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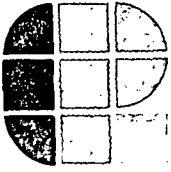
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**Contract Number 01/316**  
**MP/LEB/01/142**  
**Final Report**

**Implementation of Prototype Improvement at:**

*Al-Ammoury Refrigeration Industries, Angelidis Freres,  
Chemayssem Industries, Cold Refrigeration Co., Georgio  
Industries, International Est.Badarco, Kassha for industry  
and Trade, Le Condor refrigeration Co. and Mohieddin  
Adada Est. for Trade Industry*

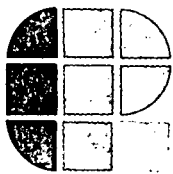
Please find herewith below our Final report concerning implementation of development of prototypes at the second group of Lebanese Small Commercial Refrigerator Manufactures.

This companies consist of *Al-Ammoury Refrigeration Industries, Angelidis Freres, Chemayssem Industries, Cold Refrigeration Co., Georgio Industries, International Est.Badarco, Kassha for industry and Trade, Le Condor refrigeration Co. and Mohieddin Adada Est. for Trade Industry*

**1- Activities.**

**Following activities were achieved during implementation of project.**

- 1- Visiting counterparts premises several times to assure precise technical data for providing necessary information for calculating refrigeration load calculation.
- 2- Assisting counterparts to select most common and well selling prototype models to be made and test under new circumstances.
- 3- Supervising related activities concerning making prototypes.
- 4- Conducting several briefing meeting and training session at our classroom located beside our hot chamber at our factory and counterparts premises to familiarize the counterparts technical staff with new refrigerant physical, chemical and operation properties and behavior.
- 5- Contacting UNDP and Ozone office in several occasion to plan for implementation of the project in time.



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- 6- Coordinating with UNIDO staff and Ozone office staff in Beirut for execution of different activities foreseen in the contract.
- 7- Storing and preserving charging equipment at our warehouse to assure safe and trustful stocking as requested by UNIDO's project manager and Ozone Office.
- 8- Deliver all charging equipment to counterparts as they were received in accordance with packing list and project documents.
- 9- Assuring safe handling and equipment free of any defects by visual inspection due to possible mechanical damages, before delivery to the counterparts.
- 10- Explaining to the counterparts operation purposes and application of each machines as purchased and supplied by UNIDO and manufacturer.
- 11- Conducting an orientation course for technical staff of counterparts to be familiarized with application of equipments and use of them.

IPEC company as pioneer in reducing and phasing out ODS in Lebanon now has the opportunity to help the small companies to achieve this goal. IPEC has invested a lot capital and cash notes to fulfill UNIDO projects. In our path to reach this goal we enjoy our 20 years industrial experience in the field of manufacturing small , medium and large commercial and industrial appliances.

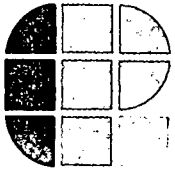
As we have been instructed by UNIDO and as of part of our contract with UNIDO we have done many activities toward achievement of contract requirements these activities could be simply summarized as below. Since our main activities at this stage of contract implementation was familiarize the counterpart with existing condition for implementation of the project. We tried to plan an intensive programme to make them concerned about project and to cooperate with our team.

Visiting counterpart premises several times to collect technical information of prototypes to be converted was our main activities. As well training course was held at our factory to familiarize the participants with new Ozone Friendly Refrigerant.

Here below you can find technical information of prototypes as well as topics of our training course.

The aim of project is to improve and establish prototypes at above mentioned companies, to enable them to use Ozone friendly Refrigerant named as R134a, this refrigerant is widely used as a suitable alternative for R12 all around the world. UNIDO also has made his main effort to help the nominated companies to achieve the CFC phase out project to use R134a as a substitute for R12.

In this report you will find our main activities at the first stage of contract, which are main concentrated on training, visiting counterpart premises, data collection for calculation of refrigeration load in order to select appropriate refrigeration system component selection



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In this report we discuss our methods of selection of refrigeration circuit component and the method that we use for calculating refrigeration load to determine capacity of compressors to fit new criteria, Technical Specifications for each prototype, making prototypes, performance test and test results methods and analysis. The new criteria is defined as new operating condition under usage of R134a Ozone friendly refrigerant. As we learnt through our experience, following components have significant role to be adapted for new environmental and technical circumference.

- 1) Compressor,
- 2) Filter Drier
- 3) Refrigerant Charge
- 4) Capillary Tube.

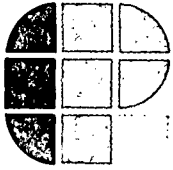
Since size of evaporator and condenser for R12 system circuit for small and medium size cooling capacity refrigeration system are selected with certain limitation due to availability of component in the market, they usually selected upper size than what really needed, therefore we considered them to be remained unchanged due to their heat removal and absorbent capacity. We concentrated our activities in evaluating the different size of Compressor with regard of availability in Lebanese market and R12 compressor cooling capacity used in old models and also total refrigeration load in watts of cooling capacity calculated in accordance with conventional methods defined mainly in different ASHRAE handbooks, which were used as our main reference to calculate and get different data for calculating heat Transfer Load, Product Load, and Miscellaneous Loads such as door opening, infiltration, electromotor, and etc.

In this report we explain briefly how we calculated compressor cooling capacity, then how we select new components, and finally different activities achieved during execution of contract after preparation of our first progress report which was submitted to you in January 2001.

#### ***1- Methods of Refrigeration Load calculation for determination of compressor cooling capacity.***

Four main elements are considered for calculation:

- a) **Transmission load;**  
Heat transfer through side walls by conduction
- b) **Product load;**  
Heat Removed from and produced by the products which are stored.
- c) **Internal load;**  
Heat produced by internal sources such as lights, fan or heaters;



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- d) Miscellaneous Load  
Heat gains associated with air entering the refrigerated space and door opening and etc.;

### **Transmission Load through side walls**

Heat gain through walls of a refrigerated space depends on cabin Temperature, liner, insulation and cabin conductivity and also the surrounded ambient air. In other word, there are four different resistance opposing heat flows between cabin space and ambient air as given in resistance circuit.

The resistance elements could be realized as Liner Resistance, Cabinet Sheet Metal Resistance, PU or Polystyrene Insulator Resistance and Air Layer Moving inside and outside side walls. Heat is transferred through Inner Liner Resistance, Cabinet Sheet Metal Resistance, PU or Polystyrene Insulator Resistance by conduction while heat transfers by convection through moving or still air around cabinet and door side walls inside and outside of the appliances. All these heat transfer elements are considered in heat coefficient resistance formula.

Heat resistance factor of Inner Liner and Cabinet carbon or stainless steel is considered negligible due to their thickness and high thermal conductivities.

$$U = \frac{1}{x1/K1 + x2/K2 + x3/K3 + \dots}$$

$1/h_o = 1/h_i = 1/9.34$  which are inside and outside air convection factor that we should consider into above formula.

$$R = \frac{x}{KA} \quad \text{Heat Resistance}$$

$$Q_{TL} = \frac{\Delta T}{R} \quad \text{Heat Transfer}$$

Where:

x = Insulation Thickness, mm

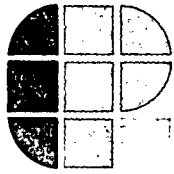
K = Insulation Conductivity,  $Wmm/m^2 \cdot C$

A = Outside Area,  $m^2$

$\Delta T$  = Temperature difference (Ta - Tc), C

If the insulation thickness of side walls, back panels, top, bottom and door are different. Heat transfer for each part can be calculated separately and then summed for freezer and refrigerator compartments as necessary, heat transfer for each compartment should be calculated separately and then added together.

### **Product Load**



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Heat removed from products (meat, fruits, vegetables, water and etc. ) to reduce temperature from receiving to storage temperature is known as product load. Following steps can be taken to calculated of product loads.

1 - Heat removed from initial temperature (  $T_i$  ) to storing temperature (  $T_{rs}$  ) in refrigerator compartment is;

$$Q_{rs} = \dot{M} C ( T_i - T_{rs} )$$

Where:

$\dot{M}$  = Mass of product, Kg / h

C = Specific heat of product, Kcal / Kg

2 - Heat removed from initial temperature (  $T_i$  ) to freezing temperature (  $T_f$  ) is ;

$$Q_{af} = \dot{M} C ( T_i - T_f )$$

Where:

$\dot{M}$  = Mass of product, Kg / h

C = Specific heat of product above freezing point, Kcal / Kg

3 - Latent heat of fusion for products is equal to;

$$Q_L = \dot{M} h$$

Where  $h$  = Latent heat of product, Kcal / Kg

4 - Heat removed from freezing temperature (  $T_f$  ) to final storage temperature (  $T_{fs}$  ) is;

$$Q_{bf} = \dot{M} C_{bf} ( T_f - T_{fs} )$$

Where:

$C_{bf}$  = Specific heat of products below freezing temperature.

For upright freezers or chest freezer, total product load is

$$Q_{pl} = Q_{af} + Q_L + Q_{bf}$$

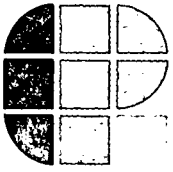
For storage products to some lower temperatures above freezing temperature in refrigerator display cases compartment is;

$$Q_{pl} = Q_{rs}$$

### **Miscellaneous Load**

Electrical energy dissipated in the refrigerated space such as lights, fan motors, heaters, should be calculated as appropriate depending on type of display cases and other products.

Infiltration Load



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Infiltration air load is the heat transfer due to exchanging of refrigerated air with ambient caused by opening of the door or leakage through the gasket area and /or open top freezer of show cases. Infiltration load is one of the most important load components.

### **Total Refrigeration load**

As it was mentioned before, transmission load (Qtl), product load (Qpl) and internal load (QIL) can be calculated separately. For infiltration load (air exchange through doorways or gasket leakage), we have to take into account that depending on the type of models we have to consider different amount of heat gain, or a percentage of amount of the above mentioned components. (Transmission load, product load and internal load). For example;

$$\underline{QTL = 1.20 ( QTL + QPL + QIL )}$$

### **Refrigeration Load Calculation for different type of Water Coolers**

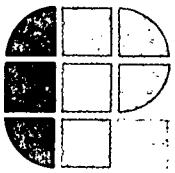
Since Refrigeration Load Calculation Load for Water coolers are slightly different form conventional refrigerators and freezers we discuss this issue seperately.

Water cooler cabinet usually consist of a sheet metal housing built around a steel framework, inside this sheet housing there is usually a condensing unit, located near the floor, and above this is the water-cooling mechanism. The latter is the only part insulated (foamed plastic) from the room. The insulation is usually specially formed and between one and one half inches and two inches thick. These cabinets are made in such a way that one or more sides may be easily removed to gain access to the interior. The basin of the water cooler is generally made of porcelain-coated cast iron, porcelai coated - steel, or stainless steel. Heat exchangers are frequently used on water coolers. These make use of the low temperature of waste water and the suction line to pre-cool the fresh water line to the evaporator coil.

Self-cooler are of two types,

- 2- Bottle Type.
- 3- Tap water type

The bottle cooler usually uses a 20 to 25 liter bottle of water inverted on the top of the cabinet. Overflow and drain water are stored in a container built the cabinet. These coolers use air-cooled condensing units exclusively. They are used where water and drains are not available or where available the plumbing insulation may be expensive.



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Water cooler using a plumbing supply and drain connection, must be installed according the relevant approved standards. The plumbing should be concealed, a hand shutoff valve should be installed in the fresh water line. Drain pipe at least 1 inches in diameter provided, and rubber opening must be above the drain in such a way as to eliminate the chance for accidental siphoning of the drain water back into the fresh water system. The tap water models use variety of evaporator coil wrapped around the water-cooling tank.

Temperatures of the cooling water are variable depending on the persons who are drinking the water. We consider 10 C for the temperature of drinking water, while our inlet temperature is considered 24 C.

In large business establishment, in office buildings, or in factories, multiple water cooler, instead of individual ones, are popular. These

coolers have one large condensing unit supplying many bubbles and these may be of many different types.

Water cooler is a device that usually is used in the public area to supply cold drinking water to the customers and different people. The appliance is mainly used in the Airports, Railways Station, Coach Terminals, Banks, Offices, Parks, and etc. therefore, it is hard to specify an standard for cold water consumption during the day from the water cooler.

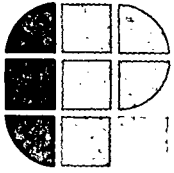
We consider three refrigeration load components that should be taken into our consideration.

- 1- Heat gain by heat transmission from, main water storage tank wall insulation.
- 2- Heat removed from water entering to the water tank at the initial refrigeration system operating condition, (water stored in storage tank during the night, with normal ambient temperature) which is divided by 24 hrs.
- 3- Heat removed from Drinking Water flow that are consumed during designated operating hours "  $\dot{M}$  "

The problem of determining the refrigeration load of a water-cooled installation is basically a specific heat and heat leakage problem combination. The water is cooled to temperature which vary upward from about 4 degree centigrade , and the amount heat removed from the water to cool it to a predetermined temperature is simple specific heat problem. The water, being maintained at these low temperature, results in a heat leakage from room into the water, and this part involves the heat leakage portion of installation.

$Q1 = m C \Delta T$ , Where:





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Q1 Total heat removed from total drinking water tank volume capacity (lit.) during specific period, related to compressor cooling capacity power in Watts, at initial compressor start up, and early in the morning. When the water temperature is 30 C.

m total weight of water in the water cooler storage tank in Kg. Considering that one liter of water at 24 C is equal to approximately one Kg.

C Specific heat factor of water in Kcal/Kg °C

$\Delta T$  Temperature difference ( $T_i - T_c$ ), where,  $T_i$  is inlet water temperature, and  $T_c$  is final cooled water.

$$Q2 = \dot{M} C \Delta T$$

Q2 Total heat removed from total drinking water flow (lit.) during specific period, 16 hours. In Kcal.

$\dot{M}$  total weight of water flow during 16 hours. in Kg.

C Specific heat factor of water in Kcal/Kg °C

T Temperature difference ( $T_i - T_c$ ), where,  $T_i$  is inlet water temperature, and  $T_c$  is final cooled water temperature.

$$Q3 = UA \Delta T$$

Where

Q3 Total Leak, gained through side wall of drinking water storage tank by conduction in Kcal..

U Heat Resistance Coefficient Factor in Kcal/Sq. mt. C

A Total Area which heat is transmitted by. In Sq. Mt.

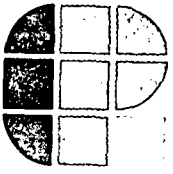
$\Delta T$  Temperature difference ( $T_a - T_c$ ), where,  $T_a$  is ambient temperature, and  $T_c$  is final cooled water temperature.

### ***Different Calculation Methods Analysis***

In preparation of the first progress report, we have chosen an appropriate method for our refrigeration load calculation. To respond our design and configuration requirements, choosing an appropriate method of refrigeration load calculation is the aim of selecting compatible components.

The method of refrigeration load calculation for a new design refrigerator could be completely different, in comparison with converting the existing Commercial refrigerators in production, because, in this case, we are not looking for the new nature of each refrigerator component or parts. In contemporary with designing new refrigerator model, we have to consider many parameters, such as heat leaks from outside through, wedge, corners, door gasket, door infiltration, door openings, heat radiation dissipated from condenser and compressor shell and etc.

A number of heat load parameters for cabinet loads in addition to the wall conduction loads could be considered. These include: electric defrost, penetrations, heaters and controls, fan heat, refrigerant line heat, in-



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wall evaporator, in-mullion evaporator, and in-wall condenser.

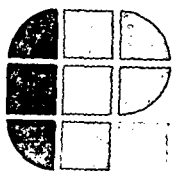
The total values shown for the cabinet type refrigerator are the hourly average loads, which must be removed by refrigeration system.

For the purpose of determination of energy consumption, two cooling capacities should be considered:

- 1) Evaporator load,
- 2) Net capacity.

Normally these two quantities are the same. If a cold-plate evaporator is used, however, the total evaporator load will be higher than the net capacity due to the heat going directly to the back of the evaporator through the insulation.

In our case, which the main consideration is selecting compatible components with existing refrigeration components, the method of refrigeration load calculation is different from the refrigeration load calculation of the new design products.



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We will discuss three different methods of refrigeration load calculations, from following sources;

- 1) EPA Refrigerator Analysis Programme (ERA).
- 2) Ariston Co.'s methods of refrigeration load calculation.
- 3) ASHRAE standards of refrigeration load calculation.

### EPA ( Environmental Protection Agency) Refrigerator Analysis

For this method, following data are required for cabinet loads:

#### 1) Cabinet Type and Dimension, as follows;

- Cabinet height is measured from the bottom to top of the cabinet, not the floor.
- Depth includes the cabinet door. This dimension measures the distance from the outside (front) surface of doors to the back of the cabinet
- Width of the gasket and the door edge thickness. The effects of door thickness on the internal volume are taken into account.
- Wedge dimensions, the cabinet wedge is the section of the cabinet near the door. In all cabinet types, except the chest freezer, the thickness of the insulation is reduced near the door to accommodate the door geometry.

#### 2) Refrigerated volume;

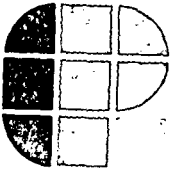
ERA considers calculation of internal volume of the cabinet compartment based on the input data for the cabinet dimensions. The calculated volume is used in the simulation of the contribution to the cabinet loads from door openings.

Normally, the compressor will be located in a space at the near, bottom of the cabinet, where it is cooled by air blown over the condenser or by natural convection. This space requirement will reduce the storage volume of the cabinet located above, and will also affect the net external surface area available for heat exchange with the room.

#### 3) Freezer and Fresh Food Cabinets;

The wall and door thickness and also insulation resistivity for each wall element and door are required to calculate the sum of thermal resistivities. The resistivity and thickness determine the net resistance of each cabinet element.

The specified thickness of wall containing a sandwich of a foam and vacuum insulation panel should be the total thickness (neglecting the thickness of the liner). When a composite insulation system is used, an average resistivity for the wall should be specified. The general case assumes a vacuum insulation panel located between inner and outer foam panels and surrounded foam along all four edges.



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#### 4) Air and Cabinet Temperature

The room air and cabinet temperatures establish the heat loads of each compartment on the refrigeration system. For DOE closed door test simulation a room air temperature of 32.2 C° is ordinary specified, along with a freezer temperature of -15 C° and fresh food cabinet temperature of 3.3 C°. Temperatures must also be specified for under cabinet (where the compressor is normally located) and for "air entering the condenser."

#### 5) Door Opening Schedule

The schedule of door opening is defined here to establish the net sensible and latent heat inputs to the cabinet during the hour. The controlling parameters are, the room relative humidity, the number of times each door is opened during the hour, and the average duration of each opening.

Parameters controlling the sensible and latent loads are, room temperature, cabinet temperature, room relative humidity, number of openings/hour, average duration of each door opening, and type of defrosting (manual or automatic). The typical schedule for door openings might be;

Commercial Fresh food door	Opening/hr.	5	Duration (sec)	20
Freezer door	Opening/hr.	1	Duration (sec)	15

#### 6) Gasket Heat Leak

The gasket areas around the cabinet doors are sources of heat due to conduction loads from the room air along the cabinet and door flanges, and through the gasket itself. Correct estimates of the heat leaks must take into consideration the geometry and materials used in the wall panels and doors.

All gasket heat leaks are expressed in units of conductance per length of the gasket. The net leak is determined by the program, from the total door perimeter and from the outside-inside air temperature difference.

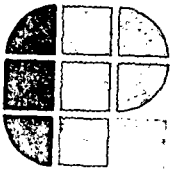
7) Others such as: defrost and control's energy use, electrical anti-sweat heat, refrigerant line anti-sweat heat, and penetration heat input.

#### Method of Heat Load Calculation by Ariston Home Appliance Manufacturing Company of Italy

In this method, the whole refrigerator circuit is designed in such manners to face the possible leakage deriving from working under stand by conditions, with an ambient temperature of 43 degree centigrade, granting at the same time the freezing at least 3 kg/24hrs. of water at temperature of 48 °C or 5 kg/24hrs of water at 32 °C.

Determination of total heat loads;

- 1) In conservation at 43 °C of outside temperature.



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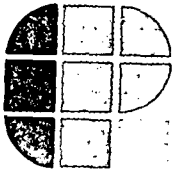
- 2) In freezing at 32 °C of outside temperature.
  - 3) Measuring all the thermal loss surfaces and thickness thereof.
  - 4) Calculate the (t) relevant to the single surfaces at following conditions;
    - 43 °C outside temperature, except 60 °C compressor shell area
    - 55 °C Condenser side.
    - 0 °C refrigerator medium temp.
    - -23 °C freezer air temp.
    - -26 °C evaporator temp.
- 1) Determination of thermal loss for following areas;
    - Refrigerator door.
    - Crisper support area.
    - Crisper back area.
    - Crisper side area.
    - Compressor upper area.
    - Refrigerator side areas.
    - Drops retainer.
    - Back panel rear areas.
    - Refrigerator gasket.
    - Freezer side areas.
    - Freezer gasket.
- 1) Determination of thermal conductivity for following materials.
    - Expanded polyurethane.
    - Magnetic gasket

Note. In order to make calculation easier, select the average thickness of sloping surfaces, assuming that the whole insulation thickness is of one single material in polyurethane, expanded polystrol PVC.

The total thermal loss in Kcal/hr. are those necessary to face all dispersions at 43 °C. Then, the heat in Kcal/hr. obtained at temperature of 32 °C are to be found and must be then added to those necessary to freeze 3 kg of water in 24 hr. In order to obtain functionality relation of the compressor at 43°C, we divide total thermal loss at 32 C° by total thermal loss at 43 C° ambient temperature.

Method of Heat Leak Load Calculation Established by  
ASHRAE Standard

1) Heat gain by conduction, in Kcal/hr. Through;



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- Refrigerator side areas.
- Refrigerator gaskets.
- Refrigerator door.
- Crisper side areas.
- Freezer side areas.
- Mullion area, positive to freezer compartment.
- Back panel

2) Determination of thermal conductivity of following materials;

- Cabinet carbon steel.
- Polyurithane of foam.
- Door and freezer gasket.
- Inner liner plastic
- Air, between mullion and evaporator.

3) The heat resistance of coefficient factor, with regard to average thickness of each substance.

4) Determination of product heat load as follows;

- Heat removed from products above freezing point in fresh food compartment.

Note: The amount of product weight kept in fresh food compartment depends upon. Internal volume and different products selected by the manufacturer.

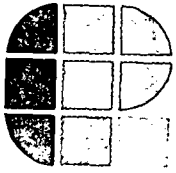
- Heat removed from products from initial temperature to freezing point in Freezer compartment.
- Heat removed from freezing point to final temperature below freezing point in Freezer compartment.
- Heat removal to freeze products ( latent heat ), in freezer compartment.

Note: The amount of product weight kept in Freezer compartment depends upon. Internal volume and different products selected by the manufacturer.

5) Calculation of total heat gain through refrigerator, evaporator, and heat removal per hour form product.

Note: The amount of heat removal from product are in 24 hrs. daily, in order to obtain total heat removal per hour we divide it by desired Compressor operating time in 24 hr.

6) To determine the grand total of the heat load, we add ten percent of the total heat gain. This ten to twenty percent additional load is for door openings, infiltration, and wedge and edge thermal loss, depending type of refrigerator and freezer.



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The theoretical performances can be compared to one of the following CFC/HCFC fluids: R12, R502 and R22. The calculations are best used as a means of finding trends in fluid performance. The cycle has not been designed to model experimental equipment in detail. Several factors, such as those from heat exchangers and compressor volumetric inefficiencies are not included in the theoretical cycle.

#### Definition of the Theoretical Cycle

The calculations are based on a point cycle. The points are as follows

- (1) Evaporator Inlet - Liquid/vapour flash
- (2) Evaporator Outlet - Saturated Vapour
- (3) Compressor Inlet - Superheated Vapour
- (4) Compressor Outlet - Compressed Vapour
- (5) Condenser Inlet - Saturated Vapour
- (6) Condenser Outlet - Saturated Liquid
- (7) Expansion Device Inlet - Subcooled Liquid

#### INPUT FIELDS

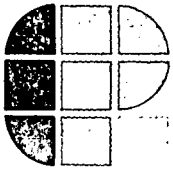
**Evaporator Temperature:** defined as the average of the liquid/vapour flash temperature at the evaporator inlet and that of the saturated vapour at the evaporator outlet. The latter is taken to be the dew point temperature at the calculated evaporator pressure. Unlike pure refrigerants, for the R32/R125/R134a blends the inlet and outlet temperature will be different.

**Condenser Temperature:** defined as the average of the temperature of the saturated vapour at the condenser inlet and the temperature of the saturated liquid at the condenser outlet. They are taken to be the dew and bubble point temperatures respectively at the condenser pressure.

**Superheating:** defined as the temperature difference between the superheated vapour at the compressor inlet and the saturated vapour at the evaporator outlet. It is assumed that the compression process begins under identical conditions to those at the compressor inlet i.e. the compressor inlet conditions are the same as the suction conditions.

**Sub-cooling:** defined as the temperature difference between the saturated liquid at the condenser outlet and that of the sub-cooled liquid at the expansion device inlet.

**Efficiency:** An isentropic compression process is used for the theoretical cycle calculations. The isentropic efficiency is the value relative to a theoretical maximum of 100%, of the efficiency with which the



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compressor can isentropically compress the superheated vapour from the suction pressure up to a pressure equivalent to the condenser pressure. It scales directly with the required compressor power.

**The Constraint: Cooling Duty or Volumetric Flowrate:**

In order to compare the calculations of several refrigerants on the same basis there is an option to constrain either the cooling duty or the volumetric flowrate of the superheated vapour prior to compression (i.e. the compressor inlet).

**Cooling Duty:** the required cooling capacity of the system. In this program, it is defined as the cooling that occurs from directly after the expansion device to the evaporator outlet i.e. the saturated vapour condition.

**Volumetric Flowrate:** defined for the superheated vapour immediately prior to the compression process (i.e. at the compressor inlet point).

#### DEFINITION OF CALCULATED FIELDS

**Pressure:** the pressure for which the average of the calculated evaporator inlet and outlet temperatures give the input evaporator temperature.

**Condenser Pressure:** the pressure for which the average of the calculated condenser inlet (dew point) and outlet (bubble point) temperatures give the input condenser temperature.

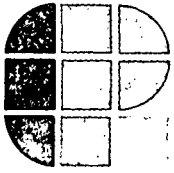
**Coefficient of Performance:** the ratio of the refrigeration effect to the heat of compression. The refrigeration effect is defined in two ways, as the difference between the evaporator inlet condition (expansion valve outlet) and either the evaporator outlet condition (exclusive of superheating), or the compressor inlet condition (inclusive of superheating). The heat of compression is defined as the enthalpy rise of the vapour as a result of the compression process.

**EER - Energy Ratio:** the ratio of the gross capacity (see below) in Btu/hr to the compressor power in watts. The EER has been defined in this way for all cycle calculations, including those in SI and METRIC units.

**Cooling Duty:** same definition as given in input fields.

**Gross Capacity:** The calculated gross cooling capacity of the system. It is defined as the cooling that occurs from directly after the expansion device to the compressor inlet i.e. superheated vapour.





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**Compressor Power:** The heat (enthalpy) required from the compressor.

**Mass Flow rate:** The refrigerant mass flow rate required around the system to meet the input constraint value at the input conditions.

**Suction Line Temperature:** The temperature of the superheated vapour at the compressor inlet point.

**Discharge Temperature:** The temperature of the compressed vapour at the compressor outlet, which in this cycle is also taken as the point at the end of the compression process.

**Temperature Glide in the Evaporator:** The difference between the evaporator inlet and outlet temperatures.

**Temperature Glide in the Condenser:** The difference between the condenser inlet and outlet temperatures.

## **2- Component Selection**

### **Compressor selection**

Assuming 16 hours daily operating time for the compressor, the calculated refrigeration load will be modified to:

$$Q_c = \frac{Q_{TL \times 24}}{16} = 1.5 Q_{TL}$$

Where :

$Q_c$  = required cooling capacity

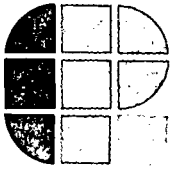
For selection of compressor from manufacturer's catalogue, we have to mention appropriate evaporating temperature;

- In refrigerators with ice compartment mounted inside, maximum evaporating temperature can be selected in order to have - 12 C ( Two Stars ) inside ice compartment.

- For upright freezers or freezer compartment of two door refrigerators, evaporating temperature should be in order to obtain -18 C ( Three Stars ) cabin temperature.

### **Capillary tube**

Capillary tube is one of the most important components in refrigerator circuits. Capillary acts as a pressure-reducing device to meter the flow of refrigerant to the low pressure side (evaporator) of the system. In other word,



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capillary tube should be capable to pass refrigerant pumped by the compressor and feed it to evaporator at available load and demand conditions.

On the contrary of the R12 or R22 refrigerants, practical equations, charts or graphs are not available for calculation of capillary size in R134a refrigeration circuits. Comparing saturation properties of R134a with R12 at a certain temperature, R134a pressure is less than R12, therefore, capillary tube for R134a shall be adjusted at low evaporating temperatures in comparison with R12 system. The capillary for R134a refrigeration system must have an increase resistance which can be estimated about 10 - 15% increase in length for a definite bore. However the exact size (bore and length) can be attainable after laboratory performance tests.

### Condenser & Evaporator

The statically cooled condenser is designed for use in small refrigeration appliance with sufficient space for the necessary condenser area. These condensers are manufactured either in tube-on-finned plate type or wire-on-tube design. Assuming that compressor casing and tubing will dissipate 80% of the heat equivalent of electrical in put, the condenser should be capable to reject heat absorbed by the refrigerant in the evaporator plus 20% of compressor power input heat equivalent.

The evaporator should balance the selected compressor capacity, not the original calculated load. Most of the refrigerators mainly employ aluminum evaporators produced on the roll-bond principal, where wire-on tube evaporators are usually installed in upright freezers.

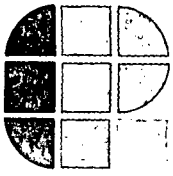
Due to the higher latent heat ( hfg ) of R134a in comparison with R12 and therefore less refrigerant charge in the system, it seems that evaporators and condensers used for R12 are also suitable for R134a refrigeration system. However more detailed information about role of these two components in the system would be cleared after laboratory performance tests. Therefore partial modifications should be done if needed.

### Refrigerant charge

As mentioned in previous sections, R134a latent heat of vaporization is about 28-30% higher than R12 in temperature range -30 C up to + 10 C. Table 2-2 shows thermodynamics saturation properties (with respect to a certain temperature) for these two refrigerants. In practice, charging amount of R134a can be 10-15% less than R12 with

the same refrigeration load.

R134a is capable to absorb more humidity of the oil in comparison with R12. Therefore, the filter drier selected for R134a should be a drier with 3A desiccant with 20% more molecular sieve ( by weight ) in comparison with conventional types.

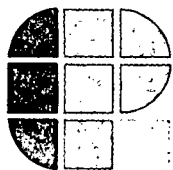


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Saturation Properties Comparison

Temp C	R12					R134a				
	P Kpa	Enthalpy Kj/Kg	Enthalpy Kj/Kg	Sp.Vol Lit/Kg	Sp.Vol Lit/Kg	P Kpa	Enthalpy Kj/Kg	Enthalpy Kj/Kg	Sp.Vol Lit/Kg	Sp.Vol Lit/Kg
		hf	hg	Vf	Vg		hf	hg	Vf	Vg
-30	100.41	172.81	338.14	0.672	159.37	84.36	61.51	277.208	0.7100	0.2219
-26	118.72	176.38	339.96	0.677	136.28	101.65	66.56	212.96	0.7171	0.1868
-22	139.53	179.96	341.78	0.682	117.16	121.62	71.63	281.86	0.7243	0.1570
-18	163.04	183.56	343.58	0.688	101.24	144.56	76.72	284.19	0.7318	0.1313
-14	189.50	187.18	345.36	0.694	87.89	170.76	81.84	286.52	0.7396	0.1138
-10	219.12	190.82	347.13	0.700	76.64	200.51	86.98	288.85	0.7475	0.0941
-6	252.14	194.47	348.88	0.706	67.11	234.13	92.162	291.18	0.7558	0.0843
-4	270.01	196.31	349.75	0.709	62.89	252.49	94.76	292.35	0.7600	0.0784
-2	288.82	198.15	350.61	0.712	58.99	271.94	97.377	293.522	0.7643	0.0730
0	308.61	200.00	351.47	0.715	55.38	292.52	100.00	294.68	0.7687	0.0681
2	329.40	201.85	352.33	0.719	52.04	314.27	102.63	295.35	0.7732	0.0635
4	351.24	203.71	353.17	0.722	48.94	337.24	105.28	297.01	0.7777	0.0594
6	374.14	205.57	354.02	0.726	46.07	361.47	107.93	298017	0.7823	0.0555
8	398.15	207.44	354.85	0.729	43.40	387.01	110.60	299.33	0.7870	0.0520
10	423.30	209.32	355.68	0.733	40.91	413.90	113.29	300.49	0.7918	0.0487



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## **Development of Prototypes.**

We have planned to train the company's technical staff in two phases, at two sessions we gave them mainly general information about the Ozone, Montreal Protocol, and an introduction to safe use of R134a Refrigerant.

The topics that could be considered as remarkable issues of our training program, could be summarized as follows.

### **Ozone**

### **Montreal Protocol**

### **Ozone Depletion Substances**

### **Ozone Friendly Alternatives**

### **R134a Refrigerant**

### **Refrigeration Concept**

### **Cause of Leakage**

### **Recovery, Recycling, Reclaiming**

At the second phase of training which will be occurred before testing prototypes, and preparing our draft final report following subjects will be trained to the trainees.

### **Safe Handling & Storage of Compressed Gases**

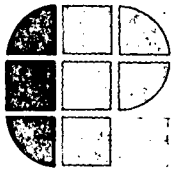
### **Model Design concept**

### **Refrigeration Load Calculation**

### **Refrigeration System Component Selection**

### **Refrigeration System Optimization Plan**

### **Making Prototype**



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### Prototype Test Procedure

### Trial Production

### Mass production

## **Making Prototype**

In order to make prototypes we should take following steps.

- a) Model Selection
- b) Refrigeration System Type
- c) Refrigeration System Components Definition
  - Condenser
  - Capillary Tube Function
  - Capillary Tube Definition
  - Thermostatic Expansion Valve Function
  - Thermostatic Expansion Valve type
  - Filter Drier
  - Evaporator
  - Compressor Cooling System
  - Compressor Pressure System
  - Compressor Type
  - Compressor refrigerant Type
  - Compressor Electrical System and Accessories
  - Compressor Mounting Pad
  - Compressor Capacity
  - Compressor Test Condition

### **CECOMAF Standards**

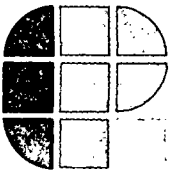
Heat Output = Capacity + Watt Consumption

### **ASHRAE STANDARD**

Conversion of Capacity From CECOMAF to ASHRAE Standard  
Compressor Capacity Relation to Different Evaporating Temp.

### **Thermostat**

Thermostat Adjustment  
Thermostat Setting



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### **New Refrigerant Operating Behavior**

Blend, Butane & Propane  
Refrigerant Charging Method  
Charging Amount  
Experimental, Trial and Error  
Calculation Basis  
Comparison with other Refrigerant

### **Testing Prototypes**

#### **Step I**

Testing Previously optimized  
R12 Model

#### **Step II**

Hot Chamber Preparation

#### **Step III**

Loading Test Package, "M" Package  
Meat, Water, Etc.

#### **Step IV**

Mounting Sensors

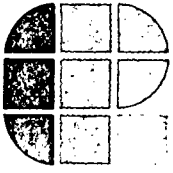
#### **Step V**

Ambiant Temperature Condition  
Relative Humidity 60% to 70%

### **Prototype Test Procedure**

- Performing R12 Refrigeration System Optimization Test
- Hot Chamber Test Criteria
- Ambient Test Condition
- Different type of test methods

- ✓ Operational Test
- ✓ Performance Test
- ✓ Energy Consumption
- ✓ Ice Making Test
- ✓ Humidity Test
- ✓



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➤ Test Process

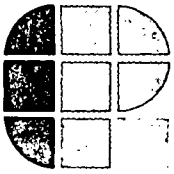
- ✓ Pull Down
- ✓ Continuous Run
- ✓ Cyclic Run
- ✓ Period of each test phase

- Test Results Data Collection
- Test Results Analysis

**Trial Production**

- Batch Production
- Customer Data System Feed Back
- Prototype Improvement
- Problem Solving

**Mass production**



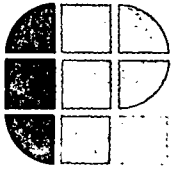
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### Prototype Technical Specification Al- Ammouy Refrigeration Industries

Description	Specification
Company name	Al- Ammouy Refrigeration Industries
Product Type	Table Refrigerator Show Case
Product model	ARI 200 T
Product Application	Dairy
Ambient Operating Temperature	32 C
Climatic Condition	Standard "Normal"
Overall Dimension WxLxH "Cm"	90x70x190
Internal Volume "Liter"	700
Refrigerator Inside Temp.	5 C
Evaporating temperature	- 10 c
Insulation Type	PU Foam
Insulation Thickness	6 Cm
Refrigerant type	R12
Refrigerant Weight	800 Grams
Compressor type, and model	Hermetic, Danfoss SC12B
Compressor Cooling Capacity	400 watts
Condenser Type, and Size	Fan Cooled Coil,
Condenser Material	Copper
Evaporator type	Copper Tube and Aluminum Fins
Evaporator Size	17t Mt. Length, 7/8 " Diameter
Drier Type	Danfoss
Drier weight	30 Grams
Capillary Tube Size	Copper, 150 Cm, and 0.40 mm Dim
Double Glass Space	N/A
Glass Thickness	8 mm
Number or Doors	2x Steel doors



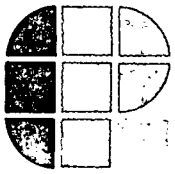


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### Prototype Technical Specification Angelidis Freres

Description	Specification
Company name	Angelidis Freres
Product Type	Upright Refrigerator
Product model	AF-80
Product Application	Meat Storage
Ambient Operating Temperature	32 C
Climatic Condition	Standard "Normal"
Overall Dimension WxLxH "Cm"	80x65x200
Internal Volume "Liter"	600
Refrigerator Inside Temp.	4 C
Evaporating temperature	- 10 c
Insulation Type	Polystyrene
Insulation Thickness	5 Cm
Refrigerant type	R12
Refrigerant Weight	700 Grams
Compressor type, and model	Hermetic, ASPERA E5187A
Compressor Cooling Capacity	600 watts
Condenser Type, and Size	Fan Cooled Coil, 2 Rows by 9 Lines
Condenser Material	Copper
Evaporator type	Copper Tube and Aluminum Fins
Evaporator Size	12 Mt. Length, 5/8" Diameter
Drier Type	FD-032 $\frac{1}{4}$ "
Drier weight	30 Grams
Capillary Tube Size	Copper, 200 Cm, and 0.48 mm Dim
Double Glass Space	N/A
Glass Thickness	N/A
Number or Doors	N/A

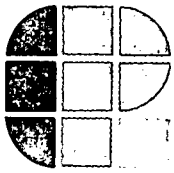


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### Prototype Technical Specification Chemayssem Industries

Description	Specification
Company name	Chemayssem Industries
Product Type	Upright Refrigerator
Product model	SI-150
Product Application	Meat Storage
Ambient Operating Temperature	32 C
Climatic Condition	Standard "Normal"
Overall Dimension WxLxH "Cm"	80x65x150
Internal Volume "Liter"	500
Refrigerator Inside Temp.	4 C
Evaporating temperature	- 10 c
Insulation Type	Polystyrene
Insulation Thickness	5 Cm
Refrigerant type	R12
Refrigerant Weight	700 Grams
Compressor type, and model	Hermetic, Necchi
Compressor Cooling Capacity	600 watts
Condenser Type, and Size	Fan Cooled Coil, 2 Rows by 9 Lines
Condenser Material	Copper
Evaporator type	Copper Tube and Aluminum Fins
Evaporator Size	12 Mt. Length, 5/8" Diameter
Drier Type	FD-032 $\frac{1}{4}$ "
Drier weight	30 Grams
Capillary Tube Size	Copper, 200 Cm, and 0.48 mm Dim
Double Glass Space	N/A
Glass Thickness	N/A
Number or Doors	N/A

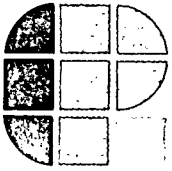


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### Prototype Technical Specification Cold Refrigeration Company

Description	Specification
Company name	Cold Refrigeration Company
Product Type	Upright Refrigerator
Product model	RP-200S
Product Application	Meat Storage
Ambient Operating Temperature	32 C
Climatic Condition	Standard "Normal"
Overall Dimension WxLxH "Cm"	85x60x1800
Internal Volume "Liter"	600
Refrigerator Inside Temp.	4 C
Evaporating temperature	- 10 c
Insulation Type	Polystyrene
Insulation Thickness	5 Cm
Refrigerant type	R12
Refrigerant Weight	700 Grams
Compressor type, and model	Hermetic, Matsushita
Compressor Cooling Capacity	600 watts
Condenser Type, and Size	Fan Cooled Coil, 2 Rows by 9 Lines
Condenser Material	Copper
Evaporator type	Copper Tube and Aluminum Fins
Evaporator Size	12 Mt. Length, 5/8" Diameter
Drier Type	FD-032 ¼"
Drier weight	30 Grams
Capillary Tube Size	Copper, 200 Cm, and 0.48 mm Dim
Double Glass Space	N/A
Glass Thickness	N/A
Number or Doors	N/A

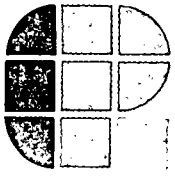


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### Prototype Technical Specification Georgio Industries

Description	Specification
Company name	Georgio Industries
Product Type	Upright Refrigerator
Product model	George 100
Product Application	Meat Storage
Ambient Operating Temperature	32 C
Climatic Condition	Standard "Normal"
Overall Dimension WxLxH "Cm"	100x65x150
Internal Volume "Liter"	650
Refrigerator Inside Temp.	4 C
Evaporating temperature	- 10 c
Insulation Type	Polystyrene
Insulation Thickness	5 Cm
Refrigerant type	R12
Refrigerant Weight	700 Grams
Compressor type, and model	Hermetic, ASPERA
Compressor Cooling Capacity	600 watts
Condenser Type, and Size	Fan Cooled Coil, 2 Rows by 9 Lines
Condenser Material	Copper
Evaporator type	Copper Tube and Aluminum Fins
Evaporator Size	12 Mt. Length, 5/8" Diameter
Drier Type	FD-032 $\frac{1}{4}$ "
Drier weight	30 Grams
Capillary Tube Size	Copper, 200 Cm, and 0.48 mm Dim
Double Glass Space	N/A
Glass Thickness	N/A
Number or Doors	N/A

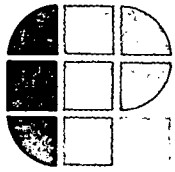


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**Prototype Technical Specification**  
**Mohiedddine Addada Est for Trade Industries**

Description	Specification
Company name	Mohiedddine Addada Est for Trade Industries
Product Type	Upright Refrigerator
Product model	IEB 300
Product Application	Meat Storage
Ambient Operating Temperature	32 C
Climatic Condition	Standard "Normal"
Overall Dimension WxLxH "Cm"	85x60x200
Internal Volume "Liter"	700
Refrigerator Inside Temp.	4 C
Evaporating temperature	- 10 c
Insulation Type	Polystyrene
Insulation Thickness	5 Cm
Refrigerant type	R12
Refrigerant Weight	700 Grams
Compressor type, and model	Hermetic, Danfoss
Compressor Cooling Capacity	600 watts
Condenser Type, and Size	Fan Cooled Coil, 2 Rows by 9 Lines
Condenser Material	Copper
Evaporator type	Copper Tube and Aluminum Fins
Evaporator Size	12 Mt. Length, 5/8" Diameter
Drier Type	FD-032 $\frac{1}{4}$ "
Drier weight	30 Grams
Capillary Tube Size	Copper, 200 Cm, and 0.48 mm Dim
Double Glass Space	N/A
Glass Thickness	N/A
Number or Doors	N/A

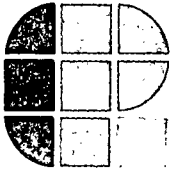


**IPEC** **إسكس**

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P.O.BOX:68 JOUNIEH

### Prototype Technical Specification Kassha for Industry and Trade

Description	Specification
Company name	Kassha for Industry and Trade
Product Type	Table top Refrigerator
Product model	REF-210
Product Application	Dairy Storage
Ambient Operating Temperature	32 C
Climatic Condition	Standard "Normal"
Overall Dimension WxLxH "Cm"	85x65x210
Internal Volume "Liter"	1000
Refrigerator Inside Temp.	4 C
Evaporating temperature	- 10 c
Insulation Type	Polystyrene
Insulation Thickness	5 Cm
Refrigerant type	R12
Refrigerant Weight	700 Grams
Compressor type, and model	Hermetic, Zanyssi Electromecanica
Compressor Cooling Capacity	600 watts
Condenser Type, and Size	Fan Cooled Coil, 2 Rows by 9 Lines
Condenser Material	Copper
Evaporator type	Copper Tube and Aluminum Fins
Evaporator Size	12 Mt. Length, 5/8" Diameter
Drier Type	FD-032 $\frac{1}{4}$ "
Drier weight	30 Grams
Capillary Tube Size	Copper, 200 Cm, and 0.48 mm Dim
Double Glass Space	N/A
Glass Thickness	N/A
Number or Doors	N/A

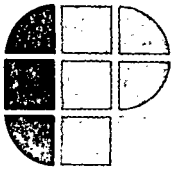


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*Product Technical Specification*  
**Le Condor Refrigeration Company**

<b>Description</b>	<b>Specification</b>
Company Name	Le Condor Refrigeration Company
Product Name	Water Cooler
Product Model	Condor 30
Product Application	Water Cooler
Operating Temperature	32 C
Climatic Condition	Normal
Product Overall Dimension WxLxH mm	50*45*140 cm
Freezer Compartment Overall Dimension and Wall Thickness	N/A
Refrigerator Compartment Overall Dimension and Wall Thickness	N/A
Product Shape, Double Doors, Upright, Chest, etc	Stand
Freezer Internal Net Volume	N/A
Refrigerator Net Volume	N/A
Product Net Volume	N/A
Product Inside Temperature C	N/A
Water Storage Tank Capacity, Water Cooler	40 Lit.
Type of Water Storage Tank Cylinder, Cubic, etc.	Cylinder
Water Fellow per hour for water cooler	50 Lit/H
Water Storage Tank Dimension	30*40*45
Water Outlet Temperature	+ 6 C
Water Inlet Temperature	35 C
Freezer Inside Temperature	N/A
Refrigerator Inside Temperature	N/A
Evaporating Temperature	-5 C
Foam Insulation Thickness mm Side Walls, Top, Bottom, Door, Back Panel	40 mm
Type of PU Foam	R 11 PU Foam
Foam Density, Kg/Cu. Mt.	40 Kg/Cu. Mt.

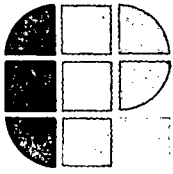


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Foam Mixture, Percentage Pol% + R11% + Isocyanate%	37% + 13% + 50%
Total amount of Foam Injection, Kg	5 Kg
Refrigerant Type	R 12
Refrigerant Charge Weight Gr.	350 Gr.
Type of Compressor, Hermetic, Semi Hermetic, Open	Hermetic
Compressor Cooling System Static, Oil Cooled, Fan Cooled	Fan Cooled
Compressor Cooling Capacity Watt	280 Watt
Compressor input Power, Watt	250 Watt
Compressor Model Number	S10 Danfus 8500
Compressor Manufacturer	Danfus
Compressor Mounting Place Top, Bottom, Front, Back	Bottom
Condenser Type, Static, Fan Cooled	Fan Cooled
Condenser Dimension, Length, Inside Tube Diameter,	Three Rows, Tube Coil and Fins
Condenser Material, Aluminum, Copper, Copper Coated, etc,	Aluminum + Copper
Condenser mounting Place, Back Wall, Top, Bottom	Bottom
Evaporator Type, Fin and Tube, Roll Bond, Wire and Tube, etc.	Tubes 5/16
Evaporator Dimension, Length, Surface Area, Inside Tube Diameter	14 M. Length , Coil Shape, 5/16 Dim.
Evaporator Material, Aluminum, Copper, Copper Coated, etc,	Copper
Dryer Type,	
Dryer Material, Weight and Size	30 Gr.
Capillary Tube Diameter and Length	0.6 mm, 3 meters length





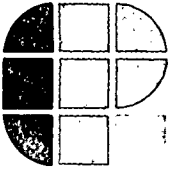
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TLX : 45482 IPEC LE  
P.O. BOX : 68 JOUNIEH

## Product Technical Specification

International Est. Badarco

Description	Specification
Company Name	International Est. Badarco
Product Name	Water Cooler
Product Model	IEB -30WC
Product Application	Water Cooler
Operating Temperature	32 C
Climatic Condition	Normal
Product Overall Dimension WxLxH mm	50*40*140 cm
Freezer Compartment Overall Dimension and Wall Thickness	N/A
Refrigerator Compartment Overall Dimension and Wall Thickness	N/A
Product Shape, Double Doors, Upright, Chest, etc	Stand
Freezer Internal Net Volume	N/A
Refrigerator Net Volume	N/A
Product Net Volume	N/A
Product Inside Temperature C	N/A
Water Storage Tank Capacity, Water Cooler	30 Lit.
Type of Water Storage Tank Cylinder, Cubic, etc.	Cylinder
Water Fellow per hour for water cooler	50 Lit/H
Water Storage Tank Dimension	30*40*45
Water Outlet Temperature	+ 6 C
Water Inlet Temperature	35 C
Freezer Inside Temperature	N/A
Refrigerator Inside Temperature	N/A
Evaporating Temperature	-5 C
Foam Insulation Thickness mm Side Walls, Top, Bottom, Door, Back Panel	40 mm
Type of PU Foam	R 11 PU Foam
Foam Density, Kg/Cu. Mt.	40 Kg/Cu. Mt.



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P.O. BOX : 68 JOUNIEH

Foam Mixture, Percentage Pol% + R11% + Isocyanate%	37% + 13% + 50%
Total amount of Foam Injection, Kg	5 Kg
Refrigerant Type	R 12
Refrigerant Charge Weight Gr.	350 Gr.
Type of Compressor, Hermetic, Semi Hermetic, Open	Hermetic
Compressor Cooling System Static, Oil Cooled, Fan Cooled	Fan Cooled
Compressor Cooling Capacity Watt	280 Watt
Compressor input Power, Watt	250 Watt
Compressor Model Number	S10 Danfus 8500
Compressor Manufacturer	Danfus
Compressor Mounting Place Top, Bottom, Front, Back	Bottom
Condenser Type, Static, Fan Cooled	Fan Cooled
Condenser Dimension, Length, Inside Tube Diameter,	Three Rows, Tube Coil and Fins
Condenser Material, Aluminum, Copper, Copper Coated, etc,	Aluminum + Copper
Condenser mounting Place, Back Wall, Top, Bottom	Bottom
Evaporator Type, Fin and Tube, Roll Bond, Wire and Tube, etc.	Tubes 5/16
Evaporator Dimension, Length, Surface Area, Inside Tube Diameter	14 M. Length , Coil Shape, 5/16 Dim.
Evaporator Material, Aluminum, Copper, Copper Coated, etc,	Cooper
Dryer Type,	
Dryer Material, Weight and Size	30 Gr.
Capillary Tube Diameter and Length	0.6 mm, 3 meters length



**AL AMMOURY Refrigeration**

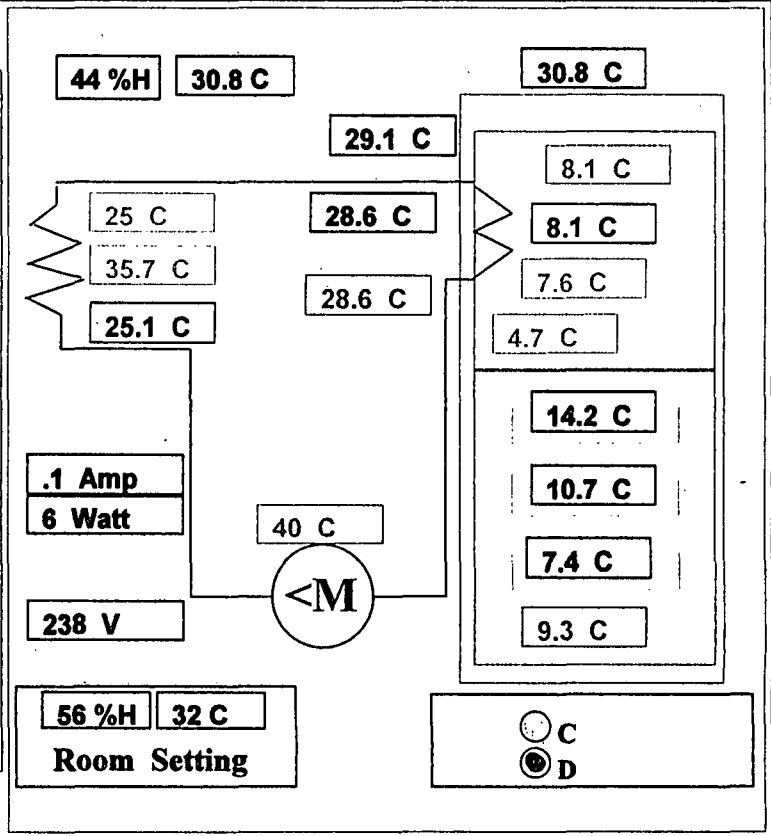
Report No.: ( ) - Page 1

PageTestName: **Energy Consumption**

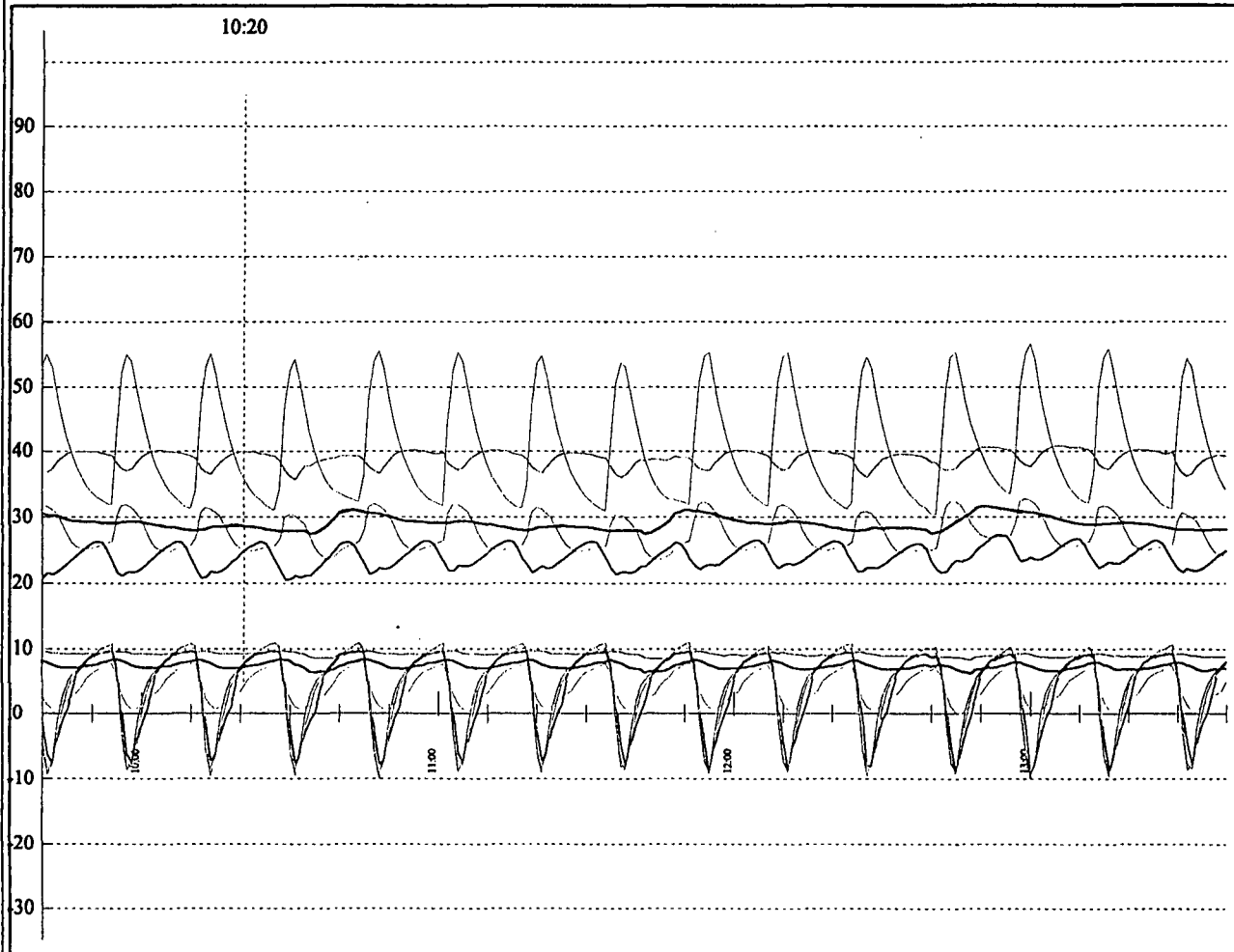
ReportDate: 2002/01/17 19:36

**Page Result :**

1 - Page Test Time	4 Hours
2 - Working Percent	19 %On
3 - Energy (Accord to page)	0.841 kwh
4 - Zoom Time	10:21 Hour
5 - Compr Current	0.1 Amp
6 - Evaprator Mean Temp	7.1 C
7 - Cabin Mean Temp	10.7 C
8 - Crisp Temp	9.3 C
9 - Compr Temp	40 C
10- Condensor In Temp	25.1 C
11- Condensor Out Temp	25 C
12- Condition	30.8 C 44 %H
13- Volt	Max=242 Mean=237 Min=225
14-	
15-	
16-	
17-	



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**International EST. BADARCO**

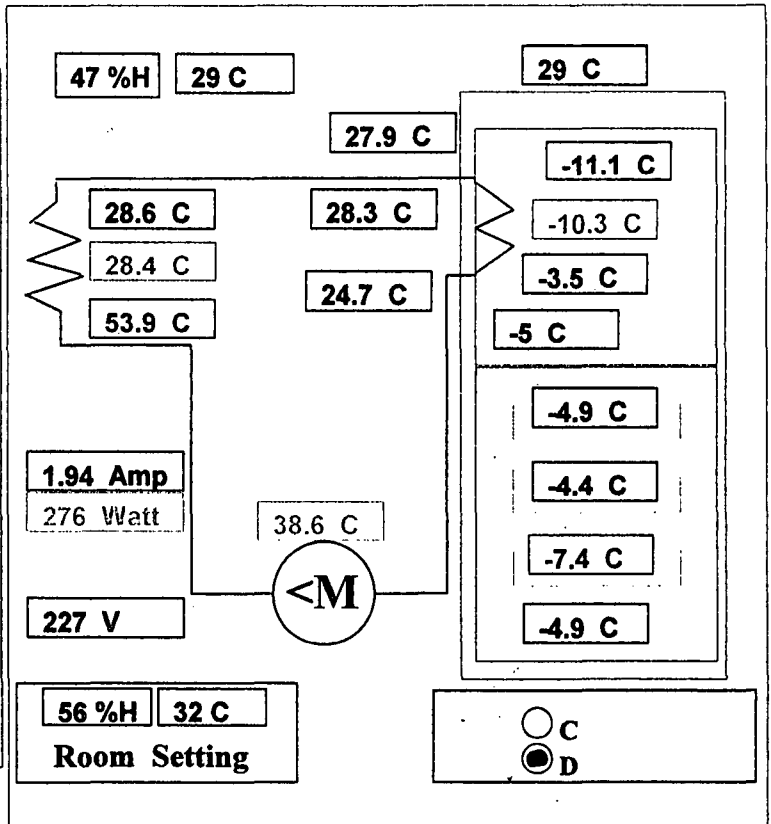
Report No.: ( ) - Page 1

PageTestName: **Energy Consumption**

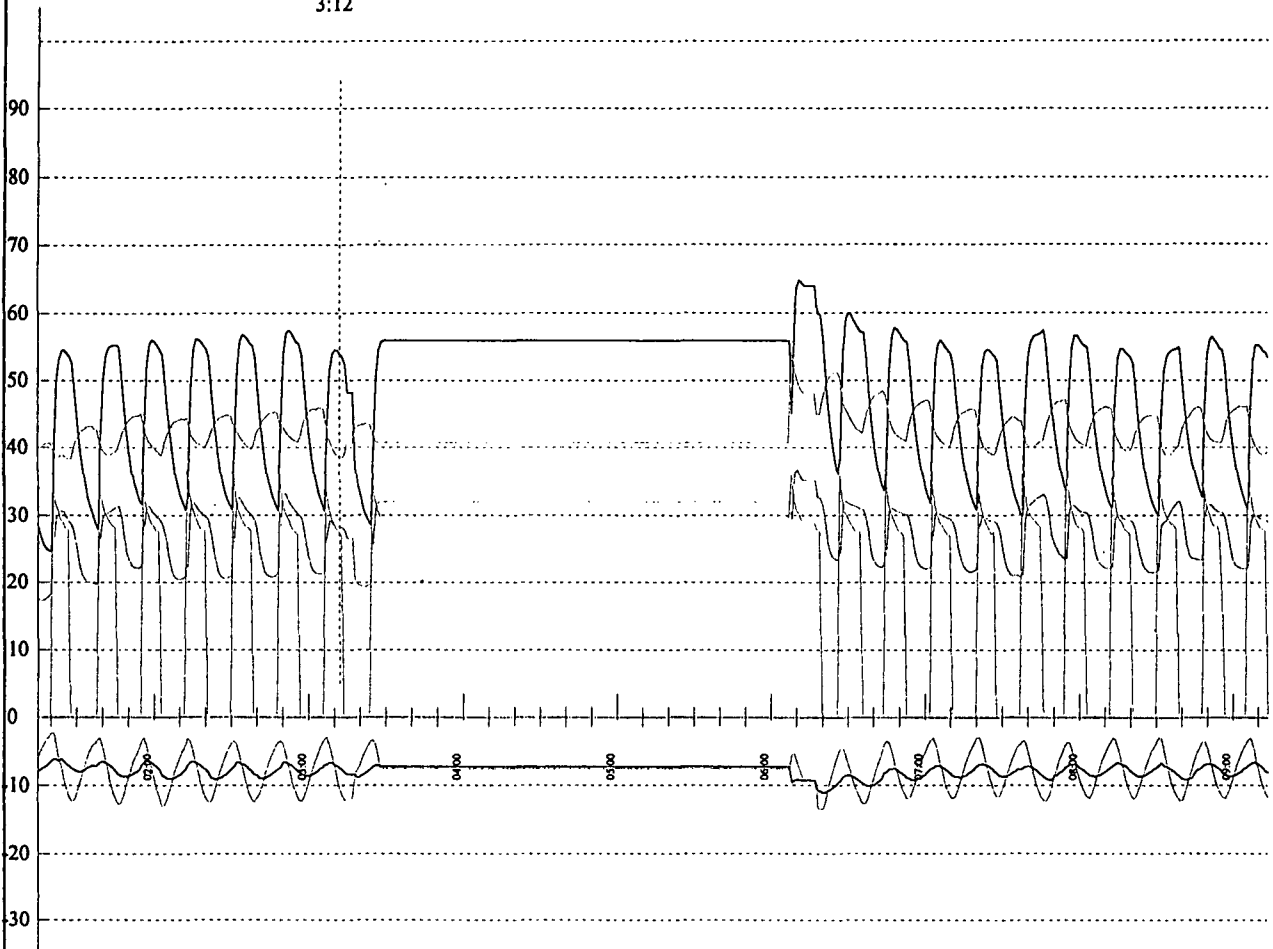
ReportDate: 2002/01/18 11:00

**Page Result :**

1 - Page Test Time	2 Hours
2 - Working Percent	43 %On
3 - Energy (Accord to page)	1.194 kwh
4 - Zoom Time	3:12 Hour
5 - Compr Current	1.94 Amp
6 - Evaprator Mean Temp	-7.4 C
7 - Cabin Mean Temp	-5.5 C
8 - Crisp Temp	-4.9 C
9 - Compr Temp	38.6 C
10- Condensor In Temp	53.9 C
11- Condensor Out Temp	28.6 C
12- Condition	29 C 47 %H
13- Volt	Max=241 Mean=236 Min=226
14-	
15-	
16-	
17-	



3:12





**COLD Refrigeration CO.**

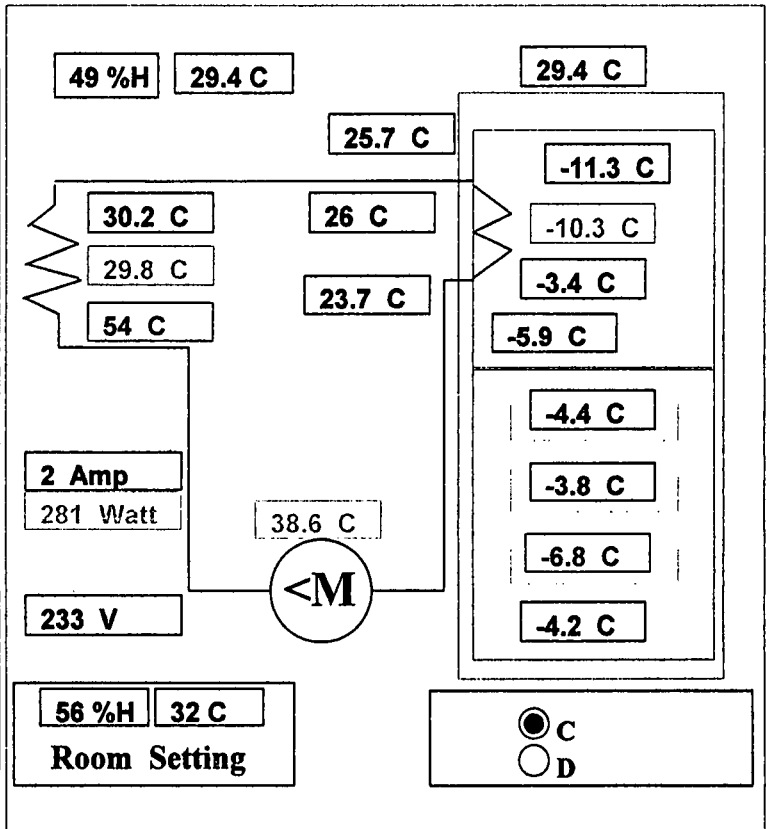
Report No.: ( ) - Page 1

PageTestName: **Energy Consumption**

ReportDate: 2002/01/18 10:47

**Page Result :**

1 - Page Test Time	3 Hours
2 - Working Percent	44 %On
3 - Energy (Accord to page)	1.167 kwh
4 - Zoom Time	1:26 Hour
5 - Compr Current	2 Amp
6 - Evaprator Mean Temp	-7.7 C
7 - Cabin Mean Temp	-5 C
8 - Crisp Temp	-4.2 C
9 - Compr Temp	38.6 C
10- Condensor In Temp	54 C
11- Condensor Out Temp	30.2 C
12- Condition	29.4 C 49 %H
13- Volt	Max=242 Mean=226 Min=224
14-	
15-	
16-	
17-	



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**MOHIEDDIN ADADA Est.**

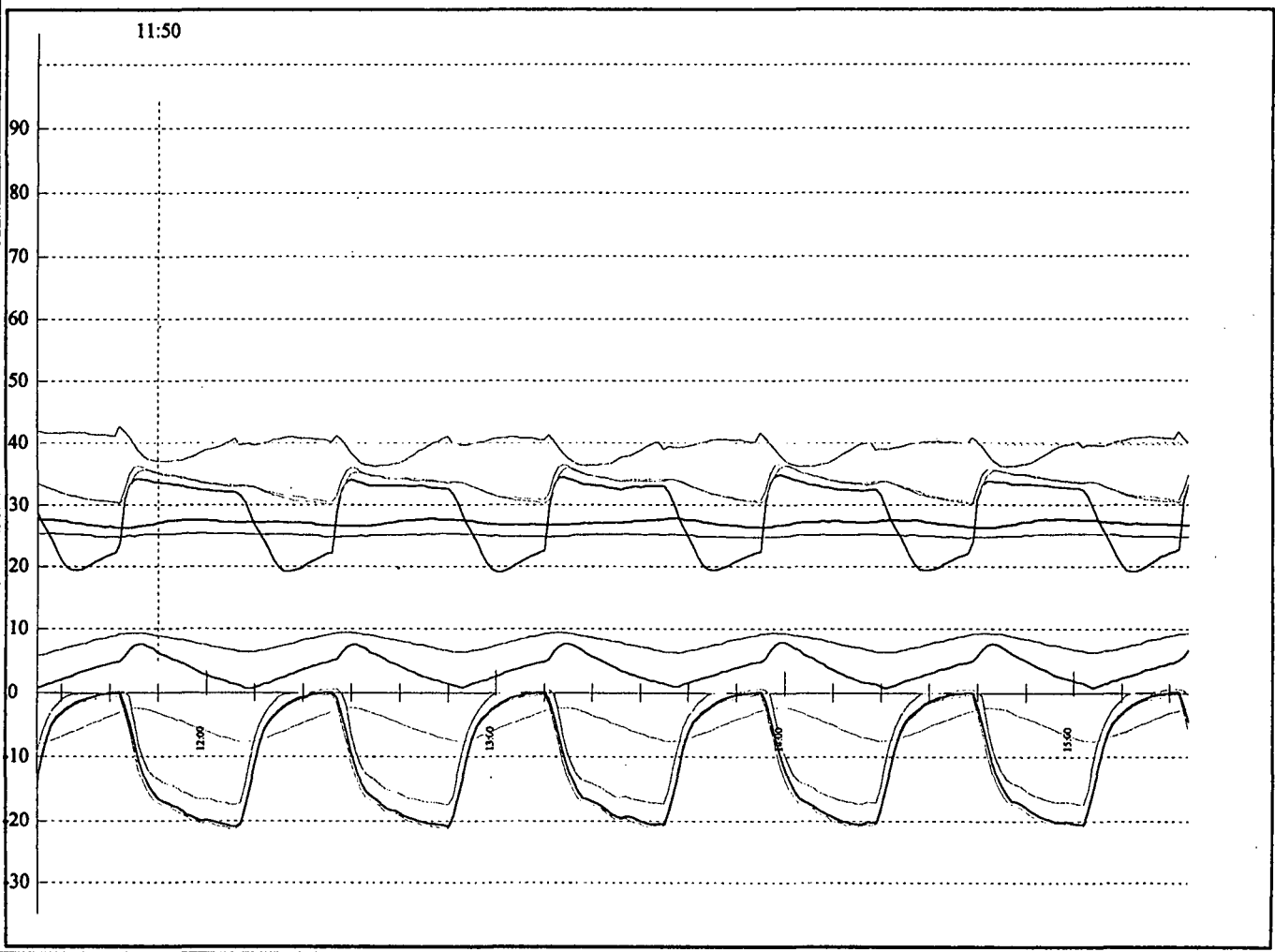
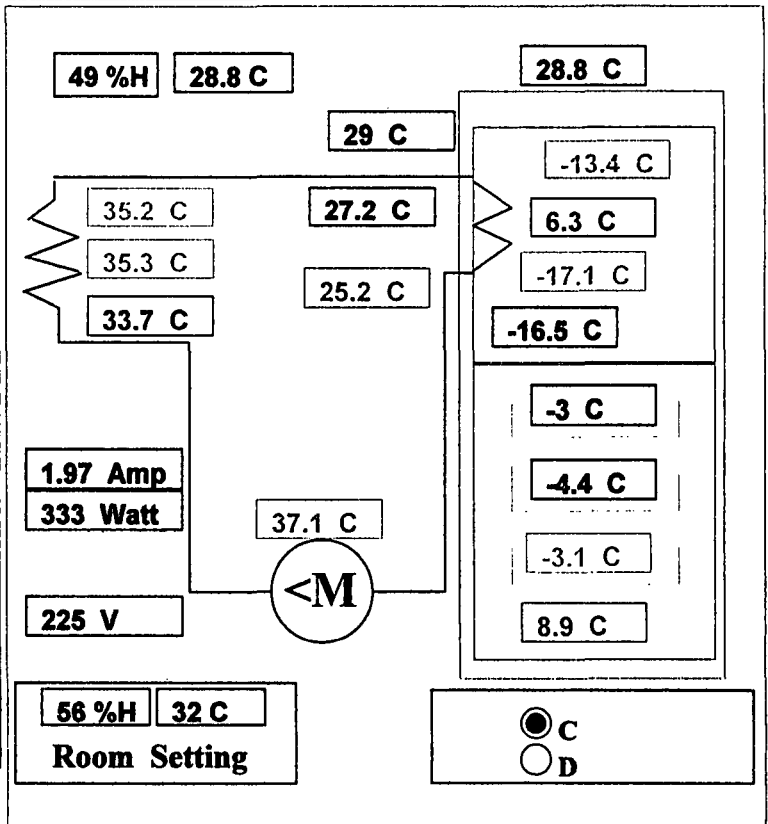
Report No.: ( ) - Page 1

PageTestName: **Energy Consumption**

ReportDate: 2002/01/16 19:18

**Page Result :**

- 1 - Page Test Time 4 Hours
- 2 - Working Percent 51 %On
- 3 - Energy (Accord to page) 1.566 kwh
- 4 - Zoom Time 11:50 Hour
- 5 - Compr Current 1.97 Amp
- 6 - Evaprator Mean Temp -10.1 C
- 7 - Cabin Mean Temp -3.5 C
- 8 - Crisp Temp 8.9 C
- 9 - Compr Temp 37.1 C
- 10- Condensor In Temp 33.7 C
- 11- Condensor Out Temp 35.2 C
- 12- Condition 28.8 C 49 %H
- 13- Volt Max=238 Mean=231 Min=222
- 14-
- 15-
- 16-
- 17-



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**KASHA FOR INDUSTRY**

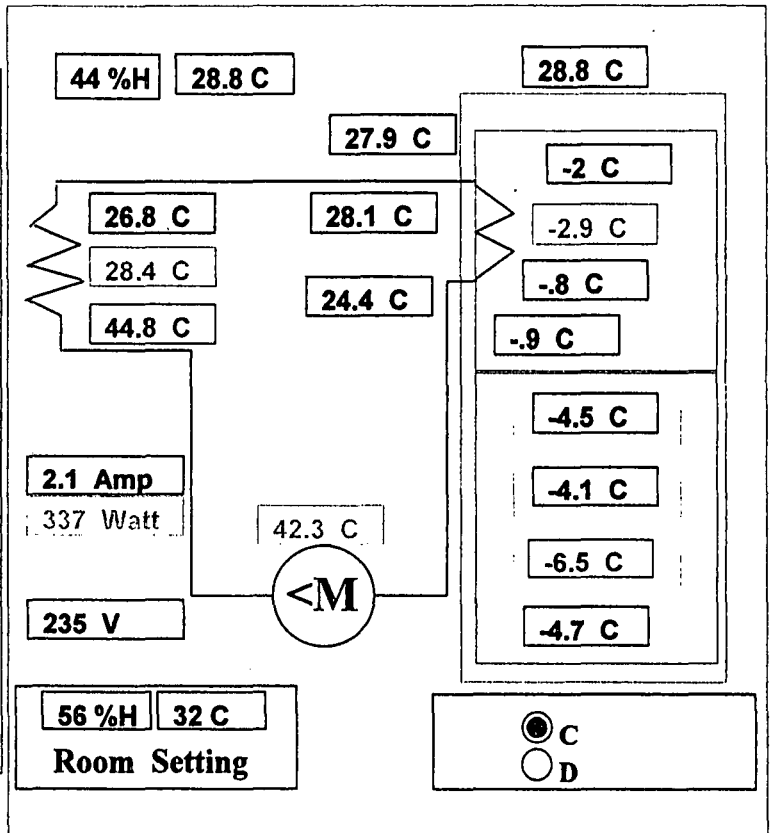
Report No.: ( ) - Page 2

PageTestName: **Energy Consumption**

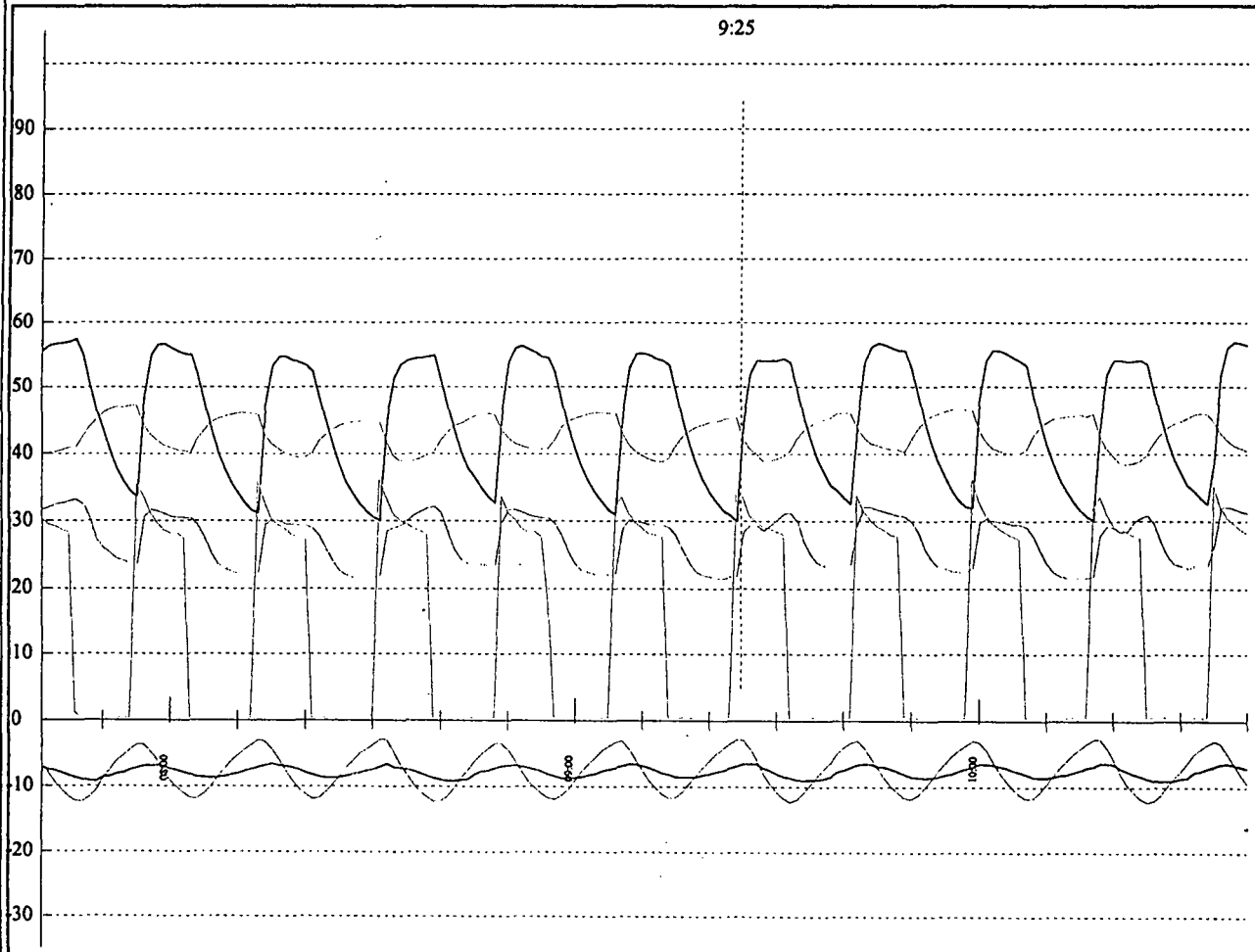
ReportDate: 2002/01/19 10:47

**Page Result :**

1 - Page Test Time	3 Hours
2 - Working Percent	45 %On
3 - Energy (Accord to page)	1.191 kwh
4 - Zoom Time	9:25 Hour
5 - Compr Current	2.1 Amp
6 - Evaprator Mean Temp	-1.6 C
7 - Cabin Mean Temp	-5 C
8 - Crisp Temp	-4.7 C
9 - Compr Temp	42.3 C
10- Condensor In Temp	44.8 C
11- Condensor Out Temp	26.8 C
12- Condition	28.8 C 44 %H
13- Volt	Max=244 Mean=237 Min=226
14-	
15-	
16-	
17-	



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**Angilidis Frères**

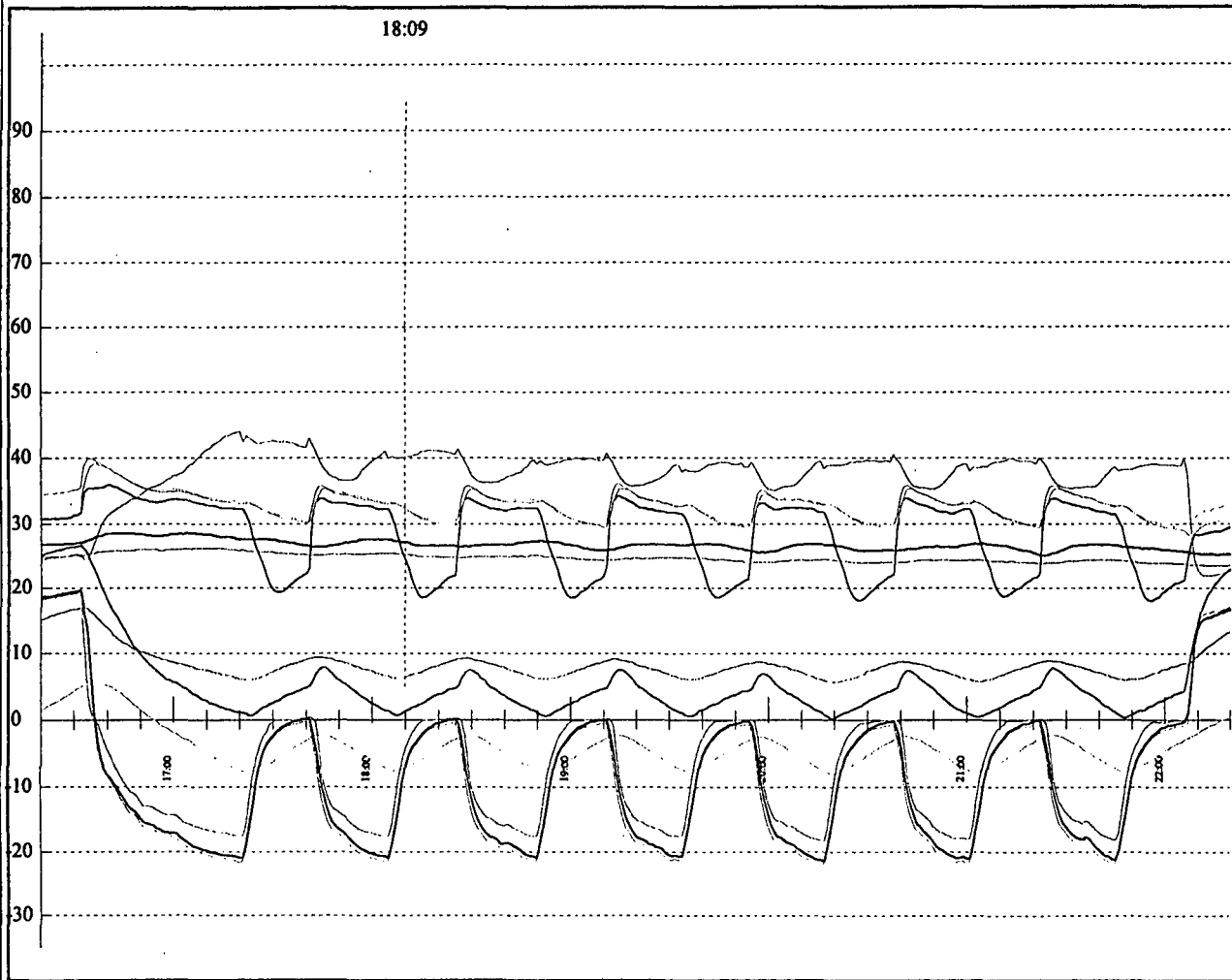
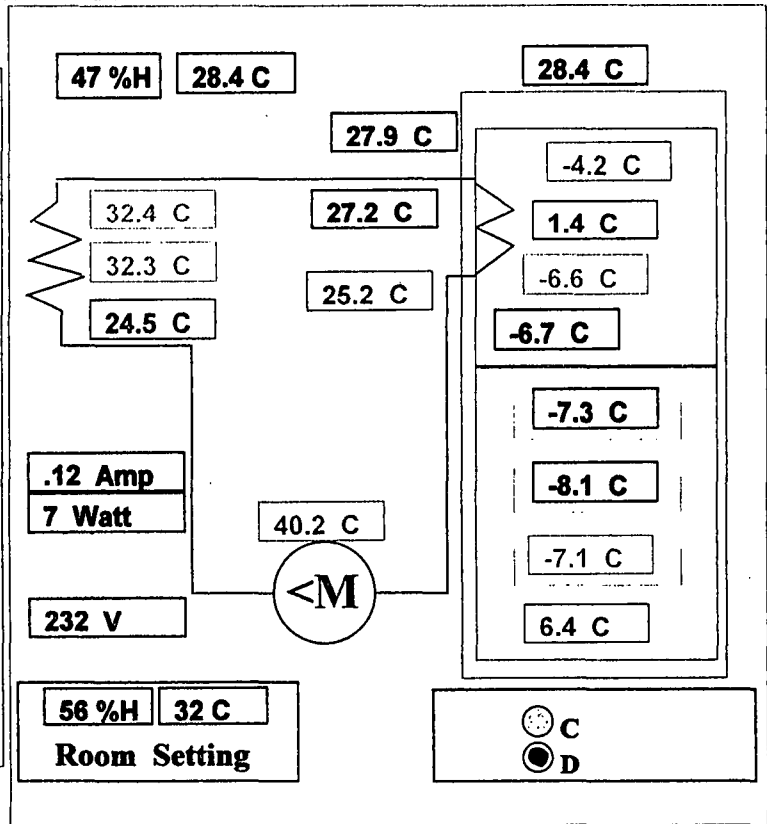
Report No.: ( ) - Page 1

PageTestName: **Energy Consumption**

ReportDate: 2002/01/19 19:22

**Page Result :**

- 1 - Page Test Time 6 Hours
- 2 - Working Percent 59 %On
- 3 - Energy (Accord to page) 1.685 kwh
- 4 - Zoom Time 18:10 Hour
- 5 - Compr Current 0.12 Amp
- 6 - Evaprator Mean Temp -4 C
- 7 - Cabin Mean Temp -7.5 C
- 8 - Crisp Temp 6.4 C
- 9 - Compr Temp 40.2 C
- 10- Condensor In Temp 24.5 C
- 11- Condensor Out Temp 32.4 C
- 12- Condition 28.4 C 47 %H
- 13- Volt Max=238 Mean=227 Min=213
- 14-
- 15-
- 16-
- 17-







**CHEMAYSEM Industries**

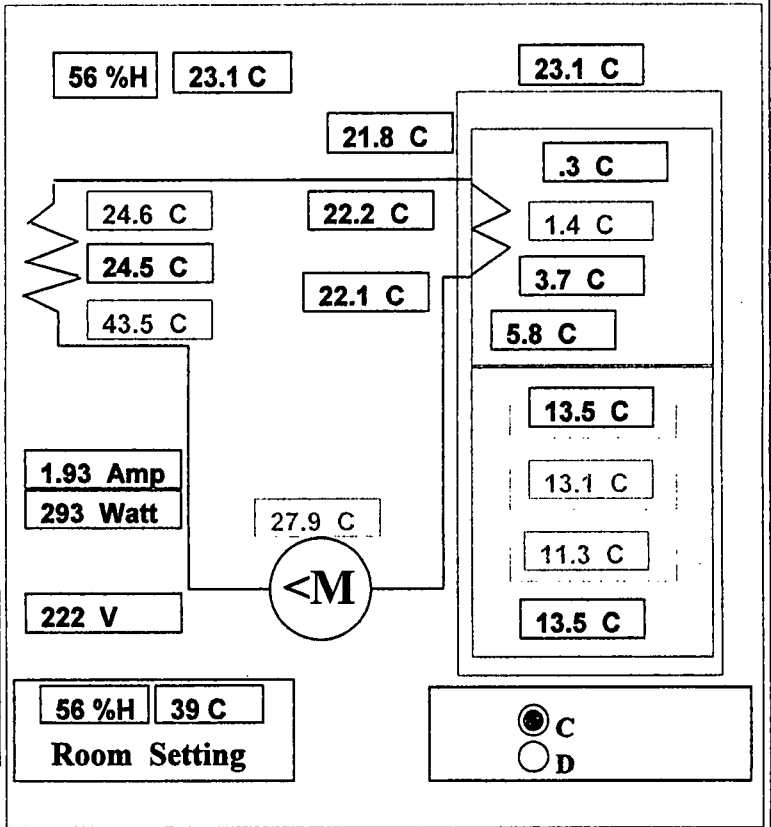
Report No.: ( ) - Page 1

PageTestName: **Energy Consumption**

ReportDate: 2002/01/18 15:11

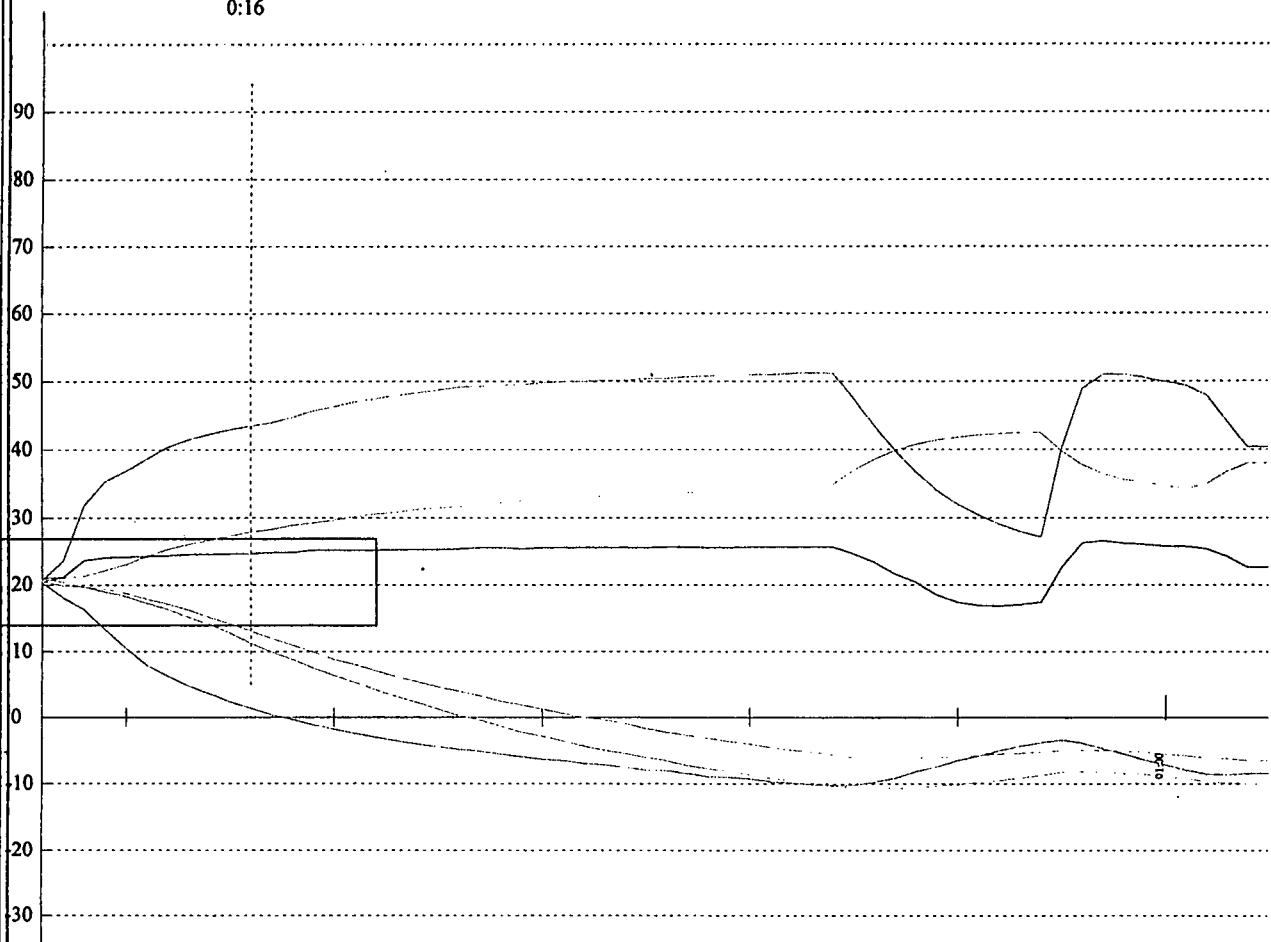
**Page Result :**

1 - Page Test Time	1 Hours
2 - Working Percent	77 %On
3 - Energy (Accord to page)	1.597 kwh
4 - Zoom Time	0:16 Hour
5 - Compr Current	1.93 Amp
6 - Evaprator Mean Temp	2.8 C
7 - Cabin Mean Temp	12.6 C
8 - Crisp Temp	13.5 C
9 - Compr Temp	27.9 C
10- Condensor In Temp	43.5 C
11- Condensor Out Temp	24.6 C
12- Condition	23.1 C 56 %H
13- Volt	Max=236 Mean=223 Min=210
14-	
15-	
16-	
17-	



0:16

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**LE CONDOR Refrigeration**

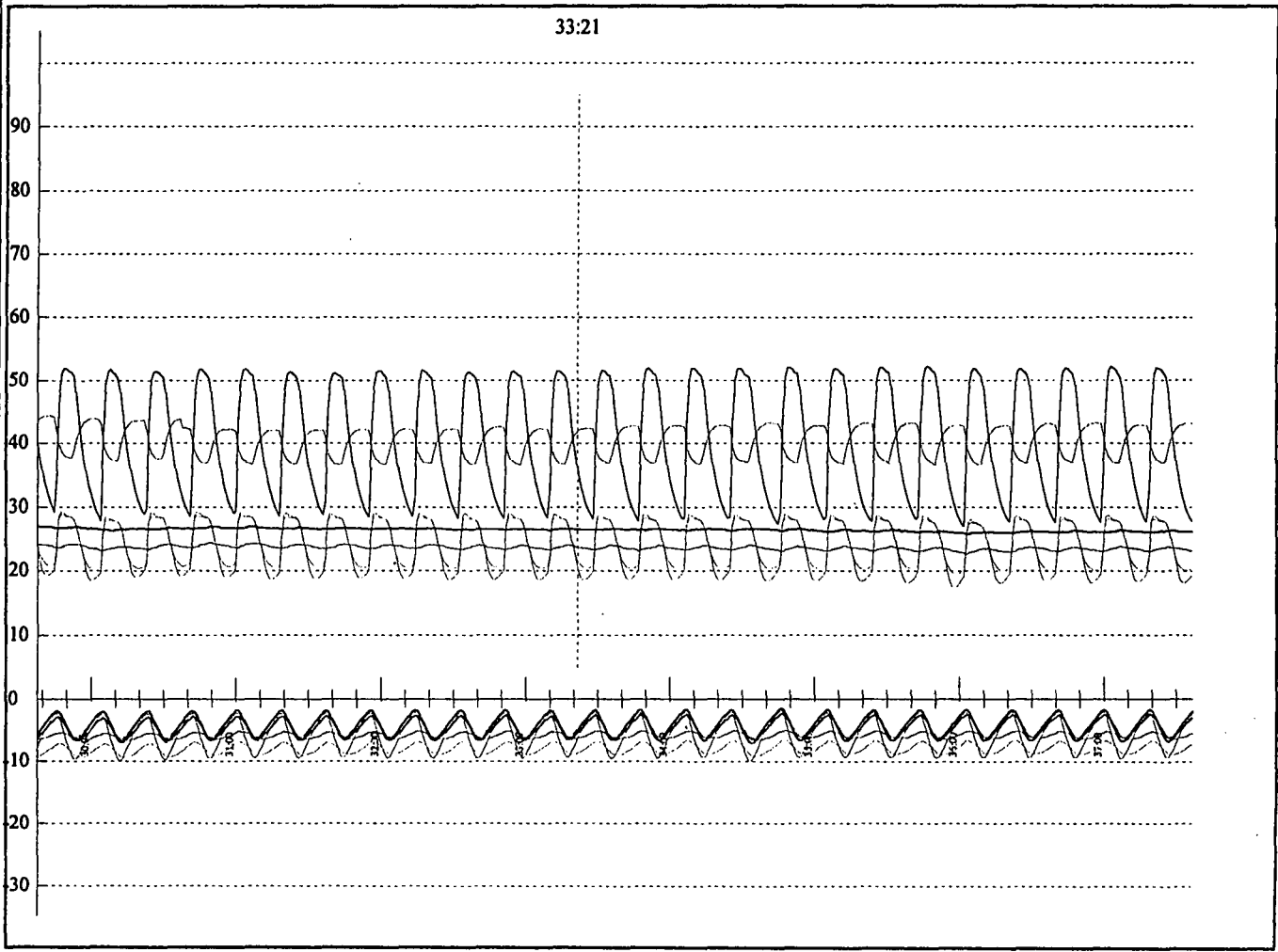
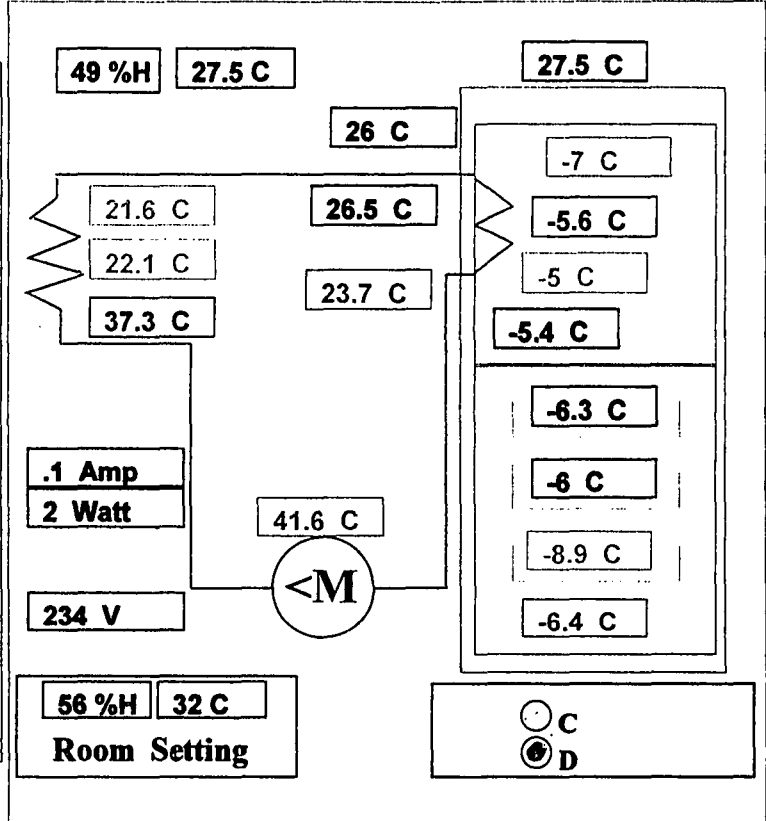
Report No.: ( ) - Page 1

PageTestName: **Energy Consumption**

ReportDate: 2002/01/18 19:25

**Page Result :**

- 1 - Page Test Time 8 Hours
- 2 - Working Percent 37 %On
- 3 - Energy (Accord to page) 0.964 kwh
- 4 - Zoom Time 33:21 Hour
- 5 - Compr Current 0.1 Amp
- 6 - Evaprator Mean Temp -5.7 C
- 7 - Cabin Mean Temp -7 C
- 8 - Crisp Temp -6.4 C
- 9 - Compr Temp 41.6 C
- 10- Condensor In Temp 37.3 C
- 11- Condensor Out Temp 21.6 C
- 12- Condition 27.5 C 49 %H
- 13- Volt Max=242 Mean=233 Min=216
- 14-
- 15-
- 16-
- 17-





**GEORGIO Industries**

Report No.: ( ) - Page 1

PageTestName: **Energy Consumption**

ReportDate: 2002/01/17 19:28

### Page Result :

1 - Page Test Time	7 Hours
2 - Working Percent	100 %On
3 - Energy (Accord to page)	1.875 kwh
4 - Zoom Time	18:54 Hour
5 - Compr Current	0.42 Amp
6 - Evaprator Mean Temp	-3.9 C
7 - Cabin Mean Temp	11 C
8 - Crisp Temp	7.4 C
9 - Compr Temp	51.4 C
10- Condensor In Temp	22.3 C
11- Condensor Out Temp	34.8 C
12- Condition	31.5 C 44 %H
13- Volt	Max=243 Mean=231 Min=215
14-	
15-	
16-	
17-	

