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22714

# SAFETY INSPECTION REPORT

## CFC - Phase out project

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 Uniw0505/BUR/BRU

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Factory Location: near Tehran, IRAN  
 Inspection dates: 15.10./22.10.1998

Accredited Testing  
 Laboratory,  
 Inspection Body,  
 Certification Body,  
 Calibration Body

Notified Body 0408

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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 inspection visits were executed on 15./22. October 1998 on the production site of Gadook near Tehran. The results of these inspections 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.

Most of the foaming machinery and equipment in Gadook is supplied by Perros, Italy. The storage tank is produced by a locally company. The production equipment consists of an aboveground storage tank (single wall), an aboveground distribution piping and one premixing and dosing unit. The foaming process shall be performed with two mixing heads arranged in one safety box (cabinet and door foaming).

At the inspection dates some principal installations and most of the main supplies have not been finished. Due to the fact, that 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 perform 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 (GADOOK).**

A final inspection by the inspection body of TUV Austria to verify the proper correction of all deviations mentioned in our draft report Uniw0378/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) Premix and dosing area
- D) Cabinet and 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). The 30 % LEL alarm in the mixing and dosing unit causes a nitrogen flushing of the boxes.

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 with ducts for the foaming area inside the safety box and the housing of the premixing / polyol-cyclopentane day storage tank and the dosing unit. There are single double speed ventilation motors provided with a function monitoring (air flow relay).

The air suction points are installed on top of the housings, the fresh air is sucked from the bottom of the boxes.

The air exchange rate shall be calculated to keep the C5/air-mixture in the safety boxes during production below 15 % LEL.

The boxes shall be flushed automatically a minimum of 5 times before energizing the electrical equipment and starting of the production process. When the gas concentration exceeds the limit of 15 % LEL (second level alarm) the fan motors shall be switched to the second speed level. The ventilation system shall continue operation when the first level alarm (30 % LEL) is active. Therefore the ventilation system (e.g. fans) has to be anti-sparking.

For the function detection of the ventilation system air flow relays are installed. In case of a failure of the ventilation system the electrical supply in the ventilated areas is switched off.

The exhausted air shall be conveyed outside the building through a chimney with a weather protected opening above the roof. A lightning protection system for the chimneys shall be installed.

#### 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) Mounting of the ventilation ducts is not finished.

Corrective action:

proper mounting of ventilation ducts and chimney.

- c) Lightning protection system for chimney is missing.

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 no automatic emergency supply is provided.

Corrective action:

Installation of an automatic stand-by generator.



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.

g) A manufacturer declaration or a test report/certificate of the antisparking characteristic according to VDMA 24169 or equivalent is not available.

Corrective action:

An evidence of the antistatic characteristic for the ventilation fans shall be provided.

### 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>).

The nitrogen is stored in an accumulator intermediate tank close to the mixing units and the safety box. There is a separate nitrogen pipe provided for the inertization of the storage tank.

The blanketing system is used in the refrigeration plant

- for the inertization of the storage tank,
- for the inertization of the C5/polyol - day storage tank (monitored by pressure switch)
- for the cabinet jigs injected manual shortly before the pouring  
(minimum amount of nitrogen is monitored)
- and in case of an alarm (30 % LEL) inside the dosing unit.

#### 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 function of the nitrogen injection in the cabinet jigs is not monitored.

Corrective action:

The proper position of the gun and the timing of the inertization has to be monitored (efficiency of nitrogen blanketing is depending on a sufficient short time between N<sub>2</sub>-injection and pouring).

### 3.1.3 Gas monitoring system

DESCRIPTION:

Two gas detectors are installed inside the ecomixing unit close to the mixer and below the C5-storage tank, two inside the ecodosing unit and further detectors must be arranged inside the safety box in proper positions and one in the storage area close to the C5-tank. All gas detectors have to be explosion-protected (the inspected sensors are protection type EEx d).

The gas monitoring system works with catalytic sensors and has an uninterruptible battery emergency supply (not connected).

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 detectors are not mounted. There is no calibration gas on site.

Corrective action:

The gas 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 is positioned outside the safety box and controls the ventilation system and the gas monitoring system.

The electrical supply of the premixing, dosing and inside of the safety box is switched off automatically and immediately in case of a first level alarm.

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 electrical supply is not connected.

Corrective action:

Completion of electrical installation.

- b) Emergency-shut-down switch near the door of the safety box is not mounted

Corrective action:

Mounting of the ESD-switch.

- c) The concept for the failsafe behavior of safety relevant systems (e.g. shut down relays) is not sufficiently specified.

Corrective action:

A detailed specification of the concept and equipment used for safety relevant circuits has to be provided.

### **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). Because of the fact, that the next available fire brigade is min. 20 minutes away, a cooling system for the storage tank should be provided. 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 the premixing and dosing unit and one close to the foaming area (safety box).

- 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) A cooling (sprinkler) system for the C5-storage tank is not installed.

Corrective action:

Installation of a water line and a sprinkler system above the storage tank. The sprinkler system shall be activated automatically by a temperature detection close to the tank with a maximum activation temperature of 45 degrees Celsius.

- d) 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 3000 l single wall steel tank arranged aboveground on a floor made of reinforced concrete. A weather-roof is mounted and a control panel is situated 2 m from the storage tank. A special grounding system for the tank and the metal roof has not been provided. The pressure switch for the tank has not been installed, a defined filling station and a safety zone has been missing. The storage tank is situated in a distance of 3 m to the factory building.

**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) A tank basin is not provided.

Corrective action:

A waterproof wall around the basin has to be built to cover the whole contents of the storage tank (app. 20 - 30 cm height).

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

Corrective action:

The company shall provide the following documentation:

- technical design criteria (e.g. calculation, materials, welding),
- internal process and quality verification data by the manufacturer (e.g. statistical tests, x-ray, destructible tests,
- welding data, certification of welding personal,
- test reports/certificates (e.g. hydrostatic pressure tests, complete tests on site)

- c) The storage tank is situated too close to the next building (app. 3 m).

Corrective action:

The minimum distance of the storage tank to the next building is not sufficient. Therefore a fire protection by a flameproof wall (resists fire min. 90 minutes) to the factory building must be erected (e.g. brick wall of minimum 15 cm strength, double side plastered). All not flameproof installations (e.g. windows) and openings have to be walled up in the same way. The C5-piping through the wall must be protected by an automatic controlled ESD-valve (closed in case of an alarm).

- d) A special designed grounding system for the tank is not provided.

Corrective action:

Installation of two grounding rods beside the basin, connected together and to the steel construction of the building and the weather roof with copper cables.

The steel construction of the factory building is a sufficiently effective grounding system for the plant and the lightning protection system (grounding resistance  $R_E = 1,4 \text{ Ohm}$ ).

Remark: All grounding connections in explosion endangered areas, e.g. the storage area and the foaming area, have to be protected against loosening (spring-washers, tooth-washers).

- e) 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. There should be no public access to the storage area.

- f) The non- explosion proof electrical control panel is arranged close to the tank in the storage area.

Corrective action:

The panel shall be rearranged outside the ex-zones with eyesight to the filling/storage area.

- g) In case of a leakage of the storage tank the whole storage area and the nearer surrounding can be explosion endangered. Therefore an automatic detection system is recommended.

Corrective action:

A gas detection sensor (close by or under the tank) shall be mounted and cut off the electrical energy in the storage area when reaching the alarm level.

- h) The piping installation and the electrical installation is not finished. The cable glands of the C5-pump are not approved for the type of protection (EEx d).

Corrective action:

Completion of the piping and installation. Exchange of the wrong cable gland(s).

## **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) A designed place for the filling of the storage tank with an electrostatic clamping system has to be provided.

Corrective action:

A defined filling station for a intermediate storage container, a drum or a barrel 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.

If the filling will be executed in the designed storage area, a separate collecting basin is not necessary.

## 5 C5-Distribution Piping system to premix area

### DESCRIPTION:

The distribution piping of cyclopentane is a threatened galvanized steel piping arranged aboveground. The C5-piping has a thermal protection, the threatened joints are sealed by PTFE. Inside of the building the distribution piping has not been mechanically protected.

### 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) The mechanical protection of the piping inside the building is not sufficient

Corrective action:

The piping should be protected by a metal tray.

- c) The piping has isolating flanges on both ends (shall be electrostatic conductible). There is no documentation of this flanges available.

The electrostatic conductivity of the threatened sealed joints of the piping is not guaranteed. The long term tightness of the joints has to be monitored. Therefore there is no thermal insulation of the connections allowed.

Corrective action:

There is no safety reason for the installation of the isolating flanges. A sufficient documentation of the design and the electrostatic conductivity has to be provided or the flanges have to be dismantled. A threatened piping must have grounding interconnection lines on each threatened joint. The sleeve must be accessible and may not be insulated with thermal insulation and must be monitored (manual, weekly, with a portable gas detection apparatus or a leak detection spray). Because of the problems mentioned before a proper welded piping is a preferable solution.

- d) An ESD-fire-shut-down-valve is not installed.

Corrective action:

Installation of the valve before the entry of the building and functional connection to the alarm panel. In case of a gas alarm or an emergency shut down (push button) the valve shall be closed.

## 6 Premix and dosing area

### 6.1 Premixing unit (Type: Ecomix 100 TL, No. P1027)

#### DESCRIPTION:

The parts and devices involved with pure C5 and with C5/polyol blend are installed in a box, separated from other devices by walls and closed doors. The box is equipped with an artificial ventilation system (double-speed) and two gas sensor mounted near the mixing unit and under the C5-storage tank to monitor flammable vapours.

The bottom of the box is a basin to collect fluids in case of maintenance or accidents.

Inside the box is:

- the C5 metering and C5/polyol mixing unit with C5 piping, static mixer to mix C5 and polyol and delivery line for the blend to the dosing unit tank;
- the C5-storage tank (100 l, nitrogen blanketed) with working- and supermax level switches, temperature transducer, minimum pressure switch and safety valves;
- nitrogen nozzle to flush the box in case of alarm.

The electrical parts in direct contact with C5 are in EEx i version.

#### 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 ventilation ducts are not mounted.

Corrective action:

The ventilation system has to be mounted before commissioning.

- b) The separation and marking of intrinsically safe circuits (EEx i) is not sufficient.

Corrective action:

Intrinsically safe circuits shall be laid separately from non-intrinsic safety circuits and be marked to separate them from non intrinsically safe circuits.

The marking can either be a light blue color of the cables or be made by signs or characters.

Inside of the control panel, the terminals from EEx i - circuits must have a minimum distance of 50 mm from other terminals.

- c) System descriptions of intrinsically safe circuits (EEx i) according to EN 50039 are missing.

Corrective action:

A system description of the intrinsically safe circuits (installed Ex-devices, cable length) have to be provided.



- d) Some internal grounding connection lines and the connection of the skid to the main grounding system is missing.

Corrective action:

The metal skids have to be connected to the main grounding system (spring-washers), the internal grounding system must be completed.

## **6.2 High pressure unit (Type: Ecodosing HFPE 2-50 DS, No. M3047)**

### DESCRIPTION:

The parts and devices involved with C5/polyol blend are installed in a box, separated from other devices by walls and closed doors. . The box is equipped with an artificial ventilation system (double-speed) and gas sensors are mounted near the heat exchanger and under the C5/polyol blend tank to monitor flammable vapours.

The bottom of the box is a basin to collect fluids in case of maintenance or accidents.

Inside the box is:

- the C5/polyol mixture tank (nitrogen blanketed) with working- and supermax level switches, temperature transducer, minimum pressure switch, stirrer, a water jacket with electrical heating devices and safety valves;
- the C5/polyol metering system with mixture pump;
- nitrogen nozzle to flush the box in case of alarm.

The electrical parts in direct contact with C5/polyol-mixture are in EEx i version.

### 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 ventilation ducts are not mounted.

Corrective action:

The ventilation system has to be mounted before commissioning.

- b) The separation and marking of intrinsically safe circuits (EEx i) is not sufficient.

Corrective action:

Intrinsically safe circuits shall be laid separately from non-intrinsic safety circuits and be marked to separate them from non intrinsically safe circuits.

The marking can either be a light blue color of the cables or be made by signs or characters.

Inside of the control panel, the terminals from EEx i - circuits must have a minimum distance of 50 mm from other terminals.

c) System descriptions of intrinsically safe circuits (EEx i) according to EN 50039 are missing.

Corrective action:

A system description of the intrinsically safe circuits (installed Ex-devices, cable length) have to be provided.

d) A connection of the skid to the main grounding system is missing.

Corrective action:

The metal skids have to be connected to the main grounding system (spring-washers).

e) Thermoregulator for heating device is not marked and not documented.

Corrective action:

A documentation about the regulator (e.g. IP-code, el. data) shall be provided.

## 7 Foaming Area (Cabinet and Door)

### DESCRIPTION:

The foaming area for doors and cabinets is located inside a combined safety box. There are two foaming heads, one for the door foaming, the other for the cabinet foaming. The cabinets and doors are preheated and dried in a separate box outside of the safety box.

The cabinet and door jigs are moved manually to the heating devices.

The installation in the safety box has not been complete.

### 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 detectors are not mounted.

Corrective action:

The position of the gas sensors shall be adjusted in order to guarantee the detection of vapours in areas around the release openings and on points of possible minimum air flow. They have to be mounted before commissioning.

b) The equipotential grounding system is not sufficient.

Corrective action:

All metal parts (e.g. grid, ventilation ducts, ...) are to be connected to the grounding bar inside the box (spring-washers).

- c) The installation of the preheating devices and dryers is not complete.

Corrective action:

The installation has to be finished before commissioning. The openings in the safety box should be closed.

- d) The marking of intrinsically safe circuits (EEx i) is not sufficient.

Corrective action:

Intrinsically safe circuits shall be marked to separate them from non intrinsically safe circuits. The marking can either be a light blue color of the cables or be made by signs or characters.

- e) The door of the safety box and the door monitoring switch is not mounted.

Corrective action:

Installation of door and monitoring switch.

- f) An ESD-switch and an escape route light close to the safety box door are missing.

Corrective action:

Mounting of the ESD-switch and connecting with the safety control panel. Mounting of the emergency route light (uninterruptible energy supply) and detection of a failure of the standard electrical supply.

## 8 General clauses

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.

### 8.1 Electrical installation

- a) The general electrical supply was not connected during inspection. The low loop resistance of the main supply circuit has been measured (0,5 Ohm) and found acceptable for a main fuse up to 250 A. The maximum allowed rating of the fuses in the control panels in respect of the resistance value would be 80 A.

Corrective action:

Installation and connection of the main supply cable. The cable has to be selected according to the main fuse in the power supply panel (e.g. 25 mm<sup>2</sup> for 80 A; 35 mm<sup>2</sup> for 100 or 125 A; 50 mm<sup>2</sup> for 150 A, ...).

b) Electrical control panels - electric schemes:

Overload protection devices are not selected according to the nominal current rates of the motors (e.g. pump motors).

Corrective action:

The overload protection switches have to be selected and adjusted on the nominal current of the protected device. The proper selection has to be double checked and, where necessary, corrected.

## **8.2 Grounding system - potential bonding**

a) The grounding and potential bonding system is generally not sufficient.

Corrective action:

Connection of metal parts (e.g. skids of mixing units, storage tanks, ventilation ducts, control panels, piping, steel construction, cable trays, ...) to the earthing system.

Remark:

All connections in ex-zones have to be protected against loosening (by using spring-washer or tooth-washers).

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

### **9.1 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

## **9.2 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

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.

## **9.3 Preventive Maintenance**

The minimum requirements for the preventive maintenance of the foaming units should be defined by the supplier (Perros). 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.

## 10 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 some important installations have not been completed and no supply with electrical energy, cyclopentane, calibration gases and other necessary goods has been provided. The documentation, especially about the tank, has not been sufficient. Therefore the inspection has been carried out mainly as a consulting during 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.

A complicating condition at Gadook is the situation of the storage area close to the factory building. This condition and the fact, that the next fire brigade is more than 20 minutes away from the factory, causes additional efforts in the field of fire protection (flame proof wall, leak detection, cooling system for the tank) to secure the safety of the storage tank and for the employees in case of a fire in the plant.

**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.*

## 11 Inspected Project Documentation

The provided documentation consisted in general of the electrical drawings and schemes for the control panels, supplied by Perros. Sufficient documentation, including e.g. layouts, certificates, tank and piping data has not been provided.

## 12 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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