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22216



## FINAL REPORT

on Technical Plant Inspections and Evaluations

National Refrigeration Company

## Bau und Betrieb

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JORDAN

Niederlassung Ulm  
Dampf und Druck

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**Project:** UNIDO Contract No. 97 / 098 with Cannon Afros  
Order No.: 98 024 3220-1 and 98 025 3126-1

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**Dates:** Juli 1998  
- Preinspection  
Oktober 1998  
- Final Plant inspections and evaluations on location  
August 1998  
- Preparation of Commission list  
- Meeting on Bono Sistemi  
Oktober 1998  
- Preparation of Final Commission list  
April 1999  
- Preparation of Final Report/Certificate

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- Hosam Hafez - NRC  
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## 1. OBJECTIVE AND SCOPE OF THE PLANT EVALUATION

The National Refrigeration Company, 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 National Refrigeration Company  
File No.: NRC-JO/02/98 - NRC\_Finalcom, Rev. 0

Final Commission List

on Technical Plant Inspection and Evaluations National Refrigeration Company  
File No.: NRC-JO/03/98 - NRC\_Finalcom3, Rev. 2, 16 November 1998

The items were discussed with representatives from NRC 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 NRC the responsible people of the NRC 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 NRC 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 NRC.

We got that confirmations:

- From NRC dated 11 April 1999
- from Bono Sistemi dated 29 March 1999

After receiving this confirmations we have prepared the final report and issued an safety Certificate.

This Certificate is valid 3 years after the last inspection. After this time a recurrent inspection of the plant is requested.

## 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 DIN V 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) Documentation about A System 100 Penta Twin

- Documentation about Penta Easy Froth 20 + 4

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

### b) Documents about the Pentane-Storage area

included: Layout  
Drawing of tank  
General P & I Diagram

### c) Detailed documentation about items

used in: storage Tank  
Wetpart  
Drypart

according to inspection book (dated 16/06/98)



### **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 are 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**

NRC 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 1199). These tank will be 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 0

- 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 over a distance of 3,5 m up to a height of 0.8 m from the floor additional to the Zone 1.

d) Fire hazard zone

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

### 3.2.4. Measurements / functional tests

Test record after the second inspection

Plant/component	Measuring result	Conforming to safety strategy		Remarks
		yes	no	
1. Filling pump pipes are not suitable			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. Safety relieve valve		-	-	could not be tested
6. Electrostatic measures - total plant - details	< 2 kV / m window of enclosure > 300 kV/m after insert of metal stripes	x	x x	see Commiss. List for deviation see Commiss. List for deviation
7. Ground resistance / potential equalisation - total plant - details	≤ 0.1 ohm > 0.1 ohm	x	x	see Commiss. List for deviation
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
12. Pressure monitoring system of tank		x		
13. Tightness of tank		x		

### 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 are listed in the TÜV Commissioning Lists.

### 3.3 Premix/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 1178.

#### 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 / premix unit 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 after the second inspection

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	see Commiss. List
4. Exhausting system - pressure switch - test smoke  - functions 20% LEL/40% LEL/emergency pushbutton / circuit switch	foaming mach. O.K.	x x		see Commiss. List
5. Leakage system - basins - pumps		x x		see Commiss. List
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 - heating system		x	x x x	see Commiss. List
9. Electric circuits - insulation resistance - overcurrent protection - UPS - test broken wires	> 30 mega ohms O.K.	x x x x		
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 - monitoring - flow monitoring - quality of inertisation (position monitoring)	8 % O <sub>2</sub>	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 inspections 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 National Refrigerator Factory, UNIDO Project No. 97/098 took place.

NRC and Bono Systemi has confirmed that all deficiencies detected during the TÜV inspection and evaluation in July 1998 and October 1998 of the related c-Pentane plants, listed in the Commission Lists mentioned in Chapter 2.1 has been fulfilled.

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

The safety against danger of fire and explosion because of using c-Pentane has been reduced to a possible minimum.

The NRC Company, Amman, Jordan will be allowed to hold a safety certificate for the above mentioned plant.

This Certificate will be valid till October 2001.

The experts

signed  
K.-J. Richardt

signed  
E. Mack

Enclosure:  
Certificate

# CERTIFICATE

No.: TÜV- BB-UL 98 025 3126-1

This is to certify that

**Subject:** Pentane-PU Foaming System  
Refrigerator Factory  
UNIDO-Project No 97 / 098

**Producer:** Cannon Afros, Italy

**Operated:** National Refrigerator Co.  
Amman 11181  
Jordan

meets the requirements of the TÜV Süddeutschland  
BB-ULM.

It was installed according to the relevant International  
Standards.

The Pentane PU foaming system has been submitted to  
an audit to verify compliance with the state of the art.

The system was audited finally in the period  
from July to October 1998.

This Certification is based on Report  
on Technical Plant Inspection and  
Evaluation of NRC Project  
TÜV BB-ULM-Ri/Be  
File No.: Bon/NRC-JO/01/99

This Certification is valid until  
30-10-2001

Ulm, April 29, 1999  
TÜV Süddeutschland experts

  
K-J Richardt

  
H-J Berger

