OCCASION

This publication has been made available to the public on the occasion of the 50th anniversary of the United Nations Industrial Development Organisation.

DISCLAIMER

FAIR USE POLICY

CONTACT

Please contact publications@unido.org for further information concerning UNIDO publications.

For more information about UNIDO, please visit us at www.unido.org

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org

شرکت مهندسی سهند مینا (با مسئولیت محدود)
SAHAND MINA ENGINEERING CO. LTD.

Our Ref.: شماره:

Date: تاریخ :

22235

CONVERSION OF PROTOTYPES INTO R134A OZONE FRIENDLY REFRIGERANT AT

YAZD ARG METAL, SHERVIN ELECTRIC AND YAZD SARDIN COMPANIES

Project Number
MP/IRA/98/087

Contract Number, 99/043P

Final Report

August 1999

تهران ،خیابان شریعتی ، بالاتر از میرداماد ساختمان ۱۲۸۰ آپارتمان شماره ۱۲ کد پستی ۱۹۵۵۸ تلفن : ۲۲۵۰۳۳۰ ، ۲۲۷۴۹۳۶ نمابر: ۲۲۷۴۹۳۶
No 12, Building 1280,Shariati Ave.,Tehran 19558 Iran. Tel.:+98 21 225 03 30 Tel.Fax :+98 21 227 49 36
e.mail, sahandmina@hotmail. com

TABLE OF CONTENTS

Introduction
General Background
General
Company Background
Aim of the Project
Scope of the Contract
Supply of the Material
Activities
Preparation of Prototypes for Performance test
Training

Refrigeration Load Calculation Methods
- water Cooler
- Domestic and Commercial Appliances
- Transmission Load
- Product Load

Equipment Selection

- Compressor
- Capillary Tube
- Condenser and Evaporator
- Refrigerant Charge

Products Technical Specification Details

Prototype Load Calculation

- Up-Right refrigerator model SAB-150 Technical Specification
- Model SAB-150 Refrigeration Load Calculation
- Up-Right refrigerator model SAB-200 Technical Specification
- Model SAB-200 Refrigeration Load Calculation
- Up-Right refrigerator model SAB-150GH Technical Specification
- Model SAB-150GH Refrigeration Load Calculation
- Up-Right refrigerator model SAB-220GH Technical Specification
- Model SAB-220GH Refrigeration Load Calculation
- Display Case model SAB-SC200 Technical Specification
- Model SAB-SC200 Refrigeration Load Calculation
- Water Cooler model SAB-WC96 Technical Specification
- Model SAB-WC96 Refrigeration Load Calculation

Attachments

- Performance Test Sheets
- Prototype Pictures

b) Shervin Electric Company

- Chest Freezer Model SE-CF285 Technical Specification
- Model SE-CF285 Refrigeration Load Calculation

- Double Door refrigerator model SE-RF16 Technical Specification
- Model SE-RF16 Refrigeration Load Calculation

- Freezer model SE-F13 Technical Specification
- Model SE-F13 Refrigeration Load Calculation

- Up-Right refrigerator model SE-R13 Technical Specification
- Model SE-R13 Refrigeration Load Calculation

c) Yazd Sardin Company

- Chest Freezer Model YS-CF884 Technical Specification
- Model YS-CF884 Refrigeration Load Calculation

- Show Case model YS-SC200BG Technical Specification
- Model YS-SC200BG Refrigeration Load Calculation

- Cold store Model YS-CS40F Technical Specification
- Model YS-CS40F Refrigeration Load Calculation

- Cold store Model YS-CS40R Technical Specification
- Model YS-CS40R Refrigeration Load Calculation

Attachments

- Performance Test Sheets
- Prototypes Pictures

Introduction

This report has been prepared based on Contract with UNIDO and relevant terms of references prepared by UNIDO. The aim of the contract is to develop and convert six models of currently in production, into Ozone Friendly Refrigerant cooling system.

Based on Montreal and I.R.Iranian agreement, R134a refrigerant was selected as suitable Ozone friendly Refrigerant replacement and an alternative for R12 refrigerant and also Cyclopentane and R141b as new blowing agent as a substitute for R11.

This change to the cooling system requires significant modification and improvement of cooling system. Due to the enhanced physical and chemical properties of the new refrigerant the main components of the cooling circuits must be replaced of adjusted as a consequence of substitution of R12 into R134a.

Please find below the calculation of prototypes for determination of cooling capacity of each prototypes and also selecting compatible compressor for substituting R12 compressor with R134a compressor, because this is the first step for making prototype. It is indeed a difficult job to find precise compressor capacity to match the installed R12 compressor in the I.R. Iranian market.

The data which has been collected from each company will help us to calculate required refrigeration load that should be produced by the compressor and evaporators. For making prototypes our policy is to keep the existing size of condenser and evaporator and perform minor changes as required in cooing circuit, we think that minor adjustment will be required in refrigerant weight charge and probably in length of capillary tube.

In this report we will give some detailed technical data in different tables for each prototype model and then we calculate the refrigeration load calculation for each prototype. The prototypes will be tested at appropriate hot chamber for determination of performance of each prototypes, at designated ambient temperature. The test results will be provided in the final report, and will be evaluated accordingly.

Project Definition

This project covers the conversion of Sabouhi refrigeration company in the Isfahan province of Iran and will phase out the use of CFC-11 and CFC-12 in the production of a range of commercial refrigeration equipment. CFC-11, which is used as a foam blowing agent in the production of polyurethane foam will be replaced by HFC-141b and CFC-12 which is used as the refrigerant in the cooling circuit of equipment will be replaced by HFC 134a The project includes technical assistance in design and implementation of the conversion.

General BACKGROUND

The Islamic Republic of Iran ratified the Montreal Protocol in March 1990. Subsequently, Iran's Country Programme has outlined a plan for the reduction of the domestic use of ODS by 75% before 1999, and aims to be ODS free by 2005.

The overall unconstrained CFC consumption in the Islamic Republic of Iran was projected to rise from 2,445 ODP tonnes in 1991 to 7,778 ODP tonnes in 2010. This corresponds to an overall annual growth rate of 6.5%. The annual growth rate for the domestic refrigeration sector, however, was estimated to be 12% in the period 1991 to 1995 and 4% between 1996 and 2010.

The revised country programme indicates four sub-sectors within the refrigeration sector as shown in table 1 below.

Table 1 : ODS consumption in Iran in 1993 (Country Programme)

Sector	*ODS consumption [MT]*	*ODS substances*
Domestic refrigeration	*1,250*	*CFC-11, CFC-12*
Commercial, industrial & transport refrigeration	*900* *750*	*CFC-11* *CFC-12*
Compressor manufacturing industry	*40*	*CFC-12*
Mobile air-conditioning	*450*	*CFC-12*
Total	*3390*	

In terms of technology and equipment employed the commercial refrigeration sector is very similar to the domestic appliance sector. The primary differences are in the scale of equipment which is used, which can be greater in commercial applications, and the variety of products which are manufactured. Most companies manufacture several types of equipment from a wide ranges of applications, including the following:

- display and sales cabinets for supermarkets and individual suppliers of food,
- upright and chest freezers for commercial application,
- different sizes of drinking water coolers,
- blood cooling cabinets,

- milk coolers,
- soft ice freezers,
- cooling chambers, cooling stores
- insulated panels for larger cold stores,
- window-type air conditioners and fan coil,
- refrigeration equipment for trucks

In common with the domestic refrigeration sub-sector ozone depleting substances are consumed in commercial applications for :

- Charging of new appliances with CFC-12, R-502 and R22
- Refilling/topping up of appliances with CFC-12, R-502 and R-22 after repair work
- Insulation foam blowing using CFC-11

It can be seen from table1 that the commercial sector consumes approximately 900 MT of CFC-11 and 750 MT of CFC-12 annually. Due to the changing market conditions the number and types of products manufactured differ from year to year although the total consumption of CFCs is relatively stable.

Table 2 Second Group of Companies Identified for ODS Phase Out In The Commercial Refrigeration Sector

No	Name	Location	Type of products	ODS Consumption [mt/year]	
				CFC-11	CFC-12
1	YAZD ARG Metal Industries	YAZD	Refrigerators and Freezers Industrial Refrigerators Water coolers Cold Stores	2,830	12,422
2	YAZD SARDIN	YAZD	Refrigerators and Freezers Drinking Water coolers Ice Cream Coolers Cold Stores Milk Coolers Display Cabinets	16,675	11,330
4	SHERVIN ELECTRIC	YAZD	Drinking Water Coolers Freezers Fridge Freezers Box Freezers Refrigerators	6,232	12,418

Total	25,737	36,170

Overall Total CFC-11 and CFC-12 [MT]: 61.91

The baseline ODS consumption is also summarised in below. It can be seen that the total ODS phase out of the project is ODP tonnes.

General

All of the companies covered by this project are similar in nature and operate using similar manufacturing techniques. In common with commercial refrigeration companies through Article countries, production is generally on a batch or to order basis and most companies manufacture a range of equipment, which can be tailored to suit the needs of the customer.

Production lines are generally in open plan factory units or workshops and consist of a series of workstations at which particular task can be carried out such as assembly, brazing, charging etc. Work in progress is moved from one station to another using trolleys or conveyors. In the majority of cases production lines can be reconfigured to suit the particular production and market requirements of the time and large equipment items are built in situ, by move production equipment to the equipment. In the case of cold stores and large industrial refrigerators and freezers, these are often built in place on the client site. It is therefore necessary for the manufacturing companies to have portable charging and leak detection equipment. A brief overview of each of the companies is given below.

Companies Background

YAZD ARG Metal Industries

Yazd Arg is a small traditional commercial refrigeration company based in Yazd city. It was established in 1977 and employs 25 staff in the manufacture of commercial refrigeration equipment. The company occupies a medium sized factory unit with 4 well laid out fabrication and assembly lines for each major product line. Manufacturing equipment is generally old and well in use, operators appear to be well trained and work in a logical fashion. A single, locally made low pressure foaming machine is used for all production, a mixture of wooded and aluminium jigs and fixtures are used for doors and panels.

YAZD SARDIN

Yazd Sardin is a relatively new, medium sized commercial refrigeration company based in Mehriz, near Yazd city. It was established in 1989 and employs 40 staff in the manufacture of a large range of commercial refrigeration equipment. The company occupies a fairly modern open plan factory unit with 4 well laid out assembly lines. Each

line can be reconfigured for number of products. Manufacturing equipment is good condition for it's age but is well in use. The diverse range of production requires a fairly large stock of portable charging machines and vacuum pumps. Operators appear to be well trained in the use of sight glass refrigerant charging equipment but rely on data tables and pressure gauges to establish and charge the correct amount of refrigerant for different product items. Two Viking low pressure foaming machines are with set of steel jigs and fixtures are used for doors and panels.

SHERVIN ELECTRIC

Shervin Electric is medium sized commercial refrigeration company based in near Yazd city. It was established in 1988 and employs 35 staff in the manufacture of a range of commercial refrigeration equipment. The company occupies a fairly old factory with 3 assembly lines. Manufacturing equipment is generally good condition. Operators appear to be well trained in the use of sight glass refrigerant charging equipment. The age of the factory means that the layout of the production equipment is not ideal but operator appear to be able to function adequately. A single small locally made low pressure foaming machine is used for all foaming applications with set of steel jigs and fixtures.

Aim of the Project

The aim of the immediate project is to;

- Design, calculation and drafting for model redefinition.
- Testing prototypes for functionality and performance criteria.
- Redesign the cooling units of the all models so that they could run on the new Ozone friendly R134a instead of the ODP active CFC12.

Scope of the Contract

A study will be made for 5 models of commercial refrigerators made by
. to specify;

- Dimensional specification;
- Type and thickness of insulation
- Refrigeration unit component details
- Working performance
- Energy consumption

Selection of HFC 134a compatible components
Redesign of the refrigeration circuit as necessary
Specifying necessary changes in the cooling system if required
Preparation of the trial equipment one prototype per model
Testing of two prototypes for functionality and performance
Evaluation of the test results

Supply of the Materia l

Following components and material must be used to make prototypes as necessary.

- R134a CompressorsR134a Refrigerant
- Refrigerant Accumulators
- Specially designed filter drier
- Specially designed evaporator and condenser

Some necessary modification of the side panels as required with the new design criteria Consumable material as required

Activities

In this report we will describe the activities achieved during execution of the contract for implementation of the project.

- Site survey of the counterpart premises in order to be familiar with the counterpart facility and production line and also define the prototypes for conversion.
- Site survey of the counterpart premises in order to collect necessary data for calculation of prototype.
- Preparation of Technical data sheet in order to define detail technical specification
- Review the existing technical drawing for the purpose of assessment of possible changes in the design criteria.
- Review each prototype refrigeration circuit for determination of cooling circuit components
- Review and assessment of design criteria following cooling circuit component in order to minimize possible changes and design improvement.
    - Compressor technical specification
    - Condenser type, material and design criteria
    - Evaporator type, material and design criteria
    - Capillary tube design, dimensions and material
    - Filter drier, size and material
    - Determination of R12 refrigerant charge for each prototype in order to adjust R134a charge weight
- Coordination with the counterparts for performing, performance test after completion of making prototypes
- Calculation of prototypes in order to determine the size of R134a compressor and implement necessary changes to the cooling circuits

- Preparation of Performance Test Results Sheet, in order to record all data obtained during functional test.

Preparation of prototypes for performance test as

The prototypes shall be tested under designated ambient temperature mostly at + 32 C, the test performance revealed that no significant changes is necessary for refrigeration system circuit, because the original size of evaporator and condensers are much bigger than cooling requirements.

The adjustment will be applied to the mainly to the amount of refrigerant charge and length of capillary tube.

Each prototypes should under go for performance test at the following test criteria.

Pull down test at + 32 C

run Test at = 32 C ambient temperature

Continues

Cyclic run test at + 32 C ambient temperature.

The test condition was selected in accordance with appropriate ISO test standards.

The material as sample for making prototypes are supplied mainly from local market, due to the limitation for purchasing R134a compressor from local market we had to contact several manufacturers to find out the technical specification for appropriate compressor.

The prices for material specially R134a and R141b blended polyol are much higher than R12 and R11,

Training

Before making prototypes we conducted a training course to train the technical staffs to make their own prototypes and also make them familiar with the new technology.

The following topics were thought during the theatrical training course.

- An orientation to UNIDO CFC phases out project.
- Montreal Protocol
- Ozone Layer and CFC side effect to Ozone layer

- Familiarization with new R134a Refrigerant, application, safety precaution, use and maintenance.
- Familiarization with the new vacuum and charging equipment, vacuum pump and charging board.
- Recovery and recycling of R12 refrigerant, and also R134a.
- Alternative for R11 and R12.
- Some explanation about R141b blowing agent,
- Selection of refrigeration components to be replaced with R12 refrigeration system.
- Calculation and redesign of prototypes
- Performance test
- Test results Evaluation.
- Refrigeration system adjustment.

Following subjects were during conduction of the course

Refrigeration Load Calculation for different type of Water Coolers

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, porcelaicoated - 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,

1- Bottle Type.
2- 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.

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.

Heat gain by heat transmission from, main water storage tank wall insulation.

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.

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:

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 litter of water at 24 C is equal to approximately one Kg.

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

T Temperature difference (Ti–Tc), where, Ti is inlet water temperature, and Tc 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 (Ti–Tc), where, Ti is inlet water temperature, and Tc 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.

T Temperature difference (Ta – Tc), where, T is ambient temperature, and Tc is final cooled water temperature.

Refrigeration Load Calculation for different type of Domestic and Commercial Appliances

Refrigeration load consist of four individual components:

1- Transmission load;
Heat transfer through walls (sides, back panels, top and bottom) and door panel.

2- Product load;
Heat Removed from and produced by the products which are brought and stored in the refrigerator;

3- Internal load;
Heat produced by internal sources such as lights, fan or heaters;

4- Infiltration load
Heat gains associated with air entering the refrigerated space;

The above mentioned components will be discussed separately to analyze and extract the most useful and practical equipment.

Transmission Load

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

Considering the above mentioned resistance, Rl, Rc and Ra are not comparable in magnitude with Ri (Insulation resistance) and so can be neglected in our calculations. Therefore, the resultant circuit and relevant equations are.

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

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

Where:

x = Insulation Thickness, mm

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

A = Outside Area, m^2

ΔT = 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 two door refrigerators, due to different cabin temperature of freezer and refrigerator compartments, heat transfer for each compartment should be calculated separately and then added together.

Product Load

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 (Ti) to storing temperature (Trs) in refrigerator compartment is;

$$Qrs = \dot{M} C (Ti - Trs)$$

Where:

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

C = Specific heat of product, Kcal / Kg

2 - Heat removed from intial temperature (Ti) to freezing temperature (Tf) is ;

$$Qef = \dot{M} C (Ti - Tf)$$

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;

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

Where h = Latent heat of product, Kcal / Kg

4 - Heat removed from freezing temperature (Tf) to final storage temperature (Tfs) is;

$$Qbf = \dot{M}\ Cbf\ (\ Tf - Tfs\ )$$

Where: Cbf = Specific heat of products below freezing temperature.

For upright freezers or freezer compartment of refrigerators, total product load is

$$Qpl = Qaf + Ql + Qbf$$

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

$$Qpl = Qrs$$

Internal Load

Electrical energy dissipated in the refrigerated space such as lights, fan motors, heaters, ... are included in the internal heat load. Due to the little amount of consumption of lighting, the effect of lighting can be negligible and only electrical

heaters of two door refrigerators or fan motors (if exist) are considered in our load calculation.

Infiltration Load

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. Infiltration load is one of the most important load components and roughly it is about 20 % of total refrigeration load.

Total Refrigeration load

As it was mentioned before, transmission load (Qtl), product load (Qpl) and internal load (Q il) can be calculated separately. For infiltration load (air exchange through doorways or gasket leakage), we can take into account from 10 to 25% of sum of the above mentioned components, (transmission load, product load and internal load). Therefore total refrigeration load can be expressed as:

$$QTL = 1.25\ (QTL + QPL + QIL)$$

As per ASHREA standard we can use following formula which is depended directly to the number of air change per day and internal volume of the appliance.

$$Q = (V \times N \times H) \div 86400$$

Where;

Q = Heat Load due to the Air Change
V = Appliance Internal Volume
H = Heat removed from cubic meter of air = 75000 jul/sec

Equipment Selection

Calculation of refrigeration load is the basis for selecting system equipment. First step is selection of a suitable compressor with cooling capacity comparable to calculated load, then a capillary tube should be selected so that the compressor and tube fix a balance point at the desired evaporating temperature, also two evaporator

and condenser should be selected to balance compressor capacity.

Compressor selection

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

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

Where :

Qc = 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, 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.

Technical Specification of the Product *Model YS-CS40R*	
Description	Technical Specification
Name of products	Cold Store above Zer0
Model Number	YS-CS40R
Dimension	500 x 300 x 270
Wall Thickness, for Foam Injection	100 Cm.
Product Internal Temperature	0 to + 4 °C
Evaporating Temperature or Evaporator Surface temperature	-5 °C
Working Temperature or Ambient Temperature	+ 40 °C
Product Internal Volume Liter	40 Cubic Meter
Compressor Manufacture	DWM England
Compressor Model	DWM
Compressor Cooling Capacity in Watt	3000
Compressor Power Input	2820
Condenser Type, Material, Length, and Diameter	Air Cooled, Fin and Tube Length = 59 Mt. Diameter ¾ inch.
Evaporator Type, Material, Length, and Diameter	Fin and Tube, Dimension ½ inch.
Capillary Tube Type, Material, Length, and Diameter	Expansion Valve TEX – 3
Dryer, Type and Weight	Dimension ½ inch with bolts and Nuts
P.U. Type, Density Percentage of Component Mixture Polyol + R11+ ISO	R11, 40 Kg/Cu. Mt., 50%(Polyol and R11) + 50% Iso, (10% R11)
Refrigerant "R12 " Charge Weight	7 Kg.
Working Voltage and Hz Starting Current Operating Current	380 Volts, three phase, 7 Amp.

Technical Specification of the Product *Model AZ-CF250*	
Description	Technical Specification
Name of products	Chest Freezer
Model Number	AS-CF250
Dimension	110x55x72
Wall Thickness, for Foam Injection	50 mm
Product Internal Temperature	-25 C
Evaporating Temperature or Evaporator Surface temperature	-28 C
Working Temperature or Ambient Temperature	+ 35 C
Product Internal Volume Liter	250 Liter
Compressor Manufacture	Gold Star
Compressor Model	1/5 hp
Compressor Cooling Capacity in Watt	135
Compressor Power Input	110
Condenser Type, Material, Length, and Diameter	Copper Wire and Tube, L = 10 Mt. Dim. = 5 mm
Evaporator Type, Material, Length, and Diameter	Wire and Tube, 35 Mt. Dim. = 6.9 mm.
Capillary Tube Type, Material, Length, and Diameter	Copper tube, L = 4 Dim. = 0.031" 0.787 mm.
Dryer, Type and Weight	15 Grams
P.U. Type, Density Percentage of Component Mixture Polyol + R11+ ISO	R11, 40 Kg/Cu. Mt., 50%(Polyol and R11) + 50% Iso, (15% R11)
Refrigerant "R12 " Charge Weight	170 Gr.
Working Voltage and Hz Starting Current Operating Current	220 Volts, 50 Hz 6 Amp. 1.15 Amp.

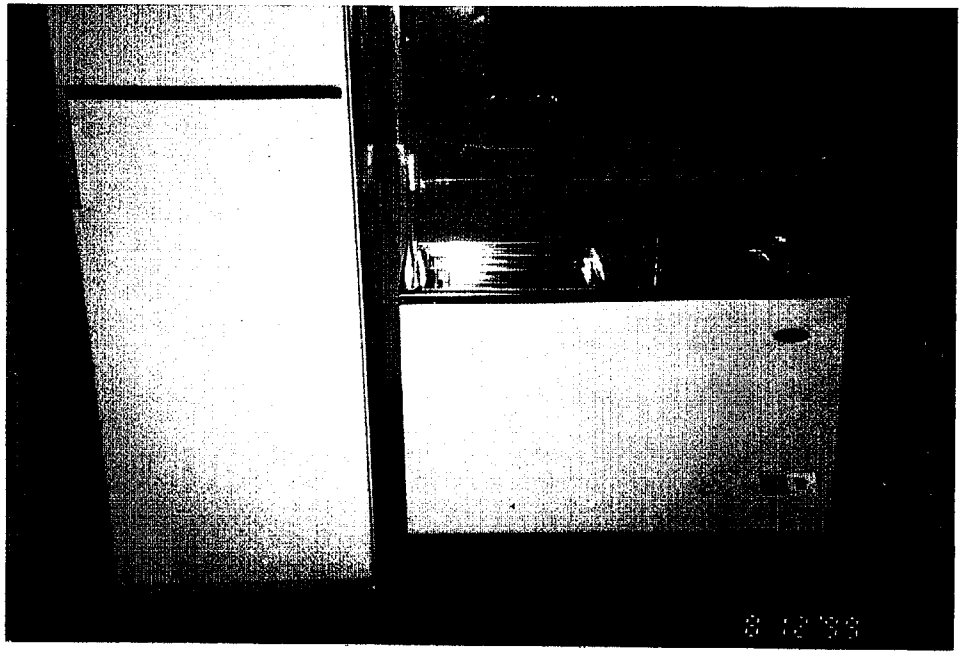
Conversion of Prototypes at
ARG YAZD CO.

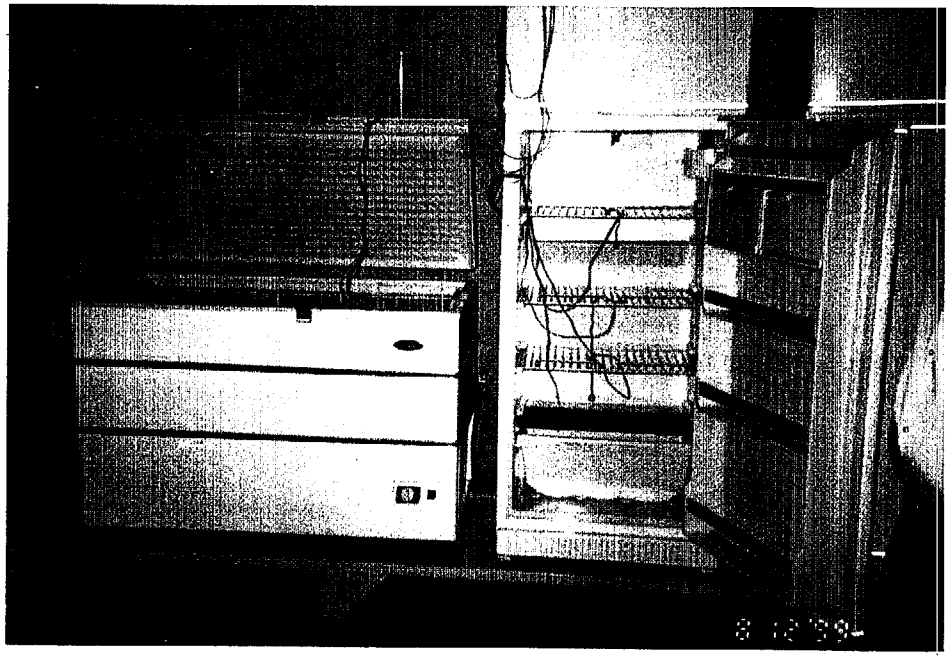
Chest Freezer Model
AZ-CF250

Refrigerator and
Freezer
Model AZ-RF13

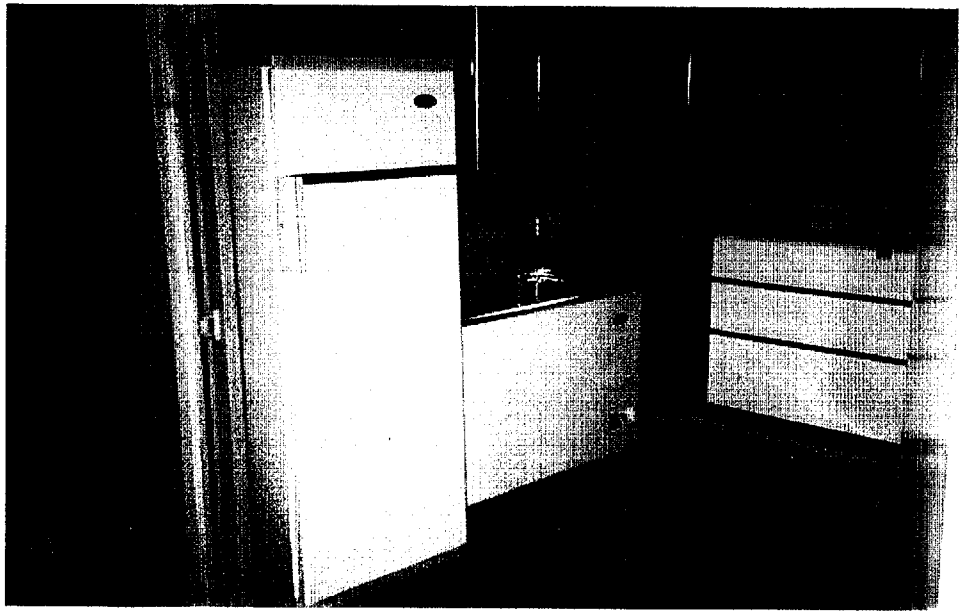
Show Case Model
AZ-SC200BG

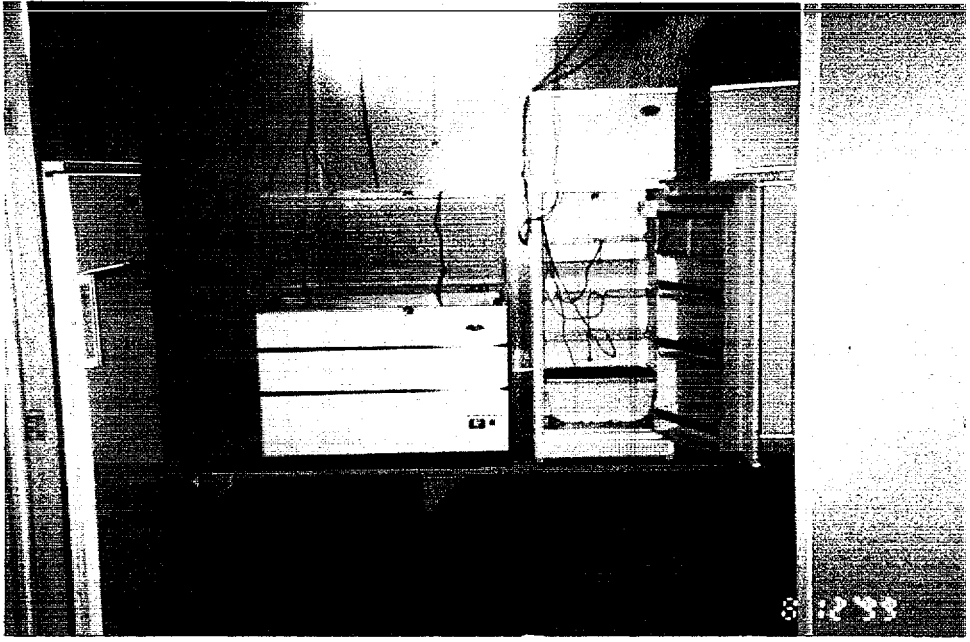
Up-Right
Refrigerator
Model AZ-200UPR



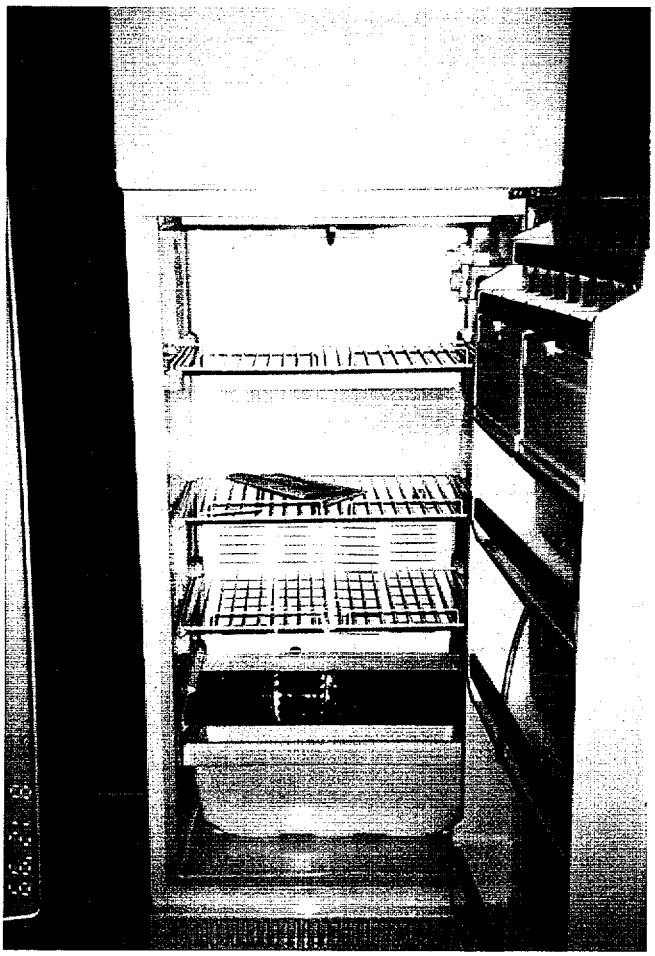


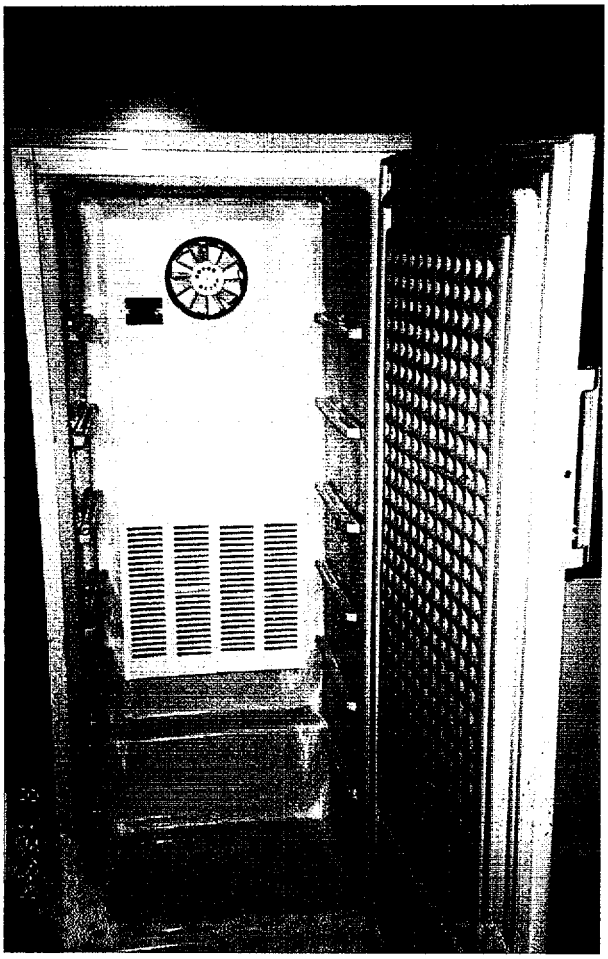
YAZD ARG METAL COMPANY
POROTOTYPES

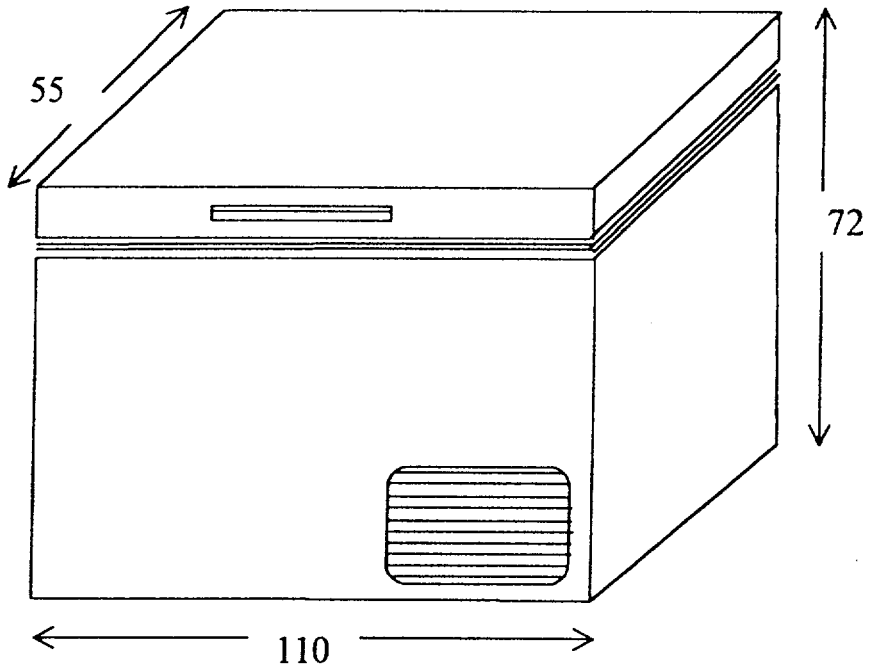




YAZD ARG METAL COMPANY
POROTOTYPES







Chest Freezer
Model AZ-CF250

Technical Specification of the Product *Model AZ-CF250*	
Description	Technical Specification
Name of products	Chest Freezer
Model Number	AS-CF250
Dimension	110x55x72
Wall Thickness, for Foam Injection	50 mm
Product Internal Temperature	-25 C
Evaporating Temperature or Evaporator Surface temperature	-28 C
Working Temperature or Ambient Temperature	+ 35 C
Product Internal Volume Liter	250 Liter
Compressor Manufacture	Gold Star
Compressor Model	1/5 hp
Compressor Cooling Capacity in Watt	135
Compressor Power Input	110
Condenser Type, Material, Length, and Diameter	Copper Wire and Tube, L = 10 Mt. Dim. = 5 mm
Evaporator Type, Material, Length, and Diameter	Wire and Tube, 35 Mt. Dim. = 6.9 mm.
Capillary Tube Type, Material, Length, and Diameter	Copper tube, L = 4 Dim. = 0.031" 0.787 mm.
Dryer, Type and Weight	15 Grams
P.U. Type, Density Percentage of Component Mixture Polyol + R11+ ISO	R11, 40 Kg/Cu. Mt., 50%(Polyol and R11) + 50% Iso, (15% R11)
Refrigerant "R12 " Charge Weight	170 Gr.
Working Voltage and Hz Starting Current Operating Current	220 Volts, 50 Hz 6 Amp. 1.15 Amp.

Refrigeration Load Calculation
Heat Leaks Through Walls
$Q = U \cdot A \cdot \Delta T$
Model AZ-CF250

Description	Dimension	Surface Area Sq. Mt.	Ambient Temp. °C	Reference Inside Temp.	ΔT Temp. Diff.	X Insulation Thickness	K Thermal Conductivity	U Coeff. Heat Resistance	Q $U \cdot A \cdot \Delta T$ *Watt*
Side Walls	2x55x72	0.792	+35	-25	60	50	0.0184	0.37	17.6
Back Panel	110x72	0.792	+45	-25	70	50	0.0184	0.37	20.5
Top surface	55x110	0.605	+35	-25	60	50	0.0184	0.37	13.4
Bottom surface	55x110	0.605	+45	-25	70	50	0.0184	0.37	15.7
Front Panel	110x75	0.792	+35	-25	60	50	0.0184	0.37	17.6
Total									84.8

Product Load Calculation

Model AZ-CF250

Product to be loaded	Product Mass Load Kg.	Product Specific heat Above Freezing Point J/Kg. K	Product Specific heat Below Freezing Point J/Kg K	Latent Heat of Fusion J/Kg.	Product Initial Temp C	Product Final Temp. C	Temp. Diff.	Q_1 $m\,C_1\,\Delta T$	Q_2 $m\,.\,C_2\,.\,\Delta T$	Q_3 $M\,.\,h$
ICE	10	4180	1650	333	24	4	20			

Q_1*=(10x20x4180)/86400 = 9.7,* Q_2 *= (10x18x1950)/86400=4.1,* Q_3*= (10x333000)/86400=38.5*

$$Total = Q_1 + Q_2 + Q_3 = 52 Watts$$

Miscellanies Heat Load

Air Change = V . N . H V = Refrigerator Internal Volume N = Number of Air Change per Day H = Heat removed from cubic meter of air = 75000 jul/sec.	Gasket U . A. ΔT *U=0.07* *L = 2.8* *Mt.* *ΔT=60*	Electrometer	Florescent Lamp	Total
(0.25x30x75000)/86400 = 4.3	11.8	N/A	N/A	16.1

Total refrigeration Load

Heal Leaks Through Walls	Product Load	Miscellanies Load	Safety Factors	Grand Total
84	52	16	15	167

Technical Specification of the Product Model AZ-RF13	
Description	Technical Specification
Name of products	Refrigerator & Freezer
Model Number	AS-RF13
Dimension	167x61x53
Wall Thickness, for Foam Injection	55 mm
Product Internal Temperature	-26 freezer & + 5 C refrigerator
Evaporating Temperature or Evaporator Surface temperature	-28 C
Working Temperature or Ambient Temperature	+ 35 C
Product Internal Volume Liter	280 Liter
Compressor Manufacture	Danfoss
Compressor Model	¼ hp
Compressor Cooling Capacity in Watt	147
Compressor Power Input	126
Condenser Type, Material, Length, and Diameter	Copper Wire and Tube, L = 16 Mt. Dim. = 5 mm
Evaporator Type, Material, Length, and Diameter	Roll Bond, 0.38 Sq. Mt.
Capillary Tube Type, Material, Length, and Diameter	Copper tube, L = 3 Dim. = 0.031" 0.787 mm.
Dryer, Type and Weight	15 Grams
P.U. Type, Density Percentage of Component Mixture Polyol + R11+ ISO	R11, 40 Kg/Cu. Mt., 50%(Polyol and R11) + 50% Iso, (15% R11)
Refrigerant "R12 " Charge Weight	185 Gr.
Working Voltage and Hz Starting Current Operating Current	220 Volts, 50 Hz 7 Amp. 1.2 Amp.

Product Load Calculation

Model SE-RF16

Product to be loaded	Product Mass Load Kg.	Product Specific heat Above Freezing Point J/Kg. K	Product Specific heat Below Freezing Point J/Kg K	Latent Heat of Fusion J/Kg.	Product Initial Temp C	Product Final Temp. C	Temp. Diff.	Q_1 $m C_1 \Delta T$	Q_2 $m . C_2 . \Delta T$	Q_3 $M . h$
ICE	10	4180	1650	333	24	4	20			

Q_1=(10x20x4180)/86400 = 9.75, Q_2 = (10x18x1950)/86400=4.1, Q_3= (10x333000)/86400=38.5

$Total = Q_1 + Q_2 + Q_3 = 52.3 Watts$

Miscellanies Heat Load

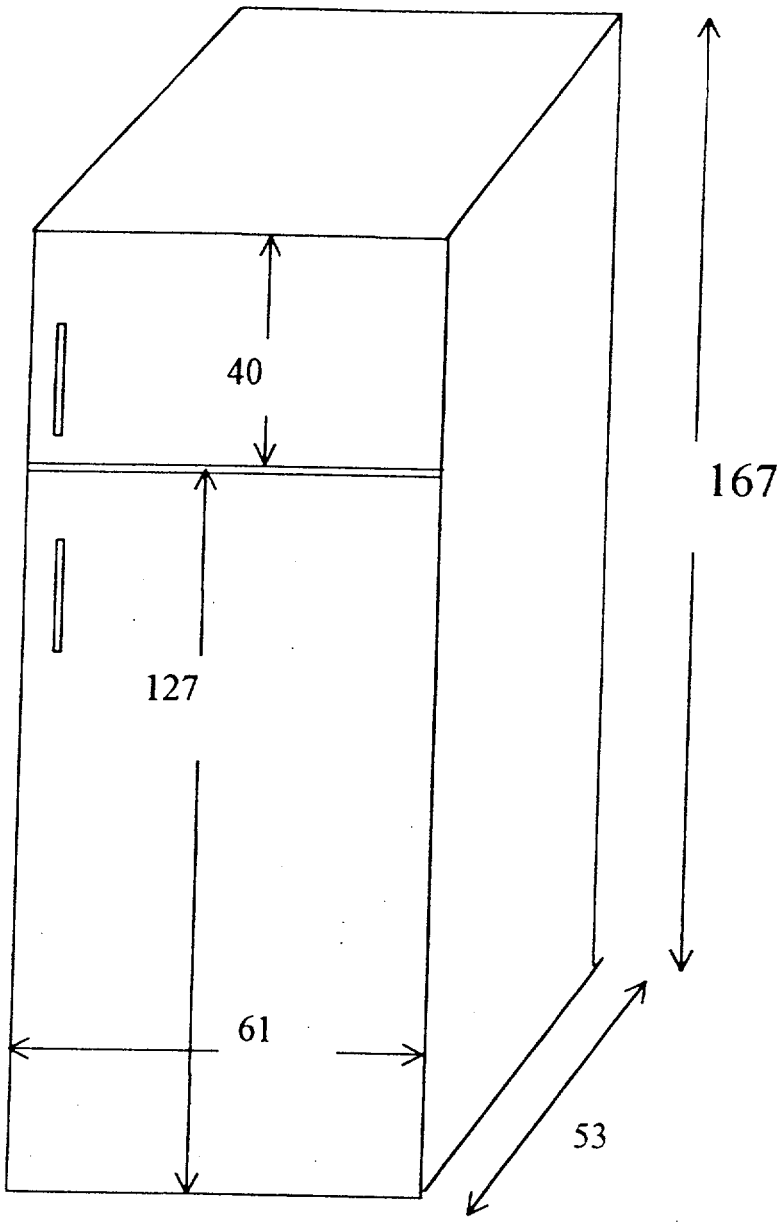
Air Change = V . N . H V = Refrigerator Internal Volume N = Number of Air Change per Day H = Heat removed from cubic meter of air = 75000 jul/sec.	Gasket U . A. ΔT $U=0.07$ $L = 4.5$ $Mt.$ $\Delta T=40$	Electrometer	Florescent Lamp	Total
(0.280x30x75000)/86400 = 7.3	12.6	N/A	N/A	20

Total refrigeration Load

Heal Leaks Through Walls	Product Load	Miscellanies Load	Safety Factors	Grand Total
68	52	20	28	168

Refrigeration Load Calculation
Heat Leaks Through Walls
$Q = U \cdot A \cdot \Delta T$
Model AZ-RF13

Description	Dimension	Surface Area Sq. Mt.	Ambient Temp. °C	Reference Inside Temp.	ΔT Temp. Diff.	X Insulation Thickness	K Thermal Conductivity	U Coeff. Heat Resistance	Q $U \cdot A \cdot \Delta T$ *Watt*
Upper Side Walls	2x40x53	0.428	35	-18	53	60	0.0184	0.31	7
Upper Back Panel	40x61	0.244	45	-18	63	60	0.0184	0.31	4.7
Top surface	61x53	0.320	35	-18	53	60	0.0184	0.31	5.3
Bottom surface	61x53	0.323	45	+10	35	45	0.0184	0.41	4.6
Upper Door Panel	40x61	0.244	35	-18	63	45	0.0184	0.41	6.3
Lower Door Panel	127x61	0.775	35	+4	31	45	0.0184	0.41	9.8
Lower Side Walls	2x127x53	1.35	35	+4	31	45	0.0184	0.41	17.1
Lower Back Panel	127x61	0.775	45	+4	41	45	0.0184	0.41	13
Total									67.8



Refrigerator and Freezer
Model AZ-RF13

Technical Specification of the Product *Model AZ-SC200BG*	
.Description	Technical Specification
Name of products	Show Case Bend Glass
Model Number	AS-200 BG
Dimension	200x81x110
Wall Thickness, for Foam Injection	40 mm
Product Internal Temperature	0 to + 5 C
Evaporating Temperature or Evaporator Surface temperature	- 10 to –15 C
Working Temperature or Ambient Temperature	+ 35 C
Product Internal Volume Liter	1080 Liter
Compressor Manufacture	Danfoss
Compressor Model	SC18B
Compressor Cooling Capacity in Watt	575
Compressor Power Input	520
Condenser Type, Material, Length, and Diameter	Copper Fin and Tube, L = 12.8 Mt. Dim. = 8.6mm
Evaporator Type, Material, Length, and Diameter	Copper Fin and Tube, Dim. 11.6 L = 19.2 Mt.
Capillary Tube Type, Material, Length, and Diameter	Copper tube, L = 3.2 Dim. = 0.055" 1.337 mm.
Dryer, Type and Weight	115 Grams
P.U. Type, Density Percentage of Component Mixture Polyol + R11+ ISO	R11, 40 Kg/Cu. Mt., 50%(Polyol and R11) + 50% Iso, (15% R11)
Refrigerant "R12 " Charge Weight	680 Gr.
Working Voltage and Hz Starting Current Operating Current	220 Volts, 4 Amp. 50 Hz.

Refrigeration Load Calculation
Heat Leaks Through Walls
$Q = U \cdot A \cdot \Delta T$
Model YS-SC200BG

Description	Dimension	Surface Area Sq. Mt.	Ambient Temp. °C	Reference Inside Temp.	ΔT Temp. Diff.	X Insulation Thickness	K Thermal Conductivity	U Coeff. Heat Resistance	Q $U \cdot A \cdot \Delta T$ *Watt*
Side Walls	2x[(40x110) +(81x40)]	1.21	35	5	30	40	0.0184	0.46	16.7
Back Panel	200x110	2.2	35	5	30	40	0.0184	0.46	30.4
Top surface	40x200	0.8	35	5	30	40	0.0184	0.46	11
Bottom surface	81x200	1.62	45	5	40	40	0.0184	0.46	29.8
Lower Front panel	40x200	0.8	35	5	30	40	0.0184	0.46	11
Front Glass	90x200	1.8	53	5	30	40	0.184	0.46	64
Total									163

Product Load Calculation

Product to be loaded	Product Mass Load Kg.	Product Specific heat Above Freezing Point J/Kg. K	Product Specific heat Below Freezing Point J/Kg K	Latent Heat of Fusion J/Kg.	Product Initial Temp C	Product Final Temp. C	Temp. Diff.	Q_1 $m C_1 \Delta T$	Q_2 $m . C_2 . \Delta T$	Q_3 $M . h$
Lamb Meat	200	3200	N/A	N/A	28	4	24	178	N/A	N/A

Q_1 = (200 x 3200 x 24)/86400 = 178

Total = Q_1 = 178

Miscellanies Heat Load

Air Change = V . N . H V = Refrigerator Internal Volume N = Number of Air Change per Day H = Heat removed from cubic meter of air = 75000 jul/sec.	Gasket U . A. ΔT *U=0.07* *L = 10.8Mt.* *ΔT=31*	Electrometer	Florescent Lamp	Total
(1.080x70x75000)/86400 = 65.6	23.5	N/A	20	109

Total refrigeration Load

Heal Leaks Through Walls	Product Load	Miscellanies Load	Safety Factors	Grand Total
163	155	109	85	512

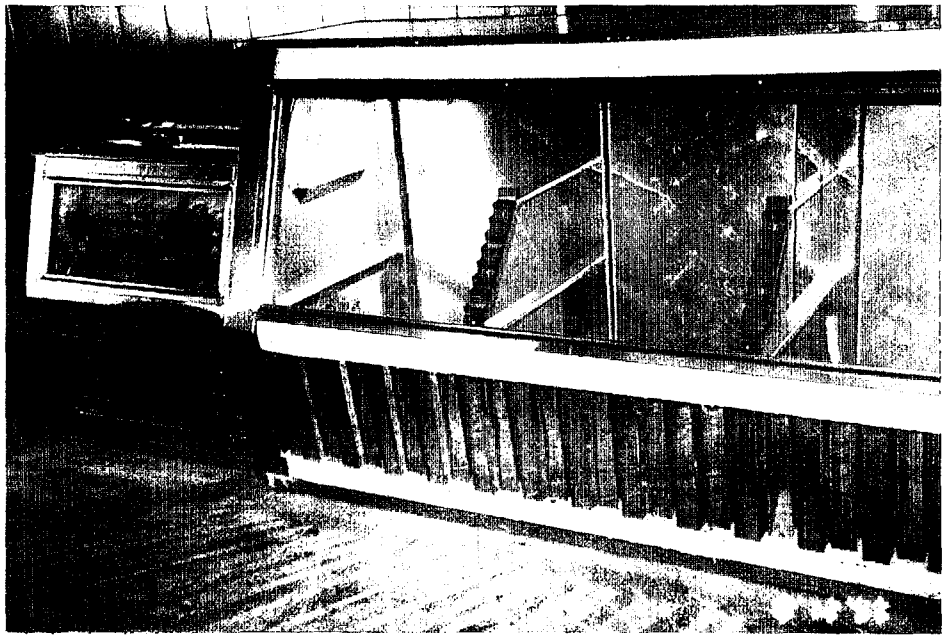
Conversion of Prototypes at
Yazd Sardin Co.

Chest Freezer Model
YS-CF884

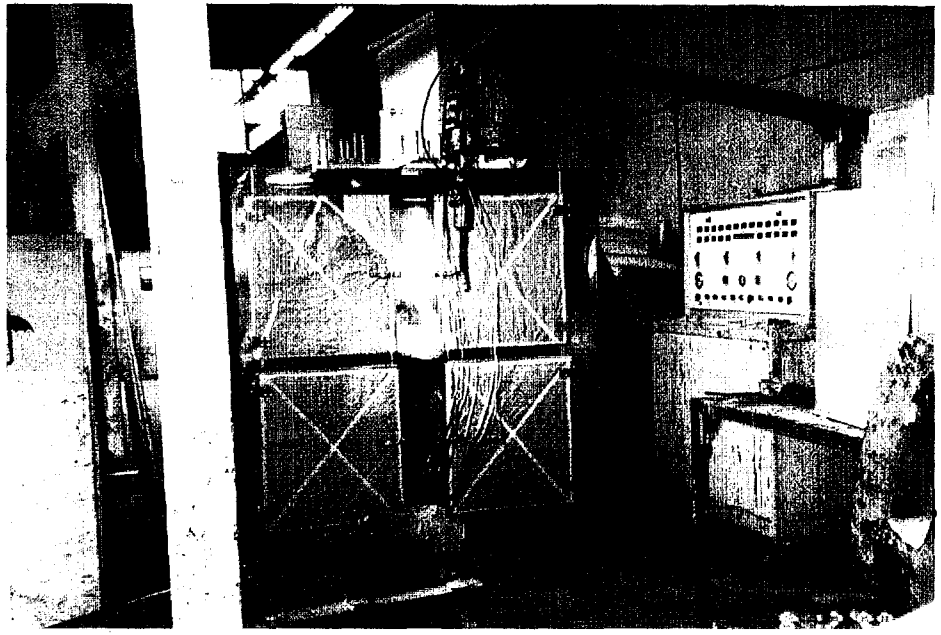
Show Case
Model YS-SC200BG

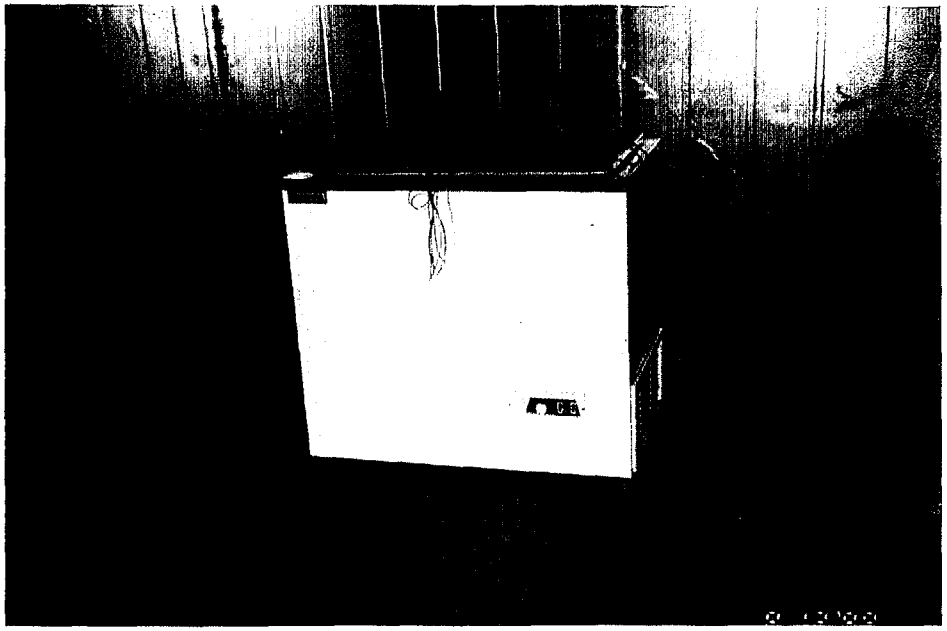
Cold Store, Freezer
Model YS-CS40F

Cold Store,
Refrigerator
Model YS-CS40R



YAZD SARDIN COMPANY
PROTOTYPES





Product Load Calculation

Model YS-CF884

Product to be loaded	Product Mass Load Kg.	Product Specific heat Above Freezing Point J/Kg. K	Product Specific heat Below Freezing Point J/Kg K	Latent Heat of Fusion J/Kg.	Product Initial Temp C	Product Final Temp. C	Temp. Diff.	Q_1 $m\,C_1\,\Delta T$	Q_2 $m.\,C_2.\,\Delta T$	Q_3 $M.\,h$
ICE	10	4180	1650	333	24	4	20			

$Q_1=(10x20x4180)/86400 = 9.7$, $Q_2 = (10x18x1950)/86400=4.1$, $Q_3= (10x333000)/86400=38.5$

$Total = Q_1 + Q_2 + Q_3 = 35.1 Watts$

Miscellanies Heat Load

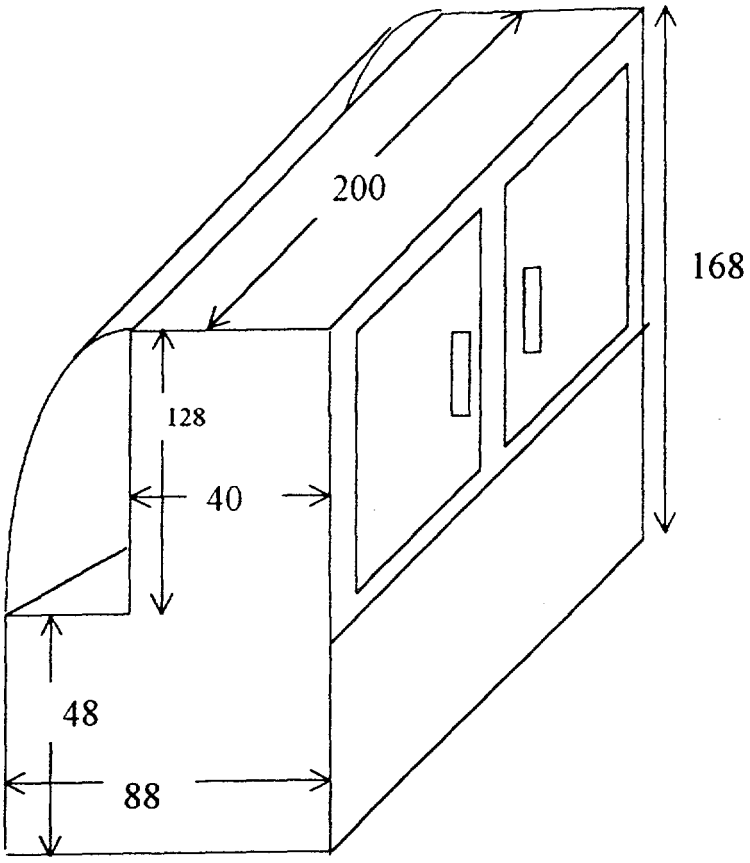
Air Change = V . N . H V = Refrigerator Internal Volume N = Number of Air Change per Day H = Heat removed from cubic meter of air = 75000 jul/sec.	Gasket U . A. ΔT $U=0.07$ $L = 8.9$ Mt. $\Delta T=63$	Electrometer	Florescent Lamp	Total
(0.884x30x75000)/86400 = 23	39	N/A	N/A	62

Total refrigeration Load

Heal Leaks Through Walls	Product Load	Miscellanies Load	Safety Factors	Grand Total
140	52	62	25	279

Refrigeration Load Calculation
Heat Leaks Through Walls
$Q = U \cdot A \cdot \Delta T$
Model YS-CF884

Description	Dimension	Surface Area Sq. Mt.	Ambient Temp. °C	Reference Inside Temp.	ΔT Temp. Diff.	X Insulation Thickness	K Thermal Conductivity	U Coeff. Heat Resistance	Q $U \cdot A \cdot \Delta T$ *Watt*
Side Walls	2x85x80	1.36	40	-18	58	60	0.0184	0.31	24.5
Back Panel	190x85	1.62	40	-18	58	60	0.0184	0.31	29.1
Top surface	190x80	1.52	40	-18	58	60	0.0184	0.31	27.3
Bottom surface	190x80	1.52	50	-18	68	60	0.0184	0.31	32
Front Panel	190x85	1.62	40	-18	58	60	0.0184	0.31	27.3
Total									140



Show Case
Model YS-SC200BG

Technical Specification of the Product *Model YS-SC200BG*	
Description	Technical Specification
Name of products	Show Case Bend Glass
Model Number	YS-200 BG
Dimension	200x88x128
Wall Thickness, for Foam Injection	50 mm
Product Internal Temperature	0 to + 4 C
Evaporating Temperature or Evaporator Surface temperature	- 5 C
Working Temperature or Ambient Temperature	+ 40 C
Product Internal Volume Liter	655 Liter
Compressor Manufacture	Danfoss or Techomseh
Compressor Model	¾ hp
Compressor Cooling Capacity in Watt	650
Compressor Power Input	580
Condenser Type, Material, Length, and Diameter	Copper Fin and Tube, L = 10 Mt. Dim. = 3/8 inch
Evaporator Type, Material, Length, and Diameter	Copper Fin and Tube, Dim. ½"
Capillary Tube Type, Material, Length, and Diameter	Copper tube, L = 3.3 Dim. = 0.064 inch
Dryer, Type and Weight	375 Grams
P.U. Type, Density Percentage of Component Mixture Polyol + R11+ ISO	R11, 40 Kg/Cu. Mt., 50%(Polyol and R11) + 50% Iso, (10% R11)
Refrigerant "R12 " Charge Weight	800 Gr.
Working Voltage and Hz Starting Current Operating Current	220 Volts, 4.5 Amp.

Refrigeration Load Calculation
Heat Leaks Through Walls
$Q = U \cdot A \cdot \Delta T$
Model YS-SC200BG

Description	Dimension	Surface Area Sq. Mt.	Ambient Temp. °C	Reference Inside Temp.	ΔT Temp. Diff.	X Insulation Thickness	K Thermal Conductivity	U Coeff. Heat Resistance	Q $U \cdot A \cdot \Delta T$ *Watt*
Side Walls	2x[(40x128) +(88x40)]	1.728	40	4	36	50	0.0184	0.37	23
Back Panel	200x127	2.56	40	4	36	50	0.0184	0.37	34.1
Top surface	40x200	0.8	40	4	36	50	0.0184	0.37	10.6
Bottom surface	88x200	1.76	50	4	46	50	0.0184	0.37	29.9
Lower Front panel	40x200	0.8	40	4	36	50	0.0184	0.37	10.7
Front Glass	150x200	3	40	4	36	50	0.184	0.37	128.5
Total									236.8

Product Load Calculation

Product to be loaded	Product Mass Load Kg.	Product Specific heat Above Freezing Point J/Kg. K	Product Specific heat Below Freezing Point J/Kg K	Latent Heat of Fusion J/Kg.	Product Initial Temp C	Product Final Temp. C	Temp. Diff.	Q_1 $m\,C_1\,\Delta T$	Q_2 $m.\,C_2.\,\Delta T$	Q_3 $M.\,h$
Lamb Meat	200	3200	N/A	N/A	28	4	24	178	N/A	N/A

$Q_1 = (200 \times 3200 \times 24)/86400 = 178$

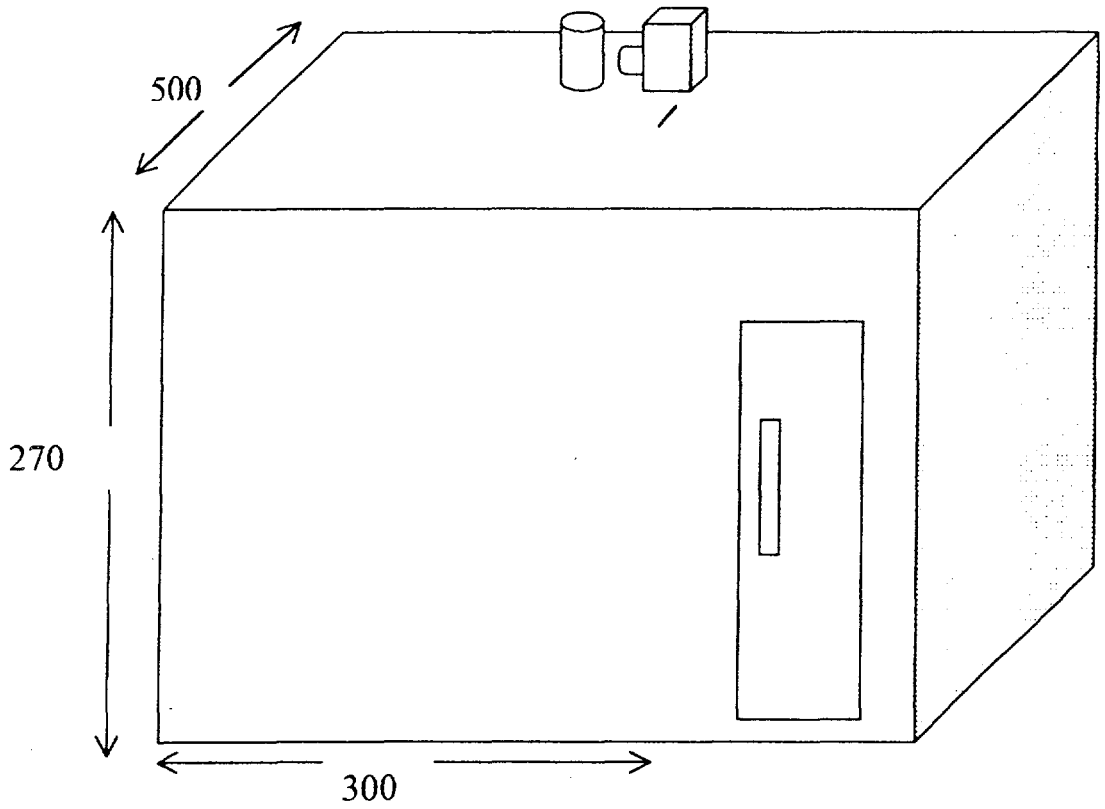
Total $= Q_1 = 178$

Miscellanies Heat Load

Air Change = V . N . H V = Refrigerator Internal Volume N = Number of Air Change per Day H = Heat removed from cubic meter of air = 75000 jul/sec.	Gasket U . A. ΔT $U=0.07$ L = 11.2Mt. $\Delta T=36$	Electrometer	Florescent Lamp	Total
(0.655x70x75000)/86400 = 39.8	23.5	20	20	10.3

Total refrigeration Load

Heal Leaks Through Walls	Product Load	Miscellanies Load	Safety Factors	Grand Total
236.8	178	103.3	103.6	622



Freezer Cold Store
Model YS-CS40F

Technical Specification of the Product *Model YS-CS40F*	
Description	Technical Specification
Name of products	Cold Store Below Zero
Model Number	YS-CS40f
Dimension	500 x 300 x 270
Wall Thickness, for Foam Injection	100
Product Internal Temperature	- 18 °C
Evaporating Temperature or Evaporator Surface temperature	- 25 °C
Working Temperature or Ambient Temperature	+ 40 °C
Product Internal Volume Liter	40 Cubic Meter
Compressor Manufacture	England or Germany
Compressor Model	D. W. M.
Compressor Cooling Capacity in Watt	8000
Compressor Power Input	5600
Condenser Type, Material, Length, and Diameter	Copper Air Cooled Tube and Fin, L = 59, Dim. = 3/8 inch
Evaporator Type, Material, Length, and Diameter	Copper Fin and Tube, Dim = ½ inch
Capillary Tube Type, Material, Length, and Diameter	Expansion valve TEX-3
Dryer, Type and Weight	½ inch Bolt and Nut
P.U. Type, Density Percentage of Component Mixture Polyol + R11+ ISO	R11 Pu Foam, 40 Kg/Cu. Mt. Ratio 50% + 50% (Pol+R11)+Iso
Refrigerant "R12 " Charge Weight	10 Kg.
Working Voltage and Hz Starting Current Operating Current	380 Volts 3 Phases, 14 Amp.

Product Load Calculation

Product to be loaded	Product Mass Load Kg.	Product Specific heat Above Freezing Point	Product Specific heat Below Freezing Point	Latent Heat of Fusion	Product Initial Temp	Product Final Temp.	Temp. Diff.	Q_1 $m C_1 \Delta T$	Q_2 $m . C_2 . \Delta T$	Q_3 $M . h$
Lamb Meat	2000	3200 j/Kg. °K	1610 j/Kg. °K	204000 j/Kg.	28	-18	46	1777	670	4722

Q_1=(2000x24x3200)/86400 = 1777, Q_2 = (2000x18x1610)/86400=670, Q_3= (2000x20000)/86400=4722

Total = $Q_1 + Q_2 + Q_3$ = 7169 Watts

Miscellanies Heat Load

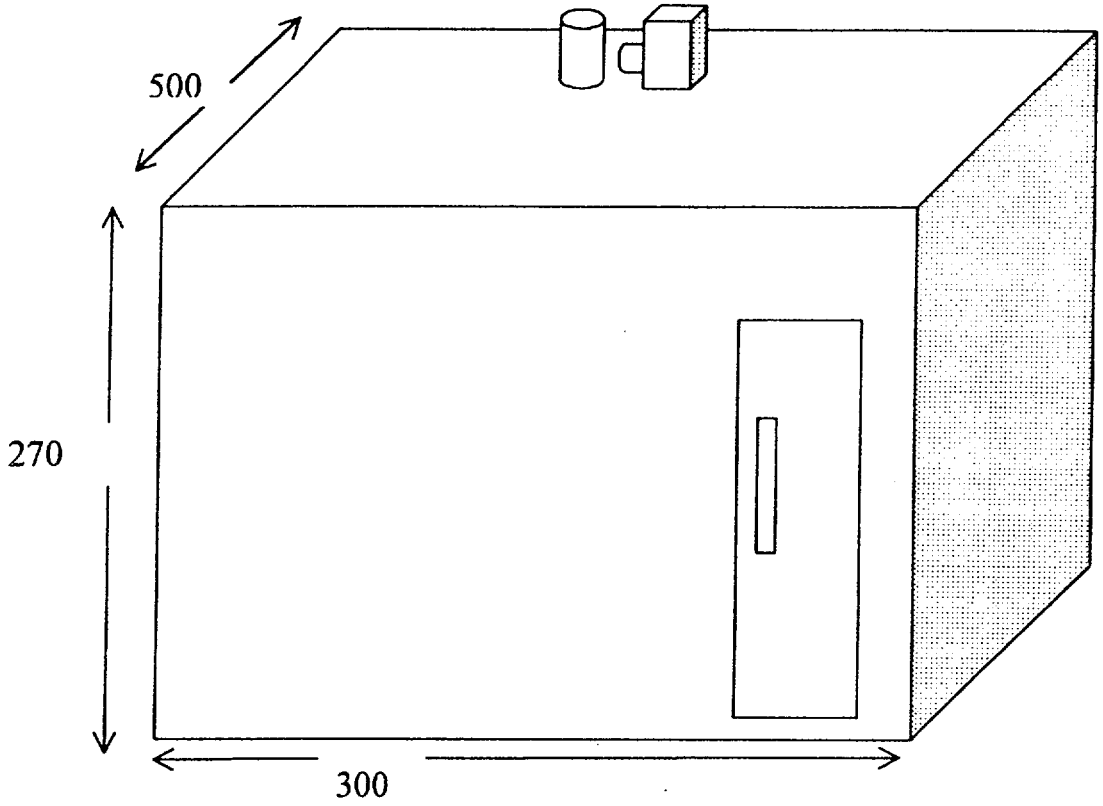
Air Change = V . N . H V = Refrigerator Internal Volume N = Number of Air Change per Day H = Heat removed from cubic meter of air = 75000 jul/sec.	Gasket U.L. ΔT $U=0.07$ $L = 6$ Mt. $\Delta T=58$	Electrometer No = 4 Each = 150 150x4= 600 watts	Florescent Lamp 4 x 20 = 80	Total
(40 x 10 x 75000)/86400 = 351	24	600	80	1055

Total refrigeration Load

Heal Leaks Through Walls	Product Load	Miscellanies Load	Safety Factors	Grand Total
413	7169	1055	864	9501

Refrigeration Load Calculation
Heat Leaks Through Walls
$Q = U \cdot A \cdot \Delta T$
Model YS-CS40F

Description	Dimension	Surface Area Sq. Mt.	Ambient Temp. °C	Reference Inside Temp.	ΔT Temp. Diff.	X Insulation Thickness	K Thermal Conductivity	U Coeff. Heat Resistance	Q $U \cdot A \cdot \Delta T$ *Watt*
Side Walls	2x300x270	16.2	40	-18	58	100	0.0184	0.184	115.2
Back Panel	500x270	13.5	40	-18	58	100	0.0184	0.184	96
Roof Panel	500x300	15	40	-18	58	100	0.0184	0.184	106.7
Front Panel	500x270	13.5	40	-18	58	100	0.0184	0.184	96
Total									413.9



Cold Store, Refrigerator
Model YS-CS40

Technical Specification of the Product *Model YS-CS40R*	
Description	Technical Specification
Name of products	Cold Store above Zer0
Model Number	YS-CS40R
Dimension	500 x 300 x 270
Wall Thickness, for Foam Injection	100 Cm.
Product Internal Temperature	0 to + 4 °C
Evaporating Temperature or Evaporator Surface temperature	-5 °C
Working Temperature or Ambient Temperature	+ 40 °C
Product Internal Volume Liter	40 Cubic Meter
Compressor Manufacture	DWM England
Compressor Model	DWM
Compressor Cooling Capacity in Watt	3000
Compressor Power Input	2820
Condenser Type, Material, Length, and Diameter	Air Cooled, Fin and Tube Length = 59 Mt. Diameter ¾ inch.
Evaporator Type, Material, Length, and Diameter	Fin and Tube, Dimension ½ inch.
Capillary Tube Type, Material, Length, and Diameter	Expansion Valve TEX – 3
Dryer, Type and Weight	Dimension ½ inch with bolts and Nuts
P.U. Type, Density Percentage of Component Mixture Polyol + R11+ ISO	R11, 40 Kg/Cu. Mt., 50%(Polyol and R11) + 50% Iso, (10% R11)
Refrigerant "R12 " Charge Weight	7 Kg.
Working Voltage and Hz Starting Current Operating Current	380 Volts, three phase, 7 Amp.

Product Load Calculation

Product to be loaded	Product Mass Load Kg.	Product Specific heat Above Freezing Point	Product Specific heat Below Freezing Point	Latent Heat of Fusion	Product Initial Temp	Product Final Temp.	Temp. Diff.	Q_1 $m\,C_1\,\Delta T$	Q_2 $m\,.\,C_2\,.\,\Delta T$	Q_3 $M\,.\,h$
Lamb Meat	2000	3200 J/Kg °K	1610 J/Kg °K	204000 J/Kg	28 °C	4 °C	24	1777	N/A	N/A

2000 x 3200 x 24 =153600000 ÷ 86400 = 1777 Watts

Total =Q_1 = 1777 Watts

Miscellanies Heat Load

Air Change = V . N . H V = Refrigerator Internal Volume N = Number of Air Change per Day H = Heat removed from cubic meter of air = 75000 jul/sec.	Gasket U . L . ΔT *0.07x6x31*	Electrometer No. 4 each 150 watts	Florescent Lamp	Total
40 x 20 x 75000 = 60000000 ÷ 86400 = 694 Watts	13	600	2 x40 = 80	1387

Total refrigeration Load

Heal Leaks Through Walls	Product Load	Miscellanies Load	Safety Factors	Grand Total
407	1777	1387	357	3928

Refrigeration Load Calculation
Heat Leaks Through Walls
$Q = U \cdot A \cdot \Delta T$
Model YS-CS40R

Description	Dimension	Surface Area Sq. Mt.	Ambient Temp. °C	Reference Inside Temp.	ΔT Temp. Diff.	X Insulation Thickness	K Thermal Conductivity	U Coeff. Heat Resistance	Q $U \cdot A \cdot \Delta T$ *Watt*
Side Walls	2x270x300	16.2	40	2	38	100	0.0184	0.184	113.3
Front & Back Panel	2x500x270	27	40	2	38	100	0.0184	0.184	188.7
Roof Panel	500x300	15	40	2	38	100	0.0184	0.184	104.9
Total									407

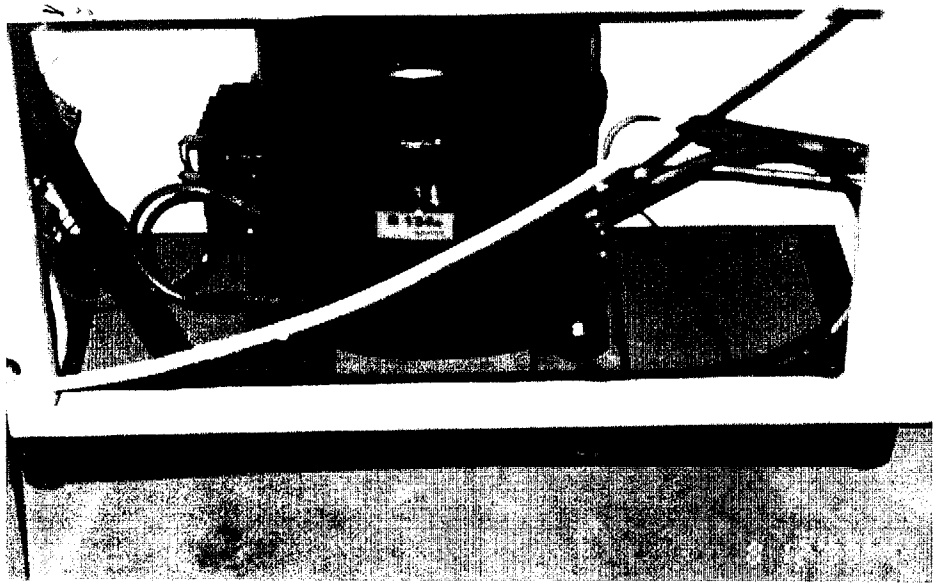
Conversion of Prototypes at SHERVIN ELECTRIC CO.

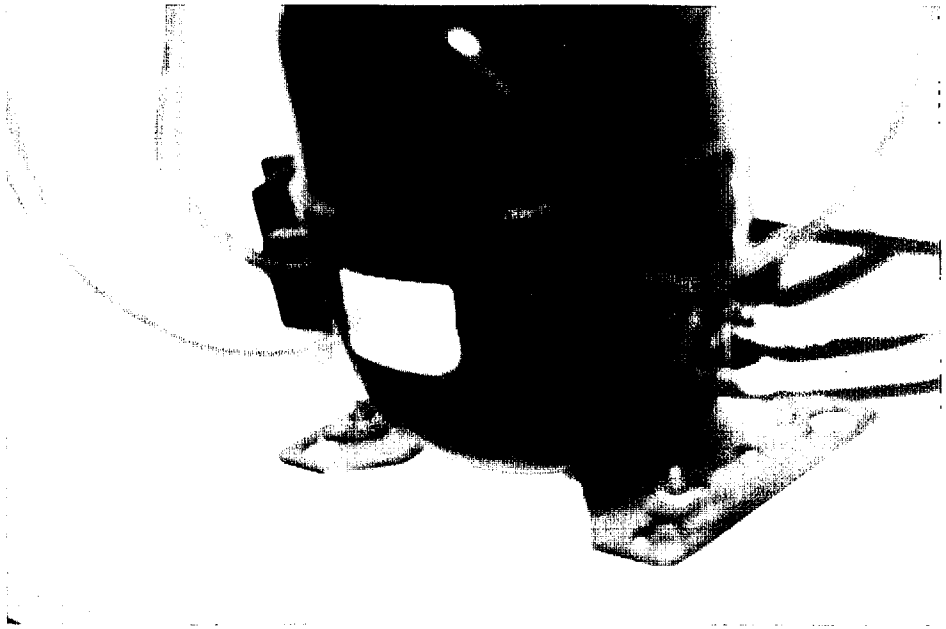
Chest Freezer Model SE-CF285

Refrigerator and Freezer Model SE-RF16

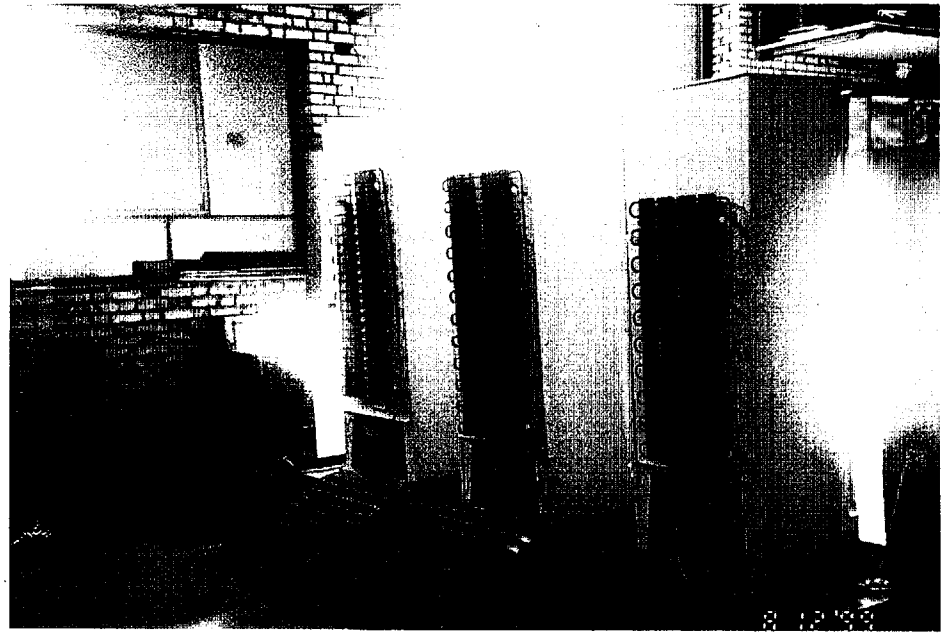
Freezer Model AZ-SE-F13

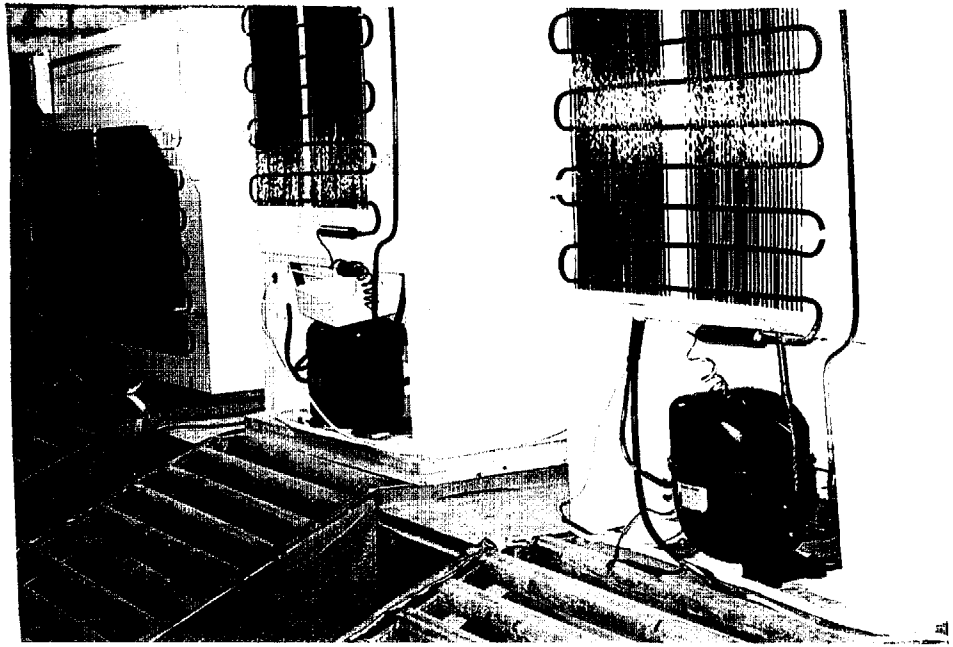
Refrigerator Model SE-R13

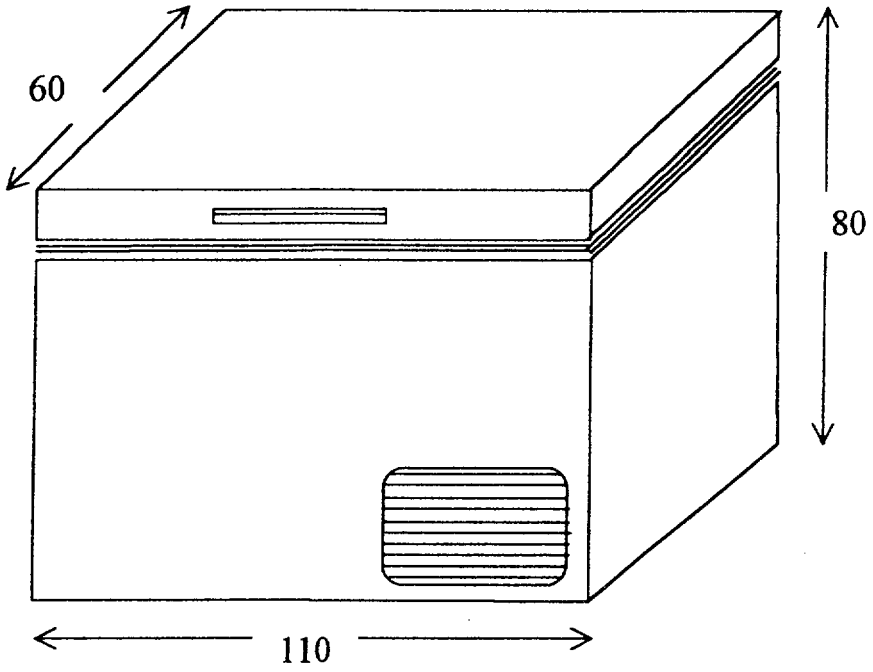




SHERVIN ELECTRO COMPANY
PROTOTYPES







Chest Freezer
Model SE-CF285

Technical Specification of the Product *Model SE-CF285*	
Description	Technical Specification
Name of products	Chest Freezer
Model Number	SE-CF285
Dimension	110x60x80
Wall Thickness, for Foam Injection	60 mm
Product Internal Temperature	-18 C
Evaporating Temperature or Evaporator Surface temperature	-28 C
Working Temperature or Ambient Temperature	+ 35 C
Product Internal Volume Liter	285 Liter
Compressor Manufacture	Danfoss
Compressor Model	¼ hp
Compressor Cooling Capacity in Watt	175
Compressor Power Input	125
Condenser Type, Material, Length, and Diameter	Copper Wire and Tube, L = 14 Mt.
Evaporator Type, Material, Length, and Diameter	Plate and Tube,
Capillary Tube Type, Material, Length, and Diameter	Copper tube, L = 3.3 Dim. = 0.036"
Dryer, Type and Weight	20 Grams
P.U. Type, Density Percentage of Component Mixture Polyol + R11+ ISO	R11, 40 Kg/Cu. Mt., 50%(Polyol and R11) + 50% Iso, (15% R11)
Refrigerant "R12 " Charge Weight	250 Gr.
Working Voltage and Hz Starting Current Operating Current	220 Volts, 50 Hz 16 Amp. 1.5 Amp.

Refrigeration Load Calculation
Heat Leaks Through Walls
$Q = U \cdot A \cdot \Delta T$
Model SE-CF285

Description	Dimension	Surface Area Sq. Mt.	Ambient Temp. °C	Reference Inside Temp.	ΔT Temp. Diff.	X Insulation Thickness	K Thermal Conductivity	U Coeff. Heat Resistance	Q $U \cdot A \cdot \Delta T$ *Watt*
Side Walls	2x80x60	0.96	+35	-18	53	60	0.0184	0.31	15.3
Back Panel	110x80	0.88	+45	-18	63	60	0.0184	0.31	16.6
Top surface	110x60	0.66	+35	-18	53	60	0.0184	0.31	10.5
Bottom surface	110x60	0.66	+45	-18	63	60	0.0184	0.31	12.5
Front Panel	110x80	0.88	+35	-18	53	60	0.0184	0.31	14
Total									68.9

Product Load Calculation

Model SE-CF285

Product to be loaded	Product Mass Load Kg.	Product Specific heat Above Freezing Point J/Kg. K	Product Specific heat Below Freezing Point J/Kg K	Latent Heat of Fusion J/Kg.	Product Initial Temp C	Product Final Temp. C	Temp. Diff.	Q_1 $m\,C_1\,\Delta T$	Q_2 $m\,.\,C_2\,.\,\Delta T$	Q_3 $M\,.\,h$
ICE	10	4180	1650	333	24	4	20			

$Q_1=(10x20x4180)/86400 = 9.7$, $Q_2 = (10x18x1950)/86400=4.1$, $Q_3= (10x333000)/86400=38.5$

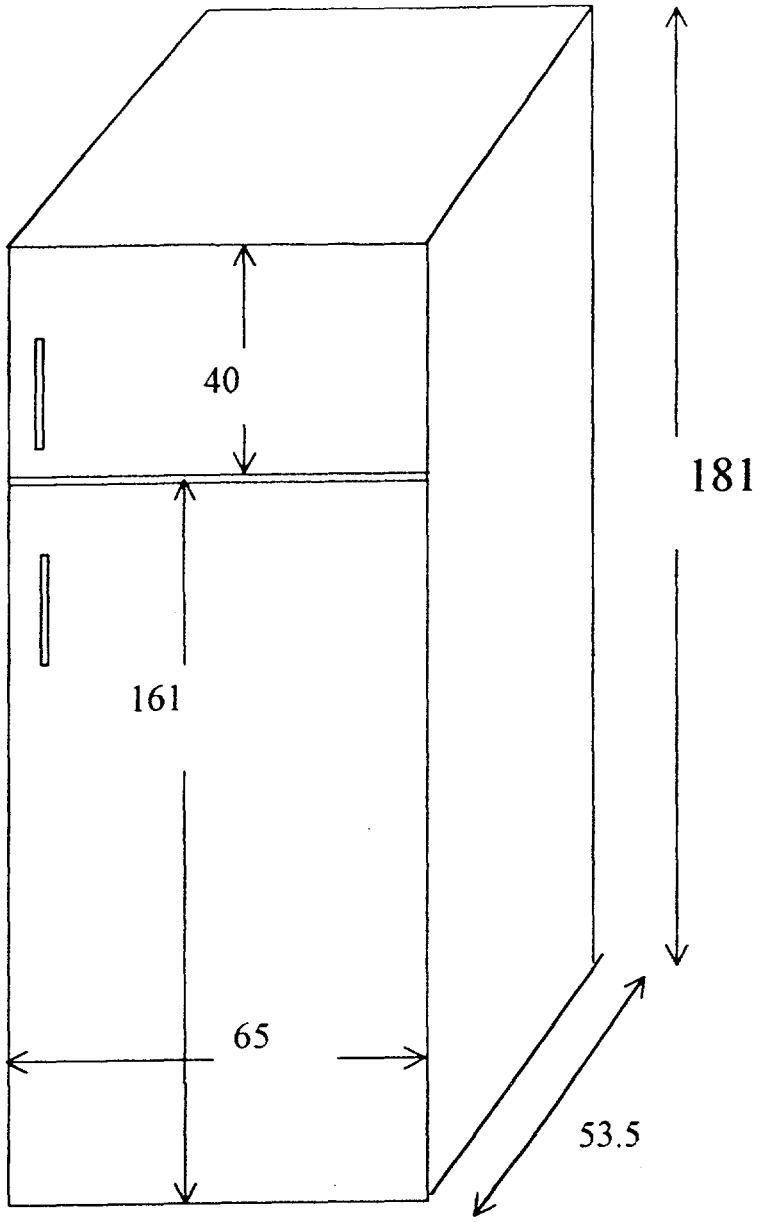
$Total = Q_1 + Q_2 + Q_3 = 52 Watts$

Miscellanies Heat Load

Air Change = V . N . H V = Refrigerator Internal Volume N = Number of Air Change per Day H = Heat removed from cubic meter of air = 75000 jul/sec.	Gasket U . A. ΔT $U=0.07$ $L = 3.4$ $Mt.$ $\Delta T=53$	Electrometer	Florescent Lamp	Total
(0.285x70x75000)/86400 = 17.3	12.6	N/A	N/A	29.9

Total refrigeration Load

Heal Leaks Through Walls	Product Load	Miscellanies Load	Safety Factors	Grand Total
68.9	52	16	30	181



Refrigerator and Freezer
Model SE-RF16

Technical Specification of the Product *Model SE-RF16*	
Description	Technical Specification
Name of products	Refrigerator & Freezer
Model Number	SE-RF16
Dimension	181x65x53.5
Wall Thickness, for Foam Injection	60 Freezer mm and Ref. 45 mm
Product Internal Temperature	-18 freezer & + 5 C refrigerator
Evaporating Temperature or Evaporator Surface temperature	-20 C
Working Temperature or Ambient Temperature	+ 35 C
Product Internal Volume Liter	580 Liter
Compressor Manufacture	Danfoss
Compressor Model	¼ hp
Compressor Cooling Capacity in Watt	175
Compressor Power Input	158
Condenser Type, Material, Length, and Diameter	Copper Wire and Tube, L = 14 Mt.
Evaporator Type, Material, Length, and Diameter	Plate and Tube
Capillary Tube Type, Material, Length, and Diameter	Copper tube, L = 3.3 Dim. = 0.036"
Dryer, Type and Weight	20 Grams
P.U. Type, Density Percentage of Component Mixture Polyol + R11+ ISO	R11, 40 Kg/Cu. Mt., 50%(Polyol and R11) + 50% Iso, (15% R11)
Refrigerant "R12 " Charge Weight	275 Gr.
Working Voltage and Hz Starting Current Operating Current	220 Volts, 50 Hz 6 Amp.

Refrigeration Load Calculation
Heat Leaks Through Walls
$Q = U \cdot A \cdot \Delta T$
Model SE-RF16

Description	Dimension	Surface Area Sq. Mt.	Ambient Temp. °C	Reference Inside Temp.	ΔT Temp. Diff.	X Insulation Thickness	K Thermal Conductivity	U Coeff. Heat Resistance	Q U . A . ΔT *Watt*
Upper Side Walls	2x53.5x40	0.428	35	-18	53	60	0.0184	0.31	7
Upper Back Panel	40x60	0.24	45	-18	63	60	0.0184	0.31	4.7
Top surface	65x53.5	0.321	35	-18	53	60	0.0184	0.31	5.3
Bottom surface	65x53.5	0.321	40	+10	30	45	0.0184	0.41	3.9
Lower Side walls	2x121x53.5	0.647	35	+4	31	45	0.0184	0.41	8.2
Lower Back Panel	121x65	0.7865	45	+4	41	45	0.0184	0.41	13.2
Upper Door	40x65	0.260	35	-18	53	45	0.0184	0.41	5.6
Lower Door Panel	121x65	0.790	35	+4	31	45	0.0184	0.41	9.9
Total									57.8

Product Load Calculation

Model SE-RF16

Product to be loaded	Product Mass Load Kg.	Product Specific heat Above Freezing Point J/Kg. K	Product Specific heat Below Freezing Point J/Kg K	Latent Heat of Fusion J/Kg.	Product Initial Temp C	Product Final Temp. C	Temp. Diff.	Q_1 $m C_1 \Delta T$	Q_2 $m . C_2 . \Delta T$	Q_3 $M . h$
ICE	15	4180	1650	333	24	4	20			

Q_1*=(10x20x4180)/86400 = 9.75,* Q_2 *= (10x18x1950)/86400=4.1,* Q_3*= (10x333000)/86400=38.5*

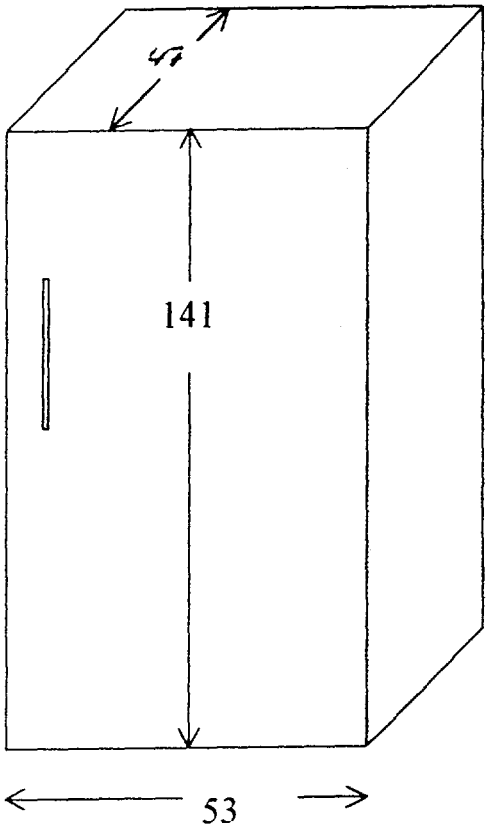
Total = $Q_1 + Q_2 + Q_3$ ***= 52.3Watts***

Miscellanies Heat Load

Air Change = V . N . H V = Refrigerator Internal Volume N = Number of Air Change per Day H = Heat removed from cubic meter of air = 75000 jul/sec.	Gasket U . A. ΔT *U=0.07* *L = 5.82 Mt.* ΔT*=53& 31*	Electrometer	Florescent Lamp	Total
(0.580x30x75000)/86400 = 15	12.6	N/A	N/A	26

Total refrigeration Load

Heal Leaks Through Walls	Product Load	Miscellanies Load	Safety Factors	Grand Total
58	52	26	14	150



Freezer
Model SE-F13

Technical Specification of the Product *Model SE-F13*	
Description	Technical Specification
Name of products	Domestic Freezer
Model Number	SE-F13
Dimension	141x47x53
Wall Thickness, for Foam Injection	60 mm
Product Internal Temperature	-18 .
Evaporating Temperature or Evaporator Surface temperature	-23 C
Working Temperature or Ambient Temperature	+ 35 C
Product Internal Volume Liter	360 Liter
Compressor Manufacture	Danfoss
Compressor Model	¼ hp
Compressor Cooling Capacity in Watt	175
Compressor Power Input	150
Condenser Type, Material, Length, and Diameter	Copper Wire and Tube, L = 14 Mt.
Evaporator Type, Material, Length, and Diameter	Plate and Tube
Capillary Tube Type, Material, Length, and Diameter	Copper tube, L = 3.3 Dim. = 0.036"
Dryer, Type and Weight	20 Grams
P.U. Type, Density Percentage of Component Mixture Polyol + R11+ ISO	R11, 40 Kg/Cu. Mt., 50%(Polyol and R11) + 50% Iso, (15% R11)
Refrigerant "R12 " Charge Weight	250 Gr.
Working Voltage and Hz Starting Current Operating Current	220 Volts, 50 Hz 6 Amp.

Refrigeration Load Calculation
Heat Leaks Through Walls
$Q = U \cdot A \cdot \Delta T$
Model SE-F13

Description	Dimension	Surface Area Sq. Mt.	Ambient Temp. °C	Reference Inside Temp.	ΔT Temp. Diff.	X Insulation Thickness	K Thermal Conductivity	U Coeff. Heat Resistance	Q $U \cdot A \cdot \Delta T$ *Watt*
Side Walls	2x141x53	1.494	35	-18	53	60	0.0184	0.31	24.5
Back Panel	141x47	0.663	45	-18	63	60	0.0184	0.31	12.9
Top surface	47x53	0.249	35	-18	53	60	0.0184	0.31	4.1
Bottom surface	47x53	0.249	45	-18	63	60	0.0184	0.31	4.8
Door Panel	141x47	0.633	35	-18	53	60	0.0184	0.31	10.9
Total									57.2

Product Load Calculation

Model SE- F13

Product to be loaded	Product Mass Load Kg.	Product Specific heat Above Freezing Point J/Kg. K	Product Specific heat Below Freezing Point J/Kg K	Latent Heat of Fusion J/Kg.	Product Initial Temp C	Product Final Temp. C	Temp. Diff.	Q_1 $m\,C_1\,\Delta T$	Q_2 $m.\,C_2.\,\Delta T$	Q_3 $M.\,h$
ICE	10	4180	1650	333	24	4	20			

$Q_1=(10x20x4180)/86400 = 9.75$, $Q_2 = (10x18x1950)/86400=4.1$, $Q_3= (10x333000)/86400=38.5$

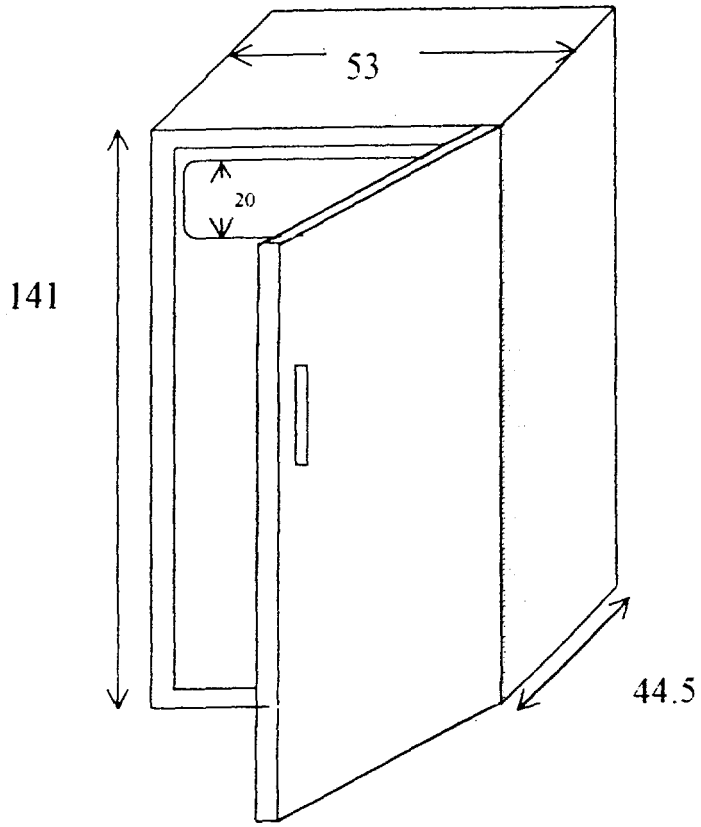
$$Total = Q_1 + Q_2 + Q_3 = 52.3 Watts$$

Miscellanies Heat Load

Air Change = V . N . H V = Refrigerator Internal Volume N = Number of Air Change per Day H = Heat removed from cubic meter of air = 75000 jul/sec.	Gasket U . A. ΔT $U=0.07$ $L = 3.76$ Mt. $\Delta T=53$	Electrometer	Florescent Lamp	Total
(0.360x30x75000)/86400 = 6.25	13.9	N/A	N/A	20

Total refrigeration Load

Heal Leaks Through Walls	Product Load	Miscellanies Load	Safety Factors	Grand Total
57	52	20	31	160



Refrigerator
Model SE- R13

Technical Specification of the Product *Model SE-R13*	
Description	Technical Specification
Name of products	Refrigerator
Model Number	SE-R13
Dimension	141x44.5x53
Wall Thickness, for Foam Injection	45 mm
Product Internal Temperature	-12 Evaporator Comp. & + 5 C Ref. Comp.
Evaporating Temperature or Evaporator Surface temperature	-20 C
Working Temperature or Ambient Temperature	+ 35 C
Product Internal Volume Liter	360 Liter
Compressor Manufacture	Danfoss
Compressor Model	1/5 hp
Compressor Cooling Capacity in Watt	150
Compressor Power Input	140
Condenser Type, Material, Length, and Diameter	Copper Wire and Tube, L = 12 Mt.
Evaporator Type, Material, Length, and Diameter	Plate and Tube
Capillary Tube Type, Material, Length, and Diameter	Copper tube, L = 3.1 Dim. = 0.036"
Dryer, Type and Weight	15 Grams
P.U. Type, Density Percentage of Component Mixture Polyol + R11+ ISO	R11, 40 Kg/Cu. Mt., 50%(Polyol and R11) + 50% Iso, (15% R11)
Refrigerant "R12 " Charge Weight	185 Gr.
Working Voltage and Hz Starting Current Operating Current	220 Volts, 50 Hz 3 Amp.

Refrigeration Load Calculation
Heat Leaks Through Walls
$Q = U \cdot A \cdot \Delta T$
Model SE-R13

Description	Dimension	Surface Area Sq. Mt.	Ambient Temp. °C	Reference Inside Temp.	ΔT Temp. Diff.	X Insulation Thickness	K Thermal Conductivity	U Coeff. , Heat Resistance	Q $U \cdot A \cdot \Delta T$ *Watt*
Side Walls	2x141x53	1.494	35	-18	53	60	0.0184	0.31	24.5
Back Panel	141x47	0.663	45	-18	63	60	0.0184	0.31	12.9
Top surface	47x53	0.249	35	-18	53	60	0.0184	0.31	4.1
Bottom surface	47x53	0.249	45	-18	63	60	0.0184	0.31	4.8
Door Panel	141x47	0.633	35	-18	53	60	0.0184	0.31	10.9
Total									57.2

Product Load Calculation

Model SE-R13

Product to be loaded	Product Mass Load Kg.	Product Specific heat Above Freezing Point J/Kg. K	Product Specific heat Below Freezing Point J/Kg K	Latent Heat of Fusion J/Kg.	Product Initial Temp C	Product Final Temp. C	Temp. Diff.	Q_1 $m C_1 \Delta T$	Q_2 $m . C_2 . \Delta T$	Q_3 $M . h$
ICE	10	4180	1650	333	24	4	20			

$Q_1=(10x20x4180)/86400 = 9.75$, $Q_2 = (10x18x1950)/86400=4.1$, $Q_3= (10x333000)/86400=38.5$

$Total = Q_1 + Q_2 + Q_3 = 52.3 Watts$

Miscellanies Heat Load

Air Change = V . N . H V = Refrigerator Internal Volume N = Number of Air Change per Day H = Heat removed from cubic meter of air = 75000 jul/sec.	Gasket U . A. ΔT $U=0.07$ $L = 3.76$ Mt. $\Delta T=53$	Electrometer	Florescent Lamp	Total
(0.360x30x75000)/86400 = 6.25	13.9	N/A	N/A	20

Total refrigeration Load

Heal Leaks Through Walls	Product Load	Miscellanies Load	Safety Factors	Grand Total
57	52	20	31	160

Printing in Labaratory Of
ARG METAL HR

ARG METAL HR

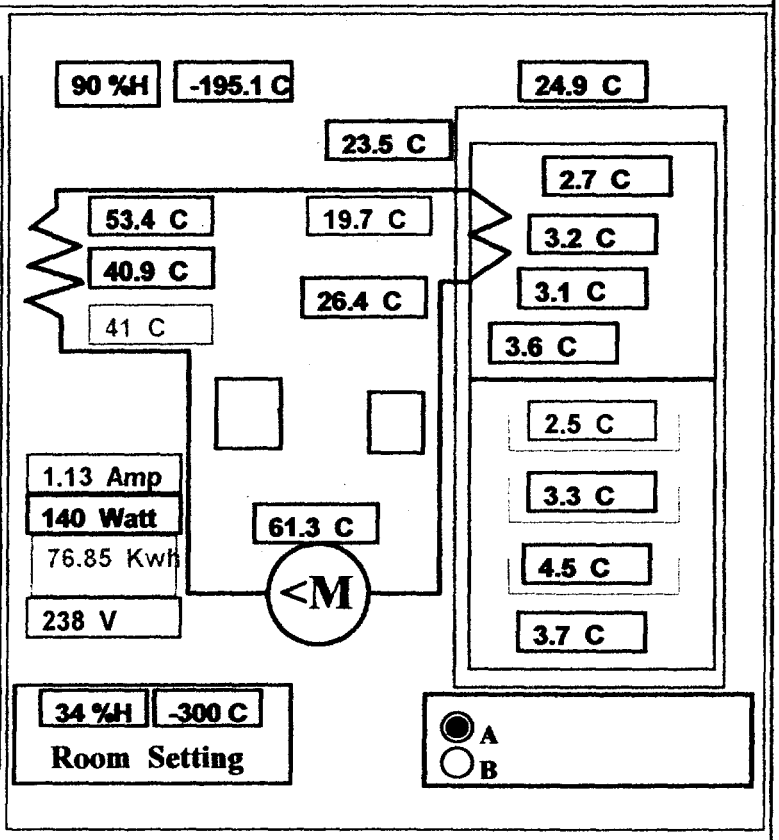
[redacted]

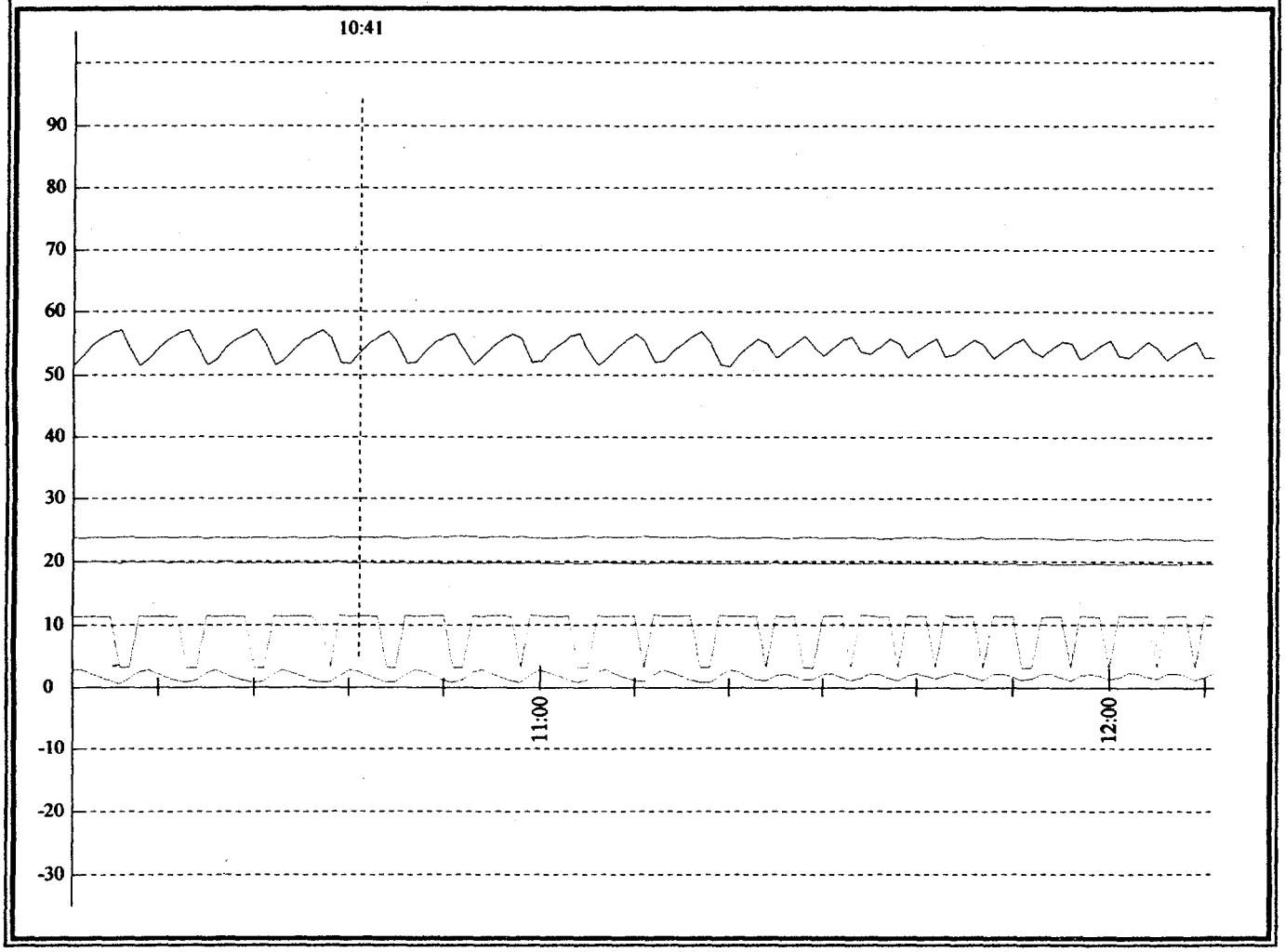
TestDate: **78/05/20 08:13** *Report No.:* ( ) - Page 5

PageTestName: Energy Consumtion *ReportDate:* 78/05/20 21:45

Page Result :

1 - Page Test Time	*2 Hours*
2 - Working Percent	*75 %On*
3 - Energy (Accord to page)	*2.52 kwh*
4 - Zoom Time	*10:41 Hour*
5 - Compr Current	*1.13 Amp*
6 - Evaprator Mean Temp	*3.1 C*
7 - Cabin Mean Temp	*3.4 C*
8 - Crisp Temp	*3.7 C*
9 - Compr Temp	*61.3 C*
10- Condensor In Temp	*41 C*
11- Condensor Out Temp	*53.4 C*
12- Condition	*-195.1 C 90 %H*
13- Volt	*Max=240 Mean=239 Min=234*
14-	
15-	
16-	
17-	





Industrial Control Research Center HotRoom Ver 5

Printing in Labaratory Of
ARG METAL HR

ARG METAL HR

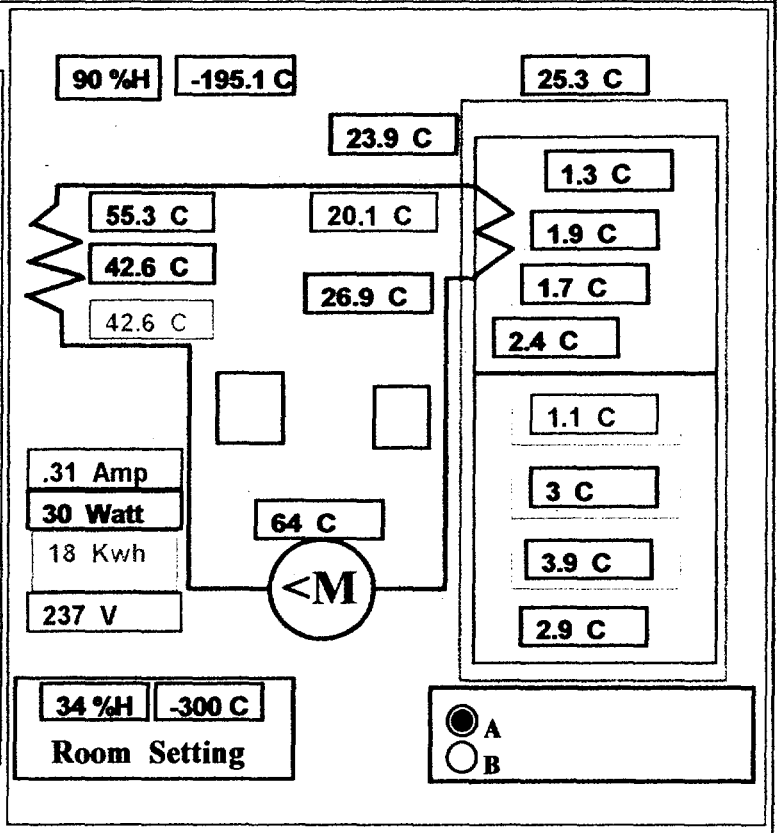
[redacted]

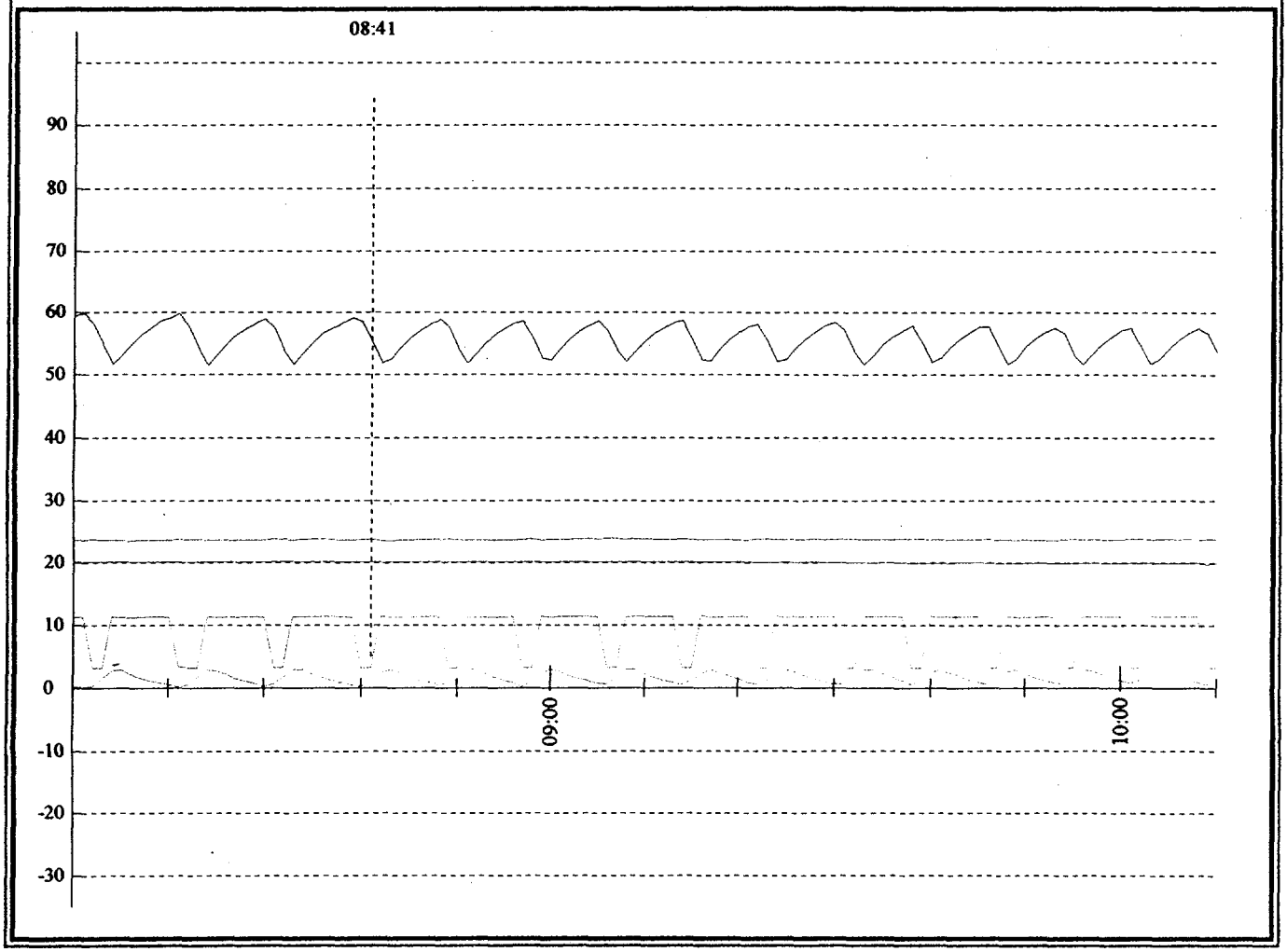
TestDate: **78/05/20 08:13** *Report No.:* ( ) - Page 4

PageTestName: Energy Consumtion *ReportDate:* 78/05/20 21:45

Page Result :

1 - Page Test Time	*2 Hours*
2 - Working Percent	*74 %On*
3 - Energy (Accord to page)	*2.523 kwh*
4 - Zoom Time	*8:41 Hour*
5 - Compr Current	*0.31 Amp*
6 - Evaprator Mean Temp	*1.8 C*
7 - Cabin Mean Temp	*2.6 C*
8 - Crisp Temp	*2.9 C*
9 - Compr Temp	*64 C*
10- Condensor In Temp	*42.6 C*
11- Condensor Out Temp	*55.3 C*
12- Condition	*-195.1 C 90 %H*
13- Volt	*Max=239 Mean=239 Min=235*
14-	
15-	
16-	
17-	





Industrial Control Research Center HotRoom Ver 5

Printing in Laboratory Of
ARG METAL HR

ARG METAL HR

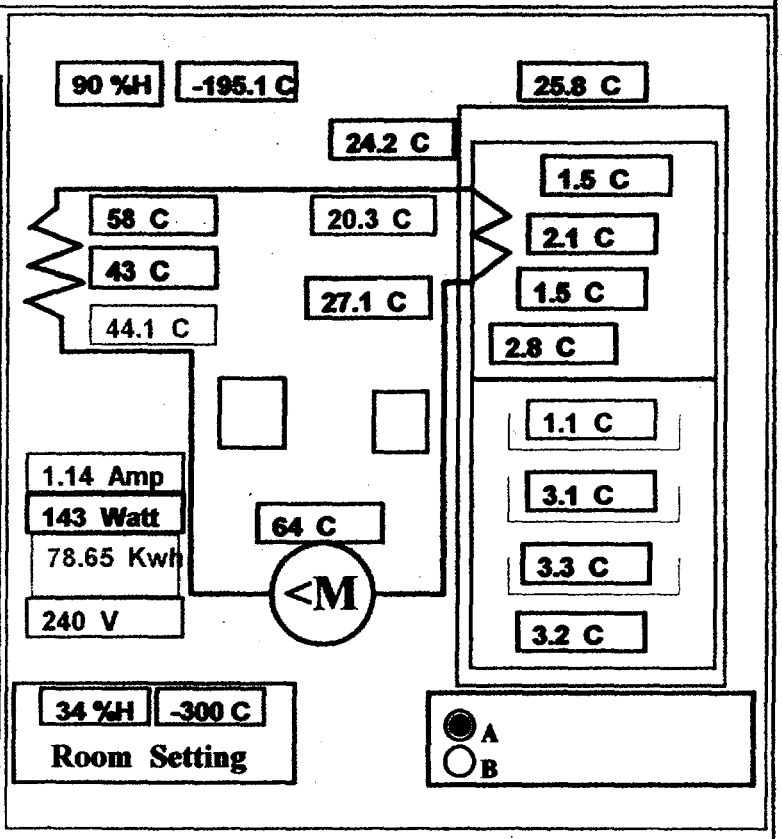
[redacted]

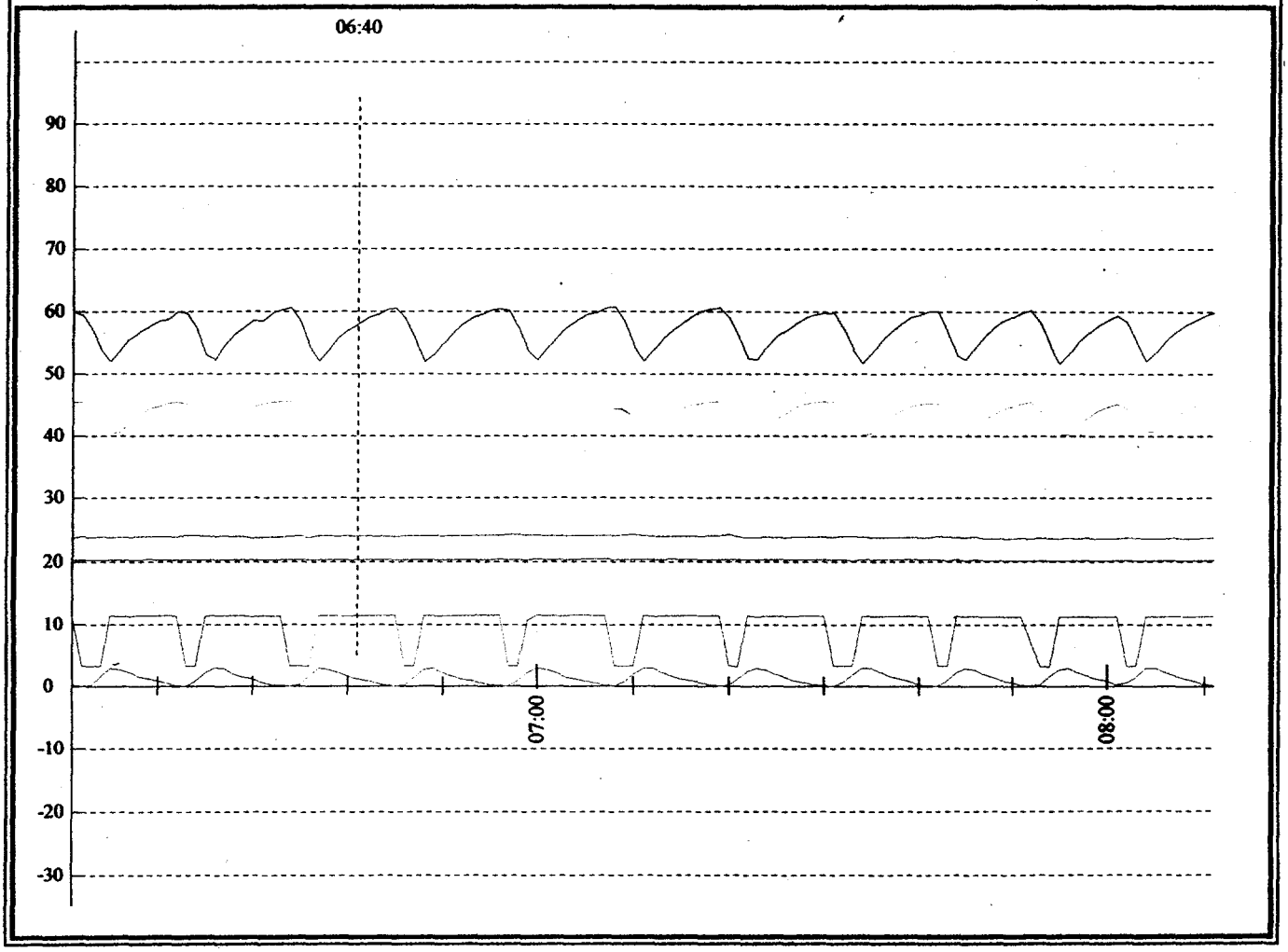
TestDate: **78/05/20 08:13** *Report No.:* ( ) - Page 3

PageTestName: Energy Consumtion *ReportDate:* 78/05/20 21:45

Page Result :

1 - Page Test Time	*2 Hours*
2 - Working Percent	*78 %On*
3 - Energy (Accord to page)	*2.642 kwh*
4 - Zoom Time	*6:41 Hour*
5 - Compr Current	*1.14 Amp*
6 - Evaprator Mean Temp	*1.9 C*
7 - Cabin Mean Temp	*2.5 C*
8 - Crisp Temp	*3.2 C*
9 - Compr Temp	*64 C*
10- Condensor In Temp	*44.1 C*
11- Condensor Out Temp	*58 C*
12- Condition	*-195.1 C 90 %H*
13- Volt	*Max=242 Mean=240 Min=235*
14-	
15-	
16-	
17-	





Industrial Control Research Center HotRoom Ver 5

Printing in Labaratory Of
ARG METAL HR

ARG METAL HR

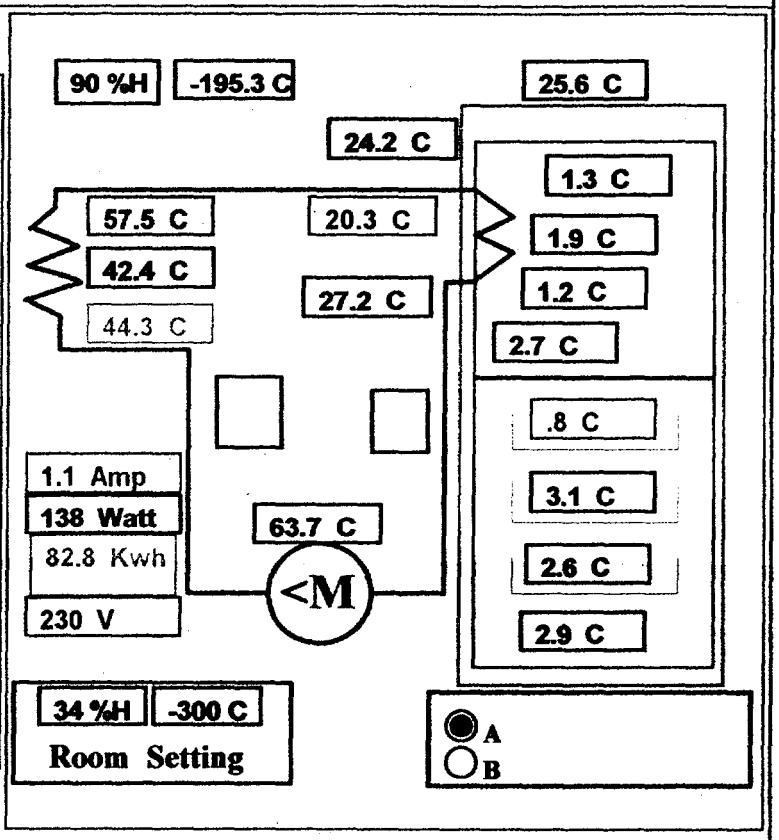
[redacted]

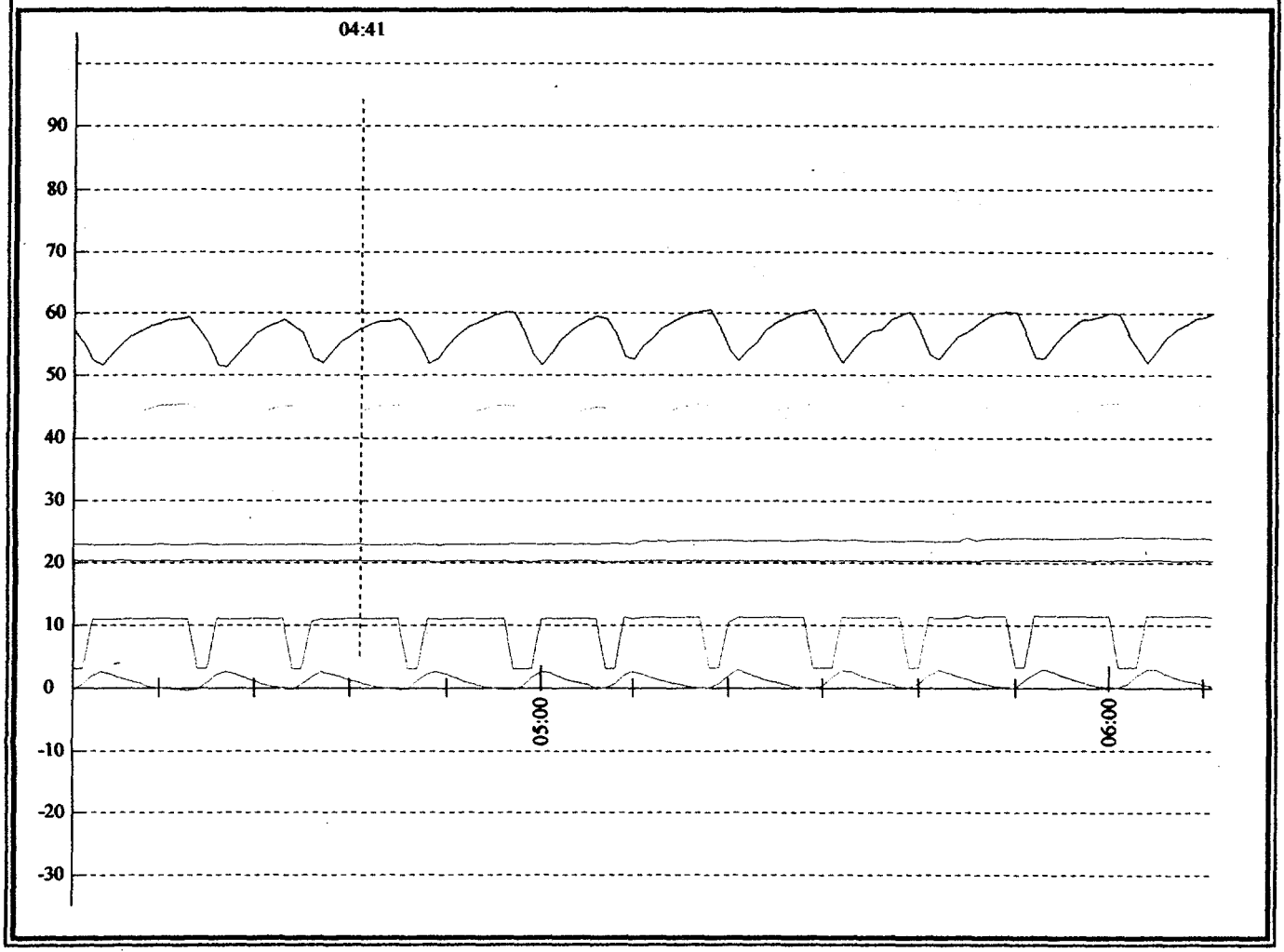
TestDate: **78/05/20 08:13** *Report No.:* ( ) - Page 2

PageTestName: Energy Consumtion *ReportDate:* 78/05/20 21:45

Page Result :

1 - Page Test Time	*2 Hours*
2 - Working Percent	*80 %On*
3 - Energy (Accord to page)	*2.605 kwh*
4 - Zoom Time	*4:41 Hour*
5 - Compr Current	*1.1 Amp*
6 - Evaprator Mean Temp	*1.7 C*
7 - Cabin Mean Temp	*2.1 C*
8 - Crisp Temp	*2.9 C*
9 - Compr Temp	*63.7 C*
10- Condensor In Temp	*44.3 C*
11- Condensor Out Temp	*57.5 C*
12- Condition	*-195.3 C 90 %H*
13- Volt	*Max=241 Mean=235 Min=229*
14-	
15-	
16-	
17-	





Industrial Control Research Center HotRoom Ver 5

Printing in Labaratory Of
ARG METAL HR

ARG METAL HR

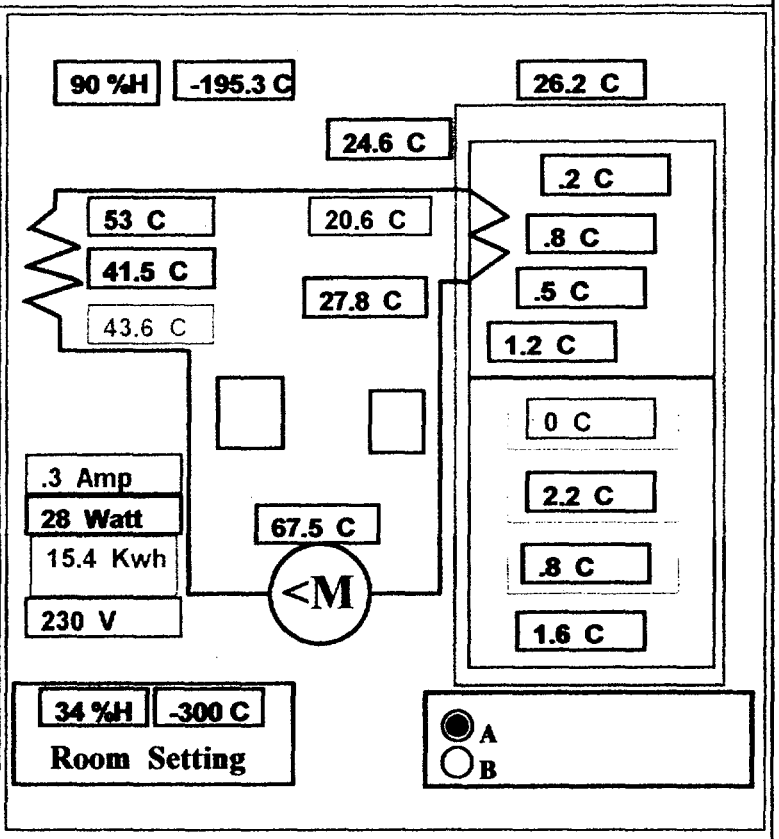
[redacted]

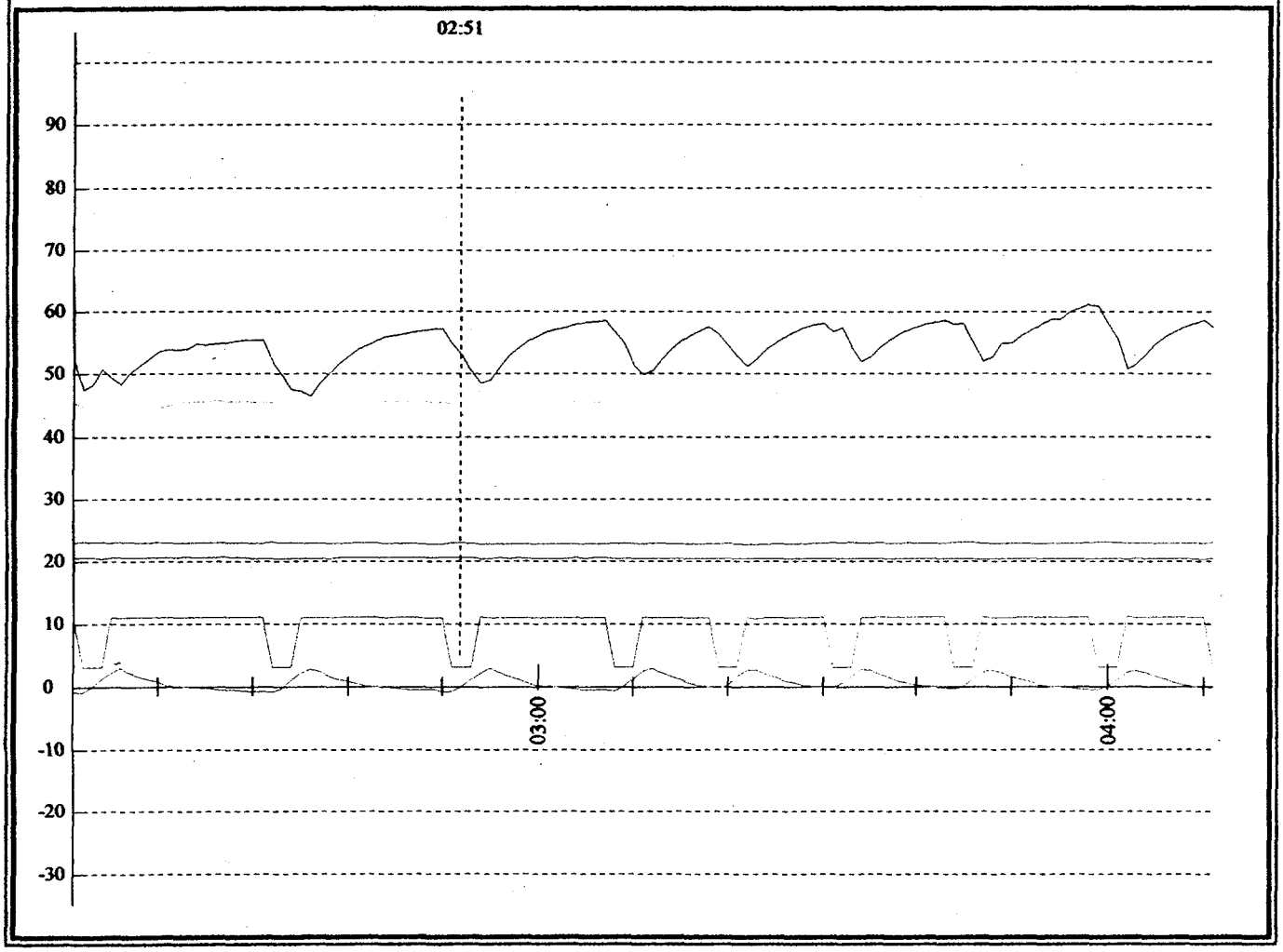
TestDate: **78/05/20 08:13** *Report No.:* ( ) - Page 1

PageTestName: Energy Consumtion *ReportDate:* 78/05/20 21:44

Page Result :

1 - Page Test Time	*2 Hours*
2 - Working Percent	*79 %On*
3 - Energy (Accord to page)	*2.604 kwh*
4 - Zoom Time	*2:52 Hour*
5 - Compr Current	*0.3 Amp*
6 - Evaprator Mean Temp	*.6 C*
7 - Cabin Mean Temp	*1 C*
8 - Crisp Temp	*1.6 C*
9 - Compr Temp	*67.5 C*
10- Condensor In Temp	*43.6 C*
11- Condensor Out Temp	*53 C*
12- Condition	*-195.3 C 90 %H*
13- Volt	*Max=232 Mean=231 Min=227*
14-	
15-	
16-	
17-	





Industrial Control Research Center HotRoom Ver 5

Printing in Laboratory Of
SHERVIN ELECTRIC

SHERVIN ELECTRIC

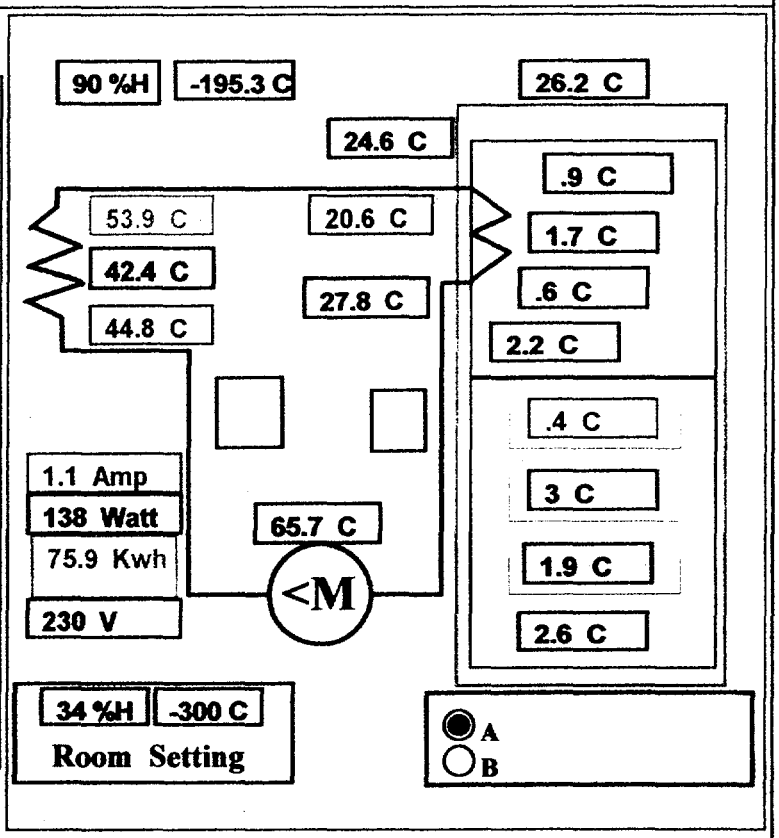
[redacted]

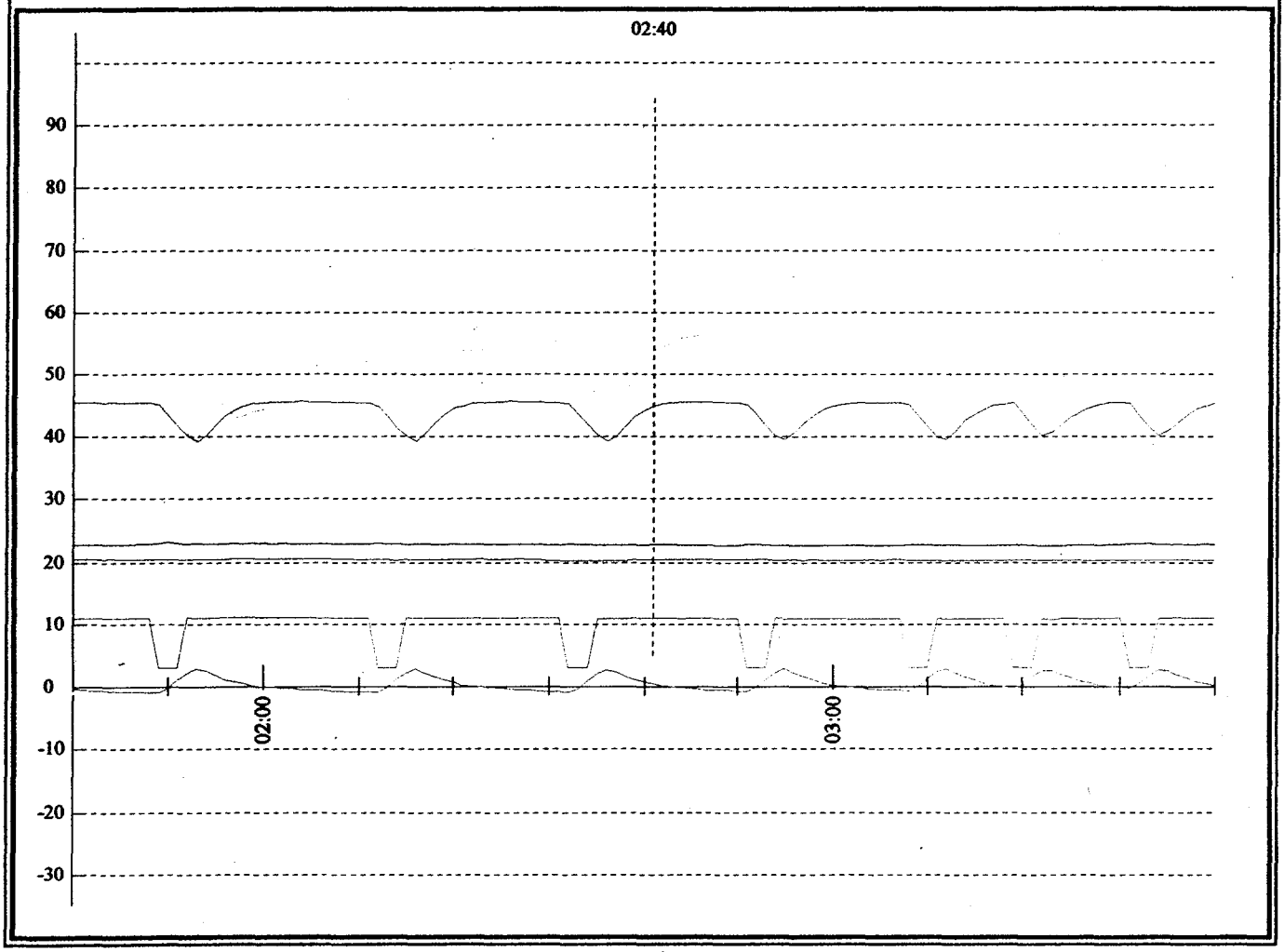
TestDate: **78/05/20 06:13** *Report No.:* ( ) - Page 1

PageTestName: Energy Consumption *ReportDate:* 78/05/21 08:23

Page Result :

1 - Page Test Time	*2 Hours*
2 - Working Percent	*83 %On*
3 - Energy (Accord to page)	*2.663 kwh*
4 - Zoom Time	*2:41 Hour*
5 - Compr Current	*1.1 Amp*
6 - Evaprator Mean Temp	*1.3 C*
7 - Cabin Mean Temp	*1.7 C*
8 - Crisp Temp	*2.6 C*
9 - Compr Temp	*65.7 C*
10- Condensor In Temp	*44.8 C*
11- Condensor Out Temp	*53.9 C*
12- Condition	*-195.3 C 90 %H*
13- Volt	*Max=233 Mean=232 Min=227*
14-	
15-	
16-	
17-	





Industrial Control Research Center HotRoom Ver 5

Printing in Labaratory Of
SHERVIN ELECTRIC

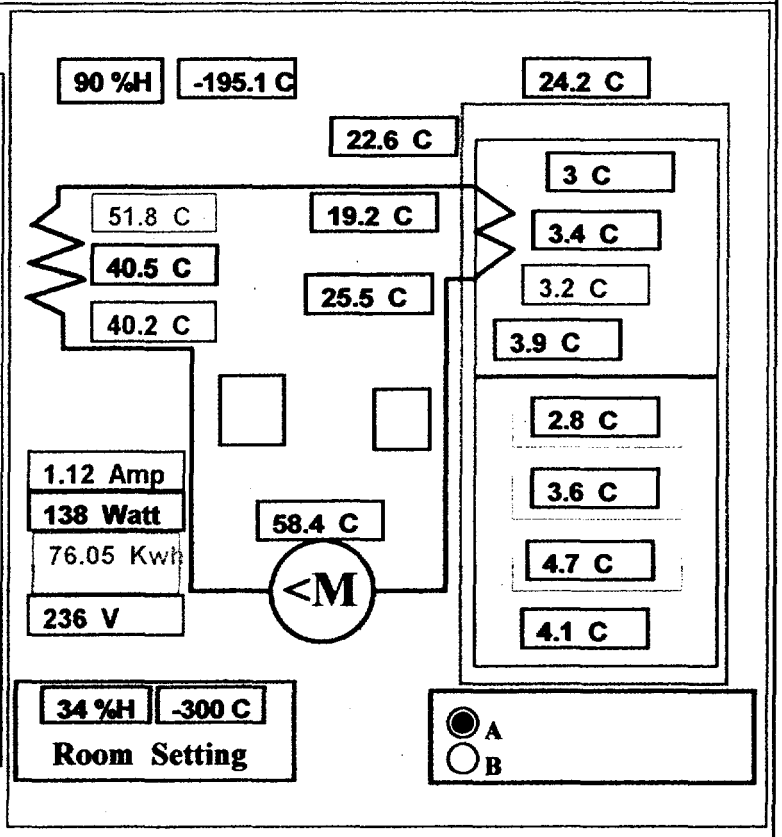
SHERVIN ELECTRIC

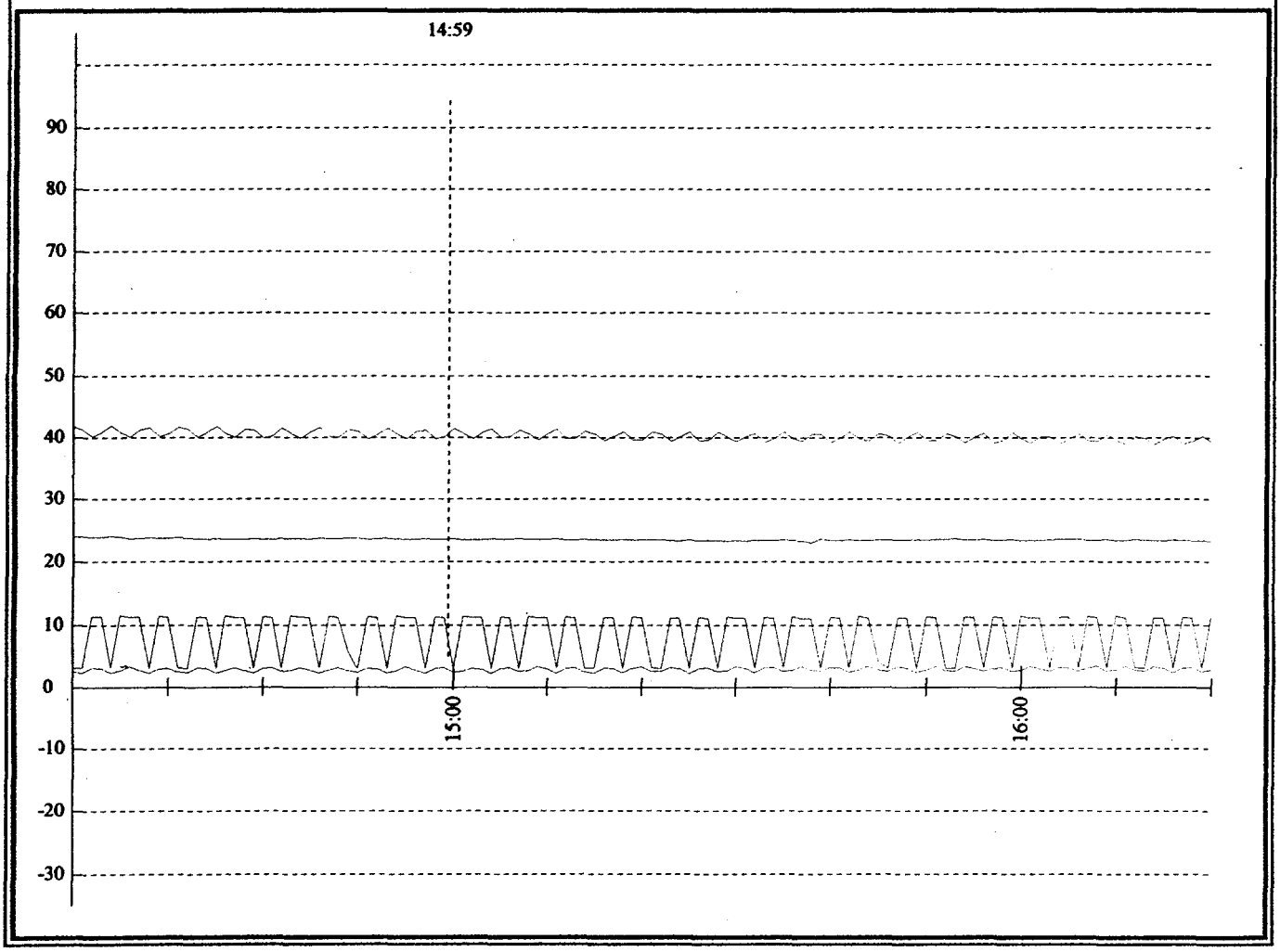
TestDate: **78/05/20 06:13** *Report No.:* ( ) - Page 6

PageTestName: Energy Consumtion *ReportDate:* 78/05/21 07:20

Page Result :

1 - Page Test Time	*2 Hours*
2 - Working Percent	*67 %On*
3 - Energy (Accord to page)	*2.316 kwh*
4 - Zoom Time	*14:59 Hour*
5 - Compr Current	*1.12 Amp*
6 - Evaprator Mean Temp	*3.3 C*
7 - Cabin Mean Temp	*3.7 C*
8 - Crisp Temp	*4.1 C*
9 - Compr Temp	*58.4 C*
10- Condensor In Temp	*40.2 C*
11- Condensor Out Temp	*51.8 C*
12- Condition	*-195.1 C 90 %H*
13- Volt	*Max=242 Mean=238 Min=231*
14-	
15-	
16-	
17-	





Industrial Control Research Center HotRoom Ver 5

Printing In Labaratory Of
SHERVIN ELECTRIC

SHERVIN ELECTRIC

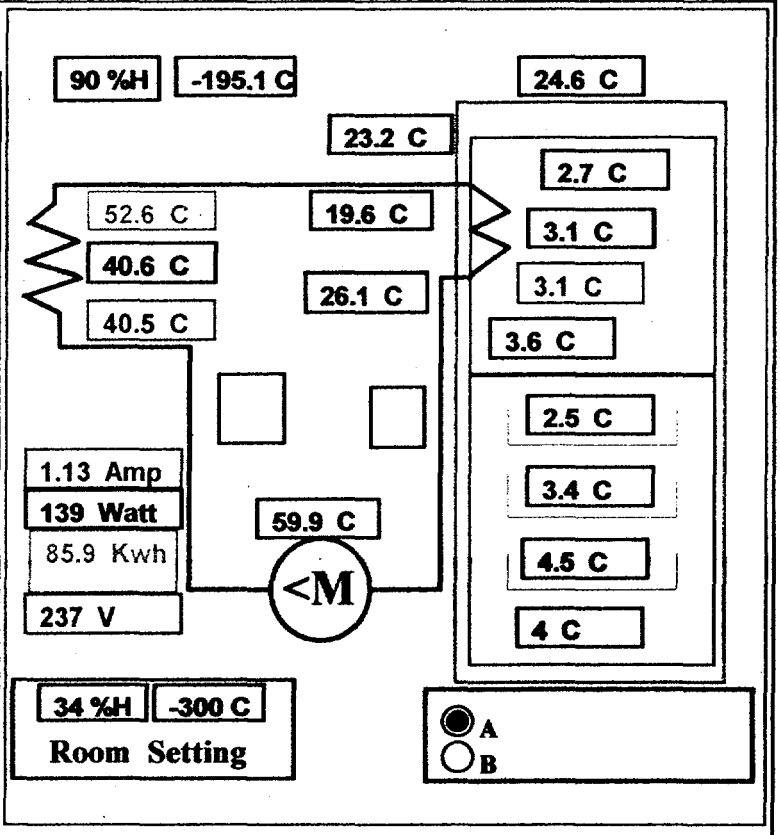
[redacted]

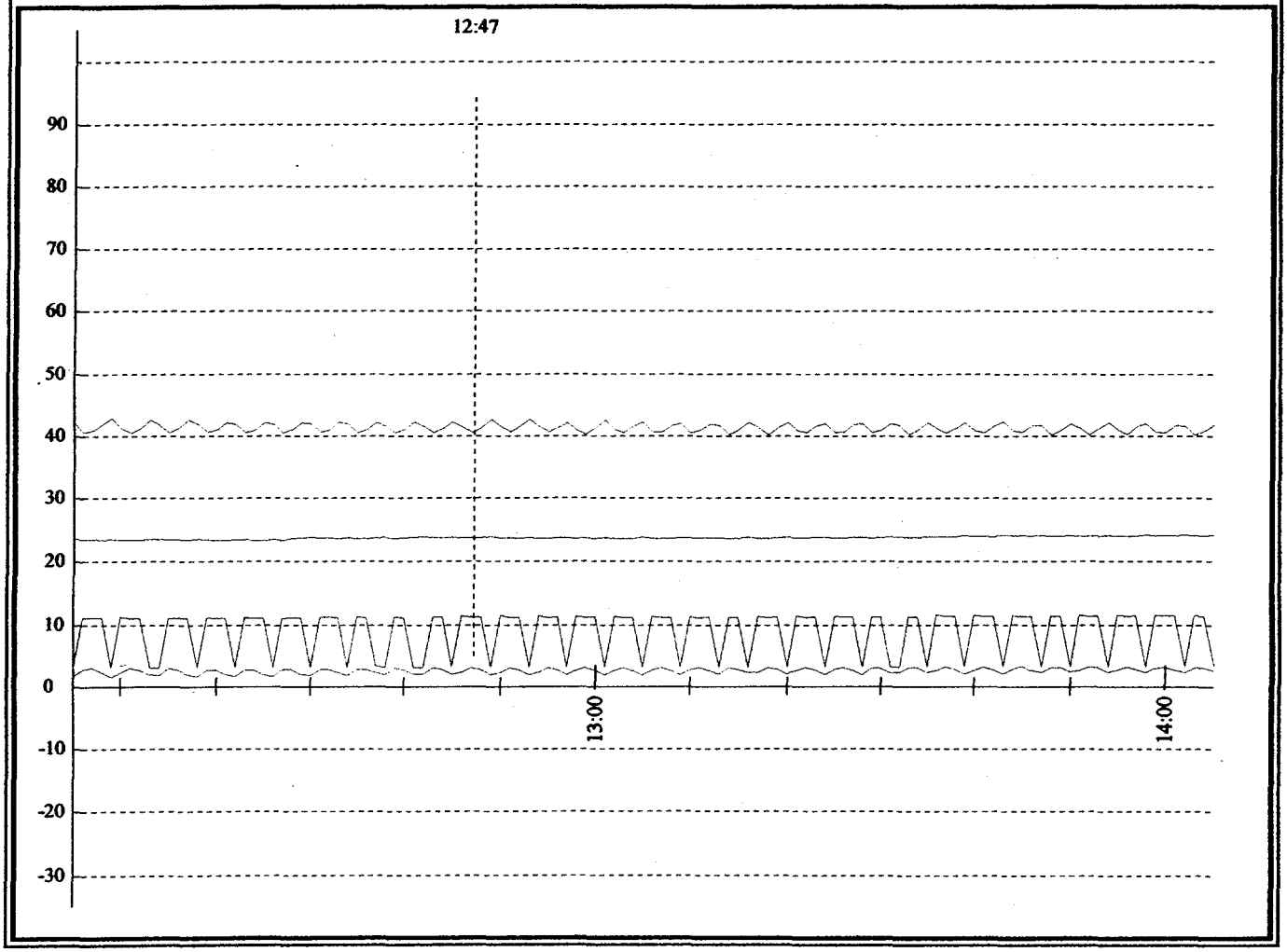
TestDate: **78/05/20 06:13** *Report No.:* ( ) - Page 5

PageTestName: Energy Consumtion *ReportDate:* 78/05/21 07:20

Page Result :

1 - Page Test Time	*2 Hours*
2 - Working Percent	*71 %On*
3 - Energy (Accord to page)	*2.455 kwh*
4 - Zoom Time	*12:47 Hour*
5 - Compr Current	*1.13 Amp*
6 - Evaprator Mean Temp	*3.1 C*
7 - Cabin Mean Temp	*3.4 C*
8 - Crisp Temp	*4 C*
9 - Compr Temp	*59.9 C*
10- Condensor In Temp	*40.5 C*
11- Condensor Out Temp	*52.6 C*
12- Condition	*-195.1 C 90 %H*
13- Volt	*Max=242 Mean=239 Min=233*
14-	
15-	
16-	
17-	





Industrial Control Research Center HotRoom Ver 5

Printing in Labaratory Of
SHERVIN ELECTRIC

SHERVIN ELECTRIC

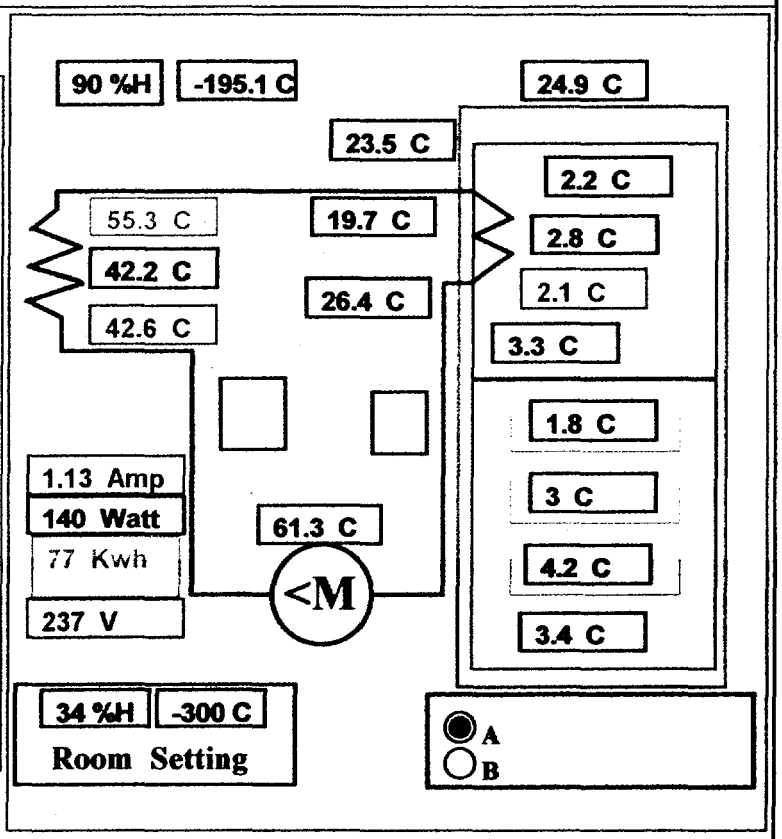
[redacted]

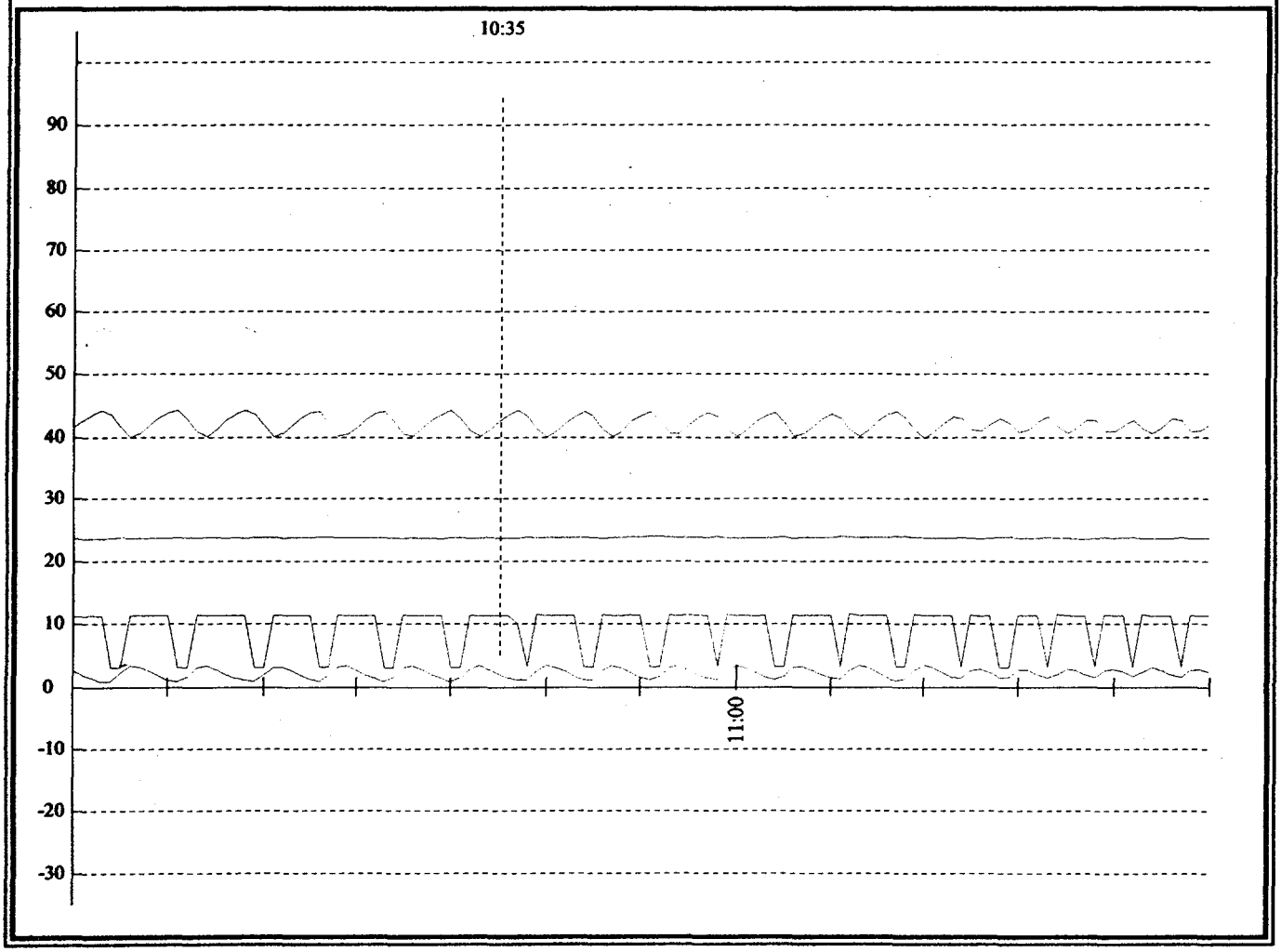
TestDate: **78/05/20 06:13** *Report No.:* ( ) - Page 4

PageTestName: Energy Consumtion *ReportDate:* 78/05/21 07:20

Page Result :

1 - Page Test Time	*2 Hours*
2 - Working Percent	*75 %On*
3 - Energy (Accord to page)	*2.526 kwh*
4 - Zoom Time	*10:35 Hour*
5 - Compr Current	*1.13 Amp*
6 - Evaprator Mean Temp	*2.6 C*
7 - Cabin Mean Temp	*3 C*
8 - Crisp Temp	*3.4 C*
9 - Compr Temp	*61.3 C*
10- Condensor In Temp	*42.6 C*
11- Condensor Out Temp	*55.3 C*
12- Condition	*-195.1 C 90 %H*
13- Volt	*Max=240 Mean=240 Min=236*
14-	
15-	
16-	
17-	





Industrial Control Research Center HotRoom Ver 5

Printing in Labaratory Of
SHERVIN ELECTRIC

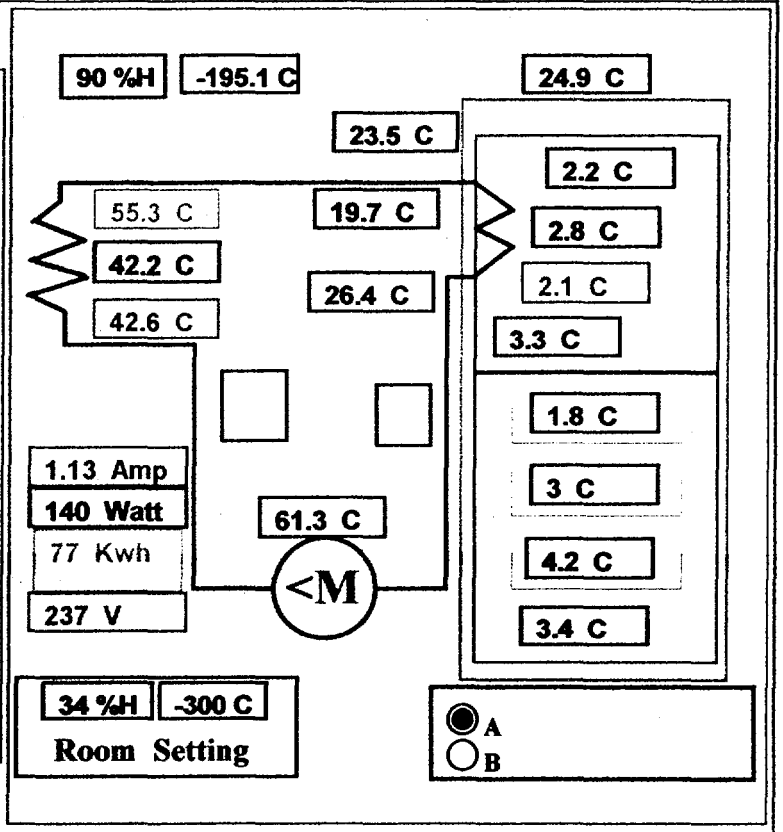
SHERVIN ELECTRIC

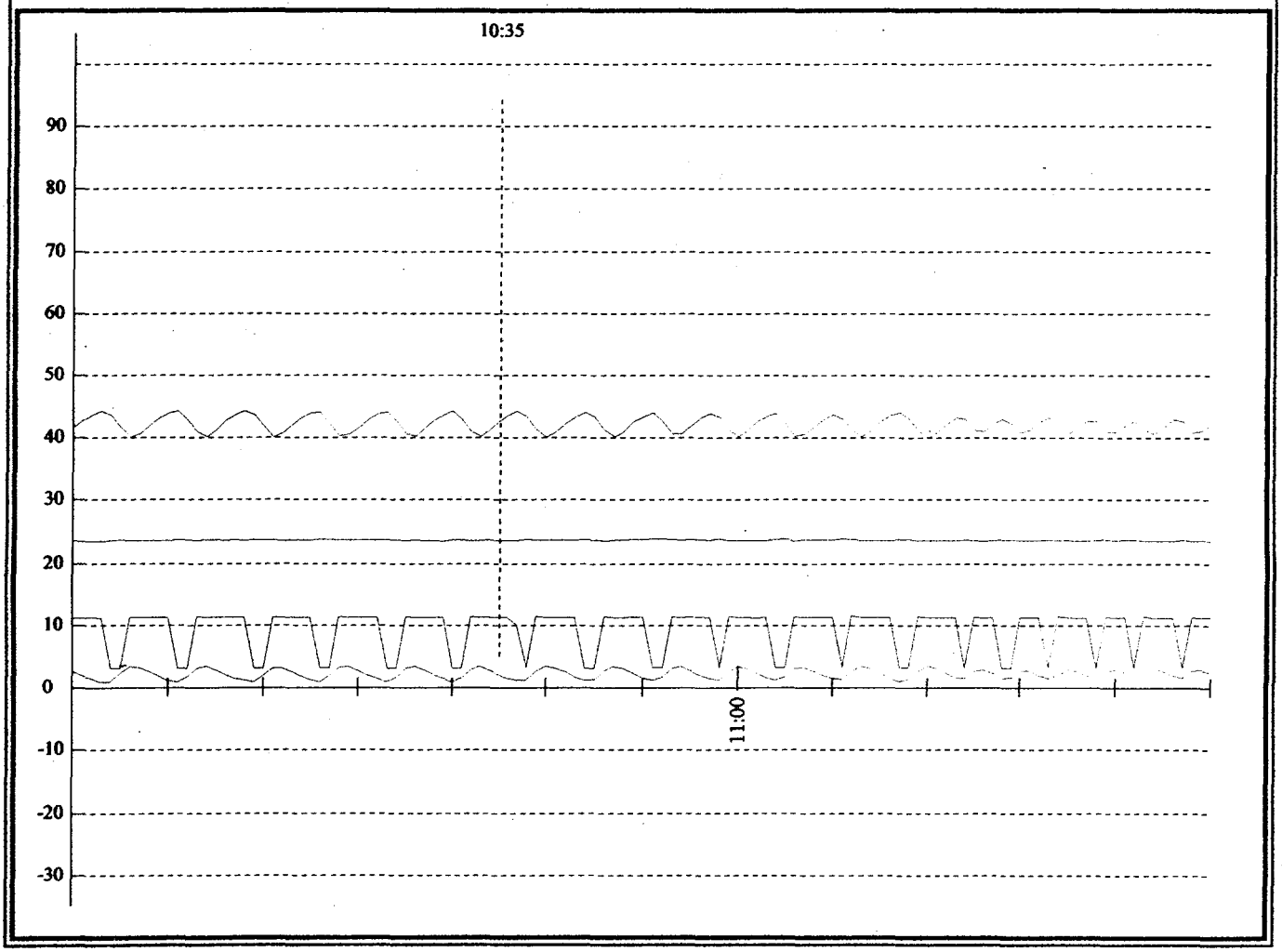
TestDate: **78/05/20 06:13** *Report No.:* ( ) - Page 4

PageTestName: Energy Consumtion *ReportDate:* 78/05/21 07:20

Page Result :

1 - Page Test Time	*2 Hours*
2 - Working Percent	*75 %On*
3 - Energy (Accord to page)	*2.526 kwh*
4 - Zoom Time	*10:35 Hour*
5 - Compr Current	*1.13 Amp*
6 - Evaprator Mean Temp	*2.6 C*
7 - Cabin Mean Temp	*3 C*
8 - Crisp Temp	*3.4 C*
9 - Compr Temp	*61.3 C*
10- Condensor In Temp	*42.6 C*
11- Condensor Out Temp	*55.3 C*
12- Condition	*-195.1 C 90 %H*
13- Volt	*Max=240 Mean=240 Min=236*
14-	
15-	
16-	
17-	





Industrial Control Research Center HotRoom Ver 5

Printing in Labaratory Of
SHERVIN ELECTRIC

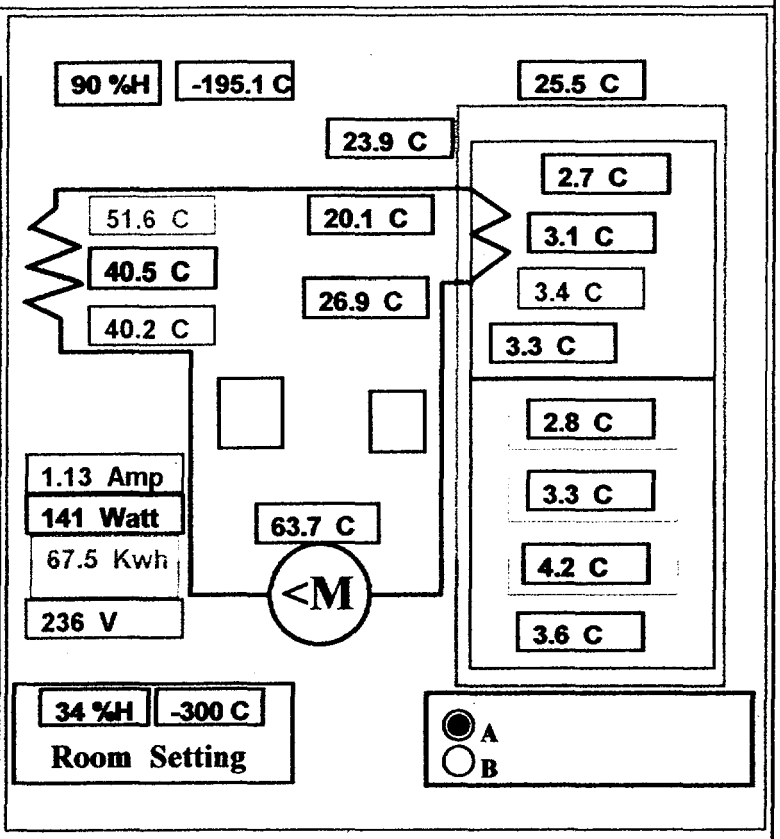
SHERVIN ELECTRIC

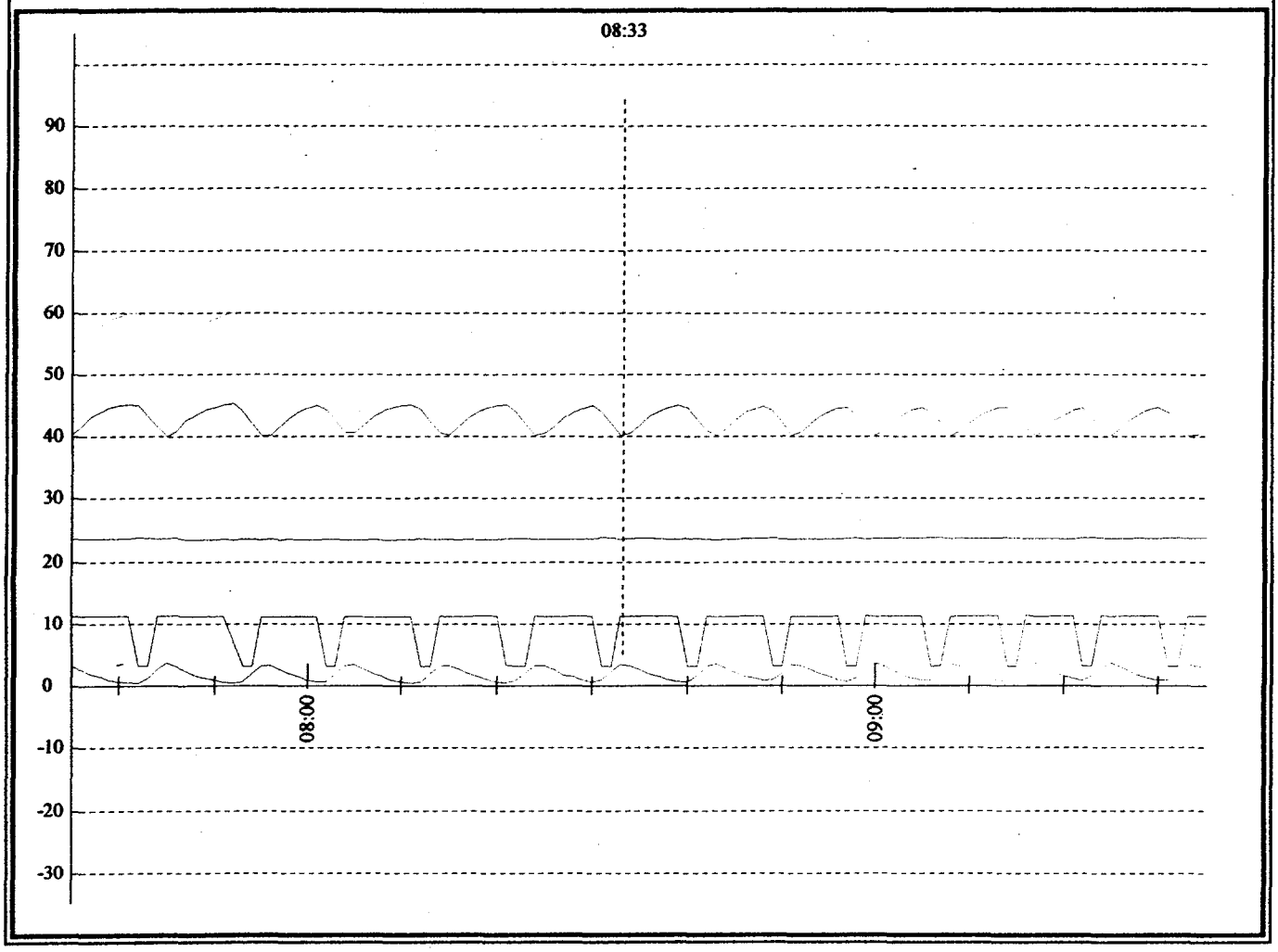
TestDate: **78/05/20 06:13** *Report No.:* ( ) - Page 3

PageTestName: Energy Consumtion *ReportDate:* 78/05/21 07:19

Page Result :

1 - Page Test Time	*2 Hours*
2 - Working Percent	*78 %On*
3 - Energy (Accord to page)	*2.578 kwh*
4 - Zoom Time	*8:33 Hour*
5 - Compr Current	*1.13 Amp*
6 - Evaprator Mean Temp	*3.1 C*
7 - Cabin Mean Temp	*3.4 C*
8 - Crisp Temp	*3.6 C*
9 - Compr Temp	*63.7 C*
10- Condensor In Temp	*40.2 C*
11- Condensor Out Temp	*51.6 C*
12- Condition	*-195.1 C 90 %H*
13- Volt	*Max=239 Mean=239 Min=235*
14-	
15-	
16-	
17-	





Industrial Control Research Center HotRoom Ver 5

Printing in Labaratory Of
SHERVIN ELECTRIC

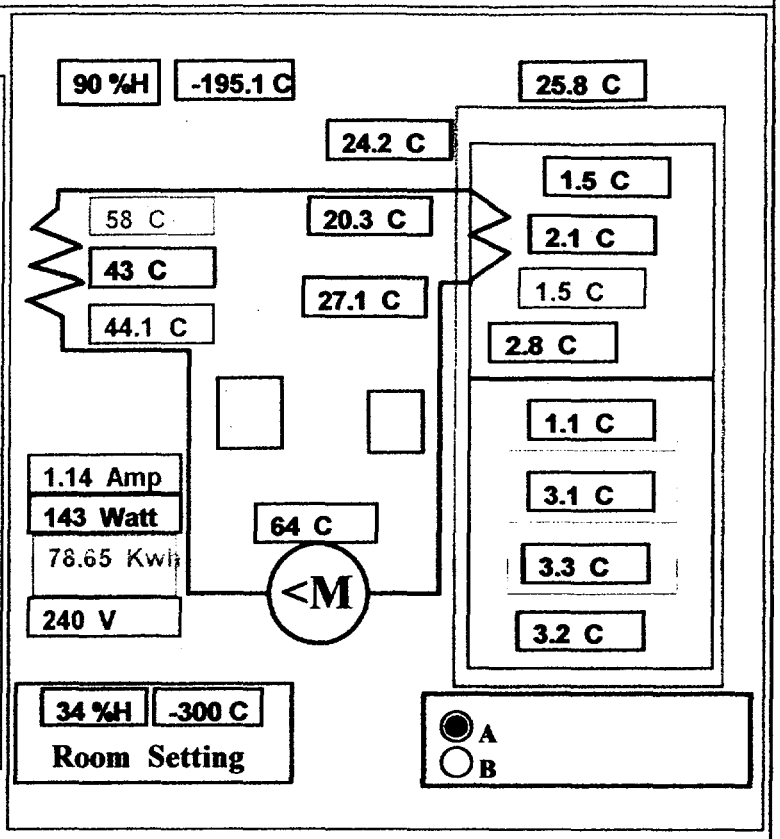
SHERVIN ELECTRIC

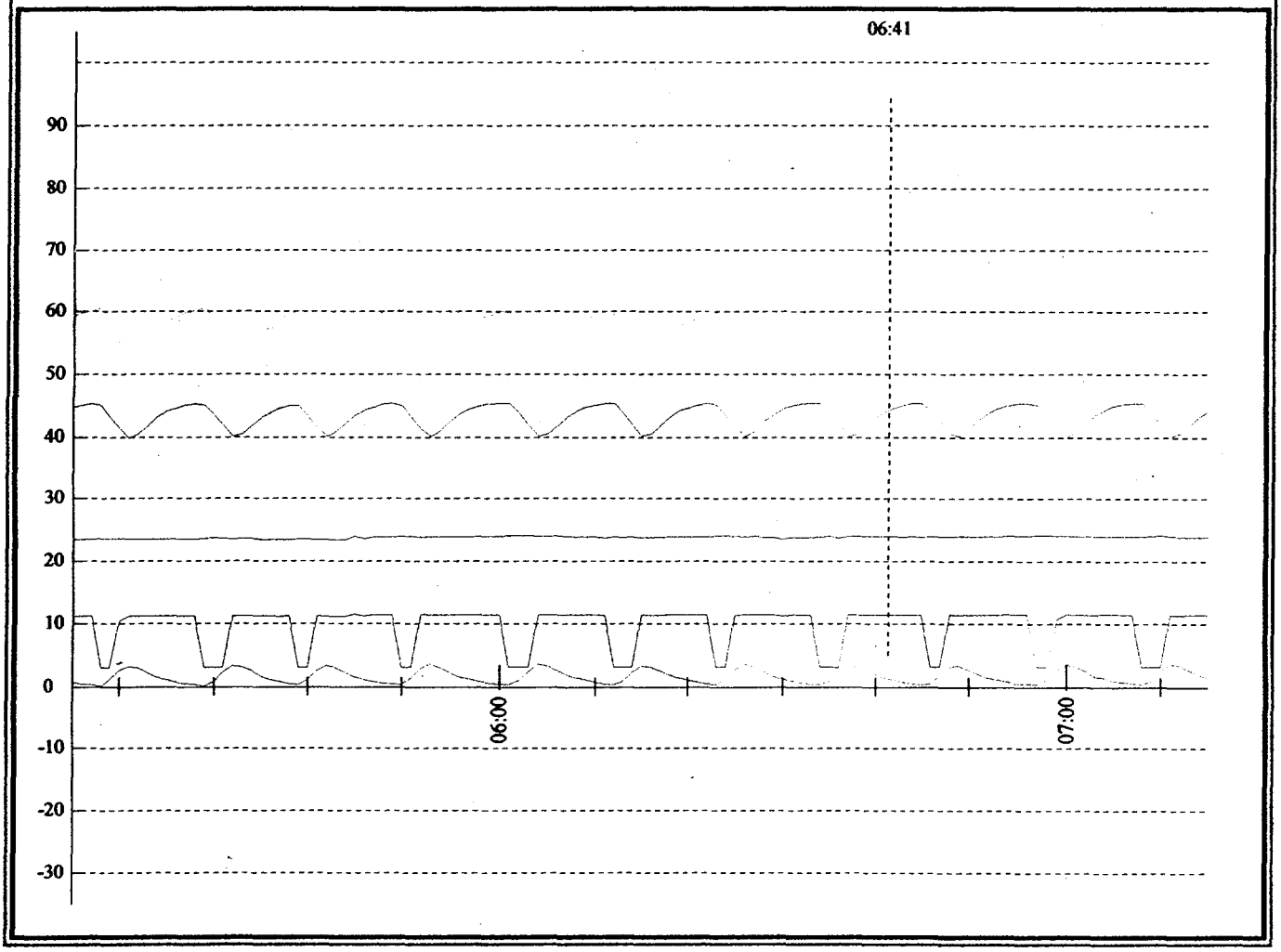
TestDate: **78/05/20 06:13** *Report No.:* ( ) - Page 2

PageTestName: Energy Consumtion *ReportDate:* 78/05/21 07:19

Page Result :

1 - Page Test Time	*2 Hours*
2 - Working Percent	*78 %On*
3 - Energy (Accord to page)	*2.652 kwh*
4 - Zoom Time	*6:41 Hour*
5 - Compr Current	*1.14 Amp*
6 - Evaprator Mean Temp	*1.9 C*
7 - Cabin Mean Temp	*2.5 C*
8 - Crisp Temp	*3.2 C*
9 - Compr Temp	*64 C*
10- Condensor In Temp	*44.1 C*
11- Condensor Out Temp	*58 C*
12- Condition	*-195.1 C 90 %H*
13- Volt	*Max=242 Mean=240 Min=234*
14-	
15-	
16-	
17-	





Industrial Control Research Center HotRoom Ver 5

Printing in Labaratory Of
SHERVIN ELECTRIC

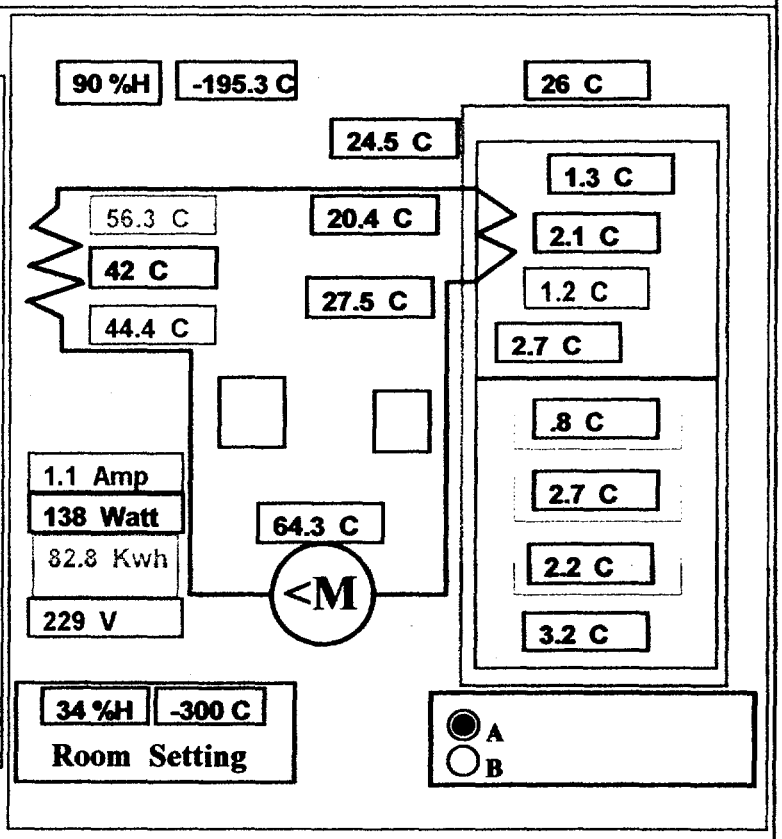
SHERVIN ELECTRIC

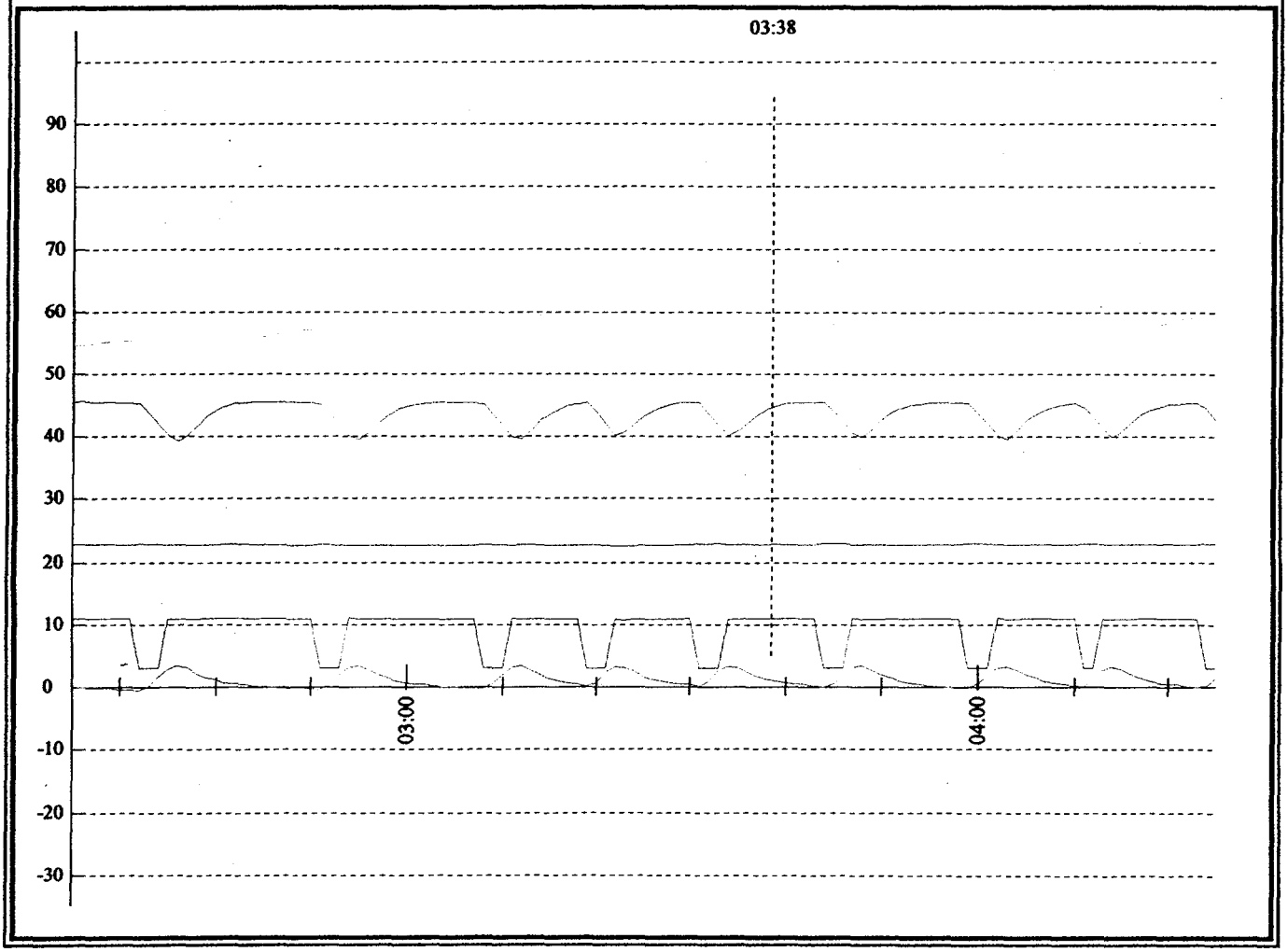
TestDate: **78/05/20 06:13** *Report No.:* ( ) - Page 1

PageTestName: Energy Consumtion *ReportDate:* 78/05/21 07:19

Page Result :

1 - Page Test Time	*2 Hours*
2 - Working Percent	*79 %On*
3 - Energy (Accord to page)	*2.594 kwh*
4 - Zoom Time	*3:38 Hour*
5 - Compr Current	*1.1 Amp*
6 - Evaprator Mean Temp	*1.8 C*
7 - Cabin Mean Temp	*1.9 C*
8 - Crisp Temp	*3.2 C*
9 - Compr Temp	*64.3 C*
10- Condensor In Temp	*44.4 C*
11- Condensor Out Temp	*56.3 C*
12- Condition	*-195.3 C 90 %H*
13- Volt	*Max=231 Mean=231 Min=227*
14-	
15-	
16-	
17-	





Industrial Control Research Center HotRoom Ver 5

Printing in Labaratory Of
Yazd Sardin HR

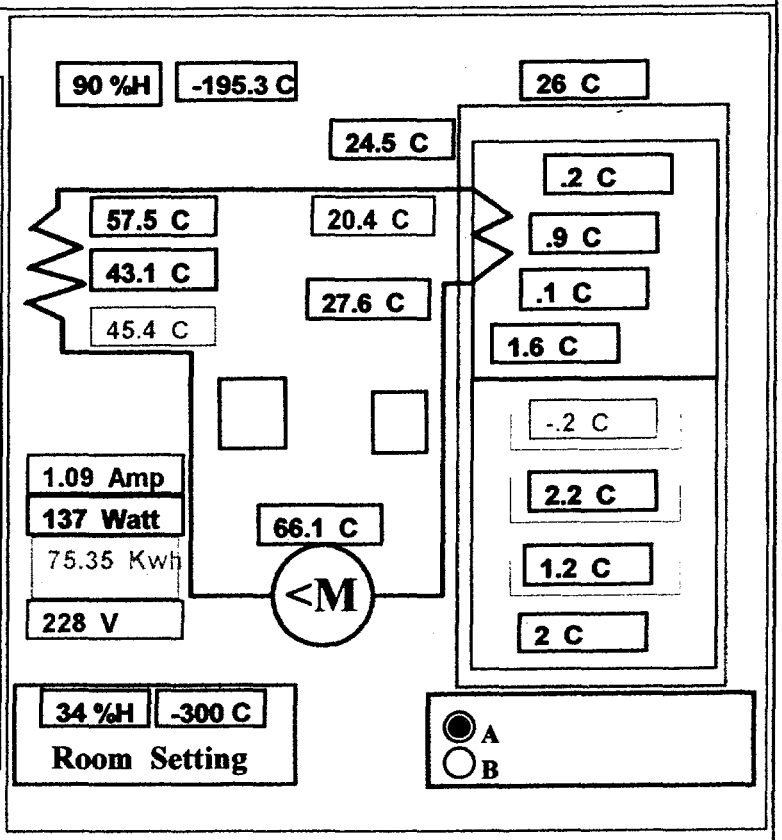
Yazd Sardin HR

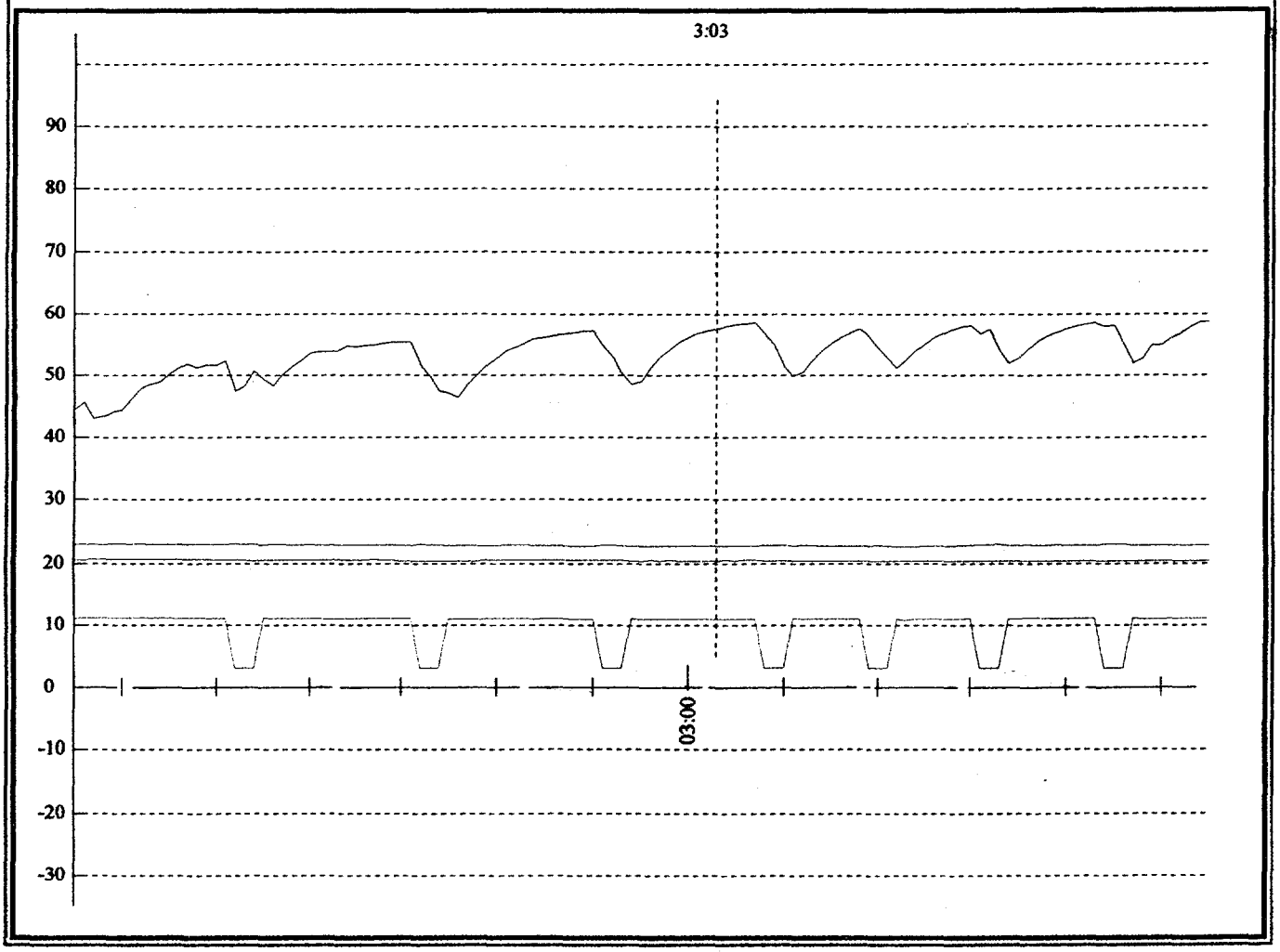
TestDate: **78/05/20 06:13** *Report No.:* ( ) - Page 1

PageTestName: Energy Consumtion *ReportDate:* 12.08.99 09:06

Page Result :

1 - Page Test Time	*2 Hours*
2 - Working Percent	*83 %On*
3 - Energy (Accord to page)	*2.677 kwh*
4 - Zoom Time	*3:03 Hour*
5 - Compr Current	*1.09 Amp*
6 - Evaprator Mean Temp	*.7 C*
7 - Cabin Mean Temp	*1 C*
8 - Crisp Temp	*2 C*
9 - Compr Temp	*66.1 C*
10- Condensor In Temp	*45.4 C*
11- Condensor Out Temp	*57.5 C*
12- Condition	*-195.3 C 90 %H*
13- Volt	*Max=232 Mean=231 Min=227*
14-	
15-	
16-	
17-	





Industrial Control Research Center HotRoom Ver 5

Printing In Labaratory Of
Yazd Sardin HR

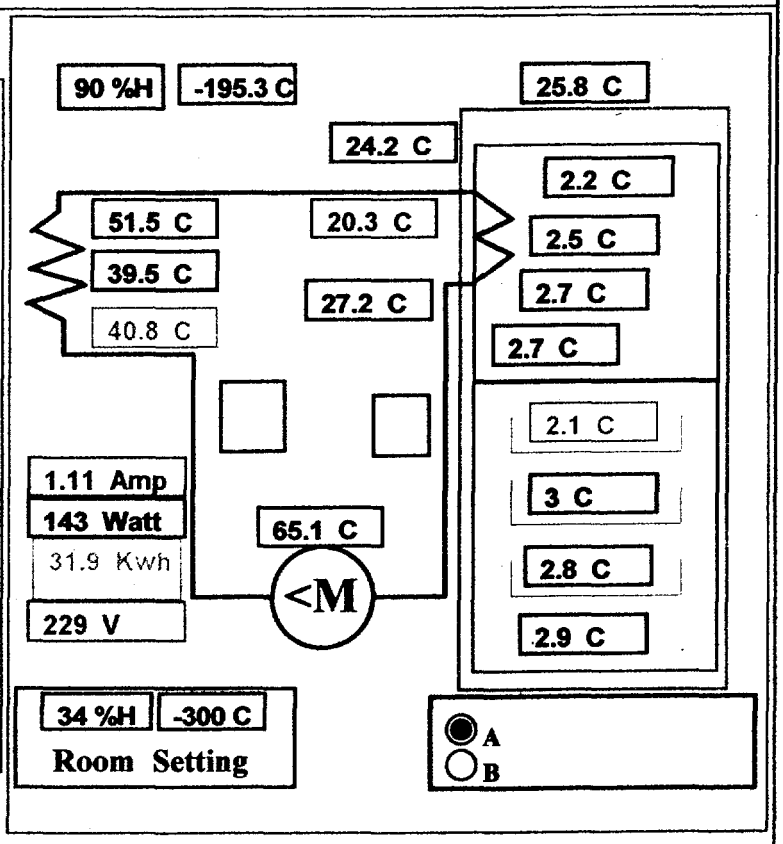
Yazd Sardin HR

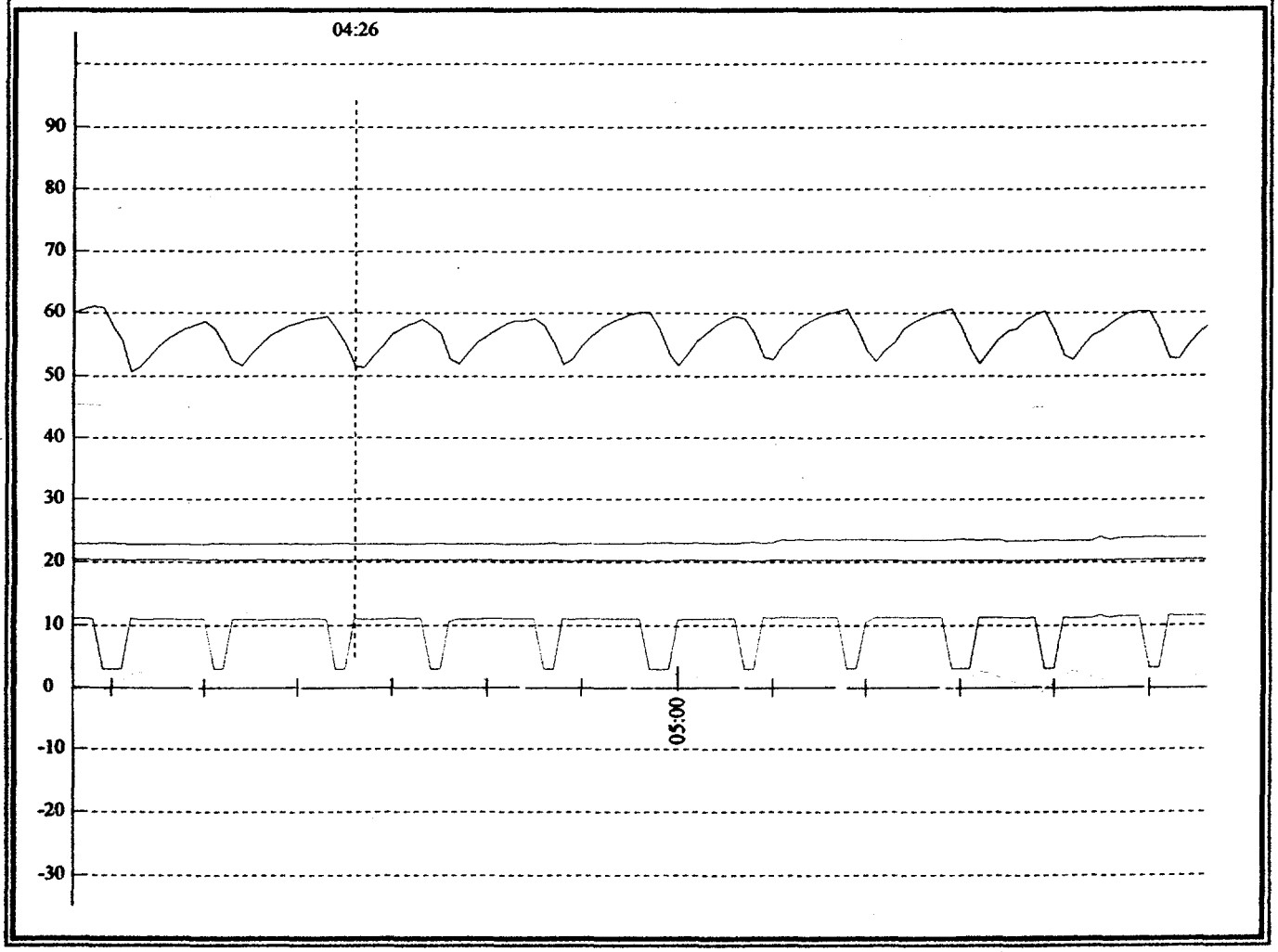
TestDate: **78/05/20 06:13** *Report No.:* ( ) - Page 2

PageTestName: Energy Consumtion *ReportDate:* 12.08.99 09:06

Page Result :

1 - Page Test Time	*2 Hours*
2 - Working Percent	*79 %On*
3 - Energy (Accord to page)	*2.571 kwh*
4 - Zoom Time	*4:26 Hour*
5 - Compr Current	*1.11 Amp*
6 - Evaprator Mean Temp	*2.5 C*
7 - Cabin Mean Temp	*2.6 C*
8 - Crisp Temp	*2.9 C*
9 - Compr Temp	*65.1 C*
10- Condensor In Temp	*40.8 C*
11- Condensor Out Temp	*51.5 C*
12- Condition	*-195.3 C 90 %H*
13- Volt	*Max=240 Mean=234 Min=229*
14-	
15-	
16-	
17-	





Industrial Control Research Center HotRoom Ver 5

Printing In Labaratory Of
Yazd Sardin HR

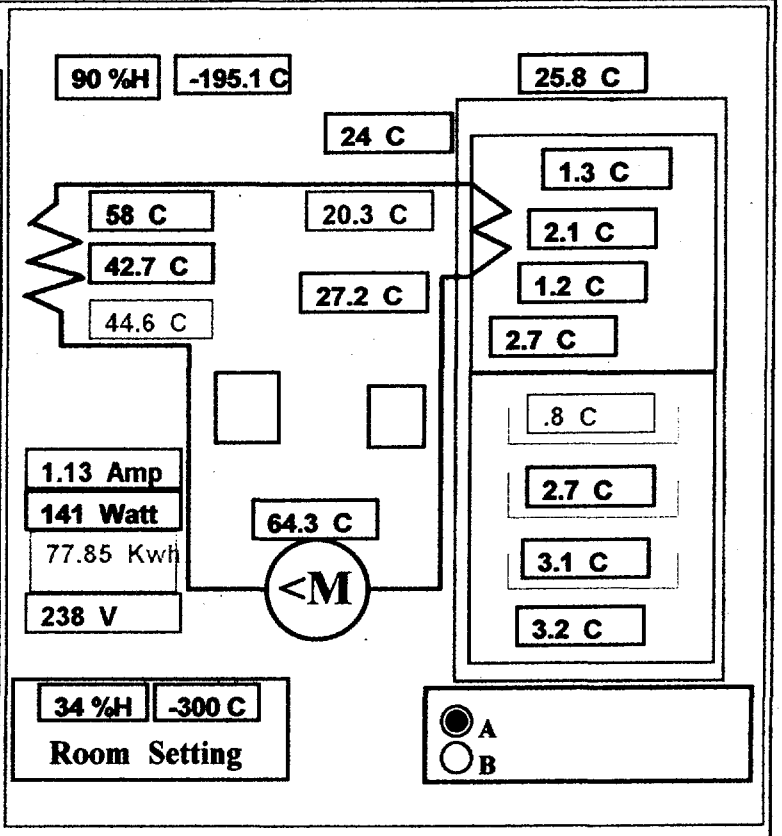
Yazd Sardin HR

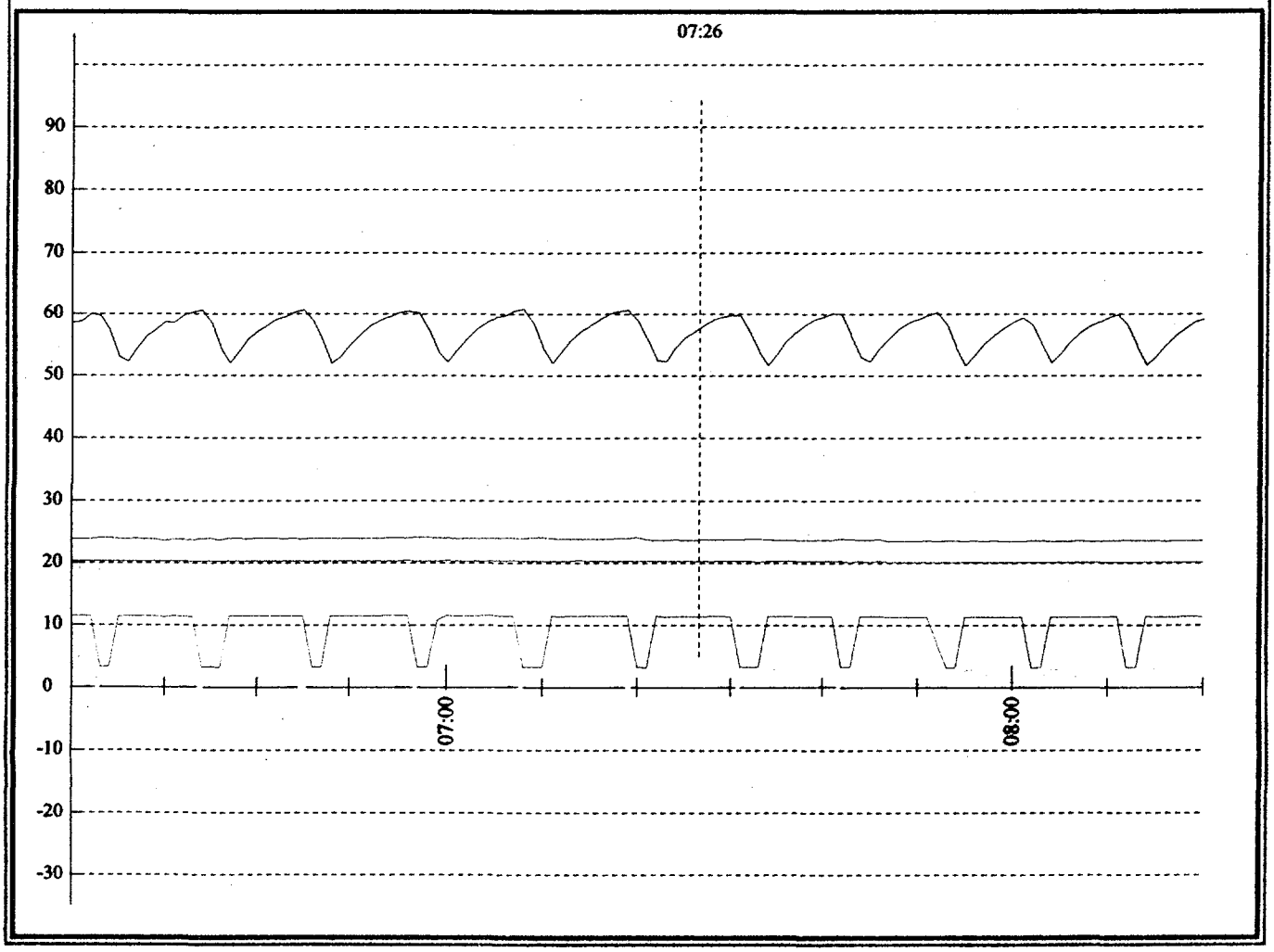
TestDate: **78/05/20 06:13** *Report No.:* ( ) - Page 3

PageTestName: Energy Consumtion *ReportDate:* 12.08.99 09:06

Page Result :

1 - Page Test Time .	*2 Hours*
2 - Working Percent	*79 %On*
3 - Energy (Accord to page)	*2.643 kwh*
4 - Zoom Time	*7:27 Hour*
5 - Compr Current	*1.13 Amp*
6 - Evaprator Mean Temp	*1.8 C*
7 - Cabin Mean Temp	*2.2 C*
8 - Crisp Temp	*3.2 C*
9 - Compr Temp	*64.3 C*
10- Condensor In Temp	*44.6 C*
11- Condensor Out Temp	*58 C*
12- Condition	*-195.1 C 90 %H*
13- Volt	*Max=242 Mean=240 Min=235*
14-	
15-	
16-	
17-	





Industrial Control Research Center HotRoom Ver 5

Printing In Labaratory Of
Yazd Sardin HR

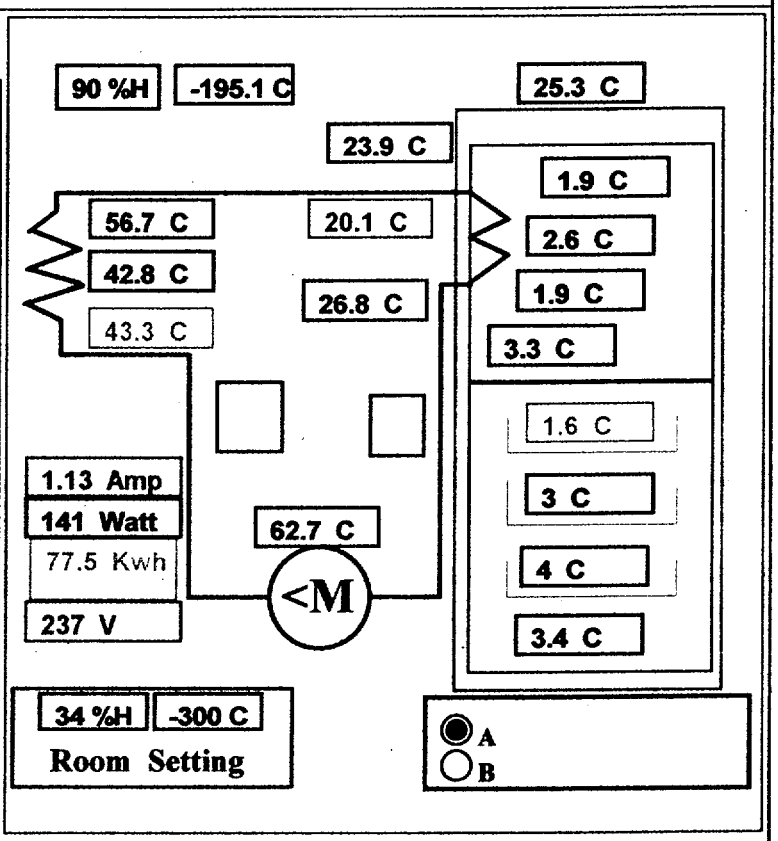
Yazd Sardin HR

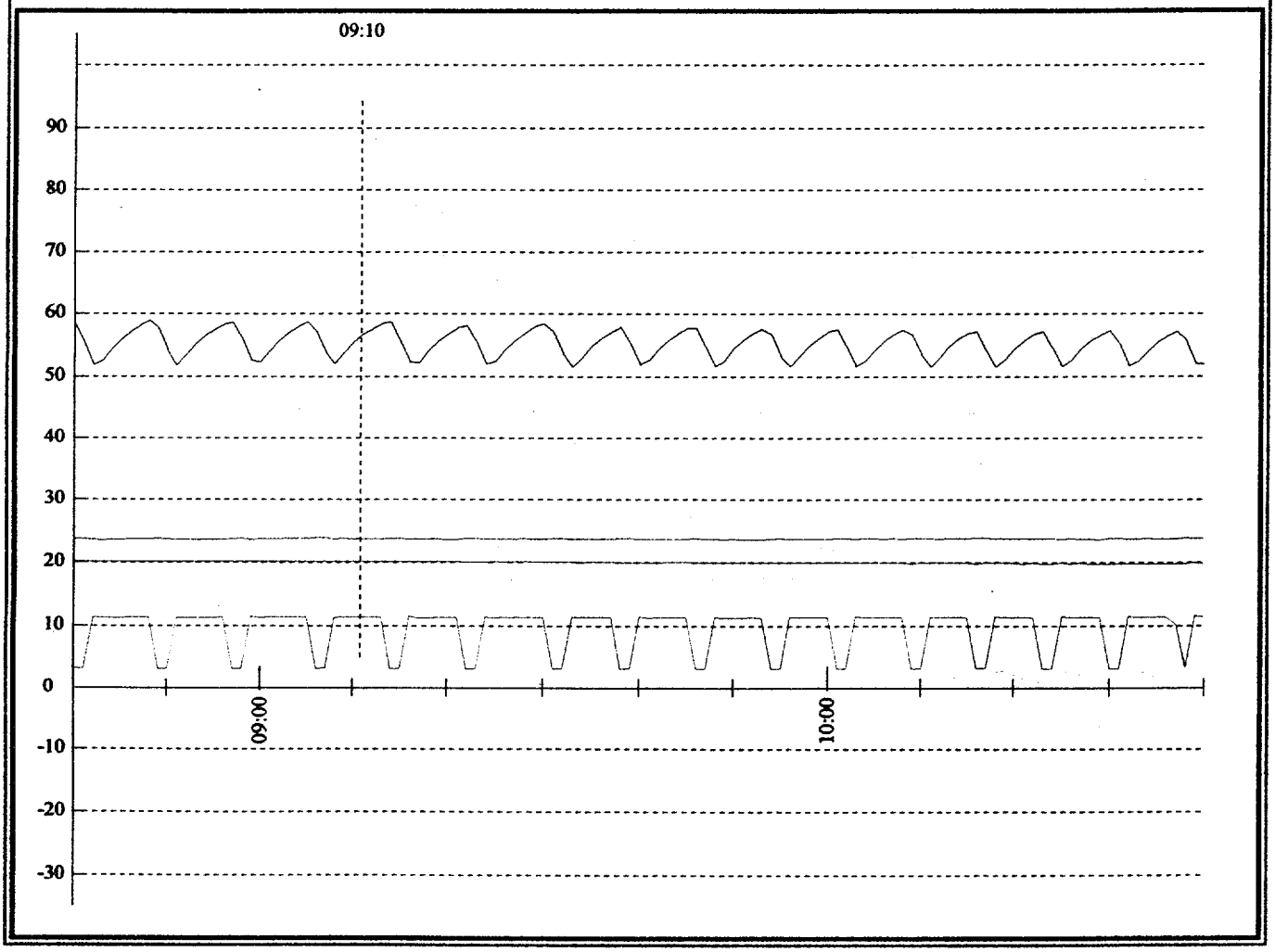
TestDate: **78/05/20 06:13** *Report No.:* ( ) - Page 4

PageTestName: Energy Consumtion *ReportDate:* 12.08.99 09:06

Page Result :

1 - Page Test Time	*2 Hours*
2 - Working Percent	*75 %On*
3 - Energy (Accord to page)	*2.524 kwh*
4 - Zoom Time	*9:11 Hour*
5 - Compr Current	*1.13 Amp*
6 - Evaprator Mean Temp	*2.4 C*
7 - Cabin Mean Temp	*2.8 C*
8 - Crisp Temp	*3.4 C*
9 - Compr Temp	*62.7 C*
10- Condensor In Temp	*43.3 C*
11- Condensor Out Temp	*56.7 C*
12- Condition	*-195.1 C 90 %H*
13- Volt	*Max=239 Mean=239 Min=235*
14-	
15-	
16-	
17-	





Industrial Control Research Center HotRoom Ver 5

Printing in Labaratory Of
Yazd Sardin HR

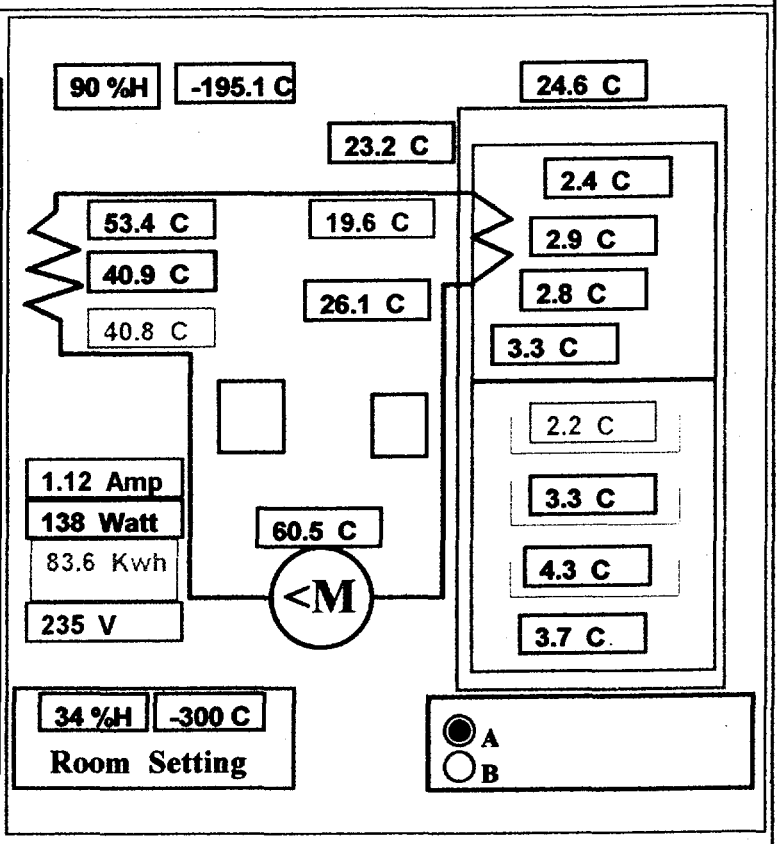
Yazd Sardin HR

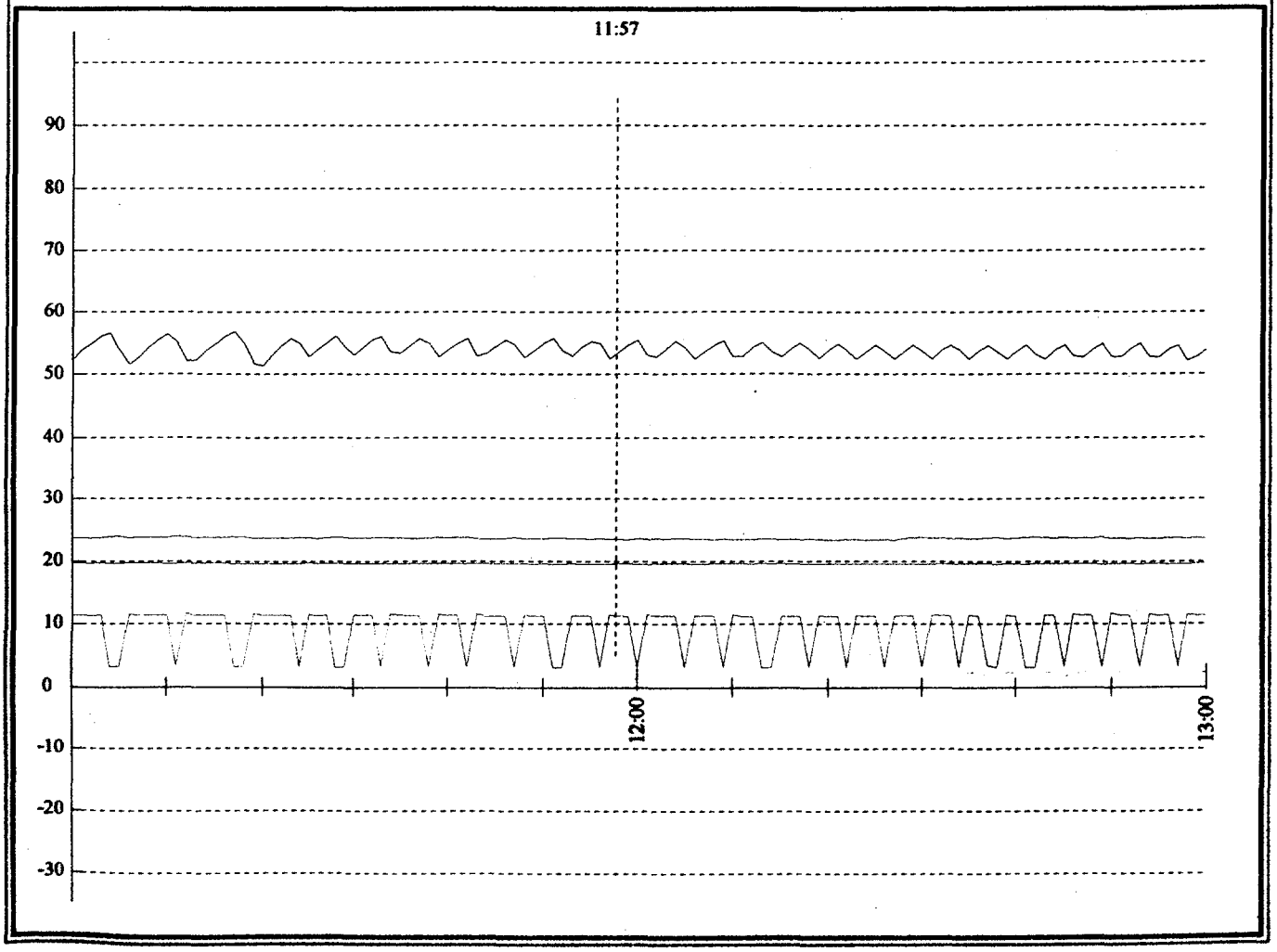
TestDate: **78/05/20 06:13** *Report No.:* ( ) - Page 5

PageTestName: Energy Consumtion *ReportDate:* 12.08.99 09:06

Page Result :

1 - Page Test Time	*2 Hours*
2 - Working Percent	*73 %On*
3 - Energy (Accord to page)	*2.488 kwh*
4 - Zoom Time	*11:58 Hour*
5 - Compr Current	*1.12 Amp*
6 - Evaprator Mean Temp	*2.8 C*
7 - Cabin Mean Temp	*3.2 C*
8 - Crisp Temp	*3.7 C*
9 - Compr Temp	*60.5 C*
10- Condensor In Temp	*40.8 C*
11- Condensor Out Temp	*53.4 C*
12- Condition	*-195.1 C 90 %H*
13- Volt	*Max=240 Mean=238 Min=233*
14-	
15-	
16-	
17-	





Industrial Control Research Center HotRoom Ver 5

Printing In Labaratory Of
Yazd Sardin HR

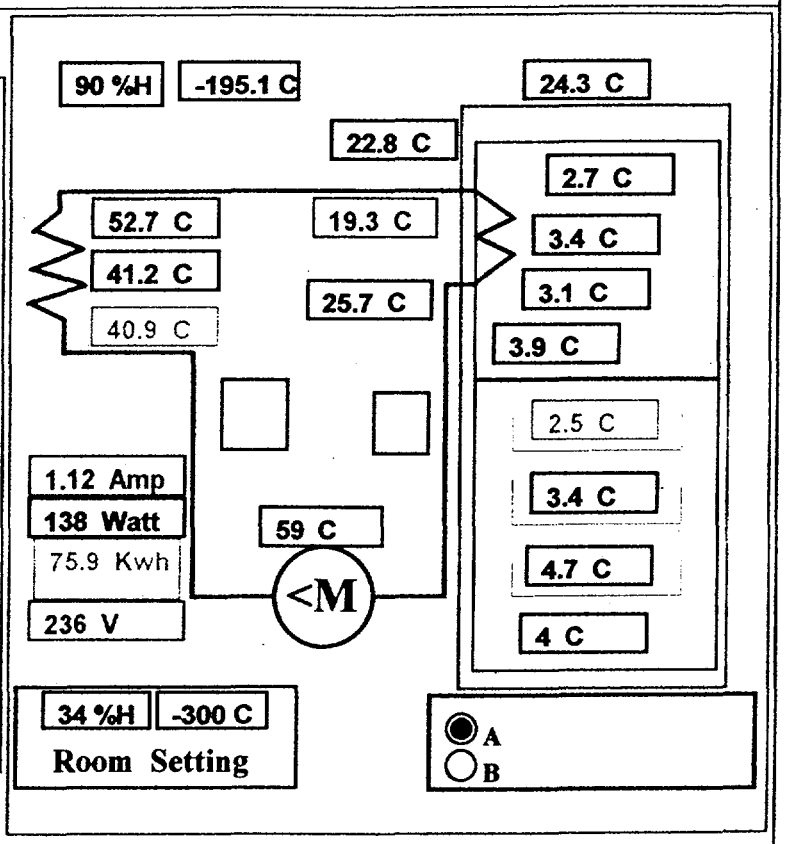
Yazd Sardin HR

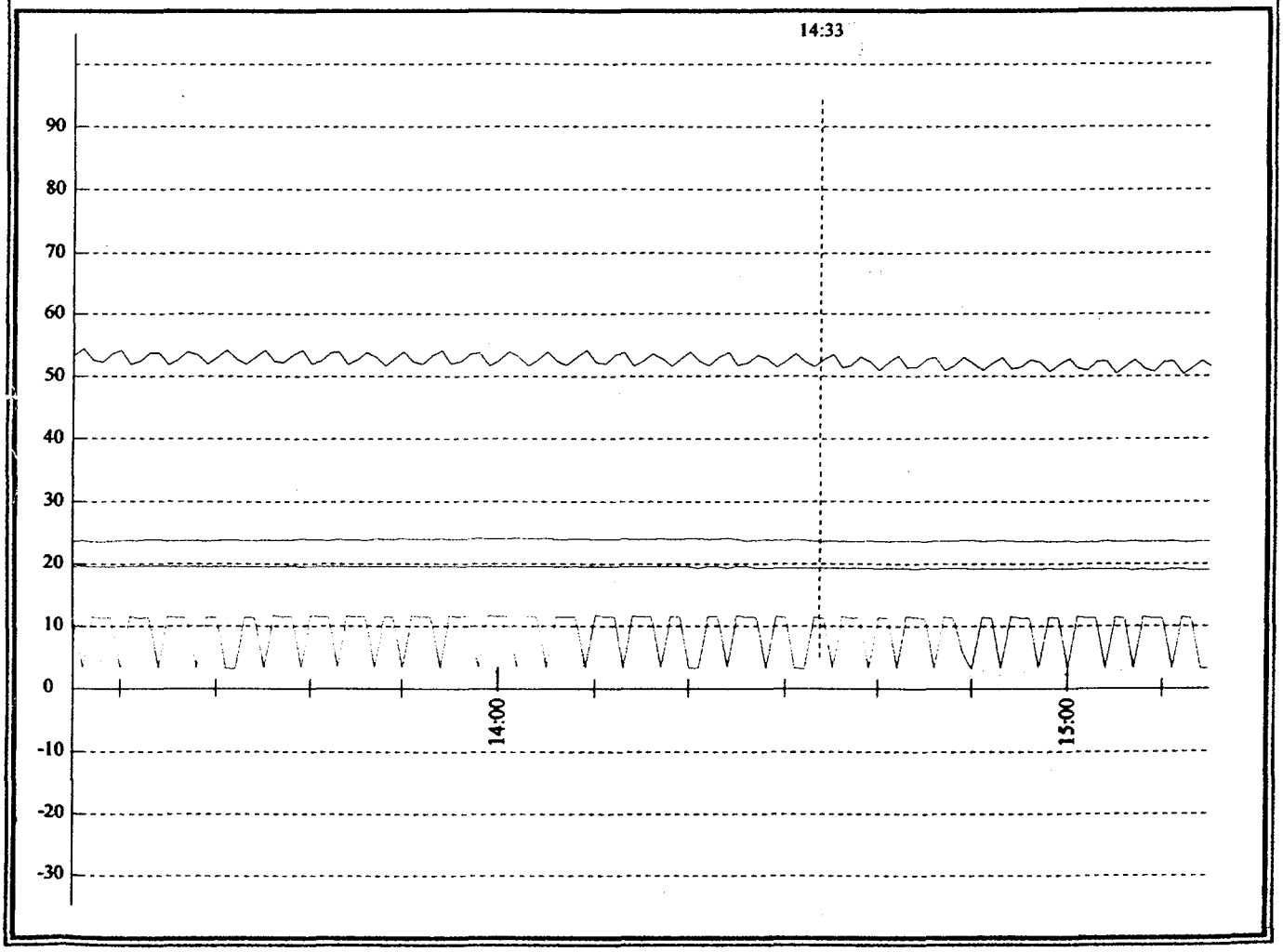
TestDate: **78/05/20 06:13** *Report No.:* ( ) - Page 6

PageTestName: Energy Consumtion *ReportDate:* 12.08.99 09:06

Page Result :

1 - Page Test Time	*2 Hours*
2 - Working Percent	*69 %On*
3 - Energy (Accord to page)	*2.404 kwh*
4 - Zoom Time	*14:34 Hour*
5 - Compr Current	*1.12 Amp*
6 - Evaprator Mean Temp	*3.2 C*
7 - Cabin Mean Temp	*3.5 C*
8 - Crisp Temp	*4 C*
9 - Compr Temp	*59 C*
10- Condensor In Temp	*40.9 C*
11- Condensor Out Temp	*52.7 C*
12- Condition	*-195.1 C 90 %H*
13- Volt	*Max=242 Mean=240 Min=235*
14-	
15-	
16-	
17-	





Industrial Control Research Center HotRoom Ver 5