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**FINAL REPORT**

**on Technical Plant Inspections and Evaluations**

**Middle East Electrical Industries, Jordan**

**Bau und  
Betrieb**

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Amman Industrial City  
JORDAN

Niederlassung Ulm  
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- Plant inspections and evaluations on location  
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- Final Plant inspections and evaluations on location  
August 1998  
- Preparation of commission list  
- Meeting on Bono Sistemi  
October 1998  
- Preparation of final commission list  
April 1999  
- Preparation of final report

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- Mr. Pulici	- Cannon Afros
- Mr. Guerra	- Cannon Afros
- Mr. Khalili	- MEC
- Mr. Thabbat	- MEC
- Mr. Ghandour	- MEC

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## 1. OBJECTIVE AND SCOPE OF THE PLANT EVALUATION

The Middle East Complex in Amman, Jordan is operating polyurethane plants for the manufacture of refrigerators.

As substitute for the previously used CFC blowing agent R 11, c-pentane (C 5) is used now for the PU foam production. C 5 is a flammable fluid constituting a class A1 hazard. The use of C 5 necessitates fire and explosion protection measures for the C 5 storage and the PU production facilities.

In conjunction with the progressive change-over to combustible blowing agents (C 5), the experts of the Ulm branch of TÜV Süddeutschland have developed German and International safety standards and accumulated a wealth of expert knowledge in this field.

All safety evaluations by the TÜV experts are based on International, European and German standards and the experience gathered with plant inspections, the evaluation of solutions based on measurements and the investigation of accidents since the start of plant conversions in 1993. A special safety strategy was developed for fire and explosion hazards.

The safety evaluations by the TÜV experts basically have covered the following tasks:

- Co-ordinate of the safety strategy with fire and explosion protection measures
- Review the feasibility of the proposed safety strategy
- Inspect existing buildings and technical facilities and components
- Functional testing of safety-related equipment at the plants
- Measurements at plant components under fire and explosion protection aspects
- Evaluate existing organisational procedures/requirements
- Review relevant parts of the documentation
- Review the state of the art of safety engineering by a comparison with plants used for similar purposes

## **2. DOCUMENTS AND INFORMATIONS USED AS A BASIS FOR THIS PLANT EVALUATION**

### **2.1 Plant inspections**

The signed TÜV - Experts carried out 2 safety plant inspection.

The results of this inspections are reported in following documents:

Commission List

on Technical Plant Inspection and Evaluations

Middle East Electrical Industries, Jordan

File No.: MEE-JO/01/98-MEEcom1, Rev. 0, 6 October 1998

Final Commission List

on Technical Plant Inspection and Evaluations

Middle East Electrical Industries, Jordan

File No.: MEC-JO/03/98-MEC Finalcom3, Rev. 2, 16 December 1998

The items were discussed with representatives from MEC and Cannon Bono during the inspections.

The pending points were additional discussed with Bono and Cannon Afros during meetings in Milan.

During the meetings in MEC the responsible people of the MEC factory and of the Supplier Cannon Bono agreed about the responsibility to solve the pending points according to our Commission List.

After our 2 inspections we could be sure, that the most important safety equipment was installed.

Therefore we did not require an additional review because we learned that Siltal and Bono could finish the job in a proper way.

But we requested that all our demands in our report has to be fulfilled till start up and we get a written confirmation by Bono and MEC.

We got a letter:

- From MEC dated 16 December 1998  
and the confirmation
- from Bono Sistemi dated 14 December 1998

After receiving this letter/confirmation we have prepared the final report.

A certificate can be issued when all pending points are solved.

## 2.2 Technical regulations

This plant evaluation is based on International, European and National regulations - in that order - as far as these are available and applicable.

These include the following essential regulations:

- International standards (ISO, IEC)
- Ordinance Regulating Facilities for Storing, Racking and Transporting combustible Liquids - Germany: VbF
- Decree for electrical plants in explosion dangerous areas, Germany: ElexV
- Decree for pressure vessels, Germany DruckbehV
- Law for immissions protection: Germany BImSchG
- Law for water protection: Germany WHG (protection against water-pollution)
- Electrotechnical regulations: International: IEC / European: EN / National: DIN VDE  
e.g. IEC 60073, IEC 439-1/A2, IEC 204-1, IEC 1310-2, EN 50054, EN 50013, EN 50020, EN 50081, EN 60529, pr. EN 1050, DIN VDE 0165, EN 349, EN 418, EN 294
- Fundamental safety aspects to be considered for measurement and control equipment: Germany DINV 19250
- Safety requirements for automated manufacturing systems: Germany VDI 2854
- Personal protection regulations / accidents prevention - European: EN..EC /  
Germany: UVV/ZH  
e.g. VBG 1, VBG 5, VBG 61, ZH 1/200, ZH 1/255, ZH 1/8, ZH 1/10
- Technical regulations for combustible liquids and for gases: Germany TRbF / TRG  
e.g. TRbF 100, 110 / TRG 280

- Ex-proof / spark-proof for ventilators: Germany VDMA-24169 part 1
- Homologation of technical plant and equipment - European: conformity certificates (e.g. PTB, Cesi, Damko)
- EN 378, Refrigerating systems and heat pumps, Safety and environmental requirements
- pr EN 1612-2 Reaction moulding machines
- EG machine directive (89/392/ESG, revised edition 91/368/EEC)
- CEI/IEG 335-2-24, Safety of household and similar electrical appliances
- IEC 79-10/EN 60079-10/VDE 0165 Part 101: Electrical apparatus for explosive gas atmospheres - classification of hazardous areas.

## 2.3 Documentation of the PU plants and the peripherals from Cannon Afros and Bono Sistemi

- a) Declaration of compliance in accordance with the directive 89/392 Cee and following modifications.
- b) Documentation about A System 100 Penta Twin
  - Documentation about Penta Easy Froth 20 + 4 Twin
    - including: e.g. Flow diagrams
    - Electrical diagrams
    - Component informations
    - Relevant Component Certificates / like PtB, LCIE, use and Maintenance information's
    - Documents about the ISPEL Certificates of the pressure vessels
- c) Documents about the Pentane-Storage area
  - included: Layout
  - Drawing of tank
  - General P & I Diagram
- d) Detailed documentation about items
  - used in: storage Tank
  - Wetpart
  - Drypart



### 3. INSPECTIONS AND EVALUATIONS

#### 3.1 Safety aspects related to organization

##### 3.1.1. The existing situation is as follows:

a) Guard room

A constantly manned guard room is available. Prealarm and alarm signals from the C 5 plants are transmitted to this room. The personnel manning the guard room has been trained for taking any emergency action that may be required to protect the C 5 facilities.

b) Job instructions

Written job instructions are available at relevant points of the C 5 facilities. For the benefit of the TÜV experts, these instructions were orally translated to English. The workers serving these facilities have received special training.

c) Fire protection

Fire extinguishers are available in the area of the C 5 facilities.

Fire extinguishers and water hydrants are available throughout the production area. The above ground tank is especially sprinklered.

d) Evacuation of personnel

The procedure to be followed in the event of an alarm triggered by a C 5 facility is organized, i.e. specially trained persons rush to the facility causing the alarm, all others escape to the open air.

Suitable escape routes available.

e) Maintenance / inspections / testing

Persons engaged in servicing and inspecting the plants have received special training. Tools and other personal aids for the C 5 plants are available.

f) Official bodies

MEC confirmed that the responsible official bodies were informed about the C 5 and there are no particular requests.

### 3.1.2 Deficiencies / recommendations

Deficiencies detected or recommendations related to C 5 subjects have been listed in the TÜV Commissioning List.

## 3.2 C 5 storage area

### 3.2.1 Brief description of the plant

Pentane is stored in an aboveground tank (see drawing D 300 B 1 206). These tank is filled from drums.

The tank is located in a basin.

The C 5 pipe to the premix room is aboveground.

The area in which C 5 will be released in the event of leakages during the filling process is designed as a liquid catch basin.

Water gutters are structurally separate from the catch basin.

The sewage system is separated from the C 5 catch basin.

The electrical control panels are installed outside the explosion zone of the C 5 storage area.

### 3.2.2. C 5 safety data

Media	Hazard class	Flash point (°C)	Ignition temp. (°C)	Explosion group	Temp. Class	LEL / HEL (vol %)	Density (air = 1)	Partially inert max O <sub>2</sub> (%)
Cyclo-pentane	Al	< - 30	380	II A	T 2	1.1 / 8.7	2.42	11

### 3.2.3. Explosion zones / fire hazard zone

Based on the above standards, the following explosion zones must to be defined:

a) Explosion zone O

- The interior of the C 5 storage tanks (without controlled inertisation)
- The interior of C 5 pipes which are not constantly filled with C 5

b) Explosion zone 1

- 1,5 m around the tank
- The interior of the storm water catch shaft (C 5 catch basin)
- A circle with a radius of 1 m about the end of the C 5 tank exhausting systems

c) Explosion zone 2

- The environment of the C 5 tank shafts over a distance of 3,5 m up to a height of 0.8 m from the floor additional to the Zone 1.
- The water drainage shafts in the region of the C 5 storage area

d) Fire hazard zone

- Total C 5 storage area (minimum 5 m around the basin)

### 3.2.4. Measurements / functional tests

Record after the second inspection

Plant/component	Measuring result	Conforming to safety strategy		Remarks
		yes	no	
1. Sprinkler System		x		see Commiss. List
2. Pentane emergency pushbutton			x	see Commiss. List
3. Remote signals guard room		x		
4. C 5 tanks - leakage system		x		Commiss. List
5. C 5 tank-pressure monitoring system		x		
6. Electrostatic measures - total plant - details	< 2 kV / m window of enclosure > 300 kV/m after insert of metal stripes	x		see Commiss. List
7. Ground resistance / potential equalisation - total plant	≤ 0.1 ohm	x		
8. Electrostatic resistance - total plant - details	< 10 kilo-ohms racking hoses 10 <sup>6</sup> ohms	x x		see Commiss. List
9. Electric circuits - insulation resistance - overcurrent protection - UPS - test broken wires	> 30 mega ohm O.K.	x x x x		
10. Pressure testing of pentane pipeline	confirmed by Bono	x		sufficient for working pressure
11. Further functional tests				Commiss. List

### 3.2.5 Deficiencies detected / action required

The deficiencies detected during inspection of the C 5 storage area and the measures had to be done after our inspection are listed in the TÜV Commissioning Lists.

### 3.3 Premix area/Polyol/C 5-wetparts and foaming machines

#### 3.3.1. Brief description of the plant

All sections except the pipes of the plant in which C 5 is used are installed in a separate enclosure.

The plant is described in the documentation mentioned in chapter 2.3 and the layout No. D 400 B 1177.

#### 3.3.2 Polyol / C 5 safety data

The safety requirements for the polyol / C 5 mixture are from safety point of view similar to those for C 5.

#### 3.3.3. Zone definitions

Based on the above standards, the following zones must be defined:

##### a) Alarm zone

1. Wetpart: within the enclosures with the polyol / C 5 tanks, Easytroth and with the high-pressure pump units
2. Foaming machines: the interior of the enclosures (rooms) with the foaming machines

Definition of alarm zone: Defined area in which the development of an explosive atmosphere answering the description of explosion zone 0,1 or 2 is prevented by technical measures in accordance with IEC 79-10 and all potential sources of ignition are switched off automatically before an explosive atmosphere arises.

Technical measures in accordance with IEC 79-10 include:

Plant sections carrying polyol / C 5 must be technically leakproof  
(e.g. special seals, leakage monitoring)

Technical ventilation dimensioned in accordance with IEC 79-10

Automatic gas warning system tested and certified in accordance with EN 50054 which automatically switches off all potential sources of ignition at 40% LEL or lower.

Only equipment which is absolutely necessary for operating the polyol / C 5 plant may be installed within the alarm zone.

b) Explosion zone 1

1. Foaming machines: a circle with a radius of 20 cm about the injection hole and 20 cm about the upper part of the mounted cabinet while the foam is rising.

c) Explosion zone 2

- The interior of the exhausting system
- A circle with a radius of 2 m about the end of the exhausting system at the open air
- A circle with a radius of 3 m about flanged joints, projected down to the floor, unless an alarm zone is defined or a special seal is used

d) Areas in which explosive atmospheres are prevented by inertisation

- The interior of the polyol / C 5 storage tank

e) Fire hazard zone

An area of 5 m about the enclosures.

## 3.3.4. Measurements / functional tests

 Record of test results after the 2<sup>nd</sup> inspections

Plant/component	Measuring result	Conforming to safety strategy		Remarks
		yes	no	
1. Gas warning system - 20% LEL - 40% LEL - system error		x x x		
2. Pentane emergency pushbutton		x		
3. Remote signals guard room	signal of backup generator	x	x	
4. Exhausting system - pressure switch - test smoke  - functions 20% LEL/40% LEL/emergency pushbutton / circuit switch	foaming mach. O.K.	x x x		
5. Leakage system - basins - pumps		x x		
6. Polyol / C 5 tank - supermax - N <sub>2</sub> -min - electrical heating		x x x		
7. Door monitoring (wetparts)		x		
8. Foaming machines - blocking electr. heater - blocking foam open with manual switch - position control of mixing head		x  x x		
9. Electric circuits - insulation resistance - overcurrent protection - UPS - test broken wires	> 30 mega ohms O.K.	x x		no complete measurement
10. Electrostatic measures - total plant - foam closing/opening - details	< 2 kV / m 3-5 kV / m ripped windows of enclosure > 300 kV / m after metal stripes was mounted	x x  x		see Commiss. List

Plant/component	Measuring result	Conforming to safety strategy		Remarks
		yes	no	
11. Ground resistance / potential equalization - total plant	≤ 0.1 ohm	x		
12. Inertisation foaming machines - pressure monitoring - N <sub>2</sub> flow measurement - time monitoring - quality of inertisation (position monitoring)	O <sub>2</sub> -concentration 7,6 %	x x x x		
13. Further functional tests				see Commiss. List

### 3.3.5 Deficiencies detected /action required

The deficiencies detected during inspection of the wetparts and the foaming machines and the measures had to be done after our inspection are listed in the TÜV Commissioning Lists.

All safety related parts of the plant must be checked regularly according to the requirements in the Cannon documentation.

These safety checks must be recorded and signed by the responsible person.



#### 4. Conclusion

The inspection of the installation of the MEC Factory, UNIDO Project No. 97/097 took place.

MEC and Bono Sistemi has confirmed that all deficiencies detected during the TÜV inspection and evaluation in April 1998 and July 1998 of the related c-Pentane plants, listed in the Commission List mentioned in Chapter 2.1 has been fulfilled except the pending points mentioned in the letter from MEC from 16 December 1998.

Now the above mentioned plant fulfill the most important safety standards and the requirements of the TÜV Süddeutschland Branch Ulm experts.

In our opinion the safety against danger of fire and explosion because of using c-Pentane has been reduced to a possible minimum when all deficiencies are solved..

The MEC Factory in Amman, Jordan will get a safety certificate for above mentioned plant in case all pending points are solved.

The experts

signed  
K.-J. Richardt

signed  
E. Mack