. Energy efficiency construction scheme of roofing engineering.

Roofing type in this engineering includes pitched roof type and flat roof type.

(1) Technological process

Operation method of flat roof (Used as common roof): press polish of reinforced concrete panel magma, cleaning of panel surface→2-thickness 911 water-proof coating→30-thickness air-sized type polystyrene heat-protective panel→a layer of dry-laying non-woven fabrics→40-thickness C20 fine concrete rigid protective layer, having Φ6 double directions @200, parting each 3×3m, slot width 20, filled water-oil emulsion.

Operation method of tile roof: press polish of reinforced concrete panel magma, cleaning of panel surface→2-thickness 911 water-proof coating→30-thickness air-sized type polystyrene heat-protective panel→a layer of dry-laying non-woven fabrics→40-thickness C20 fine concrete rigid protective layer, having Φ6 double directions @200, parting each 3×3m, slot width 20, filled water-oil emulsion→1:3 cement mortar lying tile layer.

(2) Heat-protective material

According to the first-stage Energy efficiency design of Zhenye town: The roof uses 30mm air-sized panel as heat-protective system. We choose 30mm-thickness air-sized panel made by Beijing Huiying plastic Co. Ltd.. Heat transmission coefficient of the roof K=0.786W/（m^2·K） and thermal inertia index D＞2.5. they meet the requirements (K＝1.0 W／（m^2·K）) in Energy efficiency design standard.

After the incoming of heat-protective materials, quality inspection and acceptance shall be carried out. Their sorts, specifications and performances shall accord with the requirements of designs and standards concerned. The check items are:

1) Inspect the product qualification certificate and ex-factory test report.

3) Selective recheck in site. Rechecking items: Heat transmission coefficient and compressive strength.

(3) Matters need attention for roofing Energy efficiency construction

1) Water is a very good heat conductor, so the waterproof task on the surface of heat-protective layer becomes very important. It should be paid attention during the course of construction.

①Maintenance time of rigid waterproof layer, concurrently is leveling layer, is seven days. Within this period it doesn’t crack.

②Factice caulking should be plump and close-grained. Dividing seam can prevent water penetration.

③ The harsh concrete should be used in leveling layer, and slump degree should be strictly controlled.

Considering the energy efficiency requirements, during the course of laying tiles on slope roof, except that the bottom three lines need be filled with mortar, with bottom of tile slot covered with two lines of mortar, foots of the other tiles must cling to surface of the plane roof so as to hitch master tiles on the mortar. The air layer between tile arch and roof is favorable to heat insulating.

2) Heat transmission coefficient and thermal inertia of roofing heat-protective material should meet design requirements.

3) The thickness of heat-protective layer must accord with design requirements, and minus deviation cannot be more than 3mm.

4) Non-woven fabrics must be spread completely to avoid the interspaces between fine-concrete-infill and heat-protective panels of roofing. The fabrics should be connective with the roofing structural panel to make them form heat-transmitting bridge and finally affect the heat-protection and insulation effects.

4. Construction scheme of solar water heating system

(1) Incoming of equipments and materials

in the case of incoming of equipments and materials, the supplier must provide the samples and ex-factory qualification certificates of finished products, semi-finished products, structural members, equipments and materials. Selective sampling test should be carried out in laboratory according to the specifications. Special materials must be sent to test center to be tested. For incoming materials, strict detection tests should be carried out and acceptance procedures must be strengthened according to sectional standards. The incoming products whose qualities don’t meet the requirements concerned cannot be accepted.

(2) Installation of solar collector

The foundations of thermal collecting system are placed according to the specified dimensions in drawings. They are arranged orderly. The horizontal error of angle iron foundation upper surface shouldn’t be more than 20mm. The angel iron is firm and reliable, and its surface is smooth. The bottom of angle iron foundation should be firmly contacted with the floor. In addition, waterproof task must be carried out.

Heat-absorbent surface of thermal collector should face south. The southeast angel shouldn't be more than 10°, and southwest angel shouldn't be more than 15° (if unallowable, they can be determined according to practical situation).

The channel steel of water-heating system foundation should be made beautiful with parallel of the front to the back. The overall horizontal error of system should be more than 5mm. The welding portion of channel steel and embedded parts should be firm and reliable. Welded seam should be orderly and rounding. Sizing block should be padded firmly, and the welding portion must be firm.

Collector should be fixed orderly. It must keep horizontal and vertical situation. It has the firm connection performance and strong wind-resistant ability. The lightning-protecting net on the roof is connected with the system, and lightning-protecting guard is set at the highest place of water-heater or water-heating system.

The arrangement of thermal collectors accords with gradient requirements. They are orderly and firm. The welding portion is fixed and welded seam is orderly and rounding. The heat-protective layer is tight and fixed, and the paint is uniform and beautiful.

(3) Installation of pipelines and pipefittings

The pipelines should be collocated reasonably according to the drawings. The pipelines should be flat and straight, and without obvious bends.

When the cold water pipe and hot water pipe are installed horizontally, the hot pipe should be installed at the upside of cold water pipe. When the cold water pipe and hot water pipe are installed vertically, the hot water pipe should be installed on the left of cold water pipe. The hot water pipe and the cold water pipe should be isolated. If the hot water pipe drills through the wall or floor, galvanized pipe or PVC plastic pipe whose diameter is more than that of water pipe should be used as protective thimble. Its exposed length is 10cm. After installation the two sides of protective thimble should be sealed with cement to prevent water from leaking.

The pipelines should be fixed firmly and beautifully. The distance between the adjacent two brackets should be not more than 3200. The supporting point should be located on bare pipe, and there is a supporting foundation at the bottom.

Indoor and outdoor water pipes should be tightly contacted with the wall to fix them firmly. For all kinds of pipes, valves and active joints should be set at proper positions to make maintenance convenient. Hand shank of valves should be upright and without inclination. Flexible and convenient operations must be ensured.

All of check-valves must be installed on pipelines horizontally and they must have proper flow direction. All of joints haven't leakage phenomena. All of pipelines must be flat and straight, without inclinations and bends exceeding the regulations. Water-testing must be carried out after the installations of all of pipelines. The sundries in pipelines must be flushed away to prevent pipelines from being jammed.

(4) Installation of water tank and heat protection of pipelines

The foundations of water tank should be installed according to the regulated position in design drawings. Verticality allowance of water tank after being installed shouldn't be more than 3%. Horizontal error of water tank in the same system shouldn't be more than 30mm.

The heat-protective layer of pipeline shouldn't have obvious drapes. The joints should be set at the inconspicuous position. The connecting seam should be pasted firmly. The heat-protective layer at the corner of pipe also should be made into right-angle shape without defections. The heat-protection of air-bleed hole should be pasted firmly without water accumulating and leaking phenomena.

(5) Installation of electrical control system

Power supply and its control wire must accord with design requirements. Electric cabinet should be vertically installed on the dry and impermeable wall and it is far from the ground 1200mm. The deviation shouldn't be more than 30mm (With exception that instances with special requirements). If it is installed in open air, substantial and beautiful rain-protective device is needed. All of control probes should be installed accurately. Electrically heated pipes should be installed firmly and without water leaking. After installation use 500V magneto-ohmmeter to inspect whether they are insulated (more than 200MΩ). After installation of the whole system, the measured insulation resistance shouldn't be less than 10MΩ. Galvanized round steel whose diameter isn't less than Φ12 should be used as the lightning-protecting device of the system. The round steel should be connected firmly with the whole lightning protecting net of the buildings.

(6) Protection of finished products

The heat-protective layer, leveling layer, waterproof layer and protection layer should be destroyed during the course of construction. Sundries should be cleaned up in time during roofing construction to prevent them from jamming the downspout, tapered slot and so on.

Such operations as holing, burrowing, installation and welding on roofing waterproof layer must be forbidden in case the waterproof layer is destroyed and water-leaking phenomena occur. If such operations as holing, burrowing, installation and welding on roofing are needed, the waterproof task must be carried out again at the end of construction according to roofing waterproof construction requirements.

If the ground has been paved with floor tiles during the course of construction, the ground should be protected using wood plates before construction to prevent falling articles from destroying and polluting the ground.

The wall should be protected well. Burrowing on the wall should be as few as possible. The protective measures should be done well if it is necessary. After construction, the ground and wall should be repaired to favorable state.

(II) Supervision measures

1. Firstly, study the energy efficiency design drawings conscientiously. And then organize Shenzhen institute of architectural science come the buildings site and tell them the energy efficiency techniques to make them understand its real design intentions.

2. Before every project being carried out, supervision people firstly inspect whether construction organization has corresponding construction aptitude and whether operating people have concerned mount-guarding certificate. The unit and people who don't have corresponding aptitude cannot carry out the constructions of this project.

3. Before every construction being carried out, supervision company organizes construction unit checkup the drawings jointly, examine the construction scheme or technical measures of special Energy efficiency project compiled by construction unit to ensure the construction quantity can meet the requirements.

4. Checkup the special Energy efficiency construction scheme carefully submitted by construction unit. Mainly checkup the rationality, feasibility and technicality of the scheme.

5. During the course of construction of every project, construction unit is required to establish "tripartite inspection" system of every working procedure: Self-inspection, handshaking inspection and the inspection carried by professional people. The inspection record also would be checked.

6. Increase active control strength, live up to prior telling-intentions, procedure inspection and post acceptance.

7. Before every construction being carried out, inspect the qualification certificates and performance detecting reports of all kinds of incoming Energy efficiency materials, understand the characters of materials and control the qualities of raw materials. Before construction, make familiar with the drawings and master the detailed operations. During construction side-office supervision system is adopted.

(III) Test schemes of materials and articles

For important indexes concerning with Energy efficiency and heat-protective functions, field inspection is needed. The field inspection of Energy efficiency and heat-protective project should be implemented by statutory inspection unit entrusted by development organization. Construction unit should assist the organization actively.

Development organization should entrust the statutory inspection unit test the materials and articles concerning with the project. Construction unit should assist the organization actively. For important indexes concerning with Energy efficiency and heat-protective functions, field inspection is needed. According the requirements regulated in related standards, the incoming contractual materials are inspected by random sampling for Zhenye town. The detailed specification, amount, basis and time of the samplings refer to the following table.

Serial number	Sorts	Sampling references			The planned specification and amout of samplings
		The numbers of samplings	Sampling basis	Batch	
1	Three physical properties of architectural door and window	With the same specification 3 pillars/group	GB/T7106-2002 GB/T7106-2002 GB/T7106-2002	Window with the same style and specification, three pillars as a group. Area of external window for the same project>5000m^2. Main specification window with different types (Sliding jib window) should be sent and inspected respectively. The windows made by different manufacturers should be inspected at random respectively. Area of external window for the same project<5000m^2. a group of main specification windows with the largest use level are taken randomly and inspected. The windows made by different manufacturers should be inspected at random respectively.	Six groups less than 2.5m, six groups less than 3.0m, total 36 pillars
2	Average heat transmission coefficient of external window	1 pillar/group	GB/T8484-2002	—	Seven groups with the specification 1500mm× 1500mm×（<350mm =, total 7 pillars
3	Average heat transmission coefficient of external wall	1 pillar/group	GB/T13475-92	—	Sampling according to buildings blocks with the specification 600 mm×250 mm×200 mm, total six groups and 120 blocks (used by molding of test piece)
4	Heat conduction coefficient of roofing heat-protective material	2 blocks/group	GB/T10801.2-2002	Taking 300m^3 as a batch with the same sort and the same specification. That less than 300m^3 is counted as one batch.	Sampling on the whole plate Inspection specification 300mm×300mm× 30mm） must be met. Total 6 groups and 12 blocks.

5	Water-proof material	Polyurethane water-proof material	The whole barrel (Multi-component product is taken according to mixture ratio)	GB/T19250-2003	Taking 15t as a batch with the same sort and the same specification. That less than 15t is counted as one batch.	The whole barrel
		Polymer cement water-proof material (JS)	Each 5kg for liquid material and powder material (cement)	JC/T894-2001	Taking 10t as a batch with the same sort. That less than 10t is counted as one batch.	Each 5kg for liquid material and powder material (cement)

(IV) Supervision of Energy efficiency project

Assisting the quality-monitoring station in Longgang district, municipal quality-monitoring station takes charge of detailed supervising and managing jobs of architectural energy efficiency in the course of project construction.

1.Supervision requirements

(1) Examination requirements to documents are made strictly according to engineering construction drawings. The examination and supervision jobs are carried out according to current architectural Energy efficiency forced standard and specifications, including national standard “thermo-technical design specifications of civil buildings” GB50176-93 and trade standard “Energy efficiency design standard of residential architecture in hot-summer and cold-winner region” JGJ75-2003.

(2) The whole procedure includes project establishment, feasibility study, reporting for construction, construction, supervision, final completion, acceptance, and so on. Every segment should accord with architectural Energy efficiency standard.

(3) Such procedures as joint-checkup to drawings, construction stage, final completion and acceptance should be carried out according to the documents concerned with national architectural energy efficiency, national standards, trade standards, local standards and related mandatory clauses.

During the course of joint-checkup to drawings, the special examination to architectural energy efficiency should be carried out when construction drawings are examined. In addition, the directed opinions of architectural energy efficiency should be put forward and the content should be let the people concerned know.

In the course of construction, the performance indexes of relative materials and structural members shall be inspected. If necessary, the inspection by sampling randomly shall be done according to the regulations in specifications. The special inspection task to important portions of architectural energy efficiency shall be strengthened. For example, inspect exterior-protected construction (Wall, roof, door and window) and daily hot-water system of the buildings to determine the service condition of new type walling material in the project, roofing heat-protective conditions, thermo-technical performances of door and window, thermal efficiency of daily hot-water system, heat-protective condition of pipeline and so on.

The following indexes are the keys of daily supervision and quantitative control:

① Air-tightness requirements among the examinations to the three properties of external window.

② Requirements to opening area of external window.

③ Requirements to the area ratio of window to wall.

④ Requirements to heat transmission coefficient and thermal inertia indexes of the roofing external wall material.

When the divisional (sub-divisional) project and unit (sub-unit) project are checked and accepted, there must have the corresponding supervision and inspection records about architectural energy efficiency. The supervision report should be able to reflect the supervision and inspection conditions and supervision opinions about architectural energy efficiency. The architectural Energy efficiency supervision record and documents concerned should be placed into supervision archives.

If the liability principal of every side violates the policy and mandatory clause about architectural energy efficiency, the record document of unfavorable deed will be sent to construction administrative main division according to "Shenzhen unfavorable deed record and announcement method of architectural market principal and the employed people". The evidence-collecting data will be delivered to construction main division and the people will be punished according to “Delivery procedure of administrative punish investigation informations of Shenzhen construction bureau”

2. Supervision plan

(1) Quality-monitoring station supervises the legality of engineering project, including establishment of program, contractor actions and occupational requirements.

(2) Quality-monitoring station supervises the qualities of development unit, design unit, supervision unit, construction unit and inspection unit participating this project.

(3) Physical supervision

1) Quality-monitoring station can enter construction field freely and carry out supervision and inspection according to practical situations of the engineering.

2) Owing to the particularity and complexity of the project, many new materials, techniques and technologies will be used simultaneously. Therefore, the five responsibility sides shall have a design-concluding meeting before starting operation.

3) Inspection items: In the case that the construction enters the following construction stages or portions, supervision unit will have notified the responsibility supervisor to supervise and inspect before 9:30 AM.

Serial number	**project names**
1	Incoming of Energy efficiency products, inspection of material
2	Selective examination to aerated concrete buildings blocks
3	Selective examination to roofing air-sized heat-protective panel
4	Selective examination to Low-E glass installed in external windows
5	Selective examination to solar water heater installed on roofing.
6	Acceptance of Energy efficiency buildingss, searches of information

V Time arrangement and requirements

1. Before October 30, 2005, implement group will have self-inspected and self-checked the architectural Energy efficiency sub-item according to relative regulations in “architectural Energy efficiency demonstration project”.

2. Before November 31, 2005, implement management group of municipal construction bureau will have checked and accepted the architectural Energy efficiency sub-items.

3. Before December 31, 2005, implement group will have written "Report about implement condition of Zhenye town first-stage architectural Energy efficiency project" well and submitted to the lending group.

June 24, 2005

2.10 First draft of *Shenzhen Building Energy Efficiency management Ordinance*

First draft of *Shenzhen Building Energy Efficiency management Ordinance*

Chapter Ⅰ General Provisions

Article 1 These Regulations are formulated in accordance with Law of the People's Republic of China on Energy efficiency and Law of the People's Republic of China on Construction and in the light of the practical conditions of Shenzhen (hereinafter referred to as "the City") for the purposes of strengthening the administration of buildings energy efficiency, lowering the energy consumption of buildingss, increasing the energy utilization efficiency, improving the quality of the environment and promoting the sustainable development of the economy and the society.

Article 2 The term "buildings energy efficiency", as used in these Regulations, means the acts of adopting efficient Energy efficiency measures to increase the energy utilization efficiency, improve the interior thermal environment and lower the energy consumption of buildingss in accordance with the related laws, regulations and technical standards in the city planning and in the course of designing, constructing, reconstructing and using civil architectures.

Article 3 These Regulations apply to the buildings energy efficiency in any act of constructing, reconstructing, extending, using, and maintaining civil architectures in the City's administrative division and the related administrative activities of the buildings energy efficiency.

Article 4 The work of buildings energy efficiency shall be done by developing science and technology, making good use of market mechanism and government incentive measures and adhering to the policy of combining the buildings energy efficiency of newly built buildingss with the buildings energy efficiency of reconstructing the existing buildingss.

Article 5 The City's competent administrative authorities of construction shall, under the guidance of the City's competent administrative authorities of energy efficiency, exercise comprehensive supervision over the City's buildings energy efficiency; the competent administrative authorities of construction of each district shall exercise supervision over the buildings energy efficiency of the district in accordance with its the project management competence.

The competent administrative authorities of construction may entrust buildings energy efficiency administrative organizations and project quality supervisory organizations to exercise concrete supervision over the buildings energy efficiency.

Article 6 The administrative competent authorities of development and reform, planning, land and buildings management, science and technology, finance, price, quality and technology supervision shall carry out control and administration on the work of buildings energy efficiency respectively according to their own responsibilities.

Article 7 The City's competent administrative authorities of construction may organize personnel to lay down the City's buildings energy efficiency standard and supporting technical specifications in accordance with the development situation of the City's buildings energy efficiency under the principle of advanced technology, economy and rationality.
Article 8 The City's competent administrative authorities of construction shall, in the light of the practical situation of the City, lay down measures for certifying and eliminating the buildings energy efficiency products and the related technologies and shall release the lists of products and technologies which are to be promoted or limited or prohibited.
Article 9 Construction units, designing units, units in charge of construction, construction supervision units, service agencies for testing and evaluating buildings energy efficiency and their relevant personnel shall strictly carry out the laws, regulations and mandatory standards on buildings energy efficiency and shall be responsible for their own work.
Article 10 The City's Government encourages the scientific research and technology development of buildings energy efficiency, popularizes the use of Energy efficiency construction materials, energy systems and the relevant construction technologies and improves the development and use of the regenerative energy.
Article 11 The City's Government encourages the setup of service agencies for testing and evaluating buildings energy efficiency and promotes the development of the intermediary institutions of buildings energy efficiency.

Chapter Ⅱ Planning and Design

Article 12 Buildings energy efficiency planning shall be included when the City's competent authorities of development and reform draw up the whole city's energy planning. The City's competent administrative authorities of construction shall draw up and carry out the special planning of buildings energy efficiency in accordance with the whole city's energy planning.
Article 13 When the City's competent administrative authorities of planning formulate the City's overall planning and detailed planning, they shall take into account how to make comprehensive use of energy, how to save energy and how to improve the utilization efficiency of the energy.
Article 14 When construction units draw up their feasibility reports or design assignments of the construction projects, the specialized arguments on rational energy use of the projects shall be included. The City's competent authorities of development and reform shall, in accordance with relevant Energy efficiency regulations of the state, organize personnel to expound, prove and evaluate the energy efficiency of the feasibility reports or design assignments of the construction projects and shall solicit opinions from the competent administrative authorities. The projects which do not meet the requirements of energy efficiency shall not be approved to be registered and authorized or constructed.
Article 15 Construction units shall entrust qualified design units to carry out the design according to buildings energy efficiency standard and the approved feasibility reports or design assignments of the construction projects.
The City's Government encourages people to adopt the construction materials, energy systems and technologies which have higher Energy efficiency standards than the present

buildings energy efficiency standard. Authenticated products of buildings energy efficiency shall be used in the government investment projects while in other projects, the authenticated products of buildings energy efficiency shall be chosen in priority and the obsolete products shall not be used.
Construction units shall not instruct explicitly or inexplicitly the relevant units to violate the mandatory buildings energy efficiency standard and diminish the quality of energy efficiency of the projects.
Article 16 Design units shall abide by the buildings energy efficiency laws, energy efficiency design standard and relevant energy efficiency requirements and shall carry out energy efficiency designs strictly according to energy efficiency design stand and energy efficiency requirements. There should be specialized introductions of buildings energy efficiency designs in schematic designs, preliminary designs and project drawing designs.
The designers who want to undertake buildings energy efficiency designs shall participate in the trainings and examinations organized by the competent administrative authorities of construction. Those who fail to pass the examinations shall not undertake buildings energy efficiency designs.
Article 17 In the designs of housing estates, the micro-environment of housing estates, architectural distributions and factors like shapes and orientations shall be taken into account. Natural conditions shall be exploited fully to cut down buildings energy consumption and increase the utilization efficiency of energy resources.
Article 18 The designs of central cooling systems of the new buildingss shall include temperature controlling devices and cool air measuring devices.
Energy consumption index shall be marked in the design documents of the new buildingss; if the buildingss are residential buildingss, yearly volume of cooling energy consumption of each unit shall be marked; if the buildingss are public buildingss, the yearly total volume of cooling energy consumption of the whole air conditioning system and the yearly total volume of cooling energy consumption per unit area shall be marked.
Article 19 When planning departments examine the preliminary plans of projects, they shall examine the contents about buildings energy efficiency design. They shall order the relevant personnel or units to rectify and reform the designs which do not meet the buildings energy efficiency standards of the state, locality or industry.
Article 20 Construction units shall send their construction documents to the qualified organizations for examining construction documents to be examined and shall report the results of the examinations to buildings energy efficiency administrative authorities for the record.
Construction documents which fail to pass the specialized examinations of buildings energy efficiency design shall not be used. And planning departments shall not issue planning permits of construction engineering; the competent administrative authorities of construction shall not issue construction permits.
Article 21 Organizations for examining construction documents shall examine construction documents strictly according to buildings energy efficiency design standard. The contents of examinations, with the signatures of examiners and seals of the organizations for examining construction documents, shall be listed as independent units in the examination reports. If the construction documents do not meet the mandatory buildings energy efficiency standard, the

results of the examinations of the construction documents shall be “unqualified” and the construction units shall report the construction documents for examination again after modifying the construction documents.

Examination organizations shall be responsible for the authenticity and legality of the examination results.

Article 22 Design units shall tell the units in charge of construction all the details of the technologies in the buildings energy efficiency designs.

The buildings energy efficiency design documents which have been approved shall not be modified without permission.

Chapter Ⅲ Construction and Maintenance

Article 23 Units in charge of construction shall undertake constructions in accordance with the approved qualified design documents and Energy efficiency construction technology standard and shall ensure the quality of the constructions to meet the Energy efficiency standard and the requirements of the designed quality.

Article 24 If any of the construction materials, components, parts or equipments is required in the design documents to meet a certain Energy efficiency standard, units in charge of construction shall send the relevant samples to be checked under the witness of supervision personnel. If the aforesaid construction materials, components, parts or equipments do not meet the standard in the design documents or relevant Energy efficiency standard, they shall not be used.

Article 25 Testing units shall test the Energy efficiency performance of the construction materials, components, parts and equipment according to laws, regulations and buildings energy efficiency standard and shall be responsible for the authenticity of the testing data and testing results.

Article 26 Construction supervision units shall lay down supervision guidelines of buildings energy efficiency in accordance with laws, regulations, Energy efficiency technology standard, design documents, construction project contracts and contracts for construction inspection and control so as to exercise supervision over the constructions of Energy efficiency projects and shall bear supervisory liability for the quality of the constructions of the Energy efficiency projects.

If anyone, in violation of the relevant regulations, uses the construction materials, components, parts or equipments which do not meet the requirements of buildings energy efficiency, construction supervision units shall take measures to stop such behaviors and report them to project quality supervisory organizations.

Article 27 Construction supervision units shall organize itemized inspection and acceptance for the engineering works of buildings energy efficiency and notify construction units, design units and project quality supervisory organizations to participate in the inspection and acceptance work. Those projects that have not been checked and accepted or cannot pass the inspection and acceptance shall not go into next working procedures.

Article 28 After the principal parts of the projects are completed, project quality supervisory organizations shall, in the phase of inspection and acceptance, conduct special checks on buildingss’ enclosure structures (including walls, roofing, doors, and windows and so on) and refrigeration systems and shall exercise supervision over the use of innovative wall materials, thermal insulation property of roofing, thermal performance of doors and windows and thermal insulation property of pipelines of refrigeration systems.

Article 29 After projects are completed, construction units shall apply to the competent administrative authorities of construction or the supervision and administration organizations of buildings energy efficiency which are entrusted by the competent administrative authorities of construction for the specialized inspection and acceptance of buildings energy efficiency. The specialized inspection and acceptance of buildings energy efficiency shall include three parts: buildingss' enclosure structures, buildingss' parts and buildingss' energy system.

Article 30 The relevant parameters of the buildingss' enclosure structures shall meet the requirements of buildings energy efficiency; as to buildingss' parts, recommendable products in the Energy efficiency products lists which are issued by the competent administrative authorities of construction shall be given the priority.

Article 31 When the buildingss' energy systems are checked and accepted, testing reports of energy efficiency of the buildingss' equipment and certificates of buildingss' energy consumption shall be submitted. The aforesaid testing reports and certificates are issued by energy efficiency testing organizations. Certificates of buildingss' energy consumption shall include the buildingss' enclosure structures and their thermal performance parameters, area proportions of windows to walls of every orientation of the buildingss and yearly designed energy consumption per built-up area of the buildingss.

If new technologies and new products which are not covered by the existing standards are used in the buildings energy systems, experts shall be organized to evaluate the buildings energy systems which adopt such new technologies and new products when the specialized inspection and acceptance is conducted.

Article 32 When construction units report the inspection and acceptance of the construction projects for the record, they shall, at the same time, submit the specialized inspection and acceptance certificates of buildings energy efficiency issued by the supervision and administration organizations of buildings energy efficiency and shall write the implementation contents of buildings energy efficiency clearly in their inspection and acceptance reports. Construction units shall carry out rectification and reform if the specialized inspection and acceptance of buildings energy efficiency fails.

Article 33 Construction energy consumption label system is set up. When projects are completed, construction units shall entrust qualified testing units to test and evaluate the comprehensive energy consumption of the whole buildingss and the property of the parts of the buildingss according to the relevant standards on the spot and shall label the testing or evaluating results on the relevant positions of the buildingss.

Concrete measures for the construction energy consumption label system shall be instituted by the City's competent administrative authorities.

Article 34 When they sell the houses, real estate development units shall give clear indications of the status of buildings enclosure structures, energy systems, regenerative energy utilizing systems and the relevant maintenance requirements in the Guidebook of Residential Buildings and indicate clearly the designed energy consumption level of each unit in the real estate business contracts.

If the preceding clause is not observed, the competent administrative authorities of housing shall not go though the formalities for title registration.
Article 35 Titleholders or users of the buildingss shall carry out daily maintenance to the buildings enclosure structures and energy systems according to the relevant regulations in the process of use and they shall promptly do the repairs or replacement if they find buildings enclosure structures or energy systems cannot meet the requirements of buildings energy efficiency.
Article 36 When titleholders or users of the buildingss repair the Energy efficiency buildingss, necessary measures shall be adopted to prevent the damage of the existing Energy efficiency equipment.
Persons liable shall promptly do the repairs and bear the cost of the repairs if they change the Energy efficiency measures of the buildings maintenance structures without authorization and damage the public interests or the interests of other people.

Chapter Ⅳ Reconstruction and Preference

Article 37 The City’s competent administrative authorities of construction shall, in accordance with the specialized plan of buildings energy efficiency of Shenzhen, lay down the stage Energy efficiency reconstruction plan and referential measures for the existing residential buildingss that do not meet the Energy efficiency design standard. The stage Energy efficiency reconstruction plan and referential measures shall be implemented after the approval of the City’s Government.
Those residential buildingss which fail to carry out Energy efficiency reconstructions according to the plan shall be charged in classes and grades according to the energy consumption quota of the newly built buildingss.
Article 38 Titleholders and users of the buildingss shall, according to the reconstruction plan approved by the City’s Government, carry out Energy efficiency reconstructions to the enclosure structures, air conditioning systems and lighting systems of the existing buildingss which do not meet the Energy efficiency design standard.
When the Government invests to reconstruct the existing buildingss, the energy measuring devices shall be installed so as to measure the energy consumption of the air conditioning systems, office systems, lighting systems and other construction equipment respectively.
Article 39 The City’s Government encourages a great diversity of investors to invest the Energy efficiency reconstruction of the existing buildingss through diversified channels. The investors may share the interests from the Energy efficiency reconstructions of the buildingss according to their agreements.
Article 40 The Government shall set up a special fund for the development of buildings energy efficiency. The fund, under the supervision of the City’s competent administrative authorities of finance, is mainly used for:
(1) the study of the buildings energy efficiency technologies and the development of the buildings energy efficiency products;
(2) the subsidies of buildings energy efficiency model projects and generalizing and applying pilot projects;

(3) the rewards to the Energy efficiency projects with higher Energy efficiency standards than the present Energy efficiency standards;
(4) the rewards for the projects that make use of regenerative energy or adopt the combined heating， cooling and power system;
(5) the Energy efficiency reconstruction of the existing buildingss;
(6) the publicity of buildings energy efficiency;
(7) other buildings energy efficiency expenditures approved by the City's financial departments.

Article 41 The resources of the special fund for the development of buildings energy efficiency are:
(1) financial allocations;
(2) guarantee deposit of buildings energy efficiency;
(3) 50% of the Innovative wall material Fund;
(4) 30% of the charges from the buildingss whose energy consumption volume surpasses the quota of the buildings energy consumption volume according to the classified and graded standards;
(5) social donations.

Article 42 The system of buildings energy efficiency guarantee deposit is set up. Construction units which undertake the constructions, extended constructions and reconstructions of all kinds of industrial and residential buildingss shall pay "buildings energy efficiency guarantee deposit" by the rate of 20 Yuan per square meter floorage to the competent administrative authorities of construction. And the construction units shall apply for Permit for Undertaking Construction Projects by the invoices. After the inspection and acceptance, the principal of guarantee deposit will be returned to the construction units if the projects are affirmed by the buildings energy efficiency inspection and acceptance organizations to meet the relevant standards of buildings energy efficiency. If the projects do not meet the relevant standards of buildings energy efficiency, the guarantee deposit will be appropriated to the special fund for the development of buildings energy efficiency.

Article 43 The Government encourages the housing estate and large scale public buildingss to adopt the combined heating， cooling and power system. The Government will give financial subsidies to the projects which adopt the combined heating， cooling and power system by 15% of the total investment of the combined heating， cooling and power system engineering.

Article 44 The incentive policy of accounting increment of the floor space and capacity rate is formulated for the Energy efficiency buildingss. The increased floor space due to the Energy efficiency designs shall not be listed into the construction capacity rate. The concrete measures for accounting increment shall be formulated by the City's planning administrative departments and be reported to the City's Government for approval.

Article 46 The competent administrative authorities of construction shall carry out the certifications of the Energy efficiency products with the supervisory departments of quality and technology. The tax authorities shall deduct or exempt taxes to the buildings energy efficiency products which have been certificated.

Article 47 The Government encourages people to use regenerative energy such as solar energy, wind energy, geothermal energy and so on. Power supply departments shall buy the electricity generated by the regenerative energy at a preferential price and provide such electricity with conditions to access the electric net.

Article 48 The Government encourages people to save energy and the charging system which is based on the measurement of the energy consumption is set up. Property management units shall make use of the temperature control devices and energy measuring devices of the centralized cooling systems to measure each family’s real cooling energy consumption and the electricity consumption of lighting system, office and other construction equipment system and charge each items respectively.

Article 49 The City’s competent authorities of energy shall lay down energy consumption quota standards for the newly built buildingss according to the scale, classification, function and property of the buildingss with the competent administrative authorities of construction; the City’s competent administrative authorities of price shall lay down classified and graded charging standards for the construction energy consumption according to the energy consumption quota standards; property management units shall carry out statistics of the construction energy consumption according to the standard of statistics and send the statistical data to the buildings energy efficiency administrative organizations periodically.

Article 50 The Government encourages the buildingss to use electricity in the way of staggering the peak load. The policy of low electricity price is carried out for the electricity that is used during the period of low ebb. The low electricity price shall be 25% or lower of the electricity price at the peak load.

Chapter Ⅴ Legal Liability

Article 51 Any functionary of administrative organizations who, in violation of these Regulations, commits any of the following acts shall bear administrative sanctions of demotion or dismissal; and where a crime is constitute, criminal liabilities shall be investigated in accordance with law:

(1) approving the registration or construction for the projects which do not satisfy the requirements of buildings energy efficiency;

(2) issuing permits of construction for the projects which fail to pass the specialized examinations of buildings energy efficiency design;

(3) going though the formalities for title registration for the buildingss on which the designed energy consumption level of each unit is not labeled clearly or there are no operation instructions for buildings energy efficiency;

(4) violating the relevant regulations when using the buildings energy efficiency certification products;

(5) failing to investigate the illegal acts;

(6) other acts that violate the legal duties of supervision and administration.

Article 52 Any construction unit that, in violation of these Regulations, commits any of the following acts shall be ordered to make corrections and shall be imposed of a fine of not less than RMB 200,000 Yuan but not more than RMB 500,000 Yuan; and where a crime is constitute, criminal liabilities shall be investigated in accordance with law; if other persons suffer losses, the unit shall bear the liability for compensation:

(1) lowering the norms or standards when entrusting the design task of the projects;

(2) modifying the authorized buildings energy efficiency design documents without authorization;
(3) undertaking constructions according to the construction documents which fail to pass the specialized examinations of buildings energy efficiency design;
(4) instructing explicitly or inexplicitly the units in charge of constructions to use construction materials, construction parts and equipment that fail to satisfy the requirements of the buildings energy efficiency;
(5) approving the inspection and acceptance of the buildingss which fail to meet the mandatory buildings energy efficiency standard or putting such buildingss into use.
Article 53 Any design unit that, in violation of these Regulations, does not design according to the mandatory buildings energy efficiency standard shall be ordered to make corrections and shall be imposed of a fine of not less than RMB 100,000 Yuan but not more than RMB 300,000 Yuan.
Article 54 Any unit in charge of construction that, in violation of these Regulations, commits any of the following acts shall be ordered to make corrections; if the unit does not make corrections within the given time, it shall be ordered to stop doing business for internal rectification and shall be punished according to the following regulations; if other persons suffer losses, the unit shall bear the liability for compensation according to law.
(1) Any unit in charge of construction that does not undertake constructions according to the approved qualified design documents, buildings energy efficiency standard and other relevant construction technical standards shall be imposed a fine of not less than 2% but not more than 4% of the contract cost of the project;
(2) Any unit in charge of construction that does not use the construction materials, components, parts or equipments which meet the buildings energy efficiency design documents and the relevant Energy efficiency standards shall be imposed a fine of not less than RMB 100,000 Yuan but not more than RMB 200,000 Yuan.
Article 55 Any construction supervision unit that, in violation of these Regulations, commits any of the following acts shall be ordered to make corrections and shall be imposed of a fine of not less than RMB 100,000 Yuan but not more than RMB 200,000 Yuan; if other persons suffer losses, the unit shall bear the liability for compensation:
(1) failing to take measures to stop or report the illegal acts of using construction materials, construction components and equipment which do not meet the buildings energy efficiency standard;
(2) putting the construction documents which are not checked and approved into construction;
(3) failing to take measures to stop or report the constructions which are not undertaken according to the approved construction documents by the units in charge construction or other constructions which violate laws or rules or regulations; failing to reject or report the construction units' orders which violate laws, regulations or mandatory technical standards;
(4) Construction supervision units approve with their signatures unqualified construction materials, construction fittings, components or equipment which do not meet the buildings energy efficiency standard and backward technologies which are eliminated by explicit state order and highly energy-consuming products, equipment and materials as qualified ones.
Article 56 Any Energy efficiency design examination organization that, in violation of these Regulations, issues false certificate of examination shall be imposed a fine of not less than

one time the amount of, but not more than two times the amount of its examination fees. And if there are unlawful gains, the unlawful gains shall be confiscated; at the same time, the legal representative and other directly responsible personnel shall be imposed a fine of not less than 5% but not more than 10% of the fine of the organization.

Article 57 If any testing unit, in violation of these Regulations, counterfeits testing data and testing conclusions and issues false certifications, its qualification certificates shall be revoked and the unlawful gains shall be confiscated; and the unit shall be imposed a fine of not less than one time the amount of, but not more than two times the amount of its testing fees; and where a crime is constitute, criminal liabilities shall be investigated in accordance with law.

Article 58 Administrative penalties in these Regulations shall be carried out by the competent administrative authorities of construction.

Penalties which are not stipulated in these Regulations shall be implemented according to other relevant laws and regulations which stipulate such penalties.

Chapter Ⅵ Supplementary Provisions

Article 59 These Regulations shall come into force as of__ __, 2006.

2.11 Notification for releasing *Temporary Provision of Energy Efficiency Management for Operation and Maintenance of Air-conditioning System*

Document for Bureau of Trade and Industry of Shenzhen Municipality, Shenzhen Municipal Bureau of Land Resources and Housing Management, and Shenzhen Construction Bureau

36th document 〔2005〕of Bureau of Trade and Industry of Shenzhen Municipality

Notification for releasing *Temporary Provision of Energy Efficiency Management for Operation and Maintenance of Air-conditioning System*

All Related corporations:

In order to solve the problem of seasonal and regional shortage of electric power supply, to assure central air conditioner to run with matter of safety and saving energy，Bureau of Trade and Industry of Shenzhen Municipality, Shenzhen Municipal Bureau of Land Resources and Housing Management, and Shenzhen Construction Bureau enact "Temporary Provision of Energy Efficiency Management for Operation and Maintenance of Air-conditioning System in Shenzhen"，now it is issued.

Bureau of Trade and Industry of Shenzhen Municipality, Shenzhen Municipal Bureau of Land Resources and Housing Management, Shenzhen Construction Bureau

2005-7-28

Bureau of Trade and Industry of Shenzhen Municipality 2005-7-29 issue

Temporary Provision of Energy Efficiency Management for Operation and Maintenance of Air-conditioning System in Shenzhen

Chapter 1 general provisions

Article 1 In order to solve the problem of seasonal and regional shortage of electric power supply, to assure central air conditioner to run with matter of safety and saving energy， this regulation is enacted.

Item 2 This regulation fits for all kinds of construction for civilian use orindustry （expect for artwork construction） without concentrated air conditioner system in the administer area Shenzhen.

Item 3 Related managing documents， technical files and contracts that adopted by running manager of central air conditioner system should accord with the requirements of this regulation.

Item 4 This regulation fits for operation and maintenance management of central air conditioner system in normal condition. If explosive public health accident， disaster， and terroristic attack happen and it is able to diffuse inquination and generate harm through central air conditioner system， emergent measurement should be adopted according to practical condition.

Article 5 This regulation is executed by organization submitted by Bureau of Trade and Industry of Shenzhen Municipality and supervised by Shenzhen Municipal Bureau of Land Resources and Housing Management and Shenzhen Construction bureau according to their position and responsibility respectively.

Chapter 2 Operation and Management

Section 1 Personnel Management

Article 6 The relative corporations should provide the necessary professional or part-time technological person according to the scale of the central air conditioner system, the degree of its complexity, and the workload of maintaining and management. Set up the corresponding teams and groups of operation, management, and maintaining. Purchase the corresponding maintaining devices, and test instruments, etc.

Article 7 The management and operation person can go to the position after training and education of saving resources, as well as after passing the test.

Article 8 The relative corporations should set up, and make the training and examination of management and operation person perfect.

Article 9 Operation person should be familiar with the central air conditioner system that they managed, create the awareness of saving resources and protecting the environment, and make the daily record of air conditioner and responsibility record good.

Article 10 As to the groups and individuals that adhere to the job, operate safely, and has outstanding performances in the work of saving resources, relative corporations should award them.

Section 2 Rules and Regulations

Article 11 The operation manager should set up, and make the relative rules and regulations of device operation regulation, the whole scheme of routine operation adjustment, motor room management, and water quality management perfect.

Article 12 The operation manager should set up, and make the rules and regulations of position responsibility, professional personnel responsibility, safety and sanitation regulation (include emergent treatment scheme for sudden events), operation attendance regulation, visiting checkup regulation, repair and maintaining regulation, and accident report regulation, etc.

Article 13 The management department should check the implementing condition of the relative rules and regulations periodically.

Article 14 Management person should check the staff and system condition at or not at a fixed time to do the data statistics and operation technology analysis, and correct timely if there is any abnormality.

Article 15 The relative corporations should summarize and analyze the operation of a quarter and a year of the operation condition of air conditioner system, completion degree of device, resource consumption condition, and resource saving improvement measure.

Article 16 During the working period of the device, the device supplier should offer the corresponding technique service and accessories to the users, and make the repair record good.

Article 17 As to the engineering Articles of cleaning, resource saving, adjustment, and improvement, it's better to use quantification to restrain the implement results, and the registered contract text must clearly guarantee the implementation results and expiry date.

Section 3 Technique data management

Article 18 The technique documents of the device, construction, check and accepting, test, repair, and evaluation of the central air conditioner system should be complete and preserved well. The following documents should be placed on file, and regarded as the important matter of technique administration, responsibility analysis, and administration evaluation:

(1) Technique data, qualification for turning out from factory, and checkup (test) report of the main materials, devices, finished products, and half-finished products;

(2) Qualification of instruments turning out from factory, performance introduction, and correction record;

(3) Chart paper examination record, design alteration notice and completion picture of the construction project (include renovation reform and repair reform);

(4) Check and verify records;

(5) The installment and checkup records of engineering device, blowpipe system, water pipe system;

(6) Pipe test records;

(7) Test run records of single device;

(8) Test run and debugging records of system combination;

(9) Checkup records of the safety and function test data;

(10) Examination report of the system synthetic efficacy;
(11) Maintaining records and overhauling records;
(12) Water quality examination report.

Article 19 All the operation and management records should be complete, and mainly include the chief device run record, visiting checkup record, operation attendance record, and maintaining record, etc. As to the system that never stops running, there should be duty transition record. The preliminary record should be accurate and clear, fit the requirements of relative administration regulations, and be kept well.

Article 20 The relative corporations should well keep the data of device and system running records, accident analysis and treatment records, records of big repair and alteration condition of the device and system parts, and annual running summary and analysis, etc.

Article 21 The visiting checkup should have fixed time, fixed position, and fixed person, and well make the preliminary record. Use system that is controlled by computer, and the mode of periodic print and collection of report forms and data digitalization memory can be used to record and preserve the running preliminary data.

Chapter 3 Technique Requirements

Section 1 Running and maintaining regulations

Article 22 The surface of the device, spigot, and pipe should be clear and tidy, without severe erosion and the phenomena of running out, oozing, dropping, leaking, and blocking. The electric spigot should run normally.

Article 23 The main devices and counting instruments of the air conditioner system should be tested, standardized, and maintained periodically. The place that is lack of instrument equipment should be added in time.

Article 24 The self-control device and system of air conditioner should be checked and maintained periodically, examine transducers and instruments periodically, so as to ensure the normal work of system.

Article 25 While renew or add temperature and humidity sensitive elements and testing elements, the following requirements should be fitted:

(1) Inside the room, it’s better to set up in the position that is not affected by the local heat, typical, and airiness. If the local area has strict requirement, set up at the right place;
(2) Inside the windpipe, set up at the center of the cross-section of the pipe, where the airflow is steady;
(3) The sensitive element and testing element of thaw point temperature should be installed at the typical position behind the panel blocking water, and should avoid the effect of radiant heat, vibration, water drop, and second returning wind.

Article 26 The checking hole, repairing hole, and measuring hole of the main devices and windpipes of the air conditioner system must no be cancelled or blocked. If it is necessary, the checking hole, repairing hole, and measuring hole should be added, which can make it easy to test the operation condition at times.

Article 27　The extreme devices of air conditioner system, such as wind machine serpentine, air processor, and new wind machine, etc, should be uniformly maintained by the operation administration department, check up periodically, repair in time, and replace the damaged devices and parts in time. Filtering screen should be checked and cleaned periodically.

Section 2　Safety Articles

Article 28　Relative corporations should periodically check up the cryogen leakage of the main frame in the congealer room. Devices with alarm setting should test and maintain periodically, devices interlocked with ventilating system should ensure the linkage normal, and ensure the safe and normal work of the system.

Article 29　Relative corporations should check the working condition of safety protection equipments, all kinds of pressure container, and the deposition of chemical dangerous material and petroleum.

Article 30　The electricity manipulation and operation system of the air conditioner system should be safe and reliable. The power supply should fit the requirements of devices, the link should be firm, the grounding measures fit "***Electricity Installation Testing and Verification Standard***", and with no overload running phenomenon.

Article 31　The stream switch of the cold water and cooling water of refrigerating equipment should be checked periodically, and ensure the normal work.

Article 32　The foundations of the refrigerating equipment, water pump, and wind machine should be stable and firm, the running of gearing equipment is normal, the cooling and lubrication of shaft bearing is good, with no overheat phenomenon. The air tightness of shaft bearing is good, without any abnormal sound or vibration phenomenon.

Article 33　Relative corporations should periodically check the exit and entry gradient pressure of the condenser of water-cooling machine group according to the device requirements, and clear the incrustation inside the devices.

Article 34　Relative corporations should periodically check fire prevention valve of blasting pipe and wind returning pipe of the air conditioner system, as well as its temperature sensitive and fume sensitive control elements, and ensure its normal work.

Article 35　Flammable, bursting, and poisonous matter are forbidden to put inside the machine room.

Article 36　Check the electrical refrigeration compressor group periodically, and ensure the normal work of following equipments:

(1) Safety protection of compressor;
(2) High pressure protection of venting pressure and low pressure protection of inspiration pressure;
(3) The oil gradient pressure protection of the lubricating system;
(4) The overload and phase lacking operation protection of the electromotor;
(5) Cooling water and cover-cutted water protection;
(6) The high temperature protection of the shaft bearing of centrifuge compressor;

(7) The anti-freezing protection of the cold water of evaporator;
(8) Water stop protection of the cooling water of condenser and the accident protection of the ventilator of evaporating condenser.

Article 37 The safety equipments of the safety valve, pressure gage, thermometer, and sap pressure meter of the electrical refrigerating devices, as well as high and low pressure protection equipment, low temperature anti-freezing protection, generator overflowing protection, venting temperature protection, and oil gradient pressure protection must be complete, and periodically check and verify, so as to ensure the normal work.

Article 38 The oil sign of the freezing oil of the electrical refrigerating devices should be eye-catching, the oil position should be normal, and the oil quality should fit the requirements. The operation condition of the refrigerating devices should fit the technique requirements, and there mustn't be over-temperature and overpressure phenomenon. Periodically check and record the water-flow resistance of the condenser and evaporator of the water cooled cold water machine group, and ensure its value not exceed the nominal resistance difference.

Article 39 Relative corporations should ensure the normal running of all the safety and self-control equipments according to the requirements of safety and economic operation. If there is something abnormal, record and report in time. Under special condition that need stop the safety or self-control equipment, relative examining and approving procedure or record putting procedure should be complied, and inform all the related air conditioner consumers.

Chapter 4 Resource Saving Requirements

Article 40 The operation administration department should annually do the statistics of the resource consumption and cold supply capacity of air conditioner system. The refrigeration or warming function coefficient (COP) of full burden or part burden of the electrical refrigerating condenser should fit the requirement of Article 5.4.4 GB50189-2005 in ***Design Standards for Energy Efficiency of Public Building*** (refer to appendix 2).

Article 41 When the service function and burden distribution of air conditioner system change, or the air conditioner system has obvious imbalance of temperature, the operation administration department should adjust the balance of the water system and wind system of air conditioner. Both the disproportion of water capacity (the deviation of real discharge and demand discharge/ demand discharge) and wind capacity (the deviation of real wind capacity and demand wind capacity / demand wind capacity) should not exceed 20%.

Article 42 The new wind capacity control of the whole air system operation should run according to the following principles:
(1) When the system precooling and preheating is running, no new wind running is possible;
(2) When the system runs normally, the new wind capacity should be controlled according to the concentration of CO_2 lower than 0.1%, or use according to the range in appendix 3;

(3) If increasing new wind capacity may lower the resource consumption of system, it's better to increase new wind capacity or use direct supply of whole new wind to operate;
(4) If increasing new wind capacity may enhance the resource consumption of system, it's better to reduce new wind capacity properly.

Article 43 As to the place that the peak value of people flow density is big, and the change fluctuation flow is big, it's better to use CO_2 concentration control system to adjust new wind proportion.

Article 44 The cold water entry temperature of surface cooling instrument should be at least 3.5℃ lower than that of the dry ball temperature at the air exit. The raise of cold water temperature should adopt 2.5~6.5℃. When the surface refrigerating instrument is used to the procedure of air cooling dehumidification, the temperature of the cold water exit should at least 0.7℃ lower than that of the thaw point at the air exit.

Article 45 The refrigerating condition should use big water difference to blasting, but it's not supposed to exceed the following values:
(1) When the blasting height is lower or equal to 5m, it must not exceed 10℃;
(2) When the blasting height is above 5m, it must not exceed 15℃.
(3) When the blasting height is above 10m, calculate and definite according to the efflux theory.
(4) When adopt top blasting (not-scatter flow instrument), calculate and definite according to the efflux theory.

Article 46 The heat reclaiming equipment of air conditioner system should be checked and maintained periodically, and ensure its normal work. If the air conditioner system has no heat reclaiming equipment, but it fit the following conditions, the whole heat or sensible heat reclaiming equipment can be added:
(1) When concentrative wind discharging system is set, the wind capacity is bigger than or equal to $3000m^3/h$ uniflow air conditioner system, and the designed and calculated temperature difference between new wind and discharging air is over or equal to 8℃;
(2) Concentrative wind discharging system is set, wind capacity is bigger than or equal to $10000m^3/h$, the ratio of new wind exceeds or equals 40% of the system, and the designed and calculated temperature difference between new wind and discharging air is over or equal to 8℃;
(3) Independent new wind and wind discharging system is set.

Article 47 Under the working condition of the refrigeration of air conditioner system, the temperature difference between feed-water and backwater of the system is usually smaller than 3℃ (the designed temperature difference is 5℃); under the working condition of heat supply, the temperature difference between feed-water and backwater of the system is usually smaller than 6℃ (the designed temperature difference is 10℃), it's better to use the resource saving measures that can reduce the discharge, and not affect the hydraulic equilibrium of system. Avoid the operation working condition of small temperature difference and big discharge as far as possible.

Article 48 When the wind system is running, it's better to use valid resource saving measures to increase the temperature difference of blasting and returning wind, and not affect the wind capacity balance and indoor airflow of the system.

Article 49 Relative corporations should periodically check the anteroposterion pressure difference of air filter. If the gradient pressure can not be displayed directly or from far away, visible testing instrument should be added.

Article 50 It's better for the air treatment equipment with reheating serpentine to reduce the counteraction of cold and heat while it is running.

Article 51 Multiple paralleli running devices of the same kind can be automatically or manumotively adjust the running number according to the actual burden condition, and make the output capacity (for instance, cold capacity, heat capacity, water capacity, wind capacity, and pressure, etc.) match the parameter that it is required to supply.

Article 52 The output power of the devices with the function of regulating speed can automatically change according to the change of control parameters (e.g. cold supply capacity, heat supply capacity, water supply capacity, blasting capacity, returning wind capacity, and pressure, etc.).

Article 53 As to the big space, the whole air system that adopts the concentrative treatment, transportation, and distribution of fixed wind capacity because of big personnel flowing, it's better to use frequency changing, speed adjusting, and reforming operation to the air deposition group.

Article 54 As to the refrigerating system that is composed of two or more than two refrigerating cold water groups and with low usage, its cold water pump and water cooling pump should use frequency change measures, so as to reduce the power that meaninglessly is consumed by single machine running.

Article 55 As to the cooling tower with one tower and multiple wind machines, it's better to adjust the number of running wind machines according to the returning water temperature of cooling water. Under the precondition of ensuring the cooling water temperature meet the normal running of cold water group; the running wind machine number should be the smallest.

Article 56 In the parallel cold supply system by multiple refrigerating main frames, its matched cooling tower should use parallel mode too, so as to use parallel cooling tower when it is the transition seasons, outside temperature is low, indoor cold burden is reduced, and part of the refrigerating mainframes is running. Don't open the wind machine, but use natural cooling mode to reduce resource consumption.

Article 57 When the air conditioner system is intermittent operation mode, under the situation that sufficiently considers the recuperation function of the surrounding structure of buildingss, decide the proper time of opening and stopping machines according to the daily weather condition and burden condition of indoor air conditioner.

Article 58 Under the condition that meets the indoor air control parameter, it's better for the ice cooling air condition system to increase the temperature difference of feed-water and backwater.

Article 59 Through the technique economy analysis, it's better for the refrigerating system to retrieve heat of condensation.

Article 60 The operation person of the refrigerating main frame under air conditioner working should avoid the running by adjusting the outflow water temperature of cold water under 7℃. When the burden of main frame is not big, under the condition that meets the cold capacity demand of air conditioner system, the outflow water temperature of the group can be raised properly, so as to enhance the efficacy of refrigerating machine.

Article 61 Enhance and make the automatic control level of the refrigerating system of the central air conditioner perfect. If condition is permitted, change hand operation to automatic control as far as possible.

Article 62 The separate door charge technique of central air conditioner system should be wide spread, change the traditional equal charge method that bases on the consumer's using floor space to the separate door calculation, and make the economic profit of consumer and resource saving requirements in accordance.

Article 63 Strengthen the checkup and maintaining of the insulation measures of the pipes, so as to reduce the losing of cold and heat.

Article 64 Gradually eliminate the devices that are technically falling behind, aging, and with low efficacy high resource consumption.

Article 65 In order to lower the consumption of the central air conditioner system, the temperature of air conditioner environment should be raised properly.

Article 66 It's better for the central air conditioner system to set up independent calculating devices of electricity supply.

Chapter 5 Supplementary Rules

Article 67 This regulation is carried out from the day it issued.

Appendix: 1. Comparison table of environment design temperature of indoor air conditioner and resource saving operation temperature.

2. Article 5.4.4 GB50189-2005 in "*Design Standards for Energy Efficiency of Public Building*".

3. The minimum capacity of new wind needed by the personnel in the main room of civilian using buildings (m^3/h.p)

Appendix 1

Comparison Table of Environment Design Temperature of Indoor Air conditioner and Resource Saving Operation Temperature

Room function		Design temperature	Resource saving operation temperature
		(℃)	(℃)
Office	High	23-25	25-27
	General	24-26	26-28
Spare bedroom	High	23-25	24-26

	General	24-26	25-27
Market	First layer	24-26	26-28
	Other layers	24-26	26-28
Dining hall	High	22-24	24-26
	General	24-26	26-28
Feast hall	High	22-24	24-26
	General	24-26	26-28
Multiple function hall	High	22-24	24-26
	General	23-25	25-27
Big hall	High	24-26	26-28
	General	25-27	27-28
Middle courtyard	High	24-26	26-28
	General	24-26	26-28
Recreation room	High	23-25	25-27
	General	24-26	26-28
Meeting room	High	23-25	25-27
	General	23-25	25-27

Note: 1. The palace that is not indicated can refer to the temperature control of resource saving operation. The one without fluctuation range raise 2℃ according to the design temperature.

2. Four star hotels, five star hotels and special places can control flexibly.

Appendix 2:

5.4.4 The machine group of evaporating compression circulatory cold water (heat pump) should use the type that is easy to uninstall, reliable, and with high refrigerating (heating) function coefficient (COP) of full burden and part burden, and the following requirements should be fitted:

1. The nominal working condition refrigerating function coefficient (COP) should not lower than the value in Table 5.4.4;

2. It's better that the burden energy efficiency (IPLV) of the synthetic part is not lower than the value defined in Table 5.4.4.

Table 5.4.4 Refrigerating function coefficient of cold water (heat pump) group and the burden energy efficiency (IPLV) of the synthetic part

Type		Nominal refrigerating capacity (CC)kW	Function coefficient (COP) W/W	Burden energy efficacy of the synthetic part (IPLV) W/W
Water cooling	Piston mode/ vortex mode	<528 528-1163 >1163	3.8 4.0 4.2	….
	Bolt mode	<528 528-1163 >1163	4.10 4.30 4.60	4.47 4.81 5.13
	Centrifuging mode	<528 528-1163 >1163	4.40 4.70 5.10	4.49 4.88 5.42

Wind cooling or evaporation cooling	Piston mode/ Vortex mode	<50 >50	2.40 2.60	….
	Bolt mode	<50 >50	2.60 2.80	….

Note: 1. The using side: The water temperature of refrigerating exit/entry is 12/7℃.

2. The thermal source side (or heat emission side): The entry and exit water temperature of the cooling water of water cooling is 30/35℃. The dry ball temperature of the refrigerating air of wind cooling is 35℃. The air wet bulb temperature of evaporating cooling is 24℃.

3. The fouling coefficient of the using side and thermal resource side of the water cooling is $0.056m^2$•C/kW•m^2.

4. IPLV value is based on the working condition of single mainframe operation.