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Bahman Final Report ( Page 1 )

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**REPORT**

CONVERSION OF

BAHMAN Co.

HOT CHAMBER

FINAL REPORT

Contract No. 96/176P

UNIDO's PROJECT No. MP/IRA/94/403

29 Oct. 1997

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## **SYNOPSIS**

Under supreme supervision of **UNIDO** the **CFC** phase project has been implemented in Iran to phase out 100 % ODS in five major Iranian White Industries

The project No. **MP/IRA/94/403** has been nominated to Islamic Republic of Iran for the Multilateral Fund for the implementation of The Montreal Protocol Financing.

The project was approved by Montreal Protocol Multilateral Fund executive committee. The project was actually started in November 1994, but the implementation of the project has been already started from January 1994, by recommendation of Montreal Protocol and request of Government of Islamic Republic of Iran, the refrigerant R134a was finally approved and selected by **UNIDO** as an alternative for refrigerant R12.

**Bahman. Industrial Factories Co.** As a one the largest home appliance manufacturer in Iran was established in 50 year ago, the main activities of **Bahman. Co.**, In Tehran plant is producing refrigerators and freezers, as well as washing machine and desert coolers space heater and water heater.

The total production rate of refrigerators and freezers are estimated to be more than 200,000 units per year at maximum capacity. More than 2500 people are working in Tehran plant and. Laboratory department is taking care of testing of performance criteria of our refrigerators and freezers, as well as material acceptance tests.

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## **INTRODUCTION**

According to **UNIDO** contract No. **96/176P** with Industrial Control Research Center Co. (**ICRC**) the existing **BAHMAN..** hot chambers facilities in Tehran Plant shall be converted and modified to phase out CFC-12 and suitable for **R134a** refrigerant to perform functionality and performance test of converted refrigerators and complying with ISO standards 7173, 8187, and 5155.

- 1 This proposal has been prepared based on the requirements of Islamic Republic of Iran indicated in the country program no UNEP/OZL.PRO/EX COM/10/24 dated 27 May 1993 prepared by UNDP.
- 2 The CFC phase out project in **Bahman. Co.** will enable Bahman. to convert the existing production line facilities and existing hot chambers into Non CFC production line, using **R134a** refrigerant.
- 3 The converted Hot Chamber Installations will provide more than sixteen data points in the refrigeration circuit this means more information and the ability of analyzing refrigeration system and new refrigerant effect.
- 6 The reconstructed Hot Chamber will be able to check and test four refrigerator and/or ref.-freezers units at the same time. The same equipment and data processing system, as will be used at Tehran plant test room will be installed in this chamber.
- 7 The immediate effect of this project at Bahman. is to perform all required check and tests, suitable for Refrigerator & Freezers using Ozone Friendly Gases. The existing test facilities in Bahman. Co. In Tehran are not adequate for check and testing, converted ref. and freezer units, in addition to that the hot rooms are not able to perform Energy Consumption and Optimization Program.

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## **ICRC Hot Chamber Characteristics**

In order to convert Bahman. hot rooms facilities in Tehran, ICRC shall provide following services:

- Supply of new equipment.
- Redesign of old equipment
- Delivery of technical drawings and software.
- Installation and commissioning.
- Start-up of the equipment and the technology.
- On-the-job training of the plant personnel.

With respect to ISO standards test requirements, and for the purpose of functionality and performance tests of the new redesigned Refrigerator and Ref.-Freezers using R134a refrigerants. The existing hot room in Bahman. is being converted and equipped in such a way to enable Bahman.to check and test at least two different models of refrigerators and freezers at ambient temperature 32 to 43 degree centigrade at two hot room chambers in Tehran Plant. In addition to these services is providing. But the hot room is capable to test eight refrigerators and freezers in case of adding more transducers and sensors in the main panel in the hot room:

- a) Procurement of new test measurement and data processing equipment.
- b) Redesign and rebuilding of presently used equipment and installation.
- c) Installation, commissioning, trial operation, start-up and on-the-job training

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## **Bahman. HOT CHAMBER TECHNICAL SPECIFICATION**

As previously mentioned , Bahman. Co.'s main plant is located in Tehran and is producing 1000 refrigerator daily . And subsequently the hot chamber should have been able to cover plant daily test requirement as well as other activities. Therefore, the converted hot chamber should respond to all test requirement and be able to meet ISO standards numbers 7371, 5155, 8187 as set forth in the contract and IJISI, Iranian standards numbers 254, 2482, 2818. The Tehran plant hot chamber technical specification are as follows:

- Hot Chamber Dimension about 3 mt. by 4 mt.
- Refrigerator test ability simultaneously, 2 units
- Ability to perform following operational tests and report:
  - 1 - Pull down test.
  - 2 - Continuous run test.
  - 3 - Cyclic run test.
  - 4 - Ice Freeze test.
  - 5 - Energy consumption test
- 16 Measuring points, including. (for each applia.)
  - 1 - Humidity, one point for one hot room.
  - 2 - Compressor Power, one point
  - 3 - Motor energy consumption, one point.
  - 4 - Supply Voltage, one point.
  - 5 - Hot chamber air temperature reading, one point.
  - 6 - Hot chamber relative humidity, one point

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- The ability to measure 160 points for eight models in case of improving the system by spending very low costs.
- Computerized graphical diagram of the refrigerator performance data sheet.
- Test measurement tolerance for temperature reading 0.3 degree centigrade.
- Computerized data processing system.
- Full color test sheet system reporting.
- On screen and data reporting system ability with following characteristics;

- 1 - Test number.
- 2 - Product name.
- 3 - Product model
- 4 - Product internal volume
- 5 - Compressor name
- 6 - Compressor model
- 7 - Compressor cooling capacity
- 8 - Compressor current
- 9 - Thermostat setting
- 10 - Thermostat type.
- 11 - Total test running time.
- 12 - Ambient temperature.
- 13 - Voltage rating
- 14 - Working percentage
- 15 - Evaporator mean air temperature
- 16 - Cabin mean temperature
- 17 - Evaporator bulb temperature
- 18 - Crisper temperature.
- 19 - Actual compressor running time
- 20 - Energy consumption

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- 21 - Compressor motor winding temperature
- 22 - Compressor shell temperature.
- 23 - Compressor discharge temperature.
- 24 - Condenser inlet temperature.
- 25 - Condenser out let temperature.
- 26 - Condenser mid temperature
- 27 - Evaporator inlet temperature
- 28 - Evaporator outlet temperature.
- 29 - Freezing temperature.
- 30 - Refrigeration system condition display.

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## **ACTIVITIES**

The following activities were generally accomplished toward achievement of the contract requirement as set forth by UNIDO and the counterpart.

1 - .Planning for;

- a) Hot chambers system management.
- b) Hot chambers graphic display management.
- c) Hot chambers calibration setting parameters.
- d) Hot chambers test standards management

2 - Preparing material requirement list.

3 - Component and material supply source evaluation.

4 - Technical data collecting.

5 - Engineering drawing for electronic and electrical system

6 - Hot chamber design review.

7 - Data processing software planning.

8 - Data processing hardware planning.

- 9 - Thermal amplification electronic cart design
- 10 - Thermal calibration electronic cart design.
- 11 - Initial test of data loggers electronic cart.
- 12 - Initial connection of data loggers to the computers.
- 13 - Interface electronic cart design for PC and operating system.
- 14 - RTX3 electronic diagram design.
- 15 - RTX electronic diagram design.
- 16 - UNIDO, CRC - 386 design.
- 17 - UNIDO, TC- 100 design.
- 18 - UNIDO, in-out CRC design.
- 19 - Preparation of operating system display flow chart.
- 20 - Preparation of timer 1 flow chart.
- 21- Activities at home office and project area:
  - Visiting plant.
  - Visiting and coordinating with UNDP office in Tehran four times.
  - Technical negotiation with Bahman Manufacturing Co. engineers in Tehran headquarters in order to coordinate activities in Tehran
  - Visiting Tehran hot chamber several times in order to coordinate activities.



21 -1 - Reviewing and evaluating the existing hot chamber for the purpose of:

- a) Hot Chamber Heat Control Design;
- b) Hot Chamber Heat Capacity;
- c) Hot Chamber Heat leaks;
- d) System Control Placement;
- e) Refrigerator Unit Placement;

21 - 2 - Following steps were taken to manufacture hot chamber hoods:

- a) Designing;
- b) Fabricating;
- c) Preparation;
- d) Hood Installation;
- e) Sensor Preparation;
- f) Sensor Check and Test;
- g) Sensor Installation;
- h) Wiring;
- l) Wiring Control;
- k) Selecting Blower and Fans;
- l) Blower Check and test;
- m) Blower Installation;



**21 - 3 - Following Components and parts were designed and manufactured:**

- a) Complete Data Logger System;
- b) Thermal Amplifier;
- c) Electrical Control Panel;
- d) Electronic Control Panel;
- e) Complete Heat Control System;
- f) Hot Air Circulating System;
- g) Voltage Regulator for 220 Volts and 50 Hz;
- h) Refrigerator Unit Power Supply;

**- 4 - Following Components were installed in hot chambers at Tehran Service Center:**

- a) Data Program Logger in CPU;
- b) Data Logger Check and Test;
- c) Power Supply Installation;
- d) Refrigerator Power Supply Installation;
- e) Hot air circulation hoods;
- f) Electrical Control Panel;
- g) Main Control Panel;

**- 5 - Initial Check and test of thermal measurement system and relevant sensors.**

**21 - 6 - Man Hours spent at home office:**

a) Engineer:	180	Man Hours
b) Technician:	250	Man Hours
c) Technical Assistance:	840	Man Hours
( Direct Labor, by helpers)		
d) Management:	160	Man Hours



**21 - 7 - Project Area.**

- a) Two engineers for the execution of the contract and converting of existing hot chamber facilities at plant for two man months;
- b) Two technicians for the execution of the contract and converting of existing hot chamber facilities at plant for two man months;

21 - 8 - Evaluating operating condition of the hot chamber to insure proper performance, and giving corrective action to correct discrepancies.

21 - 9 - Installation of the new refrigeration system in the hot chamber and regulate air flow system, in order to get desired ambient temperature.

21 -10 - Design, manufacturing and installing new logical evaluating system, this new system will improve the efficiency of the hot chamber and will enable the operator to determine automatically all the possible discrepancies, that may occur during the operation of the system.

-11 - Redesign and replacement of previously installed hood and installing the hood in the new position.

21 - 12 - System optimizing, in order to prolong system retirement life.

21 - 13 - System calibration in order to ensure the accuracy of the reading data and improve management information system.

21 - 14 - Performing necessary modification to the air flow circulation in order to ensure a stable and steady air temperature in the all hot chamber space.

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## **SUPPLY PARTS AND MATERIALS**

In order to fabricate components and electronic kits following material and parts have been purchased so far.

- 1 - Semiconductor sensors for measuring temperature from - 30 to + 110 degree centigrade. 20 each
- 2 - Electronic calibrator 1 each
- 3 - Electronic data logger cart for temperature measurement 6 each
- 4 - Electronic data logger cart for humidity measurement 6 each
- 5 - ADC912 converter IC for system integral management.
- 6 - Electronic parts consist of resistor. IC, capacitor, and diode, 2760 each.

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7 - Following Components and Parts were installed and procured for each hot chamber:

- a) Heat generator;
- b) Air Blower;

6 KW) with relevant  
integrated analog control ( 0 to 100 % rated );

Logger;

- e) Sensor Socket Support Bracket;
- f) Socket Channels;
- g) One room air conditioner units for maintaining hot chamber ambient temperature at 32 to 43 degree C;
- h) One Humidifier unit for hot chamber;
- I) Control panel consist of 16 thermal sensors with +110 to -25 C accuracy.
- J) Three electrical sensors for measurement of electrical current, Cos. power and energy.
- K) Two thermal and humidity control panel for control of hot chamber condition.
- L) 16 additional data logger.
- M) Data logger for collecting 128 thermal data and 16 electrical data and 16 humidity data.
- N) 16 out put control line with additional device for insulation measurement and compressor test.
- O) 4 supply transformers.
- P) 32 sensor cables with 2 mt. Length with 4 sockets.
- Q) Data logger channel.
- R) A complete soft ware program to be used with windows 3.11.



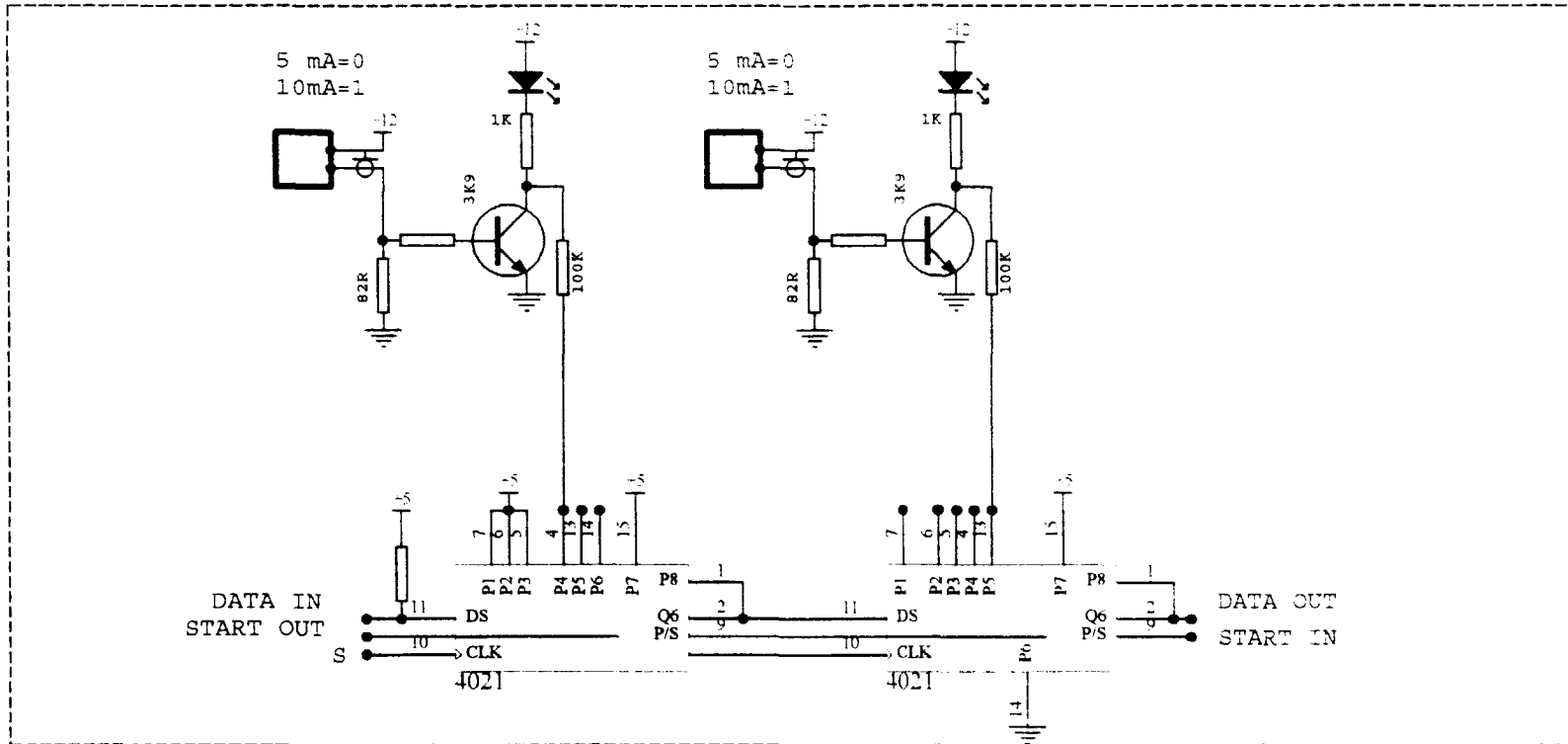


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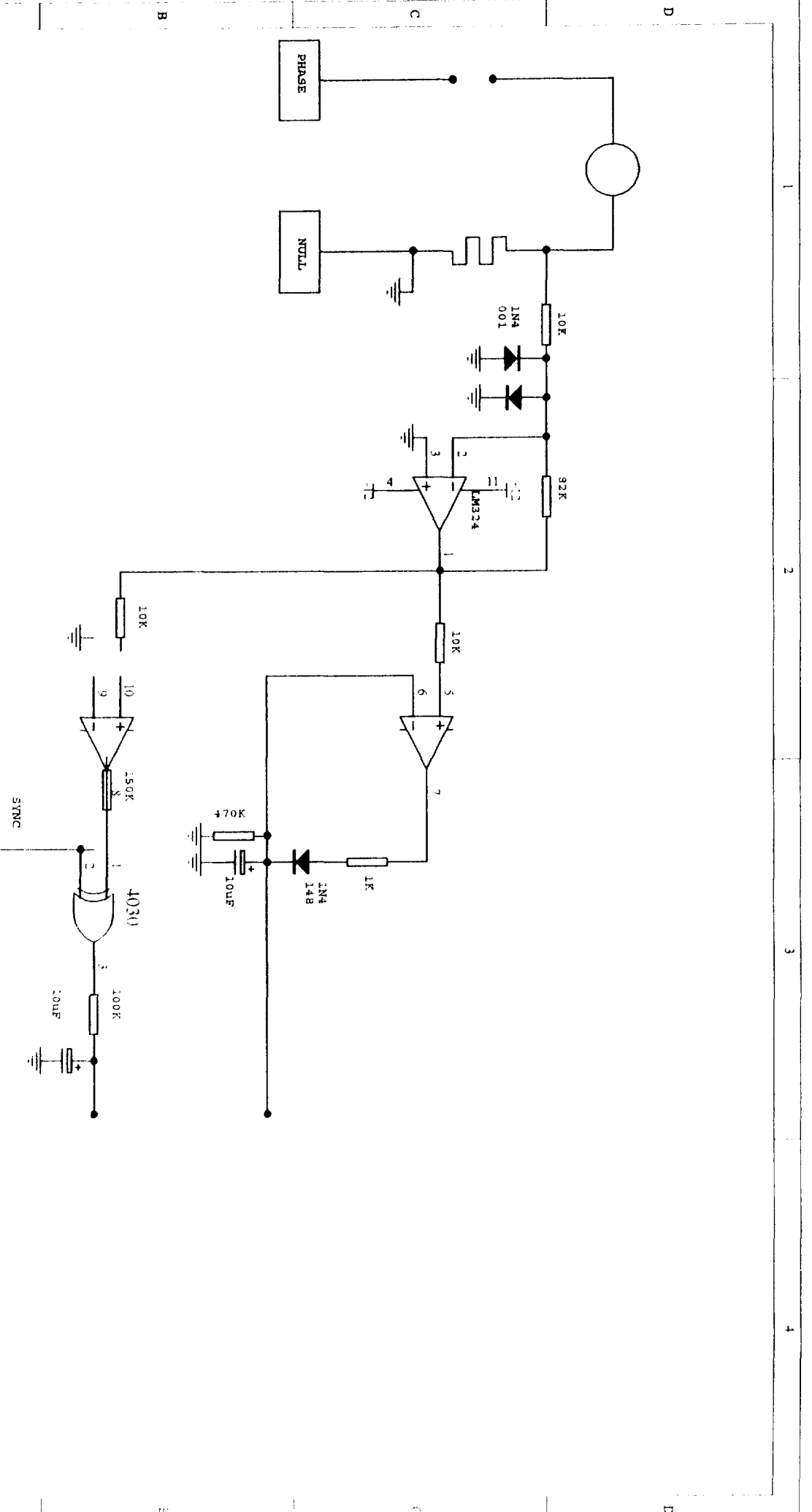
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**ICRC  
HOT CHAMBER  
GENERAL  
CHARACTERISTICS  
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SPECIFICATIONS**

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**Company Background**

ICRC was established in 1978 in Tehran. The company started with researching in the field of Industrial control system in different industrial sectors for the aim of improving product quality and productivity. ICRC Co. has improved and designed many control and test equipment in many fields such as Domestic Refrigerator Manufacturer Industries, Rubber industries, Still industries, Metal alloy Industries.

ICRC Co. as a leading engineering company in designing and producing the control system and equipment in Iran has achieved a remarkable effort in improving test equipment in the domestic refrigerator manufacturer industries so far, this achievement has lead us to design unit, modern, capable and efficient Hot Chamber control system that is used mainly for testing refrigerator and freezer appliances for many applications for different purposes.

ICRC hot camber control and test system fulfills all refrigerator manufacturers requirement to test their products under different conditions

ICRC has produced and installed six advanced refrigerator control systems Iranian domestic refrigerator manufacturer that fulfill test requirement of many production rate of 3000 units in these factories.

ICRC is proud of achievement of three contracts with UNIDO by producing and installing four control and test systems for AZMAYESH ARJ BAHMAN companies to help the implementation of CFC phase out project (project No. MP/IRA/94/403) in these companies by UNIDO.

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*Model ICRC-2RA8-1  
Hot Room*

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### 1- General Characteristic

ICRC hot chamber control and test system could be used under wide range of hot chamber working condition for the following purposes :

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- 1/1- Comply with *ISO* standards test requirements
- 1/2- Performance test applied by the manufacturer for *R&D*
- 1/3- Trouble shooting of the appliances
- 1/4- Improving refrigeration system
- 1/5- Evaluating and reviewing performance data designed for max. 7 days long performance test
  
- 1/6- Evaluating design criteria
- 1/7- Performing different test from +15 to +45 °C ambient temperature
  
- 1/8- Observing tests results on a full colored monitoring display system
- 1/9- *Energy consumption* measurement
- 1/10- Compressor real working efficiency
- 1/11- Compressor running time (*percentage*)

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## 2- Capability

- 2/1- Controlling 2 Hot Rooms ambient temperature separately
- 2/2- Testing max. 8 appliances simultaneously
- 2/3 Displaying of fully colored *MIMIC* appliance with 20 test points for each appliance
- 2/4- Providing On Line data and graph curves for each individual point and maximum 10 graphs at the same time.
- 2/5- Max. 7 *days* continuous test run time
- 2/6- Displaying any previous test while running current test
- 2/7- Color printing of a previous test on a A4 size paper while reviewing another previous tested test and running the current test
- 2/8- Max. 20 pages document of single test report could be printed individually
  
- 2/9- Facility on printing :
  - 2/9/1- each report has a report No.
  - 2/9/2 each report can be printed max. 20 pages
  - 2/9/3- each report has a main test name
  - 2/9/3- each report has a second test name
  - 2/9/4 on each report can be determine that what and how many test points are active for graphic curve and zoomed data (max. =10)
  
  - 2/9/5 each report can has max. 4 segments of time interval for printing curve .  
Each segments are separately printed

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- 2/10- Each test results could be saved in a separate file , for future valuation and review.
- 2/11- The system program could be easily used with Microsoft Windows. The program is a user friendly program and the *Iconical commands* and *graphical charts and curves* and *visual system* are specially designed for Refrigerator Hot Chamber test facility .
- 2/12- Calibration procedure of the all system sensors requires max. 10 minutes and .
- 2/13- Program and Data Logger have been designed to test max.. *8 appliances* simultaneously in the *2 separate Hot Chamber* and controlling *2 Test Room* condition separately.

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### 3- Tolerance & Precision

( Measuring and Control: )

3/1- measuring:

3/1/1-	<i>Temperature</i>	0.1	°C
3/1/2	<i>Current</i>	0.1	Amp
3/1/3	<i>Cos(Phi)</i>	1	Grade
3/1/4	<i>Power</i>	1	Watt
3/1/5	<i>Energy</i>	0.01	Kwh
3/1/6	<i>Humidity</i>	5	%
3/1/7	<i>Pressure</i>	0.5	Bar

3/2- Room Condition Controlling

*Room temp.*                       $\pm 0.5$  °C



## 4- Accessory & Equipment

(Provided by ICRC )

### 4/1- Room conditioner

4/1/1- **Heater** , for heating the Hot Room)

4/1/2- Room temperature **controller** with the **SCR** system .  
This device maintains desired temperature in a steady state condition .

4/1/3- Room temperature measuring sensors

4/1/4- Room humidity.. measuring sensors

4/1/5- Steam generator

### 4/2- Variable voltage supplier

A voltage regulator devices will be supplied with the system for measuring the setting starting voltage of the compressor and checking different compressor endurance condition.. This voltage can be varied manually from 150 to 240 volt. with the 5 volt per each step



4/3- Sensors

4/3/1- For each Appliance (and max. 8 appliances)

16 Temperature sensors for 16 different test point Refer to appliance mimic graph on the monitor consist of :

- 8 for inner side of appliance
- 3 for surface of cabin
- 1 for room air
- 3 for condenser (in-mid-out)
- 1 for compressor shell

4 Sensors for measuring electrical parameters consist of :

- 1 - for *Amp*
- 1 - for *cos(φ)*
- 1 - for *Watt*
- 1- for *Kwh*

4/3/2- For only one Appliance

2 pressure measuring sensor for inlet and outlet of compressor.

4/4- Transducer

In this system there is used

128	Temperature	to	voltage
32	Electrical param.	to	voltage
2	Pressures	to	current
2	Humidity	to	voltage
2	Pressures	to	current

traducers.

4/5- Data Logger Channel

Aluminum noise protected cavity profile with necessary Flat-Cable and disconnectable screw holder sockets for guiding the wiring for Data Logger . This devise is mounted on the top of the Hot chamber . This device has capability to provide the necessary sensors sockets for max. 8 appliances (maximum totally 32 sockets for 2 rooms )



4/6- Data Logger :

Powerful Data Logger system with ability of collecting 20 data for each appliance and managing 8 appliances in 2 separated room . This Data Logger has been designed specially for Hot Room test managing.

4/7 **\*\* Data Logger could collect data from one to max. . eight Appliances by option due to the client's requirement and request. (refrigerator. or freezer)**

4/8- Software

4/8/1 Program software has been specially designed and provided for Hot Rooms to comply with ISO and manufacturer requirement. . This program is capable to display on-line the current testing results of the 20 test points of thermodynamic condition (temperature and presser) , and electrical condition of refrigeration system as well as hot room condition.

4/8/2- The software can perform simultaneously :

- 4/8/2/1- On-line testing and displaying 8 Appliances
- 4/8/2/2- Monitoring a previously tested test for review while performing the current test
- 4/8/2/3- Printing any previously tested test on the A4 color printer while performing current test and reviewing another previous test

4/8/3- Making back up from all test results.

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### 5- Services & Equipment

(To be supplied by the Client \* )

- 5/1- *Insulated Hot Room* with desired dimension according to number of appliances that are to be tested
- 5/2- *Hot Room Air conditioner*
- 5/3- *Operator Room* for PC computer and control board .
- 5/4- 3 phase 380 volt 10 amp *Electrical power supply*
- 5/5 *Water supply* one liter per minutes with suitable Drain

\*\* ICRC will provide the drawing and specification of the equipment.

<p>Post Address: ICRC P.O.Box 18915-133 Tehran Iran Telefax (Factory) 00981-21-559120 Fax (Office) 00981-21-8852090</p>
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4/3- Sensors

4/3/1- For each Appliance (and max. 8 appliances)

16 Temperature sensors for 16 different test point Refer to appliance mimic graph on the monitor consist of :

- 8 for inner side of appliance
- 3 for surface of cabin
- 1 for room air
- 3 for condenser (in-mid-out)
- 1 for compressor shell

4 Sensors for measuring electrical parameters consist of :

- 1 - for *Amp*
- 1 - for *cos(φ)*
- 1 - for *Watt*
- 1- for *Kwh*

4/3/2- For only one Appliance

2 pressure measuring sensor for inlet and outlet of compressor.

4/4- Transducer

In this system there is used

128	Temperature	to	voltage
32	Electrical param.	to	voltage
2	Pressures	to	current
2	Humidity	to	voltage
2	Pressures	to	current

traducers.

4/5- Data Logger Channel

Aluminum noise protected cavity profile with necessary Flat-Cable and disconnectable screw holder sockets for guiding the wiring for Data Logger . This devise is mounted on the top of the Hot chamber . This device has capability to provide the necessary sensors sockets for max. 8 appliances (maximum totally 32 sockets for 2 rooms )

INDUSTRIAL

CONTROL

RESEARCH

CENTER