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SAFETY INSPECTION REPORT

CFC - Phase out project

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Uniw0504/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 17./18. October 1998 on the production site of Fariz Iran 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 equipment in Fariz Iran is supplied by Cannon, Italy. The storage tank and the distribution piping to the mixing units is produced by locally companies. The outside production equipment consists of an underground storage tank (single wall) inside of a reinforced concrete basin and a distribution piping, installed for a short part underground and a long part aboveground.

In the factory building there is one premixing and high pressure unit for the doors and another premixing/high pressure unit for the cabinets, two day-storage tanks for C5/polyol.

The foaming process shall be performed in two safety boxes, a cabinet foaming area, adapted from the existing foaming equipment, and a new built second area with one head for the foaming of doors. The six cabinet production lines (preheating, drying, conveyor lines) shall be adapted from the existing systems. The conversion of the production to the usage of flammable liquids requires the shut-down of the existing non-explosion protected devices during and 90 seconds after the foaming process. Existing storage tanks for isocyanate and polyol are used.

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 (CANNON) and the local counterpart (FARIZ IRAN).

A final inspection by the inspection body of TUV Austria to verify the proper correction of all deviations mentioned in our draft report Uniw0377/BUR/BRU, Vol. 1, 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. 1!

1 ABSTRACT	2
2 INTRODUCTION	6
2.1 GENERAL TEST PROCEDURES	6
2.2 SCOPE OF INSPECTIONS	6
2.3 DESCRIPTION OF ASSESSMENT RESULTS	6
2.4 ABBREVIATION LIST	7
3 SAFETY RELEVANT SYSTEMS	7
3.1 EXPLOSION PROTECTION	7
3.1.1 ARTIFICIAL VENTILATION SYSTEM	7
3.1.2 NITROGEN BLANKETING (INERTIZATION) SYSTEM	9
3.1.3 GAS MONITORING SYSTEM	10
3.2 SAFETY CONTROL PANEL - EMERGENCY SHUT-DOWN SYSTEM	10
3.3 FIRE PROTECTION	11
4 STORAGE AREA FOR CYCLOPENTANE	12
4.1 STORAGE TANK	12
4.2 FILLING (LOADING) STATION	13
5 C5-DISTRIBUTION PIPING SYSTEM TO PREMIX AREA	14
6 PREMIX AREA	15
6.1 DOOR PREMIXING UNIT (TYPE: A SYS PBT/PEF No. 290880.550631)	15
6.2 CABINET PREMIXING UNIT (TYPE: PM 100 TWIN No. 290881)	16
7 CABINET FOAMING AREA	17
8 DOOR FOAMING AREA	19

9 GENERAL CLAUSES

9.1	ELECTRICAL INSTALLATION	21
9.2	GROUNDING SYSTEM - POTENTIAL BONDING	21

10 SAFETY REQUIREMENTS DURING OPERATION OF THE PLANT

10.1	SAFETY INSTRUCTIONS	21
10.2	PERIODIC SURVEILLANCE	22
10.3	PREVENTIVE MAINTENANCE	22

11 CONCLUSIONS

12 INSPECTED PROJECT DOCUMENTATION

12.1	DOCUMENTATION OF THE SUPPLIERS EQUIPMENT (CANNON)	24
12.1.1	DRAWINGS	24
12.1.2	MANUALS	24
12.2	DOCUMENTATION OF FARIZ IRAN	24

13 STANDARD LIST (INTERNATIONAL, EUROPEAN AND NATIONAL)

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 area (doors)
- D) Premix area (cabinets)
- E) Cabinet foaming area (Safety box)
- F) Door foaming area (safety box)

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
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:

Two artificial ventilation systems are provided, one for the door area and the other for the cabinet area, each with local ducts for the foaming area inside the safety box and the housing of the premixing / polyol-cyclopentane day storage tank. There are redundant ventilation motors in each system with a nominal air flow rate of 2000 l/sec for each fan of the door foaming ventilation and 3200 l/sec for the fans of the cabinet ventilation system.

The air suction points are installed near the bottom of the housings and safety boxes (C5-gases and vapours are heavier than the air at ambient temperatures).

According to the documentation the air exchange rate is calculated to keep the C5/air-mixture in the safety boxes 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 second fan is switched on. 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 differential pressure switches shall be installed. In case of a failure of the ventilation system the electrical supply in the ventilated areas is switched off. The exhausted air of the ventilation systems is conveyed outside the building through separate chimneys with a side-opening above the roof.

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 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) Flexible hoses in the ventilation systems are not electrostatic conductible.

Corrective action:

All ventilation ducts with flexible hoses should be interconnected by equipotential conductors.

- e) In case of a failure in the electrical supply an automatic emergency supply is provided.
The automatic startup of the existing emergency diesel generator
(Type: Hitzinger SGB 505/4, el. dates: 400/230 V, 240 A, 167 kVA) was successfully tested.

Corrective action:

No corrective action necessary, it must only be secured, that the emergency generator supplies the safety systems of the foaming equipment.

- f) The electrical supply is not connected.

Corrective action:

Completion of electrical installation.

- g) 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 % O₂).

The nitrogen is provided by a compressor and N₂-Generator arranged in the production building and stored in an accumulator intermediate tank. It is planned to build a noise protection wall for the nitrogen generating system. There is a separate nitrogen pipe provided for the storage tank. The nitrogen system and timing shall be controlled by a specially designed nitrogen control panel.

The blanketing system is used in the refrigeration plant

- before the filling of the storage tank,
- for the inertization of the C5/polyol - day storage tanks (monitored by pressure switches)
- and for the cabinet jigs injected before the pouring through a manual nitrogen feed line and a gun (minimum amount of nitrogen is monitored by a flow meter and a timing system; the correct position of the nitrogen gun and the time between inertization and foaming has to be monitored).

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 and the separate nitrogen control panel are not energized and finally connected.

Corrective action:

The installation of the nitrogen system has to be finished.

3.1.3 Gas monitoring system

DESCRIPTION:

1 Gas detector shall be installed inside each of the two premix and day storage units close to the mixer, further gas detectors shall be mounted in a sufficient amount inside the safety boxes (below the jigs close to the release openings and the motors or microswitches, on points of minimum air-suction).

The gas monitoring system is a SENTOX 96 type, Matricola A040, with an uninterruptible battery emergency supply.

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 units 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) Functional dependencies (e.g. emergency-shut-down system, alarm levels, ...) could not be tested.

Corrective action:

Functional tests after completion of the plant has to be performed.

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 unit, one close to door foaming area (safety box) and two on both sides of the cabinet 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) 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 25000 l single wall steel tank arranged underground in a basin made of reinforced concrete. A weather-roof has been missing, the control panel is situated nearby (5 m distance from the storage tank). The grounding system for the tank is finished. The piping, the level switch and the electrical cables have not been finally 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 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)

- b) A leak detection in the basin (under the lowest point of the tank) is missing, a waterproof test of the basin is not documented.

Corrective action:

In order to guarantee an international safety standard, a single wall underground tank can only be approved if additional precautions are taken. The concrete basin can be accepted as a second safety measurement only when it is waterproofed and there is a leak detection system provided. Therefore a leak detector for dropping liquid must be installed (in a drop pan) under the lowest point of the tank. An acoustic alarm shall be generated when a leaking liquid is detected.

- c) The weather roof of the tank is not mounted and connected to the grounding system.

Corrective action:

Erection of a weather roof and connection to the grounding system. The sun protection roof shall (if necessary) consider the storage area for the filling container.

- d) The resistance of the grounding system is sufficient;
the measured values for the four grounding rods:
1) 9 Ohms; 2) 5,5 Ohms; 3) 5 Ohms; 4) 5 Ohms
are lower than the allowed maximum value of 10 Ohms.
The tank grounding system is not connected to the factory grounding system.

Corrective action:

The grounding system of the tank and the factory building shall be connected together.

- 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. The marking has to include the street and a „No parking“ sign.

- f) 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 a welded steel piping arranged underground inside a ditch made of reinforced concrete to the tank control panel and aboveground from the control panel to the building. The ditch shall be filled with sand and covered with waterproof sealed concrete plates. In the same ditch there is the nitrogen-piping and the electrical cables. The underground C5-piping had no sufficient corrosion protection and has not been separated from the electrical cables.

On the trays of the aboveground C5-piping there is also the nitrogen-piping and the electrical cables. The C5-piping had no lightning protection and had not been separated from the electrical cables. Before entering the building an ESD-fire-safe-valve is installed. Inside of the building the distribution piping has not been finally 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 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 protection and separation of the piping is not sufficient

Corrective action:

Underground part of piping: The piping should be cleaned (e.g. sandblasted) and coated against corrosion (e.g. with bitumen or polyethylen taping). It should not have a low resistance contact to the mounting iron construction (hazard of contact-corrosion).

Aboveground part of piping: The piping should be covered by a metal roof against direct lightning impact. The electrical cabling should be installed in a conduit system or inside of a metal cable tray.

c) The ESD-fire-shut-down-valve is functional not connected. The function could not be verified.

Corrective action:

Connection of the valve to the alarm panel.

6 Premix area

6.1 Door premixing unit (Type: A SYS PBT/PEF No. 290880.550631)

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 (monitored) doors. The box is connected with the artificial ventilation system and a gas sensor is mounted near by the mixing unit 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, piston metering of C5, static mixer to mix C5 and polyol and delivery line for the blend to the dosing unit tank;
- 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.

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 gas detector is not mounted.

Corrective action:

The gas sensor have to be mounted before commissioning.

b) 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.

- 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) The overload protection for internal transformers (T120 and T620) is missing.

Corrective action:

The overload protection must be double checked in accordance to the technical data of the transformers.

- f) The connection of the ventilation duct is not finished. Flexible hoses are used for the connection.

Corrective action:

The installation of the ventilation duct shall be finished, flexible joints must be interconnected with grounding wires.

6.2 Cabinet premixing unit (Type: PM 100 TWIN No. 290881)

DESCRIPTION:

The design of the cabinet premix system is similar to the door premix unit mentioned before. The safety relevant components are arranged in the same way.

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 (monitored) doors. The box is connected with the artificial ventilation system and a gas sensor is mounted near by the mixing unit 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, piston metering of C5, static mixer to mix C5 and polyol and delivery line for the blend to the dosing unit tank;
- 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.

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 gas detector is not mounted.

Corrective action:

The gas sensor have to be mounted before commissioning.

b) 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.

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) The overload protection for internal transformers (T120 and T620) is missing.

Corrective action:

The overload protection must be double checked in accordance to the technical data of the transformers.

7 Cabinet Foaming Area

DESCRIPTION:

The foaming area for the cabinets shall be situated inside a separate safety box. At the inspection date the area has been used for the refrigerator production with old production machines using CFC and had to be modified before startup of the new system. There are six existing foaming jigs provided for the cabinet foaming. It has been planned to make the nitrogen injection manually separated from the mixing heads and to have no efficiency monitoring system (detection of the position of gun, timing) only the amount of nitrogen is measured.

The cabinets are electrically preheated and dried for each jig separately inside the safety box. The cabinets are moved automatically to the foaming jigs and heating devices. The new installation in the safety box has not been complete. A documented time cycle of the production could not be provided.

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 safety box is not complete erected.

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).

- b) The gas detectors are not mounted.

Corrective action:

The gas detectors must be mounted on the positions defined during the visit before commissioning and the calibration of the sensors has to be checked with a proper calibration kit (gases and flow meter).

All non-explosion proofed apparatus must be switched off during and for at least 90 seconds after the foaming shot.

- c) The equipotential grounding system is not installed.

Corrective action:

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

- d) The endangered area could not be clearly defined due to the missing time cycle of the foaming and heating process.

Corrective action:

A definition of the minimum time cycle for the foaming process has to be provided.

- e) There are non-explosion proofed electrical installations situated inside the safety box close to the vapour release openings.

Corrective action:

All this installations (e.g. microswitches, motors, preheating, ..) must be electrically disconnected (cut off by failsafe timer system) during and 90 seconds after the foaming process. The sufficient distance of the control panels has to be inspected (measured) during commissioning.

- f) Several new devices are not installed

Corrective action:

All missing installation shall be completed before a final inspection (e.g. two further ESD-buttons, etc.).

- g) The proper function of the manual inertization is not monitored.

Corrective action:

The proper position of the nitrogen guns during injection and the allowed time between inertization and foaming must be detected.

8 Door Foaming Area

DESCRIPTION:

The foaming area for the doors shall be situated inside a new built separate safety box with one foaming head provided for the foaming of the doors. The door preheating device is a electrical heating system. The new installation in the safety box has not been complete. A documented time cycle of the production could not be provided.

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 safety box is not complete erected.

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).

- b) The amount and position of the gas detectors is not clearly specified. The gas detectors are not mounted.

Corrective action:

A sufficient amount of gas detectors has to be provided and positioned close to the release openings of the jigs below the foaming jigs and on points of possibly minimum air suction (corners or between air ducts). 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). They have to be mounted before commissioning.

- c) An equipotential grounding system is not provided.

Corrective action:

All metal parts (e.g. grid, ventilation ducts, ...) are to be connected to a grounding system inside the box (spring-washers). The grounding system has to be connected to the general grounding system in the factory.

- d) 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. There should no electrical preheating inside the safety box be active during the foaming process and 90 seconds after pouring.

- 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.

- g) The endangered area could not be clearly defined due to the missing time cycle of the foaming and heating process.

Corrective action:

A definition of the minimum time cycle for the foaming process has to be provided.

9 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.

9.1 Electrical installation

- a) The general electrical supply of the new production equipment was not connected during inspection.

Corrective action:

Installation and connection of the main supply. Functional connection of the existing ESD-Switches to the new safety control panel.

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

Corrective action:

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

9.2 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).

10 Safety requirements during operation of the plant

10.1 Safety Instructions

Adequate training and instruction of the personal working with cyclopentane and isocyanate is an 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

10.2 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.

10.3 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.

11 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 many 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.

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

A complicating condition has been the conversion (and combination) of the existing (and during inspection) still running old foaming equipment with the new cyclopentane foaming equipment. From the view of maintaining safety during all stages of the process, some additional measurements have been necessary (e e. g. failsafe-timer cut off of all standard electrical systems close to the foaming area during the foaming process). This function had to be integrated before startup of the new 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.

12 Inspected Project Documentation

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

12.1 Documentation of the Suppliers Equipment (Cannon)

12.1.1 Drawings

- General layout
- Air ducts, layout and detail

12.1.2 Manuals

- Premixing units - Use and maintenance manual
- Premixing units - Diagrams and spare parts
- Inspection book for accessories
- Mechanical manuals for accessories

12.2 Documentation of Fariz Iran

- Cyclo-Pentan Tank Inspection Sheet by manufacturer (Shahin Dasht Amin Eng. Co.) about Leak Test (compressed air: 3,1 barG) and coating test

13 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

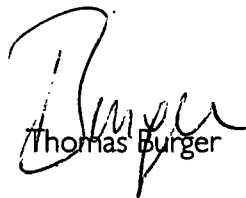
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