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

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Maurice Al-Deek
Company

UNIDO, Project Number
MP/JOR/99/123
Contract Number 99/213

Final Report

Dec. 1999

Maurice Ind. ICEBERG مـوريس الصناعية

To: ***Mr. V. Koloskov***
Contracts Officer
General Services Section
Financial Performance Control Branch
Field Operation and Administration Division
UINDO, Vienna, Austria
Fax: 00 431 26026 6815

Date: 15 Jan 2000

Subject: ***Final Report***

Reference: ***Contract Number 99/213, Project Number MP/JOR/99/123***

Dear Sir,

Please find attached herewith our final report. One original and nine copies. I also enclose our invoice number 24131dated 15 Jan 2000.

Your prompt action in reviewing the report & proceed the payment of our invoice is highly appreciated.

With regards

Maryo Al-Deek
Managing Director

مؤسسة موريس الديك
للثلاجات والمصنوعات المعدنية

هاتف معرض : ٦٥٣٢٦٢ - المصنع : ٧٣١٣٧٢ - فاكس : ٩٦٢-٦-٦١٣٣٤٠ - ص.ب : ٩٢١٩٤٠ عمان - الاردن
Tel Showroom : 653262 - Factory : 731372 - Fax : 962 -6- 613340 - P.O.Box : 921940 Amman - Jordan

Maurice Ind. ICEBERG مورييس الصناعية

To: ***Mr. V. Koloskov***
Contracts Officer
General Services Section
Financial Performance Control Branch
Field Operation and Administration Division
UINDO, Vienna, Austria
Fax: 00 431 26026 6815

Date: 15 Jan 2000

Subject: ***Invoice no. 24131, Fourth Payment***

Reference: ***Contract Number 99/213, Project Number MP/JOR/99/123***

The amount of (8,400 $) say eight thousand four hundred USD, as the fourth payment of contract 99/213 (referring to page 8 paragraph 3.05d) upon UNIDO'D receipt and acceptance of the contractor's final report, payable to:

Maurice Al-Deek Co.
Account Number 41396/8/515
Arab Bank PLC.
Abu-Alanda Branch
P.O. Box 351 Abu Alanda
Amman - Jordan

Tel: 00 962 6 4161451
Fax 00 962 6 4162161

Maryo Al-Deek
Managing Director

مؤسسة موريس الديك
للثلاجات والمصنوعات المعدنية

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Introduction

We are delighted to submit to you herewith our Final Report, concerning calculation and redesign of the prototypes made by the counterparts and they have been tested successfully at our hot chamber, at our site in Amman. These prototypes have been manufactured under our engineering supervision and were tested in accordance with appropriate ISO standard test procedure and relevant performance test characteristics for functionality and performance of the new Ozone friendly R134a refrigerant. We hope that this final report would fulfill UNIDO's requirement in order to comply with our contract. In this report provide you with test results of the prototypes which had been tested at our hot chamber. Total of 12 prototypes made by Jamal Yussef Workshop, Emad Hedjawi Workshop, Al-Bisani Workshop, Al-Amal Workshop. Refrigerators, Aqaba Al-Eslah Workshop, Lebanon Workshop, companies, and were redesigned and tested by our engineering staffs to adopt with R134a refrigeration system circuit.

Activities

1- Visiting the counter parts premises at different occasions
2- Collecting Technical Data for redesign of the prototypes
3- Preparing Technical forms for prototype technical specifications
4- Reviewing the technical characteristics of the counterpart prototypes
5- Testing six prototypes at our hot chamber
6- Evaluating Performance Test Results
7- Performing necessary changes to the refrigeration system circuits
8- Advising the counterpart for proper use of R141b blowing agent in conjuction with R134a refrigerant.
9- Redesign of Refrigerant circuits
10- Selecting suitable compressors for new system.
11- Conducting training course at our premise 20 hrs, theoretical and practical subjects were thought to the participants. The main topics that were discussed in this course could be summarized as follow;

- An Introduction to Ozone Layer.
- An orientation to UNIDO CFC phase out project
- An Introduction to the Montreal Protocol Activities and implementing agencies
- Ozone Depleting Substances, such as CFCs, Brumides, Helons, Solvents etc.
- Alternatives to the ODS
- An introduction to R134a as a suitable and acceptable substitute for CFC-12 as ozone friendly refrigerants.
- Safey Precaution for use and maintenance of new refrigerant R134a
- Selection of suitable components for new refrigeration circuit system, such as Compressor, drier, and etc.
- Recovery, Recycling and Reclaiming of the ODS refrigerants such as CFC-12
- Methods of refrigeration load calculations, for the purpose of redesign and modification of the prototypes
- The purpose of of redesign, of the prototypes for converting the old refrigeration system into
- An introduction to the commercial appliance refrigeration system ciruit.
- Methods of testing prototypes, such as, Operational test for functionality and performance at different climetic condition.
- An introduction to the ISO standards for testing prototypes
- Short briefing about use of R141b blowing agent,
- Familiarization with the new vacuum and charging equipment, vacuum pump and charging board.
- Test results Evaluation.
- Refrigeration system adjustment.
- The material as sample for making prototypes were supplied mainly

In this report we also 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 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
Continuos run Test at = 32 C ambient temperature
Cyclic run test at + 32 C ambient temperature.
The test condition was selected in accordance with appropriate ISO test standards.
All prototypes will be tested at existing hot chamber in our facilities in Awajan Amman
the test results sheet will be provided after necessary performance test evaluation and perform necessary modification.

12- Visiting the counter parts premises at different occasions
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14- Preparing Technical forms for prototype technical specifications
15- Reviewing the technical characteristics of the counterpart prototypes
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Synopsis

This report has been prepared based on the Contract between UNIDO and Maurice al-Deek company.
This project will phase out the use of CFC-11 and CFC-12 in the production of commercial refrigeration equipment at the Jamal Yussef Workshop, Emad Hedjawi Workshop, Al-Bisani Workshop, Al-Amal Workshop. Refrigerators, Aqaba Al-Eslah Workshop, Lebanon Workshop, companies in Jordan. CFC-11, which is used as a foam blowing agent in the production of polyurethane foam will be replaced by **HCFC-141b** and CFC-12 which is used as the refrigerant in the cooling circuit of appliances will be replaced by **HFC-134a**. The project includes the modification of all cooling equipment produced and the conversion of the production facilities. The model redesign element of the project includes testing, trial manufacture and reliability tests. The cost of converting foaming machines to use HCFC-141b will be covered by the counterpart organizations.

BACKGROUND

Sector Background

Jordan ratified the Montreal Protocol and the London Amendment in May 1989 and operates under Article 5 of the Protocol. The Government with the assistance of the Multilateral Fund has set up an Ozone Unit and has started the implementation of the agreed phase out programme. Phase out activities at the Al- Amal Workshop Jamal Yussef Workshop, Emad Hedjawi Workshop, Al-Bisani Workshop, , Aqaba Al-Eslah Workshop, Lebanon Workshop, companies in Jordan are co-ordinated and monitored by the Ministry of Municipal, Rural Affairs and Environment, through which UNIDO has been requested to assist selected enterprises in the refrigeration sector with their phase out activities.

The population of Jordan is approximately 4.5 million. Al- Amal Workshop Jamal Yussef Workshop, Emad Hedjawi Workshop, Al-Bisani Workshop, , Aqaba Al-Eslah Workshop, Lebanon Workshop, companies have about a 10% share of ODP Consumption. The Companies import commercial refrigeration equipment and have small service network. The sector consumption is about 150 ODP tonnes. Up to date figures are not available; Al- Amal Workshop Jamal Yussef Workshop, Emad Hedjawi Workshop, Al-Bisani Workshop, , Aqaba Al-Eslah Workshop, Lebanon Workshop, companies report their consumption as (26.89+2.00) tonnes which includes service repair and maintenance services of equipment manufactured by. Companies and sold throughout Jordan. The 1992 Country Programme gives the commercial sector usage as 150 actual tonnes of ODS. No further breakdown is given. The commercial refrigeration industry has enjoyed a modest boom as the result of the settlement of about 400,000 Palestinians displaced by the Gulf War, but current consumption are unlikely to be very different. If current sector consumption is in fact 150 tonnes, this would leave 55 tonnes a year consumed by medium and small service companies across the country. This is a credible figure.

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General Background

A some Small and Medium Commercial Refrigerator Manufacture were identified by ozone unit and recognised up to now, and Al- Amal Workshop Jamal Yussef Workshop, Emad Hedjawi Workshop, Al-Bisani Workshop, , Aqaba Al-Eslah Workshop, Lebanon Workshop, companies are selected to be considered as the second phase of this Umbrella Projects to implement CFC phase out projects at Small and Medium Commercial Refrigerator Manufacturers Sector.

The baseline date for each of the above companies is given in Appendix 1, which contains tables showing:

baseline production data
baseline ODS consumption data
baseline production equipment data

The baseline ODS consumption is also summarised in Table 2. It can be seen that the total ODS phase out of the project is 25.17 ODP tonnes.

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.

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Jamal Yussef Workshop Co.

Jamal Yussef Workshop was established in 1972. The company is 100% private. The company's CFC-1 l and CFC-12 consumption in 1997 was 5.264 metric tons, which is 3.5 % of the average CFC - 11 and CFC- 12 of commercial refrigerator sector (average sector consumption is 150 tons of ODS), for the period of 1995-1997. The company manufactures water cooler, commercial refrigerator, chest freezer and cold storage for local use. In 1997 the company produced 1145 units of different types of products. The density' of the foam used is about 40 kg/cu. mt. The consumption of the PU foam and refrigerant are shown in table 2 and 3. The consumption of CFC- 11 and CFC-12 for 1997 was 3.395 and 1.869 Mt

Type of Ownership	Private
Year of Establishment	1972
Workshop Area Square Meter	200
Number of Employee	25
Number of Servicemen	3
Number of Models Produced	9
Total Production in 1997	1145
Total ODS Consumed in 1997 Mt.	5.264

Emad Hedjawi Workshop

Emad Hedjawi Workshop was established in 1981 is 100% private company. The companies CFC-1 1 and CFC-12 consumption in 1997 was 2.602 metric tons, which is 1.73 % of the average CFC -11 and CFC-12 of commercial refrigerator sector (average sector consumption is 150 tons of ODS), for the period of 1995-1997. The company manufactures, commercial refrigerator and cold storage, water cooler, and chest freezer for local use. In 1997 the company produced 1165 units of different types of products. The density of the foam used is about 40 kg/cu. mt. The consumption of the PU foam and refrigerant are shown in table 2 and 3. The consumption of CFC-l 1 and CFC-12 for 1997 was 1.696 and 0906 Mt.

Type of Ownership	Private
Year of Establishment	1981
Workshop Area Square Meter	300
Number of Employee	19
Number of Servicemen	8
Number of Models Produced	12
Total Production in 1997	1165
Total ODS Consumed in 1997 Mt.	2.602

Al- Amal Workshop

Al- Amal Workshop established in 1982 is 100% private company. The company's CFC-1 1 and CFC-12 consumption in 1997 was 7.001 metric tons, which is 4.7 % of the average CFC - 11 and CFC- 12 of commercial refrigerator sector (average sector consumption is 150 tons of ODS), for the period of 1995-1997. The company manufactures, commercial refrigerator, and cold storage for local use. In 1997 the company produced 905 units of different types of products. The density of the foam used is about 40 kgku. mt. The consumption of the PU foam and refrigerant are shown in table 2 and 3. The consumption of CFC-1 1 and CFC-12 for 1997 was 4.476 and 2.525 Mt.

Type of Ownership	Private
Year of Establishment	1982
Workshop Area Square Meter	250
Number of Employee	27
Number of Servicemen	2
Number of Models Produced	14
Total Production in 1997	905
Total ODS Consumed in 1997 Mt.	7.001

Lebanon Workshop

Lebanon workshop company established in 1985 is 100% private company. The company's CFC-1 1 and CFC-12 consumption in 1997 was 4.566 metric tons, which is 3 % of the average CFC - 11 and CFC- 12 of commercial refrigerator sector (average sector consumption is 150 tons of ODS), for the period of 1995-1997. The company manufactures water cooler, and commercial refrigerator, for local use. In 1997 the company produced 720 units of different types of products~ The density of the foam used is about 40 kg/cu. mt. The consumption of the PU foam and refrigerant are shown in table 2 and 3. The consumption of CFC-1 1 and CFC-12 for 1997 was 2.903 and 1.662 Mt.

Type of Ownership	Private
Year of Establishment	1985
Workshop Area Square Meter	120
Number of Employee	11
Number of Servicemen	2
Number of Models Produced	5
Total Production in 1997	720
Total ODS Consumed in 1997 Mt.	4.566

Al-Besani Workshop

Al-Besani Workshop established in 1990 is 100% private company. The company's CFC-1 1 and CFC-12 consumption in 1997 was 4.164 metric tons, which is 2.8 % of the average CFC -11 and CFC-12 of commercial refrigerator sector (average sector consumption is 150 tons of ODS), for the period of 1995-1997. The company manufactures water cooler, commercial refrigerator for local use. In 1997 the company produced 1190 units of different types of products and used 2.659 tons of CFC- 11 as blowing agent and 1.505 tons CFC- 12 as refrigerant. The density of the foam used is about 40 kg/cu. mt. The consumption of the PU foam and refrigerant are shown in table 2 and 3.

Type of Ownership	Private
Year of Establishment	1990
Workshop Area Square Meter	300
Number of Employee	9
Number of Servicemen	1
Number of Models Produced	3
Total Production in 1997	1190
Total ODS Consumed in 1997 Mt.	4.164

Al-Eslah Workshop

Al-Eslah Workshop company established in 1980 is 100% private company. The company's CFC-1 l and CFC-12 consumption in 1997 was 3.292 metric tons, which is 2.2 % of the average CFC - 11 and CFC- 12 of commercial refrigerator sector (average sector consumption is 150 tons of ODS), for the period of 1995-1997. The company manufactures water cooler, commercial refrigerator, chest freezer and cold storage for local use. In 1997 the company produced 865 units of different types of products. The density of the foam used is about 40 kg/cu. mt. The consumption of the PU foam and refrigerant are shown in table 2 and 3. The consumption of CFC-1 1 and CFC-12 for 1997 was 2.121 and 1.171 Mt

Type of Ownership	Private
Year of Establishment	1980
Workshop Area Square Meter	200
Number of Employee	8
Number of Servicemen	2
Number of Models Produced	6
Total Production in 1997	865
Total ODS Consumed in 1997 Mt.	3.292

Since the companies in the commercial refrigeration sector are all small and medium scale enterprises and therefore generally too small in terms of CFC usage to warrant individual project preparation, the umbrella project approach has been sanctioned by the Government to phase out ODS usage in the commercial sector in Jordan. All of the companies in this umbrella project have a number of factors in common.

a) The choice of CFC replacement technology is the same in all cases.
b) All companies are 100% Jordanian owned.
c) The production facilities are similar and in the majority of cases consist of a single production line.

All companies involved in this project have formally committed to scrapping equipment made redundant by the conversion to non-CFC technology. As an Article 5 country, Jordan is entitled to import CFCs even after 2000. Clearly, if such equipment was sold on the open market, it could used to manufacture CFC based refrigerators, thereby negating the effect of this project and contradicting the policy of the Government. Some producers have stated that they will retain equipment for use in after sales servicing and repairs, this entirely legitimate and within the guidelines of the Montreal Protocol.

CFC consumption was carefully checked against the specifications of refrigerated models actually produced by each of the companies. A total of 17.25 tonnes of CFC-11 and 9.64 tonnes of CFC-12 was consumed in 1997, totaling 26.89 tonnes. In all cases the consumption of CFC-11 is based on a 14 % by mass ratio in the final polyurethane foam.

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Baseline ODS Consumption Data

Description of Product	Annual Production	CFC-11 Year 1997 Average kg/unit	CFC-11 Year 1997 Total kg/year 1997	CFC-12 Year 1997 Average kg/unit	CFC-12 Year 1997 Total kg/year 1997
1 Chest freezers	1330	1.08	1436	0.45	598
2 Water Cooler	1850	0.714	1321	0.4	740
3 Commercial Refrigerators	2640	4.57	12065	2.5	6600
4 Cold Storage Room	170	14.28	2428	10	1700
TOTAL	5990		17250		9638

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Main Production Equipment Currently in Use

Polyurethane foam is produced by locally made mixers and low pressure foaming machines. The equipment range requires the use of different jigs and plugs. The refrigerant circuits are charged using portable refrigerant charging machines and vacuum is applied using different hermetic compressor as vacuum pump.

The small and medium commercial refrigerator manufacturers in Jordan usually use the similar equipment for producing PU foams, locally made dry parts such as wooden and aluminum jigs and plugs and also equipment for charging refrigerant and vacuum pumps are almost the same. Therefore providing giving a detailed equipment table that can clearly describe the type, model and year of manufacture is useless. Consequently the results of our assessment show that, in Small and Medium Commercial Refrigerator Manufacturers, in general one portable refrigerant charger, one or two hermetic compressor for vacuum one or two locally made jigs and plugs, and finally one locally made mixer and low pressure dispensing machine could be found.

PROJECT OBJECTIVE

The objective of this project is to eliminate the use of CFC-12 in the production of refrigeration equipment at the Al- Amal Workshop Jamal Yussef Workshop, Emad Hedjawi Workshop, Al-Bisani Workshop, , Aqaba Al-Eslah Workshop, Lebanon Workshop, companies through conversion to the use of HFC- 134a (high/medium temperature) as refrigerant in refrigeration equipment. CFC-11 will be replaced by HCFC-141b.

PROJECT DESCRIPTION

The Al- Amal Workshop Jamal Yussef Workshop, Emad Hedjawi Workshop, Al-Bisani Workshop, , Aqaba Al-Eslah Workshop, Lebanon Workshop, companies have recognised the need to comply with The Montreal Protocol and has agreed to participate in Jordan's ODS phase-out programme. Al- Amal Workshop Jamal Yussef Workshop, Emad Hedjawi Workshop, Al-Bisani Workshop, , Aqaba Al-Eslah Workshop, Lebanon Workshop, companies are committed to phase out CFCs by converting its foaming equipment to HCFC-141b use and adopting HFC 134a as refrigerant. This project document describes the activities needed to carry out the phase out process.

Aim of the Project

The aim of the immediate project is to;

1- Design, calculate and drafting for model redefinition for 12 models.
2- Testing six prototypes for functionality and performance criteria.
3- 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

1- A study will be made for 12 models of commercial refrigerators made by Maurice Al-Deek Co. to specify;

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

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

Refrigeration Load Calculation for
Water Cooler and Chest Freezer and Display cases

Refrigeration load consist of three individual components:

1- Transmission load;
Heat transfer through side walls by conduction
2 - Product load;
Heat Removed from and produced by the products which are stored.
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 and door opening and etc.;

In this section , the above mentioned components will be discussed separately to analyze and extract the most useful and practical equipment's.

Transmission Load

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.

Trefrigerator Rliner + Rinsulation + Rcabin + Rambient ——Tambient

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 related equations is.

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

freezer and refrigerator compartments as necessary, 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 initial temperature (Ti) to freezing temperature (Tf) is ;

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

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;

$$Q\,bf = \dot{M}\ Cbf\ (T\,f - Tfs)$$

Where:

Cbf = Specific heat of products below freezing temperature.

For upright freezers or chest freezer, total product load is

$$Qpl = Qaf + Ql + Qbf$$

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

$$Qpl = Qrs$$

Internal 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

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 (Q_{tl}), product load (Q_{pl}) and internal load (Q_{IL}) 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;

$$Q_{TL} = 1.20 \, (Q_{TL} + Q_{PL} + Q_{IL})$$

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, 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,

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.

$Q_1 = m\ C\ \Delta T$, Where:

Q_1 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.

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 fresn 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.

Load Calculation for Water Cooler
Al- Amal Workshop 100 liters

Q1 = m C ΔT, 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 24 C.

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

Tank Diameter 42 Cm. Tank Height 70 Cm
Tank Valume = 21x21x3.14x70 = 96931 Cubic Cm. = Approx. 97 lit
M = 100 liter = 100 Kg.

C Specific heat factor of water in Kcal/Kg °C = 1

ΔT Temperature difference (Ti–Tc), where, Ti is inlet water temperature, and Tc is final cooled water.

Ti = 24 °C and Tc = 10 °C

Ti – Tc = 24-10 = 14 °C

Q1 = m C ΔT = 100 x 1 x 14 = 1400 Kcal = 1400 x 1.163 = 1628 Watts/24 hrs

Q1 = 1628 /24 water cooler operating time per day = 67.8 Watts

Q1 = 67.8 Watts

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

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. = H x N x M where:
H = Total Water Cooler Usage Time (Hours) = 16
N = Number of Glass of Drinking Water per Hour = 50

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M = Kg weight of water in one Glass of Water = 0.2 Kg

$\dot{M}$ = 2(16 x 50 x 0.2) = lit. + 20% Waste Water = 384

C Specific heat factor of water in Kcal/Kg °C = 1

ΔT Temperature d(Ti – Tc), where, Ti is inlet water temperature, and Tc is final cooled water temperature.

Ti = 24 °C and T= 10 °C

Ti – Tc = 24-10 = 14 °C

Q2 = m C ΔT = 384 x 1 x 14 = 5376 Kcal = 5376 x 1.163 = 6252 Watts/16 hrs

Q2 = 1563/12.8 compressor operating time per day = 122 Watts

Q2 = 260 Watts

Q3 = UA ΔT, 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

$$U = \frac{1}{x/K} = \frac{1}{0.060/0.018} = 0.33 \ Kcal/m^2.°C$$

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

A = 42x3.14x70 = 9232 Sq. Cm = 0.923 Sq. Mt.

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

Ta = 30 °C and Tc = 10 °C

Ta – Tc = 30-10 = 20 °C

Q3 = UA ΔT = 0.33 x 0.923 x 20 = 5.53 Watts

Q3 = 13.4 Watts

Qt = Q1 + Q2 + Q3 = 65.8 + 260 + 6.1 = 332.4 + 20% safety factor = 399 Watts

Compressor R134a, Model FR7GH (total cooling capacity 525 watts) manufactured by Danfoss, is selected as a suitable compressor to replace R12 compressor model SC21B to operate at –10 C evaporating temperature.

Load Calculation for Water Cooler
Aqaba Workshop (Al-Eslah) 35 liters

Q1 = m C ΔT, 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 24 C.

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

Tank Diameter 42 Cm. Tank Height 25 Cm
Tank Valume = 21x21x3.14x25= 34618 Cubic Cm. = 34.618 lit
M = 35 liter = 35 Kg.

C Specific heat factor of water in Kcal/Kg °C = 1

ΔT Temperature difference (Ti–Tc), where, Ti is inlet water temperature, and Tc is final cooled water.

Ti = 24 °C and Tc = 10 °C

Ti – Tc = 24-10 = 14 °C

Q1 = m C ΔT = 35 x 1 x 14 = 490 Kcal = 490 x 1.163 = 569 Watts/24 hrs

Q1 = 569 /24 water cooler operating time per day = 23.7 Watts

Q1 = 23.7 Watts

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

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. = H x N x M where:
H = Total Water Cooler Usage Time (Hours) = 16
N = Number of Glass of Drinking Water per Hour = 50

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M = Kg weight of water in one Glass of Water = 0.2 Kg

$\dot{M}$ = 2(16 x 50 x 0.2) = lit. + 20% Waste Water = 384

C Specific heat factor of water in Kcal/Kg °C = 1

ΔT Temperature d(Ti – Tc), where, Ti is inlet water temperature, and Tc is final cooled water temperature.

Ti = 24 °C and T= 10 °C

Ti – Tc = 24-10 = 14 °C

Q2 = m C ΔT = 384 x 1 x 14 = 5376 Kcal = 5376 x 1.163 = 6252 Watts/16 hrs

Q2 = 1563/12.8 compressor operating time per day = 122 Watts

Q2 = 260 Watts

Q3 = UA ΔT, 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

$$U = \frac{1}{x/K} = \frac{1}{0.060/0.018} = 0.33 \ Kcal/m^2 \cdot °C$$

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

A = 42x3.14x25 = 3297 Sq. Cm = 0.3297 Sq. Mt.

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

Ta = 30 °C and Tc = 10 °C

Ta – Tc = 30-10 = 20 °C

Q3 = UA ΔT = 0.33 x 0.3297 x 20 = 2.1 Watts

Q3 = 2.1 Watts

Qt = Q1 + Q2 + Q3 = 23.7 + 260 + 2.1 = 286 + 20% safety factor = 343Watts

Compressor R134a, Model FR7GH (total cooling capacity 525 watts) manufactured by Danfoss, is selected as a suitable compressor to replace R12 compressor model SC21B to operate at –10 C evaporating temperature.

Al- Bisani Water Cooler 100 liter

Q1 = m C ΔT, 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 24 C.

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

M = 100 liter = 100 Kg.

C Specific heat factor of water in Kcal/Kg ^{o}C = 1

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

Ti = 24 ^{o}C and Tc = 10 ^{o}C

Ti – Tc = 24-10 = 14 ^{o}C

Q1 = m C ΔT = 100 x 1 x 14 = 1400 Kcal = 1400 x 1.163 = 1628 Watts/24 hrs

Q1 = 1628 /24 water cooler operating time per day = 69 Watts

Q1 = 69 Watts

Q2 = $\dot{M}$ C ΔT

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. = H x N x M where:

H = Total Water Cooler Usage Time (Hours) = 16

N = Number of Glass of Drinking Water per Hour = 30

M = Kg weight of water in one Glass of Water = 0.2 Kg

$\dot{M}$ = 16 x 25 x 0.2 = 96 lit. +20% Waste Water = 96

C Specific heat factor of water in Kcal/Kg ^{o}C = 1

?T Temperature d(Ti – Tc), where, Ti is inlet water temperature, and Tc is final cooled water temperature.

Ti = 24 ^{o}C and T= 10 ^{o}C and Ti – Tc = 24-10 = 14 ^{o}C

Q2 = m C ΔT = 96 x 1 x 14 = 1344 Kcal = 1344 x 1.163 = 1563 Watts/16 hrs

Q2 = 1563/12.8 compressor operating time per day = 122 Watts

Q2 = 122 Watts

Q3 = UA ΔT, 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

$$U = \frac{1}{\frac{x}{K}} = \frac{1}{\frac{0.05}{0.018}} = 0.36 \, Watt / m^2 . ^{\circ}C$$

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

A = {(30 x 3.14x50) + [(2x30x30x3.13)/4]} = 0.6123 Sq. Mt.

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

$$Ta = 30\ ^{\circ}C \text{ and } Tc = 10\ ^{\circ}C$$

$$Ta - Tc = 30\text{-}10 = 20\ ^{\circ}C$$

Q3 = UA ΔT = 0.36 x 0.6123 x 20 = 4.4 Watts

Q3 = 4.4 Watts

Qt = Q1 + Q2 + Q3 = 69 + 122 + 4.4 = 195 Watts

Suitable compressor to be selected should have at least 195 watt cooling capacity and must be compatible with compressor model Electrolux L76AV.

Lebanon Workshop Water Cooler Model M-100

Q1 = m C ΔT, 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 24 C.

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

M = 100 liter = 100 Kg.

C Specific heat factor of water in Kcal/Kg ^{o}C = 1

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

Ti = 24 ^{o}C and Tc = 10 ^{o}C

Ti – Tc = 24-10 = 14 ^{o}C

Q1 = m C ΔT = 100 x 1 x 14 = 1400 Kcal = 1400 x 1.163 = 1628 Watts/24 hrs

Q1 = 1628 /24 water cooler operating time per day = 69 Watts

Q1 = 69 Watts

Q2 = $\dot{M}$ C ΔT

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. = H x N x M where:

H = Total Water Cooler Usage Time (Hours) = 16

N = Number of Glass of Drinking Water per Hour = 30

M = Kg weight of water in one Glass of Water = 0.2 Kg

$\dot{M}$ = 16 x 25 x 0.2 = 96 lit. + 20% Waste Water = 96

C Specific heat factor of water in Kcal/Kg ^{o}C = 1

ΔT Temperature d(Ti – Tc), where, Ti is inlet water temperature, and Tc is final cooled water temperature.

Ti = 24 ^{o}C and T= 10 ^{o}C and Ti – Tc = 24-10 = 14 ^{o}C

Q2 = m C ΔT = 96 x 1 x 14 = 1344 Kcal = 1344 x 1.163 = 1563 Watts/16 hrs

Q2 = 1563/12.8 compressor operating time per day = 122 Watts

Q2 = 122 Watts

Q3 = UA ΔT, Where:

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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

$$U = \frac{1}{\frac{x}{K}} = \frac{1}{\frac{0.05}{0.018}} = 0.36 \, Watt / m^2 . ℃$$

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

Water Storage tank dimension 130x70x45

A = {(2x45x70) + [(2x130x70) + (2x45x130)]} = 0.2.744 Sq. Mt.

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

Ta = 30 °C and Tc = 10 °C

Ta – Tc = 30-10 = 20 °C

Q3 = UA ΔT = 0.36 x 2.744 x 20 = 19.7 Watts

Q3 = 19.7 Watts

Qt = Q1 + Q2 + Q3 = 69 + 122 + 19.7 = 210Watts

Suitable compressor to be selected should have at least 210 watt cooling capacity and must be compatible with compressor model Electrolux L76AV.

Refrigeration Load Calculation
Jamal Yussef Upright Refrigerator Showcase Model 160

a) Transmission load calculation

Refrigerator Compartment	Dimension Cm.	Area (sq.mt.)	Insulation Thickness	Temp. Difference
Side Walls	2 x (80x200)	3.2	40mm	27 c
Back Panel	160x200	3.2	40mm	27 c
Bottom	80x200	1.6	40mm	27 C
Top	80x200	1.6	40mm	37 c
Doors	160x200	3.2	40mm	27 c

Insulation Type: Pu Foam with R141b blowing agent.
Thermal Conductivity for Foam = 0.0180 W/ mt. ° C
Temperature Difference Refrigerator Compartment:
$\Delta T = 32 - (+5) = 27$ ° C
Ambient Temperature = 32 °C
Refrigerator Air Temperature = +5 °C

Calculation :

Heat Leak For Refrigerator Compartment.

$$Q_{TL} = Q_{SW} + Q_{Back\ Panel} + Q_{door} + Q_{Bottom} + Q_{top}$$

$$Q = U A (T_a - T_r)$$

$$U = \frac{1}{X_1 / K_1}$$

Where :

U = Heat Resistance Coefficient Factor
K_1 = Foam Thermal Conductivity

Due to the short thickness of cabinet out side panel (0.6 mm) and plastic inner liner (1.5 mm) heat resistance of these materials have been considered negligible.
Therefore:

1- $Q_{SideWalls} = [U A (T_a - T_r)]$

T_a = Ambient Temperature 32

T_r = refrigerator air Temperature 5

U = 1 / (0.040/ 0.0180) = 0.45 W/ sq.m °C

A = 3.2 Sq. Mt., T_a = 32 °C, T_f = + 5 °C

therefore

$Q_{SideWalls}$ = 0.45 x 3.2 x 27 = 39 Watts

$Q_{SideWalls}$ = 39 Watts

2- $Q_{doors} = [U A (T_a - T_r)]$

U = 1 / [(0.040/ 0.018)] = 0.45 W/ sq.m °C , $T_a - T_r$= 27, A = 3.2,

Q_{doors} = 0.45 x 3.2 x 27 = 39 Watts Q_{doors} = 39 Watts

3- $Q_{top} = [U A (T_a - T_r)]$

U = 0.45 w/sq. Mt. °C,

$T_a - T_r$= 37 , **A = 1.6**

Q_{top} = 0.45 x 1.6 x 37 = 26.6 Watts

Q_{top} = 26.6 Watts

4 -$Q_{back\ panel} = [U A (T_a - T_r)]$

U = 0.45 w/sq. Mt. °C,

$T_a - T_r$= 27 , A = 3.2

$Q_{back\ panel}$ = 0.45x 3.2 x 27 = 39 Watts

$Q_{back\ panel}$ = 39 Watts

5 -$Q_{Bottom} = [U A (T_a - T_r)]$

U = 0.45 w/sq. Mt. °C,

$T_a - T_r$= 27, A = 1.6

$Q_{Bottom\ Surface}$ = 0.45x 1.6 x 27 = 19.4 Watt

$Q_{Bottom\ Surface}$ = 19.4 Watts

Total Refrigerator Heat Leak =39 +39 + 26.6 + 19.4 + 39= 163 W

Product Load

A product placed in a refrigerator at a temperature higher than the storage temperature will lose heat until it reaches the storage temperature. The quantity of heat to be removed may be calculated from knowledge of the product, including its state upon entering the refrigerator, its final state, its weight, specific heat above and below freezing point, its freezing temperature and latent heat.

When a definite weight of product is cooled from one state and temperature to another state and temperature, some or all of the following calculations must be made:

Heat removal from intial temperature to some lower temperature above freezing.

$$Q = mc(T_1-T_2)$$

Heat removal from initial temperature to freezing point of product.

$$\mathbf{Q = mc(T_i-T_f)}$$

Heat removal to freeze product.

$$\mathbf{Q = mh_{if}}$$

Heat removal from freezing point to final temperature below freezing.

$$\mathbf{Q = mc(T_f-T_3)}$$

Where

Q = heat removed, Kj
M = weight of product, kg
C = specific heat of product above freezing point, Kj/Kg. K
T_1 = initial temp. C
T_2 = lower temperature above freezing, C
T_f = freezing temperature of product, C
H_{if} = latent heat of fusion, kj per kg

Since this product is mainly used for storing fresh Lamb meet and beef above

freezing point at +5 C, we consider 600 Kg of meet to be stored in this refrigerator therefore we calculate as follow,

$$\mathbf{Q = mc(T_1-T_2)}$$

M = 600 kg
C = 0.67 Btu/(lb)F deg = 0.67 x 4.184 = 2.8 j/g K
T_1 = 25 C

T_2 = 5 C
Q = 600000x2.8x (25-5) =33600000 jul/86400 = 389 Watt

Internal Load
Motor Fan 16 Watt

Door Opening
Refrigerator Internal Volume 1200 lit.
Number of air change as per ASHREA standard = 70 per day
Heat removed per cubic meter of air 75000 j

Air Change load = 1.2x70x75000/86400 = 72.9 Watt

$Q_{Total} = Q_{heat\ leak} + Q_{product\ load} + Q_{internal\ load} + Q_{air\ change}$

$Q_{Total} = 163 + 389 + 16 + 73 = 641$

Considering 20 % of Q total for safety factor

$Q_{Grand\ Total} = 641 + 20\%(128) =$ ***769*** watts

With respect to the above calculation we have to select a compressor of R134a with cooling capacity of approximately 769watt at –15 degree centigrade evaporating temperature. We should select a compressor to be compatible with Electrolux compressor model S26TY.

Emad Hedjawi Chest Freezer Model MDCF-120

a) Transmission Load Calculation

Dimension

	Dimension Cm.	Area (sq. mt.)	Insulation Thickness mm
Side Walls	2 x (65x85)	1.12	50
Front & Back Panel	2 x (125x85)	2.14	50
Chest Door	120 x 65	0.81	50
Bottom Floor	120 x 65	0.81	50

Insulation Type: Pu Foam R141b expanded blowing PU foam
R141b Foam Thermal Conductivity: 0.018 W /mt.C
Temperature Difference: $(\Delta T) = 32 - (-25) = 57$ C
Ambient Temperature = 32 C
Freezer Air Temperature = - 25 C

Calculation :

$Q_{TL} = Q_{side\ Walls} + Q_{Bottom} + Q_{Top}$

$Q = U A (T_a - T_f)$

$$U = \frac{1}{X_1 / K_1 + X_2 / K_2 + \ldots\ldots}$$

Where :

U = Heat Resistance Coefficient Factor
K_1 = Foam Thermal Conductivity
X_1 = Foam Thickness

Note : Due to the short thickness of cabinet out side panel (0.6 mm) and plastic inner liner (1.5 mm) heat resistance of these materials have been considered negligible.Therefore:

$Q_{SideWalls} = [U A (T_a - T_f)]$

T_a = Ambient Temperature

T_f = Freezer air Temperature

U = 1 / (0.05/0.018) = 0.36 W/ sq.m C
A = 1.12 Sq. Mt.
T_a = 32 C, T_f = - 25 C
$Q_{SideWalls}$ = 0.36 x 1.12 x 57 = 23 Watts
$Q_{SideWalls}$ = 23 Watts

$Q_{Front\ Wall}$ = [U A (T_a - T_f)]
T_a = Ambient Temperature
T_f = Freezer air Temperature
U = 1 / (0.050/0.018) = 0.36 W/ sq.m C
A = 1.07 Sq. Mt.
T_a = 32 C, T_f = - 25 C
$Q_{Front\ Wall}$ = 0.36 x 1.07 x 57 = 22 Watts

$Q_{Front\ Wall}$ = 22 Watts

$Q_{Back\ panel}$ = [U A (T_a - T_f)]
T_a = Ambient Temperature
T_f = Freezer air Temperature
U = 1 / (0.050/0.018) = 0.36 W/ sq.m C
A = 1.07 Sq. Mt.
T_a = 42 C, T_f = - 25 C
$Q_{back\ panel}$ = 0.36 x 1.07 x 57 = 22 Watts

Q_{Top} = [U A (T_a - T_f)]
T_a = Ambient Temperature
T_f = Freezer air Temperature
U = 1 / (0.050/0.018) = 0.36 W/ sq.m C
A = 0.81 Sq. Mt.
T_a = 32 C, T_f = - 25 C
Q_{Top} = 0.36 x 0.81 x 57 = 17 Watts
Q_{Top} = 17 Watts

Q_{Bottom} = [U A (T_a - T_f)]
T_a = Ambient Temperature
T_f = Freezer air Temperature
U = 1/(0.050/ 0.018) = 0.36 W/ sq.m C

A = 0.81 Sq. Mt.
T_a = 42 C, T_f = - 25 C
Q_{Bottom} = 0.36 x 0.81 x 67 = 19 Watts

Total Heat Leaks;

Q_{TL} = 23 + 26 + 22 + 19 + 17 = 107 watts

$$Q_{\text{Total Heat Leaks}} = 107 \text{ Watts}$$

Ice Making Capacity = 5_{Kg} x 1 x (15 - 0) x1.163= 87 Watts

c) Heat gain through infiltration;
We consider 10% safety factor for door opening and infiltration
Heat gain by infiltration = 0.1 x (total heat leaks)
Heat gain by infiltration = 0.1 x (87) = 9 Watts
Total Cooling Capacity Required is calculated as follows;

$$Q_{\text{Grand Total}} = Q_{\text{Heat Leaks}} + Q_{\text{Ice Making}} + Q_{\text{Infiltration}}$$

$$Q_{\text{Grand Total}} = 107 + 87 + 9 = 203 \text{ Watts}$$

$$Q_{\text{Grand Total}} = 203 \text{ Watts}$$

The suitable R134a compressor should be compatible with cooling capacity of 203 watt. A compressor compatible with Electrolux model P12Fw should be selected.

Refrigeration Load Calculation
Jamal Yussef Upright Refrigerator Showcase Model 2000

a)- Transmission load calculation

Refrigerator Compartment	Dimension Cm.	Area (sq.mt.)	Insulation Thickness	Temp. Difference
Side Walls	2 x (80x200)	3.2	40mm	27 c
Back Panel	200x200	4	40mm	27 c
Bottom	80x200	1.6	40mm	27 C
Top	80x200	1.6	40mm	37 c
Doors	200x200	4	40mm	27 c

Insulation Type: Pu Foam with R141b blowing agent.
Thermal Conductivity for Foam = 0.0180 W/ mt. ° C
Temperature Difference Refrigerator Compartment:
$\Delta T = 32 - (+5) = 27$ ° C
Ambient Temperature = 32 °C
Refrigerator Air Temperature = +5 °C

Calculation :

Heat Leak For Refrigerator Compartment.

$$Q_{TL} = Q_{SW} + Q_{Back\ Panel} + Q_{door} + Q_{Bottom} + Q_{top}$$

$$Q = U\,A\,(Ta - T_r)$$

$$U = \frac{1}{X_1 / K_1}$$

Where :

U = Heat Resistance Coefficient Factor

K1 = Foam Thermal Conductivity

هاتف معرض : ٦٥٣٢٦٢ ـ المصنع : ٧٣١٣٧٢ ـ فاكس : ٦١٣٣٤٠ ـ٦ـ ٩٦٢ ـ ص.ب : ٩٢١٩٤٠ عمان ـ الاردن
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Due to the short thickness of cabinet out side panel (0.6 mm) and plastic inner liner (1.5 mm) heat resistance of these materials have been considered negligible.

Therefore:

1- Q SideWalls = [U A (Ta - Tr)]
Ta = Ambient Temperature 32
Tr = refrigerator air Temperature 5
U = 1 / (0.040/ 0.0180) = 0.45 W/ sq.m °C
A = 3.2 Sq. Mt., Ta = 32 °C, Tf = + 5 °C
therefore
Q SideWalls = 0.45 x 3.2 x 27 = 39 Watts
Q SideWalls = 39 Watts

2- Q doors = [U A (Ta - Tr)]
U = 1 / [(0.040/ 0.018)] = 0.45 W/ sq.m °C ,Ta - Tr= 27, A = 3.2,
Q doors = 0.45 x 4 x 27 = 48.6 Watts

3- Q top = [U A (Ta - Tr)]
U = 0.45 w/sq. Mt. °C,
Ta - Tr= 37 , **A = 1.6**
Q top = 0.45 x 1.6 x 37 = 26.6 Watts
Q top = 26.6 Watts

4 -Q back panel = [U A (Ta - Tr)]
U = 0.45 w/sq. Mt. °C,
Ta - Tr= 27 , A = 3.2
Q back panel = 0.45x 4 x 27 = 48.6 Watts
Q back panel = 48.6 Watts

5 -Q Bottom = [U A (Ta - Tr)]
U = 0.45 w/sq. Mt. °C,
Ta - Tr= 27, A = 1.6
Q Bottom Surface = 0.45x 1.6 x 27 = 19.4 Watt
Q Bottom Surface = 19.4 Watts

Total Refrigerator Heat Leak =39 +48.6 + 26.6 + 19.4 + 48.6= 182 W

هاتف معرض : ٦٥٣٢٦٢ ـ المصنع : ٧٣١٣٧٢ ـ فاكس : ٠٦ـ٦١٣٣٤٠ـ٩٦٢ ـ ص.ب : ٩٢١٩٤٠ عمان ـ الاردن
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Product Load

A product placed in a refrigerator at a temperature higher than the storage temperature will lose heat until it reaches the storage temperature. The quantity of heat to be removed may be calculated from knowledge of the product, including its state upon entering the refrigerator, its final state, its weight, specific heat above and below freezing point, its freezing temperature and latent heat.

When a definite weight of product is cooled from one state and temperature to another state and temperature, some or all of the following calculations must be made:

———Heat removal from intial temperature to some lower temperature above freezing.

$Q = mc(T1-T2)$

Heat removal from initial temperature to freezing point of product.

$Q = mc(Ti-Tf)$

Heat removal to freeze product.

$Q = mhif$

Heat removal from freezing point to final temperature below freezing.

$Q = mc(Tf-T3)$

Where

——Q = heat removed, Kj
——M = weight of product, kg
——C = specific heat of product above freezing point, Kj/Kg. K
——T1 = initial temp. C
———T2 = lower temperature above freezing, C
——Tf = freezing temperature of product, C
——Hif = latent heat of fusion, kj per kg

Since this product is mainly used for storing fresh Lamb meet and beef above

freezing point at +5 C, we consider 600 Kg of meet to be stored in this refrigerator therefore we calculate as follow,

$Q = mc(T_1-T_2)$

M = 1000 kg

C = 0.67 Btu/(lb)F deg = 0.67 x 4.184 = 2.8 j/g K

$T_1 = 25$ C

$T_2 = 5$ C

هاتف معرض : ٦٥٣٢٦٢ ـ المصنع : ٧٣١٣٧٢ ـ فاكس : ٦١٣٣٤٠ ـ٦ـ ٩٦٢ ـ ص.ب : ٩٢١٩٤٠ عمان ـ الاردن
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Q = 1000000x2.8x (25-5) =56000000 jul/86400 = 648 Watt

Internal Load

Motor Fan 16 Watt

Door Opening
Refrigerator Internal Volume 1200 lit.
Number of air change as per ASHREA standard = 70 per day
Heat removed per cubic meter of air 75000 j

Air Change load = 1.6x70x75000/86400 = 97 Watt

$Q_{Total} = Q_{heat\ leak} + Q_{product\ load} + Q_{internal\ load} + Q_{air\ change}$

$Q_{Total} = 182 + 648 + 16 + 97 = 943$

Considering 20 % of Q total for safety factor

$Q_{Grand\ Total} = 943 + 20\%(189) = 1132$ watts

With respect to the above calculation we have to select a compressor of R134a with cooling capacity of approximately 1132watt at –15 degree centigrade evaporating temperature.

هاتف معرض : ٦٥٣٢٦٢ - المصنع : ٧٣١٣٧٢ - فاكس : ٠٦-٦١٣٣٤٠-٩٦٢ - ص.ب : ٩٢١٩٤٠ عمان - الاردن
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Emad Hedjawi Chest Freezer Model IMD – 600F

(a) Transmission Load Calculation

Dimension

	Dimension Cm.	Area (sq. mt.)	Insulation Thickness mm
Side Walls	2 x (65x85)	1.12	50
Front & Back Panel	2 x (160x85)	2.72	50
Chest Door	160 x 65	1.04	50
Bottom Floor	160 x 65	1.04	50

Insulation Type: Pu Foam R141b expanded blowing PU foam
R141b Foam Thermal Conductivity: 0.018 W /mt.C
Temperature Difference: $(\Delta T) = 32 - (-25) = 57$ C
Ambient Temperature = 32 C
Freezer Air Temperature = - 25 C

Calculation :

$$Q_{TL} = Q_{side\ Walls} + Q_{Bottom} + Q_{Top}$$

$$Q = U A (Ta - T_f)$$

$$U = \frac{1}{X_1 / K_1 + X_2 / K_2 + ...}$$

Where :

U = Heat Resistance Coefficient Factor

K1 = Foam Thermal Conductivity
X1 = Foam Thickness

Note : Due to the short thickness of cabinet out side panel (0.6 mm) and plastic inner liner (1.5 mm) heat resistance of these materials have been considered negligible.Therefore:

هاتف معرض : ٦٥٣٢٦٢ ـ المصنع : ٧٣١٣٧٢ ـ فاكس : ٠٦١٣٣٤٠ ـ ٦ ـ ٩٦٢ ـ ص.ب : ٩٢١٩٤٠ عمان ـ الاردن
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Q SideWalls = [U A (T_a - T_f)]
T_a = Ambient Temperature
T_f = Freezer air Temperature
U = 1 / (0.05/0.018) = 0.36 W/ sq.m C
A = 1.12 Sq. Mt.
Ta = 32 C, Tf = - 25 C
Q SideWalls = 0.36 x 1.12 x 57 = 23 Watts
Q SideWalls = 23 Watts

Q Front Wall = [U A (Ta - Tf)]
Ta = Ambient Temperature
Tf = Freezer air Temperature
U = 1 / (0.050/0.018) = 0.36 W/ sq.m C
A = 1.36 Sq. Mt.
Ta = 32 C, Tf = - 25 C
Q Front Wall = 0.36 x 1.07 x 57 = 27.9 Watts
$Q_{Front\ Wall}$ = 27.9 Watts

Q Back panel = [U A (Ta - Tf)]
Ta = Ambient Temperature
Tf = Freezer air Temperature
U = 1 / (0.050/0.018) = 0.36 W/ sq.m C
A = 1.36 Sq. Mt.
Ta = 42 C, Tf = - 25 C
Q back panel = 0.36 x 1.36 x 57 = 27.9 Watts

Q_{Top} = [U A (Ta - Tf)]
Ta = Ambient Temperature
Tf = Freezer air Temperature
U = 1 / (0.050/0.018) = 0.36 W/ sq.m C
A = 1.04 Sq. Mt.
Ta = 32 C, Tf = - 25 C
Q_{Top} = 0.36 x 0.81 x 57 = 21.3 Watts
Q_{Top} = 21.3 Watts

Q_{Bottom} = [U A (Ta - Tf)]
Ta = Ambient Temperature
Tf = Freezer air Temperature
U = 1/(0.050/ 0.018) = 0.36 W/ sq.m C

هاتف معرض : ٦٥٣٢٦٢ - المصنع : ٧٣١٣٧٢ - فاكس : ٦١٣٣٤٠ -٦- ٩٦٢ - ص.ب : ٩٢١٩٤٠ عمان - الاردن
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A = 1.04 Sq. Mt.
Ta = 42 C, Tf = - 25 C
Q_{Bottom} = 0.36 x 1.04 x 67 = 25.2Watts

Total Heat Leaks;

$$Q_{TL} = 23 + 27.9 + 27.9 + 21.3 + 25.2 = 125 \text{ watts}$$

$$Q_{\text{Total Heat Leaks}} = 125 \text{ Watts}$$

Ice Making Capacity = 10_{Kg} x 1 x (15 - 0) x1.163= 174 Watts

iii) Heat gain through infiltration;

We consider 10% safety factor for door opening and infiltration
Heat gain by infiltration = 0.1 x (total heat leaks)
Heat gain by infiltration = 0.1 x (174) = 17.4 Watts
Total Cooling Capacity Required is calculated as follows;

$$Q_{\text{Grand Total}} = Q_{\text{Heat Leaks}} + Q_{\text{Ice Making}} + Q_{\text{Infiltration}}$$

$$Q_{\text{Grand Total}} = 125 + 174 + 17 = 316 \text{ Watts}$$

$$Q_{\text{Grand Total}} = 316 \text{ Watts}$$

The suitable R134a compressor should be compatible with cooling capacity of 316 watt.

هاتف معرض : ٦٥٣٢٦٢ - المصنع : ٧٣١٣٧٢ - فاكس : ٠٦-٦١٣٣٤٠-٩٦٢ - ص.ب : ٩٢١٩٤٠ عمان - الاردن
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Refrigeration Load Calculation
Lebanon Workshop Showcase Model SH-160R

a) Transmission load calculation

Refrigerator Compartment	Dimension Cm.	Area (sq.mt.)	Insulation Thickness	Temp. Difference
Side Walls	2 x (80x200)	3.2	40mm	27 c
Back Panel	160x200	3.2	40mm	27 c
Bottom	80x200	1.6	40mm	27 C
Top	80x200	1.6	40mm	37 c
Doors	160x200	3.2	40mm	27 c

Insulation Type: Pu Foam with R141b blowing agent.
Thermal Conductivity for Foam = 0.0180 W/ mt. ° C
Temperature Difference Refrigerator Compartment:
$\Delta T = 32 - (+5) = 27$ ° C
Ambient Temperature = 32 °C
Refrigerator Air Temperature = +5 °C

Calculation :

Heat Leak For Refrigerator Compartment.

$$Q_{TL} = Q_{SW} + Q_{Back\ Panel} + Q_{door} + Q_{Bottom} + Q_{top}$$

$$Q = U\,A\,(T_a - T_r)$$

$$U = \frac{1}{X_1 / K_1}$$

Where :

U = Heat Resistance Coefficient Factor
K_1 = Foam Thermal Conductivity

هاتف معرض : ٦٥٣٢٦٢ ـ المصنع : ٧٣١٣٧٢ ـ فاكس : ٦١٣٣٤٠ ـ ٩٦٢ ـ ص.ب : ٩٢١٩٤٠ عمان ـ الاردن
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Due to the short thickness of cabinet out side panel (0.6 mm) and plastic inner liner (1.5 mm) heat resistance of these materials have been considered negligible. Therefore:

1- $Q_{SideWalls} = [U A (T_a - T_r)]$
T_a = Ambient Temperature 32
T_r = refrigerator air Temperature 5
U = 1 / (0.040/ 0.0180) = 0.45 W/ sq.m °C
A = 3.2 Sq. Mt., T_a = 32 °C, T_f = + 5 °C
therefore
$Q_{SideWalls}$ = 0.45 x 3.2 x 27 = 39 Watts
$Q_{SideWalls}$ = 39 Watts

2- $Q_{doors} = [U A (T_a - T_r)]$
U = 1 / [(0.040/ 0.018)] = 0.45 W/ sq.m °C , $T_a - T_r$ = 27, A = 3.2,
Q_{doors} = 0.45 x 3.2 x 27 = 39 Watts Q_{doors} = 39 Watts

3- $Q_{top} = [U A (T_a - T_r)]$
U = 0.45 w/sq. Mt. °C,
$T_a - T_r$ = 37 , **A = 1.6**
Q_{top} = 0.45 x 1.6 x 37 = 26.6 Watts
Q_{top} = 26.6 Watts

4 -$Q_{back\ panel} = [U A (T_a - T_r)]$
U = 0.45 w/sq. Mt. °C,
$T_a - T_r$ = 27 , A = 3.2
$Q_{back\ panel}$ = 0.45x 3.2 x 27 = 39 Watts
$Q_{back\ panel}$ = 39 Watts

5 -$Q_{Bottom} = [U A (T_a - T_r)]$
U = 0.45 w/sq. Mt. °C,
$T_a - T_r$ = 27, A = 1.6

هاتف معرض : ٦٥٣٢٦٢ - المصنع : ٧٣١٣٧٢ - فاكس : ٦١٣٣٤٠ -٦- ٩٦٢ - ص.ب : ٩٢١٩٤٠ عمان - الاردن
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$Q_{\text{Bottom Surface}}$ = 0.45x 1.6 x 27 = 19.4 Watt
$Q_{\text{Bottom Surface}}$ = 19.4 Watts

Total Refrigerator Heat Leak =39 +39 + 26.6 + 19.4 + 39= 163 W

Product Load

A product placed in a refrigerator at a temperature higher than the storage temperature will lose heat until it reaches the storage temperature. The quantity of heat to be removed may be calculated from knowledge of the product, including its state upon entering the refrigerator, its final state, its weight, specific heat above and below freezing point, its freezing temperature and latent heat.

When a definite weight of product is cooled from one state and temperature to another state and temperature, some or all of the following calculations must be made:

Heat removal from intial temperature to some lower temperature above freezing.

$$Q = mc(T_1-T_2)$$

Heat removal from initial temperature to freezing point of product.

$$Q = mc(T_i-T_f)$$

Heat removal to freeze product.

$$Q = mh_{if}$$

Heat removal from freezing point to final temperature below freezing.

$$Q = mc(T_f-T_3)$$

Where

Q = heat removed, Kj
M = weight of product, kg
C = specific heat of product above freezing point, Kj/Kg. K
T_1 = initial temp. C
T_2 = lower temperature above freezing, C
T_f = freezing temperature of product, C
H_{if} = latent heat of fusion, kj per kg

هاتف معرض : ٦٥٣٢٦٢ - المصنع : ٧٣١٣٧٢ - فاكس : ٦١٣٣٤٠ -٦- ٩٦٢ - ص.ب : ٩٢١٩٤٠ عمان - الاردن
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Since this product is mainly used for storing fresh Lamb meet and beef above

freezing point at +5 C, we consider 600 Kg of meet to be stored in this refrigerator therefore we calculate as follow,

$$Q = mc(T_1-T_2)$$

M = 600 kg
C = 0.67 Btu/(lb)F deg = 0.67 x 4.184 = 2.8 j/g K
T_1 = 25 C
T_2 = 5 C
Q = 600000x2.8x (25-5) =33600000 jul/86400 = 389 Watt

Internal Load
Motor Fan 16 Watt

Door Opening
Refrigerator Internal Volume 1200 lit.
Number of air change as per ASHREA standard = 70 per day
Heat removed per cubic meter of air 75000 j

Air Change load = 1.2x70x75000/86400 = 72.9 Watt

$Q_{Total} = Q_{heat\ leak} + Q_{product\ load} + Q_{internal\ load} + Q_{air\ change}$

$Q_{Total} = 163 + 389 + 16 + 73 = 641$

Considering 20 % of Q total for safety factor

$Q_{Grand\ Total} = 641 + 20\%(128) = \underline{\mathbf{769}}$ watts

With respect to the above calculation we have to select a compressor of R134a with cooling capacity of approximately 769watt at –15 degree centigrade evaporating temperature. We should select a compressor to be compatible with Electrolux

هاتف معرض : ٦٥٣٢٦٢ - المصنع : ٧٣١٣٧٢ - فاكس : ٦١٣٣٤٠-٦-٩٦٢ - ص.ب : ٩٢١٩٤٠ عمان - الاردن
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compressor model S26TY.

Al-Amal Chest Freezer Model Amal-CF120

a) Transmission Load Calculation

هاتف معرض : ٦٥٣٢٦٢ - المصنع : ٧٣١٣٧٢ - فاكس : ٠٦-٦١٣٣٤٠-٩٦٢ - ص.ب : ٩٢١٩٤٠ عمان - الاردن
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Dimension

	Dimension Cm.	Area (sq. mt.)	Insulation Thickness mm
Side Walls	2 x (65x85)	1.12	50
Front & Back Panel	2 x (125x85)	2.14	50
Chest Door	120 x 65	0.81	50
Bottom Floor	120 x 65	0.81	50

Insulation Type: Pu Foam R141b expanded blowing PU foam
R141b Foam Thermal Conductivity: 0.018 W /mt.C
Temperature Difference: $(\Delta T) = 32 - (-25) = 57$ C
Ambient Temperature = 32 C
Freezer Air Temperature = - 25 C

Calculation :

$$Q_{TL} = Q_{side\ Walls} + Q_{Bottom} + Q_{Top}$$

$$Q = U A (T_a - T_f)$$

$$U = \frac{1}{X_1 / K_1 + X_2 / K_2 + \ldots\ldots}$$

Where :

U = Heat Resistance Coefficient Factor
K_f = Foam Thermal Conductivity
X_f = Foam Thickness

Note : Due to the short thickness of cabinet out side panel (0.6 mm) and plastic inner liner (1.5 mm) heat resistance of these materials have been considered negligible.Therefore:

$Q_{SideWalls} = [U A (T_a - T_f)]$
T_a = Ambient Temperature
T_f = Freezer air Temperature

هاتف معرض : ٦٥٣٢٦٢ - المصنع : ٧٣١٣٧٢ - فاكس : ٦١٣٣٤٠-٦-٩٦٢ - ص.ب : ٩٢١٩٤٠ عمان - الاردن
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U = 1 / (0.05/0.018) = 0.36 W/ sq.m C
A = 1.12 Sq. Mt.
T_a = 32 C, T_f = - 25 C
$Q_{SideWalls}$ = 0.36 x 1.12 x 57 = 23 Watts
$Q_{SideWalls}$ = 23 Watts

$Q_{Front\ Wall}$ = [U A (T_a - T_f)]
T_a = Ambient Temperature
T_f = Freezer air Temperature
U = 1 / (0.050/0.018) = 0.36 W/ sq.m C
A = 1.07 Sq. Mt.
T_a = 32 C, T_f = - 25 C
$Q_{Front\ Wall}$ = 0.36 x 1.07 x 57 = 22 Watts

$Q_{Front\ Wall}$ = 22 Watts

$Q_{Back\ panel}$ = [U A (T_a - T_f)]
T_a = Ambient Temperature
T_f = Freezer air Temperature
U = 1 / (0.050/0.018) = 0.36 W/ sq.m C
A = 1.07 Sq. Mt.
T_a = 42 C, T_f = - 25 C
$Q_{back\ panel}$ = 0.36 x 1.07 x 57 = 22 Watts

Q_{Top} = [U A (T_a - T_f)]
T_a = Ambient Temperature
T_f = Freezer air Temperature
U = 1 / (0.050/0.018) = 0.36 W/ sq.m C
A = 0.81 Sq. Mt.
T_a = 32 C, T_f = - 25 C
Q_{Top} = 0.36 x 0.81 x 57 = 17 Watts
Q_{Top} = 17 Watts

هاتف معرض : ٦٥٣٢٦٢ ـ المصنع : ٧٣١٣٧٢ ـ فاكس : ٠٦-٦١٣٣٤٠-٩٦٢ ـ ص.ب : ٩٢١٩٤٠ عمان ـ الاردن
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Q_{Top} = 0.36 x 0.81 x 57 = 17 Watts
Q_{Top} = 17 Watts

Q_{Bottom} = [U A (T_a - T_f)]
T_a = Ambient Temperature
T_f = Freezer air Temperature
U = 1/(0.050/ 0.018) = 0.36 W/ sq.m C
A = 0.81 Sq. Mt.
T_a = 42 C, T_f = - 25 C
Q_{Bottom} = 0.36 x 0.81 x 67 = 19 Watts

Total Heat Leaks;

Q_{TL} = 23 + 26 + 22 + 19 + 17 = 107 watts

$$Q_{\text{Total Heat Leaks}} = 107 \text{ Watts}$$

Ice Making Capacity = 5_{Kg} x 1 x (15 - 0) x1.163= 87 Watts

c) Heat gain through infiltration;
We consider 10% safety factor for door opening and infiltration
Heat gain by infiltration = 0.1 x (total heat leaks)
Heat gain by infiltration = 0.1 x (87) = 9 Watts
Total Cooling Capacity Required is calculated as follows;

$$Q_{\text{Grand Total}} = Q_{\text{Heat Leaks}} + Q_{\text{Ice Making}} + Q_{\text{Infiltration}}$$

$$Q_{\text{Grand Total}} = 107 + 87 + 9 = 203 \text{ Watts}$$

$$Q_{\text{Grand Total}} = 203 \text{ Watts}$$

The suitable R134a compressor should be compatible with cooling capacity of 203 watt. A compressor compatible with Electrolux model P12Fw should be selected.

هاتف معرض : ٦٥٣٢٦٢ ـ المصنع : ٧٣١٣٧٢ ـ فاكس : ٠٦٦١٣٣٤٠ ـ ٩٦٢ ـ ص.ب : ٩٢١٩٤٠ عمان ـ الاردن
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Refrigeration Load Calculation
Al-Bisani Workshop Soft Drink Display Case
Model BS-160R

a) Transmission load calculation

Refrigerator Compartment	Dimension Cm.	Area (sq.mt.)	Insulation Thickness	Temp. Difference
Side Walls	2 x (80x200)	3.2	40mm	18 c
Back Panel	65 x200	1.3	40mm	18 c
Bottom	80x65	0.52	40mm	18C
Top	80x65	0.52	40mm	28 c
Door	65x200	1.3	15mm	18 c

Insulation Type: Pu Foam with R141b blowing agent.
Thermal Conductivity for Foam = 0.0180 W/ mt. ° C
Thermal Conductivity for Double Glass and Air = 0.12 W/ mt. ° C
Temperature Difference Refrigerator Compartment:
$\Delta T = 32 - (+5) = 27$ ° C
Ambient Temperature = 32 °C
Refrigerator Air Temperature = +14 °C

Calculation :

Heat Leak For Refrigerator Compartment.

$$Q_{TL} = Q_{SW} + Q_{Back\ Panel} + Q_{door} + Q_{Bottom} + Q_{top}$$

$$Q = U A (T_a - T_r)$$

$$U = \frac{1}{X_1 / K_1}$$

Where :

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U = Heat Resistance Coefficient Factor
K_1 = Foam Thermal Conductivity

Due to the short thickness of cabinet out side panel (0.6 mm) and plastic inner liner (1.5 mm) heat resistance of these materials have been considered negligible.
Therefore:

1- $Q_{SideWalls} = [U A (T_a - T_r)]$
T_a = Ambient Temperature 32
T_r = refrigerator air Temperature 5
U = 1 / (0.040/ 0.0180) = 0.45 W/ sq.m °C
A = 3.2 Sq. Mt., T_a = 32 °C, T_f = + 18 °C
therefore
$Q_{SideWalls}$ = 0.45 x 3.2 x 18 = 2.6 Watts
$Q_{SideWalls}$ = 2.6 Watts

2- $Q_{doors} = [U A (T_a - T_r)]$
U = 1 / [(0.015/ 0.12)] = 8 W/ sq.m °C ,
$T_a - T_r$ = 18, A = 1.3,
Q_{doors} = 8 x 1.3 x18 = 187 Watts
Q_{doors} = 187 Watts

3- $Q_{top} = [U A (T_a - T_r)]$
U = 0.45 w/sq. Mt. °C,
$T_a - T_r$ = 28 , **A = 0.52**
Q_{top} = 0.45 x 0.52 x 28 = 6.5 Watts
Q_{top} = 6.5 Watts

4 -$Q_{back\ panel} = [U A (T_a - T_r)]$
U = 0.45 w/sq. Mt. °C,
$T_a - T_r$ = 18 , A = 1.3
$Q_{back\ panel}$ = 0.45x 1.3 x 18 = 10.5 Watts
$Q_{back\ panel}$ = 10.5 Watts

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5 -Q_{Bottom} = [U A (T_a - T_r)]
U = 0.45 w/sq. Mt. °C,
T_a - T_r = 18, A = 0.52
$Q_{Bottom\ Surface}$ = 0.45x0.52 x 18 = 4.2 Watt
$Q_{Bottom\ Surface}$ = 4.2 Watts

Total Refrigerator Heat Leak =2.6 +187 + 4.2 + 10.6 + 6.5 = 211 W

Product Load

A product placed in a refrigerator at a temperature higher than the storage temperature will lose heat until it reaches the storage temperature. The quantity of heat to be removed may be calculated from knowledge of the product, including its state upon entering the refrigerator, its final state, its weight, specific heat above and below freezing point, its freezing temperature and latent heat.

When a definite weight of product is cooled from one state and temperature to another state and temperature, some or all of the following calculations must be made:

Heat removal from intial temperature to some lower temperature above freezing.

$$Q = mc(T_1-T_2)$$

Heat removal from initial temperature to freezing point of product.

$$Q = mc(T_i-T_f)$$

Heat removal to freeze product.

$$Q = mh_{if}$$

Heat removal from freezing point to final temperature below freezing.

$$Q = mc(T_f-T_3)$$

Where

Q = heat removed, Kj
M = weight of product, kg
C = specific heat of product above freezing point, Kj/Kg. K
T_1 = initial temp. C

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T_2 = lower temperature above freezing, C
T_f = freezing temperature of product, C
H_{if} = latent heat of fusion, kj per kg

Since this product is mainly used for storing Soft Drink Bottels above

freezing point at +14 C, we consider 200 bottles of soft drink to be stored in this refrigerator therefore we calculate as follow, each bottle contains 300 ml of soft drink

$$Q = mc(T_1-T_2)$$

M = 300 x 200 = 60000 ml = kg
C = 0.999 Btu/(lb)F deg = 0.999 x 4.184 = 4.179 j/g K
T_1 = 28 C
T_2 = 5 C
Q = 60000x4.179x (28-5) =5768146 jul/86400 = 66 Watt

Internal Load
Motor Fan 16 Watt
Flourecent Lamps = 40 Watt
Door Opening
Refrigerator Internal Volume 800 lit.
Number of air change as per ASHREA standard = 70 per day
Heat removed per cubic meter of air 75000 j
Air Change load = (0.8x70x75000)/86400 = 48.6 Watt

$Q_{Total} = Q_{heat\ leak} + Q_{product\ load} + Q_{internal\ load} + Q_{air\ change}$

$Q_{Total} = 211 + 66 + 16 + 40 + 46.6 = 381.6$

Considering 20 % of Q total for safety factor

$Q_{Grand\ Total}$ = 381 + 20%(76) = 457watts

With respect to the above calculation we have to select a compressor of R134a with cooling capacity of approximately 457 watt at + 14 degree centigrade evaporating temperature.

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Refrigeration Load Calculation
Al- Eslah Workshop Soft Drink Display Case
Model ER-600

a) Transmission load calculation

Refrigerator Compartment	Dimension Cm.	Area (sq.mt.)	Insulation Thickness	Temp. Difference
Side Walls	2 x (80x200)	3.2	40mm	18 c
Back Panel	65 x200	1.3	40mm	18 c
Bottom	80x65	0.52	40mm	18C
Top	80x65	0.52	40mm	28 c
Door	65x200	1.3	15mm	18 c

Insulation Type: Pu Foam with R141b blowing agent.
Thermal Conductivity for Foam = 0.0180 W/ mt. ° C
Thermal Conductivity for Double Glass and Air = 0.12 W/ mt. ° C
Temperature Difference Refrigerator Compartment:
$\Delta T = 32 - (+5) = 27$ ° C
Ambient Temperature = 32 °C
Refrigerator Air Temperature = +14 °C

Calculation :

Heat Leak For Refrigerator Compartment.

$$Q_{TL} = Q_{SW} + Q_{Back\ Panel} + Q_{door} + Q_{Bottom} + Q_{top}$$

$$Q = U A (T_a - T_r)$$

$$U = \frac{1}{X_1 / K_1}$$

Where :

U = Heat Resistance Coefficient Factor

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K_f = Foam Thermal Conductivity

Due to the short thickness of cabinet out side panel (0.6 mm) and plastic inner liner (1.5 mm) heat resistance of these materials have been considered negligible. Therefore:

1- $Q_{SideWalls} = [U A (T_a - T_r)]$
T_a = Ambient Temperature 32
T_r = refrigerator air Temperature 5
U = 1 / (0.040/ 0.0180) = 0.45 W/ sq.m °C
A = 3.2 Sq. Mt., T_a = 32 °C, T_f = + 18 °C
therefore
$Q_{SideWalls}$ = 0.45 x 3.2 x 18 = 2.6 Watts
$Q_{SideWalls}$ = 2.6 Watts

2- $Q_{doors} = [U A (T_a - T_r)]$
U = 1 / [(0.015/ 0.12)] = 8 W/ sq.m °C ,
$T_a - T_r$ = 18, A = 1.3,
Q_{doors} = 8 x 1.3 x18 = 187 Watts
Q_{doors} = 187 Watts

3- $Q_{top} = [U A (T_a - T_r)]$
U = 0.45 w/sq. Mt. °C,
$T_a - T_r$ = 28 , **A = 0.52**
Q_{top} = 0.45 x 0.52 x 28 = 6.5 Watts
Q_{top} = 6.5 Watts

4 -$Q_{back\ panel} = [U A (T_a - T_r)]$
U = 0.45 w/sq. Mt. °C,
$T_a - T_r$ = 18 , A = 1.3
$Q_{back\ panel}$ = 0.45x 1.3 x 18 = 10.5 Watts
$Q_{back\ panel}$ = 10.5 Watts

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5 -Q_{Bottom} = [U A (T_a - T_r)]
U = 0.45 w/sq. Mt. °C,
T_a - T_r= 18, A = 0.52
$Q_{Bottom\ Surface}$ = 0.45x0.52 x 18 = 4.2 Watt
$Q_{Bottom\ Surface}$ = 4.2 Watts

Total Refrigerator Heat Leak =2.6 +187 + 4.2 + 10.6 + 6.5 = 211 W

Product Load

A product placed in a refrigerator at a temperature higher than the storage temperature will lose heat until it reaches the storage temperature. The quantity of heat to be removed may be calculated from knowledge of the product, including its state upon entering the refrigerator, its final state, its weight, specific heat above and below freezing point, its freezing temperature and latent heat.

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$$Q = mc(T_1-T_2)$$

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$$Q = mc(T_i-T_f)$$

Heat removal to freeze product.

$$Q = mh_{if}$$

Heat removal from freezing point to final temperature below freezing.

$$Q = mc(T_f-T_3)$$

Where

Q = heat removed, Kj
M = weight of product, kg
C = specific heat of product above freezing point, Kj/Kg. K
T_1 = initial temp. C

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T_2 = lower temperature above freezing, C
T_f = freezing temperature of product, C
H_{if} = latent heat of fusion, kj per kg

Since this product is mainly used for storing Soft Drink Bottels above

freezing point at +14 C, we consider 200 bottles of soft drink to be stored in this refrigerator therefore we calculate as follow, each bottle contains 300 ml of soft drink

$$Q = mc(T_1-T_2)$$

M = 300 x 200 = 60000 ml = kg
C = 0.999 Btu/(lb)F deg = 0.999 x 4.184 = 4.179 j/g K
T_1 = 28 C
T_2 = 5 C
Q = 60000x4.179x (28-5) =5768146 jul/86400 = 66 Watt

Internal Load
Motor Fan 16 Watt
Flourecent Lamps = 40 Watt
Door Opening
Refrigerator Internal Volume 800 lit.
Number of air change as per ASHREA standard = 70 per day
Heat removed per cubic meter of air 75000 j
Air Change load = (0.8x70x75000)/86400 = 48.6 Watt

$Q_{Total} = Q_{heat\ leak} + Q_{product\ load} + Q_{internal\ load} + Q_{air\ change}$

$Q_{Total} = 211 + 66 + 16 + 40 + 46.6 = 381.6$

Considering 20 % of Q total for safety factor

$Q_{Grand\ Total} = 381 + 20\%(76) = 457$watts

With respect to the above calculation we have to select a compressor of R134a with cooling capacity of approximately 457 watt at + 14 degree centigrade evaporating temperature.

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Product Technical Specification ***Jamal Yussef Workshop***	
Description	**Specification**
Company Name	Jamal Yussef
Product Name	Meat Refrigerator, Upright
Product Model	JM-1600
Product Application	Meat Show Case
Operating Temperature	32 C
Climatic Condition	Normal
Product Overall Dimension WxLxH mm	160x80x200
Freezer Compartment Overall Dimension and Wall Thickness	N/A
Refrigerator Compartment Overall Dimension and Wall Thickness	40 mm
Product Shape, Double Doors, Upright, Chest, etc	Upright Show case with Double Glass doors
Freezer Internal Net Volume	N/A
Refrigerator Net Volume	1300 lit
Product Net Volume	2560 lit
Product Inside Temperature C	+ 5
Water Storage Tank Capacity, Water Cooler	N/A
Type of Water Storage Tank Cylinder, Cubic, etc.	N/A
Water Fellow per hour for water cooler	N/A
Water Storage Tank Dimension	N/A
Water Outlet Temperature	N/A
Water Inlet Temperature	N/A
Freezer Inside Temperature	N/A
Refrigerator Inside Temperature	+5 C
Evaporating Temperature	- 10 C
Foam Insulation Thickness mm Side Walls, Top, Bottom, Door, Back Panel	40 mm
Type of PU Foam	R11 PU Foam
Foam Density, Kg/Cu. Mt.	40 Kg/ Cu Cm
Foam Mixture, Percentage Pol% + R11% + Isocyanate%	37% + 13% + 50%
Total amount of Foam Injection, Kg	20 Kg.
Refrigerant Type	CFC - 11
Refrigerant Charge Weight Gr.	400 gr.
Type of Compressor, Hermetic, Semi Hermetic, Open	Hermetic
Compressor Cooling System Static, Oil Cooled, Fan Cooled	Fan Cooled

Compressor Cooling Capacity Watt	600 Watts
Compressor input Power, Watt	550 Watts
Compressor Model Number	CAE4461E
Compressor Manufacturer	UNITEH HERMATIC
Compressor Mounting Place Top, Bottom, Front, Back	Top Roof
Condenser Type, Static, Fan Cooled	Fan Cooled
Condenser Dimension, Length, Inside Tube Diameter,	Four Rows Tube Coil, and Fins
Condenser Material, Aluminum, Copper, Copper Coated, etc,	Copper
Condenser mounting Place, Back Wall, Top, Bottom	Top Roof
Evaporator Type, Fin and Tube, Roll Bond, Wire and Tube, etc.	Fin and Tube
Evaporator Dimension, Length, Surface Area, Inside Tube Diameter	Tube Coils and Fins
Evaporator Material, Aluminum, Copper, Copper Coated, etc,	Copper
Dryer Type,	Cylindrical
Dryer Material, Weight and Size	Ranco, 20 gr.
Capillary Tube Diameter and Length	0.8 mm Dim, 3000 mm Length

Product Technical Specification ***Jamal Yussef Workshop***	
Description	**Specification**
Company Name	Jamal Yussef
Product Name	Meat Refrigerator, Upright
Product Model	JM-2000
Product Application	Meat Show Case
Operating Temperature	32 C
Climatic Condition	Normal
Product Overall Dimension WxLxH mm	200x80x200
Freezer Compartment Overall Dimension and Wall Thickness	N/A
Refrigerator Compartment Overall Dimension and Wall Thickness	40 mm
Product Shape, Double Doors, Upright, Chest, etc	Upright Show case with Double Glass doors
Freezer Internal Net Volume	N/A
Refrigerator Net Volume	1800 lit
Product Net Volume	3200 lit
Product Inside Temperature C	+ 5
Water Storage Tank Capacity, Water Cooler	N/A
Type of Water Storage Tank Cylinder, Cubic, etc.	N/A
Water Fellow per hour for water cooler	N/A
Water Storage Tank Dimension	N/A
Water Outlet Temperature	N/A
Water Inlet Temperature	N/A
Freezer Inside Temperature	N/A
Refrigerator Inside Temperature	+5 C
Evaporating Temperature	- 10 C
Foam Insulation Thickness mm Side Walls, Top, Bottom, Door, Back Panel	40 mm
Type of PU Foam	R11 PU Foam
Foam Density, Kg/Cu. Mt.	40 Kg/ Cu Cm
Foam Mixture, Percentage Pol% + R11% + Isocyanate%	37% + 13% + 50%
Total amount of Foam Injection, Kg	25 Kg.
Refrigerant Type	CFC - 11
Refrigerant Charge Weight Gr.	600 gr.
Type of Compressor, Hermetic, Semi Hermetic, Open	Hermetic
Compressor Cooling System Static, Oil Cooled, Fan Cooled	Fan Cooled

Compressor Cooling Capacity Watt	800 Watts
Compressor input Power, Watt	650 Watts
Compressor Model Number	1 hp
Compressor Manufacturer	Danfoss
Compressor Mounting Place Top, Bottom, Front, Back	Top Roof
Condenser Type, Static, Fan Cooled	Fan Cooled
Condenser Dimension, Length, Inside Tube Diameter,	Four Rows Tube Coil, and Fins
Condenser Material, Aluminum, Copper, Copper Coated, etc,	Copper
Condenser mounting Place, Back Wall, Top, Bottom	Top Roof
Evaporator Type, Fin and Tube, Roll Bond, Wire and Tube, etc.	Fin and Tube
Evaporator Dimension, Length, Surface Area, Inside Tube Diameter	Tube Coils and Fins
Evaporator Material, Aluminum, Copper, Copper Coated, etc,	Copper
Dryer Type,	Cylindrical
Dryer Material, Weight and Size	Ranco, 30 gr.
Capillary Tube Diameter and Length	0.8 mm Dim, 3000 mm Length

Product Technical Specification ***Imad Hedjawi Workshop***	
Description	**Specification**
Company Name	Imad Hedjawi
Product Name	Meat Freezer, Chest
Product Model	IMD-400F
Product Application	Freezer
Operating Temperature	32 C
Climatic Condition	Normal
Product Overall Dimension WxLxH mm	120x64x85
Freezer Compartment Overall Dimension and Wall Thickness	N/A
Refrigerator Compartment Overall Dimension and Wall Thickness	50 mm
Product Shape, Double Doors, Upright, Chest, etc	Upright Freezer
Freezer Internal Net Volume	400 liter
Refrigerator Net Volume	N/A
Product Net Volume	650 liter
Product Inside Temperature C	- 18 C
Water Storage Tank Capacity, Water Cooler	N/A
Type of Water Storage Tank Cylinder, Cubic, etc.	N/A
Water Fellow per hour for water cooler	N/A
Water Storage Tank Dimension	N/A
Water Outlet Temperature	N/A
Water Inlet Temperature	N/A
Freezer Inside Temperature	N/A
Refrigerator Inside Temperature	N/A
Evaporating Temperature	- 23.3 C
Foam Insulation Thickness mm Side Walls, Top, Bottom, Door, Back Panel	50 mm
Type of PU Foam	R11 PU Foam
Foam Density, Kg/Cu. Mt.	40 Kg/ Cu Cm
Foam Mixture, Percentage Pol% + R11% + Isocyanate%	30% + 10% + 60%
Total amount of Foam Injection, Kg	8 Kg.
Refrigerant Type	CFC - 11
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	350 Watts
Compressor input Power, Watt	400 Watts
Compressor Model Number	ZF11
Compressor Manufacturer	Tecomseh France
Compressor Mounting Place Top, Bottom, Front, Back	Bottom
Condenser Type, Static, Fan Cooled	Fan Cooled
Condenser Dimension, Length, Inside Tube Diameter,	Four Rows Tube Coil, and Fins
Condenser Material, Aluminum, Copper, Copper Coated, etc,	Copper
Condenser mounting Place, Back Wall, Top, Bottom	Bottom
Evaporator Type, Fin and Tube, Roll Bond, Wire and Tube, etc.	Tube
Evaporator Dimension, Length, Surface Area, Inside Tube Diameter	Tube Coils 40 mt.
Evaporator Material, Aluminum, Copper, Copper Coated, etc,	Copper
Dryer Type,	Cylindrical
Dryer Material, Weight and Size	Ranco, 20 gr.
Capillary Tube Diameter and Length	0.8 mm Dim, 3000 mm Length

Product Technical Specification ***Imad Hedjawi Workshop***	
Description	**Specification**
Company Name	Imad Hedjawi
Product Name	Meat Freezer, Chest
Product Model	IMD-600F
Product Application	Freezer
Operating Temperature	32 C
Climatic Condition	Normal
Product Overall Dimension WxLxH mm	160x64x85
Freezer Compartment Overall Dimension and Wall Thickness	N/A
Refrigerator Compartment Overall Dimension and Wall Thickness	50 mm
Product Shape, Double Doors, Upright, Chest, etc	Upright Freezer
Freezer Internal Net Volume	600 liter
Refrigerator Net Volume	N/A
Product Net Volume	650 liter
Product Inside Temperature C	- 18 C
Water Storage Tank Capacity, Water Cooler	N/A
Type of Water Storage Tank Cylinder, Cubic, etc.	N/A
Water Fellow per hour for water cooler	N/A
Water Storage Tank Dimension	N/A
Water Outlet Temperature	N/A
Water Inlet Temperature	N/A
Freezer Inside Temperature	N/A
Refrigerator Inside Temperature	N/A
Evaporating Temperature	- 23.3 C
Foam Insulation Thickness mm Side Walls, Top, Bottom, Door, Back Panel	50 mm
Type of PU Foam	R11 PU Foam
Foam Density, Kg/Cu. Mt.	40 Kg/ Cu Cm
Foam Mixture, Percentage Pol% + R11% + Isocyanate%	30% + 10% + 60%
Total amount of Foam Injection, Kg	15 Kg.
Refrigerant Type	CFC - 11
Refrigerant Charge Weight Gr.	500 gr.
Type of Compressor, Hermetic, Semi Hermetic, Open	Hermetic
Compressor Cooling System Static, Oil Cooled, Fan Cooled	Fan Cooled

Compressor Cooling Capacity Watt	400Watts
Compressor input Power, Watt	450 Watts
Compressor Model Number	ZF15
Compressor Manufacturer	Tecomseh France
Compressor Mounting Place Top, Bottom, Front, Back	Bottom
Condenser Type, Static, Fan Cooled	Fan Cooled
Condenser Dimension, Length, Inside Tube Diameter,	Four Rows Tube Coil, and Fins
Condenser Material, Aluminum, Copper, Copper Coated, etc,	Copper
Condenser mounting Place, Back Wall, Top, Bottom	Bottom
Evaporator Type, Fin and Tube, Roll Bond, Wire and Tube, etc.	Tube
Evaporator Dimension, Length, Surface Area, Inside Tube Diameter	Tube Coils 40 mt.
Evaporator Material, Aluminum, Copper, Copper Coated, etc,	Copper
Dryer Type,	Cylindrical
Dryer Material, Weight and Size	Ranco, 30 gr.
Capillary Tube Diameter and Length	0.8 mm Dim, 3000 mm Length

Product Technical Specification ***Lebanon Workshop***	
Description	**Specification**
Company Name	Lebanon Company
Product Name	Refrigerator, Upright
Product Model	SH-160R
Product Application	Soft Drink Refrigerator
Operating Temperature	32 C
Climatic Condition	Normal
Product Overall Dimension WxLxH mm	65x80x200
Freezer Compartment Overall Dimension and Wall Thickness	N/A
Refrigerator Compartment Overall Dimension and Wall Thickness	40
Product Shape, Double Doors, Upright, Chest, etc	Upright Show case with Double Glass doors
Freezer Internal Net Volume	N/A
Refrigerator Net Volume	600 lit
Product Net Volume	1040 lit
Product Inside Temperature C	+ 10
Water Storage Tank Capacity, Water Cooler	N/A
Type of Water Storage Tank Cylinder, Cubic, etc.	N/A
Water Fellow per hour for water cooler	N/A
Water Storage Tank Dimension	N/A
Water Outlet Temperature	N/A
Water Inlet Temperature	N/A
Freezer Inside Temperature	N/A
Refrigerator Inside Temperature	+10 C
Evaporating Temperature	- 5 C
Foam Insulation Thickness mm Side Walls, Top, Bottom, Door, Back Panel	40 mm
Type of PU Foam	R11 PU Foam
Foam Density, Kg/Cu. Mt.	40 Kg/ Cu Cm
Foam Mixture, Percentage Pol% + R11% + Isocyanate%	34% + 16% + 50%
Total amount of Foam Injection, Kg	20 Kg.
Refrigerant Type	CFC - 11
Refrigerant Charge Weight Gr.	450 gr.
Type of Compressor, Hermetic, Semi Hermetic, Open	Hermetic
Compressor Cooling System Static, Oil Cooled, Fan Cooled	Fan Cooled

Compressor Cooling Capacity Watt	400 Watts
Compressor input Power, Watt	450 Watts
Compressor Model Number	SC21B
Compressor Manufacturer	Danfoss
Compressor Mounting Place Top, Bottom, Front, Back	Top Roof
Condenser Type, Static, Fan Cooled	Fan Cooled
Condenser Dimension, Length, Inside Tube Diameter,	Four Rows Tube Coil, and Fins
Condenser Material, Aluminum, Copper, Copper Coated, etc,	Copper
Condenser mounting Place, Back Wall, Top, Bottom	Top Roof
Evaporator Type, Fin and Tube, Roll Bond, Wire and Tube, etc.	Fin and Tube
Evaporator Dimension, Length, Surface Area, Inside Tube Diameter	Tube Coils and Fins
Evaporator Material, Aluminum, Copper, Copper Coated, etc,	Copper
Dryer Type,	Cylindrical
Dryer Material, Weight and Size	Ranco, 20 gr.
Capillary Tube Diameter and Length	0.8 mm Dim, 3000 mm Length

Product Technical Specification ***LebanonWorkshop***	
Description	**Specification**
Company Name	Lebanon Company
Product Name	Water Cooler
Product Model	M-100
Product Application	Cooling Drinkable Water
Operating Temperature	32 C
Climatic Condition	Normal
Product Overall Dimension WxLxH mm	N/A
Freezer Compartment Overall Dimension and Wall Thickness	N/A
Refrigerator Compartment Overall Dimension and Wall Thickness	50 mm
Product Shape, Double Doors, Upright, Chest, etc	Three Water Tabs
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	100 liters
Type of Water Storage Tank Cylinder, Cubic, etc.	Cubic
Water Fellow per hour for water cooler	4
Water Storage Tank Dimension	45x70x130
Water Outlet Temperature	+ 10
Water Inlet Temperature	+ 24
Freezer Inside Temperature	N/A
Refrigerator Inside Temperature	N/A
Evaporating Temperature	- 10 C
Foam Insulation Thickness mm Side Walls, Top, Bottom, Door, Back Panel	50 mm
Type of PU Foam	R11 PU Foam
Foam Density, Kg/Cu. Mt.	40 Kg/ Cu Cm
Foam Mixture, Percentage Pol% + R11% + Isocyanate%	33% + 17% + 50%
Total amount of Foam Injection, Kg	4 Kg.
Refrigerant Type	CFC - 11
Refrigerant Charge Weight Gr.	400 gr.
Type of Compressor, Hermetic, Semi Hermetic, Open	Hermetic
Compressor Cooling System Static, Oil Cooled, Fan Cooled	Fan Cooled

Compressor Cooling Capacity Watt	200 Watts
Compressor input Power, Watt	220 Watts
Compressor Model Number	L76AV
Compressor Manufacturer	Eletrolux
Compressor Mounting Place Top, Bottom, Front, Back	Top Roof
Condenser Type, Static, Fan Cooled	Fan Cooled
Condenser Dimension, Length, Inside Tube Diameter,	Four Rows Tube Coil, and Fins
Condenser Material, Aluminum, Copper, Copper Coated, etc,	Copper
Condenser mounting Place, Back Wall, Top, Bottom	Top Roof
Evaporator Type, Fin and Tube, Roll Bond, Wire and Tube, etc.	Fin and Tube
Evaporator Dimension, Length, Surface Area, Inside Tube Diameter	Tube Coils and Fins
Evaporator Material, Aluminum, Copper, Copper Coated, etc,	Copper
Dryer Type,	Cylindrical
Dryer Material, Weight and Size	Ranco, 20 gr.
Capillary Tube Diameter and Length	0.8 mm Dim, 3000 mm Length

Product Technical Specification ***Al-Bissani Workshop***	
Description	**Specification**
Company Name	Al-Bisani Company
Product Name	Refrigerator, Upright
Product Model	BS-160R
Product Application	Soft Drink Refrigerator
Operating Temperature	32 C
Climatic Condition	Normal
Product Overall Dimension WxLxH mm	65x80x200
Freezer Compartment Overall Dimension and Wall Thickness	N/A
Refrigerator Compartment Overall Dimension and Wall Thickness	40
Product Shape, Double Doors, Upright, Chest, etc	Upright Show case with Double Glass doors
Freezer Internal Net Volume	N/A
Refrigerator Net Volume	600 lit
Product Net Volume	1040 lit
Product Inside Temperature C	+ 10
Water Storage Tank Capacity, Water Cooler	N/A
Type of Water Storage Tank Cylinder, Cubic, etc.	N/A
Water Fellow per hour for water cooler	N/A
Water Storage Tank Dimension	N/A
Water Outlet Temperature	N/A
Water Inlet Temperature	N/A
Freezer Inside Temperature	N/A
Refrigerator Inside Temperature	+10 C
Evaporating Temperature	- 5 C
Foam Insulation Thickness mm Side Walls, Top, Bottom, Door, Back Panel	40 mm
Type of PU Foam	R11 PU Foam
Foam Density, Kg/Cu. Mt.	40 Kg/ Cu Cm
Foam Mixture, Percentage Pol% + R11% + Isocyanate%	34% + 16% + 50%
Total amount of Foam Injection, Kg	20 Kg.
Refrigerant Type	CFC - 11
Refrigerant Charge Weight Gr.	450 gr.
Type of Compressor, Hermetic, Semi Hermetic, Open	Hermetic
Compressor Cooling System Static, Oil Cooled, Fan Cooled	Fan Cooled

Compressor Cooling Capacity Watt	400 Watts
Compressor input Power, Watt	450 Watts
Compressor Model Number	SC21B
Compressor Manufacturer	Danfoss
Compressor Mounting Place Top, Bottom, Front, Back	Top Roof
Condenser Type, Static, Fan Cooled	Fan Cooled
Condenser Dimension, Length, Inside Tube Diameter,	Four Rows Tube Coil, and Fins
Condenser Material, Aluminum, Copper, Copper Coated, etc,	Copper
Condenser mounting Place, Back Wall, Top, Bottom	Top Roof
Evaporator Type, Fin and Tube, Roll Bond, Wire and Tube, etc.	Fin and Tube
Evaporator Dimension, Length, Surface Area, Inside Tube Diameter	Tube Coils and Fins
Evaporator Material, Aluminum, Copper, Copper Coated, etc,	Copper
Dryer Type,	Cylindrical
Dryer Material, Weight and Size	Ranco, 20 gr.
Capillary Tube Diameter and Length	0.8 mm Dim, 3000 mm Length

Product Technical Specification ***Al Bisani Workshop***	
Description	**Specification**
Company Name	Al-Bisani Company
Product Name	Water Cooler
Product Model	BES-100WC
Product Application	Cooling Drinkable Water
Operating Temperature	32 C
Climatic Condition	Normal
Product Overall Dimension WxLxH mm	N/A
Freezer Compartment Overall Dimension and Wall Thickness	N/A
Refrigerator Compartment Overall Dimension and Wall Thickness	50 mm
Product Shape, Double Doors, Upright, Chest, etc	Three Water Tabs
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	100 liters
Type of Water Storage Tank Cylinder, Cubic, etc.	Cubic
Water Fellow per hour for water cooler	4
Water Storage Tank Dimension	45x70x130
Water Outlet Temperature	+ 10
Water Inlet Temperature	+ 24
Freezer Inside Temperature	N/A
Refrigerator Inside Temperature	N/A
Evaporating Temperature	- 10 C
Foam Insulation Thickness mm Side Walls, Top, Bottom, Door, Back Panel	50 mm
Type of PU Foam	R11 PU Foam
Foam Density, Kg/Cu. Mt.	40 Kg/ Cu Cm
Foam Mixture, Percentage Pol% + R11% + Isocyanate%	33% + 17% + 50%
Total amount of Foam Injection, Kg	4 Kg.
Refrigerant Type	CFC - 11
Refrigerant Charge Weight Gr.	400 gr.
Type of Compressor, Hermetic, Semi Hermetic, Open	Hermetic
Compressor Cooling System Static, Oil Cooled, Fan Cooled	Fan Cooled

Compressor Cooling Capacity Watt	200 Watts
Compressor input Power, Watt	220 Watts
Compressor Model Number	L76AV
Compressor Manufacturer	Eletrolux
Compressor Mounting Place Top, Bottom, Front, Back	Top Roof
Condenser Type, Static, Fan Cooled	Fan Cooled
Condenser Dimension, Length, Inside Tube Diameter,	Four Rows Tube Coil, and Fins
Condenser Material, Aluminum, Copper, Copper Coated, etc,	Copper
Condenser mounting Place, Back Wall, Top, Bottom	Top Roof
Evaporator Type, Fin and Tube, Roll Bond, Wire and Tube, etc.	Fin and Tube
Evaporator Dimension, Length, Surface Area, Inside Tube Diameter	Tube Coils and Fins
Evaporator Material, Aluminum, Copper, Copper Coated, etc,	Copper
Dryer Type,	Cylindrical
Dryer Material, Weight and Size	Ranco, 20 gr.
Capillary Tube Diameter and Length	0.8 mm Dim, 3000 mm Length

Product Technical Specification ***Al-Amal Workshop***	
Description	**Specification**
Company Name	Al- Amal
Product Name	Chest Freezer,
Product Model	Amal-CF120
Product Application	Freezer
Operating Temperature	32 C
Climatic Condition	Normal
Product Overall Dimension WxLxH mm	160x64x85
Freezer Compartment Overall Dimension and Wall Thickness	N/A
Refrigerator Compartment Overall Dimension and Wall Thickness	50 mm
Product Shape, Double Doors, Upright, Chest, etc	Upright Freezer
Freezer Internal Net Volume	600 liter
Refrigerator Net Volume	N/A
Product Net Volume	650 liter
Product Inside Temperature C	- 18 C
Water Storage Tank Capacity, Water Cooler	N/A
Type of Water Storage Tank Cylinder, Cubic, etc.	N/A
Water Fellow per hour for water cooler	N/A
Water Storage Tank Dimension	N/A
Water Outlet Temperature	N/A
Water Inlet Temperature	N/A
Freezer Inside Temperature	N/A
Refrigerator Inside Temperature	N/A
Evaporating Temperature	- 23.3 C
Foam Insulation Thickness mm Side Walls, Top, Bottom, Door, Back Panel	50 mm
Type of PU Foam	R11 PU Foam
Foam Density, Kg/Cu. Mt.	40 Kg/ Cu Cm
Foam Mixture, Percentage Pol% + R11% + Isocyanate%	30% + 10% + 60%
Total amount of Foam Injection, Kg	15 Kg.
Refrigerant Type	CFC - 11
Refrigerant Charge Weight Gr.	500 gr.
Type of Compressor, Hermetic, Semi Hermetic, Open	Hermetic
Compressor Cooling System Static, Oil Cooled, Fan Cooled	Fan Cooled

Compressor Cooling Capacity Watt	400Watts
Compressor input Power, Watt	450 Watts
Compressor Model Number	ZF15
Compressor Manufacturer	Tecomseh France
Compressor Mounting Place Top, Bottom, Front, Back	Bottom
Condenser Type, Static, Fan Cooled	Fan Cooled
Condenser Dimension, Length, Inside Tube Diameter,	Four Rows Tube Coil, and Fins
Condenser Material, Aluminum, Copper, Copper Coated, etc,	Copper
Condenser mounting Place, Back Wall, Top, Bottom	Bottom
Evaporator Type, Fin and Tube, Roll Bond, Wire and Tube, etc.	Tube
Evaporator Dimension, Length, Surface Area, Inside Tube Diameter	Tube Coils 40 mt.
Evaporator Material, Aluminum, Copper, Copper Coated, etc,	Copper
Dryer Type,	Cylindrical
Dryer Material, Weight and Size	Ranco, 30 gr.
Capillary Tube Diameter and Length	0.8 mm Dim, 3000 mm Length

Product Technical Specification ***Al – Amal Workshop***	
Description	**Specification**
Company Name	Al-AmalCompany
Product Name	Water Cooler
Product Model	AWC-100
Product Application	Cooling Drinkable Water
Operating Temperature	32 C
Climatic Condition	Normal
Product Overall Dimension WxLxH mm	N/A
Freezer Compartment Overall Dimension and Wall Thickness	N/A
Refrigerator Compartment Overall Dimension and Wall Thickness	50 mm
Product Shape, Double Doors, Upright, Chest, etc	Three Water Tabs
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	100 liters
Type of Water Storage Tank Cylinder, Cubic, etc.	Cubic
Water Fellow per hour for water cooler	4
Water Storage Tank Dimension	45x70x130
Water Outlet Temperature	+ 10
Water Inlet Temperature	+ 24
Freezer Inside Temperature	N/A
Refrigerator Inside Temperature	N/A
Evaporating Temperature	- 10 C
Foam Insulation Thickness mm Side Walls, Top, Bottom, Door, Back Panel	50 mm
Type of PU Foam	R11 PU Foam
Foam Density, Kg/Cu. Mt.	40 Kg/ Cu Cm
Foam Mixture, Percentage Pol% + R11% + Isocyanate%	33% + 17% + 50%
Total amount of Foam Injection, Kg	4 Kg.
Refrigerant Type	CFC - 11
Refrigerant Charge Weight Gr.	400 gr.
Type of Compressor, Hermetic, Semi Hermetic, Open	Hermetic
Compressor Cooling System Static, Oil Cooled, Fan Cooled	Fan Cooled

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Compressor Cooling Capacity Watt	200 Watts
Compressor input Power, Watt	220 Watts
Compressor Model Number	L76AV
Compressor Manufacturer	Eletrolux
Compressor Mounting Place Top, Bottom, Front, Back	Top Roof
Condenser Type, Static, Fan Cooled	Fan Cooled
Condenser Dimension, Length, Inside Tube Diameter,	Four Rows Tube Coil, and Fins
Condenser Material, Aluminum, Copper, Copper Coated, etc,	Copper
Condenser mounting Place, Back Wall, Top, Bottom	Top Roof
Evaporator Type, Fin and Tube, Roll Bond, Wire and Tube, etc.	Fin and Tube
Evaporator Dimension, Length, Surface Area, Inside Tube Diameter	Tube Coils and Fins
Evaporator Material, Aluminum, Copper, Copper Coated, etc,	Copper
Dryer Type,	Cylindrical
Dryer Material, Weight and Size	Ranco, 20 gr.
Capillary Tube Diameter and Length	0.8 mm Dim, 3000 mm Length

Product Technical Specification ***Al-Eslah Workshop***	
Description	**Specification**
Company Name	Al-Eslah Company
Product Name	Refrigerator, Upright
Product Model	E-R600
Product Application	Soft Drink Refrigerator
Operating Temperature	32 C
Climatic Condition	Normal
Product Overall Dimension WxLxH mm	65x80x200
Freezer Compartment Overall Dimension and Wall Thickness	N/A
Refrigerator Compartment Overall Dimension and Wall Thickness	40
Product Shape, Double Doors, Upright, Chest, etc	Upright Show case with Double Glass doors
Freezer Internal Net Volume	N/A
Refrigerator Net Volume	600 lit
Product Net Volume	1040 lit
Product Inside Temperature C	+ 10
Water Storage Tank Capacity, Water Cooler	N/A
Type of Water Storage Tank Cylinder, Cubic, etc.	N/A
Water Fellow per hour for water cooler	N/A
Water Storage Tank Dimension	N/A
Water Outlet Temperature	N/A
Water Inlet Temperature	N/A
Freezer Inside Temperature	N/A
Refrigerator Inside Temperature	+10 C
Evaporating Temperature	- 5 C
Foam Insulation Thickness mm Side Walls, Top, Bottom, Door, Back Panel	40 mm
Type of PU Foam	R11 PU Foam
Foam Density, Kg/Cu. Mt.	40 Kg/ Cu Cm
Foam Mixture, Percentage Pol% + R11% + Isocyanate%	34% + 16% + 50%
Total amount of Foam Injection, Kg	20 Kg.
Refrigerant Type	CFC - 11
Refrigerant Charge Weight Gr.	450 gr.
Type of Compressor, Hermetic, Semi Hermetic, Open	Hermetic
Compressor Cooling System Static, Oil Cooled, Fan Cooled	Fan Cooled

Compressor Cooling Capacity Watt	400 Watts
Compressor input Power, Watt	450 Watts
Compressor Model Number	SC21B
Compressor Manufacturer	Danfoss
Compressor Mounting Place Top, Bottom, Front, Back	Top Roof
Condenser Type, Static, Fan Cooled	Fan Cooled
Condenser Dimension, Length, Inside Tube Diameter,	Four Rows Tube Coil, and Fins
Condenser Material, Aluminum, Copper, Copper Coated, etc,	Copper
Condenser mounting Place, Back Wall, Top, Bottom	Top Roof
Evaporator Type, Fin and Tube, Roll Bond, Wire and Tube, etc.	Fin and Tube
Evaporator Dimension, Length, Surface Area, Inside Tube Diameter	Tube Coils and Fins
Evaporator Material, Aluminum, Copper, Copper Coated, etc,	Copper
Dryer Type,	Cylindrical
Dryer Material, Weight and Size	Ranco, 20 gr.
Capillary Tube Diameter and Length	0.8 mm Dim, 3000 mm Length

Product Technical Specification ***Al – Eslah Workshop***	
Description	**Specification**
Company Name	Al-EslahCompany
Product Name	Water Cooler
Product Model	ES-100WC
Product Application	Cooling Drinkable Water
Operating Temperature	32 C
Climatic Condition	Normal
Product Overall Dimension WxLxH mm	N/A
Freezer Compartment Overall Dimension and Wall Thickness	N/A
Refrigerator Compartment Overall Dimension and Wall Thickness	50 mm
Product Shape, Double Doors, Upright, Chest, etc	Three Water Tabs
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	100 liters
Type of Water Storage Tank Cylinder, Cubic, etc.	Cubic
Water Fellow per hour for water cooler	4
Water Storage Tank Dimension	45x70x130
Water Outlet Temperature	+ 10
Water Inlet Temperature	+ 24
Freezer Inside Temperature	N/A
Refrigerator Inside Temperature	N/A
Evaporating Temperature	- 10 C
Foam Insulation Thickness mm Side Walls, Top, Bottom, Door, Back Panel	50 mm
Type of PU Foam	R11 PU Foam
Foam Density, Kg/Cu. Mt.	40 Kg/ Cu Cm
Foam Mixture, Percentage Pol% + R11% + Isocyanate%	33% + 17% + 50%
Total amount of Foam Injection, Kg	4 Kg.
Refrigerant Type	CFC - 11
Refrigerant Charge Weight Gr.	400 gr.
Type of Compressor, Hermetic, Semi Hermetic, Open	Hermetic
Compressor Cooling System Static, Oil Cooled, Fan Cooled	Fan Cooled

Compressor Cooling Capacity Watt	200 Watts
Compressor input Power, Watt	220 Watts
Compressor Model Number	L76AV
Compressor Manufacturer	Eletrolux
Compressor Mounting Place Top, Bottom, Front, Back	Top Roof
Condenser Type, Static, Fan Cooled	Fan Cooled
Condenser Dimension, Length, Inside Tube Diameter,	Four Rows Tube Coil, and Fins
Condenser Material, Aluminum, Copper, Copper Coated, etc,	Copper
Condenser mounting Place, Back Wall, Top, Bottom	Top Roof
Evaporator Type, Fin and Tube, Roll Bond, Wire and Tube, etc.	Fin and Tube
Evaporator Dimension, Length, Surface Area, Inside Tube Diameter	Tube Coils and Fins
Evaporator Material, Aluminum, Copper, Copper Coated, etc,	Copper
Dryer Type,	Cylindrical
Dryer Material, Weight and Size	Ranco, 20 gr.
Capillary Tube Diameter and Length	0.8 mm Dim, 3000 mm Length

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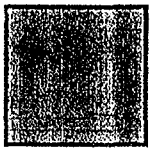

TestDate: 99/12/20 16:02
TestName: Energy Consumtion

Report No.: Spec & Remark
ReportDate: 99/12/26 09:41

Total Result :

1 - Total Test Time	*70 Hours*
2 - Working Percent	*89 %On*
3 - Energy	*3.262 kwh*
4 - Zoom Time	*70:56 Hour*
5 - Compr Current	*2.78 Amp*
6 - Evaprator Mean Temp	*6.8 C*
7 - Cabin Mean Temp	*6.7 C*
8 - Crisp Temp	*6.3 C*
9 - Compr Temp	*59.3 C*
10- Condensor In Temp	*63.2 C*
11- Condensor Out Temp	*44.7 C*
12- Condition	*43.8 C 32 %H*
13- Volt	*Max=249 Mean=238 Min=220*
14-	
15-	
16-	
17-	

Product Spec :

1 - File Name		*99122016.k02*
2 - Test Kind	G	*Performan*
3 - Product Serial		*SH-160R*
4 - Product Name		*Soft Dr.R.*
5 - Product Model		
6 - Product Capacity		*400 Lit.*
7 - Compressor Name		*Danfoss*
8 - Compressor Model		*FR11G*
9 - Compressor Power		*1/3 HP*
10- Compressor Amper		*2*
11- Thermostat No.		*3*
12- Thermostat Type		*Danfoss*
13-		
14-		

Technical Manager: ICRC

Lab Chief : MARIO AL-DEEK

Lab Specialist: ZIAD

Remark :

Lebanon Workshop
Soft Drink Refrigerator
Remark3

Remark : It was tested and has given good results

sign :

Mario M. ALDeek
مؤسسة موريس الديك
للثلاجات والمصنوعات المعدنية

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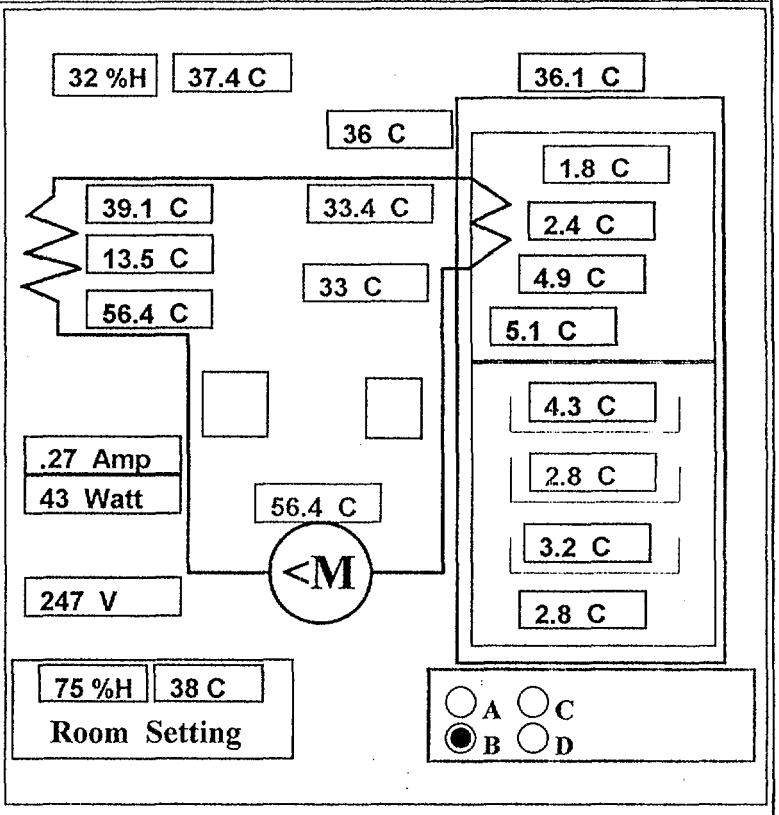
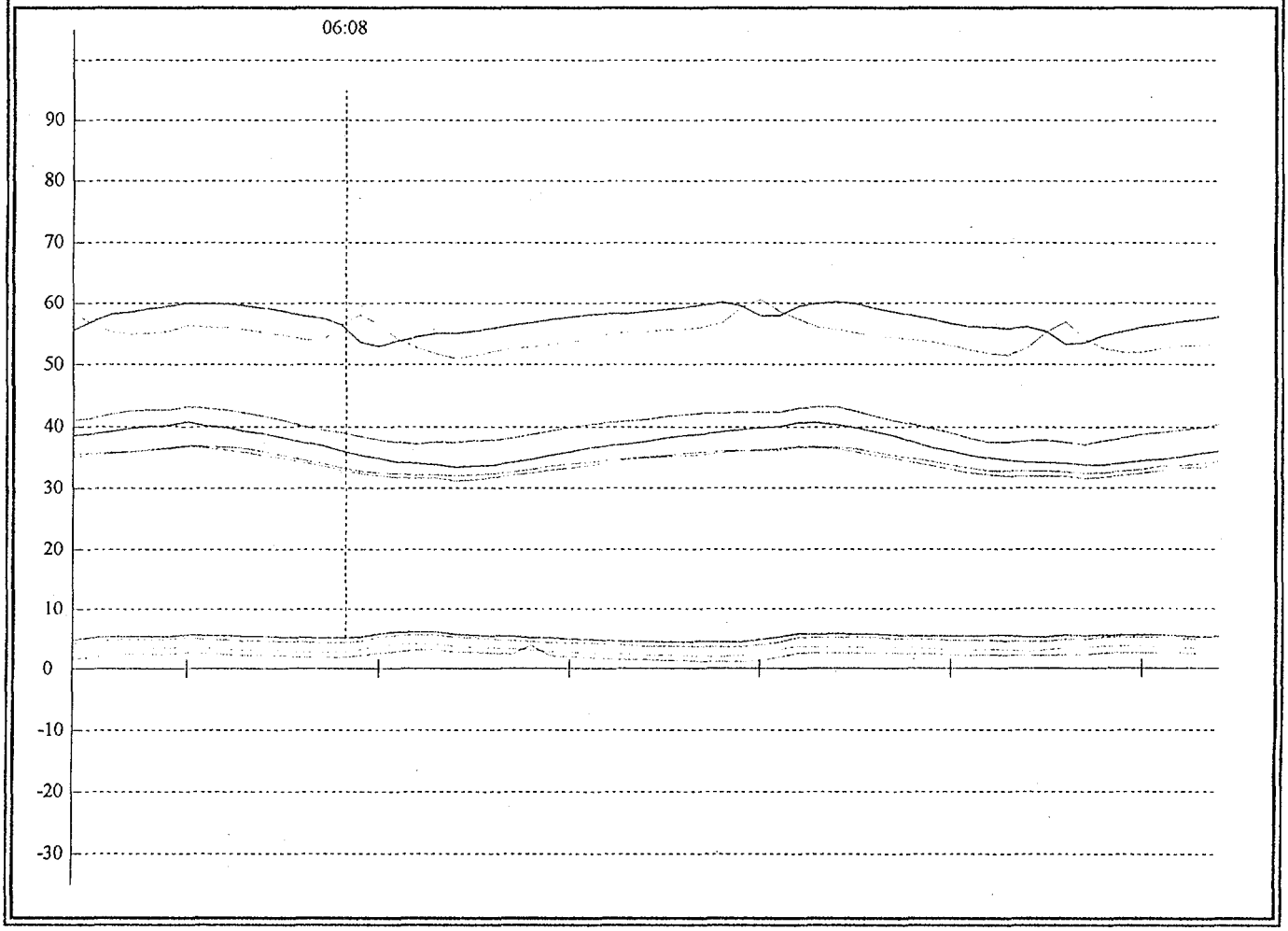
TestDate: 99/12/20 16:02 *Report No.:* ( ) - Page 1

PageTestName: Energy Consumtion *ReportDate:* 99/12/26 13:09

Page Result :

1 - Page Test Time	*1 Hours*
2 - Working Percent	*88 %On*
3 - Energy (Accord to page)	*3.388 kwh*
4 - Zoom Time	*6:08 Hour*
5 - Compr Current	*0.27 Amp*
6 - Evaprator Mean Temp	*3.5 C*
7 - Cabin Mean Temp	*3.4 C*
8 - Crisp Temp	*2.8 C*
9 - Compr Temp	*56.4 C*
10- Condensor In Temp	*56.4 C*
11- Condensor Out Temp	*39.1 C*
12- Condition	*37.4 C 32 %H*
13- Volt	*Max=247 Mean=246 Min=237*
14-	
15-	
16-	
17-	





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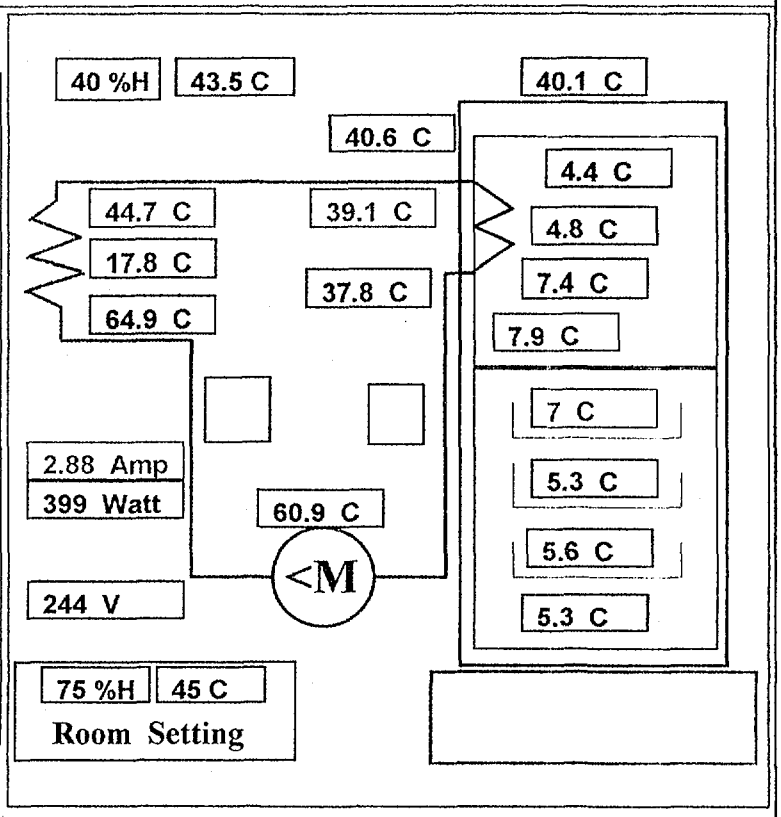
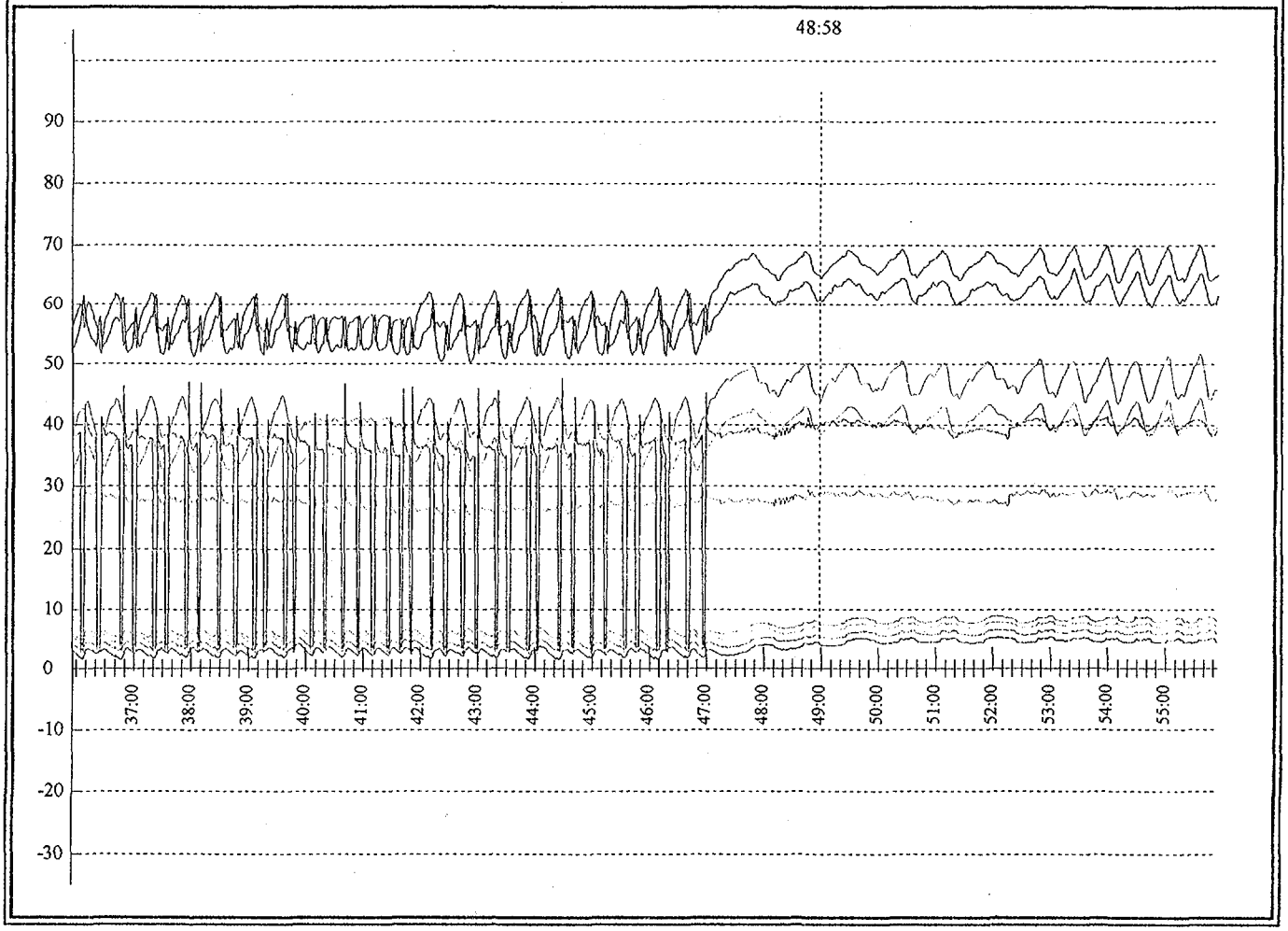
TestDate: 99/12/20 16:02 *Report No.:* ( ) - Page 1

PageTestName: Energy Consumtion *ReportDate:* 99/12/26 13:48

Page Result :

1 - Page Test Time	*20 Hours*
2 - Working Percent	*88 %On*
3 - Energy (Accord to page)	*2.953 kwh*
4 - Zoom Time	*48:58 Hour*
5 - Compr Current	*2.88 Amp*
6 - Evaprator Mean Temp	*6.1 C*
7 - Cabin Mean Temp	*5.9 C*
8 - Crisp Temp	*5.3 C*
9 - Compr Temp	*60.9 C*
10- Condensor In Temp	*64.9 C*
11- Condensor Out Temp	*44.7 C*
12- Condition	*43.5 C 40 %H*
13- Volt	*Max=249 Mean=237 Min=222*
14-	
15-	
16-	
17-	





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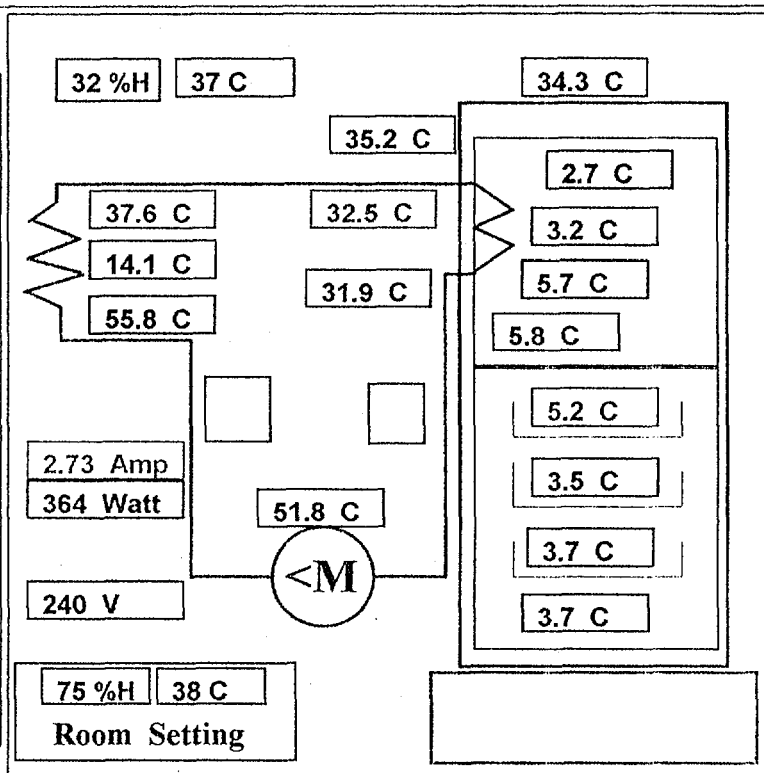
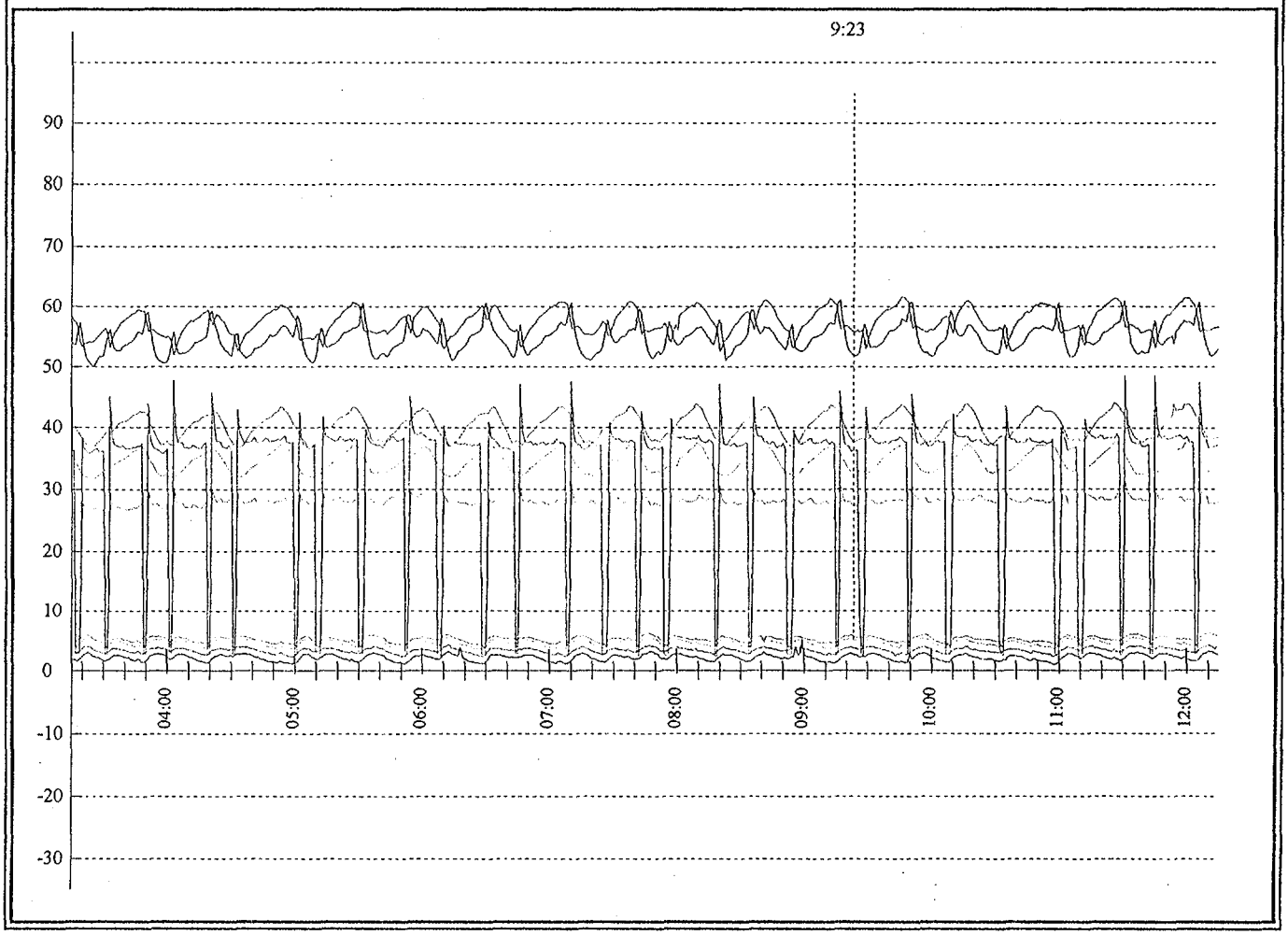
TestDate: 99/12/20 16:02 *Report No.:* ( ) - Page 1

PageTestName: Energy Consumtion *ReportDate:* 99/12/26 13:51

Page Result :

1 - Page Test Time	*9 Hours*
2 - Working Percent	*87 %On*
3 - Energy (Accord to page)	*3.363 kwh*
4 - Zoom Time	*9:23 Hour*
5 - Compr Current	*2.73 Amp*
6 - Evaprator Mean Temp	*4.3 C*
7 - Cabin Mean Temp	*4.1 C*
8 - Crisp Temp	*3.7 C*
9 - Compr Temp	*51.8 C*
10- Condensor In Temp	*55.8 C*
11- Condensor Out Temp	*37.6 C*
12- Condition	*37 C 32 %H*
13- Volt	*Max=248 Mean=242 Min=234*
14-	
15-	
16-	
17-	





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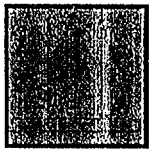

TestDate: 99/12/20 16:02
TestName: Energy Consumtion

Report No.: Spec & Remark
ReportDate: 99/12/26 13:22

Total Result :

1 - Total Test Time	*70 Hours*
2 - Working Percent	*67 %On*
3 - Energy	*1.428 kwh*
4 - Zoom Time	*70:56 Hour*
5 - Compr Current	*2.59 Amp*
6 - Evaprator Mean Temp	*12.1 C*
7 - Cabin Mean Temp	*6.6 C*
8 - Crisp Temp	*8.4 C*
9 - Compr Temp	*52 C*
10- Condensor In Temp	*64.2 C*
11- Condensor Out Temp	*41.6 C*
12- Condition	*43.8 C 32 %H*
13- Volt	*Max=249 Mean=238 Min=220*
14-	
15-	
16-	
17-	

Product Spec :

1 - File Name		*99122016.k02*
2 - Test Kind	G	*Perform.*
3 - Product Serial		*Meat ref.*
4 - Product Name		
5 - Product Model		*JM-1600*
6 - Product Capacity		*400 litt.*
7 - Compressor Name		*Copland*
8 - Compressor Model		*4440g*
9 - Compressor Power		*3/8 Hp*
10- Compressor Amper		*2*
11- Thermostat No.		*3*
12- Thermostat Type		*Ranco*
13-		
14-		

Technical Manager: *ICRC*

Lab Chief : *MARIO AL-DEEK*

Lab Specialist: *ZIAD*

Remark :

Jamal Yussef Workshop
Meat Ref. Up Right
Remark3

Remark : good result.

sign :

Mario M. AL Deek
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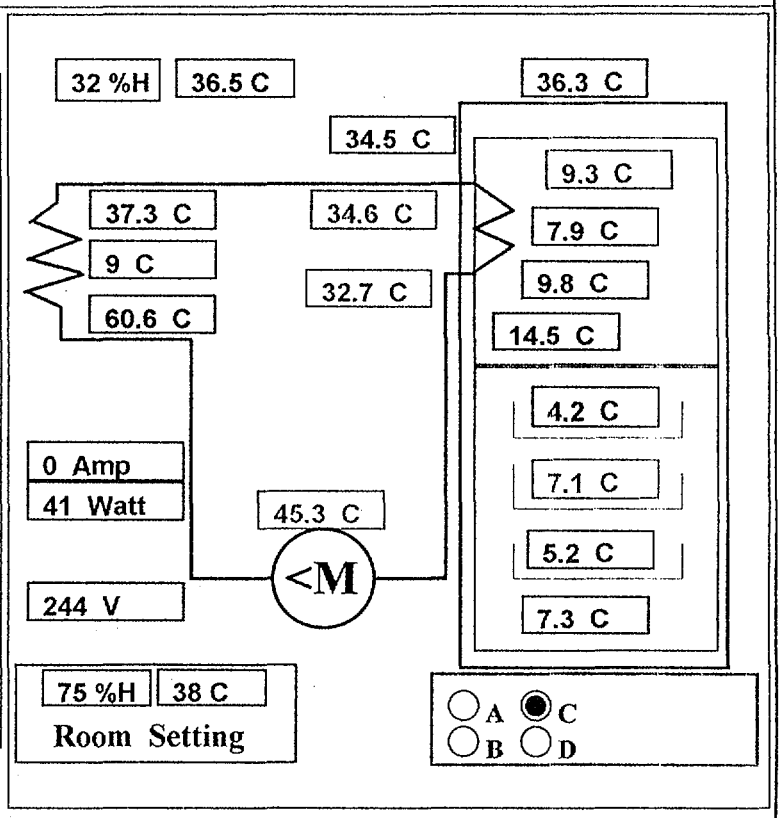
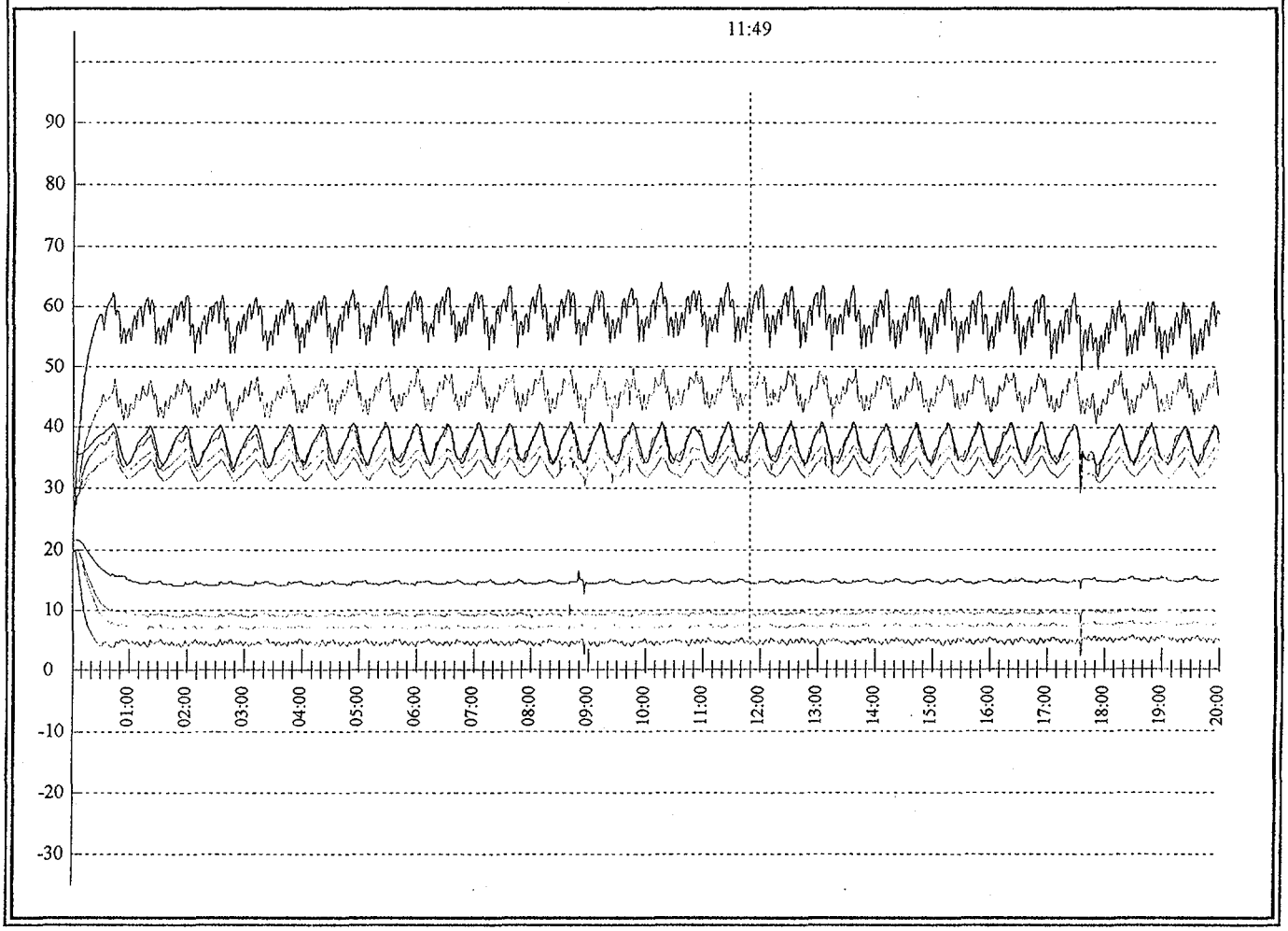
TestDate: 99/12/20 16:02 *Report No.:* ( ) - Page 1

PageTestName: Energy Consumtion *ReportDate:* 99/12/26 13:28

Page Result :

1 - Page Test Time	*20 Hours*
2 - Working Percent	*66 %On*
3 - Energy (Accord to page)	*1.587 kwh*
4 - Zoom Time	*11:49 Hour*
5 - Compr Current	*00 Amp*
6 - Evaprator Mean Temp	*10.3 C*
7 - Cabin Mean Temp	*5.5 C*
8 - Crisp Temp	*7.3 C*
9 - Compr Temp	*45.3 C*
10- Condensor In Temp	*60.6 C*
11- Condensor Out Temp	*37.3 C*
12- Condition	*36.5 C 32 %H*
13- Volt	*Max=248 Mean=238 Min=220*
14-	
15-	
16-	
17-	





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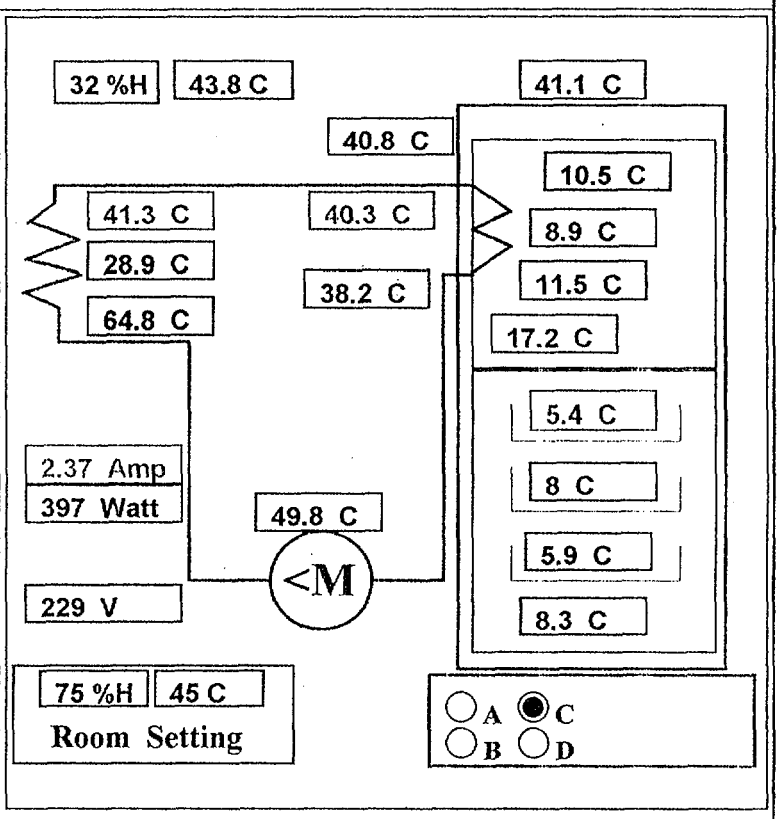
Maurice Ind. [Jordan]

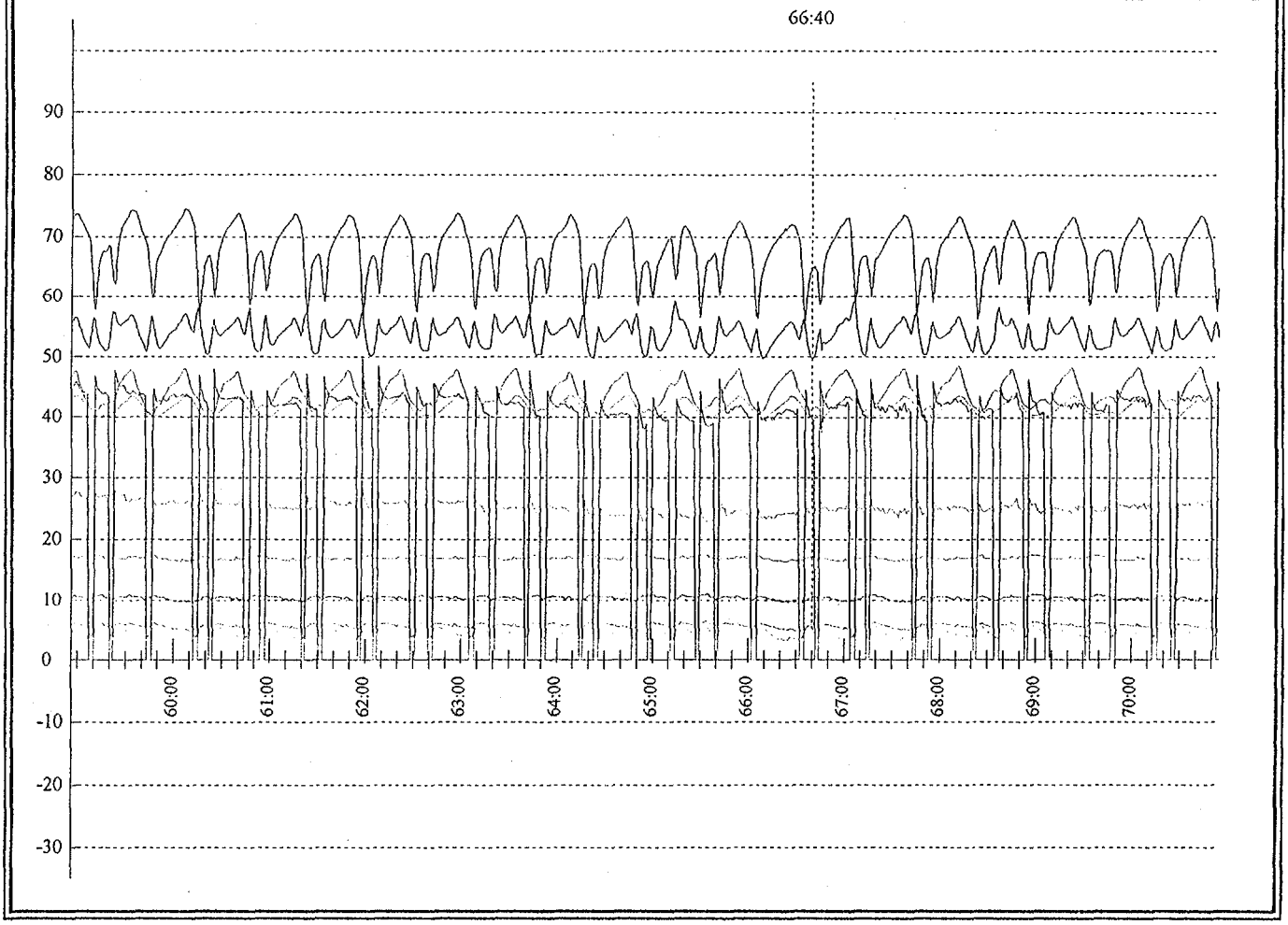
TestDate: 99/12/20 16:02 *Report No.:* ( ) - Page 1

PageTestName: Energy Consumtion *ReportDate:* 99/12/26 13:41

Page Result :

1 - Page Test Time	*12 Hours*
2 - Working Percent	*80 %On*
3 - Energy (Accord to page)	*1.371 kwh*
4 - Zoom Time	*66:40 Hour*
5 - Compr Current	*2.37 Amp*
6 - Evaprator Mean Temp	*12 C*
7 - Cabin Mean Temp	*6.4 C*
8 - Crisp Temp	*8.3 C*
9 - Compr Temp	*49.8 C*
10- Condensor In Temp	*64.8 C*
11- Condensor Out Temp	*41.3 C*
12- Condition	*43.8 C 32 %H*
13- Volt	*Max=247 Mean=235 Min=221*
14-	
15-	
16-	
17-	





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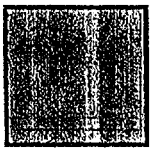
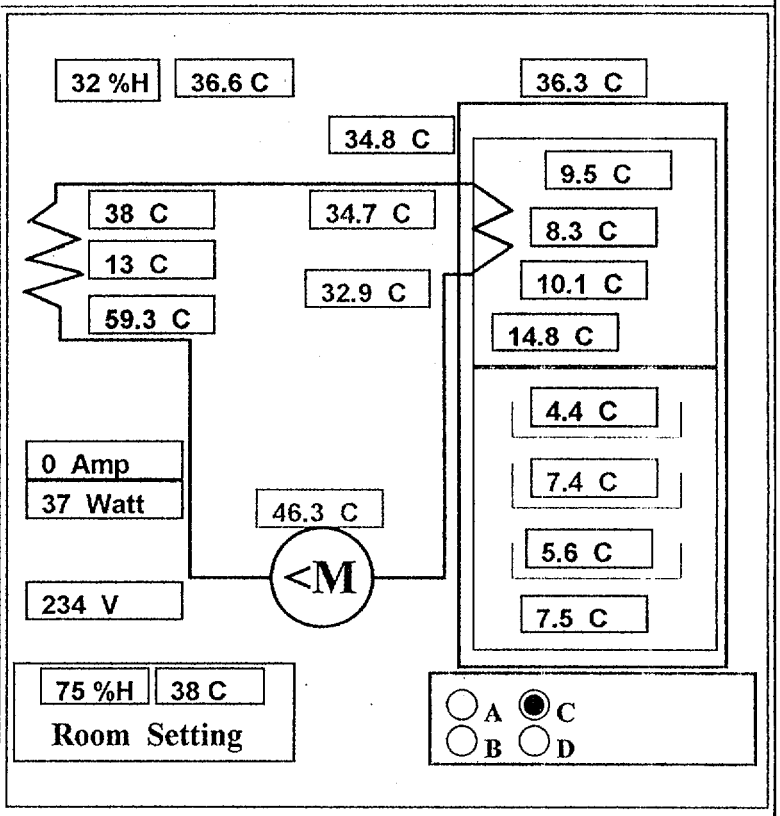


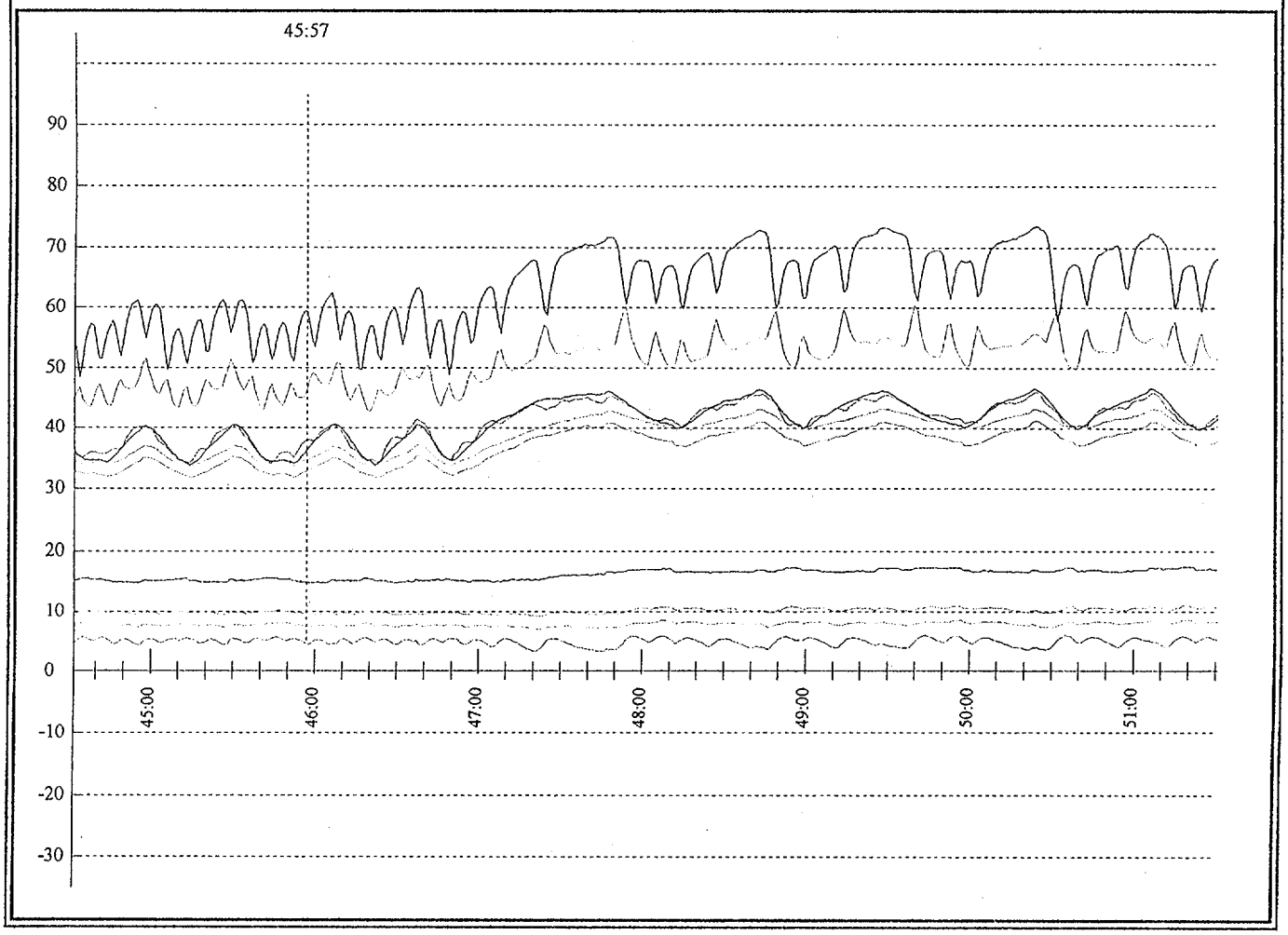
TestDate: 99/12/20 16:02 *Report No.:* ( ) - Page 1

PageTestName: Energy Consumtion *ReportDate:* 99/12/26 13:33

Page Result :

1 - Page Test Time	*7 Hours*
2 - Working Percent	*71 %On*
3 - Energy (Accord to page)	*1.215 kwh*
4 - Zoom Time	*45:57 Hour*
5 - Compr Current	*00 Amp*
6 - Evaprator Mean Temp	*10.6 C*
7 - Cabin Mean Temp	*5.8 C*
8 - Crisp Temp	*7.5 C*
9 - Compr Temp	*46.3 C*
10- Condensor In Temp	*59.3 C*
11- Condensor Out Temp	*38 C*
12- Condition	*36.6 C 32 %H*
13- Volt	*Max=246 Mean=238 Min=225*
14-	
15-	
16-	
17-	





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Printing In Labaratory Of
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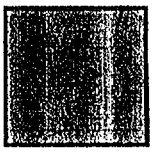

TestDate: 00/01/02 12:04
TestName: Energy Consumtion

Report No.: Spec & Remark
ReportDate: 00/01/13 09:25

Total Result :

1 - Total Test Time	*68 Hours*
2 - Working Percent	*17 %On*
3 - Energy	*0.302 kwh*
4 - Zoom Time	*62:08 Hour*
5 - Compr Current	*1.72 Amp*
6 - Evaprator Mean Temp	*13.1 C*
7 - Cabin Mean Temp	*29.6 C*
8 - Crisp Temp	*29.5 C*
9 - Compr Temp	*48.7 C*
10- Condensor In Temp	*65.7 C*
11- Condensor Out Temp	*24.9 C*
12- Condition	*45.1 C 32 %H*
13- Volt	*Max=250 Mean=215 Min=223*
14-	
15-	
16-	
17-	

Product Spec :

1 - File Name	*00010212.k04*
2 - Test Kind G	*Perform.*
3 - Product Serial	
4 - Product Name	*Water Cool*
5 - Product Model	*AWC-100*
6 - Product Capacity	*100 Lit/H.*
7 - Compressor Name	*Embraco*
8 - Compressor Model	*12HBK*
9 - Compressor Power	*1/4 Hp*
10- Compressor Amper	*3 Amp*
11- Thermostat No.	*3*
12- Thermostat Type	*Ranco*
13-	
14-	

Technical Manager: *ICRC*

Lab Chief : *MARIO AL-DEEK*

Lab Specialist: *ZIAD*

Remark :

Al-Amal Workshop
Water Cooler
Remark3

Remark :

sign :

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Industrial Control Research Center HotRoom Ver 5

Printing In Labaratory Of
Maurice Ind. [Jordan]

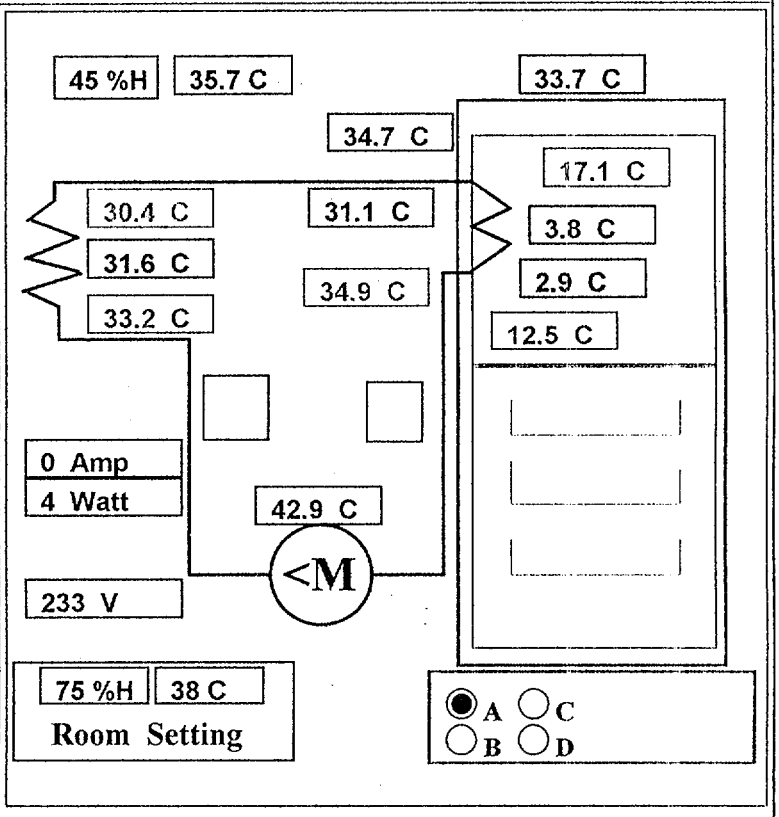
Maurice Ind. [Jordan]

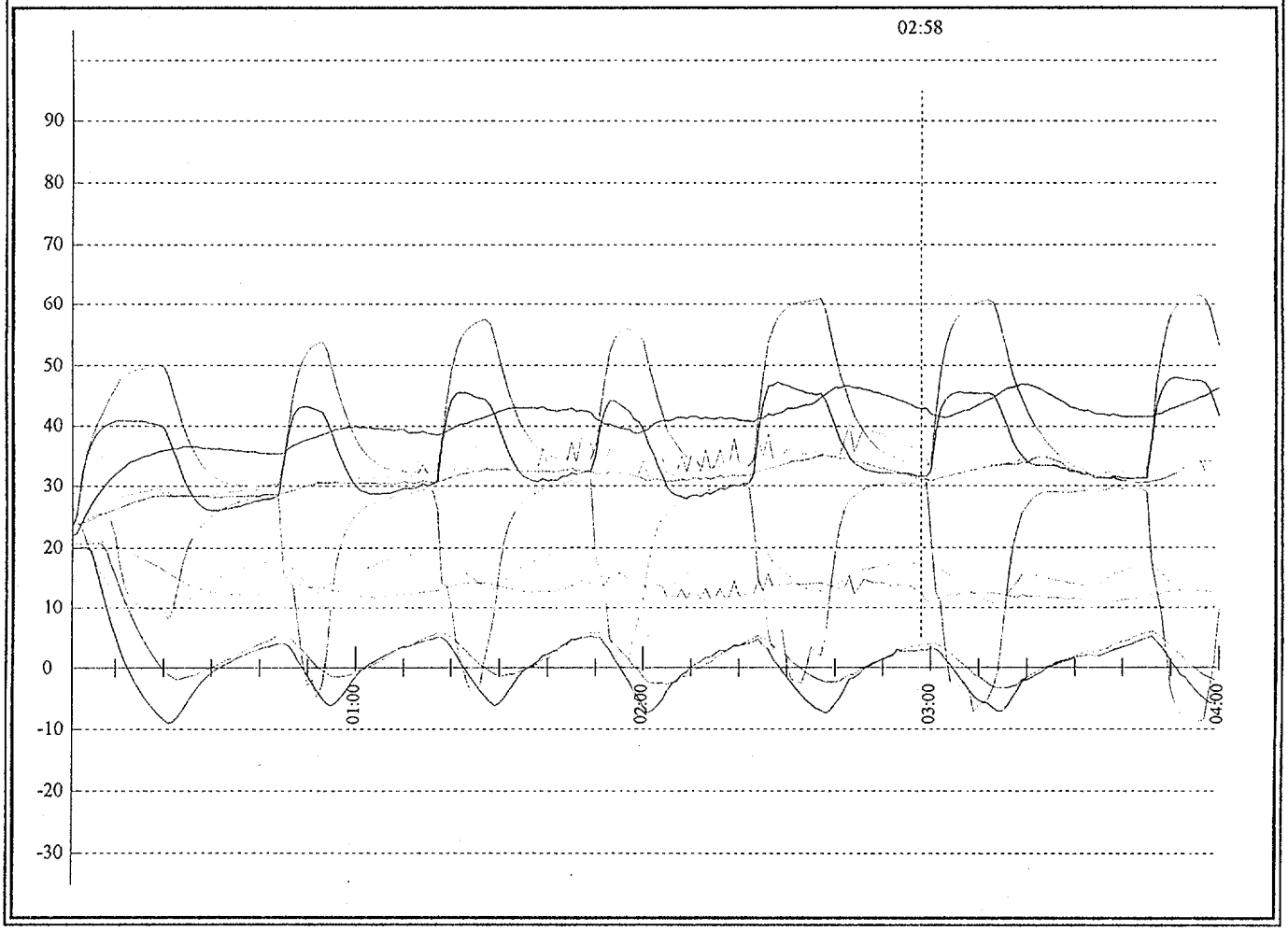
TestDate: 00/01/02 12:04 *Report No.:* ( ) - Page 1

PageTestName: Energy Consumtion *ReportDate:* 00/01/13 09:29

Page Result :

1 - Page Test Time	*4 Hours*
2 - Working Percent	*35 %On*
3 - Energy (Accord to page)	*0.446 kwh*
4 - Zoom Time	*2:58 Hour*
5 - Compr Current	*00 Amp*
6 - Evaprator Mean Temp	*9 C*
7 - Cabin Mean Temp	*27.5 C*
8 - Crisp Temp	*27.8 C*
9 - Compr Temp	*42.9 C*
10- Condensor In Temp	*33.2 C*
11- Condensor Out Temp	*30.4 C*
12- Condition	*35.7 C 45 %H*
13- Volt	*Max=243 Mean=235 Min=224*
14-	
15-	
16-	
17-	





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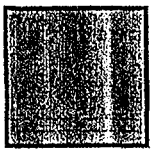
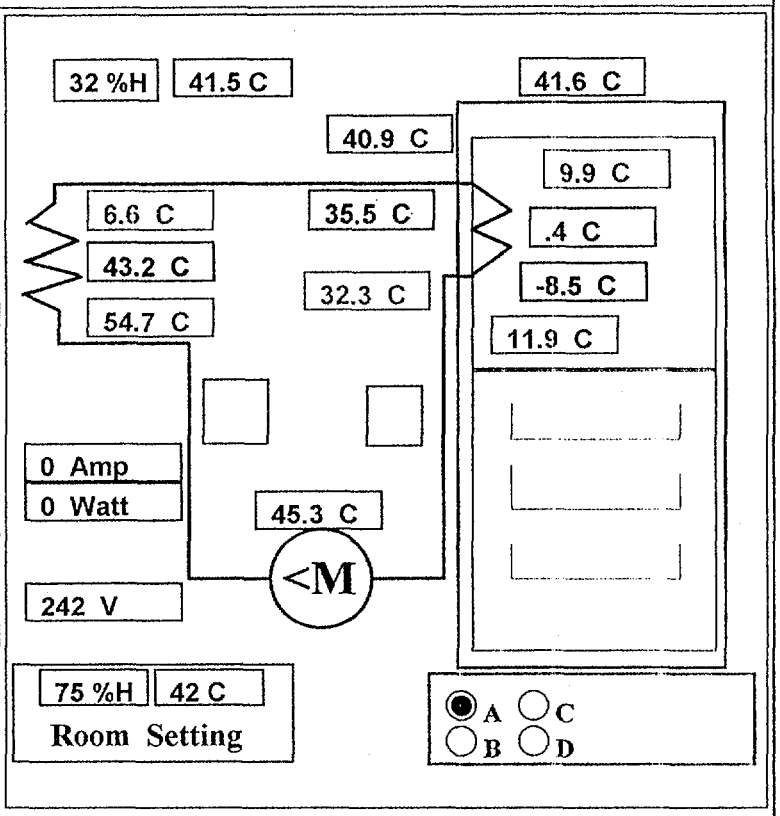


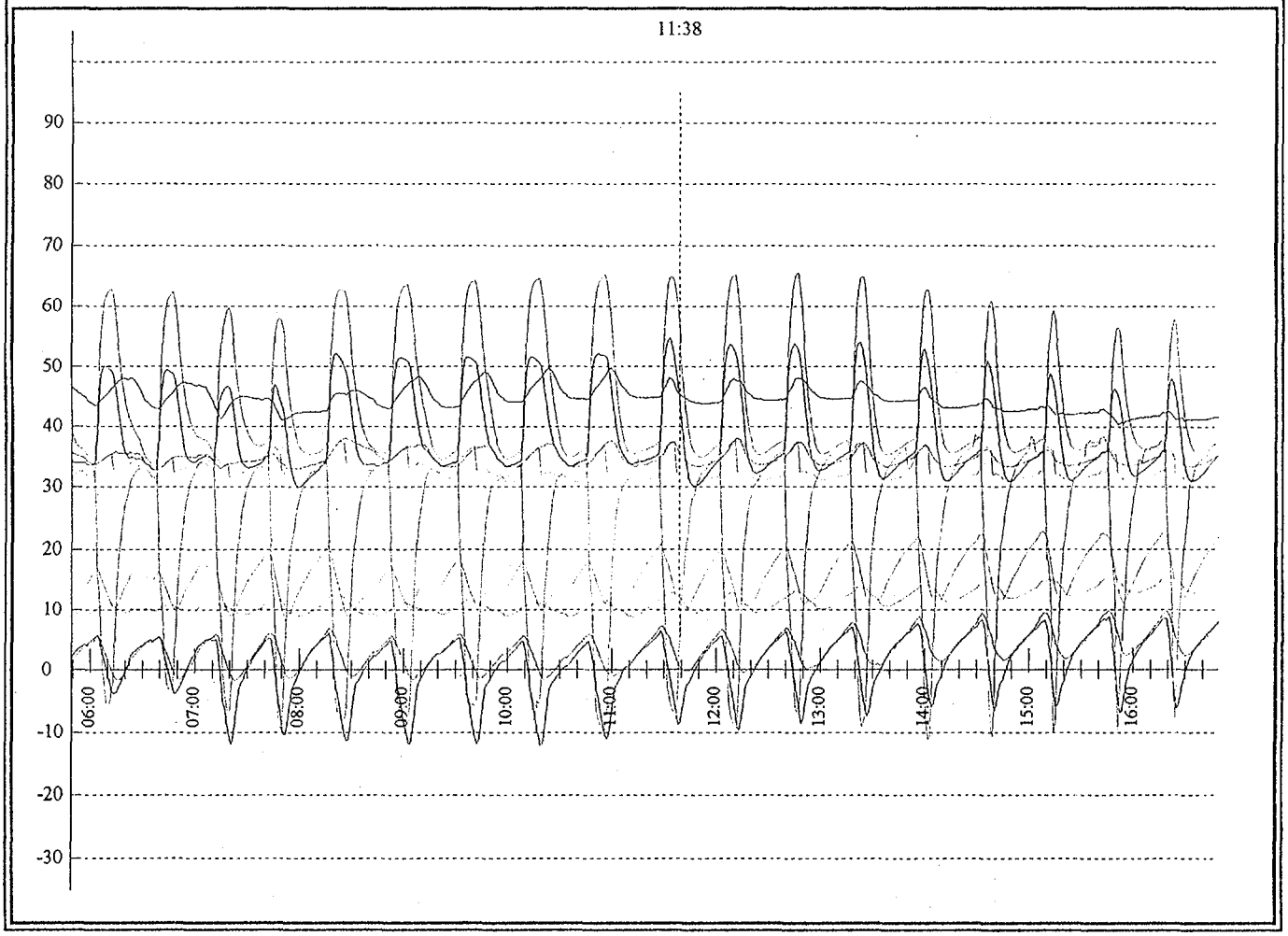
TestDate: 00/01/02 12:04 *Report No.:* ( ) - Page 1

PageTestName: Energy Consumtion *ReportDate:* 00/01/13 09:32

Page Result :

1 - Page Test Time	*11 Hours*
2 - Working Percent	*23 %On*
3 - Energy (Accord to page)	*0.34 kwh*
4 - Zoom Time	*11:39 Hour*
5 - Compr Current	*00 Amp*
6 - Evaprator Mean Temp	*3.4 C*
7 - Cabin Mean Temp	*26.3 C*
8 - Crisp Temp	*26.8 C*
9 - Compr Temp	*45.3 C*
10- Condensor In Temp	*54.7 C*
11- Condensor Out Temp	*6.6 C*
12- Condition	*41.5 C 32 %H*
13- Volt	*Max=248 Mean=242 Min=235*
14-	
15-	
16-	
17-	





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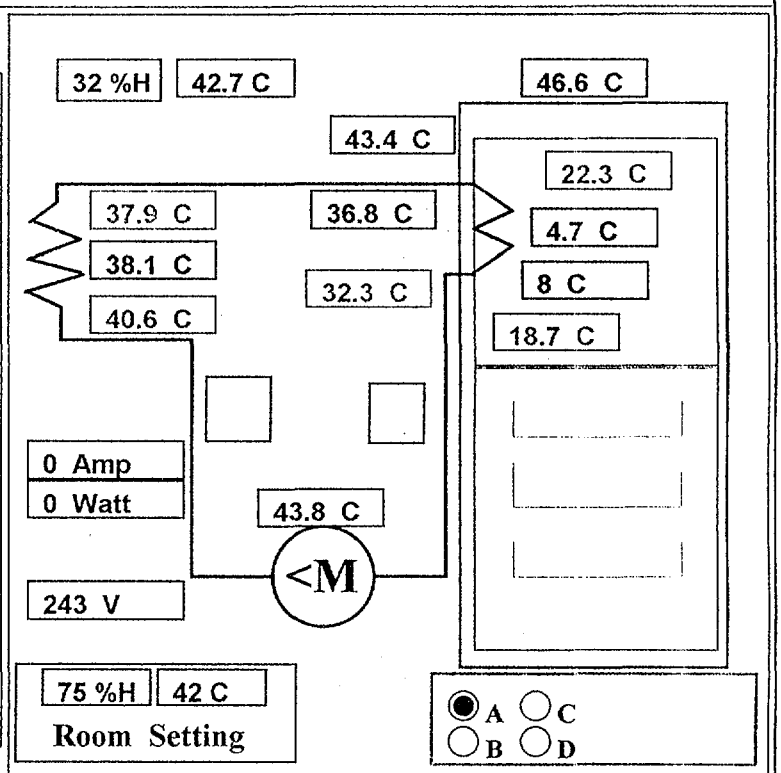
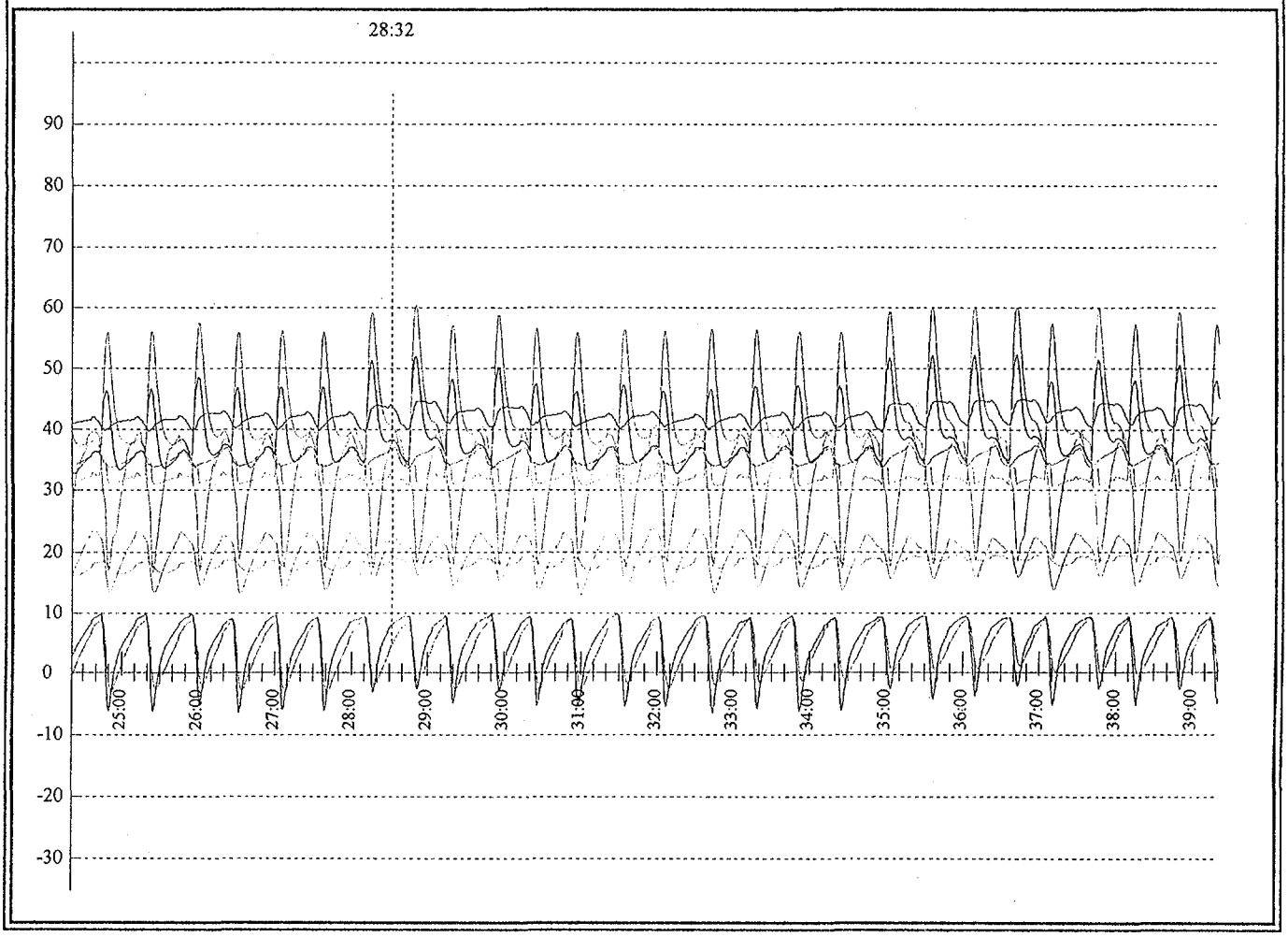
TestDate: 00/01/02 12:04 *Report No.:* ( ) - Page 1

PageTestName: Energy Consumtion *ReportDate:* 00/01/13 09:37

Page Result :

1 - Page Test Time	*15 Hours*
2 - Working Percent	*15 %On*
3 - Energy (Accord to page)	*0.28 kwh*
4 - Zoom Time	*28:32 Hour*
5 - Compr Current	*00 Amp*
6 - Evaprator Mean Temp	*13.4 C*
7 - Cabin Mean Temp	*26.6 C*
8 - Crisp Temp	*27.2 C*
9 - Compr Temp	*43.8 C*
10- Condensor In Temp	*40.6 C*
11- Condensor Out Temp	*37.9 C*
12- Condition	*42.7 C 32 %H*
13- Volt	*Max=247 Mean=240 Min=228*
14-	
15-	
16-	
17-	





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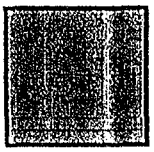
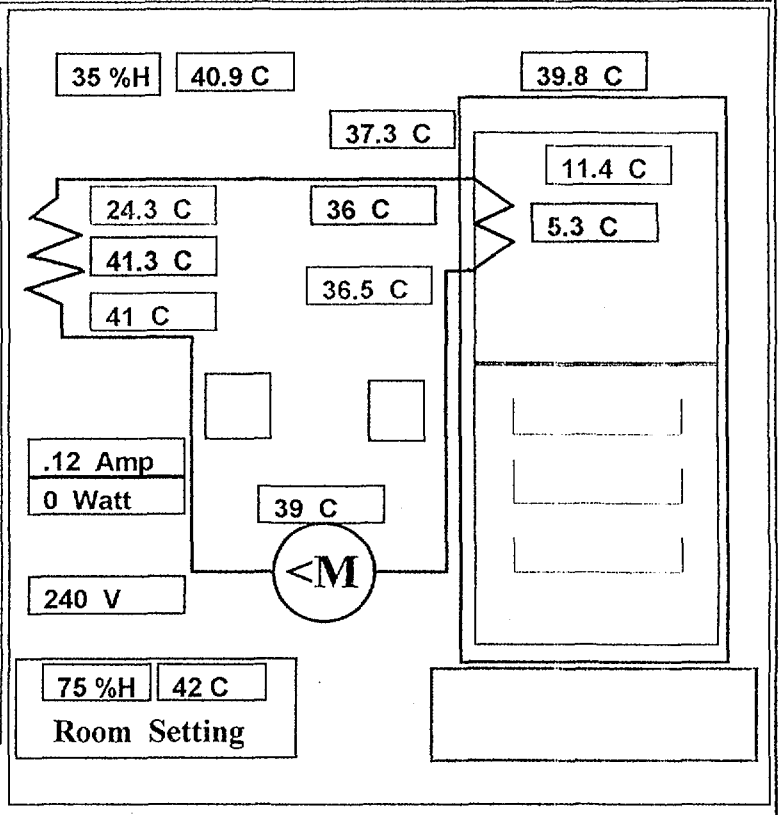


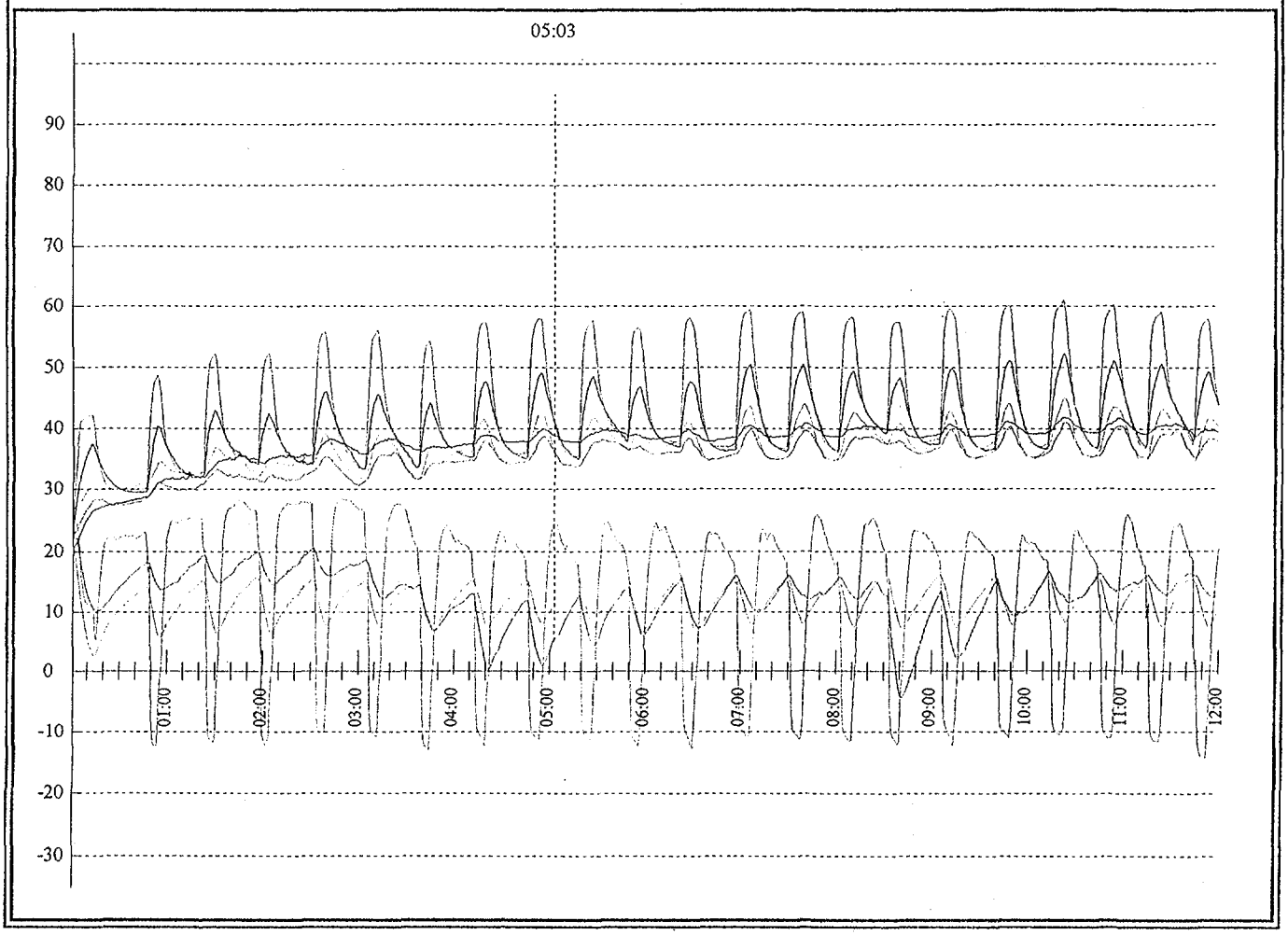
TestDate: 00/01/02 12:04 *Report No.:* ( ) - Page 1

PageTestName: Energy Consumtion *ReportDate:* 00/01/13 09:46

Page Result :

1 - Page Test Time	*12 Hours*
2 - Working Percent	*25 %On*
3 - Energy (Accord to page)	*0.498 kwh*
4 - Zoom Time	*5:03 Hour*
5 - Compr Current	*0.12 Amp*
6 - Evaprator Mean Temp	*19 C*
7 - Cabin Mean Temp	*29.4 C*
8 - Crisp Temp	*30.5 C*
9 - Compr Temp	*39 C*
10- Condensor In Temp	*41 C*
11- Condensor Out Temp	*24.3 C*
12- Condition	*40.9 C 35 %H*
13- Volt	*Max=248 Mean=239 Min=224*
14-	
15-	
16-	
17-	





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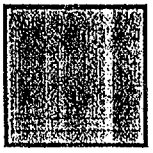
Maurice Ind. [Jordan]



TestDate: 00/01/02 12:04
TestName: Energy Consumtion

Report No.: Spec & Remark
ReportDate: 00/01/13 09:42

Total Result :

1 - Total Test Time	*68 Hours*
2 - Working Percent	*26 %On*
3 - Energy	*0.516 kwh*
4 - Zoom Time	*62:08 Hour*
5 - Compr Current	*1.87 Amp*
6 - Evaprator Mean Temp	*26.5 C*
7 - Cabin Mean Temp	*38.1 C*
8 - Crisp Temp	*41.3 C*
9 - Compr Temp	*43.8 C*
10- Condensor In Temp	*63.5 C*
11- Condensor Out Temp	*-27.5 C*
12- Condition	*45.1 C 32 %H*
13- Volt	*Max=250 Mean=215 Min=223*
14-	
15-	
16-	
17-	

Product Spec :

1 - File Name		*00010212.k04*
2 - Test Kind	G	*Performan*
3 - Product Serial		
4 - Product Name		*Water Cool*
5 - Product Model		*ES-100WC*
6 - Product Capacity		*50 Lit/h.*
7 - Compressor Name		*L.G*
8 - Compressor Model		*27UA*
9 - Compressor Power		*Al-Eslah*
10 - Compressor Amper		*2*
11 - Thermostat No.		*3*
12 - Thermostat Type		*Al-Eslah*
13-		
14-		

Technical Manager: *ICRC*

Lab Chief : *MARIO AL-DEEK*

Lab Specialist: *ZIAD*

Remark :

Al-Eslah Workshop
Water Cooler
Remark3

Remark :

sign :

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Industrial Control Research Center HotRoom Ver 5

Printing In Labaratory Of
Maurice Ind. [Jordan]

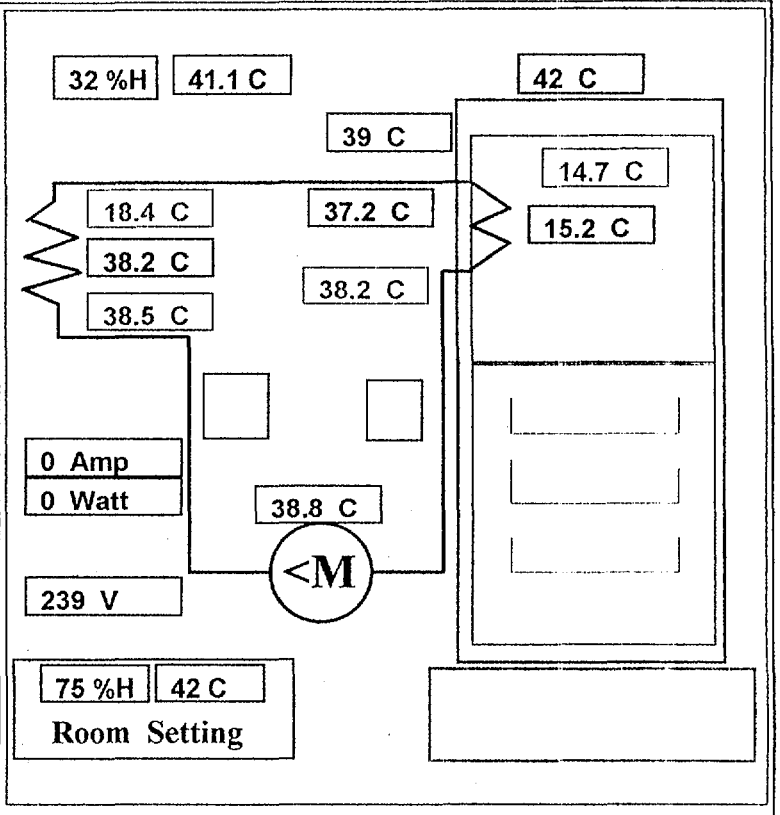
Maurice Ind. [Jordan]

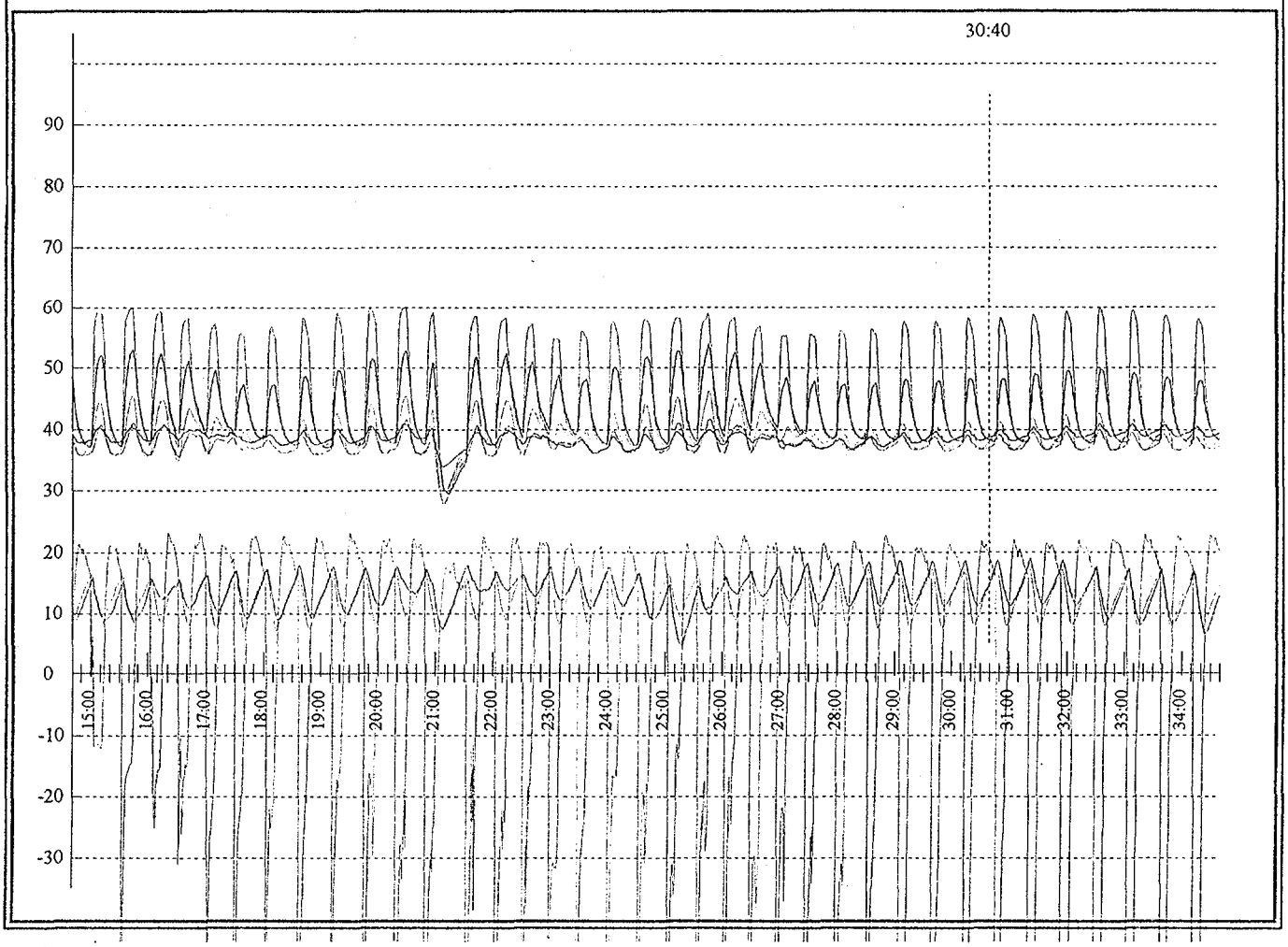
TestDate: 00/01/02 12:04 *Report No.:* ( ) - Page 1

PageTestName: Energy Consumtion *ReportDate:* 00/01/13 09:51

Page Result :

1 - Page Test Time	*20 Hours*
2 - Working Percent	*29 %On*
3 - Energy (Accord to page)	*0.56 kwh*
4 - Zoom Time	*30:40 Hour*
5 - Compr Current	*00 Amp*
6 - Evaprator Mean Temp	*23.6 C*
7 - Cabin Mean Temp	*31.4 C*
8 - Crisp Temp	*33.1 C*
9 - Compr Temp	*38.8 C*
10- Condensor In Temp	*38.5 C*
11- Condensor Out Temp	*18.4 C*
12- Condition	*41.1 C 32 %H*
13- Volt	*Max=247 Mean=237 Min=224*
14-	
15-	
16-	
17-	





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Printing in Labaratory Of
Maurice Ind. [Jordan]

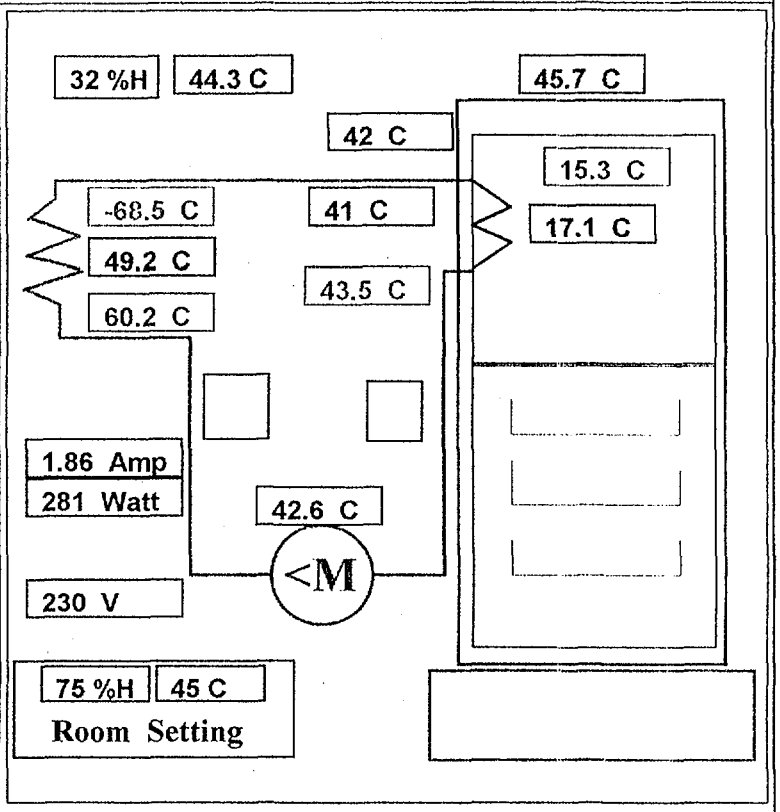
Maurice Ind. [Jordan]

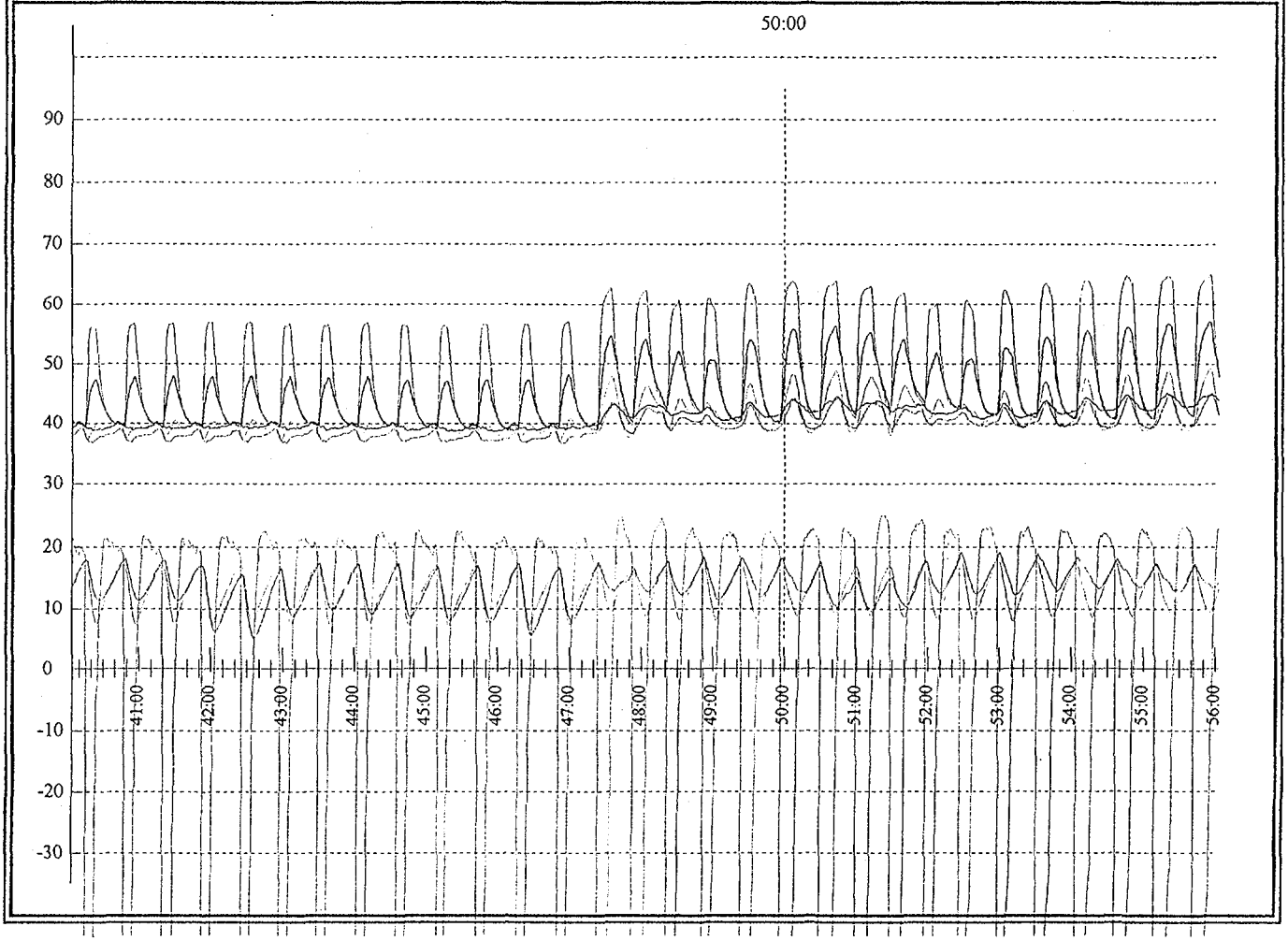
TestDate: 00/01/02 12:04 *Report No.:* ( ) - Page 1

PageTestName: Energy Consumtion *ReportDate:* 00/01/13 09:57

Page Result :

1 - Page Test Time	*16 Hours*
2 - Working Percent	*31 %On*
3 - Energy (Accord to page)	*0.584 kwh*
4 - Zoom Time	*50:00 Hour*
5 - Compr Current	*1.86 Amp*
6 - Evaprator Mean Temp	*26.9 C*
7 - Cabin Mean Temp	*36.8 C*
8 - Crisp Temp	*39.8 C*
9 - Compr Temp	*42.6 C*
10- Condensor In Temp	*60.2 C*
11- Condensor Out Temp	*-68.5 C*
12- Condition	*44.3 C 32 %H*
13- Volt	*Max=245 Mean=236 Min=223*
14-	
15-	
16-	
17-	





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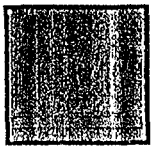
Printing in Labaratory Of
Maurice Ind. [Jordan]

Maurice Ind. [Jordan]



TestDate: 00/01/02 12:04
TestName: Energy Consumtion

Report No.: Spec & Remark
ReportDate: 00/01/13 10:02

Total Result :

1 - Total Test Time	*68 Hours*
2 - Working Percent	*90 %On*
3 - Energy	*2.455 kwh*
4 - Zoom Time	*62:08 Hour*
5 - Compr Current	*1.94 Amp*
6 - Evaprator Mean Temp	*-17.7 C*
7 - Cabin Mean Temp	*-17.7 C*
8 - Crisp Temp	*-20.8 C*
9 - Compr Temp	*68.7 C*
10- Condensor In Temp	*73.9 C*
11- Condensor Out Temp	*16.3 C*
12- Condition	*45.1 C 32 %H*
13- Volt	*Max=250 Mean=215 Min=223*
14-	
15-	
16-	
17-	

Product Spec :

1 - File Name	*00010212.k04*
2 - Test Kind G	*Perform.*
3 - Product Serial	
4 - Product Name	*Chest Free*
5 - Product Model	*IMD 400F*
6 - Product Capacity	*400 litt.*
7 - Compressor Name	*Copland*
8 - Compressor Model	*AE1410G*
9 - Compressor Power	*1/4 Hp*
10- Compressor Amper	*3*
11- Thermostat No.	*3*
12- Thermostat Type	*Ranco*
13-	
14-	

Technical Manager: *ICRC*

Lab Chief : *MARIO AL-DEEK*

Lab Specialist: *ZIAD*

Remark :

Emad Hedjawi Workshop
Chest Freezer
Remark3

Remark :

sign :

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Industrial Control Research Center HotRoom Ver 5

Printing In Labaratory Of
Maurice Ind. [Jordan]

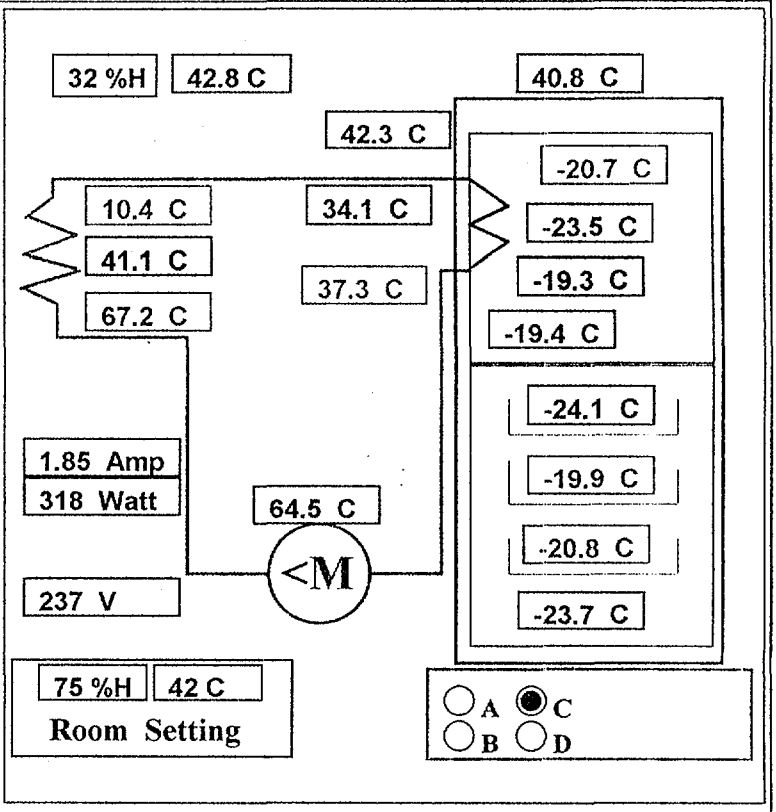
Maurice Ind. [Jordan]

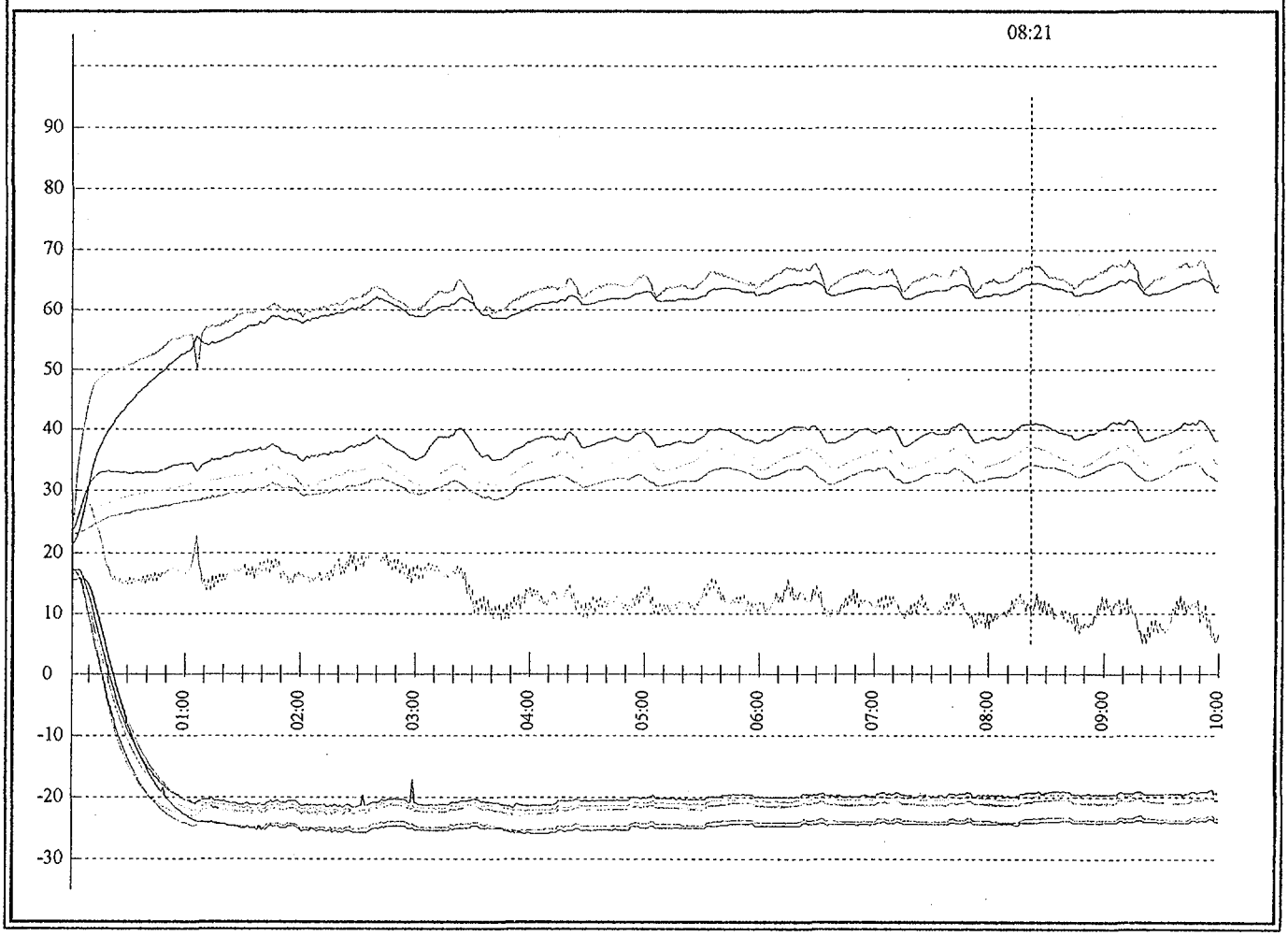
TestDate: 00/01/02 12:04 *Report No.:* ( ) - Page 1

PageTestName: Energy Consumtion *ReportDate:* 00/01/13 10:05

Page Result :

1 - Page Test Time	*10 Hours*
2 - Working Percent	*99 %On*
3 - Energy (Accord to page)	*2.498 kwh*
4 - Zoom Time	*8:22 Hour*
5 - Compr Current	*1.85 Amp*
6 - Evaprator Mean Temp	*-20.7 C*
7 - Cabin Mean Temp	*-21.6 C*
8 - Crisp Temp	*-23.7 C*
9 - Compr Temp	*64.5 C*
10- Condensor In Temp	*67.2 C*
11- Condensor Out Temp	*10.4 C*
12- Condition	*42.8 C 32 %H*
13- Volt	*Max=244 Mean=238 Min=224*
14-	
15-	
16-	
17-	





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Maurice Ind. [Jordan]

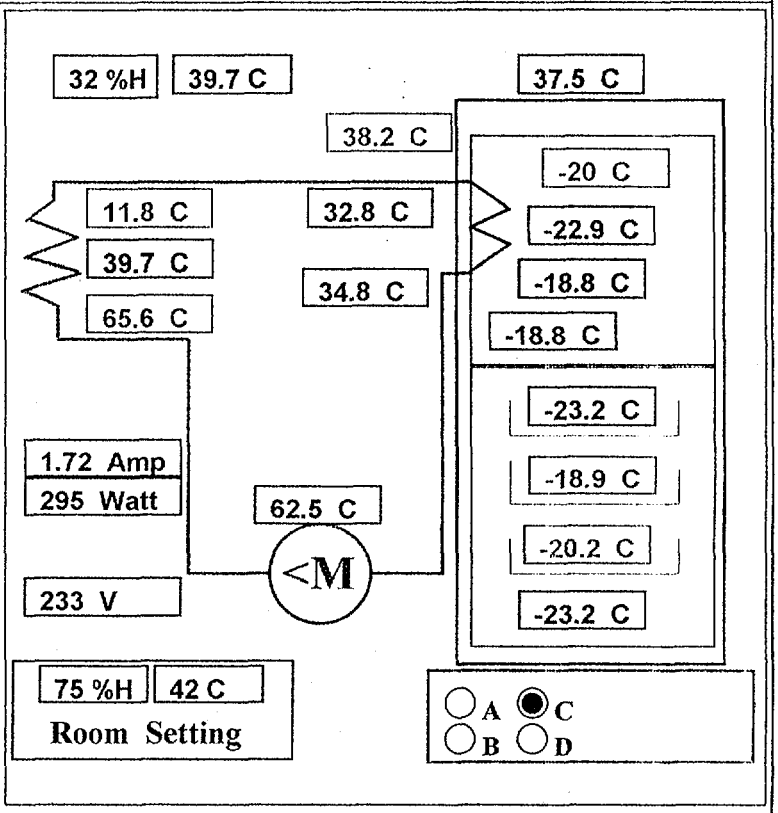
Maurice Ind. [Jordan]

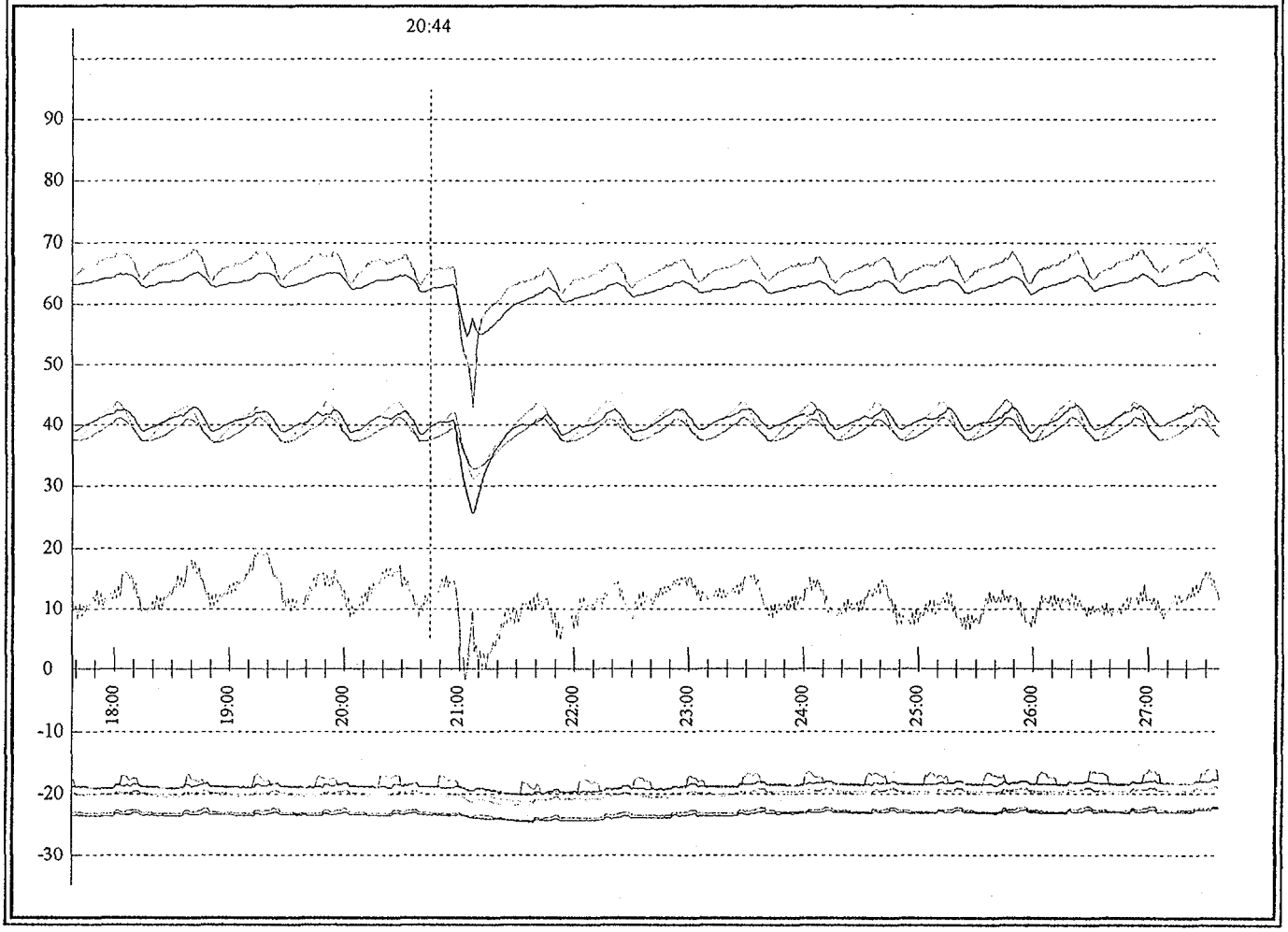
TestDate: 00/01/02 12:04 *Report No.:* ( ) - Page 1

PageTestName: Energy Consumtion *ReportDate:* 00/01/13 10:10

Page Result :

1 - Page Test Time	*10 Hours*
2 - Working Percent	*99 %On*
3 - Energy (Accord to page)	*2.463 kwh*
4 - Zoom Time	*20:45 Hour*
5 - Compr Current	*1.72 Amp*
6 - Evaprator Mean Temp	*-20.1 C*
7 - Cabin Mean Temp	*-20.7 C*
8 - Crisp Temp	*-23.2 C*
9 - Compr Temp	*62.5 C*
10- Condensor In Temp	*65.6 C*
11- Condensor Out Temp	*11.8 C*
12- Condition	*39.7 C 32 %H*
13- Volt	*Max=242 Mean=234 Min=224*
14-	
15-	
16-	
17-	





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Maurice Ind. [Jordan]

Maurice Ind. [Jordan]

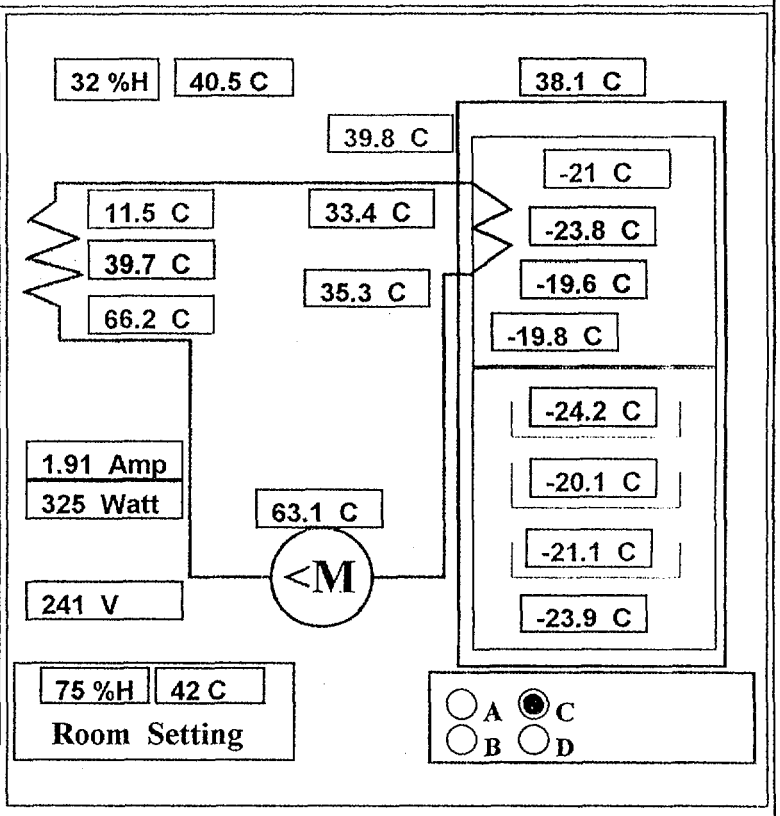
[redacted]

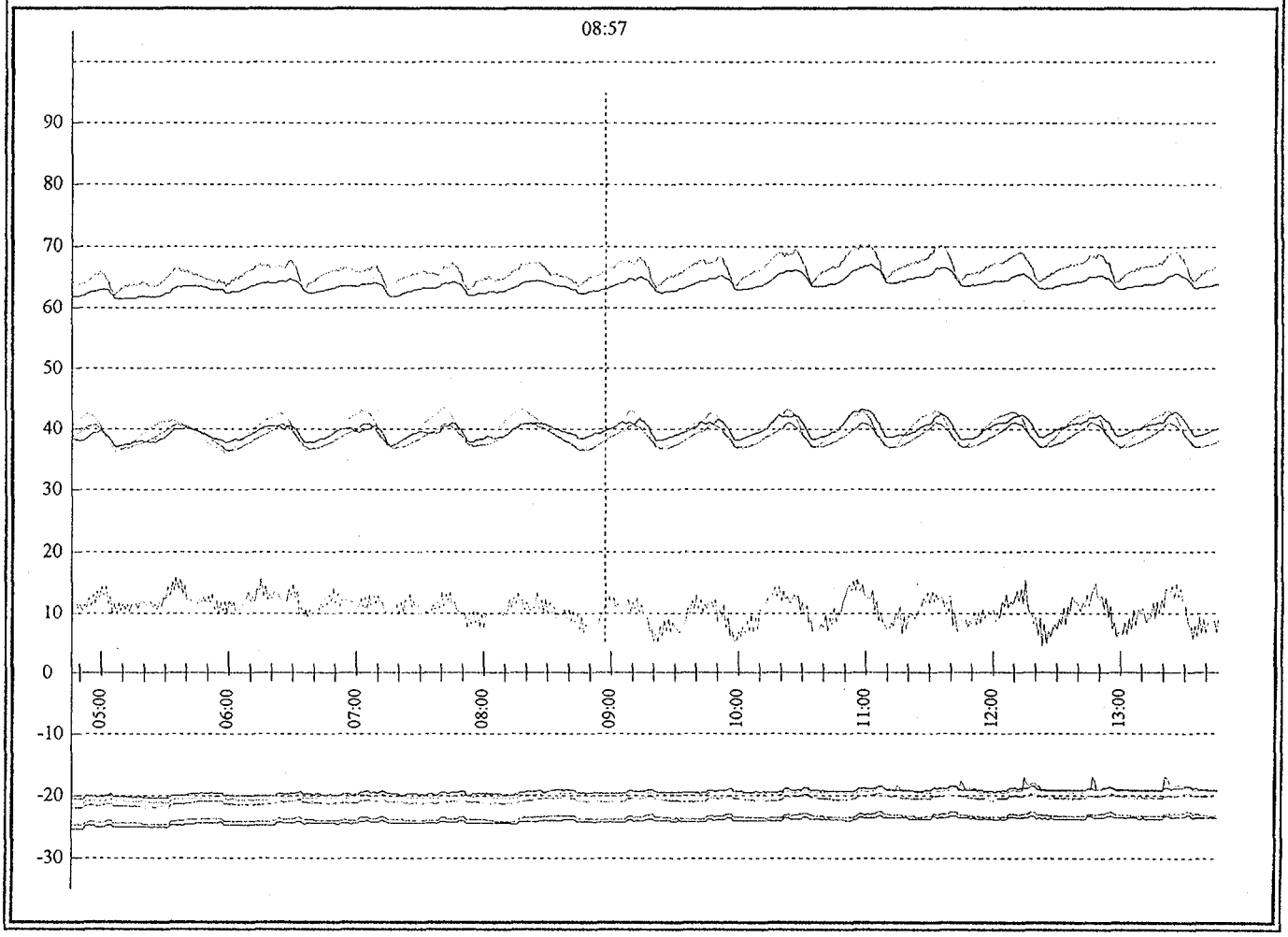
TestDate: 00/01/02 12:04 *Report No.:* ( ) - Page 1

PageTestName: Energy Consumtion *ReportDate:* 00/01/13 10:13

Page Result :

1 - Page Test Time	*68 Hours*
2 - Working Percent	*90 %On*
3 - Energy (Accord to page)	*2.455 kwh*
4 - Zoom Time	*62:08 Hour*
5 - Compr Current	*1.94 Amp*
6 - Evaprator Mean Temp	*-17.7 C*
7 - Cabin Mean Temp	*-17.7 C*
8 - Crisp Temp	*-20.8 C*
9 - Compr Temp	*68.7 C*
10- Condensor In Temp	*73.9 C*
11- Condensor Out Temp	*16.3 C*
12- Condition	*45.1 C 32 %H*
13- Volt	*Max=250 Mean=215 Min=223*
14-	
15-	
16-	
17-	





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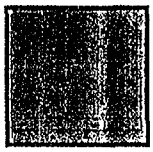
Printing in Labaratory Of
Maurice Ind. [Jordan]

Maurice Ind. [Jordan]



TestDate: 00/01/02 12:04
TestName: Energy Consumtion

Report No.: Spec & Remark
ReportDate: 00/01/13 10:19

Total Result :

1 - Total Test Time	*68 Hours*
2 - Working Percent	*3 %On*
3 - Energy	*0.076 kwh*
4 - Zoom Time	*62:10 Hour*
5 - Compr Current	*1.88 Amp*
6 - Evaprator Mean Temp	*13.6 C*
7 - Cabin Mean Temp	*1 C*
8 - Crisp Temp	*12.4 C*
9 - Compr Temp	*14.4 C*
10- Condensor In Temp	*16.9 C*
11- Condensor Out Temp	*12 C*
12- Condition	*45.8 C 32 %H*
13- Volt	*Max=250 Mean=215 Min=223*
14-	
15-	
16-	
17-	

Product Spec :

1 - File Name	*00010212.k04*
2 - Test Kind G	*Perform.*
3 - Product Serial	*BES-100WC*
4 - Product Name	*Water Cool*
5 - Product Model	*MDWC-100*
6 - Product Capacity	*100 L/H*
7 - Compressor Name	*L.G*
8 - Compressor Model	*27UA*
9 - Compressor Power	*1/4 Hp*
10 - Compressor Amper	*2 Amp.*
11 - Thermostat No.	*3*
12 - Thermostat Type	*Ranco*
13-	
14-	

Technical Manager: *ICRC*

Lab Chief : *MARIO AL-DEEK*

Lab Specialist: *ZIAD*

Remark :

Al-Besani Workshop
Water Cooler
Remark3

Remark :

sign :

مؤسسة موريس الديك
للثلاجات والمصنوعات المعدنية

Printing In Labaratory Of
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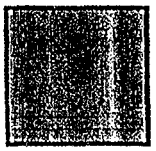
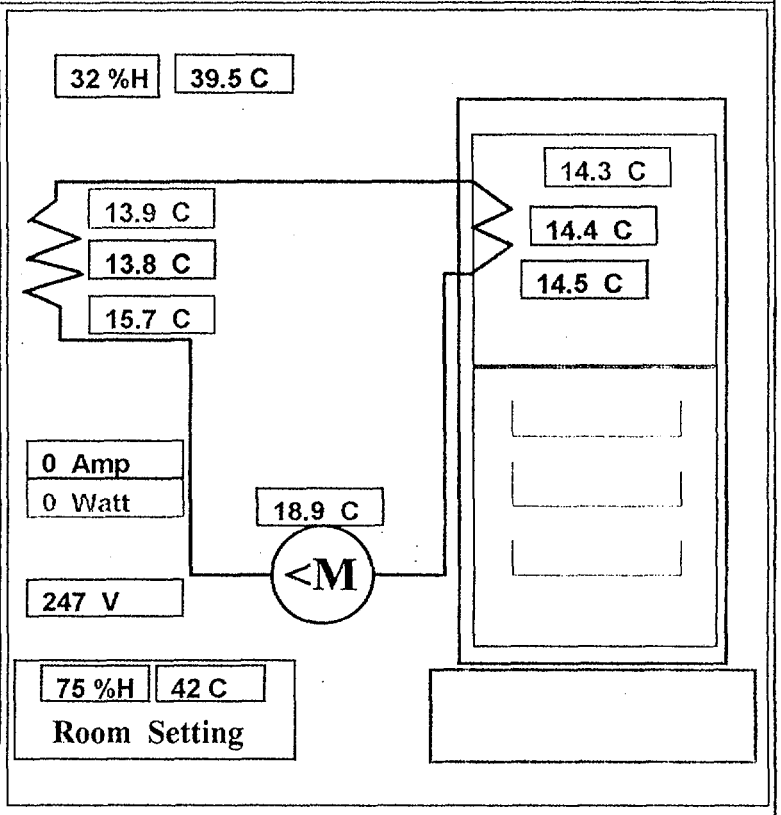


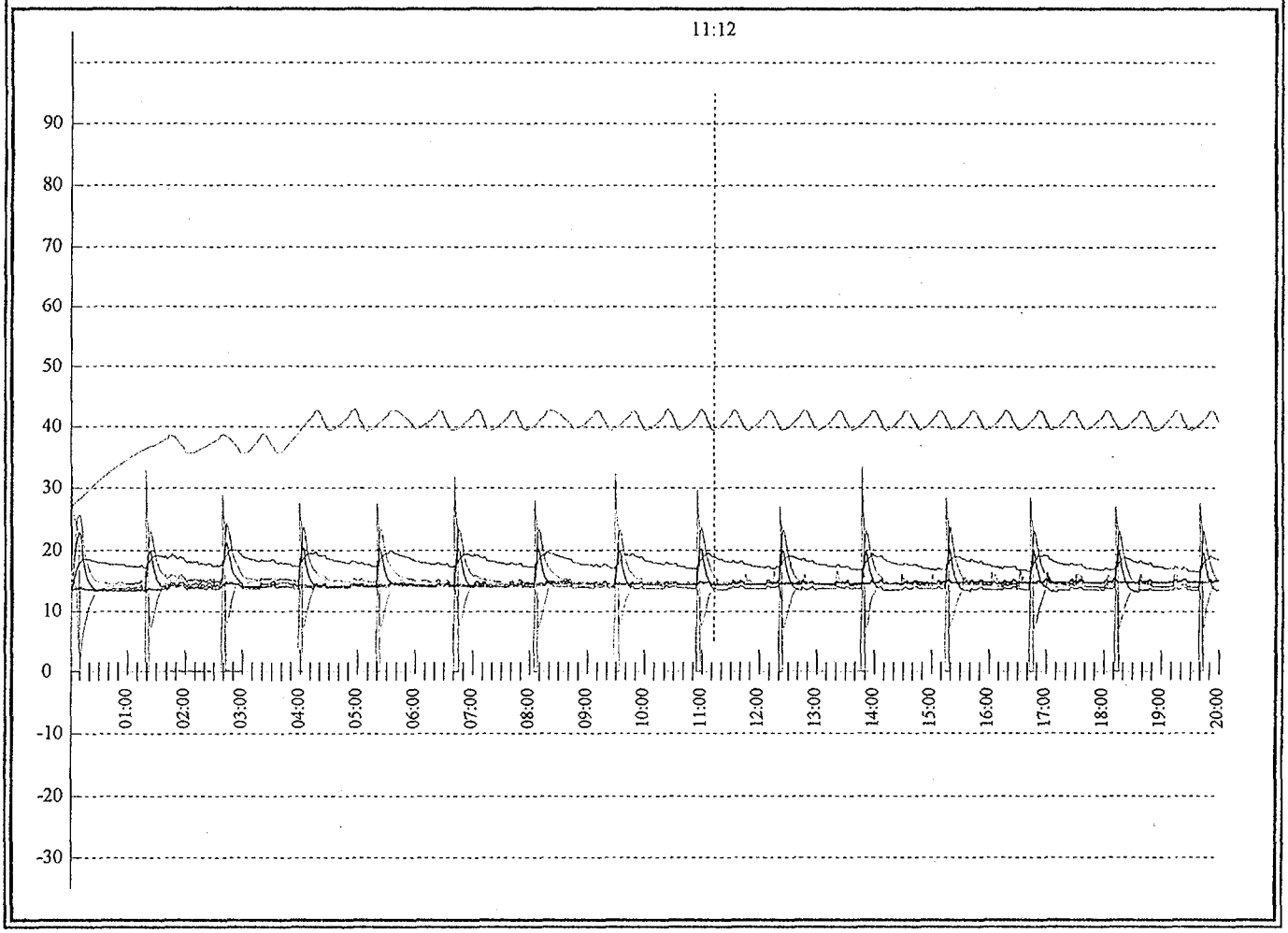
TestDate: 00/01/02 12:04 *Report No.:* ( ) - Page 1

PageTestName: Energy Consumtion *ReportDate:* 00/01/13 10:22

Page Result :

1 - Page Test Time	*20 Hours*
2 - Working Percent	*4 %On*
3 - Energy (Accord to page)	*0.086 kwh*
4 - Zoom Time	*11:13 Hour*
5 - Compr Current	*00 Amp*
6 - Evaprator Mean Temp	*14.4 C*
7 - Cabin Mean Temp	*-3.2 C*
8 - Crisp Temp	*14.1 C*
9 - Compr Temp	*18.9 C*
10- Condensor In Temp	*15.7 C*
11- Condensor Out Temp	*13.9 C*
12- Condition	*39.5 C 32 %H*
13- Volt	*Max=248 Mean=239 Min=224*
14-	
15-	
16-	
17-	





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Printing in Labaratory Of
Maurice Ind. [Jordan]

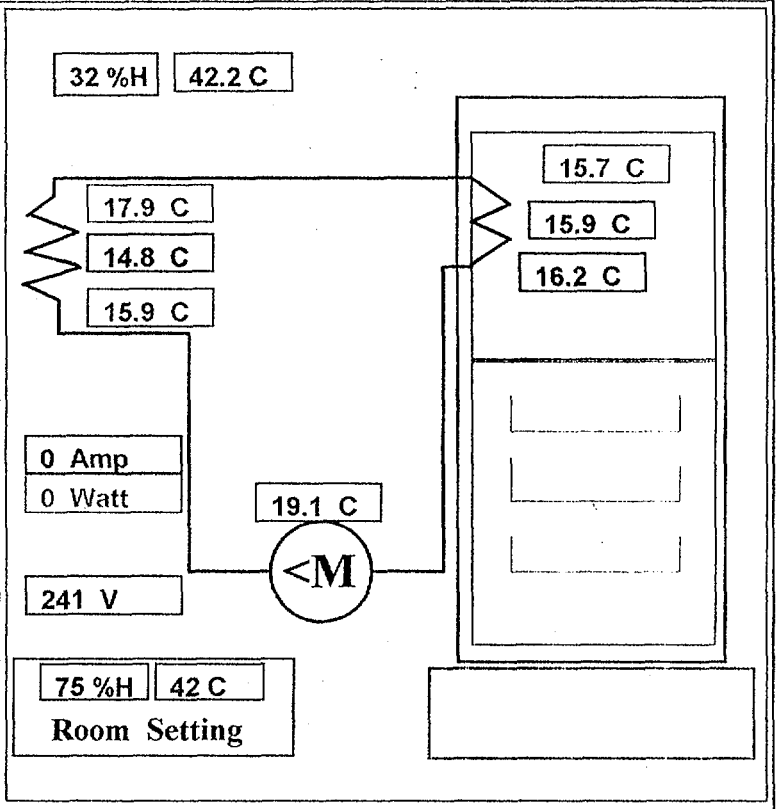
Maurice Ind. [Jordan]

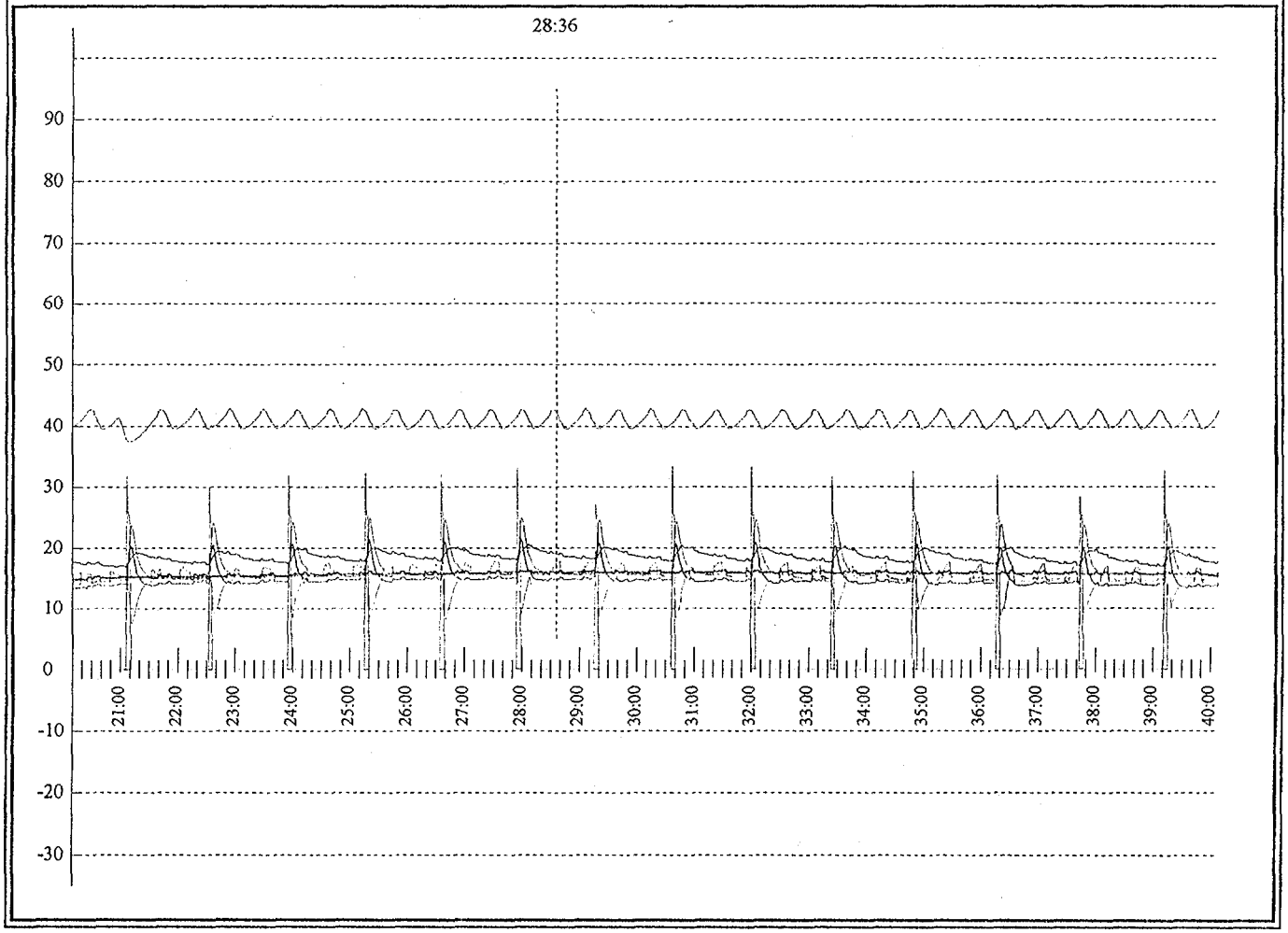
TestDate: 00/01/02 12:04 *Report No.:* ( ) - Page 1

PageTestName: Energy Consumtion *ReportDate:* 00/01/13 10:26

Page Result :

1 - Page Test Time	*20 Hours*
2 - Working Percent	*4 %On*
3 - Energy (Accord to page)	*0.086 kwh*
4 - Zoom Time	*28:36 Hour*
5 - Compr Current	*00 Amp*
6 - Evaprator Mean Temp	*15.9 C*
7 - Cabin Mean Temp	*.5 C*
8 - Crisp Temp	*15.1 C*
9 - Compr Temp	*19.1 C*
10- Condensor In Temp	*15.9 C*
11- Condensor Out Temp	*17.9 C*
12- Condition	*42.2 C 32 %H*
13- Volt	*Max=247 Mean=238 Min=224*
14-	
15-	
16-	
17-	





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Printing In Labaratory Of
Maurice Ind. [Jordan]

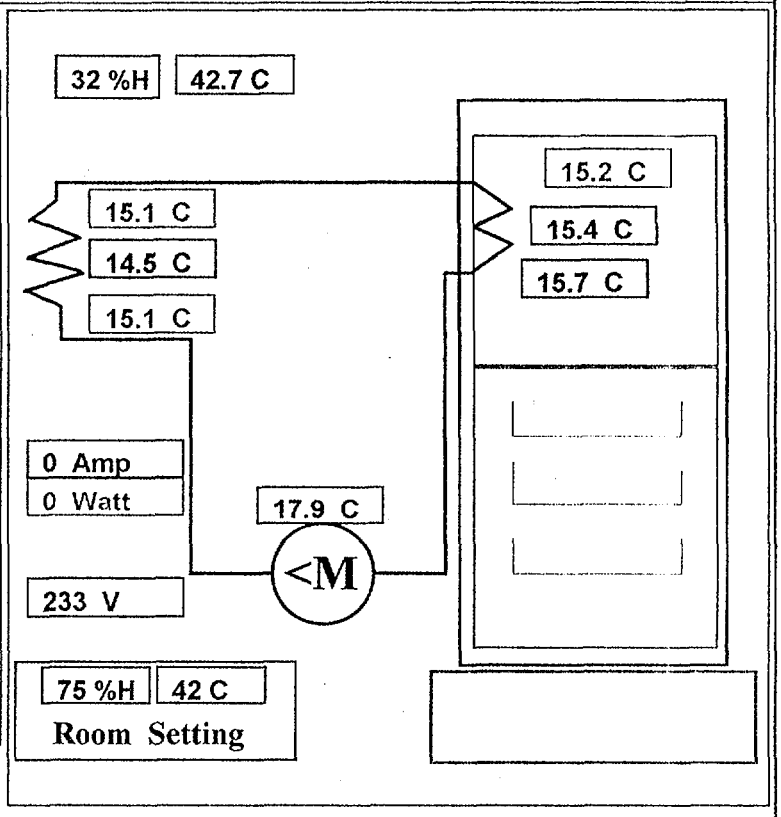
Maurice Ind. [Jordan]

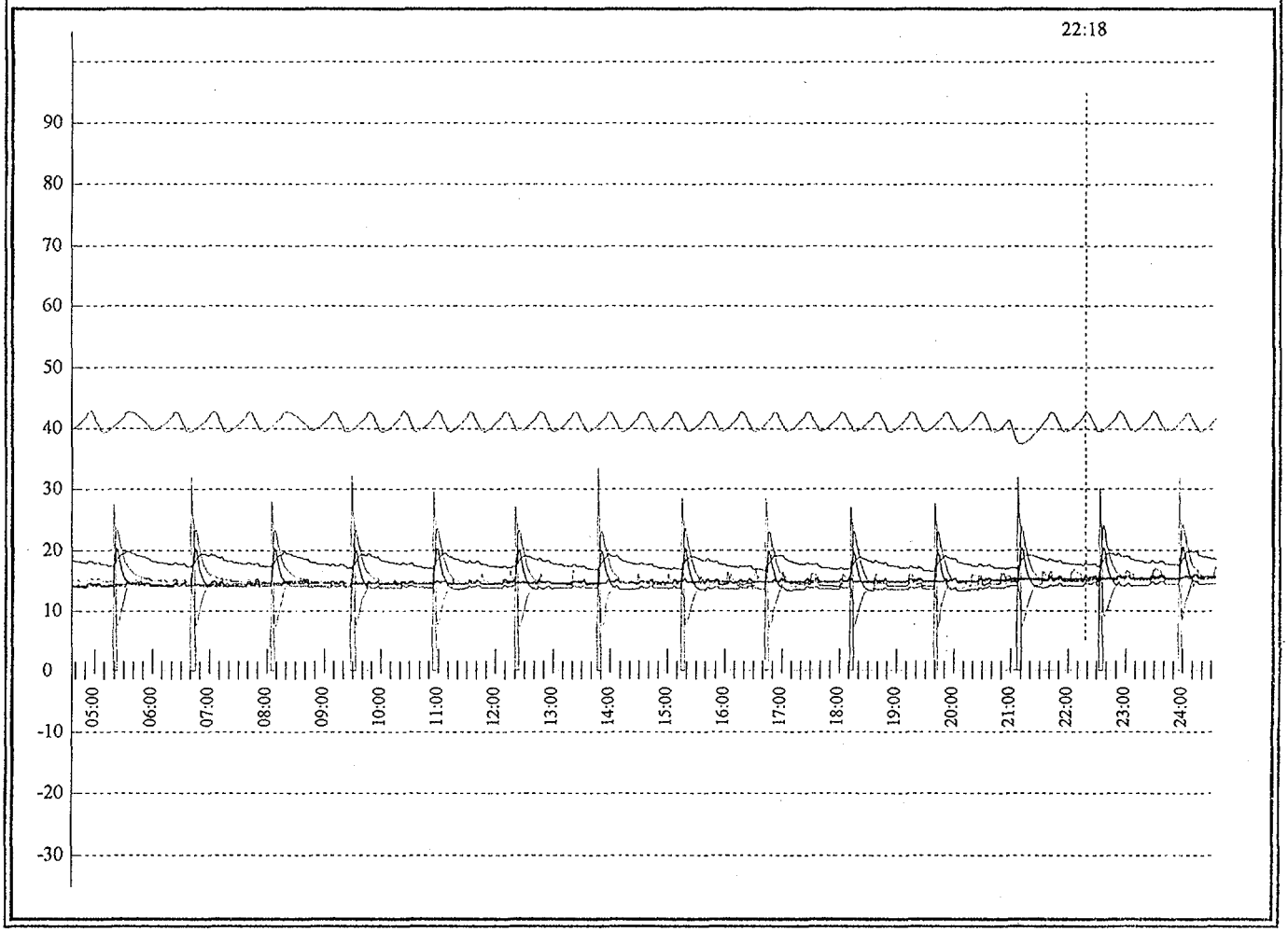
TestDate: 00/01/02 12:04 *Report No.:* ( ) - Page 1

PageTestName: Energy Consumtion *ReportDate:* 00/01/13 10:28

Page Result :

1 - Page Test Time	*68 Hours*
2 - Working Percent	*3 %On*
3 - Energy (Accord to page)	*0.076 kwh*
4 - Zoom Time	*62:10 Hour*
5 - Compr Current	*1.88 Amp*
6 - Evaprator Mean Temp	*13.6 C*
7 - Cabin Mean Temp	*1 C*
8 - Crisp Temp	*12.4 C*
9 - Compr Temp	*14.4 C*
10- Condensor In Temp	*16.9 C*
11- Condensor Out Temp	*12 C*
12- Condition	*45.8 C 32 %H*
13- Volt	*Max=250 Mean=215 Min=223*
14-	
15-	
16-	
17-	





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