**A PROJECT REPORT**

**ON**

# "DESIGN OF VRF SYSTEM"

Submitted by

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*In partial fulfillment for the award of the Degree*

*Of*

**BACHELOR OF ENGINEERING**

**IN**

**MECHANICAL ENGINEERING**

**UNDER THE GUIDANCE**

**Of**

**Prof. RAHUL THAVAI**

***DEPARTMENT OF MECHANICAL ENGINEERING***

ANJUMAN-I-ISLAKALSEKAR TECHNICAL CAMPUS NEW PANVEL,

NAVI MUMBAI – 410206

UNIVERSITY OF MUMBAI

**ACADEMIC YEAR 2019-2020**

A PROJECT
REPORT ON

**"DESIGN OF VARIABLE REFRIGERANT FLOW (VRF) SYSTEM"**

Submitted to

**UNIVERSITY OF MUMBAI**

In Partial fulfillment of the Requirement for the Award of

Bachelor's degree in Mechanical
Engineering By


| | |
|---|---|
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guidance of

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**ANJUMAN-I-ISLAM'S KALSEKAR TECHNICAL CAMPUS, NEW PANVEL**


2019-2020

Affiliated to

**UNIVERSITY OF MUMBAI**

ANJUMAN-I-ISLAM

KALSEKAR TECHNICAL CAMPUS NEW PANVEL

**(Approved by AICTE, recg. By Maharashtra Govt. DTE,**

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# CERTIFICATE

This is to certify that the project entitled

**"DESIGN OF VRF SYSTEM"**

Submitted by

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To the Kalsekar Technical Campus, New Panvel is a record of bonafide work carried out by him under our supervision and guidance, for partial fulfillment of the requirements for the award of the Degree of Bachelor of Engineering in Mechanical Engineering as prescribed by **University Of Mumbai**, is approved.

**Internal Examiner** (Prof.______)

**External Examiner** (Prof.______)

**Head of Department** (Prof. ______)

**Principal** (Dr._______)

ANJUMAN-I-ISLAM

KALSEKAR TECHNICAL CAMPUS NEW PANVEL

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## APPROVAL OF DISSERTATION

This is to certify that the thesis entitled

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Submitted by

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In partial fulfillment of the requirements for the award of the Degree of Bachelor of Engineering in Mechanical Engineering, as prescribed by University of Mumbai approved.

**(Internal Examiner)** **(External Examiner)**

___________________ ___________________

Date: ___________

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ANSARI MOHD UZER

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# Project I Approval for Bachelor of Engineering

This Project entitled *"**DESIGN OF VRF SYSTEM**"* by ***Ansari Mohd Uzer, Ansari Mohd Danish, Niwshekar Ayman, Pagarkar Junaid*** is approved for the degree of ***Bachelor of Engineering in Department of Mechanical Engineering.***

**Examiners:**

**1)** ______________________

**2)** ______________________

**Supervisors:**

**1)** ______________________

**2)** ______________________

**Chairman:**

______________________

**Declaration**

We declare that this written submission represents our ideas in our own words and where others ideas or words have been included, we have adequately cited and referenced the original sources. We also declare that we have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or violation falsified any idea/data/fact/source in my submission. We understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

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## ABSTRACT:

Air conditioning demand is rapidly increasing in many parts of the world especially in moderate climate. Air conditioners and refrigerators are the only equipment consumes more electricity say 70 percent house hold articles this result in drastic electricity demands on hot summer days which causes unwanted increase in the use of fossil fuel and nuclear energy which leads to global warming and air pollution. The VRF system uses R410A as refrigerant because it contains only Fluorine hence it has very low global warming potential. VRF systems are enhanced versions of ductless multi-split systems, permitting more indoor units to be connected to each outdoor unit and providing additional features such as simultaneous heating and cooling and heat recovery. VRF technology uses smart integrated controls, variable speed drives, refrigerant piping, and heat recovery to provide products with attributes that include high energy efficiency, flexible operation, ease of installation, low noise, zone control, and comfort using all-electric technology. VRF systems are very popular in Asia.

This thesis presents design of Variable Refrigerant Flow (VRF) system for an office building in Vashi, Navi Mumbai. The VRF system was selected as the space saving was priority of the client. The system is designed using ISHRAE hand book and Toshiba manual. The heat load was calculated considering various factors such as outdoor condition, heat gain through glass, transmission gain through wall etc. As per the heat load calculated proper selection of outdoor unit and indoor unit was done using Toshiba manual. The schematic of pipe and indoor is displayed considering cost effectiveness. The obtained results were validated by the industry.

## Keywords:

R410A, ISHRAE, outdoor unit, indoor unit, cassette, British Thermal Unit, compressor

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# CHAPTER 1

## 1. INTRODUCTION

### 1.1 Background:

Variable refrigerant flow (VRF), also known as variable refrigerant volume (VRV), is an HVAC technology invented by Daikin Industries, Ltd. in 1982. Like ductless mini splits, VRFs use refrigerant as the cooling and heating medium.

Variable refrigerant flow (VRF) systems vary the flow of refrigerant to indoor units based on demand. This ability to control the amount of refrigerant that is provided to fan coil units located throughout a building makes the VRF technology ideal for applications with varying loads or where zoning is required.

VRF systems are available either as heat pump systems or as heat recovery systems for those applications where simultaneous heating and cooling is required. In addition to providing superior comfort, VRF systems offer design flexibility, energy savings, and cost-effective installation

### 1.2 VRF Technology:

In a VRF system, multiple indoor fan coil units may be connected to one outdoor unit. The outdoor unit has one or more compressors that are inverter driven, so their speed can be varied by changing the frequency of the power supply to the compressor. As the compressor speed changes, so does the amount of refrigerant deliver by the compressor.

Variable Refrigerant Flow (VRF) system is an air conditioning system which uses refrigerant as a medium to provide zonal cooling and heating. It varies the flow of refrigerant to each room as per the required condition. the compressor used is driven by inverter so that by changing the speed of compressor the flow of refrigerant can be varied hence, the variable flow system. This ability to control the flow of refrigerant makes the VRF system ideal for applications with varying load or where zonal heating and cooling is desired. VRF systems provide design flexibility, energy savings, and cost-effective installation along with superior comfort.

Each indoor fan coil unit has its own metering device that is controlled by the indoor unit itself, or by the outdoor unit. As each indoor unit sends a demand to the outdoor unit, the outdoor unit delivers the amount of refrigerant needed to meet the individual requirements of each indoor unit.

These features make the VRF system ideally suited for all applications that have part load requirements based on usage or building orientation, as well as applications that require zoning

### 1.3 Problem Definition:

The traditional air conditioning system used takes up a lot of space and maintenance cost is quite high. moreover, they use of ducts which introduce cooling and heating losses. besides the control over the flow of refrigerant or coolant is not possible as the pump speed cannot be varied. They also have high operation cost.in order to solve these problems we have implemented VRF system considering the required cooling load.

## 1.4 Project Aim & Objectives:

### 1.4.1 Aim:

- The main aim is to design and install a Variable refrigerant flow (VRF) system in MTNL building.
- To provide heating ventilation and cooling by providing system which is environmentally friendly.
- To provide cooling and ventilation in economic cost
- To provide consistent comfort to occupants
- To ensure the quite operation of the system
- To design the system such that it provides zonal heating and cooling

1.4.2 Objectives:

- To design energy efficient system
- To provide heating ventilation and cooling by providing system which is environmentally friendly.
- To provide cooling and ventilation in economic cost.
- To provide consistent comfort to occupants.
- To ensure the quite operation of the system.
- To design the system such that it provides zonal heating and cooling

**CHAPTER 2**

# 2. LITERATURE SURVEY

## 2.1 Variable Refrigerant Flow Systems (GSA journal)

Brian Thornton and Anne Wagner published a journal for the General Service Administration of the USA. This journal gives guidelines for application of VRF system. According to it VRF systems can achieve 30% and higher HVAC energy cost savings relative to minimally code conventional compliant systems, or older inefficient systems. Buildings switching from gas heat to VRF systems offer large energy savings, but because of the price differential between electricity and gas, the utility bill savings will be greater when switching to VRF systems. The best opportunities for VRF systems include buildings with these target characteristics like inefficient HVAC systems and high energy costs , lack of cooling or inadequate cooling capacity, although adding cooling capability or capacity may increase total energy usage despite possible reductions in fan and heating energy usage, new building projects that can take advantage of opportunities to reduce floor-to-floor height, or increase usable floor space by removing mechanical equipment from inside the main building areas, VAV systems with electric reheat or heat pumps with electric back-up heat. Up to a 70% reduction in HVAC energy is possible from a VRF system with exhaust air heat recovery when compared to a VAV system with electric reheat, according to an energy modeling study (Hart and Campbell 2011), significant heating requirements – the Midwest and Northeast are good places to look for opportunities in this regard.

## 2.2 Installation guide VRF system

It is a manual published by Ingrensoll Rand. It gives step by step guide lines for installation of VRF system. Various safety precaution is explained. Guidelines for proper selection of tools and pipe dimeters is given. It explains orientation of outdoor unit and safety measures while transporting it as per the required tonnage. Various test that need nbe carried out after installation are explained unit.

## 2.3 Comparative Thermodynamic and economic analysis of conventional HVAC and VRF system

Emrah` zahi, Aseguil Abusoglu,A. ihsan Kutlar,Oguzhan Dagci carried out an experiment where they did thermodynamic and economic analyses of an existing social and cultural building which has a heating and cooling area of 8852 $m^2$ by comparing of a conventional HVAC and a VRF system. A novel contribution is given to the open literature by comparing two systems with actual data measured from the existing system. This study contains insulation, heating and cooling accounts of a building together. In this paper, VRF system is modelled to the existing building for the comparison of the conventional HVAC system. Both systems have been compared in terms of heating and cooling capacity, initial, operation and maintenance costs. It is found that the VRF system is more economic and efficient such that the VRF system is found to have 44% cost profit when compared with the conventional HVAC system.

## 2.4 A review of HVAC with VRF system

Kartik Patel did a research on VRF system and its energy saving potential in India. According to the study VRF technology is relatively new in India and gained the momentum after 2007. So, this is been relatively new and efficient way to design HVAC system with VRF technology. VRF technology uses smart integrated controls, variable speed drives, refrigerant piping, and heat recovery to provide products with attributes that include high energy efficiency, flexible operation, ease of installation, low noise, zone control, and comfort using all-electric technology. Still efficiency and energy saving depend on many variables which controls heat load of the building. So, energy saving from VRF technology may vary from 10% to 40%

## 2.5 Design of HVAC with VRF system for a space house in Ahmedabad

Kartik M Patel a PG student designed VRF system for a space house. Various heat load gain, energy efficiency ratio (EER) was calculated. The cost of the project was estimated. Design has been done using ISHRAE standards.

## 2.6 Developed a new VRF simulation module based on physics in Energy Plus version

With their comparison between measured and simulated results, normalized mean bias errors (NMBEs) were 2.8% and 4.5% for cooling and heating operations. Saving potential of VRV air conditioners could be high as 18 % compared to the energy consumed by split air-conditioning systems when used for appropriate applications. Therefore, the VRV system can be considered as a potential candidate for the installations where the building occupancy and cooling load are regularly varying. Further, Chiller (Central) air-conditioning system can also be considered as a potential candidate as it performs almost efficiently as the VRV system. It consumes around 4 % more energy than VRV system.

The major objective of the research study was to analyses the suitability of VRV air- conditioning system, analyses the actual saving potential and cost effectiveness of VRV air- conditioning system compared to the other available types of air-conditioning systems and access the maintainability of VRV air-conditioning system. (UNIVERSITY OF MORATUWA)

# CHAPTER 3

## 3. TOTAL COSTING

| | | | | | | |
|---|---|---|---|---|---|---|
| | **Cost of AIR CONDITIONING** | | | | | |
| **1** | Supplying, Installing, Testing & commissioning of outdoor type of following capacity air cooled 100% inverter compressor based VRV/VRF system using R410A/R407 refrigerant, i/c first fill of refrigerant. The system shall be suitable to operate on 3 phase, 415 V 50 HZ AC power supply and shall comprise of DC Twin Rotary/Scroll compressor, air cooled condensers and its fan with motor, micro-processors controls, control panels, suitable starters, along with internal control and power wiring internal interconnecting refrigerant pipes, charging ports, system single enclosure (the electrical and electronic components assemblies shall be protected with IP - 55 enclosures). Unit shall be complete with suitable safety steel structure COP levels not less than 5.25 at 50% capacities. | | | | | |
| **a)** | VRF Outdoor Units (28 HP) combination of 14.0 HP X 2Nos | 6 | Each | 577318 | Each | 3463908.00 |
| **2** | SITC of Cassette VRF type four directional air flow DX split indoor air conditioning units of the following capacity for mounting inside false ceiling, each comprising of cooling coil, blower with multispeed motor, electronic expansion value ,supply and return air grill, filter, insulted connection of refrigerant circuit, intake airport for fresher air entry, condensate water drain | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | pump with electronic level sensor complete, suitable to operate from central remote control & installation from ceiling with all required supports, anchor fasteners hardware's, interconnecting refrigerant copper piping, valves, supports etc. including termination at nearest power outlet with copper wire of 3C x 2.5 sq.mm in metallic flexible conduit and interlocking with outdoor units including remote controller. Units shall confirm to the detailed specification of the tender document. | | | | | |
| **a)** | 1.6 TR | 2 | Each | 47117 | Each | 94234.00 |
| **b)** | 2.5 TR | 24 | Each | 52696 | Each | 1264704.00 |
| **c)** | 3.0 TR | 31 | Each | 59516 | Each | 1844996.00 |
| **3** | Supplying & fixing Interconnecting refrigerant copper piping work with supplying and fixing (19 mm thick) closed cell elastomeric nitrile rubber tubular insulation between each set of indoor & outdoor units as per specifications, all piping inside the building shall be properly supported with MS hanger etc. complete as required. The piping shall be laid in masonry shafts, wall, roof/ ceiling, partly in existing pipe well supported at specific intervals with wooden patterns and screwed with anchor fasteners. (The insulation shall be 19 mm thick of NITRILE RUBBER). | | | | | |
| **a)** | 47.625mm OD or 1 7/8" dia | 130 | Meter | 1677 | Meter | 218010.00 |
| **b)** | 41.275mm OD or 1 5/8" dia | 130 | Meter | 1410 | Meter | 183300.00 |

| | | | | | | |
|---|---|---|---|---|---|---|
| **c)** | 34.925mm OD or 1 3/8" dia | 60 | Meter | 1286 | Meter | 77160.00 |
| **d)** | 28.575 mm OD or 1 1/8" dia | 75 | Meter | 1019 | Meter | 76425.00 |
| **e)** | 25.4 mm OD or 1" dia | 135 | Meter | 966 | Meter | 130410.00 |
| **f)** | 22.225 mm OD or 7/8" dia | 150 | Meter | 841 | Meter | 126150.00 |
| **g)** | 19.05 mm OD or 3/4" dia | 95 | Meter | 705 | Meter | 66975.00 |
| **h)** | 15.875 mm OD or 5/8" dia | 150 | Meter | 580 | Meter | 87000.00 |
| **I)** | 12.7 mm OD or 1/2" dia | 130 | Meter | 501 | Meter | 65130.00 |
| **j)** | 9.525 mm OD or 3/8" dia | 150 | Meter | 399 | Meter | 59850.00 |
| **k)** | 6.35 mm OD or 1/4" dia | 130 | Meter | 260 | Meter | 33800.00 |
| **4** | SITC of insulated Copper Refrigerant Branch Kit/ **Refinet Joint** for VRV piping complete as required. The insulation shall be 19 mm thick of NITRILE RUBER. | 57 | Each | 3864 | Each | 220248.00 |
| **5** | Supplying, installation, testing and commissioning of heavy gauge UPVC drain Piping for the VRV system fully insulated with 6mm thick NITRILE RUBBER insulation with adequate supports as per specification and instructions of Engineer in charge etc. as required. | | | | | |
| **a)** | 25 mm dia. | 90 | Meter | 144 | Meter | 12960.00 |

| | | | | | | |
|---|---|---|---|---|---|---|
| **b)** | 32 mm dia. | 290 | Meter | 177 | Meter | 51330.00 |
| **c)** | 40mm dia. | 90 | Meter | 202 | Meter | 18180.00 |
| **d)** | 50mm dia. | 70 | Meter | 255 | Meter | 17850.00 |
| **6** | Supplying, laying and fixing control cum transmission cable between indoor and outdoor units of size **2 core x 2.5 sq.mm** XLPE/PVC insulated copper conductor in PVC conduit including accessories like cable glands & Lugs etc. as required. | 800 | Meter | 132 | Meter | 105600.00 |
| **7** | Supplying Fabrication of **MS frame structure** suitable for mounting outdoor VRF unit mesh out of suitable thickness and section i/c cutting, welding and panting with 2 coats of synthetic enamel paint after primer, fixing on wall with anchor fastener etc. complete as required. | 1250 | Meter | Kg. | Meter | 190000.00 |
| | TOTAL COST | | | | | **8408220.00** |

*Table 1. Total Cost of Project*

# CHAPTER 4

## 4. METHODOLOGY:

### 4.1. Steps of Methodology

**The following are steps followed by industries for designing VRF system**

- **Site visit of engineer:** the site engineer visits the site and analyze the site and gets the architectural layout.
- **Area measurement:** This involves calculation of area which requires cooling.
- **Heat and cooling load Calculation**: Heating and cooling load are calculated considering outdoor condition, heat gain through wall, ceiling, roof etc. Heat load calculation is a fundamental skill for HVAC designers and consultants. Consider that space cooling is among the highest energy expenses in buildings, especially during the summer. However, to properly size a space cooling system, first we must know the amount of heat that must be removed - this is precisely the purpose of heat load calculation. Heat in buildings can come from internal sources such as electrical appliances, or from external sources such as the sun, heat gain through wall, ceiling, roof. A heat load calculation considers all sources present and determines their total effect.
- **Selection of indoor & outdoor unit, line of piping:** Based on the heat load calculated selection of indoor and outdoor unit is done. As per the selected outdoor and indoor units pipe dimensions for main line and branches is done using Toshiba manual.
- **Layouts & drafting:** The layout of line of piping from outdoor to indoor is created using drafting software like Auto CAD. the layout drawing is a running record of ideas and problems posed as the design evolves. In most cases the layout drawing ultimately

becomes the primary source of information from which detail drawings and assembly drawings are prepared by other draftsman under the guidance of the designer.

- **Purchasing and BOQ:** Purchasing is a business or organization attempting to acquire goods or services to accomplish its goals. Although there are several organizations that attempt to set standards in the purchasing process, processes can vary greatly between organizations. The purchasing department purchase the materials required like steel sheets for ducts, cooper pipes.

- **Material procurement:** Procurement is a term describing the purchasing process for goods and services. In material procurement is the process by which the materials required are selected, ordered, invoiced, paid for and delivered to the site. procurement typically includes expediting, supplier quality, and transportation and logistics

- **Segregation:** it involves systematic sorting of material and storing it using various work place organization technique to save space and time.

supporting is structure used to hang the indoor cassette and branch controller and other components

- **Drain line/Condensate line:** The condensate line is one of the most important components of your HVAC system. Your condensate line, also known as a condensate drain line or condensate drain does several jobs, but none are more critical to the functionality of your appliance than draining excess moisture outside of your home. It is of particular importance during periods of heavy heating or cooling.

As air is heated or cooled inside your HVAC system, humidity is released. This humidity eventually turns into condensation which must have somewhere to go. Enter: the condensate line. Your condensate line is essentially a drain line. It's typically made out of plastic (commonly PVC) or sometimes metal, although plastic is preferable. It connects directly to the HVAC unit then leads outdoors, often through an exterior wall. Its job is to efficiently funnel condensation away from your HVAC unit; sometimes a small pump is attached to the HVAC system to expedite the process, but most condensate lines utilize gravity

- **Machine hanging & copper piping:** supporting is structure used to hang the indoor cassette and branch header and other machine components. Two cooper pipelines are used one is gas line and other is liquid line, which is connected between outdoor and indoor units. The pipes have varying cross-section which is gradually decreasing from outdoor unit to indoor unit
- **Wiring:**

- **Leak detection:** Due to refrigerant leakage, the running time of the system increases continuously. Both suction as well as discharge pressures reduce due to loss of refrigerant. There will be less liquid and more flash gas, which has negative effect on several components of the system.

  Following are different method of refrigerant leakage detection:

  Visual Inspection, Soap Water Detection, Water Immersion Method, Halide Torch, Dye Interception Method, Electronic Leak Detection, Ultrasonic Leak Detection, Fluorescent Leak Detection, Nitrogen Water Detection, Gas Pressure Detection

- **Insulation:** After determining that there are no leaks in the refrigerant pipes are insulated. Insulation is done around the entire surface of each pipe, including the refrigerant pipes from the indoor unit to the service valves inside the outdoor unit, the branch joints, distribution header, and connection points on each pipe.

- **Vacuum:** In a refrigerant system, only the refrigerant and oil should be circulating. During servicing or after many years of operation, the air may enter the system. The air from the atmosphere that enters the system include oxygen, nitrogen and moisture. These unwanted components will cause Rise in head pressure, Acids are produced in the refrigerant causing electroplating and damage to the motor insulation, Sludge is formed by a combination of oil, acid and moisture in the system

In order to remove all the unwanted moisture and gases from the refrigerant system, a state of near vacuum has to be achieved in which the pressure in the system is forced to go below the atmospheric pressure Commissioning & Testing

- **Commissioning and testing:** The commissioning process of any installation is critical as it provides official certification and confirmation that a piece of equipment is performing as it should. For our VRF systems, the commissioning process begins with a pressure test using nitrogen to find leaks, testing the system at a certain level. It is kept in this condition for a minimum of 24 hours to ensure it can maintain the same pressure level before the nitrogen is allowed to die out. This first section consists of three elements – a leak test, a pressure test and a strength test.
- **Payment by customer.**
- **Hand over to customer.**

# CHAPTER 5

## 5. Theory of VRF System

### 5.1 Introduction of Air-conditioning System

Air conditioning (often referred to as AC. A/C, or air con) is the process of removing heat and moisture from the interior of an occupied space, to improve the comfort of occupants. Air conditioning can be used in both domestic and commercial environments. This process is most commonly used to achieve a more comfortable interior environment. typically for humans and other animals; however, air conditioning is also used to cool/dehumidify rooms filled with heat-producing electronic devices, such as computer servers, power amplifiers, and even to display and store some delicate products, such as artwork

Air conditioners often use a fan to distribute the conditioned air to an occupied space such as a building or a car to improve thermal comfort and indoor air quality.

Electric refrigerant-based AC units range from small units that can cool a small bed- room, which can be carried by a single adult, to massive units installed on the roof of office towers that can cool an entire building. The cooling is typically achieved through a refrigeration cycle, but sometimes evaporation or free cooling is used. Air conditioning systems can also be made based on desiccants (chemicals which re move moisture from the air). Some AC systems reject or store heat in subterranean pipes.

In the most general sense, air conditioning can refer to any form of technology that modifies the condition of air (heating, (de-) humidification, cooling, cleaning, ventilation, or air movement). In common usage, though. "air conditioning" refers to systems which cool air. In construction, a complete system of heating, ventilation, and air conditioning is referred to as HVAC.

## 5.2 what is VRF system

Variable Refrigerant Flow (VRF) system is an air conditioning system which uses refrigerant as a medium to provide zonal cooling and heating. It varies the flow of refrigerant to each room as per the required condition. the compressor used is driven by inverter so that by changing the speed of compressor the flow of refrigerant can be varied hence, the variable flow system. This ability to control the flow of refrigerant makes the VRF system ideal for applications with varying load or where zonal heating and cooling is desired. VRF systems provide design flexibility, energy savings, and cost-effective installation along with superior comfort.

## 5.3 Types of VRF system

### 5.3.1. Heat Pumps system – 2 pipes

VRF heat pump systems commonly known as 2 pipes, permit heating or cooling in all of the indoor units but NOT simultaneous heating and cooling. When the indoor units are in the cooling mode, they act as evaporators; when they are in the heating mode, they act as condensers.

*Figure 5-1. Cooling from Outdoor Unit to Different Section*

VRF heat pump systems are effectively applied in open plan areas, retail stores, cellular offices and any other area that require cooling or heating during the same operational periods.

### 5.3.2. Heat Recovery System- 3 pipe

Variable refrigerant flow systems with heat recovery (VRF-HR) capability can operate simultaneously in heating and/or cooling mode, enabling heat to be used rather than rejected as it would be in traditional heat pump systems. Each indoor unit is branched off from the 3 pipes using solenoid box which contains a series of valves. An indoor unit requiring cooling will open its liquid line and suction line valves and act as an evaporator. An indoor unit requiring heating will open its hot gas and liquid line valves and will act as a condenser. Typically, extra heat exchangers in distribution boxes are used to transfer some reject heat from the superheated refrigerant exiting the zone being cooled to the refrigerant that is going to the zone to be heated. This balancing act has the potential to produce significant energy savings. Three pipe heat pump systems are effectively applied in open plan areas, retail stores, cellular offices and any other area that require cooling and heating at the same time.

*Figure 5-2. Heating and Cooling at Different Section from Outdoor Unit*

## 5.3.3. VRF Water Cooled

Most commonly used are air-cooled systems, using packaged outdoor condensing units, which via refrigeration pipework connect to a number of indoor units. There are however some limitations, pipework runs, mainly vertical risers (although Samsung can have a vertical rise up to 115mtere), plant space and noise. Where these become an issue then water-cooled systems can be used. They operate as the Air-cooled units, but instead of having a built-in air-cooled heat exchanger they utilise and plate heat exchanger, which transfers the energy into a water loop.

*Figure 5-3.VRF Water Cooling*

This is connected to a cooling tower or dry cooler which transfers the energy/ heat to atmosphere. Due to this process the water cooled VRF systems can be placed internally with no worry about the vertical risers, in much smaller areas, taking up less space and can be attenuated to meet most environmental requirements. These systems are also ideal for building served by an existing landlords condenser water loop

## 5.4 Components of VRF system

### 5.4.1 Outdoor unit:

In a VRF system, multiple indoor fan coil units may be connected to one outdoor unit. The outdoor unit has one or more compressors that are inverter driven, so their speed can be varied by changing the frequency of the power supply to the compressor. As the compressor speed changes, so does the amount of refrigerant deliver by the compressor.

**Types of outdoor unit:**

- Top Discharge ODU.
- Side Discharge ODU.
- Higher Efficiency ODU.
- Medium Normal Range ODU.


*Figure 5-4.Outdoor Unit*

## 5.4.2. Indoor unit

The indoor unit of the split air conditioner is a box type housing in which all the important parts of the air conditioner are enclosed. The most common type of the indoor unit is the wall mounted type though other types like ceiling mounted and floor mounted are also used. An indoor unit containing the evaporator coil and blower. Split-system central air conditioning is most popular type of residential heating and air-conditioning. The indoor unit is often connected to a furnace or heat pump.

*Figure 5-5.Indoor Unit*

**Types of indoor units**

1. **4-way cassette type** - Extremely quite operation By employing a super-high-stream turbo fan (three- dimensional twisted wing large bore and high efficiency), the wind flow of efficiency has been improved with the under damping slit mounted near the center of the revolving shaft, the abnormal noise which is unique to DC motors caused by the number of magnetic poles and revolution speed of the motor, is reduced, With broad range of air supply, is suitable to be used

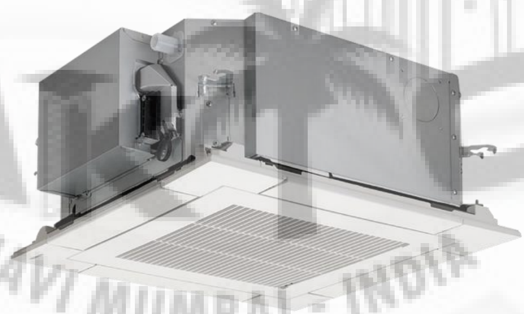

*Figure 5-6. 4-way cassette*

2. **Compact 4-way cassette type** - Installing the Mini 4 Way Cassette is easy. This compact air conditioning unit can fit into one standard ceiling tile measuring 600 W x 600 D, meaning that alterations are unnecessary. With no extra construction work to carry out, set-up time is reduced, as is the subsequent financial impact on businesses.

*Figure 5-7.Compact 4-way cassette*

3. **2-way cassette type**- The two-way cassette discharges in two directions. The two way is ceiling mounted and includes its own filter system. The ceiling-cassette indoor units in these duct-free split heat-pump systems provide comfort in large, open spaces. One-way air-flow ceiling-cassette indoor units.

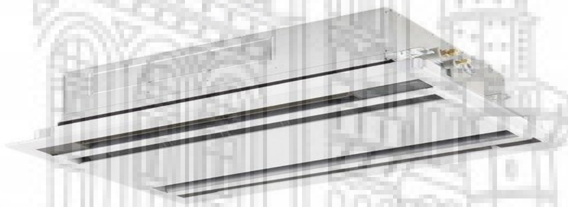

*Figure 5-8. 2-way cassette*

4. **1-way cassette type**- At a height of only 135mm, the Slim 1Way Cassette is the world's thinnest indoor air-cooling unit. The compact, lightweight design makes installation and maintenance in your space easier than ever. These high-performing units are so subtle that they can easily blend into interiors of all types and styles.

*Figure 5-9. 1-way cassette*

5. **Concealed duct ,** standard type- T*ype* and size of outdoor units and indoor units, and input air flow and external static pressure (ESP) for *ducted* indoor ... Heating and Cooling Equipment *Standard* for Safety and bear the ... Ceiling-*Concealed Ducted* units are designed for air volume against ... Cooling range can be extended from 5°F down to -4°F

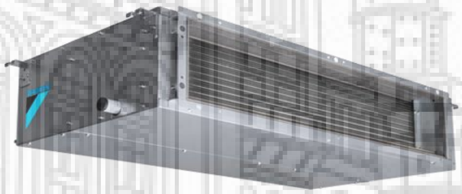

*Figure 5-10. Concealed Duct Type*

5.4.3 Raffinates (Y-joint):

Raffinates is usually called as Y-joint. Which is used to branching the pipes from outdoor unit to indoor unit. It is made up of copper with insulation cover which may protect the leakage of refringent. It is available in many sizes as per the requirement.

This joint is mainly placed between the indoor AC units & branch to the others. It is always placed parallel to the surface in order to prevent pressure loss.

*Figure 5-11. Raffinates (Y-joints)*

5.4.4 Copper Pipes:

Copper tubing is most often used for the supply of hot and cold tap water, and as a refrigerant line in HVAC systems. There are two basic types of copper tubing, soft copper and hard copper. Copper tubing is joined using flare connection, compression connection, or solder.

1. Soft Drawn Copper Tubes Coils, Pipes:
   Soft drawn, annealed, bending type copper tubes, coils, pipe for various gauge, length, size, surface finish with high quality. Suitable for VRF, VRV, Air-conditioner, Chiller applications.

*Figure 5-12. Soft Drawn copper pipe*

2. Hard Drawn Copper Pipes:

These type of copper tubes are rigid, hard and stiff. It is not easy to bent and should not be bent. There are three standard weight with different wall thickness for each type. Type K has the thickest wall tubing followed by Type L and Type M.
Type L outer diameters typically starts from 3/8 inch followed by 1/2-inch, 5/8-inch, 3/4-inch, 7/8-inch, 11/8-inch, 13/8-inch, 15/8-inch, 21/8 inch and 25/8 inch.

*Figure 5-13. Hard Drawn Copper Pipes*

5.4.5 Insulation:

Insulation is to prevent heat transfer between refrigerant and surrounding air. Under cooling mode of VRF system, the optimum insulation thickness varies between 7 and 8 mm for pipe sections of low-pressure gas pipeline and low-pressure liquid pipeline.

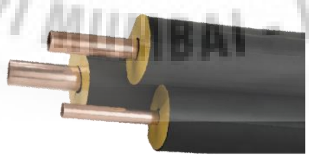

*Figure 5-14.Insulation*

# CHAPTER 6

## 6. HEAT LOAD CALCULATION

### 6.1 Method of heat load estimation

- Step One

Calculate the area in square feet of the space to be cooled,

- Step Two

Calculate CFM ventilation

CFM ventilation= (area x height x no of air change)/60

CFM person= (no person x CFM/person)

Select the higher of the two as CFM ventilation for calculation

- Step three

Find difference in DB temperature as well as GR/LB of inside and outside

By referring ISHRAE handbook and psychometric chart

- Step four

Calculate sun heat gain

Solar gain through glass (BTU) =area x temp difference x factor (BTU)

Other transmission gain (BTU) = area x temp difference x factor (BTU)

Bypass outside air sensible load (BTU) = CFM ventilation x 0.08 x 1.08 x temperature difference

get factor from ISHRAE handbook table 12

- Step five

Calculate internal sensible heat (BTU)

heat generated by occupants (BTU) = number of people x 245

Heat generated by appliances (BTU) = total equipment watts x 3.4

Heat generated by lights = (BTU) total equipment watts x 3.4

Total heat load (BTU) = solar gain through glass (BTU)+ other transmission gain (BTU)+ bypass outside air sensible load (BTU)+ internal sensible heat (BTU)

Leak loss (BTU) = 5% total heat load

Safety factor (BTU) = 5% total heat load

Total room sensible heat = Total heat load (BTU)+ Leak loss (BTU) + Safety factor (BTU)

- Step Six

Calculate outside air latent load (BTU) =CFM ventilation x G difference x bypass factor x 0.68

Internal latent heat (BTU) =no of people x factor

Get factor from ISHRAE handbook table 12

Subtotal (BTU) = outside air latent load (BTU) + Internal latent heat (BTU)

Safety factor (BTU) = 5% sub total

Total room latent heat = Subtotal (BTU) + Safety factor (BTU)

Room total heat = Total room sensible heat+ Total room latent heat

- Step seven

Outside air heat = CFM ventilation x G. Difference x (1-B.F.) x factor

Heat gain safety @ 3% = 3% Room total heat

Grand total heat (BTU) = Room total heat+ Outside air heat+ Heat gain safety @ 3%

Grand total heat (TONS) = Grand total heat (BTU)/12000

- Step eight

Sensible heat factor = Total room sensible heat/ Room total heat

Selected ADP= (ISHRAE table 15)

Dehumidified rise = (1-B.F.) (Temp difference – ADP)

Dehumidified air CFM = Total room sensible heat/ (1.08 x Dehumidified rise)

Tons as per CFM = Dehumidified air CFM/400

- Step nine

Check results

Grand total heat (BTU/HR/SQFT) = Grand total heat/area

Room sensible heat (BTU/HR/SQFT) = Room sensible heat/area

SQFT/ person = area/no of person

TONS/person = Grand total heat (TONS)/ no of person

Dehumidified CFM/ TONS = Dehumidified air CFM/ Grand total heat (TONS)

Area/TONS = area/ Grand total heat (TONS)

## 6.2 Heat load estimation

The heat load for each room on the office floor is calculated using the method as shown above an is displayed in the tables below

DESIGN CONDITION, DESIGN DETAIL:

- Design location:

– Location: Office building, sector-16, Vashi, Navi Mumbai, Maharashtra 400703.

– Latitude: 18.54º North.

- Design Data:

| SR. NO. | NAME OF ROOM | AREA (SQFT) | HEIGHT (FOOT) | LIQHTING (W/SQFT) | NO. OF AIR CHANGE | CFM/VENTILATION |
|---|---|---|---|---|---|---|
| 1. | STAFF AREA-1 | 1400 | 11 | 1.5 | 2 | 513 |
| 2. | DCIT-1 | 200 | 11 | 1.5 | 2 | 73 |
| 3. | DCIT-2 | 200 | 11 | 1.5 | 2 | 73 |
| 4. | ITO-1 | 190 | 11 | 1.5 | 2 | 70 |
| 5. | ITO-2 | 190 | 11 | 1.5 | 2 | 70 |
| 6. | ITO-3 | 190 | 11 | 1.5 | 2 | 70 |
| 7. | ITO-4 | 190 | 11 | 1.5 | 2 | 70 |
| 8. | STAFF AREA-2 | 1200 | 11 | 1.5 | 2 | 440 |
| 9. | CIT A | 270 | 11 | 1.5 | 2 | 99 |
| 10. | AO AND PS (A) | 240 | 11 | 1.5 | 2 | 88 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 11. | JCTI-1 | 290 | 11 | 1.5 | 2 | 106 |
| 12. | ADDL JCTI-1 | 270 | 11 | 1.5 | 2 | 99 |
| 13. | CIT (B) | 270 | 11 | 1.5 | 2 | 99 |
| 14. | AO AND PS (B) | 210 | 11 | 1.5 | 2 | 77 |

*Table 2. CFM/Ventilation Calculation on the Basis of Area*

Calculate CFM ventilation:

CFM Ventilation= $\frac{(\text{Area}\times\text{Height of the area}\times\text{Lighting}\times\text{No.of air change})}{60}$

Where,

CFM= Air flow in cubic feet per minute

| SR NO. | NAME OF ROOM | CFM /PERSON | NO. OF PERSON | CFM/VENTILATION |
|---|---|---|---|---|
| 1. | STAFF AREA-1 | 10 | 30 | 300 |
| 2. | DCIT-1 | 10 | 07 | 70 |
| 3. | DCIT-2 | 10 | 07 | 70 |
| 4. | ITO-1 | 10 | 06 | 60 |
| 5. | ITO-2 | 10 | 06 | 60 |
| 6. | ITO-3 | 10 | 06 | 60 |
| 7. | ITO-4 | 10 | 06 | 60 |
| 8. | STAFF AREA-2 | 10 | 30 | 300 |
| 9. | CIT A | 10 | 10 | 100 |
| 10. | AO AND PS (A) | 10 | 06 | 60 |
| 11. | JCTI-1 | 10 | 10 | 100 |
| 12. | ADDL JCTI-1 | 10 | 10 | 100 |
| 13. | CIT (B) | 10 | 10 | 100 |
| 14. | AO AND PS (B) | 10 | 02 | 20 |

*Table 3.CFM/Ventilation Calculation on the Basis of No. of Persons*

CFM Ventilation= CFM/person × No. of person

❖ Design Condition:

| PARAMETER | D.B.(F°) | W.B.(F°) | %RH | GR/LB |
|---|---|---|---|---|
| OUTSIDE | 100 | 83 | 60 | 146 |
| INSIDE | 75 | - | 50 | 64 |
| DIFFERENCE | 25 | - | - | 82 |

*Table 4.Design Condition*

## 6.2.1 STAFF AREA-1

❖ SENSIBLE HEAT GAIN:

| SOLAR GAIN- GLASS | | | | |
|---|---|---|---|---|
| DIRECTION | AREA | T.DIFF. | FACTOR | BTU |
| NORTH | 0 | 11 | 0.56 | 0 |
| SOUTH | 0 | 11 | 0.56 | 0 |
| EAST | 19 | 11 | 0.56 | 117 |
| WEST | 0 | 165 | 0.56 | 0 |
| N-E | 0 | 11 | 0.56 | 0 |
| N-W | 0 | 118 | 0.56 | 0 |
| S-E | 0 | 11 | 0.56 | 0 |
| S-W | 0 | 113 | 0.56 | 0 |

| SOLAR & TRANSMISSION GAIN -WALL | | | | |
|---|---|---|---|---|
| NORTH | 0 | 20 | 0.34 | 0 |
| SOUTH | 0 | 36 | 0.34 | 0 |
| EAST | 52 | 22 | 0.34 | 390 |
| WEST | 363 | 36 | 0.34 | 4443 |
| N-E | 0 | 17 | 0.34 | 0 |
| N-W | 0 | 13 | 0.34 | 0 |
| S-E | 0 | 25 | 0.34 | 0 |
| S-W | 0 | 21 | 0.34 | 0 |
| ROOF | 1400 | 51 | 0.15 | 0 |

| OTHER TRANSMISSION GAIN | | | | |
|---|---|---|---|---|
| AGLS | 19 | 25 | 1.13 | 537 |

| | | | | |
|---|---|---|---|---|
| PART | 1023 | 20 | 0.34 | 6956 |
| CEIL | 1400 | 20 | 0.34 | 9520 |
| FLOR | 1400 | 20 | 0.34 | 9520 |

| BYPASS O.A. SENSIBLE LOAD | | | | |
|---|---|---|---|---|
| CFM | T.DIFF. | BYPASS | FACTOR | BTU |
| 513 | 25 | 0.08 | 1.08 | 1108 |

| INTERNAL SENSIBLE LOAD | | | | |
|---|---|---|---|---|
| PEOPLE | 30 | 245 | | 7350 |
| APPL. | 5000 | 3.4 | | 17000 |
| LIGHTS | 2100 | 3.4 | 1.25 | 8925 |
| FOOD | 0 | 60 | | 0 |
| SUB TOTAL | | | | 65866 |

| | |
|---|---|
| LEAK LOSS +SAFETY FACTOR=5% | 3293 |
| ROOM SENSIBLE HEAT | 72452 |

- LATENT HEAT:

| BYPASS OUTSIDE AIR LATENT LOAD | | | | |
|---|---|---|---|---|
| CFM | G. DIFF | BYPASS | FACTOR | BTU |
| 513 | 82 | 0.08 | 0.68 | 2288 |

.

| INTERNAL LATENT LOAD | | | |
|---|---|---|---|
| PEOPLE | 30 | 205 | 6150 |

| | |
|---|---|
| SUB TOTAL | 8438 |
| SAFETY FACTOR=5% | 422 |
| ROOM LATENT HEAT | 8860 |
| ROOM TOTAL HEAT | 81312 |

- GRAND TOTAL HEAT:

| OUTSIDE AIR HEAT | | | | | |
|---|---|---|---|---|---|
| | CFM | G. DIFF | 1-B.F. | FACTOR | BTU |
| SENSIBLE | 513 | 25 | 0.92 | 1.08 | 12743 |

| | | | | | |
|---|---|---|---|---|---|
| LATENT | 513 | 82 | 0.92 | 0.68 | 26316 |
| SUB TOTAL | | | | | 39059 |
| TOTAL | | | | | 120371 |
| HEAT GAIN SAFETY FACTOR @ 3% | | | | | 3611 |
| GRAND TOTAL HEAT | | | (TONS) | 10.3 | 123982 |

| | |
|---|---|
| SENSIBLE HEAT FACTOR | 0.89 |
| SELECTED A.D.P. | 54 |
| DEHUMIDIFIED RISE | 20 |
| DEHUMIDIFIED AIR Cfm | 3354 |
| TONS AS PER Cfm | 8.38 |

| | |
|---|---|
| GRAND TOTAL HEAT (BTU/HR/SQFT.) | 92 |
| ROOM SENSIBLE HEAT (BTU/HR/SQFT.) | 51.75 |
| SQFT/PERSON | 46.67 |
| TONS PER SQFT | 0.01 |
| CFM PER SQFT | 2.39 |
| TONS/PERSON | 0.34 |
| DEHUMIDIFIED CFM/TON | 325.63 |
| AREA PER TON | 135.92 |

*Table 5.Calculation of staff Area-1*

## 6.2.2. DCIT-1

❖ SENSIBLE HEAT GAIN:

| SOLAR GAIN-GLASS | | | | |
|---|---|---|---|---|
| DIRECTION | AREA | T.DIFF. | FACTOR | BTU |
| NORTH | 0 | 11 | 0.56 | 0 |
| SOUTH | 0 | 11 | 0.56 | 0 |
| EAST | 0 | 11 | 0.56 | 0 |
| WEST | 0 | 165 | 0.56 | 0 |
| N-E | 0 | 11 | 0.56 | 0 |
| N-W | 0 | 118 | 0.56 | 0 |
| S-E | 0 | 11 | 0.56 | 0 |
| S-W | 0 | 113 | 0.56 | 0 |

| SOLAR & TRANSMISSION GAIN -WALL | | | | |
|---|---|---|---|---|
| NORTH | 0 | 20 | 0.34 | 0 |
| SOUTH | 0 | 36 | 0.34 | 0 |
| EAST | 0 | 22 | 0.34 | 0 |
| WEST | 0 | 36 | 0.34 | 0 |
| N-E | 0 | 17 | 0.34 | 0 |
| N-W | 0 | 13 | 0.34 | 0 |
| S-E | 0 | 25 | 0.34 | 0 |
| S-W | 0 | 21 | 0.34 | 0 |
| ROOF | 200 | 51 | 0.15×0 | 0 |

| OTHER TRANSMISSION GAIN | | | | |
|---|---|---|---|---|
| AGLS | 0 | 25 | 1.13 | 0 |
| PART | 176 | 20 | 0.34 | 1197 |
| CEIL | 200 | 20 | 0.34 | 1360 |
| FLOR | 200 | 20 | 0.34 | 1360 |

| BYPASS O.A. SENSIBLE LOAD | | | | |
|---|---|---|---|---|
| CFM | T.DIFF. | BYPASS | FACTOR | BTU |
| 73 | 25 | 0.08 | 1.08 | 158 |

| INTERNAL SENSIBLE LOAD | | | | |
|---|---|---|---|---|
| PEOPLE | 7 | 245 | | 1715 |
| APPL. | 250 | 3.4 | | 850 |
| LIGHTS | 300 | 3.4 | 1.25 | 1275 |
| FOOD | 0 | 60 | | 0 |
| SUB TOTAL | | | | 7915 |

| | |
|---|---|
| LEAK LOSS +SAFETY FACTOR=5% | 396 |
| ROOM SENSIBLE HEAT | 8707 |

- LATENT HEAT:

| BYPASS OUTSIDE AIR LATENT LOAD | | | | |
|---|---|---|---|---|
| CFM | G. DIFF | BYPASS | FACTOR | BTU |
| 73 | 82 | 0.08 | 0.68 | 326 |

.

| INTERNAL LATENT LOAD | | | |
|---|---|---|---|
| PEOPLE | 7 | 205 | 1435 |

| | |
|---|---|
| SUB TOTAL | 1761 |
| SAFETY FACTOR=5% | 88 |
| ROOM LATENT HEAT | 1849 |
| ROOM TOTAL HEAT | 10556 |

❖ GRAND TOTAL HEAT:

| OUTSIDE AIR HEAT | | | | | |
|---|---|---|---|---|---|
| | CFM | G. DIFF | 1-B.F. | FACTOR | BTU |
| SENSIBLE | 73 | 25 | 0.92 | 1.08 | 1813 |
| LATENT | 73 | 82 | 0.92 | 0.68 | 3745 |
| SUB TOTAL | | | | | 5558 |
| TOTAL | | | | | 16114 |
| HEAT GAIN SAFETY FACTOR @ 3% | | | | | 483 |
| GRAND TOTAL HEAT | | (TONS) | | 1.38 | 16597 |

| | |
|---|---|
| SENSIBLE HEAT FACTOR | 0.82 |
| SELECTED A.D.P. | 52 |
| DEHUMIDIFIED RISE | 20 |
| DEHUMIDIFIED AIR Cfm | 403 |
| TONS AS PER Cfm | 1.0 |

| | |
|---|---|
| GRAND TOTAL HEAT (BTU/HR/SQFT.) | 82.98 |
| ROOM SENSIBLE HEAT (BTU/HR/SQFT.) | 43.53 |
| SQFT/PERSON | 28.57 |
| TONS PER SQFT | 0.01 |
| CFM PER SQFT | 2.01 |
| TONS/PERSON | 0.19 |
| DEHUMIDIFIED CFM/TON | 292.10 |
| AREA PER TON | 144.92 |

*Table 6.Calculation of DCIT-1*

## 6.2.3. DCIT-2

❖ SENSIBLE HEAT GAIN:

| SOLAR GAIN-GLASS | | | | |
|---|---|---|---|---|
| DIRECTION | AREA | T.DIFF. | FACTOR | BTU |
| NORTH | 0 | 11 | 0.56 | 0 |
| SOUTH | 0 | 11 | 0.56 | 0 |
| EAST | 0 | 11 | 0.56 | 0 |
| WEST | 0 | 165 | 0.56 | 0 |
| N-E | 0 | 11 | 0.56 | 0 |
| N-W | 0 | 118 | 0.56 | 0 |
| S-E | 0 | 11 | 0.56 | 0 |
| S-W | 0 | 113 | 0.56 | 0 |

| SOLAR & TRANSMISSION GAIN -WALL | | | | |
|---|---|---|---|---|
| NORTH | 0 | 20 | 0.34 | 0 |
| SOUTH | 0 | 36 | 0.34 | 0 |
| EAST | 0 | 22 | 0.34 | 0 |
| WEST | 0 | 36 | 0.34 | 0 |
| N-E | 0 | 17 | 0.34 | 0 |
| N-W | 0 | 13 | 0.34 | 0 |
| S-E | 0 | 25 | 0.34 | 0 |
| S-W | 0 | 21 | 0.34 | 0 |
| ROOF | 200 | 51 | 0.15×0 | 0 |

| OTHER TRANSMISSION GAIN | | | | |
|---|---|---|---|---|
| AGLS | 0 | 25 | 1.13 | 0 |
| PART | 176 | 20 | 0.34 | 1197 |
| CEIL | 200 | 20 | 0.34 | 1360 |
| FLOR | 200 | 20 | 0.34 | 1360 |

| BYPASS O.A. SENSIBLE LOAD | | | | |
|---|---|---|---|---|
| CFM | T.DIFF. | BYPASS | FACTOR | BTU |
| 73 | 25 | 0.08 | 1.08 | 158 |

| INTERNAL SENSIBLE LOAD |
|---|

| | | | | |
|---|---|---|---|---|
| PEOPLE | 7 | 245 | | 1715 |
| APPL. | 250 | 3.4 | | 850 |
| LIGHTS | 300 | 3.4 | 1.25 | 1275 |
| FOOD | 0 | 60 | | 0 |
| SUB TOTAL | | | | 7915 |

| | |
|---|---|
| LEAK LOSS +SAFETY FACTOR=5% | 396 |
| ROOM SENSIBLE HEAT | 8707 |

❖ LATENT HEAT:

| BYPASS OUTSIDE AIR LATENT LOAD | | | | |
|---|---|---|---|---|
| CFM | G. DIFF | BYPASS | FACTOR | BTU |
| 73 | 82 | 0.08 | 0.68 | 326 |

.

| INTERNAL LATENT LOAD | | | |
|---|---|---|---|
| PEOPLE | 7 | 205 | 1435 |

| | |
|---|---|
| SUB TOTAL | 1761 |
| SAFETY FACTOR=5% | 88 |
| ROOM LATENT HEAT | 1849 |
| ROOM TOTAL HEAT | 10556 |

❖ GRAND TOTAL HEAT:

| OUTSIDE AIR HEAT | | | | | |
|---|---|---|---|---|---|
| | CFM | G. DIFF | 1-B.F. | FACTOR | BTU |
| SENSIBLE | 73 | 25 | 0.92 | 1.08 | 1813 |
| LATENT | 73 | 82 | 0.92 | 0.68 | 3745 |
| SUB TOTAL | | | | | 5558 |
| TOTAL | | | | | 16114 |
| HEAT GAIN SAFETY FACTOR @ 3% | | | | | 483 |
| GRAND TOTAL HEAT | | | (TONS) | 1.38 | 16597 |

| | |
|---|---|
| SENSIBLE HEAT FACTOR | 0.82 |
| SELECTED A.D.P. | 52 |
| DEHUMIDIFIED RISE | 20 |

| | |
|---|---|
| DEHUMIDIFIED AIR Cfm | 403 |
| TONS AS PER Cfm | 1.0 |

| | |
|---|---|
| GRAND TOTAL HEAT (BTU/HR/SQFT.) | 82.98 |
| ROOM SENSIBLE HEAT (BTU/HR/SQFT.) | 43.53 |
| SQFT/PERSON | 28.57 |
| TONS PER SQFT | 0.01 |
| CFM PER SQFT | 2.01 |
| TONS/PERSON | 0.19 |
| DEHUMIDIFIED CFM/TON | 292.10 |
| AREA PER TON | 144.92 |

*Table 7.Calculation of DCIT-2*

### 6.2.4. ITO - 1

❖ SENSIBLE HEAT GAIN:

SUN GAIN:

| SOLAR GAIN- SOLAR | | | | |
|---|---|---|---|---|
| DIRTECTION | AREA | T.DIFF. | FACTOR | BTU |
| NORTH | 44 | 11 | 0.56 | 271 |
| SOUTH | 0 | 11 | 0.56 | 0 |
| EAST | 0 | 11 | 0.56 | 0 |
| WEST | 0 | 165 | 0.56 | 0 |
| N-E | 0 | 11 | 0.56 | 0 |
| N-W | 0 | 118 | 0.56 | 0 |
| S-E | 0 | 11 | 0.56 | 0 |
| S-W | 0 | 113 | 0.56 | 0 |

| SOLAR & TRANSMISSION GAIN -WALL | | | | |
|---|---|---|---|---|
| NORTH | 78 | 20 | 0.34 | 530 |
| SOUTH | 0 | 36 | 0.34 | 0 |
| EAST | 0 | 22 | 0.34 | 0 |
| WEST | 0 | 36 | 0.34 | 0 |
| N-E | 0 | 17 | 0.34 | 0 |
| N-W | 0 | 13 | 0.34 | 0 |
| S-E | 0 | 25 | 0.34 | 0 |
| S-W | 0 | 21 | 0.34 | 0 |

| | | | | |
|---|---|---|---|---|
| ROOF | 190 | 51 | 0.15×0 | 0 |

| OTHER TRANSMISSION GAIN | | | | |
|---|---|---|---|---|
| AGLS | 44 | 25 | 1.13 | 1243 |
| PART | 369 | 20 | 0.34 | 2509 |
| CEIL | 190 | 20 | 0.34 | 1292 |
| FLOR | 190 | 20 | 0.34 | 1292 |

| BYPASS O.A. SENSIBLE LOAD | | | | |
|---|---|---|---|---|
| CFM | T.DIFF. | BYPASS | FACTOR | BTU |
| 70 | 25 | 0.08 | 1.08 | 151 |

| INTERNAL SENSIBLE LOAD | | | | |
|---|---|---|---|---|
| PEOPLE | 6 | 245 | | 1470 |
| APPL. | 250 | 3.4 | | 850 |
| LIGHTS | 285 | 3.4 | 1.25 | 1211 |
| FOOD | 0 | 60 | | 0 |
| SUB TOTAL | | | | 10819 |

| | |
|---|---|
| LEAK LOSS +SAFETY FACTOR=5% | 541 |
| ROOM SENSIBLE HEAT | 11901 |

❖ LATENT HEAT:

| BYPASS OUTSIDE AIR LATENT LOAD | | | | |
|---|---|---|---|---|
| CFM | G. DIFF | BYPASS | FACTOR | BTU |
| 70 | 82 | 0.08 | 0.68 | 312 |

.

| INTERNAL LATENT LOAD | | | |
|---|---|---|---|
| PEOPLE | 6 | 205 | 1230 |

| | |
|---|---|
| SUB TOTAL | 1542 |
| SAFETY FACTOR=5% | 77 |
| ROOM LATENT HEAT | 1619 |
| ROOM TOTAL HEAT | 13520 |

❖ GRAND TOTAL HEAT:

| OUTSIDE AIR HEAT | | | | | |
|---|---|---|---|---|---|
| | CFM | G. DIFF | 1-B.F. | FACTOR | BTU |
| SENSIBLE | 70 | 25 | 0.92 | 1.08 | 1739 |
| LATENT | 70 | 82 | 0.92 | 0.68 | 3591 |
| SUB TOTAL | | | | | 5330 |
| TOTAL | | | | | 18850 |
| HEAT GAIN SAFETY FACTOR @ 3% | | | | | 566 |
| GRAND TOTAL HEAT | | (TONS) | | 1.6 | 19416 |

| | |
|---|---|
| SENSIBLE HEAT FACTOR | 0.88 |
| SELECTED A.D.P. | 52 |
| DEHUMIDIFIED RISE | 20 |
| DEHUMIDIFIED AIR Cfm | 550 |
| TONS AS PER Cfm | 1.37 |

| | |
|---|---|
| GRAND TOTAL HEAT (BTU/HR/SQFT.) | 102.18 |
| ROOM SENSIBLE HEAT (BTU/HR/SQFT.) | 62.63 |
| SQFT/PERSON | 31.67 |
| TONS PER SQFT | 0.01 |
| CFM PER SQFT | 2.89 |
| TONS/PERSON | 0.27 |
| DEHUMIDIFIED CFM/TON | 343.75 |
| AREA PER TON | 118.75 |

*Table 8.Calculation of ITO-1*

## 6.2.5. ITO- 2

❖ SENSIBLE HEAT GAIN:
SUN GAIN:

| SOLAR GAIN- GLASS | | | | |
|---|---|---|---|---|
| DIRECTION | AREA | T.DIFF. | FACTOR | BTU |
| NORTH | 42 | 11 | 0.56 | 259 |
| SOUTH | 0 | 11 | 0.56 | 0 |
| EAST | 0 | 11 | 0.56 | 0 |
| WEST | 0 | 165 | 0.56 | 0 |

| | | | | |
|---|---|---|---|---|
| N-E | 0 | 11 | 0.56 | 0 |
| N-W | 0 | 118 | 0.56 | 0 |
| S-E | 0 | 11 | 0.56 | 0 |
| S-W | 0 | 113 | 0.56 | 0 |

| SOLAR & TRANSMISSION GAIN -WALL | | | | |
|---|---|---|---|---|
| NORTH | 81 | 20 | 0.34 | 551 |
| SOUTH | 0 | 36 | 0.34 | 0 |
| EAST | 0 | 22 | 0.34 | 0 |
| WEST | 0 | 36 | 0.34 | 0 |
| N-E | 0 | 17 | 0.34 | 0 |
| N-W | 0 | 13 | 0.34 | 0 |
| S-E | 0 | 25 | 0.34 | 0 |
| S-W | 0 | 21 | 0.34 | 0 |
| ROOF | 190 | 51 | 0.15×0 | 0 |

| OTHER TRANSMISSION GAIN | | | | |
|---|---|---|---|---|
| AGLS | 42 | 25 | 1.13 | 1187 |
| PART | 184 | 20 | 0.34 | 1251 |
| CEIL | 190 | 20 | 0.34 | 1292 |
| FLOR | 190 | 20 | 0.34×0 | 0 |

| BYPASS O.A. SENSIBLE LOAD | | | | |
|---|---|---|---|---|
| CFM | T.DIFF. | BYPASS | FACTOR | BTU |
| 70 | 25 | 0.08 | 1.08 | 151 |

| INTERNAL SENSIBLE LOAD | | | | |
|---|---|---|---|---|
| PEOPLE | 6 | 245 | | 1470 |
| APPL. | 250 | 3.4 | | 850 |
| LIGHTS | 285 | 3.4 | 1.25 | 1211 |
| FOOD | 0 | 60 | | 0 |
| SUB TOTAL | | | | 8222 |

| | |
|---|---|
| LEAK LOSS +SAFETY FACTOR=5% | 411 |
| ROOM SENSIBLE HEAT | 9044 |

❖ LATENT HEAT:

| BYPASS OUTSIDE AIR LATENT LOAD | | | | |
|---|---|---|---|---|
| CFM | G. DIFF | BYPASS | FACTOR | BTU |
| 70 | 82 | 0.08 | 0.68 | 312 |

| INTERNAL LATENT LOAD | | | |
|---|---|---|---|
| PEOPLE | 6 | 205 | 1230 |

| | |
|---|---|
| SUB TOTAL | 1542 |
| SAFETY FACTOR=5% | 77 |
| ROOM LATENT HEAT | 1619 |
| ROOM TOTAL HEAT | 10663 |

❖ GRAND TOTAL HEAT:

| OUTSIDE AIR HEAT | | | | | |
|---|---|---|---|---|---|
| | CFM | G. DIFF | 1-B.F. | FACTOR | BTU |
| SENSIBLE | 70 | 25 | 0.92 | 1.08 | 1739 |
| LATENT | 70 | 82 | 0.92 | 0.68 | 3590 |
| SUB TOTAL | | | | | 5329 |
| TOTAL | | | | | 15992 |
| HEAT GAIN SAFETY FACTOR @ 3% | | | | | 480 |
| GRAND TOTAL HEAT | | | (TONS) | 1.4 | 16472 |

| | |
|---|---|
| SENSIBLE HEAT FACTOR | 0.84 |
| SELECTED A.D.P. | 52 |
| DEHUMIDIFIED RISE | 20 |
| DEHUMIDIFIED AIR Cfm | 418 |
| TONS AS PER Cfm | 1.04 |

| | |
|---|---|
| GRAND TOTAL HEAT (BTU/HR/SQFT.) | 86.69 |
| ROOM SENSIBLE HEAT (BTU/HR/SQFT.) | 47.6 |
| SQFT/PERSON | 31.67 |
| TONS PER SQFT | 0.01 |
| CFM PER SQFT | 2.2 |
| TONS/PERSON | 0.23 |
| DEHUMIDIFIED CFM/TON | 299 |
| AREA PER TON | 135.71 |

*Table 9.Calculation of ITO-2*

**6.2.6. ITO- 3:**

❖ SENSIBLE HEAT GAIN:

| SOLAR GAIN- GLASS | | | | |
|---|---|---|---|---|
| DIRECTION | AREA | T.DIFF. | FACTOR | BTU |
| NORTH | 39 | 11 | 0.56 | 240 |
| SOUTH | 0 | 11 | 0.56 | 0 |
| EAST | 57 | 11 | 0.56 | 351 |
| WEST | 0 | 165 | 0.56 | 0 |
| N-E | 0 | 11 | 0.56 | 0 |
| N-W | 0 | 118 | 0.56 | 0 |
| S-E | 0 | 11 | 0.56 | 0 |
| S-W | 0 | 113 | 0.56 | 0 |

| SOLAR & TRANSMISSION GAIN -WALL | | | | |
|---|---|---|---|---|
| NORTH | 81 | 20 | 0.34 | 551 |
| SOUTH | 0 | 36 | 0.34 | 0 |
| EAST | 0 | 22 | 0.34 | 0 |
| WEST | 0 | 36 | 0.34 | 0 |
| N-E | 0 | 17 | 0.34 | 0 |
| N-W | 0 | 13 | 0.34 | 0 |
| S-E | 0 | 25 | 0.34 | 0 |
| S-W | 0 | 21 | 0.34 | 0 |
| ROOF | 1400 | 51 | 0.15×0 | 0 |

| OTHER TRANSMISSION GAIN | | | | |
|---|---|---|---|---|
| AGLS | 96 | 25 | 1.13 | 2712 |
| PART | 184 | 20 | 0.34 | 1251 |
| CEIL | 190 | 20 | 0.34 | 1292 |
| FLOR | 190 | 20 | 0.34×0 | 0 |

| BYPASS O.A. SENSIBLE LOAD | | | | |
|---|---|---|---|---|
| CFM | T.DIFF. | BYPASS | FACTOR | BTU |
| 70 | 25 | 0.08 | 1.08 | 151 |

| INTERNAL SENSIBLE LOAD | | | | |
|---|---|---|---|---|
| PEOPLE | 6 | 245 | | 1470 |
| APPL. | 250 | 3.4 | | 850 |
| LIGHTS | 285 | 3.4 | 1.25 | 1211 |
| FOOD | 0 | 60 | | 0 |
| SUB TOTAL | | | | 10079 |

| | |
|---|---|
| LEAK LOSS +SAFETY FACTOR=5% | 504 |
| ROOM SENSIBLE HEAT | 11087 |

- LATENT HEAT:

| BYPASS OUTSIDE AIR LATENT LOAD | | | | |
|---|---|---|---|---|
| CFM | G. DIFF | BYPASS | FACTOR | BTU |
| 70 | 82 | 0.08 | 0.68 | 312 |

.

| INTERNAL LATENT LOAD | | | |
|---|---|---|---|
| PEOPLE | 6 | 205 | 1230 |

| | |
|---|---|
| SUB TOTAL | 1542 |
| SAFETY FACTOR=5% | 77 |
| ROOM LATENT HEAT | 1619 |
| ROOM TOTAL HEAT | 12706 |

- GRAND TOTAL HEAT:

| OUTSIDE AIR HEAT | | | | | |
|---|---|---|---|---|---|
| | CFM | G. DIFF | 1-B.F. | FACTOR | BTU |
| SENSIBLE | 70 | 25 | 0.92 | 1.08 | 1739 |
| LATENT | 70 | 82 | 0.92 | 0.68 | 3591 |
| SUB TOTAL | | | | | 5330 |
| TOTAL | | | | | 18036 |
| HEAT GAIN SAFETY FACTOR @ 3% | | | | | 541 |
| GRAND TOTAL HEAT | | | (TONS) | 1.5 | 18577 |

| | |
|---|---|
| SENSIBLE HEAT FACTOR | 0.87 |
| SELECTED A.D.P. | 52 |

| | |
|---|---|
| DEHUMIDIFIED RISE | 20 |
| DEHUMIDIFIED AIR Cfm | 513 |
| TONS AS PER Cfm | 1.3 |

| | |
|---|---|
| GRAND TOTAL HEAT (BTU/HR/SQFT.) | 97.77 |
| ROOM SENSIBLE HEAT (BTU/HR/SQFT.) | 58.35 |
| SQFT/PERSON | 31.67 |
| TONS PER SQFT | 0.01 |
| CFM PER SQFT | 2.7 |
| TONS/PERSON | 0.25 |
| DEHUMIDIFIED CFM/TON | 342 |
| AREA PER TON | 125.60 |

*Table 10.Calculation of ITO-3*

### 6.2.7. ITO-4:

- SENSIBLE HEAT GAIN:

| SOLAR GAIN- GLASS | | | | |
|---|---|---|---|---|
| DIRECTION | AREA | T.DIFF. | FACTOR | BTU |
| NORTH | 39 | 11 | 0.56 | 240 |
| SOUTH | 0 | 11 | 0.56 | 0 |
| EAST | 32 | 11 | 0.56 | 197 |
| WEST | 0 | 165 | 0.56 | 0 |
| N-E | 0 | 11 | 0.56 | 0 |
| N-W | 0 | 118 | 0.56 | 0 |
| S-E | 0 | 11 | 0.56 | 0 |
| S-W | 0 | 113 | 0.56 | 0 |

| SOLAR & TRANSMISSION GAIN -WALL | | | | |
|---|---|---|---|---|
| NORTH | 92 | 20 | 0.34 | 626 |
| SOUTH | 0 | 36 | 0.34 | 0 |
| EAST | 160 | 22 | 0.34 | 1197 |
| WEST | 363 | 36 | 0.34 | 0 |
| N-E | 0 | 17 | 0.34 | 0 |
| N-W | 0 | 13 | 0.34 | 0 |
| S-E | 0 | 25 | 0.34 | 0 |
| S-W | 0 | 21 | 0.34 | 0 |

| | | | | |
|---|---|---|---|---|
| ROOF | 1400 | 51 | 0.15 | 0 |

| OTHER TRANSMISSION GAIN | | | | |
|---|---|---|---|---|
| AGLS | 71 | 25 | 1.13 | 2006 |
| PART | 0 | 20 | 0.34 | 0 |
| CEIL | 190 | 20 | 0.34 | 1292 |
| FLOR | 190 | 20 | 0.34 | 1292 |

| BYPASS O.A. SENSIBLE LOAD | | | | |
|---|---|---|---|---|
| CFM | T.DIFF. | BYPASS | FACTOR | BTU |
| 70 | 25 | 0.08 | 1.08 | 151 |

| INTERNAL SENSIBLE LOAD | | | | |
|---|---|---|---|---|
| PEOPLE | 6 | 245 | | 1470 |
| APPL. | 250 | 3.4 | | 850 |
| LIGHTS | 285 | 3.4 | 1.25 | 1211 |
| FOOD | 0 | 60 | | 0 |
| SUB TOTAL | | | | 10532 |

| | |
|---|---|
| LEAK LOSS +SAFETY FACTOR=5% | 527 |
| ROOM SENSIBLE HEAT | 11586 |

❖ LATENT HEAT:

| BYPASS OUTSIDE AIR LATENT LOAD | | | | |
|---|---|---|---|---|
| CFM | G. DIFF | BYPASS | FACTOR | BTU |
| 70 | 82 | 0.08 | 0.68 | 312 |

.

| INTERNAL LATENT LOAD | | | |
|---|---|---|---|
| PEOPLE | 6 | 205 | 1230 |

| | |
|---|---|
| SUB TOTAL | 1542 |
| SAFETY FACTOR=5% | 77 |
| ROOM LATENT HEAT | 1619 |
| ROOM TOTAL HEAT | 13205 |

❖ GRAND TOTAL HEAT:

| OUTSIDE AIR HEAT | | | | | |
|---|---|---|---|---|---|
| | CFM | G. DIFF | 1-B.F. | FACTOR | BTU |
| SENSIBLE | 70 | 25 | 0.92 | 1.08 | 1739 |
| LATENT | 70 | 82 | 0.92 | 0.68 | 3591 |
| SUB TOTAL | | | | | 5330 |
| TOTAL | | | | | 18535 |
| HEAT GAIN SAFETY FACTOR @ 3% | | | | | 556 |
| GRAND TOTAL HEAT | | | (TONS) | 1.6 | 19091 |

| | |
|---|---|
| SENSIBLE HEAT FACTOR | 0.87 |
| SELECTED A.D.P. | 52 |
| DEHUMIDIFIED RISE | 21 |
| DEHUMIDIFIED AIR Cfm | 511 |
| TONS AS PER Cfm | 1.27 |

| | |
|---|---|
| GRAND TOTAL HEAT (BTU/HR/SQFT.) | 100.47 |
| ROOM SENSIBLE HEAT (BTU/HR/SQFT.) | 61 |
| SQFT/PERSON | 31.67 |
| TONS PER SQFT | 0.01 |
| CFM PER SQFT | 2.68 |
| TONS/PERSON | 0.26 |
| DEHUMIDIFIED CFM/TON | 319.37 |
| AREA PER TON | 118.75 |

*Table 11.Calculation of ITO-4*

## 6.2.8. STAFF AREA-2:

❖ SENSIBLE HEAT GAIN:

| SOLAR GAIN- GLASS | | | | |
|---|---|---|---|---|
| DIRECTION | AREA | T.DIFF. | FACTOR | BTU |
| NORTH | 141 | 11 | 0.56 | 869 |
| SOUTH | 0 | 11 | 0.56 | 0 |
| EAST | 0 | 11 | 0.56 | 0 |
| WEST | 0 | 165 | 0.56 | 0 |
| N-E | 0 | 11 | 0.56 | 0 |

| | | | | |
|---|---|---|---|---|
| N-W | 0 | 118 | 0.56 | 0 |
| S-E | 0 | 11 | 0.56 | 0 |
| S-W | 0 | 113 | 0.56 | 0 |

| SOLAR & TRANSMISSION GAIN -WALL | | | | |
|---|---|---|---|---|
| NORTH | 112 | 20 | 0.34 | 762 |
| SOUTH | 0 | 36 | 0.34 | 0 |
| EAST | 0 | 22 | 0.34 | 0 |
| WEST | 0 | 36 | 0.34 | 0 |
| N-E | 0 | 17 | 0.34 | 0 |
| N-W | 0 | 13 | 0.34 | 0 |
| S-E | 0 | 25 | 0.34 | 0 |
| S-W | 0 | 21 | 0.34 | 0 |
| ROOF | 1200 | 51 | 0.15×0 | 0 |

| OTHER TRANSMISSION GAIN | | | | |
|---|---|---|---|---|
| AGLS | 141 | 25 | 1.13 | 3983 |
| PART | 1221 | 20 | 0.34 | 8303 |
| CEIL | 1200 | 20 | 0.34 | 8160 |
| FLOR | 1200 | 20 | 0.34 | 8160 |

| BYPASS O.A. SENSIBLE LOAD | | | | |
|---|---|---|---|---|
| CFM | T.DIFF. | BYPASS | FACTOR | BTU |
| 440 | 25 | 0.08 | 1.08 | 1064 |

| INTERNAL SENSIBLE LOAD | | | | |
|---|---|---|---|---|
| PEOPLE | 30 | 245 | | 7350 |
| APPL. | 5000 | 3.4 | | 17000 |
| LIGHTS | 1800 | 3.4 | 1.25 | 7650 |
| FOOD | 0 | 60 | | 0 |
| SUB TOTAL | | | | 63301 |

| | |
|---|---|
| LEAK LOSS +SAFETY FACTOR=5% | 3165 |
| ROOM SENSIBLE HEAT | 69631 |

❖ LATENT HEAT:

| BYPASS OUTSIDE AIR LATENT LOAD | | | | |
|---|---|---|---|---|
| CFM | G. DIFF | BYPASS | FACTOR | BTU |
| 440 | 82 | 0.08 | 0.68 | 1963 |

| INTERNAL LATENT LOAD | | | |
|---|---|---|---|
| PEOPLE | 30 | 205 | 6150 |

| | |
|---|---|
| SUB TOTAL | 8113 |
| SAFETY FACTOR=5% | 406 |
| ROOM LATENT HEAT | 8519 |
| ROOM TOTAL HEAT | 78150 |

- GRAND TOTAL HEAT:

| OUTSIDE AIR HEAT | | | | | |
|---|---|---|---|---|---|
| SENSIBLE | 440 | 25 | 0.92 | 1.08 | 10930 |
| LATENT | 440 | 82 | 0.92 | 0.68 | 22572 |
| SUB TOTAL | | | | | 33502 |
| TOTAL | | | | | 111652 |
| HEAT GAIN SAFETY FACTOR @ 3% | | | | | 3350 |
| GRAND TOTAL HEAT | | | (TONS) | 9.58 | 115002 |

| | |
|---|---|
| SENSIBLE HEAT FACTOR | 0.89 |
| SELECTED A.D.P. | 52 |
| DEHUMIDIFIED RISE | 20 |
| DEHUMIDIFIED AIR Cfm | 3224 |
| TONS AS PER Cfm | 8.06 |

| | |
|---|---|
| GRAND TOTAL HEAT (BTU/HR/SQFT.) | 95.83 |
| ROOM SENSIBLE HEAT (BTU/HR/SQFT.) | 58.02 |
| SQFT/PERSON | 40 |
| TONS PER SQFT | 0.01 |
| CFM PER SQFT | 2.68 |
| TONS/PERSON | 0.32 |
| DEHUMIDIFIED CFM/TON | 336.53 |
| AREA PER TON | 125.26 |

*Table 12. Calculation of Staff Area-2*

### 6.2.9. CIT-A:

- SENSIBLE HEAT GAIN:

| SOLAR GAIN- GLASS | | | | |
|---|---|---|---|---|
| DIRECTION | AREA | T.DIFF. | FACTOR | BTU |
| NORTH | 26 | 11 | 0.56 | 160 |
| SOUTH | 0 | 11 | 0.56 | 0 |
| EAST | 51 | 11 | 0.56 | 315 |
| WEST | 0 | 165 | 0.56 | 0 |
| N-E | 0 | 11 | 0.56 | 0 |
| N-W | 0 | 118 | 0.56 | 0 |
| S-E | 0 | 11 | 0.56 | 0 |
| S-W | 0 | 113 | 0.56 | 0 |

| SOLAR & TRANSMISSION GAIN -WALL | | | | |
|---|---|---|---|---|
| NORTH | 130 | 20 | 0.34 | 884 |
| SOUTH | 0 | 36 | 0.34 | 0 |
| EAST | 181 | 22 | 0.34 | 1354 |
| WEST | 0 | 36 | 0.34 | 0 |
| N-E | 0 | 17 | 0.34 | 0 |
| N-W | 0 | 13 | 0.34 | 0 |
| S-E | 0 | 25 | 0.34 | 0 |
| S-W | 0 | 21 | 0.34 | 0 |
| ROOF | 270 | 51 | 0.15×0 | 0 |

| OTHER TRANSMISSION GAIN | | | | |
|---|---|---|---|---|
| AGLS | 77 | 25 | 1.13 | 2175 |
| PART | 147 | 20 | 0.34 | 1000 |
| CEIL | 270 | 20 | 0.34 | 1836 |
| FLOR | 270 | 20 | 0.34 | 1836 |

| BYPASS O.A. SENSIBLE LOAD | | | | |
|---|---|---|---|---|
| CFM | T.DIFF. | BYPASS | FACTOR | BTU |
| 100 | 25 | 0.08 | 1.08 | 216 |

| INTERNAL SENSIBLE LOAD | | | | |
|---|---|---|---|---|
| PEOPLE | 10 | 245 | | 2450 |
| APPL. | 250 | 3.4 | | 850 |
| LIGHTS | 405 | 3.4 | 1.25 | 1721 |
| FOOD | 0 | 60 | | 0 |
| SUB TOTAL | | | | 14797 |

| | |
|---|---|
| LEAK LOSS +SAFETY FACTOR=5% | 740 |
| ROOM SENSIBLE HEAT | 16277 |

- ❖ LATENT HEAT:

| BYPASS OUTSIDE AIR LATENT LOAD | | | | |
|---|---|---|---|---|
| CFM | G. DIFF | BYPASS | FACTOR | BTU |
| 100 | 82 | 0.08 | 0.68 | 446 |

.

| INTERNAL LATENT LOAD | | | |
|---|---|---|---|
| PEOPLE | 10 | 205 | 2050 |

| | |
|---|---|
| SUB TOTAL | 2496 |
| SAFETY FACTOR=5% | 125 |
| ROOM LATENT HEAT | 2621 |
| ROOM TOTAL HEAT | 18898 |

- ❖ GRAND TOTAL HEAT:

| OUTSIDE AIR HEAT | | | | | |
|---|---|---|---|---|---|
| | CFM | G. DIFF | 1-B.F. | FACTOR | BTU |
| SENSIBLE | 100 | 25 | 0.92 | 1.08 | 2484 |
| LATENT | 100 | 82 | 0.92 | 0.68 | 5130 |
| SUB TOTAL | | | | | 7614 |
| TOTAL | | | | | 26512 |
| HEAT GAIN SAFETY FACTOR @ 3% | | | | | 795 |
| GRAND TOTAL HEAT | | | (TONS) | 2.3 | 27307 |

| | |
|---|---|
| SENSIBLE HEAT FACTOR | 0.86 |
| SELECTED A.D.P. | 52 |
| DEHUMIDIFIED RISE | 20 |

| | |
|---|---|
| DEHUMIDIFIED AIR Cfm | 754 |
| TONS AS PER Cfm | 1.88 |

| | |
|---|---|
| GRAND TOTAL HEAT (BTU/HR/SQFT.) | 101.13 |
| ROOM SENSIBLE HEAT (BTU/HR/SQFT.) | 60.28 |
| SQFT/PERSON | 27 |
| TONS PER SQFT | 0.01 |
| CFM PER SQFT | 2.79 |
| TONS/PERSON | 0.23 |
| DEHUMIDIFIED CFM/TON | 327.82 |
| AREA PER TON | 117.39 |

*Table 13.Calculation of CIT-A*

## 6.2.10. AO & PS (A):

- SENSIBLE HEAT GAIN:

| SOLAR GAIN- GLASS | | | | |
|---|---|---|---|---|
| DIRECTION | AREA | T.DIFF. | FACTOR | BTU |
| NORTH | 0 | 11 | 0.56 | 0 |
| SOUTH | 0 | 11 | 0.56 | 0 |
| EAST | 51 | 11 | 0.56 | 314 |
| WEST | 0 | 165 | 0.56 | 0 |
| N-E | 0 | 11 | 0.56 | 0 |
| N-W | 0 | 118 | 0.56 | 0 |
| S-E | 0 | 11 | 0.56 | 0 |
| S-W | 0 | 113 | 0.56 | 0 |

| SOLAR & TRANSMISSION GAIN -WALL | | | | |
|---|---|---|---|---|
| NORTH | 0 | 20 | 0.34 | 0 |
| SOUTH | 0 | 36 | 0.34 | 0 |
| EAST | 153 | 22 | 0.34 | 1144 |
| WEST | 0 | 36 | 0.34 | 0 |
| N-E | 0 | 17 | 0.34 | 0 |
| N-W | 0 | 13 | 0.34 | 0 |
| S-E | 0 | 25 | 0.34 | 0 |
| S-W | 0 | 21 | 0.34 | 0 |
| ROOF | 240 | 51 | 0.15×0 | 0 |

| OTHER TRANSMISSION GAIN | | | | |
|---|---|---|---|---|
| AGLS | 51 | 25 | 1.13 | 1441 |
| PART | 131 | 20 | 0.34 | 891 |
| CEIL | 240 | 20 | 0.34 | 1632 |
| FLOR | 240 | 20 | 0.34 | 1632 |

| BYPASS O.A. SENSIBLE LOAD | | | | |
|---|---|---|---|---|
| CFM | T.DIFF. | BYPASS | FACTOR | BTU |
| 88 | 25 | 0.08 | 1.08 | 190 |

| INTERNAL SENSIBLE LOAD | | | | |
|---|---|---|---|---|
| PEOPLE | 6 | 245 | | 1470 |
| APPL. | 500 | 3.4 | | 1700 |
| LIGHTS | 360 | 3.4 | 1.25 | 1530 |
| FOOD | 0 | 60 | | 0 |
| SUB TOTAL | | | | 11944 |

| | |
|---|---|
| LEAK LOSS +SAFETY FACTOR=5% | 597 |
| ROOM SENSIBLE HEAT | 13138 |

❖ LATENT HEAT:

| BYPASS OUTSIDE AIR LATENT LOAD | | | | |
|---|---|---|---|---|
| CFM | G. DIFF | BYPASS | FACTOR | BTU |
| 88 | 82 | 0.08 | 0.68 | 393 |

.

| INTERNAL LATENT LOAD | | | |
|---|---|---|---|
| PEOPLE | 6 | 205 | 1230 |

| | |
|---|---|
| SUB TOTAL | 1623 |
| SAFETY FACTOR=5% | 81 |
| ROOM LATENT HEAT | 1704 |
| ROOM TOTAL HEAT | 14842 |

❖ GRAND TOTAL HEAT:

| OUTSIDE AIR HEAT | | | | | |
|---|---|---|---|---|---|
| | CFM | G. DIFF | 1-B.F. | FACTOR | BTU |
| SENSIBLE | 88 | 25 | 0.92 | 1.08 | 2186 |
| LATENT | 88 | 82 | 0.92 | 0.68 | 4514 |
| SUB TOTAL | | | | | 6700 |
| TOTAL | | | | | 21542 |
| HEAT GAIN SAFETY FACTOR @ 3% | | | | | 646 |
| GRAND TOTAL HEAT | | | (TONS) | 1.85 | 22188 |

| | |
|---|---|
| SENSIBLE HEAT FACTOR | 0.88 |
| SELECTED A.D.P. | 52 |
| DEHUMIDIFIED RISE | 20 |
| DEHUMIDIFIED AIR Cfm | 608 |
| TONS AS PER Cfm | 1.52 |

| | |
|---|---|
| GRAND TOTAL HEAT (BTU/HR/SQFT.) | 92.45 |
| ROOM SENSIBLE HEAT (BTU/HR/SQFT.) | 54.74 |
| SQFT/PERSON | 40 |
| TONS PER SQFT | 0.01 |
| CFM PER SQFT | 2.53 |
| TONS/PERSON | 0.30 |
| DEHUMIDIFIED CFM/TON | 328.64 |
| AREA PER TON | 129.72 |

*Table 14.Calculation of AO&PO(A)*

## 6.2.11. JCTI-1:

❖ SENSIBLE HEAT GAIN:

| SOLAR GAIN-GLASS | | | | |
|---|---|---|---|---|
| DIRECTION | AREA | T.DIFF. | FACTOR | BTU |
| NORTH | 0 | 11 | 0.56 | 0 |
| SOUTH | 30 | 11 | 0.56 | 185 |
| EAST | 51 | 11 | 0.56 | 314 |
| WEST | 0 | 165 | 0.56 | 0 |
| N-E | 0 | 11 | 0.56 | 0 |
| N-W | 0 | 118 | 0.56 | 0 |

| | | | | |
|---|---|---|---|---|
| S-E | 0 | 11 | 0.56 | 0 |
| S-W | 0 | 113 | 0.56 | 0 |

| SOLAR & TRANSMISSION GAIN -WALL | | | | |
|---|---|---|---|---|
| NORTH | 0 | 20 | 0.34 | 0 |
| SOUTH | 161 | 36 | 0.34 | 1971 |
| EAST | 144 | 22 | 0.34 | 1077 |
| WEST | 0 | 36 | 0.34 | 0 |
| N-E | 0 | 17 | 0.34 | 0 |
| N-W | 0 | 13 | 0.34 | 0 |
| S-E | 0 | 25 | 0.34 | 0 |
| S-W | 0 | 21 | 0.34 | 0 |
| ROOF | 200 | 51 | 0.15×0 | 0 |

| OTHER TRANSMISSION GAIN | | | | |
|---|---|---|---|---|
| AGLS | 82 | 25 | 1.13 | 2317 |
| PART | 197 | 20 | 0.34 | 1340 |
| CEIL | 290 | 20 | 0.34 | 1972 |
| FLOR | 290 | 20 | 0.34 | 1972 |

| BYPASS O.A. SENSIBLE LOAD | | | | |
|---|---|---|---|---|
| CFM | T.DIFF. | BYPASS | FACTOR | BTU |
| 106 | 25 | 0.08 | 1.08 | 229 |

| INTERNAL SENSIBLE LOAD | | | | |
|---|---|---|---|---|
| PEOPLE | 10 | 245 | | 2450 |
| APPL. | 250 | 3.4 | | 850 |
| LIGHTS | 435 | 3.4 | 1.25 | 1849 |
| FOOD | 0 | 60 | | 0 |
| SUB TOTAL | | | | 16526 |

| | |
|---|---|
| LEAK LOSS +SAFETY FACTOR=5% | 826 |
| ROOM SENSIBLE HEAT | 18178 |

❖ LATENT HEAT:

| BYPASS OUTSIDE AIR LATENT LOAD | | | | |
|---|---|---|---|---|
| CFM | G. DIFF | BYPASS | FACTOR | BTU |
| 106 | 82 | 0.08 | 0.68 | 473 |

·

| INTERNAL LATENT LOAD | | | |
|---|---|---|---|
| PEOPLE | 10 | 205 | 2050 |

| | |
|---|---|
| SUB TOTAL | 2523 |
| SAFETY FACTOR=5% | 126 |
| ROOM LATENT HEAT | 2649 |
| ROOM TOTAL HEAT | 20827 |

❖ GRAND TOTAL HEAT:

| OUTSIDE AIR HEAT | | | | | |
|---|---|---|---|---|---|
| | CFM | G. DIFF | 1-B.F. | FACTOR | BTU |
| SENSIBLE | 106 | 25 | 0.92 | 1.08 | 2633 |
| LATENT | 106 | 82 | 0.92 | 0.68 | 5438 |
| SUB TOTAL | | | | | 8071 |
| TOTAL | | | | | 28898 |
| HEAT GAIN SAFETY FACTOR @ 3% | | | | | 867 |
| GRAND TOTAL HEAT | | | (TONS) | 2.48 | 29765 |

| | |
|---|---|
| SENSIBLE HEAT FACTOR | 0.87 |
| SELECTED A.D.P. | 52 |
| DEHUMIDIFIED RISE | 20 |
| DEHUMIDIFIED AIR Cfm | 842 |
| TONS AS PER Cfm | 2.1 |

| | |
|---|---|
| GRAND TOTAL HEAT (BTU/HR/SQFT.) | 102.63 |
| ROOM SENSIBLE HEAT (BTU/HR/SQFT.) | 62.68 |
| SQFT/PERSON | 29 |
| TONS PER SQFT | 0.01 |
| CFM PER SQFT | 2.90 |
| TONS/PERSON | 0.24 |
| DEHUMIDIFIED CFM/TON | 339.51 |
| AREA PER TON | 116.93 |

*Table 15.Calculation of JCIT-1*

## 6.2.12. ADDL JCTI-1:

- SENSIBLE HEAT GAIN:

| SOLAR GAIN-GLASS | | | | |
|---|---|---|---|---|
| DIRECTION | AREA | T.DIFF. | FACTOR | BTU |
| NORTH | 0 | 11 | 0.56 | 0 |
| SOUTH | 38 | 11 | 0.56 | 234 |
| EAST | 0 | 11 | 0.56 | 0 |
| WEST | 0 | 165 | 0.56 | 0 |
| N-E | 0 | 11 | 0.56 | 0 |
| N-W | 0 | 118 | 0.56 | 0 |
| S-E | 0 | 11 | 0.56 | 0 |
| S-W | 0 | 113 | 0.56 | 0 |

| SOLAR & TRANSMISSION GAIN -WALL | | | | |
|---|---|---|---|---|
| NORTH | 0 | 20 | 0.34 | 0 |
| SOUTH | 126 | 36 | 0.34 | 1542 |
| EAST | 0 | 22 | 0.34 | 0 |
| WEST | 0 | 36 | 0.34 | 0 |
| N-E | 0 | 17 | 0.34 | 0 |
| N-W | 0 | 13 | 0.34 | 0 |
| S-E | 0 | 25 | 0.34 | 0 |
| S-W | 0 | 21 | 0.34 | 0 |
| ROOF | 270 | 51 | 0.15×0 | 0 |

| OTHER TRANSMISSION GAIN | | | | |
|---|---|---|---|---|
| AGLS | 38 | 25 | 1.13 | 1074 |
| PART | 197 | 20 | 0.34 | 1340 |
| CEIL | 270 | 20 | 0.34 | 1836 |
| FLOR | 270 | 20 | 0.34 | 1836 |

| BYPASS O.A. SENSIBLE LOAD | | | | |
|---|---|---|---|---|
| CFM | T.DIFF. | BYPASS | FACTOR | BTU |
| 100 | 25 | 0.08 | 1.08 | 216 |

| INTERNAL SENSIBLE LOAD |
|---|

| | | | | |
|---|---|---|---|---|
| PEOPLE | 10 | 245 | | 2450 |
| APPL. | 250 | 3.4 | | 850 |
| LIGHTS | 405 | 3.4 | 1.25 | 1721 |
| FOOD | 0 | 60 | | 0 |
| SUB TOTAL | | | | 13109 |

| | |
|---|---|
| LEAK LOSS +SAFETY FACTOR=5% | 655 |
| ROOM SENSIBLE HEAT | 14419 |

❖ LATENT HEAT:

| BYPASS OUTSIDE AIR LATENT LOAD | | | | |
|---|---|---|---|---|
| CFM | G. DIFF | BYPASS | FACTOR | BTU |
| 100 | 82 | 0.08 | 0.68 | 446 |

.

| INTERNAL LATENT LOAD | | | |
|---|---|---|---|
| PEOPLE | 10 | 205 | 2050 |

| | |
|---|---|
| SUB TOTAL | 2496 |
| SAFETY FACTOR=5% | 125 |
| ROOM LATENT HEAT | 2621 |
| ROOM TOTAL HEAT | 17040 |

❖ GRAND TOTAL HEAT:

| OUTSIDE AIR HEAT | | | | | |
|---|---|---|---|---|---|
| | CFM | G. DIFF | 1-B.F. | FACTOR | BTU |
| SENSIBLE | 100 | 25 | 0.92 | 1.08 | 2484 |
| LATENT | 100 | 82 | 0.92 | 0.68 | 5130 |
| SUB TOTAL | | | | | 7614 |
| TOTAL | | | | | 24654 |
| HEAT GAIN SAFETY FACTOR @ 3% | | | | | 740 |
| GRAND TOTAL HEAT | | | (TONS) | 2.1 | 25394 |

| | |
|---|---|
| SENSIBLE HEAT FACTOR | 0.84 |
| SELECTED A.D.P. | 52 |
| DEHUMIDIFIED RISE | 20 |
| DEHUMIDIFIED AIR Cfm | 668 |

| | |
|---|---|
| TONS AS PER Cfm | 1.67 |

| | |
|---|---|
| GRAND TOTAL HEAT (BTU/HR/SQFT.) | 94.05 |
| ROOM SENSIBLE HEAT (BTU/HR/SQFT.) | 53.40 |
| SQFT/PERSON | 27 |
| TONS PER SQFT | 0.01 |
| CFM PER SQFT | 2.47 |
| TONS/PERSON | 0.21 |
| DEHUMIDIFIED CFM/TON | 318.095 |
| AREA PER TON | 128.57 |

*Table 16.Calculation of ADDL JCIT-1*

## 6.2.13. CIT-B

❖ SENSIBLE HEAT GAIN:

| SOLAR GAIN-GLASS | | | | |
|---|---|---|---|---|
| DIRECTION | AREA | T.DIFF. | FACTOR | BTU |
| NORTH | 0 | 11 | 0.56 | 0 |
| SOUTH | 34 | 11 | 0.56 | 209 |
| EAST | 0 | 11 | 0.56 | 0 |
| WEST | 0 | 165 | 0.56 | 0 |
| N-E | 0 | 11 | 0.56 | 0 |
| N-W | 0 | 118 | 0.56 | 0 |
| S-E | 0 | 11 | 0.56 | 0 |
| S-W | 0 | 113 | 0.56 | 0 |

| SOLAR & TRANSMISSION GAIN -WALL | | | | |
|---|---|---|---|---|
| NORTH | 0 | 20 | 0.34 | 0 |
| SOUTH | 153 | 36 | 0.34 | 1873 |
| EAST | 0 | 22 | 0.34 | 0 |
| WEST | 79 | 36 | 0.34 | 967 |
| N-E | 0 | 17 | 0.34 | 0 |
| N-W | 0 | 13 | 0.34 | 0 |
| S-E | 0 | 25 | 0.34 | 0 |
| S-W | 0 | 21 | 0.34 | 0 |
| ROOF | 270 | 51 | 0.15×0 | 0 |

| OTHER TRANSMISSION GAIN | | | | |
|---|---|---|---|---|
| AGLS | 34 | 25 | 1.13 | 961 |
| PART | 281 | 20 | 0.34 | 1911 |
| CEIL | 270 | 20 | 0.34 | 1836 |
| FLOR | 270 | 20 | 0.34 | 1836 |

| BYPASS O.A. SENSIBLE LOAD | | | | |
|---|---|---|---|---|
| CFM | T.DIFF. | BYPASS | FACTOR | BTU |
| 100 | 25 | 0.08 | 1.08 | 216 |

| INTERNAL SENSIBLE LOAD | | | | |
|---|---|---|---|---|
| PEOPLE | 10 | 245 | | 2450 |
| APPL. | 250 | 3.4 | | 850 |
| LIGHTS | 405 | 3.4 | 1.25 | 1721 |
| FOOD | 0 | 60 | | 0 |
| SUB TOTAL | | | | 14830 |

| | |
|---|---|
| LEAK LOSS +SAFETY FACTOR=5% | 741 |
| ROOM SENSIBLE HEAT | 16312 |

❖ LATENT HEAT:

| BYPASS OUTSIDE AIR LATENT LOAD | | | | |
|---|---|---|---|---|
| CFM | G. DIFF | BYPASS | FACTOR | BTU |
| 100 | 82 | 0.08 | 0.68 | 446 |

.

| INTERNAL LATENT LOAD | | | |
|---|---|---|---|
| PEOPLE | 10 | 205 | 2050 |

| | |
|---|---|
| SUB TOTAL | 2496 |
| SAFETY FACTOR=5% | 125 |
| ROOM LATENT HEAT | 2621 |
| ROOM TOTAL HEAT | 18933 |

❖ GRAND TOTAL HEAT:

| OUTSIDE AIR HEAT | | | | | |
|---|---|---|---|---|---|
| | CFM | G. DIFF | 1-B.F. | FACTOR | BTU |
| SENSIBLE | 100 | 25 | 0.92 | 1.08 | 2484 |
| LATENT | 100 | 82 | 0.92 | 0.68 | 5130 |
| SUB TOTAL | | | | | 7614 |
| TOTAL | | | | | 26550 |
| HEAT GAIN SAFETY FACTOR @ 3% | | | | | 796 |
| GRAND TOTAL HEAT | | | (TONS) | 2.3 | 27346 |

| | |
|---|---|
| SENSIBLE HEAT FACTOR | 0.86 |
| SELECTED A.D.P. | 52 |
| DEHUMIDIFIED RISE | 20 |
| DEHUMIDIFIED AIR Cfm | 755 |
| TONS AS PER Cfm | 1.9 |

| | |
|---|---|
| GRAND TOTAL HEAT (BTU/HR/SQFT.) | 101.29 |
| ROOM SENSIBLE HEAT (BTU/HR/SQFT.) | 60.43 |
| SQFT/PERSON | 27 |
| TONS PER SQFT | 0.01 |
| CFM PER SQFT | 2.76 |
| TONS/PERSON | 0.23 |
| DEHUMIDIFIED CFM/TON | 328.26 |
| AREA PER TON | 117.39 |

*Table 17.Calculation of CIT-B*

### 6.2.14. AO & PS (B):

- SENSIBLE HEAT GAIN:

| SOLAR GAIN-GLASS | | | | |
|---|---|---|---|---|
| DIRECTION | AREA | T.DIFF. | FACTOR | BTU |
| NORTH | 0 | 11 | 0.56 | 0 |
| SOUTH | 0 | 11 | 0.56 | 0 |
| EAST | 0 | 11 | 0.56 | 0 |
| WEST | 0 | 165 | 0.56 | 0 |
| N-E | 0 | 11 | 0.56 | 0 |
| N-W | 0 | 118 | 0.56 | 0 |
| S-E | 0 | 11 | 0.56 | 0 |

| | | | | |
|---|---|---|---|---|
| S-W | 0 | 113 | 0.56 | 0 |

| SOLAR & TRANSMISSION GAIN -WALL | | | | |
|---|---|---|---|---|
| NORTH | 0 | 20 | 0.34 | 0 |
| SOUTH | 0 | 36 | 0.34 | 0 |
| EAST | 0 | 22 | 0.34 | 0 |
| WEST | 0 | 36 | 0.34 | 0 |
| N-E | 0 | 17 | 0.34 | 0 |
| N-W | 0 | 13 | 0.34 | 0 |
| S-E | 0 | 25 | 0.34 | 0 |
| S-W | 0 | 21 | 0.34 | 0 |
| ROOF | 210 | 51 | 0.15×0 | 0 |

| OTHER TRANSMISSION GAIN | | | | |
|---|---|---|---|---|
| AGLS | 0 | 25 | 1.13 | 0 |
| PART | 204 | 20 | 0.34 | 1387 |
| CEIL | 210 | 20 | 0.34 | 1428 |
| FLOR | 210 | 20 | 0.34 | 1428 |

| BYPASS O.A. SENSIBLE LOAD | | | | |
|---|---|---|---|---|
| CFM | T.DIFF. | BYPASS | FACTOR | BTU |
| 77 | 25 | 0.08 | 1.08 | 166 |

| INTERNAL SENSIBLE LOAD | | | | |
|---|---|---|---|---|
| PEOPLE | 2 | 245 | | 490 |
| APPL. | 500 | 3.4 | | 1700 |
| LIGHTS | 315 | 3.4 | 1.25 | 1339 |
| FOOD | 0 | 60 | | 0 |
| SUB TOTAL | | | | 7938 |

| | |
|---|---|
| LEAK LOSS +SAFETY FACTOR=5% | 397 |
| ROOM SENSIBLE HEAT | 8732 |

❖ LATENT HEAT:

| BYPASS OUTSIDE AIR LATENT LOAD |
|---|

| CFM | G. DIFF | BYPASS | FACTOR | BTU |
|---|---|---|---|---|
| 77 | 82 | 0.08 | 0.68 | 343 |

.

| INTERNAL LATENT LOAD | | | |
|---|---|---|---|
| PEOPLE | 2 | 205 | 410 |

| | |
|---|---|
| SUB TOTAL | 753 |
| SAFETY FACTOR=5% | 38 |
| ROOM LATENT HEAT | 791 |
| ROOM TOTAL HEAT | 9523 |

- GRAND TOTAL HEAT:

| OUTSIDE AIR HEAT | | | | | |
|---|---|---|---|---|---|
| | CFM | G. DIFF | 1-B.F. | FACTOR | BTU |
| SENSIBLE | 77 | 25 | 0.92 | 1.08 | 1913 |
| LATENT | 77 | 82 | 0.92 | 0.68 | 3950 |
| SUB TOTAL | | | | | 5863 |
| TOTAL | | | | | 15386 |
| HEAT GAIN SAFETY FACTOR @ 3% | | | | | 462 |
| GRAND TOTAL HEAT | | | (TONS) | 1.32 | 15848 |

| | |
|---|---|
| SENSIBLE HEAT FACTOR | 0.92 |
| SELECTED A.D.P. | 52 |
| DEHUMIDIFIED RISE | 20 |
| DEHUMIDIFIED AIR Cfm | 404 |
| TONS AS PER Cfm | 1.01 |

| | |
|---|---|
| GRAND TOTAL HEAT (BTU/HR/SQFT.) | 75.47 |
| ROOM SENSIBLE HEAT (BTU/HR/SQFT.) | 41.58 |
| SQFT/PERSON | 105 |
| TONS PER SQFT | 0.01 |
| CFM PER SQFT | 1.92 |
| TONS/PERSON | 0.66 |
| DEHUMIDIFIED CFM/TON | 306.06 |
| AREA PER TON | 159.09 |

*Table 18.Calculation of AO&PS(B)*

## 6.3. Summary:

| SUBJECT: HEAT LOAD SUMMARY SHEET | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **PROJECT:** | **INCOME TAX OFFICE GROUND FLOOR** | | | | | | | | |
| **SR.** | **DISCRIPTION** | **Area** | **Occupancy** | **WATTS** | **Fresh air** | **APPL.** | **Dehumidified air** | **Tonnage** | **Cfm/Hp** | **Tonnage** |
| | | **Sq. Ft.** | **Nos.** | **Sq. Ft.** | **CFM** | **WATTS.** | | **REQ. (TR)** | | **HP** |
| 1 | STAFF AREA - 1 | 1400 | 30 | 1.5 | 513 | 5000 | 3354 | 10.3 | 13.41 | 12.4 |
| 2 | DCIT - 1 | 200 | 7 | 1.5 | 73 | 250 | 403 | 1.38 | 1.61 | 1.66 |
| 3 | DCIT - 2 | 200 | 7 | 1.5 | 73 | 250 | 403 | 1.38 | 1.61 | 1.66 |
| 4 | ITO - 1 | 190 | 6 | 1.5 | 70 | 250 | 550 | 1.6 | 2.2 | 1.92 |
| 5 | ITO - 2 | 190 | 6 | 1.5 | 70 | 250 | 418 | 1.4 | 1.67 | 1.68 |
| 6 | ITO - 3 | 190 | 6 | 1.5 | 70 | 250 | 513 | 1.5 | 2.05 | 1.8 |
| 7 | ITO - 4 | 190 | 6 | 1.5 | 70 | 250 | 511 | 1.6 | 2.04 | 1.92 |
| 8 | STAFF AREA - 2 | 1200 | 30 | 1.5 | 440 | 5000 | 3224 | 9.58 | 12.89 | 11.54 |
| 9 | CIT A | 270 | 10 | 1.5 | 99 | 250 | 754 | 2.3 | 3.01 | 2.77 |
| 10 | AO AND PSA | 240 | 6 | 1.5 | 88 | 500 | 608 | 1.85 | 2.43 | 2.22 |
| 11 | JCTI -1 | 290 | 10 | 1.5 | 106 | 250 | 842 | 2.48 | 3.36 | 2.98 |
| 12 | ADDL JCTI - 1 | 270 | 10 | 1.5 | 99 | 250 | 668 | 2.1 | 2.67 | 2.53 |
| 13 | CIT (B) | 270 | 10 | 1.5 | 99 | 250 | 755 | 2.3 | 3.02 | 2.77 |
| 14 | AO AND PS (B) | 210 | 2 | 1.5 | 77 | 500 | 404 | 1.32 | 1.61 | 1.59 |
| | TOTAL | **5310** | **146** | **21** | **1947** | **13500** | **13407** | **41** | **53.6** | **49.5** |

*Table 19.Result of Design*

## 6.4. Selection of outdoor & Indoor Unit Capacity:

### 6.4.1 Outdoor unit:

| SR.NO. | OUTDOOR UNIT | HP |
|---|---|---|
| 1. | MMY-MAP14A7T8P | 14 |
| 2. | MMY-MAP14A7T8P | 14 |
| 3. | MMY-MAP14A7T8P | 14 |
| 4. | MMY-MAP14A7T8P | 14 |
| TOTAL | 56 | |

*Table 20.Selection of Outdoor Unit*

### 6.4.2. Indoor unit:

| SR NO | NAME OF ROOM | TYPE OF IDU & MODEL NO. | NOS. OF IDU | IDU HP |
|---|---|---|---|---|
| 1. | STAFF AREA-1 | 4-way cassette MMU-AP0364HP1-E | 4 | 4HP |
| 2. | DCIT-1 | 4-way cassette MMU-AP0274HP1-E | 1 | 3HP |
| 3. | DCIT-2 | 4-way cassette MMU-AP0274HP1-E | 1 | 3HP |
| 4. | ITO-1 | 4-way cassette MMU-AP0274HP1-E | 1 | 3HP |
| 5. | ITO-2 | 4-way cassette MMU-AP0274HP1-E | 1 | 3HP |
| 6. | ITO-3 | 4-way cassette MMU-AP0274HP1-E | 1 | 3HP |
| 7. | ITO-4 | 4-way cassette MMU-AP0274HP1-E | 1 | 3HP |
| 8. | STAFF AREA-2 | 4-way cassette MMU-AP0364HP1-E | 3 | 4HP |
| 9. | CIT A | 4-way cassette MMU-AP0364HP1-E | 1 | 4HP |
| 10. | AO AND PS (A) | 4-way cassette MMU-AP0274HP1-E | 1 | 3HP |
| 11. | JCTI-1 | 4-way cassette MMU-AP0364HP1-E | 1 | 4HP |
| 12. | ADDL JCTI-1 | 4-way cassette MMU-AP0364HP1-E | 1 | 4HP |

| | | | | |
|---|---|---|---|---|
| 13. | CIT (B) | 4-way cassette MMU-AP0364HP1-E | 1 | 4HP |
| 14. | AO AND PS (B) | 4-way cassette MMU-AP0274HP1-E | 1 | 3HP |
| TOTAL | | | | 68HP |

*Table 21.Selection of Indoor Unit*

DIVERSITY=$\frac{INDOOR\ \ UNIT\ CAPACITY}{OUTDOOR\ UNIT\ CAPACITY} \times 100 = \frac{68}{56} \times 100 = 121\%$

The outdoor unit & indoor unit models according to the capacity are selected from Toshiba catalogue.

In Toshiba there is a chance to get diversity up to 135% if numbers of occupants are increases in room it will not affects the efficiency of system.

## 6.5. Pipe Size and Details

Pipe material= copper

For outdoor unit connecting pipe (Model MMY-MAP14A7T8P pipe dimension selected

Gas side = Ø 28.6mm, Liquid side= Ø 15.9mm

Between ODU connection piping kits: - Gas side=Ø41.3mm, Liquid side=Ø22.2mm

IDU connection piping kit of header unit: - Gas side=Ø41.3mm, Liquid side=Ø22.2mm

Between 2 y-joints pipe size differs according to equivalent HP

IDU connecting pipe as per the capacity of IDU

RAFFNATES according to equivalent HP

ODU connecting kit selected as per the equivalent HP

## 6.6. Insulation:

Standard insulation pipe thickness

Supply pipe insulation=19mm

Return pipe insulation=13mm

# CHAPTER 07

## 7. VALIDATION OF RESULT

| | | | |
|---|---|---|---|
| JOB : | GROUND FLOOR | | |
| SPACE : | STAFF AREA- 1 | HEAT LOAD CALCULATIONS | |
| | | DATE | 3/10/2020 |
| | | TIME | 18:23 |

| DESIGN DATA | |
|---|---|
| AREA: | 1400 |
| HT.OF THE AREA: | 11 |
| LIGHTING (WATTS/SQFT) | 1.5 |
| NO.OF AIR CHANGE REQUIRED | 2 |
| Cfm VENTILATION | 513 |
| Cfm/PERSON | 10 |
| NO.OF PEOPLE | 30 |
| Cfm VENTILATION | 300 |
| Cfm VENTILATION IN CAL. | 513 |

| | D.B. | W.B. | %RH | GR/LB |
|---|---|---|---|---|
| OUTSIDE | 100 | 83 | 60 | 146.0 |
| INSIDE | 75 | - | 50 | 64.0 |
| DIFF. | 25 | - | - | 82.0 |

| HEAT LOAD SUMMARY | TR | HP |
|---|---|---|
| GRAND TOTAL HEAT | 10.3 | |
| DEHUMIDIFIED AIR Cfm | 3314 | |
| TONS AS PER Cfm | 8.3 | |
| TONNAGE REQUIRED | 10.3 | 12.45 |
| CFM PER SQFT | 2.37 | |
| AREA PER TON | 135 | |

| | SUN GAIN AREA | or T.DIFF. | FACTOR | | BTU |
|---|---|---|---|---|---|
| **SOLAR GAIN-GLASS** | | | | | |
| NORTH | 0 | 11 | 0.56 | | 0 |
| SOUTH | 0 | 11 | 0.56 | | 0 |
| EAST | 19 | 11 | 0.56 | | 117 |
| WEST | 0 | 165 | 0.56 | | 0 |
| N-E | 0 | 11 | 0.56 | | 0 |
| N-W | 0 | 118 | 0.56 | | 0 |
| S-E | 0 | 11 | 0.56 | | 0 |
| S-W | 0 | 113 | 0.56 | | 0 |
| **SOLAR & TRANSMISSION GAIN** | | | | | |
| NORTH | 0 | 20 | 0.34 | | 0 |
| SOUTH | 0 | 36 | 0.34 | | 0 |
| EAST | 52 | 22 | 0.34 | | 390 |
| WEST | 363 | 36 | 0.34 | | 4443 |
| N-E | 0 | 17 | 0.34 | | 0 |
| N-W | 0 | 13 | 0.34 | | 0 |
| S-E | 0 | 25 | 0.34 | | 0 |
| S-W | 0 | 21 | 0.34 | | 0 |
| ROOF | 1400 | 51 | 0.15 | 0 | 0 |
| **OTHER TRANSMISSION GAIN** | | | | | |
| AGLS | 19 | 25 | 1.13 | | 534 |
| PART | 1023 | 20 | 0.34 | | 6956 |
| CEIL | 1400 | 20 | 0.34 | 1 | 9520 |
| FLOR | 1400 | 20 | 0.34 | 1 | 9520 |
| **BYPASS O.A. SENSIBLE LOAD** | CFM | T.DIFF. | FACTOR | | |
| | 513 | 25 | 0.08 | 1.08 | 1109 |
| **INTERNAL SENSIBLE LOAD** | | | | | |
| PEOPLE | 30 | 245 | | | 7350 |
| APPL. | 5000 | 3.4 | | | 17000 |
| LIGHTS | 2100 | 3.4 | | 1.25 | 8925 |
| FOOD | 0 | 60 | | | 0 |
| SUB TOT/ | 55 | | | | 65864 |
| LEAK LOSS +SAFETY FACTOR=5% | | | | | 3293 |
| ROOM SENSIBLE HEAT | | | | | 72451 |

| | CFM | G.DIFF | BYPASS | FACTOR | BTU |
|---|---|---|---|---|---|
| **BYPASS O.A. LATENT LOAD** | | | | | |
| | 513 | 82 | 0.08 | 0.68 | 2290 |
| **INTERNAL LATENT LOAD** | | | | | |
| PEOPLE | 30 | 205 | | | 6150 |
| SUB TOTAL | | | | | 8440 |
| SAFETY FACTOR=5% | | | | | 422 |
| ROOM LATENT HEAT | | | | | 8862 |
| ROOM TOTAL HEAT | | | | | 81313 |

| OUTSIDE AIR HEAT | CFM | G.DIFF | 1-B.F. | FACTOR | |
|---|---|---|---|---|---|
| SENS | 513 | 25 | 0.92 | 1.08 | 12751 |
| LAT | 513 | 82 | 0.92 | 0.68 | 26334 |
| SUB TOTAL | | | | | 39085 |
| TOTAL | | | | | 120397 |
| HEAT GAIN SAFETY FACTOR @ 3% | | | | | 3612 |
| GRAND TOTAL HEAT | | | (TONS) | 10.3 | 124009 |

| | |
|---|---|
| SENSIBLE HEAT FACTOR | 0.89 |
| SELECTED A.D.P. | 52 |
| DEHUMIDIFIED RISE | 20 |
| DEHUMIDIFIED AIR Cfm | 3314 |
| TONS AS PER Cfm | 8.3 |

| CHECK RESULTS. | |
|---|---|
| GRAND TOTAL HEAT(BTU/HR/SQFT.) | 88.58 |
| ROOM SENSIBLE HEAT(BTU/HR/SQFT.) | 51.75 |
| SQFT/PERSON | 46.67 |
| TONS PER SQFT | 0.01 |
| CFM PER SQFT | 2.37 |
| TONS/PERSON | 0.34 |
| DEHUMIDIFIED CFM/TON | 320.73 |
| AREA PER TON | 135.47 |

| | |
|---|---|
| JOB : | GROUND FLOOR |
| SPACE : | DCIT - 1 |

| HEAT LOAD CALCULATIONS | |
|---|---|
| DATE | 3/10/2020 |
| TIME | 18:23 |

| DESIGN DATA | |
|---|---|
| AREA: | 200 |
| HT.OF THE AREA: | 11 |
| LIGHTING (WATTS/SQFT) | 1.5 |
| NO.OF AIR CHANGE REQUIRED | 2 |
| Cfm VENTILATION | 73 |
| Cfm/PERSON | 10 |
| NO.OF PEOPLE | 7 |
| Cfm VENTILATION | 70 |
| Cfm VENTILATION IN CAL. | 73 |

| | D.B. | W.B. | %RH | GR/LB |
|---|---|---|---|---|
| OUTSIDE | 100 | 83 | 60 | 146 |
| INSIDE | 75 | - | 50 | 64.0 |
| DIFF. | 25 | - | - | 82.0 |

| HEAT LOAD SUMMARY | TR | HP |
|---|---|---|
| GRAND TOTAL HEAT | 1.4 | |
| DEHUMIDIFIED AIR Cfm | 398 | |
| TONS AS PER Cfm | 1.0 | |
| TONNAGE REQUIRED | 1.4 | 1.67 |
| CFM PER SQFT | 1.99 | |
| AREA PER TON | 144 | |

| | AREA | SUN GAIN or T.DIFF. | FACTOR | | BTU |
|---|---|---|---|---|---|
| **SOLAR GAIN-GLASS** | | | | | |
| NORTH | 0 | 11 | 0.56 | | 0 |
| SOUTH | 0 | 11 | 0.56 | | 0 |
| EAST | 0 | 11 | 0.56 | | 0 |
| WEST | 0 | 165 | 0.56 | | 0 |
| N-E | 0 | 11 | 0.56 | | 0 |
| N-W | 0 | 118 | 0.56 | | 0 |
| S-E | 0 | 11 | 0.56 | | 0 |
| S-W | 0 | 113 | 0.56 | | 0 |
| **SOLAR & TRANSMISSION GAIN** | | | | | |
| NORTH | 0 | 20 | 0.34 | | 0 |
| SOUTH | 0 | 36 | 0.34 | | 0 |
| EAST | 0 | 22 | 0.34 | | 0 |
| WEST | 0 | 36 | 0.34 | | 0 |
| N-E | 0 | 17 | 0.34 | | 0 |
| N-W | 0 | 13 | 0.34 | | 0 |
| S-E | 0 | 25 | 0.34 | | 0 |
| S-W | 0 | 21 | 0.34 | | 0 |
| ROOF | 200 | 51 | 0.15 | 0 | 0 |
| **OTHER TRANSMISSION GAIN** | | | | | |
| AGLS | 0 | 25 | 1.13 | | 0 |
| PART | 176 | 20 | 0.34 | | 1197 |
| CEIL | 200 | 20 | 0.34 | 1 | 1360 |
| FLOR | 200 | 20 | 0.34 | 1 | 1360 |

| BYPASS O.A. SENSIBLE LOAD | CFM | T.DIFF. | FACTOR | | |
|---|---|---|---|---|---|
| | 73 | 25 | 0.08 | 1.08 | 158 |

| INTERNAL SENSIBLE LOAD | | | | |
|---|---|---|---|---|
| PEOPLE | 7 | 245 | | 1715 |
| APPL. | 250 | 3.4 | | 850 |
| LIGHTS | 300 | 3.4 | 1.25 | 1275 |
| FOOD | 0 | 60 | | 0 |
| SUB TOTAL | | | | 7915 |
| LEAK LOSS +SAFETY FACTOR=5% | | | | 396 |
| ROOM SENSIBLE HEAT | | | | 8707 |

| BYPASS O.A. LATENT LOAD | CFM | G.DIFF | BYPASS | FACTOR | BTU |
|---|---|---|---|---|---|
| | 73 | 82 | 0.08 | 0.68 | 327 |
| **INTERNAL LATENT LOAD** | | | | | |
| PEOPLE | 7 | 205 | | | 1435 |
| SUB TOTAL | | | | | 1762 |
| SAFETY FACTOR=5% | | | | | 88 |
| ROOM LATENT HEAT | | | | | 1850 |
| ROOM TOTAL HEAT | | | | | 10557 |

| OUTSIDE AIR HEAT | CFM | G.DIFF | 1-B.F. | FACTOR | |
|---|---|---|---|---|---|
| SENS | 73 | 25 | 0.92 | 1.08 | 1822 |
| LAT | 73 | 82 | 0.92 | 0.68 | 3762 |
| SUB TOTAL | | | | | 5584 |
| TOTAL | | | | | 16140 |
| HEAT GAIN SAFETY FACTOR @ 3% | | | | | 484 |
| GRAND TOTAL HEAT | | | (TONS) | 1.4 | 16625 |

| | |
|---|---|
| SENSIBLE HEAT FACTOR | 0.82 |
| SELECTED A.D.P. | 52 |
| DEHUMIDIFIED RISE | 20 |
| DEHUMIDIFIED AIR Cfm | 398 |
| TONS AS PER Cfm | 1.0 |

| CHECK RESULTS. | |
|---|---|
| GRAND TOTAL HEAT(BTU/HR/SQFT.) | 83.12 |
| ROOM SENSIBLE HEAT(BTU/HR/SQFT.) | 43.53 |
| SQFT/PERSON | 28.57 |
| TONS PER SQFT | 0.01 |
| CFM PER SQFT | 1.99 |
| TONS/PERSON | 0.20 |
| DEHUMIDIFIED CFM/TON | 287.51 |
| AREA PER TON | 144.36 |

JOB : GROUND FLOOR

SPACE : DCIT - 2

| HEAT LOAD CALCULATIONS | |
|---|---|
| DATE | 3/10/2020 |
| TIME | 18:23 |

| DESIGN DATA | |
|---|---|
| AREA: | 200 |
| HT.OF THE AREA: | 11 |
| LIGHTING (WATTS/SQFT) | 1.5 |
| NO.OF AIR CHANGE REQUIRED | 2 |
| Cfm VENTILATION | 73 |
| Cfm/PERSON | 10 |
| NO.OF PEOPLE | 7 |
| Cfm VENTILATION | 70 |
| Cfm VENTILATION IN CAL. | 73 |

| | D.B. | W.B. | %RH | GR/LB |
|---|---|---|---|---|
| OUTSIDE | 100 | 83 | 60 | 146 |
| INSIDE | 75 | - | 50 | 64.0 |
| DIFF. | 25 | - | - | 82.0 |

| HEAT LOAD SUMMARY | TR | HP |
|---|---|---|
| GRAND TOTAL HEAT | 1.4 | |
| DEHUMIDIFIED AIR Cfm | 398 | |
| TONS AS PER Cfm | 1.0 | |
| TONNAGE REQUIRED | 1.4 | 1.67 |
| CFM PER SQFT | 1.99 | |
| AREA PER TON | 144 | |

| SUN GAIN | AREA | or T.DIFF. | FACTOR | | BTU |
|---|---|---|---|---|---|
| **SOLAR GAIN-GLASS** | | | | | |
| NORTH | 0 | 11 | 0.56 | | 0 |
| SOUTH | 0 | 11 | 0.56 | | 0 |
| EAST | 0 | 11 | 0.56 | | 0 |
| WEST | 0 | 165 | 0.56 | | 0 |
| N-E | 0 | 11 | 0.56 | | 0 |
| N-W | 0 | 118 | 0.56 | | 0 |
| S-E | 0 | 11 | 0.56 | | 0 |
| S-W | 0 | 113 | 0.56 | | 0 |
| **SOLAR & TRANSMISSION GAIN** | | | | | |
| NORTH | 0 | 20 | 0.34 | | 0 |
| SOUTH | 0 | 36 | 0.34 | | 0 |
| EAST | 0 | 22 | 0.34 | | 0 |
| WEST | 0 | 36 | 0.34 | | 0 |
| N-E | 0 | 17 | 0.34 | | 0 |
| N-W | 0 | 13 | 0.34 | | 0 |
| S-E | 0 | 25 | 0.34 | | 0 |
| S-W | 0 | 21 | 0.34 | | 0 |
| ROOF | 200 | 51 | 0.15 | 0 | 0 |
| **OTHER TRANSMISSION GAIN** | | | | | |
| AGLS | 0 | 25 | 1.13 | | 0 |
| PART | 176 | 20 | 0.34 | | 1197 |
| CEIL | 200 | 20 | 0.34 | 1 | 1360 |
| FLOR | 200 | 20 | 0.34 | 1 | 1360 |
| **BYPASS O.A. SENSIBLE LOAD** | CFM | T.DIFF. | FACTOR | | |
| | 73 | 25 | 0.08 | 1.08 | 158 |
| **INTERNAL SENSIBLE LOAD** | | | | | |
| PEOPLE | 7 | 245 | | | 1715 |
| APPL. | 250 | 3.4 | | | 850 |
| LIGHTS | 300 | 3.4 | | 1.25 | 1275 |
| FOOD | 0 | 60 | | | 0 |
| SUB TOTAL | | | | | 7915 |
| LEAK LOSS +SAFETY FACTOR=5% | | | | | 396 |
| ROOM SENSIBLE HEAT | | | | | 8707 |

| BYPASS O.A. LATENT LOAD | CFM | G.DIFF | BYPASS | FACTOR | BTU |
|---|---|---|---|---|---|
| | 73 | 82 | 0.08 | 0.68 | 327 |
| **INTERNAL LATENT LOAD** | | | | | |
| PEOPLE | 7 | 205 | | | 1435 |
| SUB TOTAL | | | | | 1762 |
| SAFETY FACTOR=5% | | | | | 88 |
| ROOM LATENT HEAT | | | | | 1850 |
| ROOM TOTAL HEAT | | | | | 10557 |
| **OUTSIDE AIR HEAT** | CFM | G.DIFF | 1-B.F. | FACTOR | |
| SENS | 73 | 25 | 0.92 | 1.08 | 1822 |
| LAT | 73 | 82 | 0.92 | 0.68 | 3762 |
| SUB TOTAL | | | | | 5584 |
| TOTAL | | | | | 16140 |
| HEAT GAIN SAFETY FACTOR @ 3% | | | | | 484 |
| GRAND TOTAL HEAT | | | (TONS) | 1.4 | 16625 |
| SENSIBLE HEAT FACTOR | | | | | 0.82 |
| SELECTED A.D.P. | | | | | 52 |
| DEHUMIDIFIED RISE | | | | | 20 |
| DEHUMIDIFIED AIR Cfm | | | | | 398 |
| TONS AS PER Cfm | | | | | 1.0 |

| CHECK RESULTS. | |
|---|---|
| GRAND TOTAL HEAT(BTU/HR/SQFT.) | 83.12 |
| ROOM SENSIBLE HEAT(BTU/HR/SQFT.) | 43.53 |
| SQFT/PERSON | 28.57 |
| TONS PER SQFT | 0.01 |
| CFM PER SQFT | 1.99 |
| TONS/PERSON | 0.20 |
| DEHUMIDIFIED CFM/TON | 287.51 |
| AREA PER TON | 144.36 |

JOB : GROUND FLOOR

SPACE : ITO - 1

| HEAT LOAD CALCULATIONS | |
|---|---|
| DATE | 3/10/2020 |
| TIME | 18:13 |

**DESIGN DATA**

| | |
|---|---|
| AREA: | 190 |
| HT.OF THE AREA: | 11 |
| LIGHTING (WATTS/SQFT) | 1.5 |
| NO.OF AIR CHANGE REQUIRED | 2 |
| Cfm VENTILATION | 70 |
| Cfm/PERSON | 10 |
| NO.OF PEOPLE | 6 |
| Cfm VENTILATION | 60 |
| Cfm VENTILATION IN CAL. | 70 |

| | D.B. | W.B. | %RH | GR/LB |
|---|---|---|---|---|
| OUTSIDE | 100 | 83 | 60 | 146 |
| INSIDE | 75 | - | 50 | 64.0 |
| DIFF. | 25 | - | - | 82.0 |

| HEAT LOAD SUMMARY | TR | HP |
|---|---|---|
| GRAND TOTAL HEAT | 1.6 | |
| DEHUMIDIFIED AIR Cfm | 545 | |
| TONS AS PER Cfm | 1.4 | |
| TONNAGE REQUIRED | 1.6 | 1.95 |
| CFM PER SQFT | 2.87 | |
| AREA PER TON | 118 | |

| | SUN GAIN AREA or | T.DIFF. | FACTOR | | BTU |
|---|---|---|---|---|---|
| **SOLAR GAIN-GLASS** | | | | | |
| NORTH | 44 | 11 | 0.56 | | 273 |
| SOUTH | 0 | 11 | 0.56 | | 0 |
| EAST | 0 | 11 | 0.56 | | 0 |
| WEST | 0 | 165 | 0.56 | | 0 |
| N-E | 0 | 11 | 0.56 | | 0 |
| N-W | 0 | 118 | 0.56 | | 0 |
| S-E | 0 | 11 | 0.56 | | 0 |
| S-W | 0 | 113 | 0.56 | | 0 |
| **SOLAR & TRANSMISSION GAIN** | | | | | |
| NORTH | 78 | 20 | 0.34 | | 527 |
| SOUTH | 0 | 36 | 0.34 | | 0 |
| EAST | 0 | 22 | 0.34 | | 0 |
| WEST | 0 | 36 | 0.34 | | 0 |
| N-E | 0 | 17 | 0.34 | | 0 |
| N-W | 0 | 13 | 0.34 | | 0 |
| S-E | 0 | 25 | 0.34 | | 0 |
| S-W | 0 | 21 | 0.34 | | 0 |
| ROOF | 190 | 51 | 0.15 | 0 | 0 |
| **OTHER TRANSMISSION GAIN** | | | | | |
| AGLS | 44 | 25 | 1.13 | | 1252 |
| PART | 369 | 20 | 0.34 | | 2507 |
| CEIL | 190 | 20 | 0.34 | 1 | 1292 |
| FLOR | 190 | 20 | 0.34 | 1 | 1292 |
| **BYPASS O.A. SENSIBLE LOAD** | CFM | T.DIFF. | FACTOR | | |
| | 70 | 25 | 0.08 | 1.08 | 150 |
| **INTERNAL SENSIBLE LOAD** | | | | | |
| PEOPLE | 6 | 245 | | | 1470 |
| APPL. | 250 | 3.4 | | | 850 |
| LIGHTS | 285 | 3.4 | | 1.25 | 1211 |
| FOOD | 0 | 60 | | | 0 |
| SUB TOTAL | | | | | 10825 |
| LEAK LOSS +SAFETY FACTOR=5% | | | | | 541 |
| ROOM SENSIBLE HEAT | | | | | 11908 |

| BYPASS O.A. LATENT LOAD | CFM | G.DIFF | BYPASS | FACTOR | BTU |
|---|---|---|---|---|---|
| | 70 | 82 | 0.08 | 0.68 | 311 |
| **INTERNAL LATENT LOAD** | | | | | |
| PEOPLE | 6 | 205 | | | 1230 |
| SUB TOTAL | | | | | 1541 |
| SAFETY FACTOR=5% | | | | | 77 |
| ROOM LATENT HEAT | | | | | 1618 |
| ROOM TOTAL HEAT | | | | | 13526 |
| **OUTSIDE AIR HEAT** | CFM | G.DIFF | 1-B.F. | FACTOR | |
| SENS | 70 | 25 | 0.92 | 1.08 | 1731 |
| LAT | 70 | 82 | 0.92 | 0.68 | 3574 |
| SUB TOTAL | | | | | 5304 |
| TOTAL | | | | | 18830 |
| HEAT GAIN SAFETY FACTOR @ 3% | | | | | 565 |
| GRAND TOTAL HEAT | | | (TONS) | 1.6 | 19395 |
| SENSIBLE HEAT FACTOR | | | | | 0.88 |
| SELECTED A.D.P. | | | | | 52 |
| DEHUMIDIFIED RISE | | | | | 20 |
| DEHUMIDIFIED AIR Cfm | | | | | 545 |
| TONS AS PER Cfm | | | | | 1.4 |

| CHECK RESULTS. | |
|---|---|
| GRAND TOTAL HEAT(BTU/HR/SQFT.) | 102.08 |
| ROOM SENSIBLE HEAT(BTU/HR/SQFT.) | 62.67 |
| SQFT/PERSON | 31.67 |
| TONS PER SQFT | 0.01 |
| CFM PER SQFT | 2.87 |
| TONS/PERSON | 0.27 |
| DEHUMIDIFIED CFM/TON | 337.05 |
| AREA PER TON | 117.56 |

JOB : GROUND FLOOR

SPACE : ITO -2

| HEAT LOAD CALCULATIONS | |
|---|---|
| DATE | 3/10/2020 |
| TIME | 18:16 |

**DESIGN DATA**

| | |
|---|---|
| AREA: | 190 |
| HT.OF THE AREA: | 11 |
| LIGHTING (WATTS/SQFT) | 1.5 |
| NO.OF AIR CHANGE REQUIRED | 2 |
| Cfm VENTILATION | 70 |
| Cfm/PERSON | 10 |
| NO.OF PEOPLE | 6 |
| Cfm VENTILATION | 60 |
| Cfm VENTILATION IN CAL. | 70 |

| | D.B. | W.B. | %RH | GR/LB |
|---|---|---|---|---|
| OUTSIDE | 100 | 83 | 60 | 146 |
| INSIDE | 75 | - | 50 | 64.0 |
| DIFF. | 25 | - | - | 82.0 |

| HEAT LOAD SUMMARY | TR | HP |
|---|---|---|
| GRAND TOTAL HEAT | 1.4 | |
| DEHUMIDIFIED AIR Cfm | 413 | |
| TONS AS PER Cfm | 1.0 | |
| TONNAGE REQUIRED | 1.4 | 1.65 |
| CFM PER SQFT | 2.18 | |
| AREA PER TON | 139 | |

| | AREA | SUN GAIN or T.DIFF. | FACTOR | | BTU |
|---|---|---|---|---|---|
| **SOLAR GAIN-GLASS** | | | | | |
| NORTH | 42 | 11 | 0.56 | | 257 |
| SOUTH | 0 | 11 | 0.56 | | 0 |
| EAST | 0 | 11 | 0.56 | | 0 |
| WEST | 0 | 165 | 0.56 | | 0 |
| N-E | 0 | 11 | 0.56 | | 0 |
| N-W | 0 | 118 | 0.56 | | 0 |
| S-E | 0 | 11 | 0.56 | | 0 |
| S-W | 0 | 113 | 0.56 | | 0 |
| **SOLAR & TRANSMISSION GAIN** | | | | | |
| NORTH | 81 | 20 | 0.34 | | 554 |
| SOUTH | 0 | 36 | 0.34 | | 0 |
| EAST | 0 | 22 | 0.34 | | 0 |
| WEST | 0 | 36 | 0.34 | | 0 |
| N-E | 0 | 17 | 0.34 | | 0 |
| N-W | 0 | 13 | 0.34 | | 0 |
| S-E | 0 | 25 | 0.34 | | 0 |
| S-W | 0 | 21 | 0.34 | | 0 |
| ROOF | 190 | 51 | 0.15 | 0 | 0 |
| **OTHER TRANSMISSION GAIN** | | | | | |
| AGLS | 42 | 25 | 1.13 | | 1179 |
| PART | 184 | 20 | 0.34 | | 1254 |
| CEIL | 190 | 20 | 0.34 | 1 | 1292 |
| FLOR | 190 | 20 | 0.34 | 0 | 0 |
| **BYPASS O.A. SENSIBLE LOAD** | CFM | T.DIFF. | FACTOR | | |
| | 70 | 25 | 0.08 | 1.08 | 150 |
| **INTERNAL SENSIBLE LOAD** | | | | | |
| PEOPLE | 6 | 245 | | | 1470 |
| APPL. | 250 | 3.4 | | | 850 |
| LIGHTS | 285 | 3.4 | | 1.25 | 1211 |
| FOOD | 0 | 60 | | | 0 |
| SUB TOTAL | | | | | 8217 |
| LEAK LOSS +SAFETY FACTOR=5% | | | | | 411 |
| ROOM SENSIBLE HEAT | | | | | 9038 |

| **BYPASS O.A. LATENT LOAD** | CFM | G.DIFF | BYPASS | FACTOR | BTU |
|---|---|---|---|---|---|
| | 70 | 82 | 0.08 | 0.68 | 311 |
| **INTERNAL LATENT LOAD** | | | | | |
| PEOPLE | 6 | 205 | | | 1230 |
| SUB TOTAL | | | | | 1541 |
| SAFETY FACTOR=5% | | | | | 77 |
| ROOM LATENT HEAT | | | | | 1618 |
| ROOM TOTAL HEAT | | | | | 10656 |
| **OUTSIDE AIR HEAT** | CFM | G.DIFF | 1-B.F. | FACTOR | |
| SENS | 70 | 25 | 0.92 | 1.08 | 1731 |
| LAT | 70 | 82 | 0.92 | 0.68 | 3574 |
| SUB TOTAL | | | | | 5304 |
| TOTAL | | | | | 15960 |
| HEAT GAIN SAFETY FACTOR @ 3% | | | | | 479 |
| GRAND TOTAL HEAT | | | (TONS) | 1.4 | 16439 |

| | |
|---|---|
| SENSIBLE HEAT FACTOR | 0.85 |
| SELECTED A.D.P. | 52 |
| DEHUMIDIFIED RISE | 20 |
| DEHUMIDIFIED AIR Cfm | 413 |
| TONS AS PER Cfm | 1.0 |

| CHECK RESULTS. | |
|---|---|
| GRAND TOTAL HEAT(BTU/HR/SQFT.) | 86.52 |
| ROOM SENSIBLE HEAT(BTU/HR/SQFT.) | 47.57 |
| SQFT/PERSON | 31.67 |
| TONS PER SQFT | 0.01 |
| CFM PER SQFT | 2.18 |
| TONS/PERSON | 0.23 |
| DEHUMIDIFIED CFM/TON | 301.82 |
| AREA PER TON | 138.69 |

**JOB : GROUND FLOOR**

**SPACE : ITO - 3**

| HEAT LOAD CALCULATIONS | |
|---|---|
| DATE | 3/10/2020 |
| TIME | 18:32 |

| DESIGN DATA | |
|---|---|
| AREA: | 190 |
| HT.OF THE AREA: | 11 |
| LIGHTING (WATTS/SQFT) | 1.5 |
| NO.OF AIR CHANGE REQUIRED | 2 |
| Cfm VENTILATION | 70 |
| Cfm/PERSON | 10 |
| NO.OF PEOPLE | 6 |
| Cfm VENTILATION | 60 |
| Cfm VENTILATION IN CAL. | 70 |

| | D.B. | W.B. | %RH | GR/LB |
|---|---|---|---|---|
| OUTSIDE | 100 | 83 | 60 | 146 |
| INSIDE | 75 | - | 50 | 64.0 |
| DIFF. | 25 | - | - | 82.0 |

| HEAT LOAD SUMMARY | TR | HP |
|---|---|---|
| GRAND TOTAL HEAT | 1.5 | |
| DEHUMIDIFIED AIR Cfm | 507 | |
| TONS AS PER Cfm | 1.3 | |
| TONNAGE REQUIRED | 1.5 | 1.86 |
| CFM PER SQFT | 2.67 | |
| AREA PER TON | 123 | |

| SUN GAIN | AREA | or T.DIFF. | FACTOR | | BTU |
|---|---|---|---|---|---|
| **SOLAR GAIN-GLASS** | | | | | |
| NORTH | 39 | 11 | 0.56 | | 238 |
| SOUTH | 0 | 11 | 0.56 | | 0 |
| EAST | 57 | 11 | 0.56 | | 351 |
| WEST | 0 | 165 | 0.56 | | 0 |
| N-E | 0 | 11 | 0.56 | | 0 |
| N-W | 0 | 118 | 0.56 | | 0 |
| S-E | 0 | 11 | 0.56 | | 0 |
| S-W | 0 | 113 | 0.56 | | 0 |
| **SOLAR & TRANSMISSION GAIN** | | | | | |
| NORTH | 81 | 20 | 0.34 | | 553 |
| SOUTH | 0 | 36 | 0.34 | | 0 |
| EAST | 0 | 22 | 0.34 | | 0 |
| WEST | 0 | 36 | 0.34 | | 0 |
| N-E | 0 | 17 | 0.34 | | 0 |
| N-W | 0 | 13 | 0.34 | | 0 |
| S-E | 0 | 25 | 0.34 | | 0 |
| S-W | 0 | 21 | 0.34 | | 0 |
| ROOF | 190 | 51 | 0.15 | 0 | 0 |
| **OTHER TRANSMISSION GAIN** | | | | | |
| AGLS | 96 | 25 | 1.13 | | 2703 |
| PART | 184 | 20 | 0.34 | | 1254 |
| CEIL | 190 | 20 | 0.34 | 1 | 1292 |
| FLOR | 190 | 20 | 0.34 | 0 | 0 |
| **BYPASS O.A. SENSIBLE LOAD** | CFM | T.DIFF. | FACTOR | | |
| | 70 | 25 | 0.08 | 1.08 | 150 |
| **INTERNAL SENSIBLE LOAD** | | | | | |
| PEOPLE | 6 | 245 | | | 1470 |
| APPL. | 250 | 3.4 | | | 850 |
| LIGHTS | 285 | 3.4 | | 1.25 | 1211 |
| FOOD | 0 | 60 | | | 0 |
| SUB TOTAL | | | | | 10073 |
| LEAK LOSS +SAFETY FACTOR=5% | | | | | 504 |
| ROOM SENSIBLE HEAT | | | | | 11080 |

| BYPASS O.A. LATENT LOAD | CFM | G.DIFF | BYPASS | FACTOR | BTU |
|---|---|---|---|---|---|
| | 70 | 82 | 0.08 | 0.68 | 311 |
| **INTERNAL LATENT LOAD** | | | | | |
| PEOPLE | 6 | 205 | | | 1230 |
| SUB TOTAL | | | | | 1541 |
| SAFETY FACTOR=5% | | | | | 77 |
| ROOM LATENT HEAT | | | | | 1618 |
| ROOM TOTAL HEAT | | | | | 12698 |
| **OUTSIDE AIR HEAT** | CFM | G.DIFF | 1-B.F. | FACTOR | |
| SENS | 70 | 25 | 0.92 | 1.08 | 1731 |
| LAT | 70 | 82 | 0.92 | 0.68 | 3574 |
| SUB TOTAL | | | | | 5304 |
| TOTAL | | | | | 18002 |
| HEAT GAIN SAFETY FACTOR @ 3% | | | | | 540 |
| GRAND TOTAL HEAT | | | (TONS) | 1.5 | 18542 |
| SENSIBLE HEAT FACTOR | | | | | 0.87 |
| SELECTED A.D.P. | | | | | 52 |
| DEHUMIDIFIED RISE | | | | | 20 |
| DEHUMIDIFIED AIR Cfm | | | | | 507 |
| TONS AS PER Cfm | | | | | 1.3 |

| CHECK RESULTS. | |
|---|---|
| GRAND TOTAL HEAT(BTU/HR/SQFT.) | 97.59 |
| ROOM SENSIBLE HEAT(BTU/HR/SQFT.) | 58.32 |
| SQFT/PERSON | 31.67 |
| TONS PER SQFT | 0.01 |
| CFM PER SQFT | 2.67 |
| TONS/PERSON | 0.26 |
| DEHUMIDIFIED CFM/TON | 328.04 |
| AREA PER TON | 122.96 |

JOB : GROUND FLOOR

SPACE : ITO - 4

| HEAT LOAD CALCULATIONS | |
|---|---|
| DATE | 3/10/2020 |
| TIME | 18:32 |

**DESIGN DATA**

| | |
|---|---|
| AREA: | 190 |
| HT.OF THE AREA: | 11 |
| LIGHTING (WATTS/SQFT) | 1.5 |
| NO.OF AIR CHANGE REQUIRED | 2 |
| Cfm VENTILATION | 70 |
| Cfm/PERSON | 10 |
| NO.OF PEOPLE | 6 |
| Cfm VENTILATION | 60 |
| Cfm VENTILATION IN CAL. | 70 |

| | D.B. | W.B. | %RH | GR/LB |
|---|---|---|---|---|
| OUTSIDE | 100 | 83 | 60 | 146 |
| INSIDE | 75 | - | 50 | 64.0 |
| DIFF. | 25 | - | - | 82.0 |

| HEAT LOAD SUMMARY | TR | HP |
|---|---|---|
| GRAND TOTAL HEAT | 1.6 | |
| DEHUMIDIFIED AIR Cfm | 530 | |
| TONS AS PER Cfm | 1.3 | |
| TONNAGE REQUIRED | 1.6 | 1.91 |
| CFM PER SQFT | 2.79 | |
| AREA PER TON | 120 | |

| | AREA | SUN GAIN or T.DIFF. | FACTOR | | BTU |
|---|---|---|---|---|---|
| **SOLAR GAIN-GLASS** | | | | | |
| NORTH | 39 | 11 | 0.56 | | 238 |
| SOUTH | 0 | 11 | 0.56 | | 0 |
| EAST | 32 | 11 | 0.56 | | 200 |
| WEST | 0 | 165 | 0.56 | | 0 |
| N-E | 0 | 11 | 0.56 | | 0 |
| N-W | 0 | 118 | 0.56 | | 0 |
| S-E | 0 | 11 | 0.56 | | 0 |
| S-W | 0 | 113 | 0.56 | | 0 |
| **SOLAR & TRANSMISSION GAIN** | | | | | |
| NORTH | 92 | 20 | 0.34 | | 626 |
| SOUTH | 0 | 36 | 0.34 | | 0 |
| EAST | 160 | 22 | 0.34 | | 1198 |
| WEST | 0 | 36 | 0.34 | | 0 |
| N-E | 0 | 17 | 0.34 | | 0 |
| N-W | 0 | 13 | 0.34 | | 0 |
| S-E | 0 | 25 | 0.34 | | 0 |
| S-W | 0 | 21 | 0.34 | | 0 |
| ROOF | 190 | 51 | 0.15 | 0 | 0 |
| **OTHER TRANSMISSION GAIN** | | | | | |
| AGLS | 71 | 25 | 1.13 | | 2010 |
| PART | 0 | 20 | 0.34 | | 0 |
| CEIL | 190 | 20 | 0.34 | 1 | 1292 |
| FLOR | 190 | 20 | 0.34 | 1 | 1292 |

**BYPASS O.A. SENSIBLE LOAD**

| CFM | T.DIFF. | FACTOR | | |
|---|---|---|---|---|
| 70 | 25 | 0.08 | 1.08 | 150 |

**INTERNAL SENSIBLE LOAD**

| | | | | |
|---|---|---|---|---|
| PEOPLE | 6 | 245 | | 1470 |
| APPL. | 250 | 3.4 | | 850 |
| LIGHTS | 285 | 3.4 | 1.25 | 1211 |
| FOOD | 0 | 60 | | 0 |
| SUB TOTAL | | | | 10538 |
| LEAK LOSS +SAFETY FACTOR=5% | | | | 527 |
| ROOM SENSIBLE HEAT | | | | 11592 |

**BYPASS O.A. LATENT LOAD**

| CFM | G.DIFF | BYPASS | FACTOR | BTU |
|---|---|---|---|---|
| 70 | 82 | 0.08 | 0.68 | 311 |

**INTERNAL LATENT LOAD**

| | | | |
|---|---|---|---|
| PEOPLE | 6 | 205 | 1230 |
| SUB TOTAL | | | 1541 |
| SAFETY FACTOR=5% | | | 77 |
| ROOM LATENT HEAT | | | 1618 |
| ROOM TOTAL HEAT | | | 13210 |

**OUTSIDE AIR HEAT**

| | CFM | G.DIFF | 1-B.F. | FACTOR | |
|---|---|---|---|---|---|
| SENS | 70 | 25 | 0.92 | 1.08 | 1731 |
| LAT | 70 | 82 | 0.92 | 0.68 | 3574 |
| SUB TOTAL | | | | | 5304 |
| TOTAL | | | | | 18514 |
| HEAT GAIN SAFETY FACTOR @ 3% | | | | | 555 |
| GRAND TOTAL HEAT | | | (TONS) | 1.6 | 19070 |

| | |
|---|---|
| SENSIBLE HEAT FACTOR | 0.88 |
| SELECTED A.D.P. | 52 |
| DEHUMIDIFIED RISE | 20 |
| DEHUMIDIFIED AIR Cfm | 530 |
| TONS AS PER Cfm | 1.3 |

**CHECK RESULTS.**

| | |
|---|---|
| GRAND TOTAL HEAT(BTU/HR/SQFT.) | 100.37 |
| ROOM SENSIBLE HEAT(BTU/HR/SQFT.) | 61.01 |
| SQFT/PERSON | 31.67 |
| TONS PER SQFT | 0.01 |
| CFM PER SQFT | 2.79 |
| TONS/PERSON | 0.26 |
| DEHUMIDIFIED CFM/TON | 333.71 |
| AREA PER TON | 119.56 |

| | | | | | |
|---|---|---|---|---|---|
| JOB : | GROUND FLOOR | | | | |
| SPACE : | STAFF AREA - 2 | | | | |

| HEAT LOAD CALCULATIONS | |
|---|---|
| DATE | 3/10/2020 |
| TIME | 18:32 |

| DESIGN DATA | | | | |
|---|---|---|---|---|
| AREA: | | | | 1200 |
| HT.OF THE AREA: | | | | 11 |
| LIGHTING (WATTS/SQFT) | | | | 1.5 |
| NO.OF AIR CHANGE REQUIRED | | | | 2 |
| Cfm VENTILATION | | | | 440 |
| Cfm/PERSON | | | | 10 |
| NO.OF PEOPLE | | | | 30 |
| Cfm VENTILATION | | | | 300 |
| Cfm VENTILATION IN CAL. | | | | 440 |
| | D.B. | W.B. | %RH | GR/LB |
| OUTSIDE | 100 | 83 | 60 | 146.0 |
| INSIDE | 75 | - | 50 | 64.0 |
| DIFF. | 25 | - | - | 82.0 |

| HEAT LOAD SUMMARY | TR | HP |
|---|---|---|
| GRAND TOTAL HEAT | 9.6 | |
| DEHUMIDIFIED AIR Cfm | 3180 | |
| TONS AS PER Cfm | 8.0 | |
| TONNAGE REQUIRED | 9.6 | 11.53 |
| CFM PER SQFT | 2.65 | |
| AREA PER TON | 125 | |

| | AREA | SUN GAIN or T.DIFF. | FACTOR | | BTU |
|---|---|---|---|---|---|
| **SOLAR GAIN-GLASS** | | | | | |
| NORTH | 141 | 11 | 0.56 | | 871 |
| SOUTH | 0 | 11 | 0.56 | | 0 |
| EAST | 0 | 11 | 0.56 | | 0 |
| WEST | 0 | 165 | 0.56 | | 0 |
| N-E | 0 | 11 | 0.56 | | 0 |
| N-W | 0 | 118 | 0.56 | | 0 |
| S-E | 0 | 11 | 0.56 | | 0 |
| S-W | 0 | 113 | 0.56 | | 0 |
| **SOLAR & TRANSMISSION GAIN** | | | | | |
| NORTH | 112 | 20 | 0.34 | | 758 |
| SOUTH | 0 | 36 | 0.34 | | 0 |
| EAST | 0 | 22 | 0.34 | | 0 |
| WEST | 0 | 36 | 0.34 | | 0 |
| N-E | 0 | 17 | 0.34 | | 0 |
| N-W | 0 | 13 | 0.34 | | 0 |
| S-E | 0 | 25 | 0.34 | | 0 |
| S-W | 0 | 21 | 0.34 | | 0 |
| ROOF | 1200 | 51 | 0.15 | 0 | 0 |
| **OTHER TRANSMISSION GAIN** | | | | | |
| AGLS | 141 | 25 | 1.13 | | 3996 |
| PART | 1221 | 20 | 0.34 | | 8303 |
| CEIL | 1200 | 20 | 0.34 | 1 | 8160 |
| FLOR | 1200 | 20 | 0.34 | 1 | 8160 |
| **BYPASS O.A. SENSIBLE LOAD** | | | | | |
| | CFM | T.DIFF. | FACTOR | | |
| | 440 | 25 | 0.08 | 1.08 | 950 |
| **INTERNAL SENSIBLE LOAD** | | | | | |
| PEOPLE | 30 | 245 | | | 7350 |
| APPL. | 5000 | 3.4 | | | 17000 |
| LIGHTS | 1800 | 3.4 | | 1.25 | 7650 |
| FOOD | 0 | 60 | | | 0 |
| SUB TOT/ | 55 | | | | 63199 |
| LEAK LOSS +SAFETY FACTOR=5% | | | | | 3160 |
| ROOM SENSIBLE HEAT | | | | | 69519 |

| | CFM | G.DIFF | BYPASS / 1-B.F. | FACTOR | BTU |
|---|---|---|---|---|---|
| **BYPASS O.A. LATENT LOAD** | | | | | |
| | 440 | 82 | 0.08 | 0.68 | 1963 |
| **INTERNAL LATENT LOAD** | | | | | |
| PEOPLE | 30 | 205 | | | 6150 |
| SUB TOTAL | | | | | 8113 |
| SAFETY FACTOR=5% | | | | | 406 |
| ROOM LATENT HEAT | | | | | 8518 |
| ROOM TOTAL HEAT | | | | | 78038 |
| **OUTSIDE AIR HEAT** | | | | | |
| | CFM | G.DIFF | 1-B.F. | FACTOR | |
| SENS | 440 | 25 | 0.92 | 1.08 | 10930 |
| LAT | 440 | 82 | 0.92 | 0.68 | 22572 |
| SUB TOTAL | | | | | 33501 |
| TOTAL | | | | | 111539 |
| HEAT GAIN SAFETY FACTOR @ 3% | | | | | 3346 |
| GRAND TOTAL HEAT | | | (TONS) | 9.6 | 114885 |
| SENSIBLE HEAT FACTOR | | | | | 0.89 |
| SELECTED A.D.P. | | | | | 52 |
| DEHUMIDIFIED RISE | | | | | 20 |
| DEHUMIDIFIED AIR Cfm | | | | | 3180 |
| TONS AS PER Cfm | | | | | 8.0 |
| **CHECK RESULTS.** | | | | | |
| GRAND TOTAL HEAT(BTU/HR/SQFT.) | | | | | 95.74 |
| ROOM SENSIBLE HEAT(BTU/HR/SQFT.) | | | | | 57.93 |
| SQFT/PERSON | | | | | 40.00 |
| TONS PER SQFT | | | | | 0.01 |
| CFM PER SQFT | | | | | 2.65 |
| TONS/PERSON | | | | | 0.32 |
| DEHUMIDIFIED CFM/TON | | | | | 332.19 |
| AREA PER TON | | | | | 125.34 |

JOB : GROUND FLOOR

SPACE : CIT A

| HEAT LOAD CALCULATIONS | |
|---|---|
| DATE | 3/10/2020 |
| TIME | 18:32 |

| DESIGN DATA | |
|---|---|
| AREA: | 270 |
| HT.OF THE AREA: | 11 |
| LIGHTING (WATTS/SQFT) | 1.5 |
| NO.OF AIR CHANGE REQUIRED | 2 |
| Cfm VENTILATION | 99 |
| Cfm/PERSON | 10 |
| NO.OF PEOPLE | 10 |
| Cfm VENTILATION | 100 |
| Cfm VENTILATION IN CAL. | 100 |

| | D.B. | W.B. | %RH | GR/LB |
|---|---|---|---|---|
| OUTSIDE | 100 | 83 | 60 | 146 |
| INSIDE | 75 | - | 50 | 64.0 |
| DIFF. | 25 | - | - | 82.0 |

| HEAT LOAD SUMMARY | TR | HP |
|---|---|---|
| GRAND TOTAL HEAT | 2.3 | |
| DEHUMIDIFIED AIR Cfm | 745 | |
| TONS AS PER Cfm | 1.9 | |
| TONNAGE REQUIRED | 2.3 | 2.74 |
| CFM PER SQFT | 2.76 | |
| AREA PER TON | 119 | |

| | AREA | SUN GAIN or T.DIFF. | FACTOR | | BTU |
|---|---|---|---|---|---|
| **SOLAR GAIN-GLASS** | | | | | |
| NORTH | 26 | 11 | 0.56 | | 158 |
| SOUTH | 0 | 11 | 0.56 | | 0 |
| EAST | 51 | 11 | 0.56 | | 317 |
| WEST | 0 | 165 | 0.56 | | 0 |
| N-E | 0 | 11 | 0.56 | | 0 |
| N-W | 0 | 118 | 0.56 | | 0 |
| S-E | 0 | 11 | 0.56 | | 0 |
| S-W | 0 | 113 | 0.56 | | 0 |
| **SOLAR & TRANSMISSION GAIN** | | | | | |
| NORTH | 130 | 20 | 0.34 | | 883 |
| SOUTH | 0 | 36 | 0.34 | | 0 |
| EAST | 181 | 22 | 0.34 | | 1357 |
| WEST | 0 | 36 | 0.34 | | 0 |
| N-E | 0 | 17 | 0.34 | | 0 |
| N-W | 0 | 13 | 0.34 | | 0 |
| S-E | 0 | 25 | 0.34 | | 0 |
| S-W | 0 | 21 | 0.34 | | 0 |
| ROOF | 270 | 51 | 0.15 | 0 | 0 |
| **OTHER TRANSMISSION GAIN** | | | | | |
| AGLS | 77 | 25 | 1.13 | | 2180 |
| PART | 147 | 20 | 0.34 | | 998 |
| CEIL | 270 | 20 | 0.34 | 1 | 1836 |
| FLOR | 270 | 20 | 0.34 | 1 | 1836 |
| **BYPASS O.A. SENSIBLE LOAD** | CFM | T.DIFF. | FACTOR | | |
| | 100 | 25 | 0.08 | 1.08 | 216 |
| **INTERNAL SENSIBLE LOAD** | | | | | |
| PEOPLE | 10 | 245 | | | 2450 |
| APPL. | 250 | 3.4 | | | 850 |
| LIGHTS | 405 | 3.4 | | 1.25 | 1721 |
| FOOD | 0 | 60 | | | 0 |
| SUB TOTAL | | | | | 14802 |
| LEAK LOSS +SAFETY FACTOR=5% | | | | | 740 |
| ROOM SENSIBLE HEAT | | | | | 16282 |

| BYPASS O.A. LATENT LOAD | CFM | G.DIFF | BYPASS | FACTOR | BTU |
|---|---|---|---|---|---|
| | 100 | 82 | 0.08 | 0.68 | 446 |
| **INTERNAL LATENT LOAD** | | | | | |
| PEOPLE | 10 | 205 | | | 2050 |
| SUB TOTAL | | | | | 2496 |
| SAFETY FACTOR=5% | | | | | 125 |
| ROOM LATENT HEAT | | | | | 2621 |
| ROOM TOTAL HEAT | | | | | 18903 |
| **OUTSIDE AIR HEAT** | CFM | G.DIFF | 1-B.F. | FACTOR | |
| SENS | 100 | 25 | 0.92 | 1.08 | 2484 |
| LAT | 100 | 82 | 0.92 | 0.68 | 5130 |
| SUB TOTAL | | | | | 7614 |
| TOTAL | | | | | 26517 |
| HEAT GAIN SAFETY FACTOR @ 3% | | | | | 796 |
| GRAND TOTAL HEAT | | (TONS) | | 2.3 | 27313 |
| SENSIBLE HEAT FACTOR | | | | | 0.86 |
| SELECTED A.D.P. | | | | | 52 |
| DEHUMIDIFIED RISE | | | | | 20 |
| DEHUMIDIFIED AIR Cfm | | | | | 745 |
| TONS AS PER Cfm | | | | | 1.9 |

| CHECK RESULTS. | |
|---|---|
| GRAND TOTAL HEAT(BTU/HR/SQFT.) | 101.16 |
| ROOM SENSIBLE HEAT(BTU/HR/SQFT.) | 60.30 |
| SQFT/PERSON | 27.00 |
| TONS PER SQFT | 0.01 |
| CFM PER SQFT | 2.76 |
| TONS/PERSON | 0.23 |
| DEHUMIDIFIED CFM/TON | 327.26 |
| AREA PER TON | 118.63 |

JOB : GROUND FLOOR

SPACE : AO AND PSA

| HEAT LOAD CALCULATIONS | |
|---|---|
| DATE | 3/10/2020 |
| TIME | 18:32 |

| DESIGN DATA | |
|---|---|
| AREA: | 240 |
| HT.OF THE AREA: | 11 |
| LIGHTING (WATTS/SQFT) | 1.5 |
| NO.OF AIR CHANGE REQUIRED | 2 |
| Cfm VENTILATION | 88 |
| Cfm/PERSON | 10 |
| NO.OF PEOPLE | 6 |
| Cfm VENTILATION | 60 |
| Cfm VENTILATION IN CAL. | 88 |

| | D.B. | W.B. | %RH | GR/LB |
|---|---|---|---|---|
| OUTSIDE | 100 | 83 | 60 | 146 |
| INSIDE | 75 | - | 50 | 64.0 |
| DIFF. | 25 | - | - | 82.0 |

| HEAT LOAD SUMMARY | TR | HP |
|---|---|---|
| GRAND TOTAL HEAT | 1.9 | |
| DEHUMIDIFIED AIR Cfm | 602 | |
| TONS AS PER Cfm | 1.5 | |
| TONNAGE REQUIRED | 1.9 | 2.23 |
| CFM PER SQFT | 2.51 | |
| AREA PER TON | 130 | |

| SUN GAIN | AREA | or T.DIFF. | FACTOR | | BTU |
|---|---|---|---|---|---|
| **SOLAR GAIN-GLASS** | | | | | |
| NORTH | 0 | 11 | 0.56 | | 0 |
| SOUTH | 0 | 11 | 0.56 | | 0 |
| EAST | 51 | 11 | 0.56 | | 317 |
| WEST | 0 | 165 | 0.56 | | 0 |
| N-E | 0 | 11 | 0.56 | | 0 |
| N-W | 0 | 118 | 0.56 | | 0 |
| S-E | 0 | 11 | 0.56 | | 0 |
| S-W | 0 | 113 | 0.56 | | 0 |
| **SOLAR & TRANSMISSION GAIN** | | | | | |
| NORTH | 0 | 20 | 0.34 | | 0 |
| SOUTH | 0 | 36 | 0.34 | | 0 |
| EAST | 153 | 22 | 0.34 | | 1146 |
| WEST | 0 | 36 | 0.34 | | 0 |
| N-E | 0 | 17 | 0.34 | | 0 |
| N-W | 0 | 13 | 0.34 | | 0 |
| S-E | 0 | 25 | 0.34 | | 0 |
| S-W | 0 | 21 | 0.34 | | 0 |
| ROOF | 240 | 51 | 0.15 | 0 | 0 |
| **OTHER TRANSMISSION GAIN** | | | | | |
| AGLS | 51 | 25 | 1.13 | | 1453 |
| PART | 131 | 20 | 0.34 | | 888 |
| CEIL | 240 | 20 | 0.34 | 1 | 1632 |
| FLOR | 240 | 20 | 0.34 | 1 | 1632 |
| **BYPASS O.A. SENSIBLE LOAD** | CFM | T.DIFF. | FACTOR | | |
| | 88 | 25 | 0.08 | 1.08 | 190 |
| **INTERNAL SENSIBLE LOAD** | | | | | |
| PEOPLE | 6 | 245 | | | 1470 |
| APPL. | 500 | 3.4 | | | 1700 |
| LIGHTS | 360 | 3.4 | | 1.25 | 1530 |
| FOOD | 0 | 60 | | | 0 |
| SUB TOTAL | | | | | 11958 |
| LEAK LOSS +SAFETY FACTOR=5% | | | | | 598 |
| ROOM SENSIBLE HEAT | | | | | 13153 |

| BYPASS O.A. LATENT LOAD | CFM | G.DIFF | BYPASS | FACTOR | BTU |
|---|---|---|---|---|---|
| | 88 | 82 | 0.08 | 0.68 | 393 |
| **INTERNAL LATENT LOAD** | | | | | |
| PEOPLE | 6 | 205 | | | 1230 |
| SUB TOTAL | | | | | 1623 |
| SAFETY FACTOR=5% | | | | | 81 |
| ROOM LATENT HEAT | | | | | 1704 |
| ROOM TOTAL HEAT | | | | | 14857 |
| **OUTSIDE AIR HEAT** | CFM | G.DIFF | 1-B.F. | FACTOR | |
| SENS | 88 | 25 | 0.92 | 1.08 | 2186 |
| LAT | 88 | 82 | 0.92 | 0.68 | 4514 |
| SUB TOTAL | | | | | 6700 |
| TOTAL | | | | | 21557 |
| HEAT GAIN SAFETY FACTOR @ 3% | | | | | 647 |
| GRAND TOTAL HEAT | | | (TONS) | 1.9 | 22204 |
| SENSIBLE HEAT FACTOR | | | | | 0.89 |
| SELECTED A.D.P. | | | | | 52 |
| DEHUMIDIFIED RISE | | | | | 20 |
| DEHUMIDIFIED AIR Cfm | | | | | 602 |
| TONS AS PER Cfm | | | | | 1.5 |

| CHECK RESULTS. | |
|---|---|
| GRAND TOTAL HEAT(BTU/HR/SQFT.) | 92.52 |
| ROOM SENSIBLE HEAT(BTU/HR/SQFT.) | 54.81 |
| SQFT/PERSON | 40.00 |
| TONS PER SQFT | 0.01 |
| CFM PER SQFT | 2.51 |
| TONS/PERSON | 0.31 |
| DEHUMIDIFIED CFM/TON | 325.20 |
| AREA PER TON | 129.71 |

| | |
|---|---|
| JOB : | GROUND FLOOR |
| SPACE : | JCTI - 1 |

| HEAT LOAD CALCULATIONS | |
|---|---|
| DATE | 3/10/2020 |
| TIME | 18:32 |

| DESIGN DATA | |
|---|---|
| AREA: | 290 |
| HT.OF THE AREA: | 11 |
| LIGHTING (WATTS/SQFT) | 1.5 |
| NO.OF AIR CHANGE REQUIRED | 2 |
| Cfm VENTILATION | 106 |
| Cfm/PERSON | 10 |
| NO.OF PEOPLE | 10 |
| Cfm VENTILATION | 100 |
| Cfm VENTILATION IN CAL. | 106 |

| | D.B. | W.B. | %RH | GR/LB |
|---|---|---|---|---|
| OUTSIDE | 100 | 83 | 60 | 146 |
| INSIDE | 75 | - | 50 | 64.0 |
| DIFF. | 25 | - | - | 82.0 |

| HEAT LOAD SUMMARY | TR | HP |
|---|---|---|
| GRAND TOTAL HEAT | 2.5 | |
| DEHUMIDIFIED AIR Cfm | 832 | |
| TONS AS PER Cfm | 2.1 | |
| TONNAGE REQUIRED | 2.5 | 2.99 |
| CFM PER SQFT | 2.87 | |
| AREA PER TON | 117 | |

| SUN GAIN | AREA | or T.DIFF. | FACTOR | | BTU |
|---|---|---|---|---|---|
| **SOLAR GAIN-GLASS** | | | | | |
| NORTH | 0 | 11 | 0.56 | | 0 |
| SOUTH | 30 | 11 | 0.56 | | 187 |
| EAST | 51 | 11 | 0.56 | | 317 |
| WEST | 0 | 165 | 0.56 | | 0 |
| N-E | 0 | 11 | 0.56 | | 0 |
| N-W | 0 | 118 | 0.56 | | 0 |
| S-E | 0 | 11 | 0.56 | | 0 |
| S-W | 0 | 113 | 0.56 | | 0 |
| **SOLAR & TRANSMISSION GAIN** | | | | | |
| NORTH | 0 | 20 | 0.34 | | 0 |
| SOUTH | 161 | 36 | 0.34 | | 1975 |
| EAST | 144 | 22 | 0.34 | | 1074 |
| WEST | 0 | 36 | 0.34 | | 0 |
| N-E | 0 | 17 | 0.34 | | 0 |
| N-W | 0 | 13 | 0.34 | | 0 |
| S-E | 0 | 25 | 0.34 | | 0 |
| S-W | 0 | 21 | 0.34 | | 0 |
| ROOF | 290 | 51 | 0.15 | 0 | 0 |
| **OTHER TRANSMISSION GAIN** | | | | | |
| AGLS | 82 | 25 | 1.13 | | 2311 |
| PART | 197 | 20 | 0.34 | | 1342 |
| CEIL | 290 | 20 | 0.34 | 1 | 1972 |
| FLOR | 290 | 20 | 0.34 | 1 | 1972 |
| **BYPASS O.A. SENSIBLE LOAD** | | | | | |
| | CFM | T.DIFF. | FACTOR | | |
| | 106 | 25 | 0.08 | 1.08 | 230 |
| **INTERNAL SENSIBLE LOAD** | | | | | |
| PEOPLE | 10 | 245 | | | 2450 |
| APPL. | 250 | 3.4 | | | 850 |
| LIGHTS | 435 | 3.4 | | 1.25 | 1849 |
| FOOD | 0 | 60 | | | 0 |
| SUB TOTAL | | | | | 16528 |
| LEAK LOSS +SAFETY FACTOR=5% | | | | | 826 |
| ROOM SENSIBLE HEAT | | | | | 18181 |

| BYPASS O.A. LATENT LOAD | CFM | G.DIFF | BYPASS | FACTOR | BTU |
|---|---|---|---|---|---|
| | 106 | 82 | 0.08 | 0.68 | 474 |
| **INTERNAL LATENT LOAD** | | | | | |
| PEOPLE | 10 | 205 | | | 2050 |
| SUB TOTAL | | | | | 2524 |
| SAFETY FACTOR=5% | | | | | 126 |
| ROOM LATENT HEAT | | | | | 2651 |
| ROOM TOTAL HEAT | | | | | 20832 |
| **OUTSIDE AIR HEAT** | | | | | |
| | CFM | G.DIFF | 1-B.F. | FACTOR | |
| SENS | 106 | 25 | 0.92 | 1.08 | 2641 |
| LAT | 106 | 82 | 0.92 | 0.68 | 5455 |
| SUB TOTAL | | | | | 8096 |
| TOTAL | | | | | 28928 |
| HEAT GAIN SAFETY FACTOR @ 3% | | | | | 868 |
| GRAND TOTAL HEAT | | | (TONS) | 2.5 | 29796 |
| SENSIBLE HEAT FACTOR | | | | | 0.87 |
| SELECTED A.D.P. | | | | | 52 |
| DEHUMIDIFIED RISE | | | | | 20 |
| DEHUMIDIFIED AIR Cfm | | | | | 832 |
| TONS AS PER Cfm | | | | | 2.1 |

| CHECK RESULTS. | |
|---|---|
| GRAND TOTAL HEAT(BTU/HR/SQFT.) | 102.74 |
| ROOM SENSIBLE HEAT(BTU/HR/SQFT.) | 62.69 |
| SQFT/PERSON | 29.00 |
| TONS PER SQFT | 0.01 |
| CFM PER SQFT | 2.87 |
| TONS/PERSON | 0.25 |
| DEHUMIDIFIED CFM/TON | 334.98 |
| AREA PER TON | 116.80 |

| | |
|---|---|
| JOB : | GROUND FLOOR |
| SPACE : | ADDL JCTI -1 |

| HEAT LOAD CALCULATIONS | |
|---|---|
| DATE | 3/10/2020 |
| TIME | 18:32 |

| DESIGN DATA | |
|---|---|
| AREA: | 270 |
| HT.OF THE AREA: | 11 |
| LIGHTING (WATTS/SQFT) | 1.5 |
| NO.OF AIR CHANGE REQUIRED | 2 |
| Cfm VENTILATION | 99 |
| Cfm/PERSON | 10 |
| NO.OF PEOPLE | 10 |
| Cfm VENTILATION | 100 |
| Cfm VENTILATION IN CAL. | 100 |

| | D.B. | W.B. | %RH | GR/LB |
|---|---|---|---|---|
| OUTSIDE | 100 | 83 | 60 | 146 |
| INSIDE | 75 | - | 50 | 64.0 |
| DIFF. | 25 | - | - | 82.0 |

| HEAT LOAD SUMMARY | TR | HP |
|---|---|---|
| GRAND TOTAL HEAT | 2.1 | |
| DEHUMIDIFIED AIR Cfm | 660 | |
| TONS AS PER Cfm | 1.6 | |
| TONNAGE REQUIRED | 2.1 | 2.55 |
| CFM PER SQFT | 2.44 | |
| AREA PER TON | 128 | |

| | AREA | SUN GAIN or T.DIFF. | FACTOR | | BTU |
|---|---|---|---|---|---|
| **SOLAR GAIN-GLASS** | | | | | |
| NORTH | 0 | 11 | 0.56 | | 0 |
| SOUTH | 38 | 11 | 0.56 | | 237 |
| EAST | 0 | 11 | 0.56 | | 0 |
| WEST | 0 | 165 | 0.56 | | 0 |
| N-E | 0 | 11 | 0.56 | | 0 |
| N-W | 0 | 118 | 0.56 | | 0 |
| S-E | 0 | 11 | 0.56 | | 0 |
| S-W | 0 | 113 | 0.56 | | 0 |
| **SOLAR & TRANSMISSION GAIN** | | | | | |
| NORTH | 0 | 20 | 0.34 | | 0 |
| SOUTH | 126 | 36 | 0.34 | | 1536 |
| EAST | 0 | 22 | 0.34 | | 0 |
| WEST | 0 | 36 | 0.34 | | 0 |
| N-E | 0 | 17 | 0.34 | | 0 |
| N-W | 0 | 13 | 0.34 | | 0 |
| S-E | 0 | 25 | 0.34 | | 0 |
| S-W | 0 | 21 | 0.34 | | 0 |
| ROOF | 270 | 51 | 0.15 | 0 | 0 |
| **OTHER TRANSMISSION GAIN** | | | | | |
| AGLS | 38 | 25 | 1.13 | | 1085 |
| PART | 197 | 20 | 0.34 | | 1342 |
| CEIL | 270 | 20 | 0.34 | 1 | 1836 |
| FLOR | 270 | 20 | 0.34 | 1 | 1836 |

| BYPASS O.A. SENSIBLE LOAD | CFM | T.DIFF. | FACTOR | | |
|---|---|---|---|---|---|
| | 100 | 25 | 0.08 | 1.08 | 216 |

| INTERNAL SENSIBLE LOAD | | | | |
|---|---|---|---|---|
| PEOPLE | 10 | 245 | | 2450 |
| APPL. | 250 | 3.4 | | 850 |
| LIGHTS | 405 | 3.4 | 1.25 | 1721 |
| FOOD | 0 | 60 | | 0 |
| SUB TOTAL | | | | 13109 |
| LEAK LOSS +SAFETY FACTOR=5% | | | | 655 |
| ROOM SENSIBLE HEAT | | | | 14419 |

| BYPASS O.A. LATENT LOAD | CFM | G.DIFF | BYPASS | FACTOR | BTU |
|---|---|---|---|---|---|
| | 100 | 82 | 0.08 | 0.68 | 446 |
| **INTERNAL LATENT LOAD** | | | | | |
| PEOPLE | 10 | 205 | | | 2050 |
| SUB TOTAL | | | | | 2496 |
| SAFETY FACTOR=5% | | | | | 125 |
| ROOM LATENT HEAT | | | | | 2621 |
| ROOM TOTAL HEAT | | | | | 17040 |

| OUTSIDE AIR HEAT | CFM | G.DIFF | 1-B.F. | FACTOR | |
|---|---|---|---|---|---|
| SENS | 100 | 25 | 0.92 | 1.08 | 2484 |
| LAT | 100 | 82 | 0.92 | 0.68 | 5130 |
| SUB TOTAL | | | | | 7614 |
| TOTAL | | | | | 24654 |
| HEAT GAIN SAFETY FACTOR @ 3% | | | | | 740 |
| GRAND TOTAL HEAT | | | (TONS) | 2.1 | 25394 |

| | |
|---|---|
| SENSIBLE HEAT FACTOR | 0.85 |
| SELECTED A.D.P. | 52 |
| DEHUMIDIFIED RISE | 20 |
| DEHUMIDIFIED AIR Cfm | 660 |
| TONS AS PER Cfm | 1.6 |

| CHECK RESULTS. | |
|---|---|
| GRAND TOTAL HEAT(BTU/HR/SQFT.) | 94.05 |
| ROOM SENSIBLE HEAT(BTU/HR/SQFT.) | 53.41 |
| SQFT/PERSON | 27.00 |
| TONS PER SQFT | 0.01 |
| CFM PER SQFT | 2.44 |
| TONS/PERSON | 0.21 |
| DEHUMIDIFIED CFM/TON | 311.72 |
| AREA PER TON | 127.59 |

| | |
|---|---|
| JOB : | GROUND FLOOR |
| SPACE : | CIT (B) |

| HEAT LOAD CALCULATIONS | |
|---|---|
| DATE | 3/10/2020 |
| TIME | 18:32 |

**DESIGN DATA**

| | |
|---|---|
| AREA: | 270 |
| HT.OF THE AREA: | 11 |
| LIGHTING (WATTS/SQFT) | 1.5 |
| NO.OF AIR CHANGE REQUIRED | 2 |
| Cfm VENTILATION | 99 |
| Cfm/PERSON | 10 |
| NO.OF PEOPLE | 10 |
| Cfm VENTILATION | 100 |
| Cfm VENTILATION IN CAL. | 100 |

| | D.B. | W.B. | %RH | GR/LB |
|---|---|---|---|---|
| OUTSIDE | 100 | 83 | 60 | 146 |
| INSIDE | 75 | - | 50 | 64.0 |
| DIFF. | 25 | - | - | 82.0 |

| HEAT LOAD SUMMARY | TR | HP |
|---|---|---|
| GRAND TOTAL HEAT | 2.3 | |
| DEHUMIDIFIED AIR Cfm | 746 | |
| TONS AS PER Cfm | 1.9 | |
| TONNAGE REQUIRED | 2.3 | 2.75 |
| CFM PER SQFT | 2.76 | |
| AREA PER TON | 118 | |

| SUN GAIN | AREA | or T.DIFF. | FACTOR | | BTU |
|---|---|---|---|---|---|
| **SOLAR GAIN-GLASS** | | | | | |
| NORTH | 0 | 11 | 0.56 | | 0 |
| SOUTH | 34 | 11 | 0.56 | | 210 |
| EAST | 0 | 11 | 0.56 | | 0 |
| WEST | 0 | 165 | 0.56 | | 0 |
| N-E | 0 | 11 | 0.56 | | 0 |
| N-W | 0 | 118 | 0.56 | | 0 |
| S-E | 0 | 11 | 0.56 | | 0 |
| S-W | 0 | 113 | 0.56 | | 0 |
| **SOLAR & TRANSMISSION GAIN** | | | | | |
| NORTH | 0 | 20 | 0.34 | | 0 |
| SOUTH | 153 | 36 | 0.34 | | 1876 |
| EAST | 0 | 22 | 0.34 | | 0 |
| WEST | 79 | 36 | 0.34 | | 963 |
| N-E | 0 | 17 | 0.34 | | 0 |
| N-W | 0 | 13 | 0.34 | | 0 |
| S-E | 0 | 25 | 0.34 | | 0 |
| S-W | 0 | 21 | 0.34 | | 0 |
| ROOF | 270 | 51 | 0.15 | 0 | 0 |
| **OTHER TRANSMISSION GAIN** | | | | | |
| AGLS | 34 | 25 | 1.13 | | 965 |
| PART | 281 | 20 | 0.34 | | 1909 |
| CEIL | 270 | 20 | 0.34 | 1 | 1836 |
| FLOR | 270 | 20 | 0.34 | 1 | 1836 |
| **BYPASS O.A. SENSIBLE LOAD** | CFM | T.DIFF. | FACTOR | | |
| | 100 | 25 | 0.08 | 1.08 | 216 |
| **INTERNAL SENSIBLE LOAD** | | | | | |
| PEOPLE | 10 | 245 | | | 2450 |
| APPL. | 250 | 3.4 | | | 850 |
| LIGHTS | 405 | 3.4 | | 1.25 | 1721 |
| FOOD | 0 | 60 | | | 0 |
| SUB TOTAL | | | | | 14832 |
| LEAK LOSS +SAFETY FACTOR=5% | | | | | 742 |
| ROOM SENSIBLE HEAT | | | | | 16316 |

| BYPASS O.A. LATENT LOAD | CFM | G.DIFF | BYPASS | FACTOR | BTU |
|---|---|---|---|---|---|
| | 100 | 82 | 0.08 | 0.68 | 446 |
| **INTERNAL LATENT LOAD** | | | | | |
| PEOPLE | 10 | 205 | | | 2050 |
| SUB TOTAL | | | | | 2496 |
| SAFETY FACTOR=5% | | | | | 125 |
| ROOM LATENT HEAT | | | | | 2621 |
| ROOM TOTAL HEAT | | | | | 18937 |
| **OUTSIDE AIR HEAT** | CFM | G.DIFF | 1-B.F. | FACTOR | |
| SENS | 100 | 25 | 0.92 | 1.08 | 2484 |
| LAT | 100 | 82 | 0.92 | 0.68 | 5130 |
| SUB TOTAL | | | | | 7614 |
| TOTAL | | | | | 26550 |
| HEAT GAIN SAFETY FACTOR @ 3% | | | | | 797 |
| GRAND TOTAL HEAT | | | (TONS) | 2.3 | 27347 |
| SENSIBLE HEAT FACTOR | | | | | 0.86 |
| SELECTED A.D.P. | | | | | 52 |
| DEHUMIDIFIED RISE | | | | | 20 |
| DEHUMIDIFIED AIR Cfm | | | | | 746 |
| TONS AS PER Cfm | | | | | 1.9 |
| **CHECK RESULTS.** | | | | | |
| GRAND TOTAL HEAT(BTU/HR/SQFT.) | | | | | 101.29 |
| ROOM SENSIBLE HEAT(BTU/HR/SQFT.) | | | | | 60.43 |
| SQFT/PERSON | | | | | 27.00 |
| TONS PER SQFT | | | | | 0.01 |
| CFM PER SQFT | | | | | 2.76 |
| TONS/PERSON | | | | | 0.23 |
| DEHUMIDIFIED CFM/TON | | | | | 327.52 |
| AREA PER TON | | | | | 118.48 |

| JOB : | GROUND FLOOR | | |
|---|---|---|---|
| SPACE : | AO AND PS (B) | HEAT LOAD CALCULATIONS | |
| | | DATE | 3/10/2020 |
| | | TIME | 18:32 |

| DESIGN DATA | |
|---|---|
| AREA: | 210 |
| HT.OF THE AREA: | 11 |
| LIGHTING (WATTS/SQFT) | 1.5 |
| NO.OF AIR CHANGE REQUIRED | 2 |
| Cfm VENTILATION | 77 |
| Cfm/PERSON | 10 |
| NO.OF PEOPLE | 2 |
| Cfm VENTILATION | 20 |
| Cfm VENTILATION IN CAL. | 77 |

| | D.B. | W.B. | %RH | GR/LB |
|---|---|---|---|---|
| OUTSIDE | 100 | 83 | 60 | 146 |
| INSIDE | 75 | - | 50 | 64.0 |
| DIFF. | 25 | - | - | 82.0 |

| HEAT LOAD SUMMARY | TR | HP |
|---|---|---|
| GRAND TOTAL HEAT | 1.3 | |
| DEHUMIDIFIED AIR Cfm | 399 | |
| TONS AS PER Cfm | 1.0 | |
| TONNAGE REQUIRED | 1.3 | 1.59 |
| CFM PER SQFT | 1.90 | |
| AREA PER TON | 159 | |

| | AREA | SUN GAIN or T.DIFF. | FACTOR | | BTU |
|---|---|---|---|---|---|
| **SOLAR GAIN-GLASS** | | | | | |
| NORTH | 0 | 11 | 0.56 | | 0 |
| SOUTH | 0 | 11 | 0.56 | | 0 |
| EAST | 0 | 11 | 0.56 | | 0 |
| WEST | 0 | 165 | 0.56 | | 0 |
| N-E | 0 | 11 | 0.56 | | 0 |
| N-W | 0 | 118 | 0.56 | | 0 |
| S-E | 0 | 11 | 0.56 | | 0 |
| S-W | 0 | 113 | 0.56 | | 0 |
| **SOLAR & TRANSMISSION GAIN** | | | | | |
| NORTH | 0 | 20 | 0.34 | | 0 |
| SOUTH | 0 | 36 | 0.34 | | 0 |
| EAST | 0 | 22 | 0.34 | | 0 |
| WEST | 0 | 36 | 0.34 | | 0 |
| N-E | 0 | 17 | 0.34 | | 0 |
| N-W | 0 | 13 | 0.34 | | 0 |
| S-E | 0 | 25 | 0.34 | | 0 |
| S-W | 0 | 21 | 0.34 | | 0 |
| ROOF | 210 | 51 | 0.15 | 0 | 0 |
| **OTHER TRANSMISSION GAIN** | | | | | |
| AGLS | 0 | 25 | 1.13 | | 0 |
| PART | 204 | 20 | 0.34 | | 1386 |
| CEIL | 210 | 20 | 0.34 | 1 | 1428 |
| FLOR | 210 | 20 | 0.34 | 1 | 1428 |
| **BYPASS O.A. SENSIBLE LOAD** | CFM | T.DIFF. | FACTOR | | |
| | 77 | 25 | 0.08 | 1.08 | 166 |
| **INTERNAL SENSIBLE LOAD** | | | | | |
| PEOPLE | 2 | 245 | | | 490 |
| APPL. | 500 | 3.4 | | | 1700 |
| LIGHTS | 315 | 3.4 | | 1.25 | 1339 |
| FOOD | 0 | 60 | | | 0 |
| SUB TOTAL | | | | | 7937 |
| LEAK LOSS +SAFETY FACTOR=5% | | | | | 397 |
| ROOM SENSIBLE HEAT | | | | | 8731 |

| BYPASS O.A. LATENT LOAD | CFM | G.DIFF | BYPASS | FACTOR | BTU |
|---|---|---|---|---|---|
| | 77 | 82 | 0.08 | 0.68 | 343 |
| **INTERNAL LATENT LOAD** | | | | | |
| PEOPLE | 2 | 205 | | | 410 |
| SUB TOTAL | | | | | 753 |
| SAFETY FACTOR=5% | | | | | 38 |
| ROOM LATENT HEAT | | | | | 791 |
| ROOM TOTAL HEAT | | | | | 9522 |
| **OUTSIDE AIR HEAT** | CFM | G.DIFF | 1-B.F. | FACTOR | |
| SENS | 77 | 25 | 0.92 | 1.08 | 1913 |
| LAT | 77 | 82 | 0.92 | 0.68 | 3950 |
| SUB TOTAL | | | | | 5863 |
| TOTAL | | | | | 15385 |
| HEAT GAIN SAFETY FACTOR @ 3% | | | | | 462 |
| GRAND TOTAL HEAT | | | (TONS) | 1.3 | 15846 |
| SENSIBLE HEAT FACTOR | | | | | 0.92 |
| SELECTED A.D.P. | | | | | 52 |
| DEHUMIDIFIED RISE | | | | | 20 |
| DEHUMIDIFIED AIR Cfm | | | | | 399 |
| TONS AS PER Cfm | | | | | 1.0 |

| CHECK RESULTS. | |
|---|---|
| GRAND TOTAL HEAT(BTU/HR/SQFT.) | 75.46 |
| ROOM SENSIBLE HEAT(BTU/HR/SQFT.) | 41.58 |
| SQFT/PERSON | 105.00 |
| TONS PER SQFT | 0.01 |
| CFM PER SQFT | 1.90 |
| TONS/PERSON | 0.66 |
| DEHUMIDIFIED CFM/TON | 302.47 |
| AREA PER TON | 159.03 |

| SUBJECT : HEAT LOAD SUMMARY SHEET | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **PROJECT :** | **INCOME TAX OFFICE GROUND FLOOR** | | | | | | | | |
| **SR.** | **DISCRIPTION** | **Area** | **Occupancy** | **WATTS** | **Fresh air** | **APPL.** | **Dehumidified** | **Tonnage** | **Cfm/Hp** | **Tonnage** |
| | | **Sq.ft.** | **Nos.** | **Sq.ft.** | **CFM** | **WATTS.** | **air** | **REQ. (TR)** | | **HP** |
| 1 | STAFF AREA - 1 | 1400 | 30 | 1.5 | 513 | 5000 | 3314 | 10.3 | 13.3 | 12.5 |
| 2 | DCIT - 1 | 200 | 7 | 1.5 | 73 | 250 | 398 | 1.4 | 1.6 | 1.7 |
| 3 | DCIT - 2 | 200 | 7 | 1.5 | 73 | 250 | 398 | 1.4 | 1.6 | 1.7 |
| 4 | ITO - 1 | 190 | 6 | 2 | 70 | 250 | 545 | 1.6 | 2.2 | 1.9 |
| 5 | ITO - 2 | 190 | 6 | 2 | 70 | 250 | 413 | 1.4 | 1.7 | 1.7 |
| 6 | ITO - 3 | 190 | 6 | 2 | 70 | 250 | 507 | 1.5 | 2.0 | 1.9 |
| 7 | ITO - 4 | 190 | 6 | 2 | 70 | 250 | 530 | 1.6 | 2.1 | 1.9 |
| 8 | STAFF AREA - 2 | 1200 | 30 | 2 | 440 | 5000 | 3180 | 9.6 | 12.7 | 11.5 |
| 9 | CIT A | 270 | 10 | 2 | 100 | 250 | 745 | 2.3 | 3.0 | 2.7 |
| 10 | AO AND PSA | 240 | 6 | 2 | 88 | 500 | 602 | 1.9 | 2.4 | 2.2 |
| 11 | JCTI -1 | 290 | 10 | 2 | 106 | 250 | 832 | 2.5 | 3.3 | 3.0 |
| 12 | ADDL JCTI - 1 | 270 | 10 | 2 | 100 | 250 | 660 | 2.1 | 2.6 | 2.5 |
| 13 | CIT (B) | 270 | 10 | 2 | 100 | 250 | 746 | 2.3 | 3.0 | 2.7 |
| 14 | AO AND PS (B) | 210 | 2 | 2 | 77 | 500 | 399 | 1.3 | 1.6 | 1.6 |
| | TOTAL | **5310** | **146** | **21** | **1950** | **13500** | **13271** | **41** | **53** | **50** |

**CHAPTER 08**

## 8. PHOTOGRAPHY:

*Figure 8-1.Project visit with staff*


*Figure 8-2. Outdoor Unit*


*Figure 8-3 ODU*

*Figure 8-4 Raffinates*

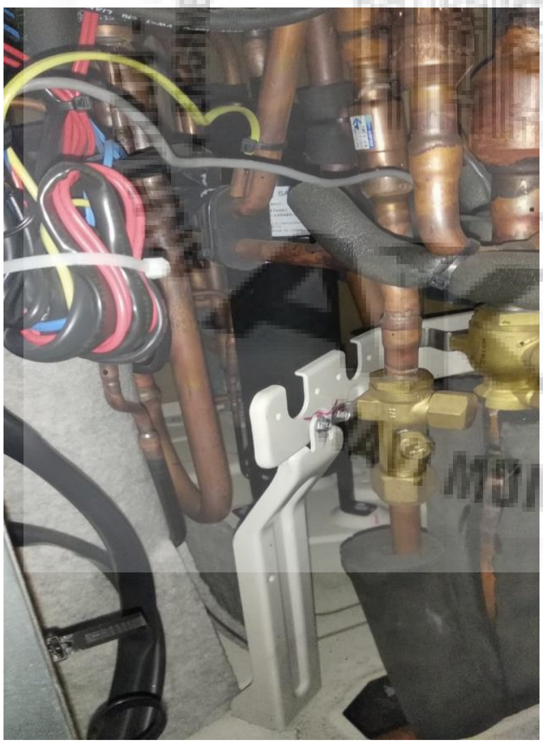

*Figure 8-5. Component of ODU*

*Figure 8-6.Cassette*

Figure 8-7.IDU Cassette

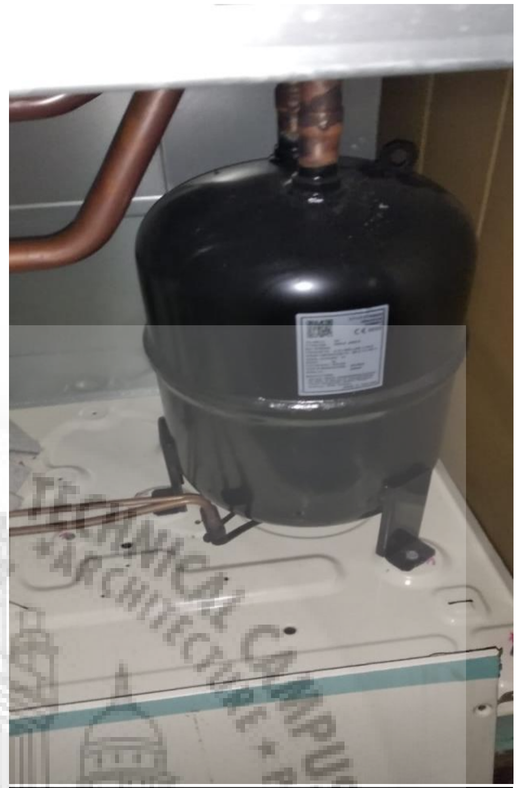

Figure 8-8.Scroll Compressor

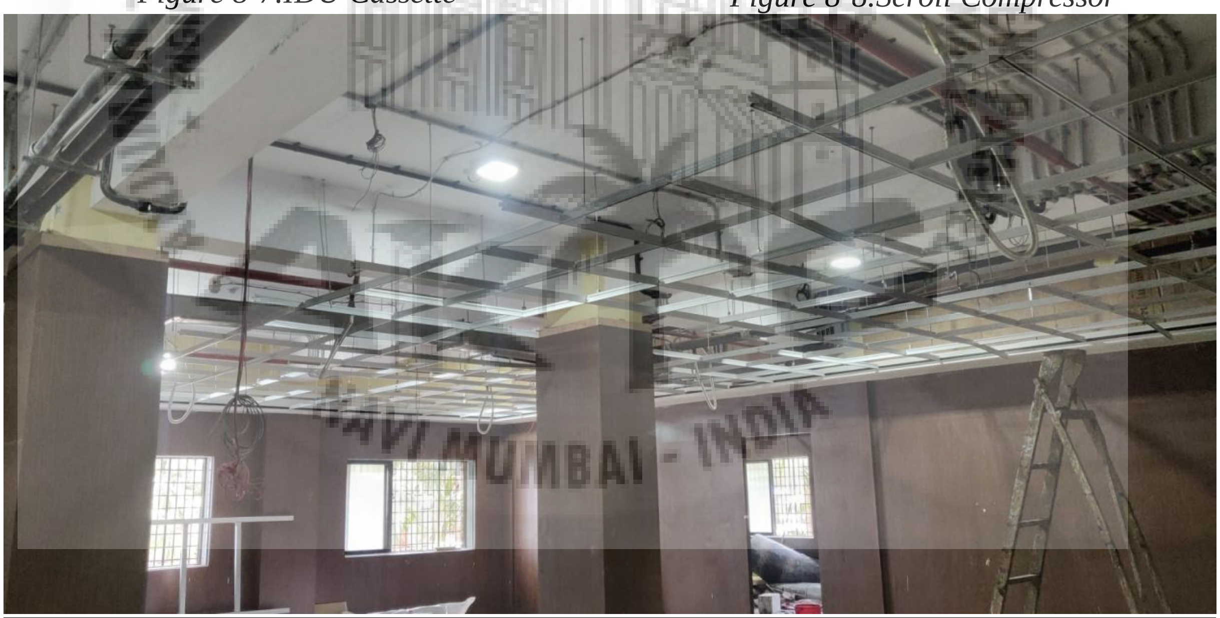

Figure 8-9.False Ceiling for IDU Installation


*Figure 8-10. Inventory*

*Figure 8-11. Grill of IDU*

# CHAPTER 09

## 9. FUTURE SCOPE & CONCLUSION

### 9.1. Future Scope:

A new refrigerant detection and management system works with VRF (Variable Refrigerant Flow) air conditioning systems. In the unlikely event of a refrigerant leak, it shuts down the specific section of pipework involved, while enabling the rest of the system to continue operating as normal.

The VRF systems that are out today will undoubtedly be improved as the popularity of this system continues to increase and competition exists between manufacturers to produce the best product. In the meantime, it is best to study the operating principles of what's already out there so that the performance of these installed systems can be optimized through proper design, installation and commissioning.

The overall efficiency, design flexibility, and total life cycle cost of variable refrigerant flow (VRF) systems are driving growth of the technology in the HVAC market. Such growth is evidenced by a recent report from Markets and Markets, which reports the global VRF market is projected to reach approximately $9.65 billion by 2021, registering a compound annual growth rate (CAGR) of 10.8 percent between 2016 and 2021.

We should get better efficient system by calculating heat & cooling load on TOSHIBA SMMS7 software. This software is fully automated due to which we can calculating heat load of complicate space easily. We will also be using Carrier HAP software for the calculating the heat & cooling load which is fully automated.

## 9.2. Conclusion:

The VRF system has been designed successfully considering the required indoor condition. proper pipe dimensions and material has been selected. indoor and outdoor units as per requirement are selected.

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Design of HVAC with VRF System for a Space House in Ahmedabad (IJSTE/ Volume 1 / Issue 10 / 006) All rights reserved by www.ijste.org 35

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