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AUSTRIA

# SAFETY INSPECTION REPORT

## CFC - Phase out project

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**Manufacturer: LORESTAN REFRIGERATOR  
MANUFACTURING INDUSTRIES**



Factory Location: Khoram Abad, IRAN  
Inspection dates: 19.10.1998

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Certification Body,  
Calibration Body

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## 1 Abstract

According to the definitions of the contract No. 98/184 a safety inspection of the converted plant using cyclopentane as blowing agent should guarantee the correct implementation and installation of safety procedures and systems. This inspection should be based on international standards and documented in a safety inspection report.

The scope of the inspections is specified in clause 4 of the „terms of reference“ from 18 June 1998.

For that purpose an inspection visit was executed on 19. October 1998 on the production site of Lorestan in Khoram Abad. The results of this inspection are stated in detail in the following report. Faults and deviations to the applicable international standards are listed related to the main areas and systems. Under the term „corrective action“ the possibilities to eliminate each inadequacy or incompleteness are mentioned.

The production machinery and equipment in Lorestan is supplied by Perros, Italy. The storage tank is produced by a locally company. The production equipment consists of an underground storage tank (double wall), an aboveground distribution piping and one premixing and two ecodosing units (door and cabinet). The foaming process shall be performed with one mixing head arranged in the door foaming safety box and eight mixing heads in the cabinet foaming safety box.

At the inspection date there have no principal installations and none of the main supplies been erected. The only existing unit has been the underground storage tank, the foaming machinery has been still packed and stored inside the factory building. Due to the fact, that all the equipment has been still packed, all necessary supplies have not been connected, calibration gases and a lot of installations have not been completed at inspection date, there has been no possibility to execute the functional tests of safety relevant systems and components.

In order to issue a positive safety report the deviations had to be fixed, the missing installations had to be completed and the functional tests had to be performed.

**During several missions to Iran, UNIDO's Project Manager has had the opportunity to check the plant site and confirmed (acc. to UNIDO-FAX dated 01-12-04 / 14:38:40) that all corrective actions required in this report have been taken care of and completed by the contractor (PERROS) and the local counterpart (LORESTAN).**

A final inspection by the inspection body of TUV Austria to verify the proper correction of all deviations mentioned in our draft report Uniw0380/BUR/BRU, Vol. 01, has not been executed, therefore all results are based on the information of UNIDO (as mentioned above).

*Note: A list of all deviations as collected during the inspection visit in 1998, an inspection protocol and a measurement protocol is provided with the draft report, Vol. 01!*

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## 2 INTRODUCTION

### 2.1 General test procedures

All inspections and tests mentioned in this report are carried out in the same manner:

- A) Theoretical check of planning documents, certificates, schedules etc.
- B) Practical tests (visual inspection and/or measurements)
- C) Verification of test results according to international standards

### 2.2 Scope of inspections

The tests are performed in order to make a safety certification of the new installed refrigerator production plant possible. Therefore the safety relevant aspects of each part of the production line has to be carefully inspected and the safe function has to be verified.

The parts of the production line(s) under surveillance during the safety inspection are:

- A) General safety relevant systems
- B) Storage facilities for cyclopentane (storage tank, filling station etc.)
- C) C5-distribution piping
- D) Premix and dosing areas
- E) Cabinet foaming area
- F) Door foaming area

### 2.3 Description of Assessment results

For any clause of this report there is provided first a brief description of the existing equipment and a requirement list for all deviations existing at the inspection date in 1998.

**Referring to the latest information of UNIDO (Dez. 2001), all points of the requirement lists have been corrected and inspected by the UNIDO Project Manager after completion of the converted plant.**

The results of measurements and a list of basically international standards are mentioned in the final clauses of the report.

As there could no national regulations for the handling and storage of cyclopentane be provided by the recipient company, relevant technical rules and the engineering standard of developed countries was taken under consideration for the assessment of the safe design and function of the converted refrigeration plant.

## 2.4 Abbreviation list

C5	Cyclopentane
O <sub>2</sub>	Oxygen
N <sub>2</sub>	Nitrogen
LEL	Lower Explosion Limit
app.	Approximately
ESD	Emergency Shut Down
EEx d	Explosion protection type „flameproof enclosures - d“
EEx e	Explosion protection type „Increased safety - e“
EEx i	Explosion protection type „intrinsic safety - i“

## 3 Safety relevant systems

Safety relevant systems in general shall provide a suitable degree of protection against all dangers which can occur from the handling and storage of an easy flammable liquid (cyclopentane). This includes a safe design under consideration of the hazards of fire, explosion and leakage's.

### 3.1 Explosion protection

#### GENERAL DESCRIPTION:

The explosion protection system is based on primary and secondary protection equipment. Primary protection is the prevention of the occurrence of potentially explosive atmospheres by means of ventilation and inertization in endangered areas. A secondary explosion protection system is the detection of explosible atmospheres and the shut down of ignition sources when reaching the second alarm level of 30 % of the lower explosion limit (LEL).

Where the limitation of the concentration of an explosible gas mixture is not secured or an electrical device has to work in an explosion endangered area (zone 0, 1 or 2), the device must be properly explosionproofed for the degree of danger. The minimum degree for zone 1 is explosion group IIA and temperature class T2.

#### 3.1.1 Artificial Ventilation system

##### DESCRIPTION:

Local artificial ventilation systems shall be provided for the foaming area inside the safety boxes (three fans for the cabinet foaming area, one fan for the door foaming area) and the housings of the premixing, day storage tank and ecodosing units. There are double speed ventilation motors with a monitoring relay for the airflow.

The air suction points are designed on the top of the housings, the fresh air shall be sucked from the air inlets at the bottom of the boxes.

In case of a failure of a ventilation system the electrical supply in the ventilated area shall be switched off.

The exhausted air shall be conveyed outside the building through a chimney above the roof with a weather protection and a mesh for the opening.

#### REQUIREMENTS/DEVIATIONS:

**Referring to the latest information of UNIDO, all points of the requirement lists have been corrected and inspected by the UNIDO Project Manager after completion of the converted plant.**

- a) No calculation of the air exchange for the safety boxes available.

Corrective action:

providing of calculation documents for each safety box.

- b) No ventilation system mounted.

Corrective action:

proper mounting of all ventilation systems, ducts, chimney(s) etc.

- c) Lightning protection system for chimney shall be provided.

Corrective action:

Installation of a lightning rod or lightning rods or a metal frame beside/above the chimney (approximately 1 m distance and 1 m higher than the chimney). The lightning rods shall not be placed in the direction of the exhaust opening (app. 1 m against exhaust direction) and shall be properly mounted and connected to the steel construction of the building which fulfills the function of a lightning protection system.

- d) In case of a failure in the electrical supply an automatic emergency supply for the safety relevant systems (e.g. ventilation, ESD, etc.) shall be provided.

Corrective action:

Installation of an automatic stand-by generator or changing of an existing generator from manual to automatic switch on.

- e) The electrical supply is not connected.

Corrective action:

Completion of electrical installation.



f) The function and effectiveness of the artificial ventilation system could not be tested.

Corrective action:

After finishing of the installation and connection of the electrical supply the correct function can be tested.

### 3.1.2 Nitrogen blanketing (inertization) system

DESCRIPTION:

The system of nitrogen blanketing is used in order to reduce the amount of oxygen in a gas/air-mixture below the critical point for inertization, where no ignition of the mixture can take place because of the lack of oxygen (11,6 % O<sub>2</sub>).

At inspection date no nitrogen system has been installed.

The nitrogen system shall be used in the refrigeration plant

- for the inertization and leak detection (intermediate space between double walls) of the storage tank,
- for the inertization of the C5/polyol - day storage tank (monitored by pressure switch)
- and for the cabinet jigs injected shortly before the pouring through the mixing head.

REQUIREMENTS/DEVIATIONS:

**Referring to the latest information of UNIDO, all points of the requirement lists have been corrected and inspected by the UNIDO Project Manager after completion of the converted plant.**

a) The nitrogen system is not installed.

Corrective action:

The whole nitrogen system shall be installed before final inspection.

### 3.1.3 Gas monitoring system

DESCRIPTION:

2 Gas detectors shall be installed inside the premix areas (one close to the mixer, one under the storage tank), further gas detectors shall be mounted inside the safety boxes. All gas detectors must have an explosion-protection type for zone 1.

## REQUIREMENTS/DEVIATIONS:

Referring to the latest information of UNIDO, all points of the requirement lists have been corrected and inspected by the UNIDO Project Manager after completion of the converted plant.

- a) The gas monitoring system is not mounted. There is no calibration gas on site.

Corrective action:

A sufficient amount of gas detectors has to be provided and positioned close to the release openings of the jigs and on points of possibly minimum air suction (e.g. corners).

The gas monitoring system and the detectors must be mounted before commissioning and the calibration of the sensors has to be checked with a proper calibration kit (gases and flow meter).

**3.2 Safety control panel - emergency shut-down system**

## DESCRIPTION:

The safety control panel has not been installed (still packed during inspection).

## REQUIREMENTS/DEVIATIONS:

Referring to the latest information of UNIDO, all points of the requirement lists have been corrected and inspected by the UNIDO Project Manager after completion of the converted plant.

- a) Installation of safety panel is missing.

Corrective action:

The safety control panel has to be installed and functional connected.

**3.3 Fire protection**

## DESCRIPTION:

The company shall provide a sufficient fire extinguishing system close to endangered areas for the first and enhanced aid with hand-operated powder extinguishers on easy accessible position and a trained personal. To guarantee the efficiency of fire fighting a sufficient water supply and a fire brigade with foam for flammable liquids is necessary (company or local fire brigade). An emergency plan designed in case of fire shall be established.

## REQUIREMENTS/DEVIATIONS:

Referring to the latest information of UNIDO, all points of the requirement lists have been corrected and inspected by the UNIDO Project Manager after completion of the converted plant.

- a) The fire extinguishing system for the first aid is missing.

Corrective action:

There should be easy accessible powder extinguishers with at least 20 kg powder situated by the tank storage area, one fire extinguisher close to each premixing/dosing unit and one close to each foaming area (safety boxes).

- b) A sufficient supply with foam or equivalent means of fire extinguishing for flammable liquids is not provided.

Corrective action:

The local fire brigade can be contacted to be prepared for the possible amount of flammable liquids in case of a fire alarm.

- c) There is no emergency plan in case of a fire alarm provided.

Corrective action:

Creation of a fire alarm plan for accidents inside and outside the factory building.

## 4 Storage area for cyclopentane

### 4.1 Storage tank

## DESCRIPTION:

The storage tank is a 35000 l double wall steel tank arranged underground in a basin made of reinforced concrete. The grounding system for the tank and the metal roof has not been complete finished. A weather protection roof, the control panel, the piping and the filling station have been missing.

## REQUIREMENTS/DEVIATIONS:

Referring to the latest information of UNIDO, all points of the requirement lists have been corrected and inspected by the UNIDO Project Manager after completion of the converted plant.

- a) The design, production, quality and test documentation of the storage tank is not complete.

Corrective action:

- test reports/certificates for the pressure/leak/insulation test on site shall be provided.

- b) Classification, documentation and marking of hazardous areas is missing (ex-zones, safety zone)

Corrective action:

A drawing of the tank and filling area should be provided with the relevant dangerous areas marked (e.g. 1,5 m around exhaust openings of tank zone 1; 5 m around exhaust openings zone 2; inside the tank zone 1; a 5m zone around the storage tank and the filling station as safety zone (non-smoking, no storage of flammable materials, ...)).

The border of the safety zone and the area should be easily visible marked with a fire danger and no smoking sign. The control panel must be mounted outside of the ex-zones with eyesight to the storage and filling area.

- c) The piping installation and the electrical installation is not finished.

Corrective action:

Completion of the piping and installation.

## **4.2 Filling (loading) station**

### DESCRIPTION:

No filling station has been designed. There has been no equipment for the filling of the tank and no adequate documentation available.

### REQUIREMENTS/DEVIATIONS:

**Referring to the latest information of UNIDO, all points of the requirement lists have been corrected and inspected by the UNIDO Project Manager after completion of the converted plant.**

- a) Corrective action:

A defined filling station for a intermediate storage container or drum shall be provided with a waterproof drop basin for the storage of dropping cyclopentane during filling operation (ca. 200 - 300 l). If necessary (demand of supplier of C5), a sunroof shall protect the whole filling area. A clamping system for the connection of the grounding system with the storage container must be installed. The filling pump must be suitable for cyclopentane and for the use in explosible atmospheres (ex-zone 1). The filling velocity of the cyclopentane has to be limited according to the diameter of the filling piping to reduce electrostatic charging of the flammable liquid itself. A maximum filling speed of 3m/sec is sufficient anyway.

The flexible pipe connections to the storage tank has to be electrostatic conductible.

## 5 C5-Distribution Piping system to premix area

### DESCRIPTION:

The distribution piping of cyclopentane is arranged aboveground and has not been existing at inspection date.

### REQUIREMENTS/DEVIATIONS:

Referring to the latest information of UNIDO, all points of the requirement lists have been corrected and inspected by the UNIDO Project Manager after completion of the converted plant.

- a) The design, production and test documentation of the C5-piping is not complete.

Corrective action:

The company shall provide the following documentation:

- technical design criteria (e.g. design pressure, material, welding),
- welding data, certification of welding personal,
- test report (e.g. x-ray, pressure test on site before commissioning)

- b) Before entering the building between tank and wall an automatic controlled ESD-failsafe-valve (in order to guarantee the disconnection of the tank from the equipment in the building in case of fire) shall be installed.

Corrective action:

Installation of the ESD-valve.

- c) The aboveground piping outside the factory building has to be sun and lightning protected and thermal insulated.

Corrective action:

Providing of a sun and lightning protection roof (metal) and coating of the piping with a thermal insulation.

## 6 Premix Areas and Foaming Areas (Cabinet and Door)

### DESCRIPTION:

At the inspection the preconfigured Perros equipment has been still packed after transport inside of the factory building. There could no inspection or test be executed. But to guarantee a proper and safe installation the requirements and deviations mentioned in the reports of the other companies (especially with Perros equipment) should be considered. Therefore a (informative) list of general requirements is provided for the use of Lorestan during installation.

### REQUIREMENTS (informative):

**Referring to the latest information of UNIDO, all points of the requirement lists have been corrected and inspected by the UNIDO Project Manager after completion of the converted plant.**

- a) Grounding system:  
All metal parts (e.g. grid, ventilation ducts, ...) are to be connected to the grounding system inside and outside the boxes (inside with spring-washers).
- b) The safety boxes for the foaming area have to be erected. All accessible parts shall be of antistatic material. The floor shall be antistatic too (e.g. cement- or concrete floor, metal grating connected to grounding system, no electrostatic chargeable synthetic floor covering or sealing shall be used).
- c) The door of the safety box should be monitored. An escape route light (uninterruptible supplied) for the foaming areas shall be provided, an ESD-push button positioned close to the door.
- d) Mechanical protection for electric cabling must be considered (closed metal trays, conduit systems etc.)
- e) The amount and positioning of gas detectors is a most important safety relevant decision!
- f) In principal, in all the inspected systems, the marking and description of EEx i circuits is insufficient. This should be taken under consideration.

## **7 Safety requirements during operation of the plant**

### **7.1 Safety Instructions**

Adequate training and instruction of the personal working with cyclopentane and isocyanate is a integral part of the plant safety. In a production process using flammable and poisonous liquids the following instructions for handling and training are a minimum safety requirement:

- Instructions for handling and storage of cyclopentane and isocyanate
- Instruction for the filling and periodic supervision of the C5 storage tank
- Working and safety instruction for the foaming process of the doors and cabinets
- Specification documents for the execution of periodic tests for safety relevant devices and functions and the calibration of the gas monitoring system. A test register has to be kept and stored for inspection visits.
- A fire alarm and emergency plan

In addition to the external surveillance the company shall execute a periodic internal surveillance of the storage area and the C5-piping (weekly) making a visual inspection and a leakage test of flanged joints either by a portable gas detector system or a leak detector spray.

### **7.2 Periodic Surveillance**

An initial safety inspection covers the principal safety of the plant and the installation at the time of inspection (commissioning). To secure a safe operation for a lifetime period of the plant, the execution of periodic surveillance through an independent expert (third party) is an essential part of the safety concept.

The interval of the external surveillance is preferably one year. If the time between two surveillance inspections exceeds one year, the functional tests of safety systems and components have to be executed internal at least annual and must be properly documented.

The periodic surveillance inspections shall include all relevant systems, e. .g.:

- a check of the test register,
- the test of relevant safety functions and alarms,
- function tests of safety relevant components,
- the calibration of the gas monitoring system,
- a visual inspection of the properly condition and maintenance of the installation and equipment,
- a leakage (pressure) test for the C5-distribution piping

### **7.3 Preventive Maintenance**

The minimum requirements for the preventive maintenance of the foaming units should be defined by the supplier (Cannon, Use and maintenance manual). For the locally supplied parts of the plant a internal guide including the necessary inspections and maintenance should be prepared by the company.

It is recommended to document all maintenance works and inspections in a register.

## **8 Conclusions**

The aim of the safety inspection visit of the refrigerator plant in Iran as mentioned in the contract and the „terms of reference“ was the execution of all necessary checks and tests in order to prepare a safety report for the plant. The safety inspection report, generally based on international standards, should guarantee the safe design and function of the converted plant.

A precondition for a positive inspection result is the completion of the whole installation and the preparation of all necessary supplies (electrical, liquids, gases).

At the time of the inspection visit all important installations (exclusive the storage tank) have not been completed or still packed and no supply with electrical energy, cyclopentane, calibration gases and other necessary goods has been provided. Therefore the inspection has been carried out mainly as a consulting during or before erection and the not finished or missing installations/systems and the deviations at this project stage are stated in this report.

The correction of this deviations has been a necessary condition to achieve a positive inspection result.

**Referring to the latest information of UNIDO (Dez. 2001), all points of the requirement lists have been corrected and inspected by the UNIDO Project Manager after completion of the converted plant.**

*Note: The TUV Austria takes no responsibility for results and declarations which have not been executed / inspected by the qualified personnel of the accredited inspection body.*



## 9 Inspected Project Documentation

The provided documentation consists of the drawings of the supplier (Perros) and the documentation obtained by the recipient company concerns the locally supplied storage tank.

### 9.1 Documentation of Lorestan

- Cyclopentane storage tank, Manufacturer Description and test documentation (Reactorsaz Company), Job. No. 76/2584/1, Clients Dwg. No. US000070

## 10 Standard List (international, european and national)

This list must not be complete but shall provide the reader of this report a sufficiently detailed information of the applicable regulations for the safety assessment.

In case there exists no adequate international standard for the review of a detailed requirement a basic risk assessment has been performed in order to achieve a practical solution.

- IEC 60079-14 Electrical apparatus for explosive gas atmospheres - Part 14: Electrical installations in hazardous areas (other than mines)
- IEC 60079-10 Electrical apparatus for explosive gas atmospheres - Part 10: Classification of hazardous areas
- EN 50014 Electrical apparatus for potentially explosive atmospheres - General requirements
- EN 50018 Electrical apparatus for potentially explosive atmospheres - Flameproof enclosures "d"
- EN 50019 Electrical apparatus for potentially explosive atmospheres - Increased safety "e"
- EN 50020 Electrical apparatus for potentially explosive atmospheres - Intrinsic safety "i"
- EN 50021 Electrical apparatus for potentially explosive atmospheres - Type of protection "n"
- EN 50039 Electrical apparatus for potentially explosive atmospheres - Intrinsic safety "i" Systems
- IEC 61024-1 Protection of structures against lightning - Part 1: General principles
- IEC/EN 60204-1 Safety of machinery - Electrical equipment of machines Part 1: General requirements
- TRbF 40 Petrol stations
- TRbF 100 General safety requirements
- TRbF 110 Stores

- TRbF 120 Stationary tanks of metallic and nonmetallic materials; general information
- ZH 1/8 Safety rules for requirements on the properties of stationary gas alarm systems for explosions protection
- ZH 1/10 Guidelines for the avoidance of dangers by explosive atmosphere including collection of examples - guidelines on protection against explosion (EX-RL)
- ZH 1/200 Guidelines for avoiding the dangers of ignition due to electrostatic charges; guidelines "Static Electricity"
- VDMA 24169-1 Air handling units; design-related explosion protection measures for fans; specifications for fans used to handle flammable gases, vapours or mist-containing atmospheres

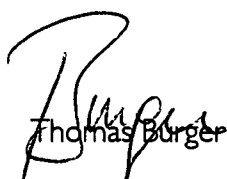
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