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SAFETY INSPECTION REPORT

CFC - Phase out project

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Uniw0501/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 11. October and 18. October 1998 on the production site of Pars Machine 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 Pars Machine is supplied by Cannon, Italy. The storage tank and the distribution piping to the mixing units is produced by locally companies. The production equipment consists of an aboveground storage tank (single wall), an aboveground distribution piping and one premixing and mixing 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 (CANNON) and the local counterpart (PARS MACHINE MFG. CO).

A final inspection by the inspection body of TUV Austria to verify the proper correction of all deviations mentioned in our draft report Uniw0374/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
<hr/>	
2 INTRODUCTION	5
2.1 GENERAL TEST PROCEDURES	5
2.2 SCOPE OF INSPECTIONS	5
2.3 DESCRIPTION OF ASSESSMENT RESULTS	5
2.4 ABBREVIATION LIST	6
<hr/>	
3 SAFETY RELEVANT SYSTEMS	6
3.1 EXPLOSION PROTECTION	6
3.1.1 ARTIFICIAL VENTILATION SYSTEM	6
3.1.2 NITROGEN BLANKETING (INERTIZATION) SYSTEM	8
3.1.3 GAS MONITORING SYSTEM	9
3.2 SAFETY CONTROL PANEL - EMERGENCY SHUT-DOWN SYSTEM	9
3.3 FIRE PROTECTION	10
<hr/>	
4 STORAGE AREA FOR CYCLOPENTANE	11
4.1 STORAGE TANK	11
4.2 FILLING (LOADING) STATION	12
<hr/>	
5 C5-DISTRIBUTION PIPING SYSTEM TO PREMIX AREA	13
<hr/>	
6 PREMIX AREA	14
6.1 PREMIXING UNITS (TYPE: A SYS 100 PBT/PEF Nr. 290879.550630)	14
<hr/>	
7 FOAMING AREA (CABINET AND DOOR)	15

8 GENERAL CLAUSES	17
8.1 ELECTRICAL INSTALLATION	17
8.2 GROUNDING SYSTEM - POTENTIAL BONDING	17
9 SAFETY REQUIREMENTS DURING OPERATION OF THE PLANT	18
9.1 SAFETY INSTRUCTIONS	18
9.2 PERIODIC SURVEILLANCE	18
9.3 PREVENTIVE MAINTENANCE	19
10 CONCLUSIONS	19
11 INSPECTED PROJECT DOCUMENTATION	19
11.1 DOCUMENTATION OF THE SUPPLIERS EQUIPMENT (CANNON)	20
11.1.1 DRAWINGS	20
11.1.2 MANUALS	20
11.2 DOCUMENTATION OF PARS MACHINE	20
12 STANDARD LIST (INTERNATIONAL, EUROPEAN AND NATIONAL)	20

2 INTRODUCTION

2.1 General test procedures

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

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

2.2 Scope of inspections

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

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

- A) General safety relevant systems
- B) Storage facilities for cyclopentane (storage tank, filling station etc.)
- C) C5-distribution piping to premix area
- D) Premix area
- E) Cabinet and 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:

A global artificial ventilation system is provided 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 with a nominal air flow rate of ca. 2000 l/sec each.

The air suction points are installed near the bottom of the housings (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 a differential pressure switch 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 is conveyed outside the building through a chimney 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 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) 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 no automatic emergency supply is provided.

Corrective action:

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

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.

h) A declaration or certification of the antisparking characteristic (according to VDMA 24169 or an equivalent standard) for the fans is not available.

Corrective action:

A corresponding manufacturer declaration or test certificate has to 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 stored in an accumulator intermediate tank close to the mixing units and the safety box. There is a separate nitrogen pipe provided for the storage tank.

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 tank (monitored by pressure switch)
- and for the cabinet jigs injected shortly before the pouring through the mixing head (minimum amount of nitrogen is monitored by a flow meter and a timing system).

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 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:

1 Gas detector shall be installed inside the premix area close to the mixer, 6 gas detectors shall be mounted inside the safety box (3 close to the release openings on one side, 3 close to the housing on the other side) below the metal grate. All gas detectors have explosion-protection type EEx d. The gas monitoring system is a SENTOX 96 type, Matricola A042, 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 premixer 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, no functional test possible.

Corrective action:

Completion of electrical installation and execution of the tests of safety functions during the next inspection visit.

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

Corrective action:

Mounting of the ESD-switch.

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 the premixing 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) 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 6000 l single wall steel tank arranged aboveground on a basin made of reinforced concrete. A provisionally weather-roof is mounted and a control panel has been situated 5 m from the storage tank. The grounding system for the tank and the metal roof has not been complete 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) The weather roof of the tank is not properly mounted, the thermal insulation for the tank is missing.

Corrective action:

Redesign of the weather roof and enlargement (possibly with inclined areas around) to protect the tank against direct sun light; installation of a sufficient thermal insulation. The sun protection roof shall (if necessary) consider the storage area for the filling container.

- c) The tank basin could not be inspected (filled with gravel).

Corrective action:

The basin shall not be filled with gravel and must be waterproofed.

- d) The resistance of the grounding system is not sufficient;
the measured values: 408 Ohms on 11 October,
 145 Ohms on 19 October
are high above the maximum value of 10 Ohms.

Corrective action:

Increasing the depth of the grounding rods, adding of new grounding rods, improvement of the grounding connections.

Remark: All grounding connections in explosion endangered areas 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. 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:

There has no filling station 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.

Flexible filling pipe connections to the storage tank have to be electrostatic conductible.

5 C5-Distribution Piping system to premix area

DESCRIPTION:

The distribution piping of cyclopentane is a welded ¾"-steel piping arranged aboveground. On the same trays there is the nitrogen-piping and the electrical cables. The C5-piping had no corrosion, thermal or lightning protection and has 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 mounted.

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:

The piping should be cleaned and coated against corrosion and thermal insulated. It 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 piping inside of the building is not properly fixed.

Corrective action:

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

d) 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 Premixing units (Type: A SYS 100 PBT/PEF Nr. 290879.550630)

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 detectors 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 is 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 Foaming Area (Cabinet and Door)

DESCRIPTION:

The foaming area for doors and cabinets is situated inside a combined safety box. There are two foaming heads, one for the door foaming, the other for the cabinet foaming. The cabinets are preheated and dried in a separate box on one side of the safety box by an oven. According to the management of the company the heating device will be changed to hot water heating. The door preheating device is a hot water heating system situated on the opposite side of the safety box and was not ready installed.

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 6 gas sensors has been discussed during the visit (3 sensors close to the release point of the vapour below the grid, 3 on the other side between the ventilation ducts at the points of the estimated 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 cross-section of the provided power cable is not sufficient (16 mm²).

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 mm² for 80 A; 35 mm² for 100 or 125 A; 50 mm² for 150 A, ...).

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

Corrective action:

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

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 shall 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 shall 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 has been 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 precondition 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 (Cannon). The only documentation obtained by the recipient company concerns the locally supplied storage tank.

11.1 Documentation of the Suppliers Equipment (Cannon)

11.1.1 Drawings

- General layout
- Air ducts, layout and detail

11.1.2 Manuals

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

11.2 Documentation of Pars Machine

- Translation of test report for cyclopentane storage tank:
serial No. 1516, hydrostatic test (test pressure 70 psi, design pressure 45 psi)

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
- IEC 60364-4-41 Electrical installations of buildings; part 4: protection for safety; chapter 41: protection against electric shock
- 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

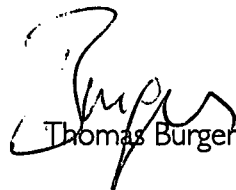
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