CHAPTER ONE

Introduction

1.1. Background:

The science of air-conditioning may be defined as that of providing and maintaining a desirable internal atmospheric environment irrespective of external conditions. As rule 'ventilation' involves the delivery of air which may be warmed, while 'air-conditioning' involves delivery of air which may be warmed or cooled and have the moisture content (humidity) raised or lowered.

Air condition signifies the automatic control of an atmospheric environment either for comfort of human beings or animal or for the proper performance of some industrial or scientific process.

Air conditioning systems should be designed to match the anticipated cooling load and be capable of expansion if necessary; year –round, if continuous operation may be required. Expansion of air –conditioning systems while maintaining continuous operation of the data center may also be necessary. A separate system data communications equipment rooms maybe desirable where system requirements differ from those provided for other building and process systems, or where emergency power requirements pre-clued combined systems.[1]

1.2. Purpose of Air Conditioning:

Is to supply sufficient volume of clean air with comfort air temperature and humidity. [2]

1.3. Function of Air Conditioning:

1. To control the temperature.
2. To control the humidity.
3. To control the speed of air movement.
4. Air cleanliness.

1.4. Air Conditioning System Type:

The air conditioning type is classified into two type of font:

1. Comfort air conditioning.
2. Industrial air conditioning.

The essential feature of comfort air conditioning system is to provide an environment which is comfortable to the majority of the occupants.[2]

1.5. Classification of Air Conditioners:

1. Classification by expansion methods.
2. Classification by heat rejection methods.
3. Classification by structure.
4. Classification by using positions.
5. Classification by installation methods of fan coil (indoor) units.

1.5.1. Classification by Expansion Methods:

1. **Direct Expansion (DX):**

Heat is directly exchanged between air to be conditioned and the refrigerant.

2. **Indirect Expansion:**

Heat is exchanged indirectly between air to be conditioned and the refrigerant by means of water.

1.5.2. Classification by Heat Rejection Methods:

1. Air –Cooled.
2. Water –Cooled.

1.5.3.Classification by Structure:

1. Split type.
2. Single package.

1.5.4. Classification by Using Position:

1. Residential.
2. Industrial.
3. Commercial.

1.5.5. Classification by Installation Methods of Fan Coil (indoor) Units:

1. Floor mounted type.
2. Wall mounted type.
3. Ceiling suspended type.
4. Ceiling mounted cassette type, duct type ... etc.

Before the advent of different processes for cooling and air conditioning there were problems encountered in working life and leisure life of the human being and not feeling comfortable because of the unhealthy atmosphere and in the workplace, whether in offices or factories or commercial markets, etc., and because of uncomfortable and unhealthy atmosphere containing large amounts of dust, humidity and temperature or due to gases and viruses circulating in the atmosphere so necessary to think about the things that provide comfort in all areas of life.

In the past, air conditioning is considered a luxury, but now is considered a necessity because it provides:

1. Healthy atmosphere appropriate to increase production .
2. Special atmosphere that fits the operating rooms in hospitals, pharmaceutical factories and assembly factories instrumentation .

3. Atmosphere suitable for some industries such as the textile industry, paper industry, smoke and food industries.
4. A special atmosphere to save the books, drawings and objects in libraries and museums.
5. Air conditioning for human comfort in transportation by land, air, and sea.
6. Comfortable setting for a person in homes, hotels, theaters, cinemas, restaurants, shops, office buildings and private offices and public.[2]

1.6. Scope:

Calculating cooling loads of central air conditioning unit using computer program (Hourly Analysis Program), case study" Faculty of Engineering Building , Elimam Elmahdi University .

1.7. Objectives:

1. Calculating of cooling loads of building using Hourly Analysis Program(HAP) .
2. Calculating of cooling loads of building using manual method (mathematical equations).
3. Comparison cooling loads between manual method (mathematical equations) and Hourly Analysis Program (HAP).

1.8. Methodology:

Using HAP program to calculate cooling load because the Hourly Analysis Program (HAP) is the most important program that was used in adjustment operations in general, and that because of its ability to give accurate accounts of the cooling load in all spreads , no matter what their shape and composition, and HAP program which is the fastest and easiest to calculate the thermal loads because it gives you idea of what is happening in the system and how distribution loads can flows within the space through the introduction of all data location of the dimensions and the introduction of surrounding it and all the information , since all the conditions were available choices in the program .

1.9. Overview of the Thesis:

This Chapter has presented an introduction of air conditioning, background, and Scope ,objectives, Methodology and Overview of the thesis, Chapter two presents a literature, While Chapter three presents a mathematical equations method to calculate the cooling load, Chapter four presents a methodology using HAP program, Chapter five presents the results , Chapter six conclusion recommendation.

CHAPTER TWO

Literature Review

Heating Air Ventilation and Conditioning systems generally share common basic elements even though they differ greatly in physical appearance and arrangement. These systems may also differ greatly in the manner in which they are controlled and operated. HAVC systems are categorized according to manner by which they distribute energy and ventilate air, by how they are controlled, and by their special equipment arrangements.

2.1. Types of All-Air Systems:

An all air system has acquired that name since everything required in the conditioned space heating and humidification as well as cooling and dehumidification, may by furnished to the space by air, some systems require no heating and some require only perimeter heating by baseboard reheat coils, or radiant panels. It is common to refer to cooling systems with such heating provisions as all air systems. In most large commercial systems, liquid is used to transfer energy between the boilers or furnaces and chillers and the air handlers, but it is air that transfers the energy and the ventilation between the air handlers and the conditioned spaces. Figure 2-1 shows only part of a typical all air system. not shown is the air distribution system (ductwork). The ductwork arrangement between the air handler and the conditioned space determines the type of all air system. [3]

2.1.1. Single Zone System:

The air-handling unit can be installed either within a zone or within remote from the space it serves and may operate with or without ductwork. A single zone system responds to only one set of space conditions thus it is limited to applications where reasonably uniform temperatures can be maintained throughout the zone. Figure(2-1) shows a schematic of the air handler, associated dampers, and controls for a single zone constant volume all air system. Definitions of abbreviations Figure(2-1)

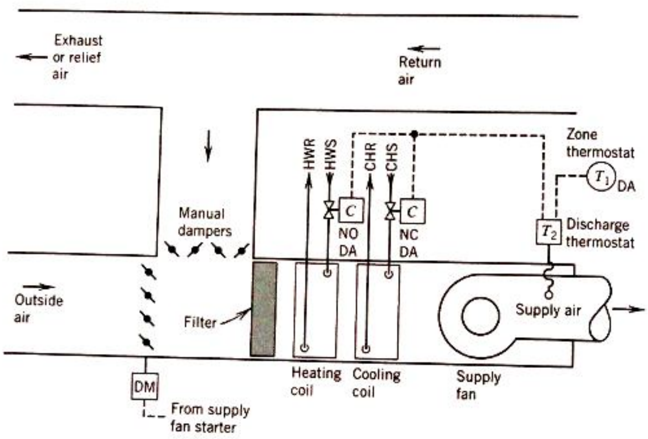


Figure (2.1) Air Handler and Associated Controls for a Simple Single –Zone Constant –Volume All –Air System [3]

C	Controller; Motor Starter	CHR	Chilled Water Return
CHS	Chilled Water Supply	DA	Direct Acting
DM	Damper Motor	DR	Discriminator Relay
FS	Fire Safety Switch	HWR	Hot Water Return
HWS	Hot Water Supply	LLT	Low Temperature Safety
MPS	Motor Positioning System	z	normally closed
NO	Normally Open	P	Pressure Switch or Sensor
RAP	Reverse Acting	V	Coil for Solenoid Value

In this particular system the room thermostat maintains the desired temperature in the zone by control of the temperature of the air being supplied to the zone. The discharge thermostat takes a signal from the zone thermostat and opens or closes the appropriate valve on the heating or cooling coil to maintain the desired room temperature. Because the heating valve is normally open and direct acting and the zone thermostat is direct acting, an increase in room temperature will cause the hot water valve to close to a lower flow condition. The cold-water valve will be closed as long as there is a call for heat. When cooling is required, the hot water valve will be closed and the cooling water valve will respond in the proper direction to the thermostat. The discharge thermostat could be eliminated from the circuit and the zone thermostat control the valves directly, but response to space temperature changes would be slower.

It this case, where the air delivered by the fan is constant, the rate of outside air intake is determined by the setting of the dampers. The outside dampers have a motor to drive them from a closed position when the fan is off to the desired full open position with the fan running. The dampers in the reticulated airstream are manually adjustable in this case. They are often set to operate in tandem with the outside air dampers and with the exhaust or relief dampers should they be present.

2.1.2. Reheat Systems:

The reheat system is a modification of the single zone constant volume system. Its purpose is to permit zone or space control for areas of unequal loading, or to provide heating or cooling of perimeter areas with different exposures. It is an excellent system in which low humidity need to be maintained. As the word reheat implies, the application heat is a secondary process, being applied to either preconditioned (cooled) primary air or reticulated room air. A single low-pressure reheat system is produced when a heating coil is inserted in the zone supply. The more sophisticated systems utilize higher-pressure duct designs and pressure reduction devices to permit system balancing at the reheat zone. The medium for heating may be hot water, steam, or electricity, conditioned air is supplied from a central unit at a fixed cold air temperature sufficiently low to take care of the zone having the maximum cooling load. The zone control thermostats in other zone activate their reheat units when zone temperatures fall below the desired level. A schematic arrangement of the components for a typical reheat system is shown in Figure (2.2).

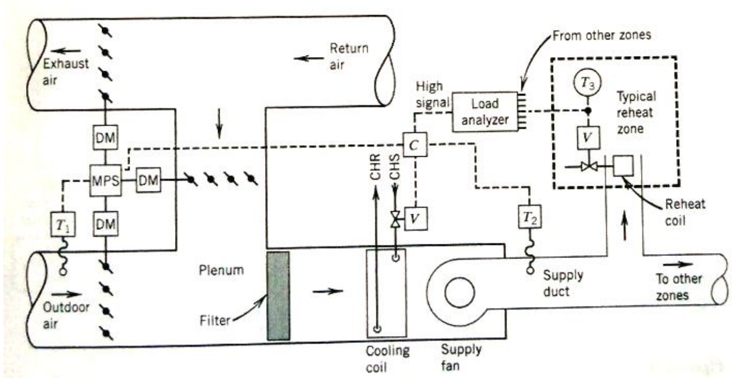


Figure (2.2) Simplified Control Schematic for a Constant –Volume Reheat System [3]

ANSI/ASHRAE/IESNA Standard 90.1-2000 limits the applications where new energy (not recovered from some other part of the system) can be used in reheat systems. Situations where it is allowed include smaller terminal equipment and midsize equipment that is capable of unloading to 50 percent capacity before reheat is used. Reheat is also permitted in systems that serve applications, such as museums, surgical suites, and supermarkets, and in systems where at least 75 percent of the reheat energy is recovered. Building codes should be consulted before considering reheat systems. Figure (2-2) also shows an economizer arrangement where outdoor air is used to provide cooling when outdoor temperatures are sufficiently low. Sensor determines the damper positions and thus the outdoor air intake.

The outdoor damper must always be open sufficiently to provide the minimum outdoor air required for maintaining good indoor air quality. Since humidity may be a problem, many designers provide a humidistat on the outdoor air intake to assure that air is not used for cooling when outdoor humidity are too high for comfort in the controlled space.

2.1.3. Variable Volume System:

The variable volume system compensates for variations in cooling requirement by regulating [throttling] the volume of air supplied to each zone. Air is supplied from a single-duct system and each zone has its own damper. Individual zone thermostats control the damper and the amount of air to each zone. Figure (2-3) is a schematic of a single-duct variable air volume system with a throttling (damper only) terminal unit. Some variable air volume systems have fan-powered terminal units. In fan-powered units, as airflow is reduced from the main duct by damper action, more return air from the room is drawn into the box by the fan and mixed with the primary cold air supply to give a constant airflow into the room.

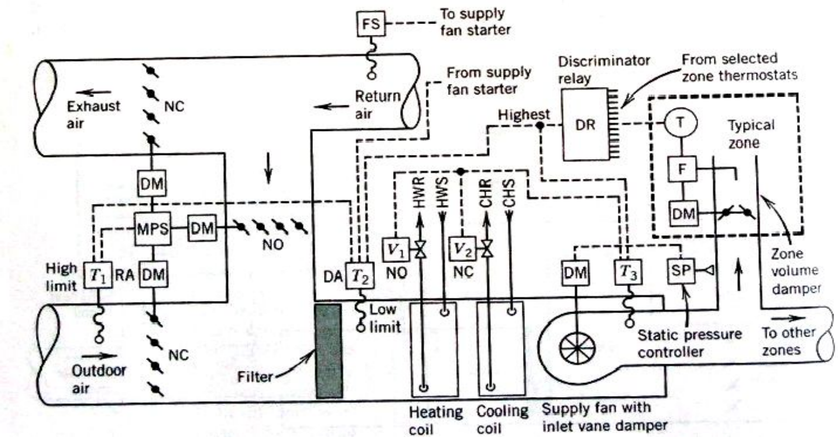


Figure (2.3) Simplified Control Schematic of a Single VAV System.

A significant advantage of the variable – volume system is the low initial and operating costs; the first cost of the system is far lower than that of other systems that provide individual space control, because it requires only single runs of duct and a simple control at the air terminal.

Where diversity of loading occurs, lower –capacity central equipment can be used, and operating costs are generally the lowest among all the air system. fan speed is controlled by maintaining a fixed static pressure at some appropriate location in the ductwork. As cooling demand in individual zones drops and dampers close, the increasing static pressure in the main duct gives a signal that causes the fan speed to back off. Because the total volume of ducted air is reduced as the zone loads decrease, the refrigeration and fan horsepower closely follow the actual is air conditioning load of the building there are significant fan power savings where fan speed is reduced in relation to the volume of air being circulated.

During intermediate and cold seasons, the economizer arrangement discussed previously can be used with outdoor air for cooling. In addition, the variable air volume system is virtually self –balancing, making the requirement of duct design less stringent, improvement in damper and outlet diffuser design and variable speed drives for fan operation have allowed variable air volume system to be throttled down to very low rates of flow without being noisy and inefficient.

Although some heating may be done with a variable – volume system, it is primarily a cooling system and should be applied only in location where cooling is required for the major part of the year. Building with internal spaces having large internal loads are the best candidates. A secondary heating system, such as baseboard perimeter or radiant panel heat should be provided for exterior zones. During the heating season, van systems simply provide tempered ventilation air to these exterior spaces. Reheat may be used in conjunction with the system. In the case reheat takes over single – duct variable – volume system should be considered in applications such as office building, hotels, hospitals, apartments, and schools.

2.1.4. Dual –Duct System:

In the dual duct [double-duct] system, the central equipment supplies warm air through one duct run and cold air through the other. The temperature in an individual space is controlled by mixing the warm and cool air in proper proportions. Variations of the dual duct system are possible; a simplified control schematic of one form is shown in figure (2-4). For best performance, some form of regulation should be incorporated in to the system to maintain a constant flow of air. Without this regulation, the system is difficult to control because of the wide variations in system static pressure that occur as load patterns change. Many double duct system are installed in office buildings, hotels, hospitals, schools, and large laboratories. Where there are multiple, highly variable sensible heat loads this system provides great flexibility in satisfying the loads and in providing prompt and opposite temperature response as required.

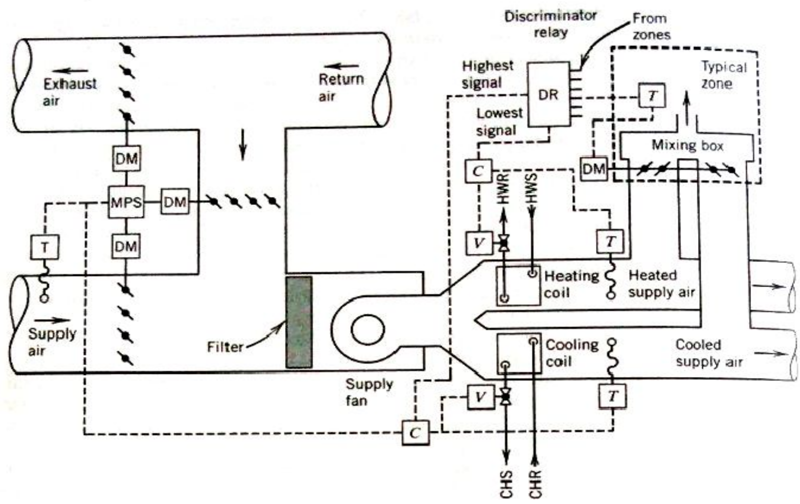


Figure (2.4) Simplified Control Schematic of a Dual-Duct System. [3]

Space or zone thermostats may be set once to control year-round temperature conditions. All outdoor air (an economizer) can be used when the outdoor temperature is low enough to handle the cooling load. The mixing of hot and cold air in dual-duct systems generally causes them to be energy inefficient. Be sure to carefully consult standard 90 or local building codes before adopting a dual duct system. To save energy a dual-duct system should be provided with control that will automatically reset the cold air supply to the highest temperature acceptable and the hot air supply to the lowest temperature acceptable. Using individual zone controls that supply either hot or cold air with a neutral or dead zone where only minimum outdoor air is supplied gives energy conservation that is better than with systems that mix hot and cold air. Many dual-duct systems are in operation, but fewer are now being designed and installed. Improved performance can be attained when the dual duct system is combined with the variable air volume system. Two supply fans are usually used in this case, one for the hot deck and one for the cold deck, with each controlled by the static pressure downstream in each duct.

2.1.5. Multi-Zone System:

The multi-zone central units provide a single supply duct for each zone and obtain zone control by mixing hot and cold air at the central unit in response to room or zone thermostats. For a comparable number of zones, this system provides greater flexibility than the single duct and involves lower cost than the dual-duct system, but it is limited in the number of zone that may be provided at each central unit by the ducting space requirements.

Multi-zone equipment is similar in some respects to the dual-duct system, but the hot and cold airstreams are proportioned mixed at the air handler instead of at each zone served. Air for each zone is at the proper temperature provide zone comfort as it leaves the equipment. Figure (2-5) shows a simplified control schematic of a multi zone system. The system conditions groups of room or zone by means of a blow-through arrangement having heating and cooling coil in parallel downstream from the fan.

The multi-zone system is best suited to applications having high sensible heat loads and limited ventilation requirements. The use of multiple duct runs and control system can make initial costs of this system high compared to other all-air systems. In addition, obtaining very close control of this system may require a lager capacity in refrigeration and air–handling equipment, increasing both initial and operation costs.

The use of these systems with simultaneous heating and cooling is now discouraged for reasons of energy conservation.

However, through the use outdoor air and controls that limit supply to either heating or cooling, satisfactory performance has been attained in many applications. [3]

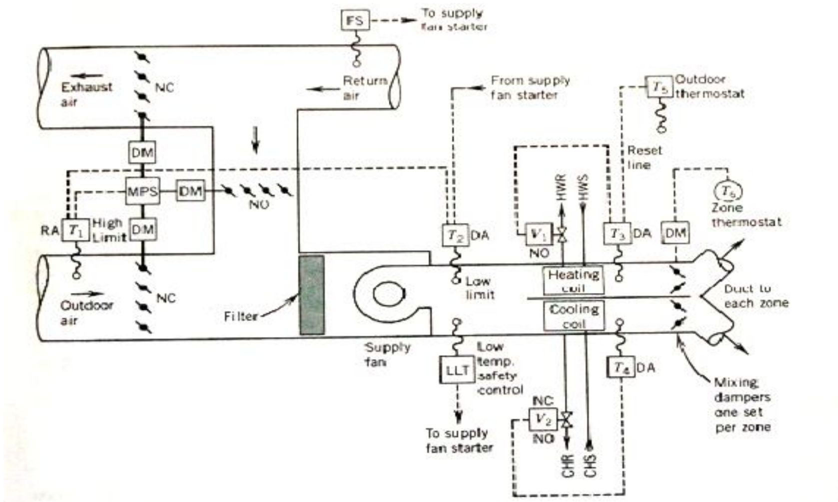


Figure (2.5) Simplified Control Schematic of a Multi Zone System With Hot and Cold Plenum Reset. [3]

2.2. Air and Water System:

In the all air systems discussed in the previous section, the spaces within a building are cooled solely by air supplied to them from the central air conditioning equipment.

In contrast, in an air and water system both air and water are distributed to each space to perform the cooling function. Generally, the cooling water is furnished to carry away most of the sensible energy from the conditioned space. The air provides the required for air quality and carries away the moisture resulting from the space latent load. The air may also provide some additional sensible cooling. Where required these systems can also provide heating electrically or by hot circulating water or steam carrying energy from a boiler or furnace.

Air and water system can provide additional moisture (humidification) typically needed during heating seasons.

There are several basic reason to use an air and water system. Because of the greater specific heat and much greater density of water than of air, the space required for the distribution pipe is much less than that required for ductwork to accomplish the same cooling task. Consequently, less building space need be allocated for the Heating Air Ventilation and Conditioning distribution system.

The reduced quantity of air can lead to a high velocity method of air distribution to further minimize the space required. If the system is designed so that the supply is equal to that needed to meet ventilation (outside air) requirements or to balance exhaust (including building leakage) or both, the return air ductwork can be eliminated.

The pumping horsepower to circulate the water throughout the building is significantly less than the fan horsepower to deliver and return the amount of air needed for both energy and ventilation. Thus, not only space (initial cost) but also operating cost savings can be realized. Space saving has made these systems particularly beneficial in high-rise structures. Systems of this type have also been commonly applied to office buildings, hospitals, hotels, schools, apartment houses, research laboratories, and other buildings.

The air side of an air and water system is made of an air handler, with air intake, filters, fan, heat exchanger coil, and a humidifier connected to terminal device in the conditioned space by a duct distribution system. As mentioned earlier, the duct system may be a high-pressure, high velocity supply system with no return ducting.

The air is supplied at constant volume and is often referred to as primary air to distinguish it from room air that is drawn in to the terminal device and recalculated to the room.

The water side consists of a pump and piping to convey water to the heat transfer surface within each conditioned space. The heat exchange surface may be a coil that is an integral part of the air terminal (as with induction units),a completely separated component within the conditioned space, or a combination of these (as is true of fan-coil units). Entire surface of a room may be heated or cooled with radiant panels.

Individual room temperature control is obtained by varying the output of the terminal device(s) within the room by regulation of either the water flow or the airflow.

The terminal device may be capable of providing heating service during the winter, or a second heating device within the space may required energy input for heating.

2.2.1. Air-Water Induction System:

In some situations, a greater volume of heated or cooled air needs to be diffused into a space to provide comfort then is required to maintain air quality in the space.

In an induction system, primary air from a central system provides the air quality and humidity level needed, and induced air from the space is utilized to provide the quantity of air needed for air circulation and comfort. This allows the transporting of much smaller quantities or air in the central system, and no fans are required in the conditioned space.

2.2.2. Fan –Coil Conditioner System:

The fan –coil conditioner unit is a versatile room terminal that is applied to both air-water and water only system. The basic elements of fan-coil unit are a finned tube coil and a fan section as in Figure (2-6). The fan section recalculates air continuously from within the perimeter space through the coil, which is supplied with either hot or chilled water. In addition, the unit may contain an auxiliary heating coil, which is usually of the electric resistance type but which can be of the steam or hot water type. Thus, the recalculated room air is either heated or cooled. Primary air made up of outdoor air sufficient to maintain air quality is supplied by a separated central system usually discharged at ceiling level. The primary air is normally tempered to room temperature during the heating season, but is cooled and dehumidified in the cooling season.

The primary air may be shut down during unoccupied periods to conserve energy. [2]

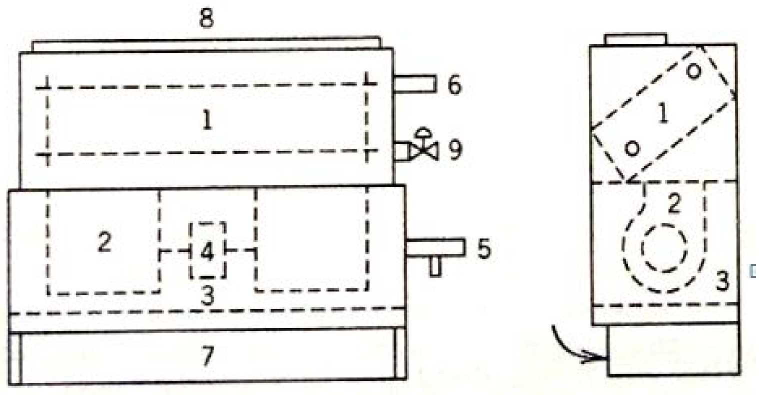


Figure (2.6) Typical Fan – Coil Unit [3]

1. Finned tube coil
2. Fan scrolls
3. Filter
4. Fan motor
5. Auxiliary condensate pan
6. Coil connections
7. Return air opening
8. Discharge air opening
9. Water control valve

2.3. All-Water Systems:

The all water fan coil unit system is well suited for many applications. Is particularly application to a multi-room building where duct work costs may be prohibitive.

The system is used in many application, such as hotels , motels, hospitals , office building ,apartment professional building and clinics . Units may be located under the window , over closets , in dropped ceilings or furred down spaces. All –water system are those with fan-coil, unit ventilator, with unconditioned ventilation air supplied by an opening through the wall or by infiltration. Cooling and dehumidification are provided by circulating chilled water or brine through a finned in the unit. Heating is provided by supplying hot water through the some or a separate coil using water distribution from central equipment. Electric heating or a separate steam coil may also be used. Humidification is not practical in all –water system unless a separate package humidifier is provided in each room. The greatest advantage of the all-water system is its flexibility for adaptation to many building module requirements and for remodeling work.

A fan-coil system applied without provision for ventilation or one tasking ventilation air through an aperture is one of the lowest-first-cost central station-type perimeter system in use today. It requires no ventilation air ducts, it is comparatively easy to install in existing structures, and as with any central station perimeter system utilizing water in pipes of air duct, its use results in considerable space saying throughout the building. However, this type may not meet today's stringent indoor air quality standards required by building codes.

All –water system have individual room control with quick response to thermostat settings and freedom from recirculation of air other conditioned space. The heating and chilling equipment is located remotely from the space, offering some advantages in maintenance and safety. When fan-coil unit are used , each in its own zone with a choice of heating or cooling at all times, no seasonal changeover is required. All-water systems can be installed in existing buildings with a minimum of interference with the use of occupied space.

There is no positive ventilation unless openings to the outside are used, and then ventilation can be affected by wind pressures and stack action on the building.

Special precautions are required at each unit to prevent freezing of the coil and water damage from rain. Because of these problems, it is becoming standard practice to rely on additional or alternate system to provide outdoor air. All-water system are not recommended for applications requiring high indoor air quality. Some maintenance and service work has to be done in the occupied areas. Each unit requires condensate drain line. Filters are small and inefficient compared to central system filters and require frequent changing to maintain air volume.

Figure (2.7) illustrates atypical unit ventilator used in all-water systems, with two separate coils, one used for heating and the other for cooling. In some cases the unit the heating coil may use hot water, steam, or electricity. The cooling coil can be either a chilled water coil or direct expansion refrigerant coil. Unit ventilator capacity control is essentially the same as described for fan-coil in the previous section. Notice that air for ventilation is obtained through a wall opening. Return air is mixed with the outdoor air to give sufficient volume and exit velocity for better room mixing and uniform temperature. Some unit ventilation tend to be noisy at high fan speeds.

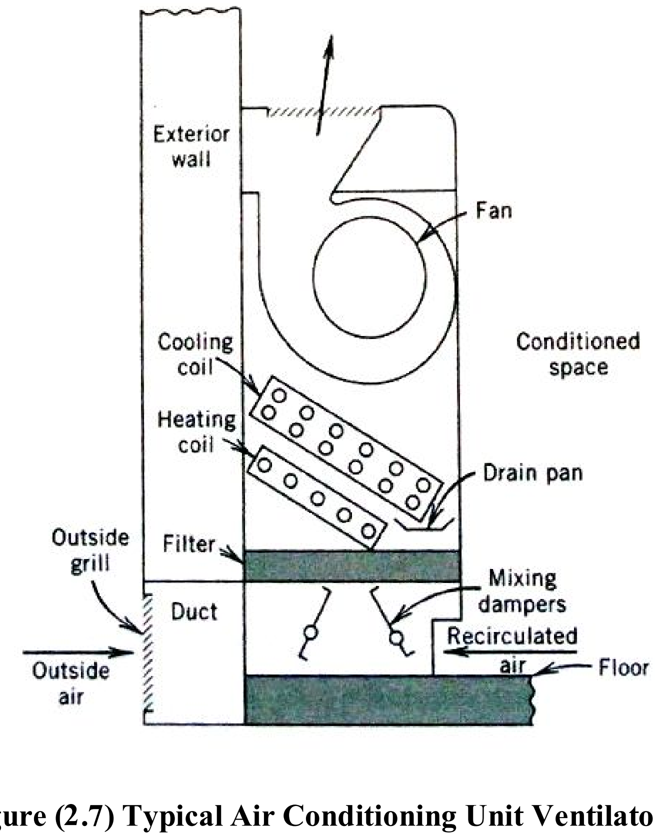


Figure (2.7) Typical Air Conditioning Unit Ventilator with Separate Coil [3]

2.4. Decentralized Cooling and Heating:

Almost all types of building can be designed to utilize decentralized cooling and heating system. These usually involve the use of packaged system, which are systems with an integral refrigeration cycle. Packaged system components are factory designed and assembled into a unit that include fans, filters, heating coil, cooling coil, refrigerant compressor and controls, airside controls, and condenser. The term packaged air conditioner is sometimes used interchangeable with the term unitary air conditioner. The air conditioning and refrigerating institute defines a unitary air conditioner as one more factory-made assemblies that normally include an evaporator or cooling coil and a compressor and condenser combination.

The air conditioning and refrigerating institute classification system of unitary air conditioners depends on the location of the compressor and condenser relative to each other and the presence or absence of a fan or heating system and its location. Systems with both indoor and outdoor factory-made assemblies are called split systems. The following list of variations is indicative of the vast number of types of unitary air conditioner available.

1. Arrangement: single or split (evaporator connected in the field).
2. Heat rejection: air –cooled, evaporative condenser, water –cooled.
3. Unit exterior: decorative for in-space application, functional for equipment room and duct, weather proofed for outdoors.
4. Placement: floor –standing, wall-mounted, ceiling-suspended, roof-mounted.
5. Indoor air: vertical up-flow, counter flow, horizontal, 90 and180 degree turns, with fan, or for forced air furnace.
6. Locations: indoor-exposed with plenums or furred in ductwork, concealed in Closets, attics, crawl spaces, basements, garages, utility rooms, or equipment rooms, wall-built- in, window, transom, outdoor rooftop, wall-mounted, or on ground.
7. Heat: intended for use with up-flow, horizontal, or counter-flow forced –air furnace, combined with furnace, combined with electrical heat, combined with hot water or steam coil.

The many combinations of coil configurations, evaporator temperatures, air-handling arrangement, refrigerating capacities. And other variations that are available in built-up central system are not possible with standard unitary systems. Consequently, in many respects more design ingenuity is required to obtain good system performance using unitary equipment than using central system.

Through the wall and window –mounted room air conditioning units are common in residences and in renovations of older buildings.

Heavy-duty, commercial-grade through the wall units, usually capable of providing both heating and cooling, are sometimes referred to as packaged terminal air conditioners.

Multiple packaged units may be installed for a single large space such as a retail store or a gymnasium. Each unit provides heating or cooling for its own zone, part of the large space. This arrangement show in Figure (2-8), Allows for some diversity as energy may cross-nonexistent zone boundaries and other units can compensate for the outage of unit.

Rooftop units are a special class of package units that are designed to be installed on the roofs the building. These may be supplied directed from the heating and/or cooling to multiple zones or the air may be directly from the unit into a zone. A large commercial packaged rooftop system Figure (2-8).

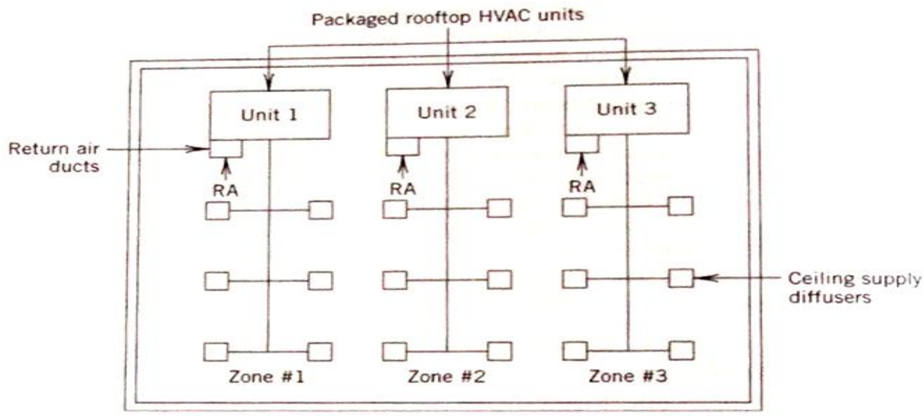


Figure (2.8) Multiple Packaged Units Serving a Single Large Space Such As a Store Or Gymnasium.

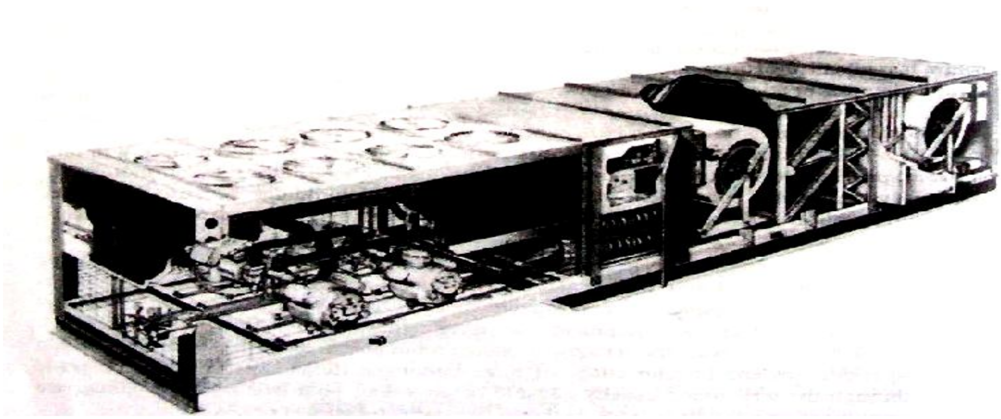


Figure (2.9) A large Commercial Packaged Air-Conditioning System.

Interconnected room-by systems operate with a package unit in each zone (such as an apartment) and these units have a common condensing and heat source loop.

Residential and light commercial split systems have separate units with the indoor evaporator and the outdoor condenser and compressor connected by refrigerant tubing. Mini-split systems have one or more indoor evaporator units tied a single outside condenser and compressor system. These are sometimes referred to as ductless systems.

2.5. Heat Pump Systems:

Any refrigeration system is a heat pump in the sense that energy is a low. Temperature source to a higher temperature sink. In heating, ventilation and air conditioning, the term heat pump most often defines a system in which refrigeration equipment is used to both heat and cool. The thermal cycle is identical to that of ordinary refrigeration, however, in most heat pump systems a reversing valve permits flow reversal of refrigerant leaving the compressor such that the evaporator and condenser roles are switched. In some applications both the heating and cooling effects obtained in the cycle can be utilized at the same time. As with air conditioners, unitary (packaged) heat pumps (as opposed to applied heat pumps) are shipped from the factory as a complete preassembled unit including internal wiring, controls, and piping. Only the ductwork, external power wiring, and piping (for water – source heat pumps) are required to complete the installation. For the split system, it is also necessary to connect the refrigerant piping between the indoor and outdoor sections on site.

In appearance and dimensions, casings of unitary heat pump closely resemble those of conventional air-conditions units having equal capacity.

CHAPTER THREE

Basic Concepts of Hourly Analysis Program (HAP) and Calculation Cooling Load Using Hourly Analysis Program

3.1. Hourly Analysis Program (HAP):

HAP is a computer tool, which assists engineers in designing Heating Ventilation and Air Conditioning systems for commercial buildings.

HAP is two tools in one. First, it is a tool for estimating loads and designing systems. Second, it is a tool for simulating energy use and calculating energy costs. schematic design and detailed design energy cost evaluations. HAP uses the ASHRAE-endorsed transfer function method for load calculations and detailed 8,760 hour-by-hour energy simulation techniques for the energy analysis.

This program is released as two similar, but separate products. The "HAP System Design Load "program provides the system design and load estimating features. The full "Hourly Analysis Program" program provides the same system design capabilities plus energy analysis features. [11]

Hap is a program of the most important programs that are used in adjustment operations in general, and that because of its ability to give accurate accounts of the cooling load in all spreads , no matter what their shape and composition. First run the program shows a list to open the old project or start a new project, by clicking on the new opens a new project , the main interface of the program appears. Preferably the onset save the project directly through the project menu and then the command save as, and then enter the name of the project from the view menu, then Preferences command make sure the units used Is it English or Metric.[12]

The HAP main program window consists of six components used to operate the program. Working from top to bottom in Figure (3.1):

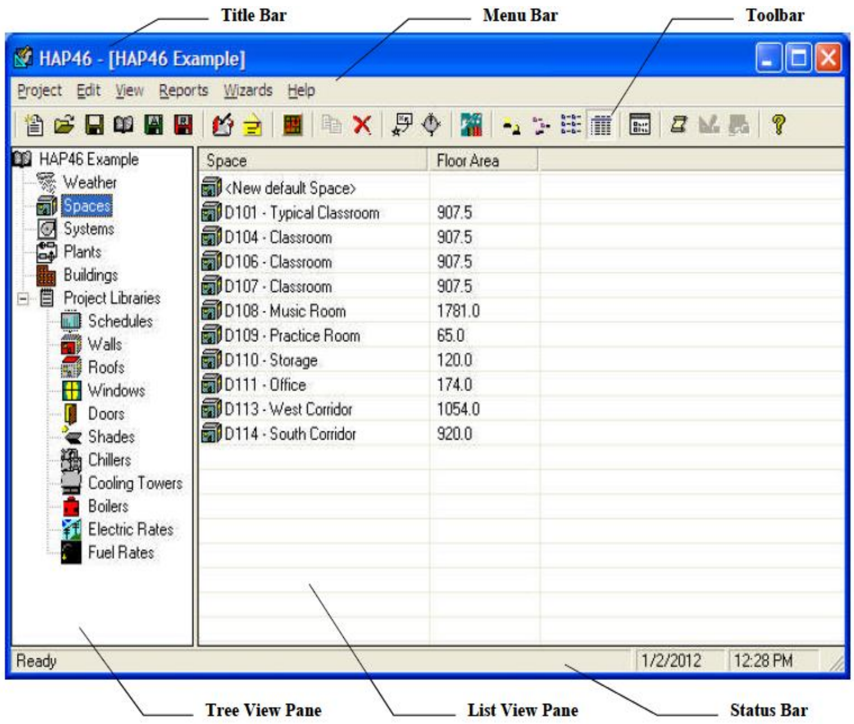


Figure (3.1) the HAP Main Program Window [11]

3.1.1. HAP System Design Features:

HAP estimates design cooling and heating loads for commercial buildings in order to determine required sizes for Heating Ventilation and Air Conditioning system components. Ultimately, the program provides information needed for selecting and specifying equipment. Specifically, the program performs the following tasks:

1. Calculates design cooling and heating loads for spaces, zones, and coils in the HVAC system.
2. Determines required airflow rates for spaces, zones and the system.
3. Sizes cooling and heating coils.
4. Sizes air circulation fans.
5. Sizes chillers and boilers.[11]

3.1.2. HAP Energy Analysis Features:

HAP estimates annual energy use and energy costs Heating Ventilation and Air Conditioning an dnon - Heating Ventilation and Air Conditioning energy consuming systems in a building by simulating building operation for each of the 8,760 hours in a year. Results of the energy analysis are used to compare the energy use and energy costs of alternate Heating Ventilation and Air Conditioning system designs so the best design can be chosen. Specifically, HAP performs the following tasks during an energy analysis:

1. Simulates hour-by-hour operation of all heating and air conditioning systems in the building.
2. Simulates hour-by-hour operation of all plant equipment in the building.
3. Simulates hour-by-hour operation of non- Heating Ventilation and Air Conditioning systems including lighting and appliances.
4. Uses results of the hour-by-hour simulations to calculate total annual energy use and energy costs.

Costs are calculated using actual utility rate features such as stepped, time-of-day and demand charges, if specified.

5. Generates tabular and graphical reports of hourly, daily, monthly and annual data.[11]

3.2. Working With HAP Input Forms:

This section discusses the basic operating principles of HAP's input forms. While much of your work with the program is done on the main program window, the actual entry of data is done using input forms. An input from appears when you choose to create a new item or edit an existing item. A separate input form is provided for each category of HAP data.

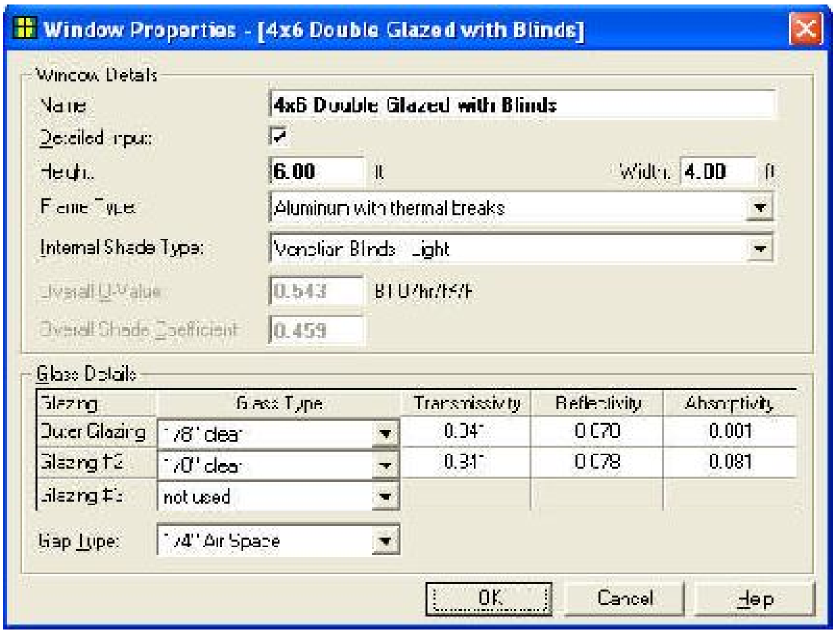


Figure (3.2) Simple Input Form [11]

Many input forms have a simple appearance as shown in Figure 3.2. These simple kinds of input forms consist of three components:

1. The Title Bar. Is found at the top of the input form. It lists the type of data contained in the input form and the name of the current item being edited. In the example above, data for a window assembly named “4x6 Double Glazed with Blinds” is being edited. The title bar also contains a close button.

If you press this button, the program will return to the main program window without saving any changes you made on the form. Thus, the close button performs the same function as Cancel.

2. The Data Area is the middle portion of the form. It contains all the data describing the current item.

In the example above, the data area contains information describing a window assembly: its dimensions, framing properties, internal shades, glazing's and thermal performance.

While entering information in the data area, you can display explanations of each input item by pressing the F1 key. For example, if you press F1 while the cursor is on the “Frame Type” item in the figure above, the help topic for “Window Frame Type” will appear automatically. This feature is useful for learning about the program while you work.

1. The Command Buttons are found in the lower right-hand portion of the form. All forms contain three buttons:

2. Press the OK button to return to the main program window after saving any changes you made on the input form.

3. Press the Cancel button to return to the main program window without saving any changes you made on the input form. The Cancel button performs the same function as the close button in the title bar.

4. Press the Help button to display an overview of the current input form. This overview describes how the input form is organized and how to use it. It also contains links to help topics for the individual input items on the form.[11]

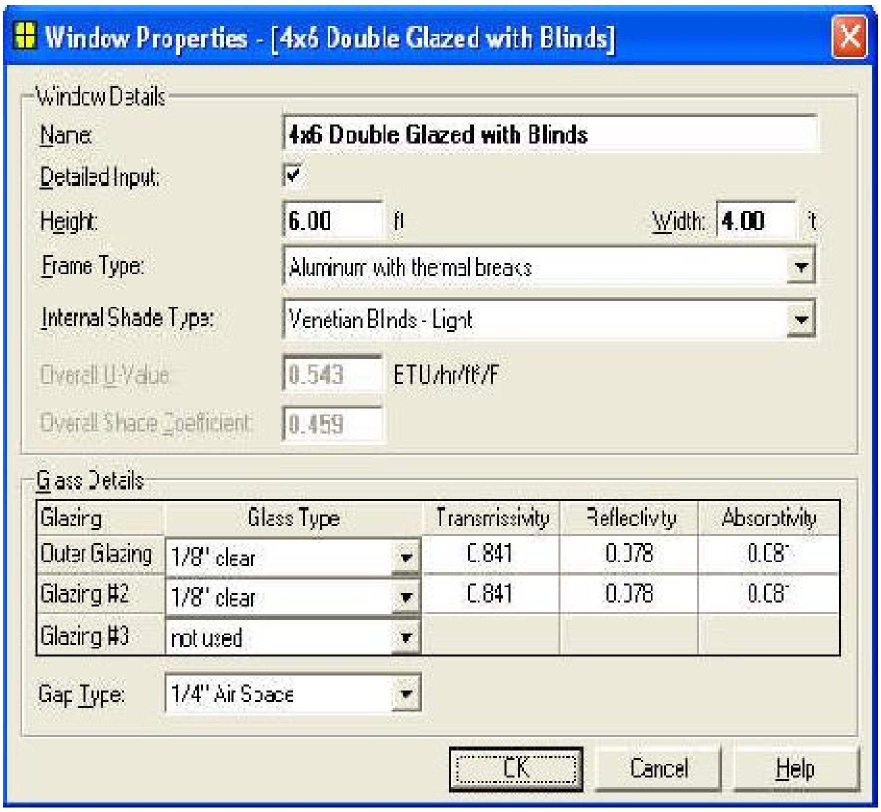


Figure (3.3) A Tabbed Input Form Tabbed Input Forms[11]

Tabbed Input Forms. For certain categories of HAP data, the input form has a more complex appearance as shown in Figure (3.3). This input from contains the same basic elements (title bar, data area, command buttons) as discussed earlier, but the data area contains multiple categories of information rather than a single set of information. Categories of data are represented as tabs in a notebook. Space data is divided into five categories:

1. General data.
2. Internal load data.
3. Wall, Window, Door data.
4. Roof, Skylight data.
5. Infiltration data.
6. Floor data.
7. Partition data.

To switch between the different categories of data, simply click on the tab title. For example, to switch to the "Walls, Windows, Doors" category of data, click on the "Walls, Windows, Doors" tab. [12]

3.3. Using HAP to Design Systems and Plants:

This section briefly describes, in conceptual terms, how to use HAP to design systems and plants. All design work requires the same general five-step procedure:

3.3.1. Define the Problem:

First define the scope and objectives of the design analysis.

3.3.2. Gather Data:

Before design calculations can be performed, information about the building, its environment and its Heating Ventilation and Air Conditioning equipment must be gathered. This step involves extracting data from building plans, evaluating building usage and studying Heating Ventilation and Air Conditioning system needs. Specific types of information needed include:

1. Climate data for the building site.

2. Construction material data for walls, roofs, windows, doors, exterior shading devices and floors, and for interior partitions between conditioned and non-conditioned regions.
3. Building size and layout data including wall, roof, window, door and floor areas, exposure orientations and external shading features.
4. Internal load characteristics determined by levels and schedules for occupancy, lighting systems, office equipment, appliances and machinery within the building.
5. Data concerning Heating Ventilation and Air Conditioning equipment, controls and components to be used.

3.3.3. Enter Data Into HAP:

Next, use HAP to enter climate, building and Heating Ventilation and Air Conditioning equipment data. When using HAP, your base of operation is the main program window .

From the main program window, first create a new project or open an existing project.

Then define the following types of data which are needed for system design work:

3.3.3.1. Enter Weather Data:

Weather data defines the temperature, humidity and solar radiation conditions the building encounters during the course of a year. These conditions play an important role in influencing loads and system operation. To define weather data, a city can be chosen from the program's weather database, or weather parameters can be directly entered. Within the main interface of the program , there on the left Threaded list the contents of the project by clicking on the word weather determine the status of the city and the weather for the project you are studying , and then through the main space in the program interface Click dually on the weather properties it own definition of the city and the weather painting show. Through existing Region determines the region or the country from the Location list and then determine the country from the list and then define the city, notes that all the data that appears in the following fields specific to the selected city, according to the organization of ASHRAE data . Notably can change any of the values if we're not convincing, according to the custom field, as it is possible to add a new city by typing a new name, place of the existing city then add data to this new city with the observation that this city will not be added to the program's database .[11]

3.3.3.2. Design Parameters Tab:

Latitude: to determine the latitude of the city (positive above the equator) Longitude: to determine the longitude of the city (positive West Greenwich) Elevation: influences psychrometric calculations for the building site, since air density and psychrometric properties vary with elevation above sea level.

Summer Design DB and : design degree dry heat in summer Winter Design DB: dry heat degree design winter(Winter Coincident) WB: the degree of moist heat approval winter Atmospheric clearness number : the degree of purity of the weather, and takes a value of 1 in normal circumstances (scattered light) or 1111 values if the sky is clear completely or value of 51.1 in the event of the sky was cloudy or thick dust.

Average Ground Reflectance: defines how much solar radiation is reflected by ground surfaces surrounding the building, the reflectivity of the land surrounding the building studied , and takes the following values depending on the nature of the land:

Surface Type	Reflectance
New Concrete	0.31 to 0.34
Old Concrete	0.22 to 0.25
Bright Green Grass	0.21 to 0.31
Crushed Rock	0.20
Bitumen and Gravel Roof	0.14
Bituminous Parking Lot	0.09 to 0.12.

Soil Conductivity: Soil Conductivity refers to the thermal conductivity of soil surrounding a building, take the following values depending on the nature of the land:

Classification	Normal Rang (Btu / hr .ft .F)
Sands	0.35 to 1.45
Silts	0.50 to 1.45
Clays	0.50 to 0.95
Loams	0.50 to 1.45

Design Cooling Calculation Months: This item defines the range of months considered when performing cooling design calculations for systems and plants. Once you choose start and end months, your specification will be used for all subsequent system and plant design calculations in the current project.

Time Zone: This item defines the difference between Local Standard Time and Greenwich Mean Time in hours, noting that the value Positive time zone values indicate the time zone is to the west of the Greenwich Meridian. Negative values indicate the time zone is to the east. [12]

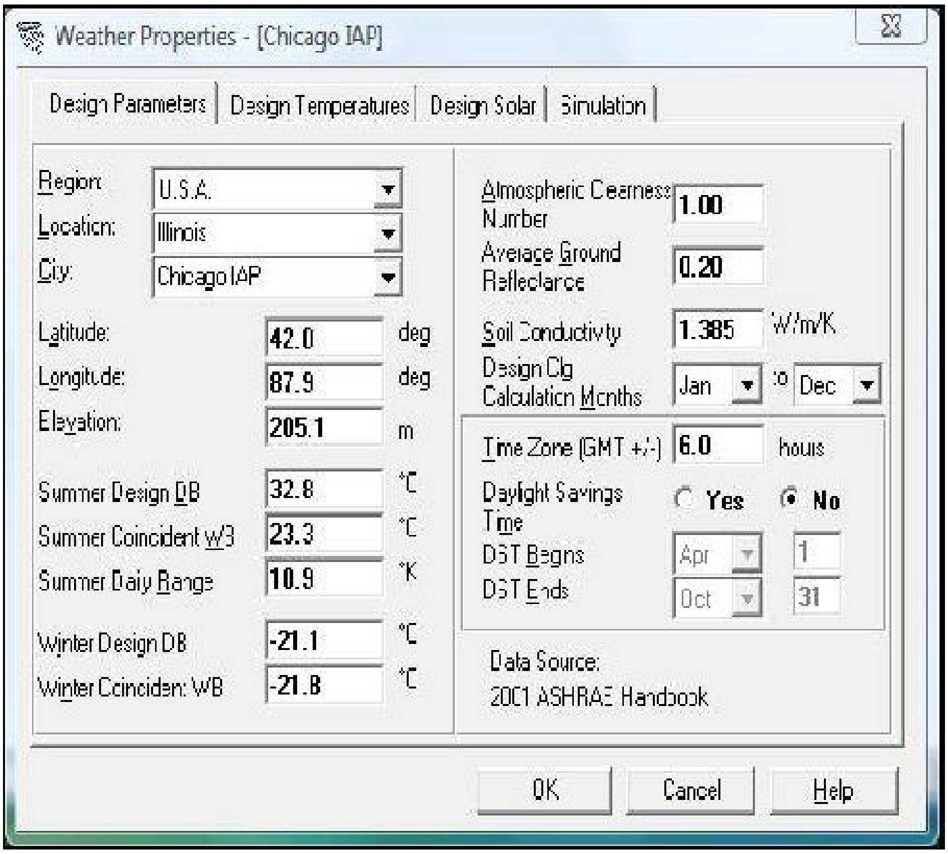


Figure (3.4) Definition of the Weather Window [12]

3.4. Enter Data of the project Library:

After the definition of the city and the state of the weather we come to the definition of the so-called library project , which includes the definition of work schedules final exterior walls , ceilings, windows and doors. And all elements of the library can be accessed from a tree branch menu under Project Libraries.

3.4.1. Definition of the Work Schedule:

Work schedule is the degree of effectiveness of any component change with time , assuming that we have an office he gets 15 staff at eight o'clock in the morning and then everyone leaves at one o'clock noon time hours (break food) until two o'clock pm , then 6 staff back only to the office and the rest goes to the workshops , for example, , then go out six staff at five in the afternoon time . The number of employees has changed the clock is entered for the program through the work schedule , and this speech also applies to lighting and electrical

loads and loads of sensible and latent , if any, in order to define loads as precisely as possible .

To define a new work schedule click on Schedules painting of the tree , then from the main interface double click on the new default schedule showing the working schedule of the plate.

Within the first list Schedule type determines the table name in the field name is a reference name used to identify the schedule, and then schedule table identifies the type of schedule type option defines the kind of schedule being entered ,where we have two choices:

Fractional ≡ schedules define hourly and daily behavior in percentages and The Fractional option should be selected when defining a schedule for overhead lighting, task lighting, electric equipment, occupant heat gains, miscellaneous sensible or latent loads, when using the special "scheduled" control option for outdoor ventilation air, and when defining hot water usage schedules, where the effectiveness of that element could be changed in part from 5% to 155%

Fan / Thermostat ≡ schedules define the hours in each Heating Ventilation and Air Conditioning equipment operating period. Hours of a day are designated as "occupied" or "unoccupied." During occupied hours and we choose only when defining the "thermostat schedule" for an air system.

Utility Rate: schedules define on-peak and off-peak pricing periods for electricity. This option should be used when scheduling time-of-day periods for an electric rate structure.

To define the persons work schedule as mentioned above in the office , we know a new work schedule and we call , for example, Schedule People then we go to the second list Hourly Profiles and begin to define profiles .

At first we recall where we choose the first profile of Profile One drop-down menu , note that the profile is a horizontal axis represents time throughout the day from time 0 to 24 hours (mean 12 for the night), while the vertical axis represents the percentage it effectively. Considering that always in the office starts at eight in the morning any that employees do not exist from time 0 to 7 am , so of fields minor neighboring higher profile define the time 0 and the percentage of 0 and repeat this process for the clock 1, 2, 3, 4, 5 , 6, 7 ,at eight o'clock in the morning it starts entering the full number of staff so it's time . Am to 13 the percentage of 100 %, then the staff goes out for an hour the food so the ratio is at 12 is 5 , then return 6 staff so the ratio is 65% of the time 14 until at 16 , then staff go out at five in the afternoon so we make the ratio is equal to 0 from time 17 to 23 hours.

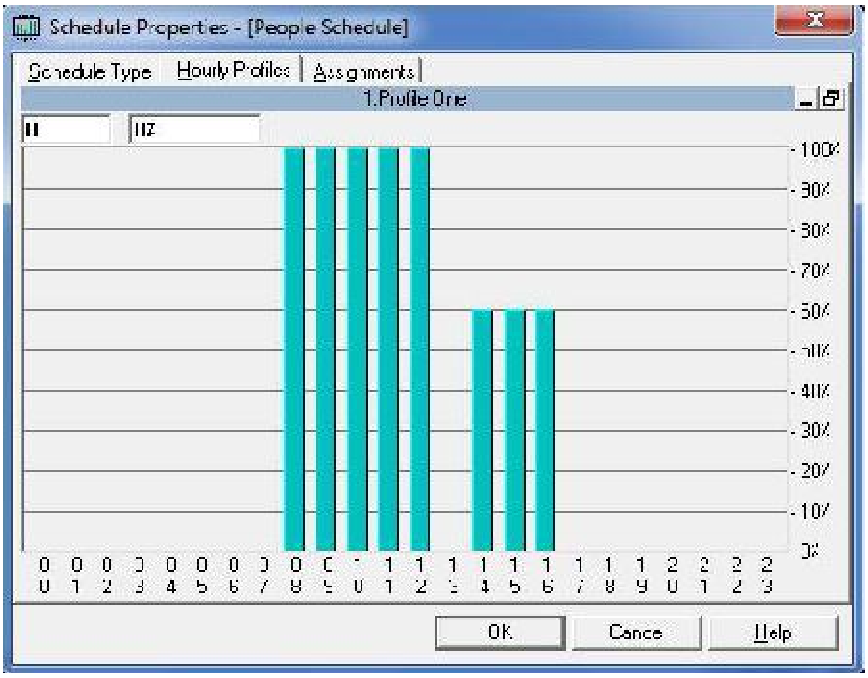


Figure (3.5) Illustrates a Window Definition of the Work [12]

assuming that disrupts the Office for always in the eighth month (August) so we know the second profile and make all percentages clock equal to zero . Then we go to the third list Assignment which is about the horizontal axis represents months scheme and its axis vertical days , but the important thing is the first line only Design, make the first line takes the same profile value that we have known for the entire months means that takes a value of 1 for all months except the eighth month, takes the value of the second profile , and so we have come to know the work schedule of the people.

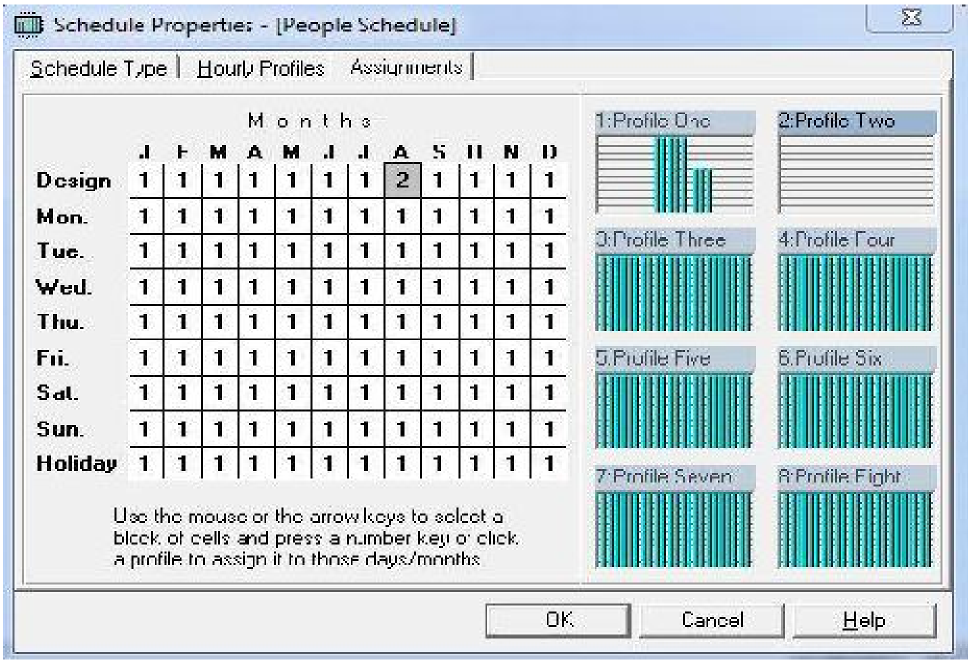


Figure (3.6) Illustrates a Window Definition Work for People [12]

The second type of work schedules Fan / Thermostat we choose if we want to define the agenda of the air conditioning or fan , as an example you have a conditioning device works in the same former office , and we want to define its own work schedule , as the device operates from eight o'clock in the morning until one in the afternoon then stop working for an hour and then work back from two o'clock pm until five o'clock in the afternoon and then stops working , and exactly the same way we know the table with a note that within the profiles there are percentages , but there are only two choices : the work of the Occupied or stop. [12}

3.4.2. Definition of Wall Outside:

The exhibition is a wall to the sun (the periphery) , and the definition of external wall click on the Walls in the tree menu and then double click on the new default wall show own definition of a new external wall painting .

Specifies the name of this wall within the wall field assembly name then the outside surface color drop-down menu, select the outside of the wall color

(detector dark center) notes that the value of the absorbance absorptive, or This value can be input directly in the field if they are available within the Layers You constituent layers definition of the wall, by choosing the first class from the dropdown menu and then selecting the thickness, and note that the program automatically selects the density of matter and the specific heat and thermal resistance, and of course you can change these values that were different from the values set by the program, and that you can add a new layer by clicking the right mouse button on the left List classes (along with Black Triangle Shining) and the selection and definition insert a new layer does not exist between the materials available in the program or delete layer select remove. As for the value of thermal resistance defines the thermal resistance of the material layer R-Value it can be obtained from the quotient of thickness on the thermal conductivity k (with attention to the homogeneity of units)

We note that the program gives us the value of the overall heat transfer factor U- Value bottom of the table.

3.4.3. Definition Window:

This is a reference name for the window. It will appear on selection lists when linking a window type to exposures in a space and will also appear in reports. Select Window Name this is a reference name for the window. It will appear on selection lists when linking a window type to exposures in a space and will also appear in reports.

and select high window in the height field and the width of the window in the width field , then select the overall heat transfer window factor value within the field overall U - Value and worker shading within the field overall shade coefficient and thus define a new window ends . When defining a window without using the "detailed input" option, the full dimensions of the window aperture must still be defined since manufacturer's ratings for U-value and shade coefficient refer to performance of the complete window unit, including the frame material.

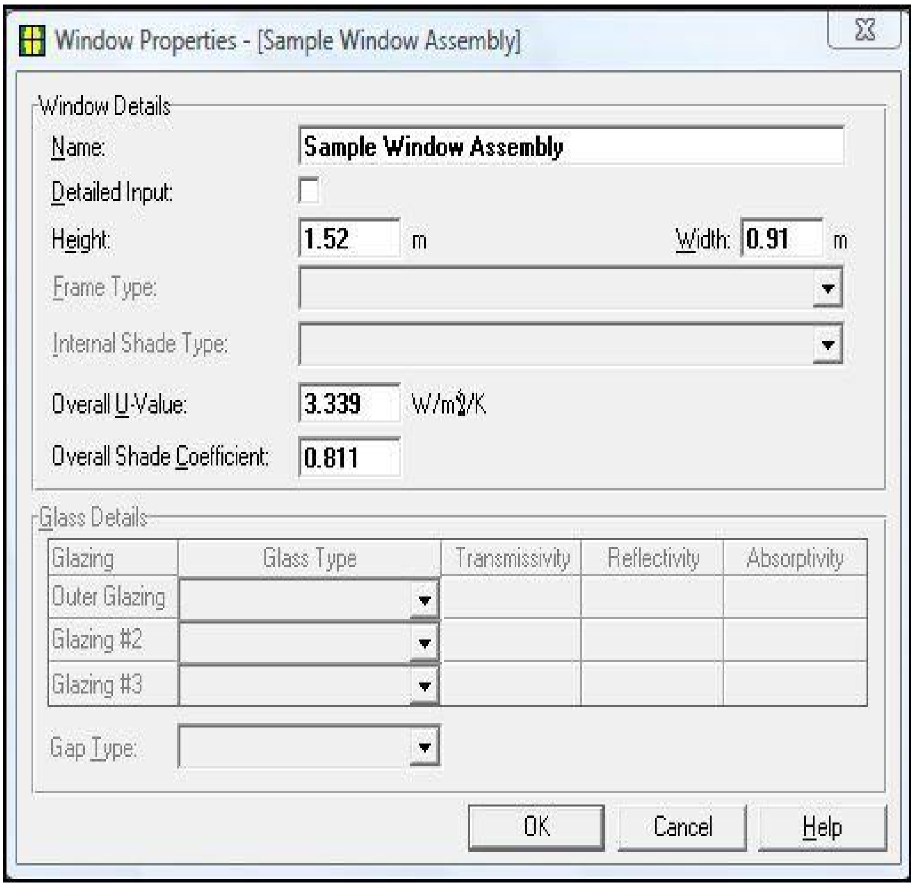


Figure (3.7) Illustrates the Definition Window

Then of painting glass details, select the external glass layer specification in the first line outer glazing and selecting the thickness and type of glass from glass type drop-down menu, and if the glass double select the thickness and type of the inner layer of glass from the second line, or choose not used if the glass solely, as well as the command For the third line if the glass is made up of three layers. Then through the Gap type drop-down menu, select the space between the glass layers and the type of gas thickness existing between them. It notes that the program calculates the heat transfer factor and shading factor value.

3.4.4. Definition of the Door:

Door it intended to show the door to the sun and not the interior doors. To define a new door click on the door of the tree menu and then double click on the new default door own definition of the door panel show.

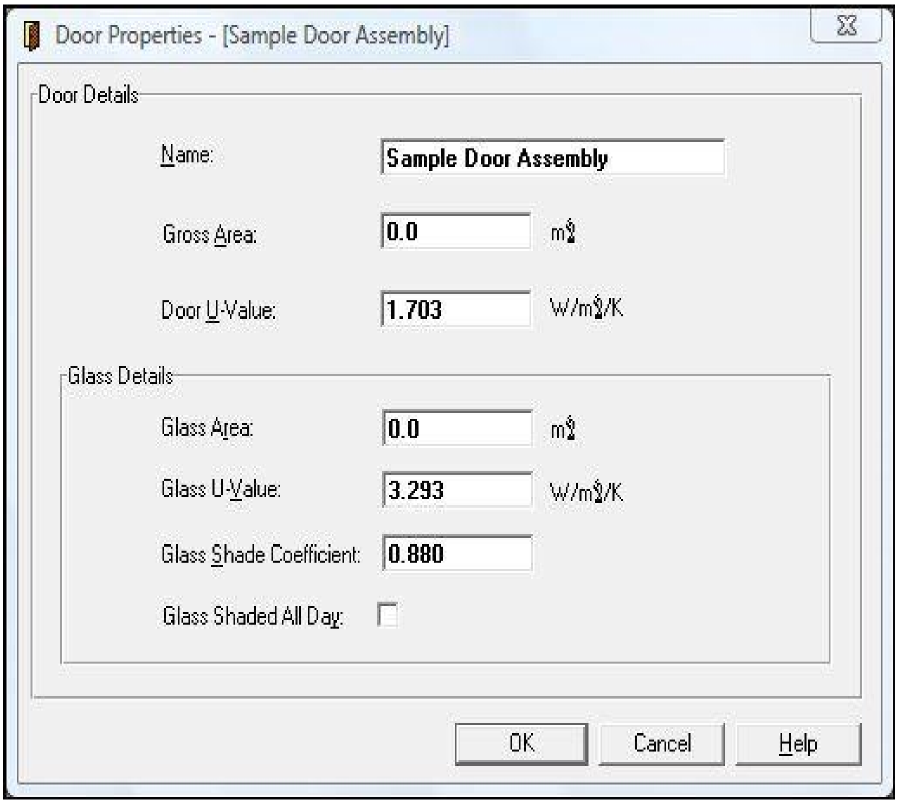


Figure (3.8) Illustrates the Definition Door [12]

Select the door 's name in the name field and select the total area of the door within the field gross area and factor the heat of a substance door transmission (Wood ,aluminum ,iron) within the field - door u-value, if the door has a glass Select wiper only within the field glass area and the value of the transmission factor temperature of the glass only within the field glass u-value and the value of the shading factor within the field glass shade coefficient If the composite glass door curtains closed throughout the day select box .glass shaded all day

Thus we have completed the project definition library , the next step is to start by defining the project spreads .

3.5. Enter Space Data:

A space is a region of the building comprised of one or more heat flow elements and served by one or more air distribution terminals.

Usually a space represents a single room. However, the definition of a space is flexible. For some applications, it is more efficient for a space to represent a group of rooms or even an entire building.

To define a space, all elements which affect heat flow in the space must be described. Elements include walls, windows, doors, roofs, skylights, floors, occupants, lighting, electrical equipment, miscellaneous heat sources, infiltration, and partitions. While defining a space, information about the construction of walls, roofs, windows, doors and external shading devices is needed, as well as information about the hourly schedules for internal heat gains. This construction and schedule data can be specified directly from the space input form (via links to the construction and schedule forms), or alternately can be defined prior to entering space data. Space information is stored in the project database and is later linked to zones in an air system. Click to define into the spaces of the tree menu and then click of the main interface on the new default space for the definition of the window into show is divided into lists

3.5.1. Explain the Space Data:

3.5.1.1. General Tab:

Enter Space Name is a reference name used to identify the space and Enter the total floor area for the space and the average ceiling nickname rise, and enter the Average ceiling height defines the average floor-to-ceiling height for the space. It is used in conjunction with the total space floor area to compute the space air volume, which in turn is used when calculating infiltration air changes per hour, . Building weight Building weight defines the overall weight of the interior walls, floors, ceilings and contents of the building. This value plays a key role in influencing how heat gains are converted into loads. In general terms, heavy buildings tend to absorb and store heat for longer periods than light buildings. As a result, there is more of a lag between the time a heat gain occurs and the time it becomes an air-conditioning load.

Within the existing outside air ventilation requirement, select the desired value for the ventilation space as follows:

Of the existing space usage select the nature of the studied space and the program will automatically select the proper ventilation value according to ASHRAE.

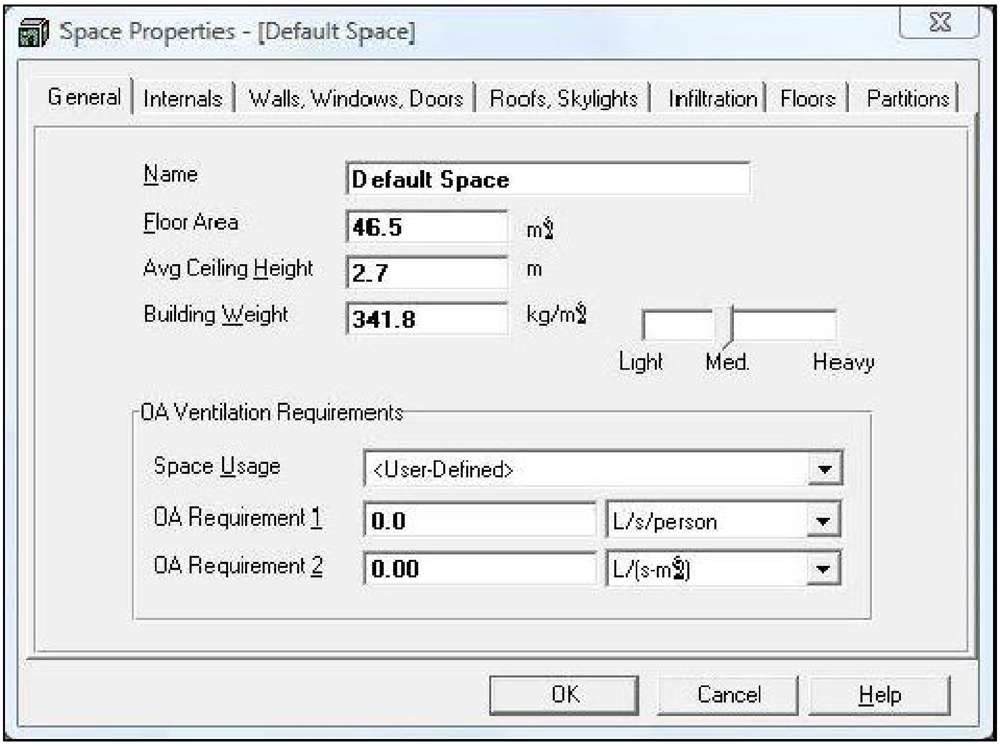


Figure (3.9) Definition of Space Window [12]

4.5.1.2. Internals Tab:

This item defines the type of overhead lighting fixture used in the space. Painting overhead lighting to define the lighting ceiling , fixture type from the drop-down menu, select the type of lighting which is on three types : recessed unvented in the event of a wig cap and the air conditioning system to the reflux does not pass within Lighting fittings, recessed vented in the event of a wig cap and the air conditioning to the reflux device within the ceiling nickname and passes within lighting devices, free hanging radiates to the ceiling as well as the walls and floor. Within the field wattage lamp wattage for the overhead lighting fixture. This is the total of bulb wattages when all lights in the space are on and within the ballast multiplier select fluorescent lights, power is used to drive both the bulb and a ballast starter device. Then select your lighting from Schedule drop-down list work schedule. Painting task lighting similar to the previous panel, but reserved for special lighting furnishings and has a special work schedule. Painting electrical equipment dedicated electrical equipment, if any, such as a computer or a printer and others. From painting people is defined the maximum quantity of people present in the space. Occupancy can be entered either in terms of sqft/person (sqm/person) or total people. To switch between these units use the drop-down list to the left of the occupancy input, and then determines the degree of activity of people depending on the nature of their work from the dropdown menu activity level in order to determine pregnancy sensible and latent per person , can be determined by these two loads of the same student if chosen from the menu and enter the user defined values sensible and latent. Then select the private persons from Schedule drop-down list work schedule . Miscellaneous loads of painting select loads sensible and latent additional , if any , as is the case in the coffee boilers or furnaces or washing machines , with determining the appropriate work schedule for each pregnancy.

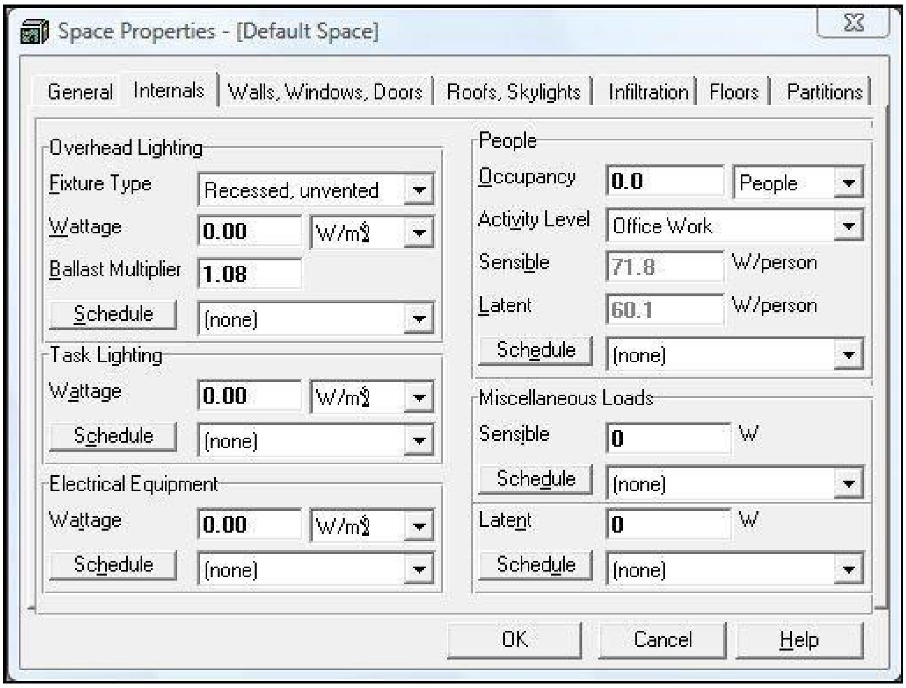


Figure (3.10) Illustrates the Definition of Window Space [12]

3.5.1.3. Walls, Windows, Doors Tab

It is dedicated to the definition of the external walls and windows and exterior doors, and can be added. different directions of space each. We start the first line and determine from Exposure direction of the wall drop-down menu, and then determine the total wall space (height to Structural ceiling including windows space) and then identify a number of the windows of the first type within the window field 1 quantity,, and then determine the number of windows of the second type within the window 2 field quantity if any, perhaps there is only one type of windows in this wall or two, and of course we put the value 5 if there is not any window, and then determine the number of doors within the field door quantity Then from the right side to choose from the menu wall first wall structure and we have set at the beginning of the project definition library, and so is the first window1 second window2 and door.

3.5.1.4. Roofs, Skylights Tab:

Similar to the List definition walls we know the final surface , if any, as well as the celestial windows in the roof, where from the list Exposure determine initially whether the surface is horizontal (H), tends towards a specific destination , and determine the total area of the surface within the field Roof Gross Area. In case the horizontal surface completely if the inclination angle on the horizon equal to zero So it does not show us the list Roof Slope, but if a particular region of the surface tends then determine the inclination of the field Roof Slope angle . And determine the number of celestial windows of the field Skylight quantity, then define the field of Roof ceiling that is defined and skylight field define the celestial window that have been defined.

3.5.1.5. Infiltration Tab:

This list is intended to identify expected to air this space leak.

Design cooling the first line dedicated to determine the leakage in the case of cooling summer.

The second line Design Heating dedicated to determine the leakage in the case of heating the winter.

The third line dedicated Energy Analysis to determine the leakage in case of desert determine the amount of energy consumption in the project.

There is potential for the introduction of leakage in three cases (we choose only one and a computer calculates the other two cases) are either one estimate leakage flow L / s (or cfm) in case we had expected leakage flow of the room. Or leakage is one account (L / s / m^2 or cfm / ft^2) and is intended to estimate the leakage in one of the walls of the external space, If there is no external walls of our space in this option does not appear to us. Or flow is calculated according to the number of times air change per hour ACH. If the leak is permanently regardless of if the air conditioning fan was working or not we choose the option All hours but if the leak occurs only if the fan stops choose option Only when fan off.

3.5.1.6. Floors Tab:

It is the definition of floor space . At first identified case of the earth , and we have four options :

1. Floor above conditioned space there is no need to enter additional data .
2. Floor above unconditioned space: and then determine floor space in the field floor Area factor and temperature of the ground Total floor transition U-value, then we have four fields as follows :

a. Unconditioned space max temperature and expresses the degree of space is expected adjuster great heat in summer.
b. b-Ambient at space max temperature expressed in degrees outside the center expected in summer heat at the time of the degree of the previous heat.
c. c-Unconditioned space min temperature expressed in degrees space is conditioned Minor expected temperatures of winter
d. d -Ambient at space min temperature expressed in degrees outside center-expected temperatures in winter when a previous degree heat.

3. floor above the natural ground slab floor on grade: And then we define space and the factor of heat transfer, Ocean outer space within the field exposed perimeter and the intended sum of the lengths of the outer walls, Finally, in the event of a thermal insulation outer circumference into select thermal resistance factor of dielectric value within the Edge insulation R-value field
4. the floor of the underground (basement) Slab floor below grade: and then determine floor space and along the outer perimeter and the factor of heat transfer to the floor of the basement and the depth of the cellar within the field Floor depth (and intended height difference between the floor of the basement and the level of the Earth's natural and not necessary to be equal to the height of the basement.

3.5.1.7. Partitions Tab:

It is dedicated to the definition of internal partitions, if any, and the internal cutter meant either a wall separating the space for non-conditioner place (not an outside wall) or roof space separated from the non-air place (not final) surface initially determine cutter type of wall or roof. Then define the cutter space within the Area field worker and heat transfer within the field U-value. Then in the following four fields which we identify as explained in the floor above the place is air-conditioning. After the completion of the definition of all spreads by clicking the space defined by the right mouse button to do one of the following commands can:

1. Make an exact copy of the realm by the command Duplicate
2. 2.alomr Replace to replace the value of the group spreads with a new value. After selecting this define Place value required replacing the menus above, and then determine the type of value from the dropdown menu Type of Data to Replace, and here we have two options: either to replace a certain value other value and here we must put the value to be replaced within the Specific Value field to Replace, or that we replace all the values of this kind then whatever is left of this field is empty, and we put the new value within the replace field with value.
3. You can rotate selected spreads by the command Rotate and then move north to the shares of the compass new corner.
4. Can delete any space by Delete command.
5. command program prints the input data by the command Print Input Data or review in the form of a report by the command View Input Data .[12].

3.6. Enter Air System Data:

An Air System is the equipment and controls used to provide cooling and heating to a region of a building. An air system serves one or more zones. Zones are groups of spaces having a single thermostatic control. Examples of systems include central station air handlers, packaged rooftop units, packaged vertical units, split systems, packaged DX fan coils, hydraulic fan coils and water source heat pumps. In all cases, the air system also includes associated ductwork, supply terminals and controls. To define an air system, the components, controls and zones associated with the system must be defined as well as the system sizing criteria. This data is entered on the air system input form. [11]

3.6.1. Explain the Air System Data Fields:

3.6.1.1.General Tab

Important Definitions:

- Zone: We use this term if system serving several areas. . A "zone" is a group of one or more spaces having a single thermostatic

- System: is a set of controls and the device that provides heating and cooling for the building, the system can serve one or more single zone area single zone: We use this term if the system only serves a single zone if several areas Multi
- CAV Constant Air Volume: that the transmission flow to all openings fixed size does not change with the change of size convection.
- VAV Variable Air Volume: Meaning that transmission flow to all openings with variable load change size warming. From the tree menu, click on the system and then twice on the new default system Click show General tab:

To determine the general information about the system: Within the field air system name: This is a reference name used to identify the air system. It appears on the main program window, on system input reports and system design reports. It also appears on selection lists when linking systems to plants. Therefore, it is useful to make this name as descriptive as possible so you can easily differentiate this system from others in your project.

3.6.1.2. System Components Tab:

The System Components tab on the System Form contains information about centrally located components in the system such as fans and coils, and information about the distribution duct system, which is composed of the following lists:

3.6.1.2.1. Ventilation Air:

This list dedicated to the characterization of ventilation air, where it can be of Airflow Control drop-down list to choose the control method of air ventilation either fixed with time and change pregnancy Constant or according to a particular work schedule Scheduled and then must choose a work schedule special ventilation, or as needed Demand Controlled Ventilation any according the use of CO_2 sensors in each zone to control ventilation air.

3.6.1.2.2. Ventilation Reclaim

The Ventilation Reclaim data view contains information about a ventilation heat reclaim device used with the system. A ventilation reclaim device transfers heat between the outdoor ventilation and exhaust air streams in order to reduce loads on air system cooling and heating coils. In the beginning are selected retrieval type as if it were sensible heat only Sensible Heat or sensible and latent heat.

Thermal Efficiency in the field, enter the percentage of heat that can be transferred within the device 5%, which is usually between 15%, The exchanger (air -air) do not consume any energy. Schedule in the field, enter the months in which the use of heat recovery device, Input Kw in the field, enter the value of the energy consumption needed to run a rescue device and heat it for thermal Cupboards dried and heat recovery wheels to swap between the outside air temperature and air centrifuge works And to reduce the thermal load of air.

3.6.1.2.3. Humidification:

The Humidification data view contains information about the humidification controls and equipment in the system. Humidification control operates differently in central systems and tempering or common ventilation systems..

Humidifier Type Choose the type of humidifier used within the field Input Power Enter the value of the electric power needed to generate kg of steam per hour, no one Kw .h / Kg.

3.6.1.2.4. Drying Dehumidification:

The Dehumidification component contains information about active dehumidification controls. Dehumidification controls operate differently in central systems and tempering ventilation or common ventilation systems.. within the field Enter Maximum RH Set point specifies the maximum relative humidity maintained by the control.

3.6.1.2.5.Central Cooling :

- The Central Cooling data view contains information about the central cooling coil and related control and sizing characteristics. Initially are selected parameter nutrition to be controlled from the drop-down list, and here there are three options:
- Supply Temperature : Specify the design supply air temperature (SAT) delivered to zone supply terminals. transmission slots are standard design.
- Supply CFM or L/s - Specify the airflow rate delivered by the supply fan. This airflow will be divided among zones in a multiple-zone system based on the ratio of peak zone sensible loads.
- Supply CFM/sqft or L/s/sqm - Specify the airflow rate delivered by the supply fan in terms of airflow per unit floor area. HAP will calculate the total system airflow by multiplying the CFM/sqft or L/s/sqm by the total floor area in zones served by the system .

3.6.1.2.6. Central Heating:

The Central Heating data view contains information about the central heating coil and related control and sizing characteristics.

Precool Coil: The Cooling Coil data view contains information about a cooling coil located in a Tempering Ventilation unit or in a Common Ventilation Unit used with terminal fan coils or water source heat pumps..

Preheat Coil: The Preheat Coil data view contains information about a supplemental heating coil positioned upstream of the main coils.

3.6.1.2.7. Supply Fan:

This help topic discusses the data view for central fans. from the pull-down menu of fan type choose the a specific type of fan to display defaults for fan efficiency and part-load performance, or choose "user-defined" to specify your own performance data.

3.6.1.2. 8. Duct System:

The Duct System data view contains information about supply duct heat gain or loss, supply duct leakage and return duct or plenum data.

Within the field Duct Heat Gain Enter Heat gains or losses in the supply ductwork can be considered with this item. Heat gains and losses will affect system performance and increase cooling and heating coil loads., and typically range this ratio between 3% -1% , within the Duct Leakage field, enter Air leakage in supply ductwork increases the airflow requirement for the central supply fan, and in turn increases the fan heat gain and power use. - usually between 12% rate to 15% or more if the design .

You can select either the reflux air condition within the airway Ducted Return or within the ceiling nickname Return Air Plenum. If you choose the second option: Enter the following percentages:

- Wall Heat Gain to Plenum: A portion of wall heat gain can be removed by air flowing through the return plenum when the plenum has an exterior wall exposure.
- Roof Heat Gain to Plenum: A portion of roof heat gain can be removed by air flowing through the return plenum when the plenum is beneath a roof, and on average can be adopted ratio.% 0.5
- Lighting Heat Gain to Plenum: A portion of lighting heat gain can be removed as plenum air flows over the upper surface of the lighting troffer, or when return air flows through the lighting fixture., usually ranging between 25 and 15.[12]

3.6.1.3. Zone Components Tab:

- Spaces:

The Zone Components tab on the System Form contains information about components located in or adjacent to zones served by the system. This includes supply terminals, thermostats, supplemental heating units and the spaces included in the zone.

- Thermostat:

The Thermostats data view contains information about zone thermostat controls, the zone diversity factor and direct exhaust air, Select whether the input information for this list applied to all existing in the system or regions that each region has its own private data. If the situation √ mark within the box All Zones are the Same specifies whether one set of data will apply to all zones in the system, or whether data will be defined on a zone-by-zone basis.

3.6.1.4. Sizing Data Tab:

Within the field Chilled Water Delta - T defines the temperature difference between water leaving and entering a cooling coil. It is used together with the peak coil load to determine the required water flow rate for the coil. Note that this value is used to size water flow rate for all cooling coils whose cooling source is "chilled water".

Within the field Hot Water Delta - T defines the temperature difference between water entering and leaving a heating coil. It is used together with the peak coil load to determine the required water flow rate for the coil. Note that this value is used to size water flow rate for all heating coils in the system whose heat source is "hot water.

Then we add a safety factor accounts through the fields:

1. Sensible Cooling Factor is used in cooling design calculations to increase zone sensible cooling loads before cooling supply airflow rates and coil loads are calculated.
2. Latent Cooling Factor is used in cooling design calculations to increase zone latent cooling loads before coil loads are calculated.
3. Heating Factor is used in heating design calculations to increase zone heating loads before heating supply airflow rates and coil loads are calculated..

3.6.1.5. Equipment Tab:

This item defines the equipment classification for the Heating Ventilation and Air Conditioning system being analyzed. The choice of an equipment type determines the system types offered in the next input item, the components and controls which can be included in the system, choices for cooling and heating sources and whether a system can be linked to certain types of plants. For example, a Chilled Water Air Handling Unit can be connected to a chiller plant for plant sizing calculations, but a Packaged Rooftop Unit cannot. Users may choose from six equipment classifications:

1. Undefined: This option allows you to avoid making an equipment type choice. It is often used for preliminary block load estimates in which equipment type is not yet relevant. It is also used in detailed system design studies in which the equipment type is not yet known.[12]

When Undefined is selected, cooling and heating sources for coils will default to "any". It will not be possible to choose specific sources such as "chilled water" or "hot water". Systems using the "undefined" equipment type are, however, allowed to be connected to chiller and boiler plants for plant sizing calculations.

2. Packaged Rooftop Units: Packaged rooftop DX cooling units. The equipment can be cooling only, or can also provide electric, combustion, hot water, steam or heat pump heating.
3. Packaged Vertical Units: Packaged indoor DX cooling units. The equipment can be cooling only, or can also provide electric, combustion, hot water, or steam heating.
4. Split Air Handling Units: Packaged or built-up air handling units using a DX cooling coil and a separate condensing unit. Equipment can be cooling only, or can also provide electric, combustion, hot water, steam or heat pump heating.
5. Chilled Water Air Handling Units: Packaged or built-up air handling units using a chilled water cooling coil. Equipment can be cooling only or can also provide electric, combustion, hot water or steam heating.
6. Terminal Units: This class of equipment involves separate cooling/heating units located in each zone.

After the completion of the system definition can generate input data report by clicking on the system Asking the right mouse button and choose the command View Input Data also can generate a system accounts through the Print / view design results it shows a report similar to the following report:

Air System Sizing Summary for 01-AHU-GF-01

Project Name: Project 1 — 11/26/2012
Prepared by: HVAC Zone — 02:27PM

Air System Information

Air System Name	01-AHU-GF-01		Number of zones	1	
Equipment Class	CW AHU		Floor Area	197.2	m²
Air System Type	SZCAV		Location	Damascus, Syria	

Sizing Calculation Information

Zone and Space Sizing Method:

Zone L/s	Sum of space airflow rates	Calculation Months	Jan to Dec
Space L/s	Individual peak space loads	Sizing Data	Calculated

Central Cooling Coil Sizing Data

Total coil load	36.4	kW	Load occurs at	Jul 1600	
Sensible coil load	36.1	kW	OA DB / WB	38.3 / 17.8	°C
Coil L/s at Jul 1600	3053	L/s	Entering DB / WB	25.6 / 17.9	°C
Max block L/s	3053	L/s	Leaving DB / WB	15.0 / 14.2	°C
Sum of peak zone L/s	3053	L/s	Coil ADP	13.8	°C
Sensible heat ratio	0.998		Bypass Factor	0.100	
m²/kW	5.4		Resulting RH	52	%
W/m²	184.8		Design supply temp	14.4	°C
Water flow @ 5.0 °K rise	1.74	L/s	Zone T-stat Check	1 of 1	OK
			Max zone temperature deviation	0.0	°K

Central Heating Coil Sizing Data

Max coil load	38.2	kW	Load occurs at	Des Htg	
Coil L/s at Des Htg	3053	L/s	W/m²	193.6	
Max coil L/s	3053	L/s	Ent. DB / Lvg DB	19.1 / 30.2	°C
Water flow @ 10.0 °K drop	0.91	L/s			

Humidifier Sizing Data

Max steam flow at Jan 1500	22.31	kg/hr	Air mass flow	12283.33	kg/hr
Airflow Rate	3053	L/s	Moisture gain	.00182	kg/kg

Supply Fan Sizing Data

Actual max L/s	3053	L/s	Fan motor BHP	0.00	BHP
Standard L/s	2840	L/s	Fan motor kW	0.00	kW
Actual max L/(s-m²)	15.48	L/(s-m²)	Fan static	0	Pa

Outdoor Ventilation Air Data

Design airflow L/s	166	L/s	L/s/person	4.49	L/s/person
L/(s-m²)	0.84	L/(s-m²)			

Figure (3.11) Illustrates the Reports Drawn from HAP Program [12]

Where within the Air Group System Information shows general information on the studied system such as the system name and the type of device and the type of air system and number of zones, the total floor area served by the system and the location of the project.

While in Central Cooling Coil Sizing Data Group show accounts total Central Cooling Coil Sizing such as sensible coil load and necessary air flow and water flow of the cooling load in the event of use system operates on the coolant water, and an hour peak

load and outside temperature at rush hour The temperature of the air inside and outside of the coil temperature, relative humidity and expected others.

Central Heating Coil Sizing Data Group specification defines the heating and necessary Capacity of preheat coil and air flow and the flow of hot water and the temperature of the air inside and outside temperature of coil.

Group Humidifier Sizing Data sets humidifier specifications if any, Supply Fan Sizing Data specifications air flow rate , Outdoor Ventilation Air Data group sets air ventilation calculated values , as several other reports can be generated as needed.

3.7. Use HAP to Generate Design Reports:

Once weather, space, air system and plant data has been entered, HAP can be used to generate system and plant design reports.

To generate design reports, go to the main program window and select the desired air systems or plants. Next choose the “Print/View Design Results” menu bar option, toolbar button, or pop-up menu option. For systems this displays the System Design Reports form; for plants this displays the Plant Design Reports form. Select the desired report options on this form. If calculations are needed to supply data for these reports, the program will automatically run the calculations before generating the reports. If all the data needed for the reports already exists, reports are generated immediately.[12]

3.8. Evaluate Results:

Finally, use data from the simulation reports you generated to draw conclusions about the most favorable design alternatives.

design alternative being considered in the study. Building data consists of lists of plants and systems included in the building, utility rates used to determine energy costs and data for non-HVAC energy or fuel use. Data is entered using the building form.

3.9. Use HAP to Generate Simulation Reports:

Once all input data has been entered, HAP can be used to generate simulation reports.

To generate building simulation reports, go to the main program window and select the desired buildings. If data for a single building is being evaluated, select only one building. If energy use and costs for a number of alternatives is being compared, select a group of buildings. Next choose the "Print/View Simulation Results” option on the Reports Menu. This displays the Building Simulation. Reports Selection window. Choose the desired reports. Then press Preview to display the reports or press Print to directly print the reports. If system, plant or building calculations are needed to supply data for your reports, HAP will automatically run these calculations first. Otherwise, if no calculations are needed there ports will be generated immediately.

Simulation reports for individual air systems and plants included in your analysis can also be generated. Use the same procedure but select air system or plant items instead. System and plant

Simulation reports provide more detailed performance information for individual pieces of equipment. They are often useful for learning about equipment performance and for troubleshooting unexpected results.

3.10. Evaluate Results:

Finally, use data from the simulation reports you generated to draw conclusions about the most favorable design alternative. In many cases energy use and energy cost data will be used for further study of lifecycle economics. [11]

3. 11. Specifications of the Building:

The building is one floor has total area (1050.25 m^2) and height (3.5m).

This building consists of six classrooms with an area (7 *12 m) and 2 rooms area (4*12 m) and 3 offices with an area (6* 4.5 m).

The details of the internal building as follows:

- Six class room area (7*12m).
- Two room area (4*12 m)
- Three offices with an area (6*4.5 m)
- Electric room with area of (5 *5.75 m)
- Two-corridor (137.5 m) and (105.25 m)
- Reception room with an area of (77.5 m)
- Rooms mean Offices.
- Surface type for each building is a flat surface is medium thickness
- Each hall for 66 people and offices for 10 people and the offices of teachers contains 6 people the type of activity they perform is official work from eight in the morning until six pm
- Walls of medium thickness.

- Each of the rooms and halls and office windows dimensions (3.9*0.5 m) ,
- (1.5*1 m), (3.4*0.5 m) and (2.2*0.5m).
- Contains based on doors with dimensions (1.5* 2.5 m) and (1*1.2 m) ,(2.5*2.5m).

Rabak city in located between Longitude 32.65111 and latitude 13.1775 ,ranging higher temperatures of the city between 42 ℃ in the month of April and 33 ℃ in August, and temperatures ranging minimum between 24℃ heat in May and 15℃ in January..

- Rabak city at a height of 362 m above sea level and this represents the design conditions of the building .

3.12 .Cooling Load Calculation Using Hourly Analysis Program

3.12.1. Calculation:

It was carried out design calculations for the system of central adjustment of the building in the rabak City located at Longitude 32.65111 and latitude 13.1775 ,ranging higher temperatures of the city between 42 ℃ in the month of April and 33 ℃ in August, and temperatures ranging minimum between 24℃ heat in May and 15℃ in January.

Rabak city located at a height of 362m above sea level and these conditions represent the design of the building.

الصفحات من ٥١-٨٠ توجد في تكملة الباب الثالث (نتائج برنامج الهاب)

CHAPTER FOUR

Cooling Load Calculation Using Mathematical Equation

4.1. Introduction:

General procedure; calculation of space cooling load due to heat gain by conduction through exterior roofs and wall ; calculation of space cooling load due to conduction and solar through heat gain through fenestration areas; calculation of space cooling load due to heat gain by conduction through interior partitions ,ceiling ,roofs ; calculation of space cooling load due to heat sources within the conditioned space ; calculation of space cooling load due to ventilation and infiltration air; calculation of cooling coil load due to moisture transfer through permeable building materials ; calculation of space cooling load from space cooling load. [6]

To choose and adjust air systems designed to be precise calculations of the building , including the knowledge of space and the number of people and the contents of computers and audio equipment , lighting and ventilation and also should know the following concepts at the design :

1. Heat gain
2. Cooling load
3. Heat extraction rate

It is important to differentiate between heat gain, cooling load, and heat extraction rate.

Thermal loads of air-conditioned buildings account such as refrigeration cooling load in summer and heating in winter is very important for accurate design and good choice for air conditioning equipment and air handling units to achieve operational requirements , thermal comfort and good distribution of the air conditioner in place.[4]

4.2. Heat Gain:

Heat gain is the rate at which energy is transferred to or generated within a space. It has two components, sensible heat and latent heat, which must be computed and tabulated separately. Heat gain usually occur in the following forms :

1. Solar radiation through openings.

2. Heat conduction through boundaries with convection and radiation from the inner surfaces into the space.
3. Sensible heat convection and radiation from internal objects.
4. Ventilation (outside air) and infiltration air ,
5. Latent heat gains generated within the space.

4.3. Cooling Load:

The cooling load is the rate at which energy must be removed from a space to maintain the temperature and humidity at the design values. The cooling load will generally differ from the heat gain because the radiation from the inside surface of walls and interior objects as well as the solar radiation coming directly into the space through openings does not heat the air within the space directly .

This radiant energy is mostly absorbed by floors, interior walls, and furniture, which are then cooled primarily by convection as they attain temperatures higher than that of the room air.

Is a rate of withdrawal of heat required to maintain the air temperature and humidity inside the air-conditioned places.[4]

4.4. Heat Extraction:

The heat extraction rate is the rate at which energy is removed from the space by the cooling and dehumidifying equipment. This rate is equal to the cooling load when the space condition are constant and the equipment is operation.

4.5. Calculate The Cooling Load Modes (Cooling Load Calculation):

There are three methods to calculate the cooling load, namely:

4.5.1. Accurate Method:

This method uses the computer to appoint a maximum load cooling during the summer months, June , July, August and September. Calculations are about 2928 times , taking into account the different thermal loads change with time.

This method is known as the Transitional performance manner (Transfer Function Method) and of course, it is expensive and served on a large air conditioning projects such as large hotels and administrative buildings.

4.5.2. Approximation Method:

This method is used to designate the computer manual maximum load cooling during the summer months only in peak periods , i.e., 10 am , 2 pm and 4 pm for the warmest day of the month , conducted the accounts of about 12 times this method is known as the middle way (Average Method) which is less expensive compared to the way the subtle but give a cooling loads greater than the exact manner , this method benefit for small- air conditioning for homes , offices , and shops.

4.5.3.FamiliarMethod:

This method uses a manual computer once to appoint the cooling load to the highest degree of outside air temperatures during the summer months, this method is used for projects of residential and commercial air conditioning.[4]

4.6. Heat Gain:

Is an algebraic sum of thermal energy gained by the building of internal and external heat sources. It can be classified as heat gained to:

4.6.1. Sensible Heat:

Is a temperature that is working to change the air temperature, heat sources are as follows :

1. Heat transmitted through walls, Ceilings, floors, windows and doors of the building because of the temperature difference between the air inside and outside the room.
2. Transmitted heat through the walls of the building, roofs, windows and doors exposed to the sun.
3. Heat generated by lighting, equipment and the occupants of the rooms.
4. Heat caused by air leakage through cracks in windows and doors
5. Heat resulting from treatment of air ventilation.[5]

4.6.2. Latent Heat:

Is a heat that works to increase air humidity inside the rooms. In addition, thermal sources are as follows:

1. Water vapor that gives the occupants of the rooms because of respiration and evaporation of sweat.
2. Moisture associated with air leakage and ventilation.
3. Humidity resulting from operations within the building

Distinction must be made between the following expressions : Heat acquired , cooling load and pull the heat to reflect heat gained from heat gained by the building and stored in the indoor air , walls , ceilings , and inclusions based and represents the cooling load maximum rate of withdrawal of heat for the unity of air-conditioning to maintain the state of comfort inside the building , while crossing withdraw heat from the rate of withdrawal of heat from the air-conditioned places.

It is noted that the cooling load is usually greater than the withdrawal of heat and heat gained and equal in the case of stability only. [4]

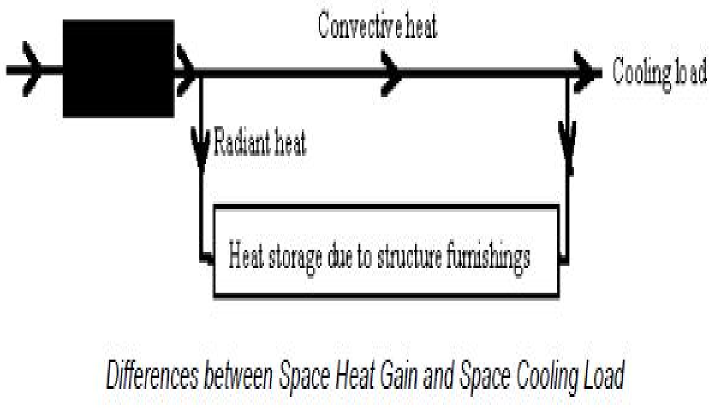


Figure (4.1) Shows the Relationship Between the Heat Gained, the Cooling Load and Heat Extraction. [5]

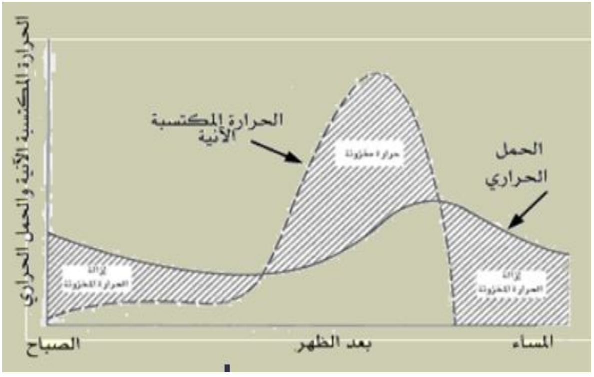


Figure (4.2) Shows the Relationship Between Temperature and Convection Acquired at Rush Hour. [5]

4.7. Factors Influencing Heat Gain

The most important factors that affect the acquisition of the passive heat are:

4.7.1. Thermal Sources:

These can be classified in to:

4.7.1.1. External Sources, Namely:

1. Heat transfer through the external walls, interior, ceilings and floors.
2. The sun's rays on the exterior walls, windows and ceilings effect.
3. Heat transfer with air ventilation and air leaking into the building

4.7.1.2. Internal Sources, Namely:

1. the heat generated by the occupants of the place.
2. the heat generated by lighting.
3. the heat from the thermal and electrical equipment located inside the building.

4.7.2. Exterior Design Conditions:

Is an air temperature dry and wet degree temperature and which is repeated during the summer months (June, July, August and September) for a time ranging from 1 %, 2.5%, and 0.5 % of the total number of hours (2928 hour).

4.7.3. Interior Design Conditions:

Should the temperature difference between the degree of air inside and outside the building between (8-11) °C so that the occupants of air-conditioned places not exposed to the common popular when they came out of the building.

Terms range from comfort to most people between (24-27) °C and dry heat (45-50) % relative humidity. [4]

4.7.4. Create Buildings:

Can be built light, medium or heavy because the degree of the external air temperature differs from the internal air temperature, therefore the heat transmitted through walls, ceilings, floors, doors and windows.

Part of the transmitted heat stored in the building components and the rest is transferred to the air inside the air-conditioned places and heat transfers depend on the thermal resistance of the components of the various sections rate. [4]

4.7.5. Dimensions of the Building and the Direction of the Walls:

Affect the direction of the walls is based on the amount of heat gained from the sun's rays they be large at around six in the evening western walls.

4.8. Design Conditions:

Design of internal and external conditions affect the amount of thermal loads of space, air-conditioned attic is considered certain values to the degree of dry and moist heat and relative humidity as well as for each of the conditions of internal and external design. [4]

4.8.1. Internal Design Conditions:

System Comfortable, air-conditioning systems are used for public buildings and commercial the following conditions:

- Has been determining the degree of dry heat as 24 degrees Celsius.
- The value of the relative humidity of 50 %.

4.8.2. External Design Conditions:

- The highest temperature external dry in the rabak monitor city of in month of June were valued at 42 °C from appendix (4.1).

- Also imposed a degree of moist heat on the value of 26°C.

4.9. Find the Value of T_o (T_o Create Value):

Was chosen three hours separated by seven hours during the day was chosen Watches (7-14-21) and by reference to the tables (ASHRAE) to determine the percentage of the temperature per hour.

Can be found (T_o) of the following relationship:

$$T_o = \frac{T_7 + T_{14} + 2T_{21}}{4} \rightarrow (4.1)$$

It can be found from the following relationship:

$$T_x = T_m - \Delta T_m \times P_C \rightarrow (4.2)$$

T_x ≡ Medium degree of external air temperature throughout the day.

T_m ≡ Maximum air temperature during the day.

Pc ≡ range between the maximum temperature and the lower the temperature of the day.

ΔT_m ≡ percentage of the extent of change in the temperature of the air at the hour of convective account.

Can the percentage of temperature per hour of extension account (4.2).

Table (4.1) Shows the Percentage of Temperature per Hour

21	14	7	**Hour**
58	3	93	**ΔTm %**

Was selected value:

Pc = 18

$$T_x = T_m - \Delta T_m \times P_C$$

T7 = 42– (0.93 × 18) = 25.26 ℃

T14 = 42– (0.03 × 18) = 41.46 ℃

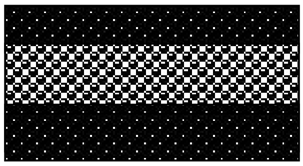
T21 = 42– (0.58 × 18) = 31.56 ℃

$$T = \frac{25.26 + 41.46 + 31.56}{4}$$

$T = 32.46$ ℃

4.10. Overall Labs Account For Heat Transfer for Different Sections:

1. **Walls:**



2 c m cement plaster k = (0 .72 $W/m.k$)

20 c m brick block k = (0.77 $W/m.k$)

2 c m cement plaster k = (0 .72 $W/m.k$)

$$R_T = \frac{1}{h_i} + \Sigma\frac{\delta}{K} + \frac{1}{h_o} \qquad \rightarrow (4.3)$$

$$\frac{1}{8.29} + \frac{0.02}{0.72} + \frac{0.2}{0.77} + \frac{0.02}{0.72} + \frac{1}{22.7} = 0.4799$$

$$U = \frac{1}{R_T} \qquad \rightarrow (4.4)$$

$= \frac{1}{0.4799} = 2.054(\ W/m^{2}$°C)

Where:

U ≡ Overall coefficient of heat transfer .

hi = Internal heat transfer coefficient of the situation .

ho ≡ The external heat transfer coefficient of the situation .

k ≡ Thermal conductivity for each section separately.

Find the value of the thermal conductivity of different sections of the extension (4.3).

Can the value of heat transfer coefficient for the calculation of internal state of extension (4.4), while the value of the external heat transfer coefficient of the situation has been calculated from the following relationship

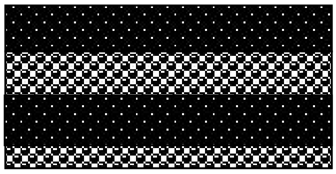
$$h_o = 6 + 4v \quad \rightarrow \quad (4.5)$$

$V \equiv$ air velocity at the surface (m / s), which represents the wind speed

$V = 4.2\ m/s$

$h_o = 6 + (4 * 4.2) = 22.7\ W/m^2$°C

2. Roof :



k = $(0.72 W/m.k)$ cement plaster 2 cm

15 cm concrete k = $(1.72\ W/\ m.k)$

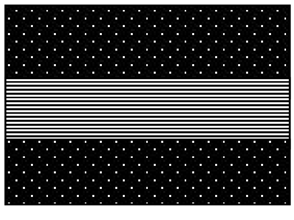
2 cm cement plaster k = $(0.72\ W/m.k)$

$$R_T = \frac{1}{h_i} + \Sigma\frac{\delta}{K} + \frac{1}{h_o}$$

{1/8.29 + 0.02/0.72 + 0.15/1.72 + 0.02/0.72 + 1/22.7} = 0.30744

U = 1/RT = 3.252 W/m^2°C

3. Floor :



cm concrete k =(1.72 $W/m.k$ 10)

cement plaster k = (0.72 $W/\ m.\ k$) 3cm

k = (1.39 $W/\ m.k$) 2 cm tiles

$$R_T = \frac{1}{h_i} + \Sigma\frac{\delta}{K} + \frac{1}{h_o}$$

= (1/8.29 + 0.1/1.72 + 0.03/0.72 + 0.02/1.39 + 1/22.7)

= 0.2793

U = 1/R

= 3.5810 (W/m^2°C)   = 1/0.2793

4.11. Heat Gain Resulting From Thermal Sources:

4.11.1. Heat Gain Output by Walls:

Heat gained through the wall or walls is a total transmitted heat on a regular basis (Steady State) from the outside to the inside as a result of the temperature difference between inside and outside , the heat transmitted irregularly (Unsteady State) as a result of the difference in the amount of incident radiation on the wall.

Appoints heat gain resulting from the walls of the relationship below:

$$CLTD_{corr} = \left(CLTD_{incorr} + L_m \right) \times k + \left(25.5 - T_r\right) + \left(T_o - 29.4\right) \quad \rightarrow (4.6)$$

Where:

$CLTD_{incorr}$ ≡ Temperature teams uncorrected for walls

Lm ≡ Latitude correction coefficient .

T∙ ≡ degree of foreign design medium heat

K ≡ coefficient determines the color of the wall have been chosen value equivalent to k=1.

Tr ≡ design degrees internal temperature .

$CLTD_{corr}$ ≡ temperature difference to carry the corrected cooling.

Calculate the heat load resulting from the walls of the months (April-May-June), the hours of design (12-14 -16) by the equation below:

$$Q_{wall} = A \times U \times CLTD_{corr} \quad \rightarrow (4.7)$$

Where :

$A \equiv$ surface of the wall space (m^2)

$U \equiv$ heat transfer coefficient of the wall $(W/m^2°C)$

Table (4.2) Illustrates Lm Values for the Months (4-5-6) of the ASHRAE Extension Tables (4.5)

Direction	4	5	6
N	17.708-	-14.931	-13.819
S	14.236	13.889	13.889
W	17.222	17.014	17.014

The temperature difference uncorrected account of (ASHRAE).

Table (4.3) Shows the Non -Corrected Values for the Month (4-5-6) Hours of Design (12.14. 16) of the Extension (4.6) (A).

DIRECTION	12	14	16
N	26.488-	25.928-	25.378-
S	7.126	7.676	9.346
E	14.552	16.222	17.892
W	12.332	11.782	12.332

Table (4.4) Shows $CLTD_{corr}$ for the Month of April.

DIRECTION	12	14	16
N	-23.711	-23.151	-22.601
S	6.779	7.329	8.999
E	14.344	16.014	17.684
W	12.124	11.574	12.124

Table (4.5) $CLTD_{corr}$ Explains May.

DIRECTION	12	14	16
N	-22.599	-22.039	-21.489
S	6.779	7.329	8.999
E	14.344	16.014	17.684
W	12.124	11.574	12.124

Heat gain resulting from the walls during the month of April

Table (4.6) Shows the Heat Gain Resulting from the Walls During April.

DIRECTION	**U**	**A**	**12**		**14**		**16**	
			$CLTD_{corr}$	***Qw(w)***	**$CLTD_{corr}$**	***Qw(w)***	**$CLTD_{corr}$**	***Qw(w)***
N	2.054	319.675	-26.448	-17364.394	-25.928	-17024.648	-25.378	-16663.511
S	2.054	315.775	7.126	4621.937	7.676	4978.668	9.346	6061.833
E	2.054	473.351	14.552	14148.371	16.222	15772.050	17.892	17395.729
W	2.054	463.693	12.332	11745.310	11.782	11221.476	12.332	11745.310
Total			**13151.224**		**14947.546**		**18539.361**	

Heat gain resulting from the walls during the month of May:

Table (4.7) Shows the Heat Gain Resulting from the Walls During May.

DIRECTION	***U***	***A***	**12**		**14**		**16**	
			$CLTD_{corr}$	***Qw(w)***	**$CLTD_{corr}$**	***Qw(w)***	**$CLTD_{corr}$**	***Qw(w)***
N	2.054	319.675	-23.711	-15568.938	-23.151	-15201.235	-22.601	-14840.098
S	2.054	315.775	6.779	4396.872	7.329	4753.603	8.999	5836.762
E	2.054	473.351	14.344	13946.140	16.014	15569.819	17.684	17193.498
W	2.054	463.693	12.124	11547.206	11.574	11023.372	12.124	11547.206
Total			**14321.280**		**16145.559**		**19737.368**	

Heat gain resulting from the walls during the month of June:

Table (4.8) Shows the Heat Gain Resulting from the Walls through June

DIRECTION	***U***	***A***	**12**		**14**		**16**	
			$CLTD_{corr}$	***Qw(w)***	**$CLTD_{corr}$**	***Qw(w)***	**$CLTD_{corr}$**	***Qw(w)***
N	2.054	319.675	-22.599	-14838.785	-22.039	-14471.082	-21.489	-14109.945
S	2.054	315.775	6.779	4396.872	7.329	4753.603	8.999	5836.762
E	2.054	473.351	14.344	13946.140	16.014	15569.819	17.684	17193.498
W	2.054	463.693	12.124	11547.206	11.574	11023.372	12.124	11547.206
Total			**15051.433**		**16875.712**		**20467.521**	

4.11.2. Heat Gain Resulting from the Ground:

Appoints thermal heat gain resulting from the ground through the following relationship:

$$Q = U \times A \times \Delta T \qquad \rightarrow (4.8)$$

$\Delta T = T_o - T_I = (32.46 - 24) = 8.46$ ℃

$U = 3.5810$ (W/m^2℃)

$A = \{(36\times29.5) + (15.5\times5) - (89.2)\} = 1050.25m^2$

$Q = (3.5810)\ (1050.25)\ (8.46) = 31817.597$ (Watt)

4.11.3. Heat Gain Resulting from the Ceiling:

Appoints thermal heat gain resulting from the ceiling through the following relationship:

$$Q = U \times A \times CLTD_{corr}$$

$$CLTD_{corr} = \left(CLTD_{incorr} + L_m\right) \times k + \left(25.5 - T_r\right) + \left(T_o - 29.4\right)$$

Table (4.9) Illustrates $CLTD_{incorr}$ been Found of the Extension (4.6) D.

Hour	12	14	16
$CLTD_{incorr}$	26	40	51

Table (3.10) Illustrates Lm Months (4-5-6) was Found Out Extension (4.5)

DIR	4	5	6
Hour	17.569	17.361	17.361

Table (4.11) Illustrates $CLTD_{corr}$ for the Month of April.

Hour	12	14	16
CLTDcorr	48.129	62.129	73.129

Table (4. 12) Illustrates $CLTD_{corr}$ for May.

Hour	12	14	16
$CLTD_{corr}$	47.921	61.921	72.921

Table (4.13) Illustrates $CLTD_{corr}$ for June.

Hour	12	14	16
CLTDcorr	47.921	61.921	72.921

Table (4.14) Shows the Heat Gain Resulting from the Ceiling

Hour	*A*	*U*	$CLTD_{corr}$	*Q* (w)
12	1050.25	3.252	48.129	164380.412
14	1050.25	3.252	62. 129	212196.194
16	1050.25	3.252	73.129	249765.737
Total				478399.972

4.11.4. Heat Gain output by the Glass:

The sun's rays enter the building through the windows and through the direct radiation heating the air surrounding the pregnancy, the heat leak through the glass is affected by the air inside the place and we fell directly on the image of a rise in air temperature.

It is noted that the glass allows passing four times the heat transmitted through the walls.

The Glass divides heat Gain into Two Parts:

1. Gain by pregnancy and delivery.

2. Gain by radiation.

Calculated heat gain of the glass by pregnancy following relationship :

$$Q = U \times A \times CLTD_{corr}$$

$$CLTD_{corr} = CLTD_{incorr} + (25.5 - T_r) + (T_O - 29.4)$$

Table (4.15) Illustrates $CLTD_{incorr}$ was Calculated from the Extension (4.6) (E)

Hour	12	14	16
$CLTD_{incorr}$	5	7	8

Table (4.16) Illustrates $CLTD_{corr}$ was Calculated from the Relationship (4.6)

Hour	12	14	16
$CLTD_{corr}$	9.56	11.56	12.56

Find Area of windows:

Table (4.17) Shows the Upper Area of the High-Level Windows in the Four Directions.

Direction	Number of Window	Width * Hi	*A* Total
N	5	(3*6.40*0.5)+(1*1.5)+(3.4*0.5)	12.8
S	5	(3*6.40*0.5)+(3.4*0.5)	11.3
E	—		
W	3	(3*3.9*0.5)	5.85

Table (4.18) Illustrates the Windows Space

Direction	Number of Window	Width * Hi	*A* Total
N	1	(1*1.5)	1.5

Table (4.19) Shows the Area of the Door

Direction	Number of Doors	Width * Hi	*A* Total
N	5	(5*1.2*2.50)	15
S	5	(5*1.2*2.50)	15
E	6	(2*1.5*2.5)+(3*1*2.5)	15
W	—	—	—

Table (4.20) Shows the Area of the Glass Wall

Direction	Number of Glass Wall	Width * Hi	A_T
N	1	(3*3.45)	10.35
S	1	(3*3.45)	10.35
E	3	(2*3*3.45)	20.7
W	—	—	—

The total area of the glass = doors space + windows space + space upper high-level windows (skylights).

Table (4.21) Shows the Total Area

Direction	A_T (Total Area)
N	39.65
S	36.65
E	35.7
W	5.85

Single glass U = 5.9 (W/m^2℃) in summer

Table (4.22) Shows the Heat Gain Resulting from the Glass to Conduction

Direction	***U***	***A***	**12**		**14**		**16**	
			$CLTD_{corr}$	***Qw(w)***	**$CLTD_{corr}$**	***Qw(w)***	**$CLTD_{corr}$**	***Qw(w)***
N	5.9	39.65	9.56	2236.419	11.56	2704.289	12.56	2938.224
S	5.9	36.65	9.56	2067.07	11.56	2499.677	12.56	2715.912
E	5.9	35.7	9.56	2013.623	11.56	2434.883	12.56	2645.513
W	5.9	5.85	9.56	329.963	11.56	398.993	12.56	433.508
Total				6647.074	8037.842		8733.157	

Calculated heat gain of the glass by radiation following relationship

$$Q = A \times S_c \times SHGF \times CLF \quad \rightarrow (4.9)$$

Where:

$A \equiv$ area of glass (m^2)

$Sc \equiv$ shading coefficient for glass and no extension of the (4.8).

$SHGF \equiv$ maximum solar heat gain coefficient no of destructive (4.9).

$CLF \equiv$ cooling load factors for glass with interior shading and no extension of (4.10).

Table (4.23) Illustrates the Different Spaces of the Clips Doors and Windows and High Level Windows (H)

DIRECTION	DOOR	Glass wall	High Level Windows(H)	WINDOW	A Total
N	15	10. 35	12.8	1.5	39.65
S	15	10. 35	11.3	___	36.65
E	15	20.7		___	35.7
W	__	__	5.85	___	5.85

Table (4.24) Shows the Heat Gain of the Glass by Radiation for April.

		12				14				16			
Direction	*A*	*SHGF*	*SC*	*CLF*	*Q w (w)*	*SHGF*	*SC*	*CLF*	*Q w (w)*	*SHGF*	*SC*	*CLF*	*Q w (w)*
N	39.65	123	0.94	0.89	4080.956	123	0.94	0.86	3942.526	123	0.94	0.75	3438.250
S	36.65	142	0.94	0.83	4060.395	142	0.94	0.68	3326.589	142	0.94	0.35	1712.215
E	35.7	716	0.94	0.27	6487.433	716	0.94	0.22	5286.056	716	0.94	0.17	4084.680
W	5.85	716	0.94	0.17	669.338	716	0.94	0.53	2086.761	716	0.94	0.82	3228.573
Total					13151.224				14641.932				12463.718

Table (4.25) Shows the Heat Gain of the Glass by Radiation for May

		12				14				16			
Direction	***A***	***SHGF***	***SC***	***CLF***	***Q w (w)***	***SHGF***	***SC***	***CLF***	***Q w (w)***	***SHGF***	***SC***	***CLF***	***Q w (w)***
N	39.65	164	0.94	0.89	5440.075	164	0.94	0.86	5256.702	164	0.94	0.75	4584.333
S	36.65	129	0.94	0.83	3688.669	129	0.94	0.68	3022.042	129	0.94	0.53	2355.415
E	35.7	678	0.94	0.27	6143.127	678	0.94	0.22	5005.511	678	0.94	0.17	3867.895
W	5.85	678	0.94	0.17	633.815	678	0.94	0.53	1976.011	678	0.94	0.82	3057.224
Total					36855.750				15260.266				13864.867

Table (4.26) shows the Heat gain of the Glass by Radiation for June

		12				14				16			
Direction	*A*	*SHGF*	*SC*	*CLF*	*Q w (w)*	*SHGF*	*SC*	*CLF*	*Q w (w)*	*SHGF*	*SC*	*CLF*	*Q w(w)*
N	39.65	208	0.94	0.89	6899.608	208	0.94	0.86	6667.036	208	0.94	0.75	5814.276
S	36.65	129	0.94	0.83	3688.669	129	0.94	0.68	3022.042	129	0.94	0.35	1555.463
E	35.7	653	0.94	0.27	5916.611	653	0.94	0.22	4820.942	653	0.94	0.17	3725.274
W	5.85	653	0.94	0.17	610.444	678	0.94	0.53	1906.402	678	0.94	0.82	2944.495
Total					17115.332				16416.422				14039.508

4.11.5. Heat Gain Resulting from the People:

Gives the occupants of air-conditioned heat places depends on the nature of the status of each person , man give sensible heat as a result of difference in body temperature (37°C) the degree of comfort inside the place conditioner also gives the latent heat as a result of water vapor evaporated within the lung and the evaporation of sweat from the body surface the show to air.

The leaking heat that human generated in one of three ways : by radiation as heat felt , pregnancy as heat sensible and evaporate moisture that the human body secreted in a latent heat, and the higher the temperature of the dry bulb in space adjuster greater the body 's dependence on evaporation to secure cooled and thus increasing convection underlying playing level Hits and movement of the human being an important role in the division of the heat load of people to the latent and imperceptible as well as in the total rate of metabolic (metabolic rate). [4]

Calculates the thermal gain for the occupants of the place the following relationship:

$$Q_{occupants} = Q_{sp} + Q_{lp}$$

$$Q_{sp} = N \times SHG \times Fd \quad \rightarrow (4.10)$$

$$Q_{lp} = N \times LHG \times Fd \quad \rightarrow (4.11)$$

Where:

N ≡ number of people inside the conditioned space.

SHG ≡ sensible heat per person has been found worth of extension (4.11).

LHG ≡ latent heat per person has been found of the extension (4.11).

Fd ≡ variation that has been worth the expense of the extension coefficient (4.12).

$Q_{s,p} = 402 \times 75 \times 0.75 = 22612.5\ (W)$

$Q_{l,p} = 402 \times 55 \times 0.75 = 16582.5\ (W)$

Occupants = (22612.5 + 16582.5) = 39195 (W)

4.11.6. Heat Gain Resulting from the Lighting:

Lighting classified in the natural and artificial. In addition, operates industrial lighting to increase the air temperature in air-conditioned places. [5]

It determines the thermal gain resulting from the lighting of the relationship

$$Q_l = n \times \left(Watt / m^2\right) \times Fd \times Fsa \quad \rightarrow (4.12)$$

Where:

n ≡ number of bulbs and their value (236)

(Watt/m^2) ≡ Light intensity

Fd ≡ use coefficient was calculated from an extension (4.12).

Fsa ≡ fluorescent bulbs coefficient is taken (1.25)

The intensity of the lighting of the extension account (4.13) and it was worth:

$(watt/m^2)$ = 20

1 m^2 ⟶ 20

X ⟶ 1050.25m^2

X =21005 ($Watt$)

Fd = 0.75

Fsa = 1.25

Q_L= (236 × 0.75 × 1.25 × 21005)

= 4647.356 (KW) = 4647356.25 (W)

4.11.7. Heat Gain Resulting from the Ventilation:

The case of ventilation air when external conditions are different from the case of the air conditioner inside the place , so it is necessary to address the ventilation air to reduce the degree of dry temperatures and lowering humidity .[8]

It was calculated by the amount of air required for ventilation of the relationship:

$$\dot{m}_v = \frac{A \times H \times NAHC}{3600 V_o} \quad \rightarrow (4.13)$$

Where :

V_o ≡ specific volume outside air is calculated from the extension (4.14)

A ≡ floor space

H ≡ high place

NACH ≡ number of times air renewal per hour was calculated from the extension (4.15)

at:

Tdb = 42 °

Twb = 26°

$V_\cdot$ = 0.915 m / kg

A= 1050.25 m²

H = 3.45m

NACH = 6

$\dot{m}_v$ = 1050.25 × 3.45 × 6 × (1/ (3600×0.915)) = 5.526 (Kg/sec)

Sensible heat gain associated with the ventilation air:

$$Q_{s,v} = \dot{m}_v \times cp \ (To - Ti) \quad \rightarrow (4.14)$$

Where:

$\dot{m}_v$ ≡ Force of air ventilation rate.

$C\,pair$ ≡ the specific heat of air and value = [1.005 kJ / kgK]

T_o ≡ degree heat external design of the building and tied (42 °).

T_i ≡ degree heat the interior design of the building and tied (24 °)

$Q_{v,s}$= 5.526× 1.005 (42 – 24) = 99.965 (W)

Latent Heat Gain Resulting from the Ventilation Air:

$$Q_{l,v} = \dot{m}_v \left(W_O - W_I\right) hfg \quad \rightarrow (4.15)$$

Where:

W_o ≡ humidity attributed to external circumstances were calculated from the psychometric chart.

W_i ≡ humidity attributed to internal conditions were calculated from the psychometric chart

$h\,fg$ ≡ potential energy to vaporize the water was calculated from the steam table.

W_o = 0.0146 ($kg\ water / kg\ air$)

W_i = 0.0093 ($kg\ water / kg\ air$)

h_{fg} = (2500 kJ / kg)

$Q_{l,v}$ =5.526× (0.0146 – 0.0093) × 2500= 73.22 (W)

Overall heat gain is the algebraic sum of sensible heat and latent

$Q_{v,T}$ = 99.965 + 73.22 = 173.185 (W)

4.11.8. Heat Gain Resulting from the Infiltration:

Air leakage occurs as a result of the differential pressure through the walls of the pore , through the cracks in the walls and around windows and door openings , air leakage into the room (Infiltration) air leak from the room (Ex Filtration) causes convection because it is necessary to extract heat from the air leaking from the external situation to become a status similar air inside the case of air-conditioned places.[8]

It calculates the rate of air leaking from the relationship :

$$\dot{m}_i = \frac{A \times H \times £}{3600\ V_o} \quad \rightarrow (4.16)$$

Where:

$A \equiv$ space to be adapted .

$H \equiv$ high place .

£ ≡ number of times air change per hour.

$\dot{m}_i$ =1050.25× 3.45 × 2 × (1/3600 × 0.915) × 10-3=0.002 (*Kg/Sec*)

Thermal sensible and latent gain is calculated from two relationships following cases:

$$Q_{S,I} = \dot{m}_i \left(h_N - h_R \right) \quad \rightarrow (4.17)$$

$$Q_{L,I} = \dot{m}_i \left(h_O - h_N \right) \quad \rightarrow (4.18)$$

Through the psychometric chart was calculated by the following relationships were as follows:

$h_N = 66.5\ kJ\ kg$

$h_R = 48\ kJ\ kg$

$ho = 80\ kJ\ kg$

$Qs,i = 0.002 \times (66.5 - 48)\ 10\text{-}3 = 0.000037\ (W)$

$Qvi = 0.002 \times (80 - 66.5)\ 10\text{-}3 = 0.0000\ 29\ (W)$

Gain overall heat resulting from the leakage is an algebraic sum gain sensible and latent

$Q_{v,T} = 0.000037 + 0.0000\ 29 = 0.000066\ (W)$

When the cooling load calculations take the greatest value in the cases of earning through ventilation and leakage and here is the value of the largest heat gain through ventilation.[5]

4.11.9. Heat Gain from Equipment:

Heat gain due Equipment can be calculated by the following relationships:

$Q_E = (1 - \eta)E$ → (4.19)

Fan load:

$Q_f = (1 - \eta)E = n(1 - \eta) = 60*(1-0.65)*80 = 1680(W)$

Refrigerator load:

$Q_R = (1 - \eta)E = n(1 - \eta)\ E = 5*(1-0.67)*150 = 232.5\ (W)$

computer load (desktop):

$Q_{com} = (1 - \eta)E = n(1 - \eta)\ E = 5*(1-0.77)*125 = 143.75\ (W)$

laser printer load :

$Q_p = (1 - \eta)E = n(1 - \eta)\ E = 5*(1-0.89)*150 = 82.5\ (W)$

copier load :

$Q_{cop} = (1 - \eta)E = n(1 - \eta)\ E = 5*(1-0.85)*250 = 187.5\ (W)$

heater load :

$Q_h = (1 - \eta)E = n(1 - \eta)\ 1500 = 5*(1-0.88)*1500 = 900\ (W)$

$Q_{E,T} = 1680+232.5+143.75+82.5+187.5+900 = 3226.25\ (W)$

Table (4.27) Shows the Total Heat Gain of the Vehicle Passengers During April.

Hour	*Q* building			*Q* *galss*		*Q* Person		*Q* Light	*Q*ventilaton	*Q*equipment	*Q* *Total*
	Q wall	*Q* roof	*Q* floor	R	C	S	L				
12	13151.224	164380.412	31817.597	15298.122	6647.074	22612.5	16582.5	4647.356	173.185	3226.25	278536.220
14	14947.546	212196.194	31817.597	14641.923	8037.842	22612.5	16582.5	4647.356	173.185	3226.25	312300.393
16	18539.361	249765.737	31817.597	12463.718	8733.157	22612.5	16582.5	4647.356	173.185	3226.25	368561.361

Table (4.28) Shows the Total Heat Gain of the Vehicle Passengers During May.

Hour	*Q* building			*Q galss*		*Q* Person		*Q* Light	*Q*ventilaton	*Q*equipment	*Q Total*
	***Q* wall**	***Q* wall**	***Q* wall**	**R**	**C**	**S**	**L**				
12	14321.280	164380.412	31817.597	36855.750	6647.074	22612.5	16582.5	4647.356	173.185	3226.25	296617.214
14	16145.559	212196.194	31817.597	15260.266	8037.842	22612.5	16582.5	4647.356	173.185	3226.25	314116.749
16	19737.368	249765.737	31817.597	13864.867	8733.157	22612.5	16582.5	4647.356	173.185	3226.25	342524.517

Table (4.29) Shows the Total Heat Gain of the Vehicle Passengers During June

Hour	*Q* building			*Q* *galss*		*Q* Person		*Q* Light	*Q*ventilaton	*Q*equipment	*Q* *Total*
	Q wall	*Q* wall	*Q* wall	R	C	S	L				
12	15051.433	164380.412	31817.597	17115.332	6647.074	22612.5	16582.5	4647.356	173.185	3226.25	282253.639
14	16875.712	212196.194	31817.597	16416.422	8037.842	22612.5	16582.5	4647.356	173.185	3226.25	332585.558
16	20467.521	249765.737	31817.597	14039.508	8733.157	22612.5	16582.5	4647.356	173.185	3226.25	372065.311

4.12. Hours a Month to Determine the Design:

Intended time and the month in which the heat load is greater as you can and be determined after heat load calculation during the summer months, April , May and June and during the hours when temperatures reach as high as possible and then the pregnancy is a pregnancy design .

Been identified convection greatest design in the month of June which is worth(372065.311) W and when four o'clock in the evening.

4.13. Total Heat Load:

Convection total (sensible and latent) for building the college shown in Table (4.30) .

Table (4.30) Shows the Total Heat Load

Ql **(*Watt*)**	***Qs*** **(*Watt*)**	**Type of Heat Load**
–	20467.521	Walls
–	249765.737	Roof
–	31817.597	Ground
–	8733.157	Glass conduction
–	14039.508	Glass radiation
16582.5	22612.5	People
—	4647.356	Lighting
73.22	99.965	Ventilation
—	3226.25	Equipment
16655.720	355409.070	*Q* Total (*Watt*)

4.14. Determining Air Feeding Specifications:

Intended by air ventilation air passing through the cooling and abroad file across a Hungarian fan nutrition and is distributed to the rooms according to the requirements of the air. The calculation of the amount of air provided depending on the heat load significantly and are determining the degree of air feeding temperature (Ts) and guidance (ASHRAE) so that can be the difference between the degree of air feeding temperature (Ts) and the temperature of the air conditioner (air space) (Tr) in the long (8-12℃) average and take in this situation any consideration 10℃ teams

$$T = Tr - Ts = 10^{O} C$$

$$= 24 - Ts = 10$$

$$\therefore Ts = 14^{o} C$$

3.14.1. Determine Outdoor Air Specifications:

Intended to air the reflux of air drawn from the space through customized by dragging fans and which is mixed later with the outside air in the mixing chamber clouds slots (Blending) note that part of the air reflux is eliminated and often is used in mixing inside the compartment blending to be with the air outside of what is known as the air the new .

4.14.2. Determine the Percentage of Blending (N):

Calculated as the blending ratio of the following relationship

$$N = \frac{\dot{m}_{out}}{\dot{m}_{r}} \qquad \rightarrow (4.19)$$

4.14.3. Determine the Point (m) on the Psychometric Chart:

Determine the mixing point (m) on the psychometric chart according to the following steps:

1. Determine the status of the outside air (*O*) at the intersection of the external design conditions (*RH, Tdb*) determine the internal state of the air *(R)* at the intersection of interior design conditions (*RH, T ωb)*.

2. Connect the two points *(R, O)* and then determine the intermediate case (*m)* which lies on the line connecting

3. between the two cases (*R, O)*

4. determine the value of (h_m) of the blending ratio equation described below

$$\frac{\dot{m}_o}{\dot{m}_R} = \frac{h_m - h_R}{h_o - h_m} \quad \rightarrow (4.20)$$

3.14.4. Determine the Feeding Point on Psychometric:

Air Feeding:

It is an air passing through the cooling and abroad file across duct fan nutrition and is distributed to the rooms according to the requirements of the air.

To determine the feeding point on psychometric i follow these steps:

1. Calculate the sensible heat of the room coefficient selecting sensible and latent heat and faculty of the building.

And it gives the equation below:

$$RSHF = \frac{Q_S}{Q_S + Q_L} \quad \rightarrow (4.21)$$

2. Then convey RSHF with the design point (*RH* = 50%, *Tdb* = 24 °C) and then draws a parallel line with the point (*R)* until the cut line feed temperature (*Ts*) and then is determined by a point (*S)*.

$$\text{RSHF} = \frac{355409.070}{355409.070 + 16655.720} = 0.955$$

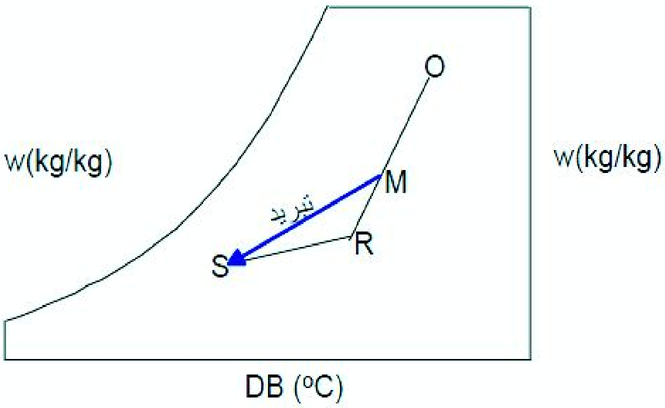


Figure (4.3) Illustrates Psychometric Chart

Extension of (3.14) We Find the Following Values:

$h_R = 48 \quad kJ\, kg$

h_o=80 $kJ\, kg$

$h_s = 35.5 \quad (kJ\, kg)$

$Q_T = \dot{m}_S (h_R - h_S)$ → (4.22)

$$\dot{m}s = \frac{(355409.070 + 16655.720) * 10^{-3}}{48 - 35.5} = 29.765kg/s$$

$\dot{m}_o = \dot{m}v = 5.526kg/s$

$\dot{m}_R = \dot{m}_S - \dot{m}_O$ → (3.23)

=29.765 – 5.526= 24.239 (kg/sec)

Make up for the values in the equation below:

$$\frac{\dot{m}_O}{\dot{m}_R} = \frac{h_m - h_R}{h_O - h_m}$$ → (4.24)

$$\frac{5.526}{24.239} = \frac{h_m - 48}{80 - h_m}$$

$h\text{m} = 53.94\ kJ/kgk$

Where:

ho ≡ enthalpy quality of outside air . (kJ / kg)

h_N ≡ enthalpy quality of air mixture.(kJ / kg)

h_m ≡ enthalpy quality of air reflux. (kJ /kg)

h_s≡ enthalpy air quality nutrition. (kJ/ kg)

4 .15. Cooling Coil Load Capacity:

To find the cooling capacity of the file we use the equation below:

$$C.C.C = m_s^{\bullet}(h_m - h_s) \rightarrow (4.25)$$

$\boldsymbol{C.C.C} = 29.765(53.94 - 35.5) = 548.867\ kw$

1Kw = 3.5 TR

CHAPTER FIVE

Conclusions And Recommendations

5.1. Conclusion:

This research identified the different types of cooling systems , using the manual method to calculate each of the maximum cooling load, which was valued (372.063 kW) and cooling coil capacity (548 kW) as well as to calculate the cooling load by using the computer (Hourly Analysis Program) which is the valued (483 kW.

5.2. Recommendation

Due to the large size of the project and it contains many topics we recommend the following:

1. We recommend that this research is to be put in focus of attention of the implementation and to see the light on the reality.
2. Conduct design calculations for the air supply duct
3. Having identified the cooling load and ventilation rates for the buildings to be conditioned we recommend for choosing air conditioning equipment that will be used.
4. We recommend for making a detailed comparison between the method of manual calculations (mathematical equations) and HAP program in terms of calculating the thermal loads of external temperature dry and wet, and the number of people in the rooms and activity and the value of the expected leakage, lighting and shading windows and other loads.

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