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TÜV

ÖSTERREICH

SAFETY INSPECTION REPORT

CFC - Phase out project

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Uniw0507/BUR/BRU

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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 20./21. October 1998 on the new built production site of Bahman in 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 machinery and the foaming equipment in Bahman is supplied by Perros, Italy. The two storage tanks are produced by locally companies. The production equipment consists of the underground storage tanks (double wall), an underground distribution piping in a ditch and two premixing and dosing units. The foaming process shall be performed in a cabinet foaming safety box with fourteen heads and in a door foaming safety box with two foaming carrousel.

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 (BAHMAN).

A final inspection by the inspection body of TUV Austria to verify the proper correction of all deviations mentioned in our draft report Uniw0379/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 cabinets
- D) Premix and dosing area doors
- 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 ₂	Oxygen
N ₂	Nitrogen
CO ₂	Carbon dioxide
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 with local ducts for the foaming areas inside the safety box and the housing of the premixing / polyol-cyclopentane day storage tank and dosing units. There are single double speed ventilation motors provided with a function monitoring (air flow relays).

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 (can be estimated from Perros calculation and rated positive).

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 chimneys with a weather protected opening above the roof. A lightning protection system for the chimneys shall be installed if the chimneys are not protected by the roof construction (protection area includes all parts covered under an protection angle of 45° from the highest point of the roof construction).

A separate artificial ventilation has to be provided for the C5-piping ditch between the storage area and the mixing area. The efficiency of the ventilation must be monitored and cause an alarm in case of failure.

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 differential pressure switches not finished.

Corrective action:

proper mounting of pressure switches.

c) Lightning protection system for chimneys are missing.

Corrective action:

Installation of a lightning rod or lightning rods or a metal frame beside/above each 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 with a power rate of minimum 35 kW.

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 % O₂).

The nitrogen is generated with two N₂-generators close to the mixing units. A special accumulator intermediate tank has not been provided. 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 tanks,
- for the inertization of the C5 - day storage tank (monitored by pressure switch)
- for the cabinet jigs injected automatically shortly before the pouring
(minimum amount of nitrogen is monitored)
- and in case of an alarm (30 % LEL) inside the C5-day storage and the mixing/dosing units.

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) An accumulator tank for the nitrogen injection in the foaming areas is not provided.

Corrective action:

The amount of nitrogen for the inertization of the cabinet jigs is measured only at the nitrogen generator. The length of the piping and the amount of jigs makes the installation of an intermediate buffer tank necessary.

- b) The nitrogen piping inside of the building is not properly fixed.

Corrective action:

The piping should be properly mechanical fixed (e.g. at branch lines).

3.1.3 Gas monitoring system

DESCRIPTION:

Two safety control panels for the gas monitoring system are provided. The gas detectors provided for the safety panel - cabinet productions are:

One for each cabinet jig (2 x 7) , one for the ecomixing and one for the ecodosing (cabinet) box.

The second gas monitoring system in the door safety panel consists of:

Four gas detectors in the door foaming area and two detectors in the ecodosing unit (doors).

All gas detectors have to be explosion-protected (the inspected sensors are protection type EEx d).

The gas monitoring systems (type: SCAB 1S 1011-97/19") work with catalytic sensors and have 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 partially 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). 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.

- b) As a minimum an additional gas detector has to be mounted inside the safety box of the C5 - day storage tank.

Corrective action:

The gas detector must be mounted before commissioning.

3.2 Safety control panels - emergency shut-down system

DESCRIPTION:

The two safety control panels are positioned outside the safety box and control the ventilation system and the gas monitoring system.

The electrical supply of the premixing, dosing, C5-day storage tank and inside of the safety boxes 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 switches near the safety box doors and on the storage tank/filling area are not mounted.

Corrective action:

Mounting of the ESD-switches.

- c) The concept for the failsafe behavior of safety relevant systems (e.g. shut down relays) is not sufficient 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). An emergency plan designed in case of fire shall be established.

A fire protection system with flame detectors and a CO₂-extinguishing nozzle is situated inside the safety boxes of the ecomixing, ecodosing and C5 - day storage tank.

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 partially missing.

Corrective action:

There should be easy accessible powder extinguishers with at least 20 kg powder situated by each storage tank, one fire extinguisher close to the premixing unit and the C5/polyol-day storage tank, one close to each dosing unit and one close to the foaming areas (safety boxes).

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

Corrective action:

The company (Bahman) installs a fire alarm system in the factory with a privileged phone line to the next fire brigade and will prepare fire extinguishing water line and their own fire extinguishing equipment. If the equipment is not dimensioned for the possible amount of flammable liquids in case of a fire alarm the local fire brigade has to be prepared for the extinguishing of the C5 (sufficient amount of foam for flammable liquids).

- 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 tanks

DESCRIPTION:

The two storage tanks are 35000 l double wall steel tank arranged underground in a basin made of reinforced concrete. A leak detection of the intermediate space of the double walled tanks shall be provided, the basins shall be filled with sand. One tank has been already installed inside of the basin, the other has not been mounted a the inspection date. Weather protection roofs have not been mounted.

In the basins there are separated areas for the distribution pump and piping prepared. Two trenches are leading from the basins to the mixing area inside the factory building. A control panel shall be located 10 m from the storage tank on the wall of the next building. The grounding system for the tank and the metal roof has not been 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) The design, production, quality and test documentation of the storage tanks are 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)

b) The weather roof of the tanks is not mounted.

Corrective action:

Installation of a weather roof; covering the storage area. The sun protection roof shall (if necessary) consider the storage area for the filling container.

c) The grounding system for the storage area is not installed.

Corrective action:

A grounding system for the storage and filling area in the same manner as the existing factory grounding system shall be provided and connected together. The grounding system shall have terminals for function measurement.

Remark: All grounding connections in explosion endangered areas have to be protected against loosening (spring-washers, tooth-washers)

- d) 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.

- e) 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) 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 tank 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 shall be a welded steel piping arranged underground in a ventilated ditch. The ventilation system shall suck the air out of the building and must be closed by a fire damper inside the building in case of a fire (temperature-activated). In a second ditch there is the nitrogen-piping and the electrical cables. The distribution piping has not been mounted at the inspection dates. The piping shall be sufficiently grounded on both ends and does not need any electrostatic isolation because the grounding systems are not separated!

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 piping system as mentioned in the description is not mounted.

Corrective action:

A C5-distribution piping as described shall be properly installed.

b) 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)

6 Premix, dosing and day storage areas

6.1 Premixing unit (Ecomix)

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), one gas sensor mounted near the mixing unit and a fire sensor is mounted inside the safety box to activate a CO₂-flushing of the box.

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;
- nitrogen nozzle to flush the box in case of alarm;
- a fire sensor and a CO₂ nozzle to flush the box in case of a fire 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) The doors of the safety box are not monitored.

Corrective action:

Installation of a door monitoring system.

- e) 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).

- f) Some terminals inside the control panel are not securely fixed.

Corrective action:

All terminals inside of control panels shall be fixed in a proper way.

6.2 C5 - day storage tank (1000 l)

DESCRIPTION:

The storage tank and the tank equipment 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 fire sensors are mounted inside the safety box to activate a CO₂-flushing of the box.

Inside the box is:

- the 1000 l C5-tank (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;
- fire sensors and a CO₂ nozzle to flush the box in case of a fire 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) The doors of the safety box are not monitored.

Corrective action:

Installation of a door monitoring system.

e) 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).

f) A gas detector for the storage tank is missing.

Corrective action:

A gas detector has to be mounted in the storage tank box.

6.3 High pressure units (Ecodosing door and ecodosing cabinet)

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 boxes are equipped with an artificial ventilation system (double-speed), gas sensors are mounted near the heat exchanger and under the C5/polyol blend tank to monitor flammable vapours and a fire sensor is mounted inside the safety boxes to activate a CO₂-flushing of the box.

The bottom of the boxes are basins to collect fluids in case of maintenance or accidents.

Inside the boxes are:

- 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;
- a fire sensor and a CO₂ nozzle to flush the box in case of a fire 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) The doors of the safety box are not monitored.

Corrective action:

Installation of a door monitoring system.

- e) 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).

- f) 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.

- g) Ecodosing 2-50 (doors): A fixed terminal for the PEN-wire is not provided.

Corrective action:

All terminals inside of control panels shall be fixed in a proper way.

7 Foaming Areas (Cabinet and Door)

7.1 Cabinet foaming area

DESCRIPTION:

The foaming area for the cabinets is situated inside a large safety box with two rows of seven jigs on each side. The cabinets are electrically preheated in an oven before they are conveyed to the jigs. The jigs are heated with electrical heated hot air. The control panels of the foaming jigs are mounted in close distance to the jigs. The safety box has not been erected at inspection date. A fire extinguishing water spray system shall be provided around the inner side of the safety box. The ventilation system and gas monitoring system have not been mounted.

The installation in the safety box has not been completed.

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:

Gas sensors must be mounted in a proper position. 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 safety box is not erected. The door of the safety box and the door monitoring switch is not mounted.

Corrective action:

The safety box for the foaming area has 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). Installation of door and monitoring switch.

- d) If there are no doors for each jig, a sufficient amount of easy accessible ESD-switches outside and an escape route light close to the safety box door must be provided.

Corrective action (according to the realization of the box):

Mounting of the ESD-switches 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.

- e) Classification and documentation of hazardous areas is missing (ex-zones). The documentation and qualification of the heating system (e.g. motors, protection systems, limiters etc.) is missing.

Corrective action:

A specification of the calculated hazardous areas around the release openings shall be provided. If non-explosion protected electrical apparatus are installed in endangered areas, they have to be shut off (failsafe) during and min. 90 seconds after the foaming process. The qualification of the heating system for the use inside the safety box must be documented.

7.2 Door foaming area

DESCRIPTION:

The door foaming area consists of two foaming carrousel with seven jigs inside of a safety box. The safety box has not been erected at inspection date. The door preheating device is a hot water heating system. The ventilation system and gas monitoring system have not been mounted. The installation in the safety boxes have not been completed.

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:

Gas sensors must be mounted in a proper position. 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 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.

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

Corrective action:

The safety box for the foaming area has 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). Installation of door and monitoring switch.

- e) 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) A general electrical supply was not provided during inspection. The electrical installation was not complete.

Corrective action:

Installation and connection of the main supply cable. Completion of the electrical installation.

- b) The mechanical protection for the electrical installation is not sufficient.

Corrective action:

Laying of cables in trays; all cable trays should be closed.

- c) Electrical control panels - electric schemes:

Overload protection devices are not selected according to the nominal current rates of the motors (e.g. pumps: polyol storage tank, isocyanate tank, C5-storage tank - page 3, 3M1).

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 (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.

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. 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.

Some possible solutions (e.g. for the piping, filling station etc.) have been provided during the inspection visit.

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.

11 Inspected Project Documentation

The provided documentation consists in general of the manuals, drawings and certificates of the supplier (Perros). The only documentation obtained by the recipient company concerns the locally supplied storage tank.

11.1 Documentation of the Suppliers Equipment (Perros)

11.1.1 Drawings

- General layouts

11.1.2 Manuals (incl. appendices)

- Polyol storage tank 1000 l - technical manual, book no. 550
- C5 storage tank - technical manual, book no. 528
- Isocyanate tank - technical manual, book no. 549
- C5-polyol intermediate tank - technical manual, book no. 530
- Monitoring unit - book no. 548
- Cabinet plants monitoring unit - book no. 546
- Ecomix 20-S100 - technical manual, book no. 529
- Thermoregulation Group (heating - cooling), book no. 551
- Suction Calculation (fax, 21 pages, dated 05/06/00)

11.2 Additional documentation of Bahman

- Drawing of water spray system inside the cabinet safety box

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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Division Electrical Engineering

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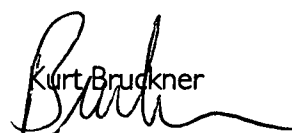


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