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cc. Regierung

UNIDO Project MP/CPR/96/042 – Phasing out ODS at Hangzhou Huari Refrigerator Company UNIDO contract No. 97/020 UNIDO contract No. 98/105

Final Report

Final Report according to § 3.23 h) of the UNIDO contract No. 97/020 and § 3.22 e) of the UNIDO contract No. 98/105 including all the work performed at the Plant Site (and abroad if any) required in the Terms of Reference and attaching the Certificate of Acceptance of the Work

Content

Scharfenstein, 12.12.2000

for H. V. Lang
President

W. Reh
Project Engineer

PLEASE BE AWARE THAT
ALL OF THE MISSING PAGES IN THIS DOCUMENT
WERE ORIGINALLY BLANK

1. Elaboration of the Safety Strategy, Staff Training, Model Redesign, Model Testing - Part I of the Terms of Reference

1.1 Elaboration of the Safety Strategy – TOR point 5.1.1

For this project the Safety Strategy has been elaborated (see attached table of contents.)

In this document the theoretical aspects of hydrocarbons were described in detail.

The required technical and physical parameters of the alternative blowing agents and refrigerants were listed.

The adapted foaming technology using cyclopentane has been explained in detail.

The new equipment necessary for modification of existing foaming lines has been described regarding the construction and processing.

In special chapters the safety requirements of cyclopentane as new blowing agent and isobutane as refrigerant were pointed out.

The necessary modification of the appliance design based on the use of hydrocarbons as refrigerant were presented.

In the third part of the documentation the necessary modification of the assembly lines were explained.

The adjustments in the assembly technology and the resulting new equipment were described. in detail.

The function and construction from the new parts were explained by drawings.

The realisation of the safety requirements was part of the special chapter of this document.

The related regulations and standards which are valid in Germany were listed as the new foaming and assembly equipment will be certified by TÜV Germany.

The document has been explained and handed over to Huari during the visit in March 1997 (see attached Minutes of Meeting dated March 7th 1997 point 1.)

1.2 Staff Training – TOR points 5.1.7; 5.1.8; 5.1.9

Based on the Safety Strategy and the Guide for refrigerant conversion of refrigerators and freezers to the alternative refrigerant R600a the first training has been performed during the visit in March 1997 (see attached Minutes of Meeting dated March 7th 1997 point 3.)

The single conversion steps together with the required ambient conditions were explained.

The second training has been carried out during the study tour at dkk premises. In this training the first results of the conversion of the Huari appliance in dkk's lab were discussed (see attached Minutes from the Study Tour.)

1.3 Technical documentation for model redesign, model preparation, technical and safety requirements of refrigerators and freezers – TOR points 5.1.2; 5.1.3; 5.1.4; 5.1.5;

The necessary technical documentation for the preparation and realisation of the model redesign including the theoretical, practical and safety requirements has been prepared and handed over to Huari with the Guide for refrigerant conversion of refrigerators and freezers to the alternative refrigerant R600a (see attached table of contents.)

1.4 Preparation of the detailed work programme – TOR point 5.1.3

Based on the conclusions from the visit in March 1997 the work programme schedule has been updated and submitted to Huari (see attached fax dated March 13th 1997.)

1.5 Model redesign, Model testing – TOR point 1.3; 5.1.9

Two samples of the model BCD 218 have been shipped to dkk for the conversion to the refrigerant isobutane.

The conversion work has been done by dkk staff and in their own lab.

The parameters from the converted model have been defined during the tests carried out according to DIN/EN standards.

The test results have been listed in the test report (see attached test report.)

Recommendations for further optimisation have been described in this report also.

The carried out appliance conversion has to be evaluated as successful as the measured results are at the same R12-level or could be improved.

Based on the dkk test report Huari has converted the other 5 models by themselves and considers the results as successful (see attached confirmation from Huari dated December 11th 2000)

1.6 Study Tour to Europe

The study tour to Europe has been performed in August 1997 with aim that the contractor should become familiar with the new technology and the new equipment and to get a further training for the appliance conversion.

The members of the Huari delegation have visited the suppliers of the equipment which have presented their new machinery in meetings and also in practical demonstration.

During the visit of dkk the conversion training was performed and the first results of the test with the Huari model BCD 218 were discussed.

In the several meetings the equipment specification has been discussed (see also attached Minutes of the Study Tour.)

2. Modification of the foaming equipment on two assembly lines to blow the foam insulation using cyclopentane as foam blowing agent instead of CFC-11 – Part II of the Terms of Reference

2.1 Technical services UNIDO contracts No. 97/020 and No. 98/105

TOR point 5.1.1 – documentation and specification for adjustments
During the visit in March 1997 the general information about the scope of the necessary modification of the foaming lines and the new equipment have been described and explained with the handed over Safety Strategy.

During the following visits the exact scope of equipment supply has been defined and the equipment specification has been submitted to UNIDO by fax dated October the 1st 1997 for confirmation (see attached fax dated October 1st 1997.)

TOR point 5.1.2 – counterparts responsibilities
The counterpart has been informed about his obligations and responsibilities in general during the first visit and during the meetings at the Study Tour to Europe.
The detailed information have been submitted to Huari by several fax for the preparation of the installation of the single equipment parts.

TOR point 5.1.3 – Technical an safety requirements, documentation for operation, transportation, handling, maintenance, and repair of the new equipment
The technical and safety requirements have been listed and explained together with the information for the preparation of the equipment installation submitted to Huari before each installation and commissioning step.

The technical documentation for the operation, transportation, handling, maintenance and repair of the new equipment have been handed over to Huari during the single installation and commissioning activities.

TOR point 5.1.4 – Safety Certificate
The Safety Certificate has been prepared by TÜV Germany (see attached TÜV report) for the individual new equipment concerning the safety requirements in two steps.

TÜV has visited Huari in May 1999 for inspection the local conditions and the delivered goods and to define the requirements for the modification of the foaming lines.

In July 2000 the engineers from TÜV have controlled the realisation of the modification of the foaming lines and the installation of the pentane storage and premixing area to check the compliance with the safety requirements.

As dkk, Perros and Huari have eliminated the lacks listed in the TÜV report the equipment meet the related safety regulations as requested by TÜV.

TOR point 5.1.5 – on-the-job-training
During each installation and commissioning the on-the-job-training for the plant personal has been performed concerning the operation, maintenance of the new production equipment.

TOR point 5.1.6 – installation, start-up
The installation of the foaming equipment started in February and has been finished in June 2000.

After finishing of the modification of each foaming line the equipment have been commissioned for test runs and performance tests which have been carried out successfully.

TOR point 5.1.7 – Starting mass production
The mass production has been started after TÜV inspection on July 15th 2000 (see attached Minutes of meeting dated July 27th 2000.)

2.2 Supply of equipment

UNIDO contract 97/020

TOR point 5.2.1- Replacement of an existing low pressure foaming machine for doors
An existing low pressure foaming machine for doors has been replaced by a high pressure foaming machine type ECODOSING ED 2-20 P designed for the use of cyclopentane. This unit has been delivered completely with all necessary safety accessories, exhaustion system, working tanks, valves etc.

TOR point 5.2.2 - Modification of two foaming machines for cabinets including mixing stations, exhaust system and safety equipment
Two existing foaming machines for cabinet have been modified for the use of cyclopentane. Therefore two ECOKIT 50 have been delivered together with all necessary safety equipment (sensors, airflow meters, monitoring system) housing, exhaustion system, valves and control panels to Huari.

Together with the ECOKITs two premixing stations type ECOMIX 20 have been shipped to the Chinese counterpart. This premixing stations are completely designed with safety equipment (sensors, airflow meters, monitoring system), exhaustion system and control panels.

TOR point 5.2.3 - cyclopentane storage tank including piping and pump
For the safe and sufficient storage of the alternative blowing agent cyclopentane a 40 m^3 tank together with the pump and all necessary accessories for the safe filling and unloading have been delivered to Huari.
The necessary cyclopentane feeding pipe has been shipped to the counterpart premises also.

TOR point 5.2.4 – fire protection system
The foaming units delivered to Huari are equipped with a CO_2 fire protection system.
For the cyclopentane storage tank there is no extra fire protection system necessary as the tank has been underground installed.

TOR point 5.2.5 – Redesign of mould for the cabinets and doors – delivery of drawings
To allow the Chinese counterpart to redesign the moulds for the use of cyclopentane drawings and lists of instructions have been submitted to Huari.

UNIDO contract 98/105

TOR points 5.2.1 – 5.2.3
For the modification of the dry part of the second cabinet line the following items have been supplied

- 4 exhaust systems
- 4 airflow sensors
- 8 gas detectors
- automatic nitrogen injection system for cabinets
- monitoring system
- engineering drawings for the safety box and the safety system
- material for the construction of the safety box to cover 8 stationary moulds

3. Modification of the refrigeration assembly lines; additional equipment needed for the application of isobutane as refrigerant instead CFC-12 – Part III of the Terms of Reference

3.1 Technical Services

TOR point 5.1.1 – documentation and specification for adjustments
During the visit in March 1997 the general information about the scope of the necessary modification of the assembly lines and the new equipment have been described and explained with the handed over Safety Strategy.

During the following visits the exact scope of equipment supply has been defined and the equipment specification has been submitted to UNIDO by fax dated October the 1st 1997 for confirmation (see attached fax dated October 1st 1997.)

TOR point 5.1.2 – counterparts responsibilities
The counterpart has been informed about his obligations and responsibilities in general during the first visit and during the meetings at the Study Tour to Europe.
The detailed information have been submitted to Huari by several fax for the preparation of the installation of the single equipment parts.

TOR point 5.1.3 – Technical an safety requirements, documentation for operation, transportation, handling, maintenance, and repair of the new equipment
The technical and safety requirements have been listed and explained together with the information for the preparation of the equipment installation submitted to Huari before each installation and commissioning step.

The technical documentation for the operation, transportation, handling, maintenance and repair of the new equipment have been handed over to Huari during the single installation and commissioning activities.

TOR point 5.1.4 – Safety Certificate
The Safety Certificate has been prepared by TÜV Germany (see attached TÜV report) for the individual new equipment concerning the safety requirements.

In July 2000 the engineers from TÜV have inspected the modification of the assembly lines and the installation of the isobutane storage to check the compliance with the safety requirements.

As dkk and Huari have eliminated the lacks listed in the TÜV report the equipment meets the related safety regulations as requested by TÜV.

TOR point 5.1.5 – on-the-job-training
During each installation and commissioning the on-the-job-training for the plant personal has been performed concerning the operation, maintenance of the new production and the service equipment.

TOR point 5.1.6 – installation, start-up
The installation of the equipment for the assembly lines started in February 2000 and has been finished in March 2000.

After finishing of the modification of each assembly line the equipment have been commissioned for test runs and performance tests which have been carried out successfully.

TOR point 5.1.7 – Post commissioning monitoring
The Chinese counterpart has been visited after the start of mass production carried out on July 15th 2000 for post commissioning on July 27th and October 30th 2000 (see attached Minutes of meeting dated July 27th and October 30th 2000.)

The existing problems have been eliminated by dkk and Huari.

3.2 Supply of equipment

TOR point 5.2.1 – refrigerant charging stations
Two refrigerant charging stations with vacuum pump built-in including the refrigerant supply pump and the necessary safety systems (with isobutane sensors, ventilation system and safety switch) have been installed and commissioned successfully during the visit in February and March 2000.

TOR point 5.2.2 – ultrasonic welding units
The three ultrasonic welding units which have to be supplied in this project have been installed and commissioned in March 2000.

TOR point 5.2.3 – isobutane storage tank
The 5 m^3 isobutane storage tank delivered to Huari has been installed during the visit in February 2000.

In addition to the required service dkk has supplied one piping set for the feeding of the isobutane from the tank to the refrigerant supply pump and to the charging station.

The installed isobutane pipe has been tested according to the required test conditions described in detail in the handed over technical documentation.

The test results are recorded in the pressure test protocols (see attached protocols from the Minutes dated February 29th and March 23rd 2000.)

TOR point 5.2.4 – leak detectors
The three delivered isobutane leak detectors ECOTEC 500 have been commissioned during the visit in February 2000 (see attached Minutes dated February 29th 2000.)

The test leak for calibration has been also handed over to Huari.

TOR point 5.2.5 – safety system for gas detection and ventilation
Two safety systems containing isobutane sensors, air flow meters, fans and control units have been installed and commissioned for the two charging places.
The work has been done together with the installation and commissioning of the refrigerant charging stations in February and March 2000 (see attached Minutes dated February 29th and March 23rd 2000.)

TOR point 5.2.6 – vacuum pumps
Altogether six vacuum pump stations have been delivered installed and commissioned during the visit in March 2000 (see attached Minutes dated March 23rd 2000.)

The existing vacuum pumps at the two assembly lines have been cleaned.

TOR point 5.2.7 – Fire protection system
The installation of the special fire protection system is not necessary according to the related safety regulations as the charging area is continuously monitored by the installed safety system.

TOR point 5.2.8 – Commissioning and start-up
The equipment which have to be supplied in this project have been completely installed and commissioned successfully after finishing of the modification of the assembly lines and the realised conversion of the appliances to the refrigerant isobutane.

The function and performance tests have been carried out successfully.

TOR point 5.2.9 - training
For each equipment part which has to be supplied in this project the training has been performed during the installation and commissioning.

TOR point 5.2.10 – Start of mass production
The mass production has been started on July 15th 2000 after the TÜV inspection (see attached Minutes from July 27th 2000)
After each commissioning Huari has signed their acceptance with confirmation of the handing over from the new equipment (see attached Minutes.)

4. Installation and Commissioning of the supplied equipment

Foaming Lines I and II – Part II of the Terms of Reference

Equipment required in TOR points 5.2.1- 5.2.5 UNIDO contract 97/020
Equipment required in TOR points 5.2.1- 5.2.3 UNIDO contract 98/105

The equipment which have been delivered DDU Plant Site have been installed and commissioned successfully beginning from February until June 2000.

Each foaming line has been modified and after the commissioning of the tank, premixing stations and foaming machines the complete foaming Line I and II have been commissioned for test trials and performance tests.

The carried out performance tests meet the requirements from Huari and after TÜV inspection they have used the modified foaming lines for mass production since July 15th 2000 (see attached Minutes dated July 27th 2000.)

Assembly Lines I and II - Part III of the Terms of Reference

Equipment required in TOR points 5.2.1- 5.2.6
The equipment which have been delivered DDU Plant Site have been installed and commissioned successfully in February and March 2000.

The assembly Line I and II have been modified and after the commissioning of the isobutane storage tank, the refrigerant feeding pipe and the safety systems the new assembly equipment delivered under this UNIDO project have been commissioned for test trials and performance tests.

The carried out performance tests meets the requirements from Huari and after TÜV inspection they have used the modified assembly lines for mass production since July 15th 2000 (see attached Minutes dated July 27th 2000.)

Huari has confirmed their acceptance of the new equipment with signature of the single handing over and for the whole plant see attached Minutes dated July 27th and November 20th 2000.)

5. TÜV certificate

As required in the Terms of Reference the individual new equipment supplied in this project under the UNIDO contracts No. 97/020 and 98/105 have been certified by TÜV Germany regarding the safety requirements (see attached TÜV reports.)

Huari and Perros have implemented all recommendations from TÜV (see attached Minutes of Meeting dated November 20th 2000, point 5and 6.)

dkk has implemented all recommendations from TÜV (see Minutes of Meeting dated December 7th 2000, point 1 and 2.)

The detailed TÜV reports please find attached.

Certificate of Acceptance

for the work under the UNIDO project **MP/CPR/96/042**

The following activities have been carried out under the UNIDO contracts **No. 97/020** and **No. 98/105**:

Part I: Elaboration of a Safety Strategy, Staff Training, Model Redesign, Model Testing

- Elaboration, explanation and handing over of the Safety Strategy(carried out during the first visit at Huari in March 1997)

- Staff Training (performed during the visit in March 1997, handing over of the conversion guideline to Huari, training during the visit of the Huari's team at dkk while the Study Tour in Europe, separate information during the other visits at Huari)

- Model redesign to isobutane and testing (redesign and testing of Huari's model BCD 218 by dkk and in dkk labs, redesign and testing of other models by Huari in their labs)

Part II: Modification of the foaming equipment on two assembly lines to blow the foam insulation using cyclopentane as foam blowing agent instead of CFC-11

- Delivery, installation, and commissioning of new equipment needed for the modification of the foaming Lines I and II for the use of cyclopentane as blowing agent

- Delivery of engineering drawings for modification of the moulds, jigs and plugs by the counterpart

- Safety certification of the modified foaming Lines I and II by TÜV Germany

- Start of mass production

Part III: Modification of the refrigeration assembly lines; additional equipment for the application of isobutane (R600a) instead of CFC

- Modification of the assembly Line I and II (carried out during the visit at Huari in February and March 2000)
- Installation and commissioning of the new equipment needed for the use of isobutane as refrigerant
- Safety certification of the assembly Line I and II by TÜV Germany
- Start of mass production

for UNIDO:

for dkk GEP Ltd.:

12.12.2000

Annex

Safety Strategy – Table of contents

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Minutes of Meeting – First visit

MINUTES OF THE MEETING

Contract meeting at Huari premises in week 10 1997

Participants : **Huari**
Mr. Wang Jian Chen, Assistant General Manager and Projectmanager
Ms. Tang Zhaoyang, Product Design Assistant Engineer
Mr. He Shaoyong, Engineer and Head of Technical Department
Mr. Dai Tiejun, Engineer and Head of Technological Procedure Department
Mr. Shen Xuekuan, Engineer and Head of Mould-Design Department
Mr. Huang Yuejin, Equipment Engineer
Mr. Zhang Ke, Translator

dkk
Mr. Harald V. Lang President
Mr. Winfried Reh Project-Engineer

The following topics were treated:

1. Safety concept for conversion
2. Factory tour
3. Conversion training
4. Bill of equipment
5. Study tour to Europe
6. Project Schedule

Topic 1:
Based on the handover of a binder with specific technical documentation the safety issues related to hydrocarbon were explained. Safety strategies for the product, the storage and handling of hydrocarbon, the foaming area and the assembly line were described.

Topic 2:
The new factory which is still partly under commissioning was visited in order to locate potential places for isobutane and cyclopentane storage tanks.
It was agreed to place the cyclopentane tank underground outside in the corner place. The isobutane tank could be inside the hall next to the outside wall which requires specific safety housing or outside the hall.
Dkk will identify the best location based on the factory layout.
In any case adirect pipe connection to the charging station with an adaquately dimensioned pump is recommended by dkk in order to increase the sefety level and to reduce the operating costs.

Topic 3:
dkk' s guideline for conversion to the refrigerant R 600 a was handed over and explained. It was reconfirmed that dkk will convert one model in it' s own lab and supervise and guide five more models at Huari' s premises.
The following actions were agreed:
A1: dkk will provide ISO standard 8187 and 8561 for Huari.
A2: Huari will immediately airship to samples of the pilot model to be converted to dkk together with the drawings and all available technical descriptions. Time is important to have the first results for the visit of huari engineers to dkk planned for May 1997.
A3: For all othe five models to be converted Huari will send with normal seafreight one sample of each model together with the technical data.

A4: As Huari has not yet selected the future compressors it is up to dkk to make a preliminary selection for the conversion.

Topic 4:
It was reconfirmed that the following lines have to be modified.
- One cabinet line with Cannon A
- One cabinet line with Cannon B
- Replacement of low pressure door foaming machine by a new one and modification
- of the door line

UNIDO Terms of Reference Part III chapter 5 are different. However dkk will supply what is required and clarify the differential costs with UNIDO.
The Specification as submitted to UNIDO on September 16 were handed over and explained. The quantities were checked and confirmed.
A5: dkk will deliver in April leaflets and brochures of the selected equipment. Also all major supplier will be visited during the study tour.

Topic 5:
The tentative date for the study tour was set for week 22/23 with arrival to Frankfurt on May 25/26 and leave on June 7/8.
The study tour will contain
three days of conversion training at dkk' s premises
two days of training at PERROS Italy
one day of training at Leybold Cologne
one day of training at A' Gramkow Offenbach
one after-sales service training
one or two refrigerator factory visits
one day UNIDO visit Vienna

A6: dkk will check with UNIDO whether the study group shall consist of four or five people and inform Huari immediately.
A7: Huari will fax to dkk names, birthday and passport number of the delegation members.
Dkk will mail the original invitations for Austria, Germany and Italy.

3/

5

Topic 6:
Huari has decided that Line I will consist of the Cannon B and the door foaming line as well as assembly line B.
Line II will be the Cannon A and the remaining assembly line A.
Equipment for line I should be in the factory in Octobe 1997 to enable production start January 1 1998. For this ambitous target it is mandatory to finalize equipment specification in April and to place factory orders right after.
Line II should be ready for production start July 1 1998.
A8: dkk will adapt the work schedule to those requirements and fax it to Huari in week 12.

Date: Hangzhou, March 7, 1997

Wang Jian Chen

Harald V. Lang

Minutes of the Study Tour

Minutes of the Study Tour

Participants:

Mr. Wang Jian Cheng	Huari
Mr. Xie Jian Feng	Huari
Mr. Huang Yue Jin	Huari
Mr. He Shao Yong	Huari
Ms. Tang Zhao Yang	Huari
Mr. H. V. Lang	dkk GEP mbH
Mr. W. Reh	dkk GEP mbH

Date : 03.08. - 16.08.97

03.08.97	Arrival in Frankfurt/Main Welcome by Mr. Lang
04.08.97	Trip to Scharfenstein Welcome at dkk premises Presentation of the facilities from dkk GEP mbH
05.08.97	Training for conversion of refrigerator/freezer to isobutane(R600a) - general introduction classification of the appliance, DIN-standard conversion of BCD 218 G to R600a safety requirements Technical Service of appliances operating with hydrocarbons
06.08.97	Visit of Plasttechnik Greiz (manufacturer of foaming equipment) company presentation factory visit, explanation of foaming equipment designed for cyclopentane cyclopentane foaming technology safety aspects
07.08.97	Visit of the refrigerator/freezer manufacturer FORON in Niederschmiedeberg foaming plant assembly line products of FORON Trip to Cologne

08.08.97 Visit of the LEYBOLD Company in Cologne
company presentation
leak detection technology, ECOTEC 500
vacuum pumps for normal evacuation
special vacuum pumps for evacuation of charged appliances at the repair line
factory tour

Presentation of A'GRAMKOW
charging equipment for the refrigerant isobutane
safety aspects

09/10 .08.97 Program for weekend

10.08.97 Trip to Milan, Italy

11.08.97 Visit of PERROS
factory tour
company presentation
technical questions
safety aspects

12.08.97 Meeting with dkk
discussions of technical questions
project aspects

13.08.97 Trip to Vienna, Austria
Welcome by Mr. Nowotny, UNIDO

14/15.08.97 Meeting at UNIDO office in Vienna
meeting with Mr. Gurkok, Director, ISED/EM
evaluation of the Study Tour
specification of the List of Equipment and Services provided to Huari within the project
discussion about the Work Plan for implementation of the project
conclusions and preparation of the Draft Minutes of Meeting
final meeting

16.08.97 Departure to Beijing

Scharfenstein, August 1997

Wang Jian Cheng
Huari Refrigerator Comp.

W. Reh

Winfried Reh
for dkk GEP mbH

Conversion guide – Table of contents

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Time schedule

dkk GEP mbH
Company ltd. for Development and Projectmanagement

dkk GEP mbH • August-Bebel-Street 22 A • D-09435 Scharfenstein

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Phone 0049/3725-7076-0
Fax 0049/3725-7076-21

HUARI Group Co., LTD.
Mr. Wang Jian Chen - Assistant General Manager and Project Manager

Fax: 0086 571 6045501

Scharfenstein, 13.03.1997

Ref.: UNIDO Project: MP/CPR/96/042

Dear Sir!

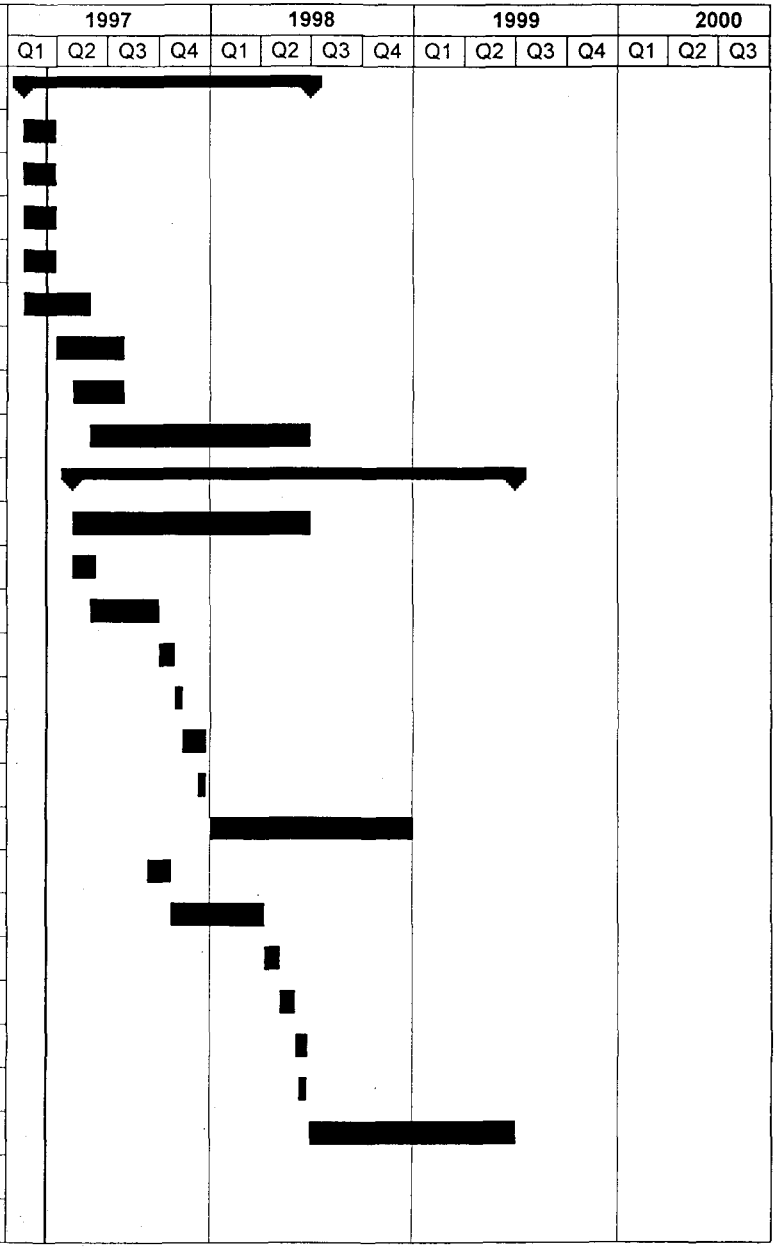
As agreed during our last visit in March 8 I send to you the project plan based on our common conclusions.

With kind regards

W. Reh
Project Engineer

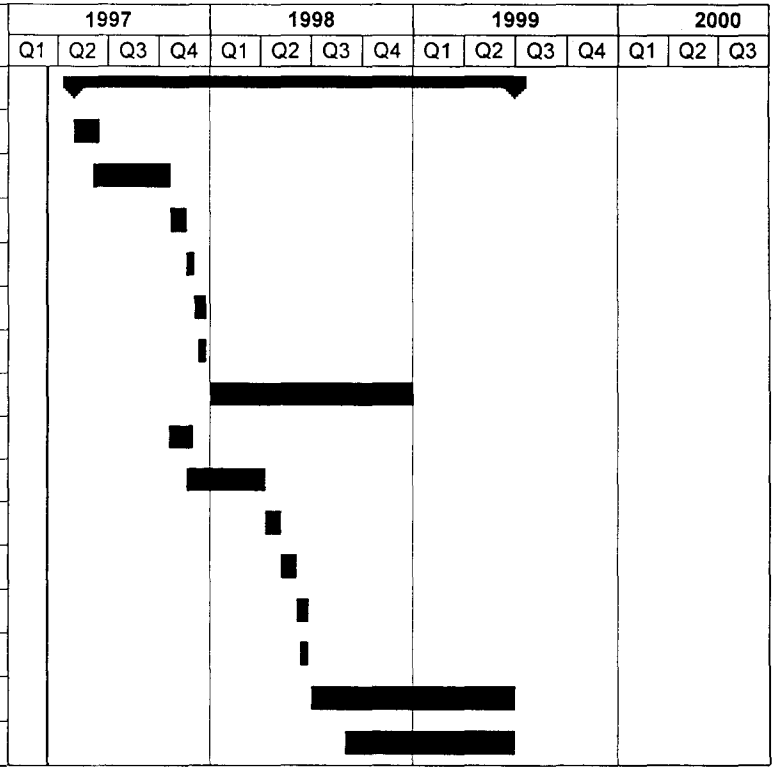
Project plan for conversion of Hangzhou Huari Refrigerator Company

Nr.	Name
1	Part I: Safety strategy, staff training, model redesign, models testing
2	Award of contract
3	Visiting the counterpart
4	Preparation of the work plan
5	Elaboration of the safety strategy
6	Training of the staff
7	Redesign of the first model
8	Prototype testing
9	Redesign of remaining models
10	Part II: Modification of the foaming equipment using cyclopentane as foam blowing agent
11	Implementation of the safety strategy
12	Purchase new foaming equipment Line I
13	Manufacturing of the equipment Line I
14	Shipment to Shanghai
15	Customs and transport to Hangzhou, Huari
16	Installation, commissioning
17	Safety Certification
18	Starting mass production using cyclopentane as foam blowing agent Line I
19	Purchase new foaming equipment Line II
20	Manufacturing of the equipment Line II
21	Shipment to Shanghai
22	Customs and transport to Hangzhou, Huari
23	Installation, commissioning
24	Safety Certification
25	Starting mass production using cyclopentane as foam blowing agent Line II
26	
27	



Project plan for conversion of Hangzhou Huari Refrigerator Company

Nr.	Name
28	Part III: Modification assembly lines using isobutane (R 600 a) instead of R12
29	Purchase Equipment for Assembly Line I
30	Manufacturing of the equipment
31	Shipment to Shanghai
32	Customs and transport to Hangzhou, Huari
33	Installation, commissioning
34	Safety Certification
35	Starting mass production using isobutane (R 600 a) as refrigerant Assembly Line I
36	Purchase Equipment for Assembly Line II
37	Manufacturing of the equipment
38	Shipment to Shanghai
39	Customs and transport to Hangzhou, Huari
40	Installation, commissioning
41	Safety Certification
42	Starting mass production using isobutane (R 600 a) as refrigerant Assembly Line II
43	Post commissioning monitoring, Final Report



Test results – conversion done by dkk

Huari

Test with the refrigerant R12
Conversion to R600a
Mount Refrigerator/Freezer

Bottom

Final Report

Date: 05.01.1998

Contents

1. Summary

The tests of the bottom mount refrigerator/freezer by dkk GEP mbH have been performed based on the UNIDO contract No.97/020. The R12 tests should provide the data basis for the design adjustment of the refrigerators from Huari to hydrocarbons - R600a as refrigerant. The tests and design adjustments shall lead to the first prototype of hydrocarbon refrigerator according to DIN/EN conditions.The tests carried out with Isobutane as refrigerant allow to compare the performance of the two refrigerants directly.The converted refrigerator should reach the same values compare to R12 at least.

Dkk should select the R600a - compressor available in Germany.

2. Methodology

1. The domestic refrigerator supplied with R12 refrigerant have been inspected to check safety requirements for tests.

2. For the R12 baseline test programme and the R600a adjusted version tests two units of test chambers have been made available.

3. The tests have been carried out following the German standard DIN EN 28187. The tests correspond to German quality standards of measurements.

4. Dkk has performed the following tests, both with R12 and the hydrocarbon R600a:

   - Continuous running test at ambient temperature of t_a = 32 °C
   - Energy consumption at t_a = 25 °C, $t_i \leq 5$ °C
   - Running test at low ambient temperature t_a = 16 °C
   - Running test at high ambient temperature t_a = 32 °C, compartment temperature $t_i \leq 5$ °C
   - Freezing capacity test
   - Compressor test

   The tests are performed at a voltage and frequency of 230 V/50 Hz.

3. Type of refrigerator tested

3.1. Technical data indicated

		Huari BCD-218G	
Volume Cool./Fr.	[l]	135/103	
Charging amount of R12	[g]	80	
Type of compressor		FN 66 Q11G	
Energy consumption	[kWh/d]	1,35	

3.2. Visual observations

This type of refrigerator correspond to European security standards regarding the outside electrical connections (safty cable).

4. R12-Test results

4.1. Continuous Running Test (t_a = 32 °C)

		Huari BCD-218G		remarks
t_{im} Cooler	[°C]	-2,3		
t_i Freezer	[°C]	- 28,8		air temp.,average 3 temp.
t_{sensor}	[°C]	- 26,1		-
$t_{suction\ pipe}$	[°C]	24,8		outside appliances
P	[W]	95		-

4.2. Energy consumption (t_a = 25 °C)

	R12	Huari BCD-218G	required	remarks
t_{im} Cool.	[°C]	1,2	0≤ t ≤10°C	$t_{2,3}$ < 0°C !
t_{im} Freez.	[°C]	- 22,2	≤ -18	warmest package compartm. 3 -16°C
switch on time	[%]	55	-	
energy cons.	[kWh/d]	1,3	1,35 (leaflets)	
Thermostat pos.		6		

4.3. Running test at low ambient temperature (t_a = 16°C, Classification)

		Huari BCD-218G	required	remarks
$t_{imCool.}$	[°C]	1,6	0≤ t ≤10°C	t_3 < 0°C
t_{im} Freez.	[°C]	-20,0	≤ -18	warmest package compartm. 3 -16°C
Thermostat pos.		6		-
				-

4.4 Running test at high ambient temperature (t_a = 32°C, Classification)

		Huari BCD-218G/1	Huari BCD-218G/2	Huari BCD-218G/3	required	remarks
t_{im} Cool.	[°C]	5,2	0,7	-1,9	0 < t < 10°C	218G/2 $t_{2,3}$ < 0 °C 218G/3 $t_{2,3}$ < 0 °C
t_{im} Freez.	[°C]	-18,7	-22,1	-25,4	≤ -18	warmest pack.218G/1 - 12,2°C warmest pack.218G/2 - 15,0°C warmest pack.218G/3 - 17,5°C
thermost.pos.		4	5	5,5	-	cont. running at therm.pos.5,5

BCD-218G/**1** -No. of measuring

4.5 Freezing Capacity test

		Huari BCD-218G	required	remarks	
time (light load)	[h]	25,3	22-26 h t_i light load ≤ -18°C		
t_{im} cool.(coldest point)	[°C]	-2,2	$t_{1,2,3} \geq 0$	$t_{2,3}$ < 0 °C	
light load	[kg]	4,5			
thermost.pos.	[°C]	6			

4.6 Compressor Test

The original Compressor FN 66Q11G has been tested according to DIN 8977 with refrigerant R12 at the Calorimeter.

Following data have been measured:

- Cooling Capacity Qo according to CECOMAF and ASHRAE

- Input Power P_1 according to CECOMAF and ASHRAE

- COP according to CECOMAF and ASHRAE

- Start test : * Start cold

* Start warm

Compressor tests - Calorimeter

Parameter		FN 66Q11G	NBM1114 Y	NBM1116 Y
Evaporation temp.	[°C]	LBP (-25 o. -23,3°C)		
Refrigerant		R12	R 600a	
Qo	[W]			
CECOMAF		113,6	115,6	147,8
ASHRAE		151,5	154,1	197,0
P_1	[W]			
CECOMAF		130,2	124,0	134,7
ASHRAE		137,1	130,5	141,8
COP	[W/W]			
CECOMAF		0,87	0,93	1,10
ASHRAE		1,10	1,18	1,39
Start test				
cold tw = 32°C /187V		o.k.	o.k.	o.k.
warm tw = 100°C		o.k.	o.k.	o.k.

additional data see Annex

5. Discussion of the R12-results

5.1. Running Test at t_a = 32 °C

The inside temperatures are in a normal range at continuous running and 32°C ambient temperature. This temperature of -2,3°C agreed with the values that we know from the experience. But the tests show at ambient temperature 25°C an other tendency. According to our experience this conditions are sufficiently for single evaporator systems. The two evaporator cycle has always the problem of the adjustment and regulation between cooler and freezer evaporator.

All appliances, which are equipped with this evaporator system need an exact adjustment of the parameters of influence (see annex 7). This process is difficult, because of the influence of the great number of the different parameters.

5.2. Energy consumption

The reported energy consumption of refrigerator is in the same value range provided by the manufacturer.

The refrigerator fulfills the declared value, but the temperature in the cooling compartment is not in the correct range. see 4.2

One problem exists fundamentally. The temperature could not reach -18°C in the freezer compartment 3 of the lowest position (lowest comp.).

5.3. Running test at low temperature (t_a = 16 °)

The refrigerator fulfills not the test requirements in the cooling compartment 0 $\leq t \leq$ 10 °C, t_3 = -1,5°C at thermostat pos. 6. The warmest package in the freezer at the same thermostat pos. reached not $t_{i\,Freez.} \leq$ -18 °C. This is the same problem corresponding to point 5.2.

5.4 Freezing Capacity test

The refrigerator fulfills the requirements for the freezing capacity in 24 hour relating to cooling rate of the light load.

The exact conditions see point 4.5

5.5 Compressor Test

The compressor FN66 Q11G with R12 and the NBM1114Y with R600a have the same cooling capacity at the rated point. The R600a compressor NBM1114Y reached a better COP (7%) than the R12 compressor at the CECOMAF rated point.

6. Design adjustment for the R600a-refrigerant

1. dkk has selected and built in a suitable compressor for R600a.
   The filled quantity of refrigerant has been optimized with a quantity of 45 g.
   see diagram Optimization of cryogenic parameter
2. dKK did'nt need to replace the thermostate at the outside of the
   refrigerator (safety considerations),because the evaporator position is behind the liner. Filling quantity and flammability limits have been assessed carefully before starting R600a test operations.
3. A new filter drier has been built in vertically.
4. The present capillary tube has been used for R600a too.
5. The evaporator in the cooler is behind the liner and therefore it is not to change.

7. Test results - Conversion

7.1 Optimization of technical parameters

The optimization of technical parameters have been performed with the

NBM 1114 Y . (see compressor test)

In the annex 1 the diagram from the optimization with the compressor NBM1114Y is attached.

The constant inside temperatures have been reached in the range between 40g and about 60g. In this range the Input Power moves at low level. That is important for a low Energy consumption.

The result of the optimization doesn't show instantly, that the temperatures in *the cooler constitute a problem for the regulation in the range* $0 < t < 10°C$.

If the cooling capacity of the compressor is to large than the temperature -on - breaking in the cooling compartment will be reached quickly. Than the time relation run-not run can be to small and the temperature in the freezer doesn´t reach $\leq$ -18°C.

7.2 Continuous Running Test (t_a = 32 °C)R600a

		Huari BCD-218G
t_{im} Cooler	[°C]	-3,2
t_i Freezer	[°C]	-27,2
t_{sensor}	[°C]	-28
$t_{suction\ pipe}$	[°C]	22,0
P	[W]	94

7.3 Energy consumption (t_a = 25 °C)

		Huari BCD-218G	Huari BCD-218G	required	remarks
t_{im} Cool.	[°C]	2,5	0,2	$0 \leq t \leq 10°C$	$t_{2,3} < 0°C$!
t_{im} Freez.	[°C]	-19,9	- 21,5	$\leq$ -18	warmest package compartm. 3 218G/1 -14,5°C 218G/2 -16°C
switch on time	[%]	47,6	58	-	
energy cons.		1,16	1,35	-	
Thermostat pos.	[kWh/d]	5,5	6	-	

7.4 Running test at low temperature (t_a = 16 °)

		Huari BCD-218G/1	Huari BCD-218G/2	required
t_{im} Cool.	[°C]	1,6	0,3	$0 \leq t \leq 10°C$
t_{im} Freez.	[°C]	-17,7	-19,2	$\leq$ -18
thermost.pos.		5,5	6	-

7.5 Running test at high ambient temperature (t_a = 32°C, Classification)

		Huari BCD-218G/1	Huari BCD-218G/2	required	remarks
t_{im} Cool.	[°C]	2,6	0,7	0 < t < 10°C	218G/1 t_3 < 0 °C 218G/2 $t_{2,3}$ < 0 °C
t_{im} Freez.	[°C]	-19,6	-21,6	≤ -18	warmest pack.218G/1 - 13,3°C warmest pack.218G/2 - 15,0°C
thermost.pos.		5	6	-	cont. running at therm.pos.6

7.6 Freezing Capacity test

		Huari BCD-218G	required	remarks
time (light load)	[h]	25,2	22-26 h t_i light load ≤ -18°C	
t_{im} cool.(coldest point)	[°C]	-2,4	$t_{1,2,3} \geq 0$	$t_{1,2,3}$ < 0 °C
light load	[kg]	4,5		
thermost.pos.	[°C]	6		

8. Discussion of the results

8.1. Energy consumption (t_a = 25 °C)

The value of energy consumption has been reached with R600a is 15 % lower as the test with R12.

8.2. Running test at low temperature (t_a = 16 °C)

The first measurement shows with the smaller compressor, that the decreasing of temperature level is a problem for the not adjusted evaporator. The low pressure on discharge and suction side is a disadvantage for the regulation of evaporator.

8.3 Freezing Capacity test

The refrigerator fulfills the requirements for the freezing capacity in 24 hour relating to cooling rate of the light load.

The exact conditions see point 7.6

9. Safety Requirements

For the Huari BCD-218G exist not special requirement because the evaporator is not located free in the room.

Draining off the refrigerant

The hydrocarbons don't pollute the athmosphere. The refrigerant can be drained off at the capillary tube, filter drier or process tube at the compressor.

Attention: room must be vetilated, no open fire or other ignition sources near the working aera.

Evacuation

For this procedure, the existing R12 equipment can be used. To get the purity in the refrigerant circuit the system must be evacuated on both sides till the highest possible vacuum is reached.

Leak test and operational check

An exact test can be made at the filled refrigerant circuit. Different test procedures are possible:

- Electronic leak detection,flammable gases

- Leak detection sprays

- Leak detection oil

- Foam bilding procedures

The leak test at the pressure side can be realised during the function test. The test on the suction side will be performed , as following.

- the refrigerator don´t operating

- door open ==> leak detection

10. Recommendation

The results of the tests show, that with the refrigerant R600a it is possible to reach the same or better values compared to R12 if the steps described in chapter 6 will be implemented.

A normal operation according to DIN is only possible at determined thermostat positions. This is valid for R12 and R600a.

In the cooling compartment will be reached a low temperature at normal conditions. (see energy consump.) In order to have more reserve (warmer cooling compartment) the evaporator in cooling compartment should be smaller. The power of the evaporator is to large in the cooling compartment.

An improvement could be reached relating to the temperature of the warmest parcel in the freezer compartment, if :

1. more thickness of the isolation on the bottom

2. the boxes in the freezer with openings

The ratio between operating time (runing time) and not operating time(compressor off) should not be lesser than about 50%.

11. Annex

Annex 1 - Optimized quantity of refrigerant for Huari BCD-218G

Annex 2 - Storage plan - Freezing compartment

Annex 3 - Diagramm log p-h Isobutan

Annex 4 - Calorimeter measurement NBM1114 Y

Annex 5 - Calorimeter measurement NBM1116 Y

Annex 6 - Calorimeter measurement FN 66 Q11G

Annex 7 - Parameters of Influence for the Optimization of Appliances with two evap.cycle

Annex 8 - List of abbreviations

Statement for conversion from Huari

STATEMENT of CONVERSION

According to UNIDO Contract MP/ CPR/96/046 the Huari Zhejiang Group has successfully converted the major product models to the use of CFC free refrigerant and blowing agent.
As pilot product the model BCD-218G was converted by the contrractor dkk to be used afterwards as the basis for further conversion.

The further conversion in the first phase consists of:
BCD252, BCD 196,BCD 188, BCD 195 BCD 215.

Today the actual product offer for hydrocarbon based refrigerators consists of the converted models:
BCD-218H, BCD-196H, BCD-268H, BCD-188H, BCD-215H,
BCD-245H.

Furthermore new models have been designed to be used with hydrocarbon right from the beginning, such as:
BCD-206, BCD-201. BCD-221, BCD-233, BC 78.

Mr. Wang Jiancheng
Project Manager, Huari

Mr. Harald V. Lang
President dkk

11/12/00

Equipment specification

dkk GEP mbH
Company ltd. for Development and Projectmanagement

dkk GEP mbH • August-Bebel-Street 22 A • D-09435 Scharfenstein

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D-09435 Scharfenstein
Phone 0049/3725-7076-0
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United Nations Industrial Development Organization
(UNIDO)
Contracts Section
P.O. Box 300
A-1400 Vienna, AUSTRIA
Att. Mr. V. Koloskov

Scharfenstein, 01.10.1997

UNIDO Project: MP/CPR/96/042-Huari

Dear Mr. Koloskov,

Please find attached the list of equipment foreseen to supply in the above named project. We kindly ask for confirmation of the list to start the negotiations with the suppliers and the purchase of the equipment.

With kind regards

W. Reh
Project Engineer

Annex

List of Equipment

foreseen to supply for Hangzhou Huari Refrigerator Company

Part I Appliance conversion (in dkk labs)

Pos 1 **Materials elements**
compressors, filter dryers, capillary tubes, refrigerant, oil

Part II Foaming

Pos 1 **No. 1 New high pressure foaming machine for doors complete with all necessary safety accessories and one mixing head for the use of cyclopentane for the door foaming plant**

double wall tank 230 l with temperature conditioning jacket
tanks tested at a pressure of 10 bar and fed, during operation, at a pressure of 3 bar
minimum and maximum pressure switch
polyol tank pressurised with nitrogen (3 bar)
Hydromatic high pressure dosing pumps with double sealing and manual adjustable output (hand wheel)
Independent electric motors with coupling joint for pumps vertical coaxial mounting
explosion proof motor for the polyol pump
hydraulic unit for heads control mounted on machine base
self-cleaning blade filters on pump inlet
feeding of the high pressure pumps by pressurisation of the components in the tanks
stirrer with explosion proof motor on the polyol/pentane tank
heat exchanger for optimum temperature conditioning
heating of chemicals by electric cartridge heaters on the heat exchangers
water connections for temperature conditioning on heat exchangers and jacket of the tanks
thermoresistances for chemicals temperature control
chiller with closed loop water circulation and compressor for components cooling
visual levels of the tank contents
automatic capacitive levels for maximum, working and minimum level for the automatic/manual loading of chemicals
electronic control panel with thermal relays, safety fuses, general switch and auto/manual selectors with pushbuttons for cycle start/stop
PLC Siemens S5 100U for controlling of the manual/automatic on/off sequences of the machine
electronic timers for the presetting of the pouring/injection programs (4) and for calibration (1) and high pressure recycle (1)

pushbotton panel for the control of the injection head with auto/manual selector and pushbuttons for cycle start and emergency
safety box for the high pressure machine (wet part)
double speed exhaust fan with explosion proof fan (1500 m^3/hour)
air flow sensor
gas detectors with monitoring system with acustic and visual alarms
piping ring system installed on the bottom part for the nitrogen spray/ventilation in case of first alarm (15 % LEL) complete with nozzles and solenoid valve

Mixing head

- Laminar flow which allows injection in closed mould or pouring into open mould
- Monoblock body in special heat treated steel
- 3-ways rotary valve for recycle/mixing position
- Independent chemical valves, simultaneously operated by a single rod connected to an hydraulic cylinder
- self-cleaning plunger, operated by an hydraulic cylinder, mounted parallel to the recycle switching valve cylinder
- adjustable pouring nozzles with completely extractable body
- recycle nozzles similar to pouring ones
- proximity switch for the control of the position of the self-cleaning plunger
- 3 ways rotary valve stream distributor operated by a hydraulic cylinder for high pressure recycle/mixing sequence mounted on component circuits

Mixing head pipe connection:
High pressure rigid steel piping with flexible pipe terminals with relevant manual valves and accessories

No. 2 ECOMIX with monitoring

- automatic on/off valves
- pressure gauge
- self cleaning filter
- high pressure pump with adjustable output for polyol. Min. output 4 lt/min - max. 20 lt/min with explosion proof motors
- flow transducers connected to the electronic process controller with display for the control of output and ratio
- injectors for cyclopentane on polyol stream
- high pressure pump with adjustable output for cyclopentane complete with explosion proof motor. Min output 0,5 lt/min - max. 2,7 lt/min
- pressure gauge for cyclopentane
- self cleaning filter for cyclopentane and polyol
- pressure gauge for mixture
- one-way valve for cyclopentane
- static mixers (2 pcs) for improving the mixture
- automatic on/off valve
- steel tank capacity 100 liters for cyclopentane complete with temperature conditioning jacket, necessary valves and safety valves and automatic levels control

The ECOMIX is complete with safety box made in aluminium profile and polycarbonate panels and maintenance doors with microswitch and alarm for control of closed position. The box is also complete with:

- container for polyol + cyclopentane mixture in case of leakage
- all electric/electronical components made according to explosion proof rooms
- suction hood with fan and explosion proof double speed motor with independent wiring in order that in case one winding burns, the motor goes automatically on the second speed

Suction capacity 1st speed 4.500 m³/h - 2nd speed 7.200 m³/h.
The suction hood is complete with air flow control.
The cyclopentane vapours must not exceed 0,15 %
All the ECOMIX parts are grounded/earthed with copper cables.

- gas detectors with monitoring card
- nitrogen spray system in case of alarm
- electric/electronic control panel with display and keyboard for the control of chemical output and ratio with alarms
- monitoring system for ECOMIX

dkk is able to realise the foaming part with one premixing station based on the requests of Huari.

Pos. 2 **No. 2 ECOKIT 50 for the modification of existing Cannon high pressure foaming machines**

The ECOKIT includes:
- double wall tank 230 l with temperature conditioning jacket
safety box
double speed exhaust fan with explosion proof fan
air flow sensor
polyol + cyclopentane feeding pump, 28 cc. with explosion-proof motor (15 kW - 1450 r.p.m.)
gas detectors with monitoring card
stirrer
heat exchanger
capacitive sensors for levels
automatic filling valve
self-cleaning filter
electronic control panel (to be interfaced with the existing foaming machine panel)
automatic nitrogen spray system in case of alarm

Monitoring system for the complete door plant

The system includes:

- one centralised monitoring system foreseen with independent power feeding with:
- main control unit with space for the gas detectors monitoring cards installed in the ECODOSING and in the dry part
- control for the exhaust system and air flow sensor for ECODOSING and dry part
- control for the automatic nitrogen spray system for ECODOSING and dry part

Monitoring system for one complete cabinet plant

The system includes:

- one centralised monitoring system foreseen with independent power feeding with:
- main control unit with space for the gas detectors monitoring cards installed in the ECOKIT and in the dry part
- control for the exhaust system and air flow sensor for ECOKIT and dry part
- control for the automatic nitrogen spray system for ECOKIT and dry part
- Automatic nitrogen injection system for the inertization of the cabinets to be installed on the cabinet loading carrier

Safety package for the door dry part

- exhaust system with double speed explosion-proof motor with air flow sensor
- gas detectors
- automatic nitrogen spray system
- earth/grounding connection

Safety package for one cabinet dry part

- exhaust system with double speed explosion-proof motor with air flow sensor
- gas detectors
- automatic nitrogen spray system
- earth/grounding connection

Piping connection with necessary valves

Rigid/flexible piping foreseen for the following chemical connections

- Piping for CP tank to ECOMIX
- flexible pipe for polyol from drum to ECOMIX
- piping for CP + polyol mixture from ECOMIX to door plant
- piping for CP + polyol mixture from ECOMIX to cabinet plants

Pos. 3 **No. 1 40 m³ Cyclopentane storage tank**

Cyclopentane storage tank to be installed underground, foreseen as follows:
- capacity 40.000 l
- tank designed according DIN 6608
- insulation

Accessory for cyclopentane storage tank
- automatic level control
- mechanical overfilling device
- necessary valves/safety valves
- 1 pump pneumatically operating

supplier: ATE Eberswalde

Pos. 4 **Training off the Huari staff**

It is foreseen to be made by PERROS technicians in a period of ca. 6 weeks.

Pos. 5 **Engineering drawings, specification and instructions to modify existing door plant (dry part)**

This includes:

- visit of one technician to counterpart factory (China) for 1 week,
- engineer drawings
- part list with instruction/suggestion

Engineering drawings, specification and instructions to modify one cabinet plant (dry part)

This includes:

- visit of one technician to counterpart factory (China) for 1 week.
- engineer drawings
- part list with instruction/suggestion

Part II will be delivered by PERROS exclusive $40m^3$ tank

Part iII Assembly lines

Pos. 1 **No. 2 Isobutane charging stations**
microprocessor-controlled charging station for Isobutane (1 refrigerant) - typ HC.1
incl each:
2-stage vacuum pump - D16B
Charging amount : 10 - 99,999 g
Charging speed: 10g/s

Refrigerant Supply System for R 600a
- Capacity : min 30g/s
- pneumatically operated
- with visible alarm for empty cylinder
- incl. automatic change-over between Bottle/Bottle ore Tank/Bottle

A'GRAMKOW

Safety supervision system
incl each:
- 2 off gas measuring heads type Polytron Ir-Ex
- 2 off air flow sensor
- monitoring system
- fan with explosion proof double speed motor

Pos.2 **No. 3 Ultrasonic welding station**
3 seperate items consisting of :
1.power supply
2.ultraweld controller
3.welding actuator

STAPLA or AMTECH

Pos. 3 **No. 1 Isobutane storage tank**

- installed above the ground on a concrete base
- capacity 5.000 lt
- accessories for isobutane storage tank
- safety equipment

The tank should be directly connected to the charging stations

Autogen Morgenstern

Pos. 4 **No. 3 Isobutane leak detectors**

-Quadrupole leak detector ECOTECH 500
- incl.highly flexible sniffer line with pistol grib, LED and buzzer

Leybold Vakuum AG

Pos. 5 **No. 6 Vacuum pumps**

vacuum min. $1x10^{-4}$ mbar
capacity 25,7 m^3 /h
includes:
vacuum pump TRIVAC D 25 B ,220 V , oil filling Anderol 500
vacuum measuring by PIRANI principale THERMOVAC TM 21
2 m evacuation hose
adjustable vacuum level pressure set point

Leybold Vakuum AG

Minutes of Meetings

Minutes of Meeting

Subject: Monitoring of implementation of project MP/CPR/96/042, Huari
Venue: Zhejiang Huari Group
Date: 27 July 2000
Participants:

Mr. Wang Jiancheng, Assistant General Manager, Project Manager, Huari
Mr. Sun Yongjian, Head of Foaming Dept., Huari
Mr. Huang Yuejin, Manager of Equipment Department
Mr. He Yunsong, Deputy Manager of Equipment Department
Ms. Wang Hui, Interpreter, Huari
Mr. Tamás Gróf, Project Manager, UNIDO Vienna
Ms. Li Zaiheng, UNIDO Beijing Office
Mr. Harald Lang, President, dkk

1. After inspection of the plant it was noted with appreciation that all equipment of the converted plant has been commissioned and operational.
2. The TÜV inspection took place on 10-12 July 2000. The report is still not available and expected to arrive soon. According to the preliminary information of the inspectors the following items still have to be repaired by dkk:
   a. The cyclopentane tank still has to be equipped with a cyclopentane sensor
   b. The isobutane tank room has to be equipped with safety ventilation and alarm system
   c. The flexible cyclopentane tank filling hose has to be replaced with a proper one designed for this application.
   d. There is a need for a nitrogen flow gauge in the cabinet flushing system.

   Dkk will take appropriate actions in light of the remarks of TÜV.
3. According to the Amtech engineer who visited the plant the ultrasonic welding machine is equipped with improper welding head and this is the reason for the short lifetime of the heads. Dkk will urgently contact Amtech to resolve this problem taking note that Huari has no more spares on stock.
4. The Leybold leak detectors are defective already since March. Furthermore, there are doubts about the correct operation of the standard leaks, since the two standard leaks on site show 300% deviation. Dkk will immediately instruct Leybold to carry out the repairs free of charge.
5. There are frequent false alarms on the cyclopentane alarm system of the foaming machines.
6. Within two weeks dkk will inform in writing Huari and UNIDO how to implement the guarantee repairs.

Mr. Wang Jiancheng, Huari Mr. Harald Lang, dkk Mr. Tamás Gróf, UNIDO

P.S. Huari has started mass production of CFC free refrigeration and fully phased out CFC. SEPA is requested to officially Commion the Project.

Minutes of the Meeting

Subject: Conversion PROJECT MP/CPR/96042, Huari
Place: Zhejiang Huari Grou
Date: 30. October 2000
Participants:
Huari:
Mr. Wang Jiancheng, Assistant General Manager, Project Manager
Mr. Sun Yongjisn, Head of FoamingDept.
Mr.Huang Yuejin, Manager of Equipment Dept.
Mr. He Yunsong, Deputy Manager of Equipment Dept.
Ms Wang Hui, Interpreter
Dkk: Ms. Jessica Tuan
Mr. Harald Lang

1. Open Issues from last meeting

1.1 Cyclopentane loading pipe

Based on the specification of Huari dkk will immediately provide a new loading set with a 7 m pipe. Financing will be agreed with UNIDO by dkk.

1.2 Ultrasonic welding machine

The problem has been refered to Alcal in Germany and some hints of the origin were given in a report, which will be sent to Huari after translation. For further exploration of the potential origin, Huari has handed over to dkk samples of actual copper used to have a material check in the German laboratory, where the initial copper was also checked.

1.3 Leybold sniffers

Dkk has handed over three new sets of sniffers and a 2/2 way valve. Huari will replace this without further assistance.

2. TUEV report for foaming

2.1 The report has been studied by Huari. All recommendations allocated to Huari will be implemented by the end of November, provided the new loading system for cyclopentane will be on site in time.

2.2 dkk will assure the installation of the extra leakage sensor in the cylopentane storage area via the technicians of Perros, who are still in Hangzhou.

3. TUEV report for assembly line

3.1 The revised version was handed over to Huari and accepted.

3.2 The extra sensor installation in the isobutane storage area will be implemented after cost clarification with UNIDO through dkk, although it is not mandatory for safety reasons in this installation.

3.3 Huari already has implemented all other recommendations apart from the extra civil work required in the storage room. This also will be ready by the end of November.

12/

4. Warranty

4.1 Warranty period

The production equipment is used officially since the TUEV inspection in July. So it was agreed to start the one – year – warranty period on July 15th 2000.

4.2. **Warranty procedure**

In case a defect is considered by Huari to be a warranty issue, Huari will immediately inform dkk in writing of the kind of the defect and whether Huari is able to remedy locally including the costs expected.

Dkk then will in adequate time decide whtether the proposal of Huari should be accepted or whether it is more feasible to cure the problem via dkk or it's supplier from Europe directly.

5. Study tour to Germany

Huari will visit Germany again early December and dkk will assist in organising all appointments required as well a in the execution of the trip

.....

Mr. Wang Jiancheng, Huari

2000.10.30.

.....

Mr. Harald Lang, dkk

Minutes of Meeting

Date: 21.02.- 29.02.2000

Participants: Huari Mr. Wang Jian Cheng-Assistant General Manager and Project Manager
Member of the staff

dkk Mr. W. Reh-Project Engineer

The following topics were treated.

1. Installation of the 40 m³ cyclopentane tank
2. Installation of the 5 m³ isobutane tank
3. Installation of the isobutane pipe
4. Commissioning of the leak detectors
5. Commissioning of the ultrasonic welding units
6. Miscellaneous

Point 1: Installation of the 40 m³ cyclopentane tank

The 40 m³ cyclopentane tank has been installed. During the installation the high voltage test for checking of the tank isolation has been performed successfully.
After the installation the function test of the pump has been performed successfully.
The training on site and the handing over of the technical documentation to Huari have been carried out.
The anchor bands will be fixed finally by Huari on the screws which have been installed by Huari after the concrete has come to the rigid status.
The tank pit will be filled with stone free sand by Huari according to the instructions submitted by dkk.

Point 2: Installation of the 5 m³ isobutane tank

The 5 m³ isobutane tank has been installed in the tank room built by Huari.
The thickness of the outside walls has to be increased up to 36 cm according to the regulations for the storage of liquid gases.
The technical documentation has been handed over to Huari.

Point 3: Installation of the isobutane pipe

The isobutane feeding pipe delivered by dkk has been installed by Huari.
The required pressure test has been carried out successfully.
The related documentation is contained in the tank documentation and has been handed over to Huari together.
The accumulator has been installed directly near by the foreseen location of the first charging station.
Huari will perform the pressure test again as it's described in detail in the handed over documentation, if any adjustment with the isobutane pipe has been carried out.
The pressure test for the pipe between tank and refrigerant supply pump will be carried out again at the next visit. Huari will supply for this the correct equipment.

Point 4: Commissioning of the leak detectors

The three leak detectors which have been supplied in this project have been commissioned successfully.
The training for the related staff from Huari has been carried out.
The three leak detectors, test leak and the technical documentation have been handed over to Huari.

Point 5: Commissioning of the ultrasonic welding units

Three ultrasonic welding units which have to be delivered in this project have not been commissioned based on technical problems.
This problems will be solved by AMTECH and the local representative and the missing documentation will be delivered to Huari as soon as possible.
Huari will store the units safely.

Point 6: Miscellaneous

6.1 Refrigerant charging station

The two refrigerant charging stations could not be installed and commissioned as the necessary ventilation ducts have been not installed by Huari.
This installation will be carried out until March 15th 2000 and after the completion Huari will immediately inform dkk for the installation of the charging station.

6.2 Vacuum pumps

Together with the refrigerant charging stations the delivered vacuum pump stations will be commissioned.

6.3 Storage of the charging stations and vacuum pump stations

Huari will cover the charging stations and the vacuum pump station with a plastic foil and will also safely store this goods again as this equipment have been unpacked already during this visit.

6.4 Additional storage tank and day tank for the foaming lines

During an onsite discussion between Huari, Perros and dkk it has been agreed, that the additional polyol storage tank is not necessary as Huari can use the existing polyol storage tank. Huari wants to have an additional day tank for the polyol-pentane mixture based on possible quality problems.
As this is out of the scope of supply in this project and based on the confirmation from Perros not necessary for the conversion of the foaming lines this problem will be cleared with UNIDO. Dkk has pointed out again that Huari has a sufficient capacity for the polyol-pentane mixture as there will be installed two premixing stations.

for Huari: Mr. Wang Jian Cheng
Project Manager

2000.2.29.

for dkk: Mr. Winfried Reh
Project Engineer

Pressure test protocol

For the isobutane feeding pipe from the refrigerant supply pump up to the connection points of the refrigerant charging stations the required pressure test has been performed by Huari under supervision from dkk GEP Ltd. as follows:

date: February 28th 2000

pressure: 27,5 bar

duration: 30 minutes

conditions: without safety valves

pressure: 22 bar

duration: 15 minutes

conditions: with on screwed safety valves

test gas: nitrogen

remarks: the installed safety valves are setup at 25 bar for opening

The carried pressure test has to be evaluated as successful.

For the isobutane pipe between tank and the supply pump the required pressure test has been performed by Huari under supervision from dkk GEP Ltd. as follows:

date: February 29th 2000

pressure: 27,5 bar

duration: 30 minutes

conditions: without safety valves

test gas: nitrogen

The carried pressure test has to be evaluated as successful.

for Huari

Huang Yue Jin
Head Equipment Department

for dkk GEP Ltd.

W. Reh
Project Engineer

Minutes of Meeting

Date: 21.03.- 23.03.2000

Participants: Huari — Mr. Wang Jian Cheng-Assistant General Manager and Project Manager
Member of the staff

dkk — Mr. W. Reh-Project Engineer

The following topics were treated:
1. Installation and commissioning of the refrigerant charging stations
2. Installation and commissioning of the safety systems
3. Commissioning of the vacuum pump stations
4. Pressure test of the isobutane feeding pipe
5. Miscellaneous

Point1: Commissioning of the refrigerant charging stations
The two delivered refrigerant charging stations have been installed.
The function test has been performed.
The performance test (defining of the charging quantities) will be carried out when Huari has prepared the right test cylinder according to the recommendations from A'GRAMKOW.
The technical documentation has been handed over.
The training has been performed onsite.

Point 2: Installation and commissioning of the safety systems
Together with the refrigerant charging stations two safety systems have been installed and the function test has been performed.
Huari will check the level position of the motor and the fan wheel from the fans no. 2 as the motor location has been changed by the counterpart during the installation at the assembly lines.
dkk will check with the fan supplier if the installation of the exhaustion basin designed by Huari will influence the fan performance.
Huari will protect the cables finally to avoid any damage.
The training has been carried out for the Huari staff and the technical documentation has been handed over.

Point 3: Commissioning of the vacuum pump stations
The six vacuum pump stations have been commissioned successfully and were handed over to Huari.
The documentation has been handed over and the training has been performed for the staff

Point 4: Pressure test of the isobutane pipe

The last pressure test for the isobutane pipe from the tank to the refrigerant supply pump has been performed successfully at the required test conditions (see attached pressure test protocol.)

The pipe has been filled with the refrigerant isobutane for the function test of the refrigerant charging station and has been ventilated after finishing of work.

Point 5: Miscellaneous

Point 5.1 Charging area

For the function test of the refrigerant charging station the production was had to be stopped, as there is an open flame in the charging area (present technology for closing the compressor charging pipe.)

After the function test the isobutane pipe including the accumulator has been ventilated completely, because Huari wants to start the production of isobutane appliances later.

dkk informed Huari, that from the beginning of the isobutane filling of the feeding pipe the closing of the compressor charging pipe has to be replaced by the ultrasonic welding and all electrical parts which are not explosion proof have to be displaced from the charging area (radius: 3 m.)

Point 5.2 Housing of the accumulator

The installed accumulator will be housed in and a ground channel will be installed by Huari for the connection to the exhaustion basin of the assembly line.

The design of the housing and the channel will be carried out as it has been discussed during the last visit.

Point 5.3 Flexible exhaustion pipe

Huari will replace the flexible plastic exhaustion pipe for the connection of the charging station by a metal pipe.

for Huari: Mr. Wang Jian Cheng
Project Manager

for dkk: Mr. Winfried Reh
Project Engineer

Pressure test protocol

For the isobutane feeding pipe from the tank to the refrigerant supply pump the required pressure test has been performed by Huari under supervision from dkk GEP Ltd. as follows:

date: March 22nd 2000

pressure: 24 bar

duration: 15 minutes

conditions: with on screwed safety valves

test gas: nitrogen

remarks: the installed safety valves are adjusted at 25 bar for opening

The carried pressure test has to be evaluated as successful.

for Huari

Huang Yue Jin
Head Equipment Department

for dkk GEP Ltd.

W. Reh
Project Engineer

c 4. 20/11

Minutes of Meeting

Subject: Monitoring of implementation of project MP/CPR/96/042, Huari
Venue: Zhejiang Huari Group
Date: 20 November 2000
Participants: Mr. Wang Jiancheng, Assistant General Manager, Project Manager, Huari
Mr. Sun Yongjian, Head of Foaming Dept., Huari
Mr. Huang Yuejin, Chief of Equipment Section, Huari
Ms. Mounira Latrech, Contract Officer UNIDO Vienna
Mr. Tamás Gróf, Project Manager, UNIDO Vienna
Mr. Li Zaiheng, UNIDO Beijing Office
Ms. Rana Ghoneim, Junior Expert, UNIDO Vienna
Mr. Ákos Kőszegváry, Junior Expert, UNIDO Vienna
Mr. Roberto Trivella, Area Manager, Perros, Italy
Mr. Alberto Gianfrancesco, Chief Elec. Department Perros, Italy
Mr. Luigi Portalupi, Site Engineer Perros, Italy
Mr. Giovanni Dall'Acqua, Site Engineer Perros, Italy

1. Huari has converted the whole factory to cyclopentane and isobutane and are already using the new technology according to the original design in the project. This was checked and confirmed by UNIDO delegation.
2. The TÜV reports for the foam part and for the refrigeration part were prepared end August 2000 and were sent to Huari end October 2000.
3. In the recent weeks Huari studied the reports and implemented almost all requirements of TÜV mentioned in the report. The content of the report was also discussed with Perros representatives in the course of October 2000.
   The content of the reports was checked in details with the enterprise and Perros and the following observations were made:
   a. in the foaming department the following deficiencies were not corrected yet:
      - cyclopentane unloading hose (responsible dkk),
      - preparation of operating instructions (responsible dkk),
      - installation of gas sensor in the pit (responsible dkk),
      - removal of polyol/R11 pipe (responsible Huari),
      - safety instruction in case of alarm (responsible dkk, Huari);

   b. in the refrigerant storage and charging area the following deficiencies were not corrected yet:
      - installation of safety monitoring system in the R600a room (responsible dkk),
      - grounding of R600a charging gun (responsible dkk),
      - safety monitoring system of the repair line (responsible dkk).
5. It was agreed that Huari will send within a week a letter to dkk, TÜV, Perros and UNIDO that all deficiencies in the scope of responsibility of Huari, identified by TÜV

in their reports were corrected in the foaming line. Regarding the refrigerant part the major outstanding job is the installation system in the repair line which might take approximately 2-3 months.

6. Within ten days within ten days Perros will issue a similar letter as described in para. 5.
7. Perros requests UNIDO to arrange through dkk release of final payment upon installation of the new foaming head lubrication/flushing system for the door line, since by then all work will have been completed in line with the contract and the TÜV requirements.
8. The installation of the 1000 litre polyol blend day tank is expected in January 2001. The equipment will be delivered this month.
9. Huari will decide within this month on the final content of the spare parts list. UNIDO will issue the purchase order upon receipt of Huari's decision.
10. The official commissioning of the plant by the Chinese authorities is planned for February 2001.
11. The two replaced foaming machines were dismantled and stored in pieces in a store room. The replaced two charging machines have been dismantled and are stored in a store room. Two other charging machines are used for charging CFC-free blend refrigerant for some models. The halogen leak detectors are not used for production and will be transferred to the service department.
12. The Project Completion Report will be prepared by UNIDO still this year since the project is practically completed.

Mr. Wang Jiancheng
Project Manager, Huari

Mr. Tamás Gróf
Project Manager, UNIDO

Mr. Roberto Trivella,
Area Manager, Perros

Minutes of the Meeting

Subject: Conversion PROJECT MP/CPR/96042, Huari
Place: Frankfurt / Main, dkk office
Date: 7. December 2000
Participants:
SEPA: Mr. Yang Lirong. Senior Project Officer
Huari:
Mr. Wang Jiancheng, Assistant General Manager, Project Manager
Mr. Sun Yongjian, Head of Foaming Dept.
Mr. Huang Yuejin, Manager of Equipment Dept.
Mr. He Yunsong, Vice Manager of Equipment Dept
Dkk: Mr. Harald Lang

The following decisions were taken:

1. Cyclopentane Sensor

Huari will handcarry the sensor provided by dkk and install according to the drawing of dkk.

2. Isobutane storage tank

Huari prefers the installation of an isobutane sensor including the electronic rack instead of extra exhaust equipment.
Dkk will provide the equipment including the installation guide so that Huari can handcarry it back and install at dkk 's expenses.

3. Ultrasonic welding

After discussion of with the German branch it became obvious to have an onsite follow-up training by specialists. Until December 11th dkk will have clarified, whether the Shanghai representative of Amcal or the German engineer will conduct this training and engineering consultation.

4. Statements on TÜV recommendations

Huari will immediately issue a statement on the implementation of the TÜV recommendations.

5. Repair Line

No further assistance required by dkk for the pending repair line issue .

.....
Mr. Yang Lirong

.....
Mr. Wang Jiancheng, Huari

.....
Mr. Harald Lang, dkk

TÜV reports

TÜV SÜDDEUTSCHLAND

REPORT

of a Safety Technical Plant Inspection

Project:
- HUARI Company, Hangzhou / PR China
- Substitution of CFC blowing agent at the production of refrigerators
- UNIDO-project

Plant location: ZHEJING HUARI GROUP Co., LTD
JIUBAO, HANGZHOU, CHINA

Plants:
- Foaming Plants for Production of Refrigerators
  - Pentane Storage
  - Premix Station
  - Cabinet Foaming Plants (Plant A and B)
  - Door Foaming Plant

Manufactorer of the Plants:
1. PERROS INDUSTRIALE, Italy
2. dkk GEP, Germany (Engineering)
3. ZHEJIANG HUARI, China (Local works)

TÜV-Order-No.: 200 364 556 / 200 364 559

TÜV-Experts: Dipl.-Ing. Rainer Schulz
TÜV BB-ULM, Dep. NDD

Dipl.-Ing. (FH) E. Mack
TÜV BB-ULM, Dep. NEG

Company Group TÜV Süddeutschland

Data:
- July, 10th-12th, 2000 - Inspection
- August, 16th/17th, 2000 - Report

Participants on location:
- Mr. Luigi Portalupi - PERROS
- Mr. Winfried Reh - dkk
- Mr. Wang Jian Chen - HUARI
- Mr. Sun Yong Jian - HUARI

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BBNEG/NDD-ka 29.08.00

File-No.: PER-DKK/HUA-PRC/02/00

Das Dokument besteht aus:
40 Seiten

TÜV

– Technicians of HUARI

TÜV SÜDDEUTSCHLAND

0. Table of contents

TÜV SÜDDEUTSCHLAND

1. OBJECTIVE AND SCOPE OF THE PLANT EVALUATION

The HUARI company in Hangzhou is operating polyurethane plants for the manufacturing 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 hazard class AI. The use of C 5 necessitates fire and explosion protection measures for the C 5 storage and the PU production facilities.

In connection with the progressive change-over to the combustible blowing agent (C 5) the experts of the Ulm branch of TÜV Süddeutschland have developped a safety strategy to fulfill 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 developped for fire and explosion hazards.

Safety evaluations by the TÜV experts basically cover 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
- Define the state of the art of safety engineering by a comparison with plants used for similar purposes

TÜV SÜDDEUTSCHLAND

2 DOCUMENTS AND INFORMATION USED AS A BASIS FOR THIS PLANT EVALUATION

2.1 Former Plant Inspections

Experts of TÜV Süddeutschland branch Ulm, have already visited HUARI company in connection with the subject matter Pentane.

The first mission , done in May 1999, was for a pre-inspection and evaluation of the existing foaming plants and the new wet part units.

The new wet part units were not installed at that moment.

The result of this mission is included in the TÜV-Report File No. PerDkk/HUA-PRC/01/99.

During this mission mentioned above the experts got information and knowledge of the technical systems and organisations in HUARI company.

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

The following documentation was available during the inspection; respectively was sended from Perros to the TÜV office.

a) Pentane storage area
   - Diagram of the pentane tank
   - Approvals / certificates for the explosion proof devices
   - Protocol of the pressure test at the pentane feeding pipe
   - Electrical diagram
   - Technical data sheets and manuals of the technical equipment

b) Foaming plants general
   - Layout of gas sensors and air flow meters
   - Flow diagram of the whole wetparts (Ecomix, Ecodosing)

- Protocol of the measurements at the ventilation system
- Function matrix of the safety relevant functions
- Calculations of suctions (ventilation system)
- Declaration of Moro company concerning suitability of the used blowers („non-spark"; Ex-zone 2).
- Approvals / certificates for explosion proof devices and for the safety relevant devices.
- Electrical diagrams
- Technical documentation of the nitrogen generator
- Description and calculation of the nitrogen inertisation system for cabinets / doors.

c) Ecomix , Ecodosing

- Files with technical documentation e.g. flow diagrams, electrical diagrams, technical data sheets, operators manuals, CE-declarations, I.S.P.E.S.L-approvals, CESI-approval, TÜV-approvals, PTB-approvals

d) Technical documentation of the fire fighting system
(e.g. layouts, calculations, wiring diagram, CESI-certificate)

e) Technical documentation of the chillers

TÜV SÜDDEUTSCHLAND

3. Task and method of inspection

3.1 Task

It's task of the TÜV-inspection, which has been carried out, to evaluate the measures against fire and explosion danger that have become necessary in connection with Pentane usage.

Following plants are constituents of this inspection:

- Pentane storage area
- Premix station with Ecomix A and Ecomix B
- Foaming plant for cabinets - line A
- Foaming plant for cabinets - line B
- Foaming plant for doors

3.2 Method

The basic way of the TÜV-inspection is the following:

- Visual check of plants and surrounding
- Technical check of the plants in detail
- Safety-relevant measurements
- Safety-relevant function tests
- Check of the documentation
- Check of the organisation matters related to safety
- Evaluation of the conditions in the environment of the plants
- Check of the safety equipments in the peripherals with influence of the Pentane plants.

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4. General definitions of c-pentane-foaming-plants

4.1 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_2 (%)
Cyclo-pentane	A I	< - 30	380	II A	T 3	1.1 / 8.7	2.42	11

4.2 Definition of Zones

The areas of the zones mentioned in this report are related to the realised safety strategy.

Explosion Zones

At the foaming plants which work with C 5 as blowing agent following explosion zones are existing:

Explosion Zone 0

Explosion Zone 1

Explosion Zone 2

The physical definition of these ex-zones is based on standard 94/9/EG-Atex 100a.

The area definition of the checked foaming plants is based on the standard IEC 79-10.

For the plants which are using pentane a special safety strategy has been developped which contains also other relevant safety zones.

The size of the area of the explosion and safety zones of the particular plants are described under consideration of the realised safety strategy.

a) „Alarm Zone"

The alarm zone is a zone which has been defined in relation with the pentane safety strategy by using particular parts of IEC 79-10.

The definition is as follows:

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 / C4 /C5 must be technically leak-proof (e.g. special seals, leakage monitoring)
- Technical ventilation dimensioned in accordance with IEC 79-10 to reach a non dangerous zone
- Automatic gas warning system tested and certified in accordance with EN 50054 which automatically switches off of all potential sources of ignition at 40% LEL or lower.
- Only equipment which is absolutely necessary for operating the polyol C 4 / C 5 plant must be installed within the alarm zone.

c) Fire danger zone

Around 5 m of the pentane-foaming plant a fire danger zone must be defined.

The installed technical equipment must meet following general requirements:

- The electrical equipment and units must meet the IEC-standards.
- Smoking and using fire is strictly forbidden.
- Special work with the danger of fire like welding and soldering is only allowed with a special permit.
- The flammable materials must be reduced to a minimum.

d) Zone of Nitrogen (N2) inertisation

This is an area in which through the inertisation of N2 no explosive atmosphere is possible.

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5. Results of inspection and evaluation

5.1 Pentane storage area

5.1.1 Brief description of the plant

a) General

Pentane is stored in an underground tank with a volume of 40 m³.

The tank will be filled by a truck via flexible hoses for unloading and for gas return feeding.

The tank is double-walled with a liquid monitoring system.

The extraction of pentane from the tank is made by an air-powered membrane-pump. This feeding pump is placed in the tank-dom-shaft.

From the storage tank the pentane can be feeded with the membrane pump through an above ground pipe into the Ecomix unit in the premix station.

The area with the unloading place of the truck and the pentane tank is limited by a fence.

b) Data of the tank

DEHOUSI GmbH, Heidenau
DIN 6608 0/6/01 -. 40 m³
No. 93./98 4044

Liquid in the double-wall:	60 l
Test pressure:	3 bar
Jacket:	0.6 bar

A flame proof arrester is installed in the exhausting pipe.

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5.1.2 Zone definitions and dimension of the Zones

a) Explosion Zone 0

- The interior of C 5 pipes, pumps etc., which are not constantly filled with C 5 and not inertisated by Nitrogen.

b) Explosion zone 1

- Truck unloading place:
  - A distance of 0.5 m around the tank of the truck during the unloading process.
  - The environment of the equipment for connecting the C 5-filling and vapour hoses in a circle with a radius of 1.00 m.
- Pentane tanks:
  - A circle with a radius of 1.00 m around the end of the tanks exhausting system.
  - The interior of the tank-dom-shaft

c) Explosion zone 2

- Truck unloading place:
  - A distance of 1.0 m behind the above defined zone 1 (1.0 m) around the tank of the truck during the unloading process.
  - The environment of the equipment for connecting the C 5-filling and vapour hoses behind the above defined zone 1 (1.00 m) in a circle with a radius of 1.00 m.
- Pentane tank:
  - The environment of the tank equipment (tank-shaft) behind the above defined zone 1 (1.00 m) in a distance of 2.00 m up to a height of 0.8 m from the floor.

d) Fire danger zone

- The surrounding area of 5.00 m around the above mentioned Ex-Zones 1 and 2.

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5.1.3 Measurements and Function tests

- Pentane storage area -

Plant/component	Measuring result	Function Conforming to safety strategy		Remarks
		yes	no	
A. <u>Measurements</u>				
1. Electrostatic resistance of floor (conductivity)				
– position of tank-truck during unloading	4.0 - 7.0 kohm	x		
– explosion dangerous area around the tank-equipment	2.0 - 3.0 kohm	x		
2. Ground resistance / potential equalisation				
a) earth resistance				
– earthing system tank area	0.8 ohm	x		
– lighting protection tank area	0.8 ohm	x		
– earthing system pentane-feeding pipe (approx. each 25 m)	11 - 16 ohm	x		
b) Potential equalisation				
– tank equipment	≤ 0.3 ohm	x		
– truck grounding	-		x	– a flexible grounding cable is missing (see chap. 5.1.4)
3. Conductivity				
– racking hoses	> 10^6 ohm		x	– the hoses are not suitable (see chap. 5.1.4)
4. Pressure testing of pentane-feeding pipe	test pressure: 20 bar test time: 24 h	x		– test was done under supervision of dkk

Plant/component	Measuring result	Function Conforming to safety strategy		Remarks
		yes	no	
B. <u>Function tests</u>				
1. Pentane emergency push button		x		
2. Leakage monitoring				
– electrical function		x		– the system functioned correctly after a repair
– flow of the monitoring liquid		x		
3. Overfilling protection				
– electrical function		x		

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5.1.4 Detected deficiencies and required actions

- Pentane storage area -

		Responsible dkk = dkk PE = PERROS HU = HURARI		
		dkk	PE	HU
1.	***Unloading place for truck***			
1.1	Equipment for unloading:			
	a) The hoses for unloading of pentane (filling hose, gas return hose) are electrostatically chargeable and therefore not suitable for use of pentane (electrical resistance must be <1 mega ohm).	x		
	b) A flexible cable for grounding the tank truck must be present.			x
1.2	Pentane collecting basin:	x		x
	The place, where the truck stands while unloading must be constructed as a collecting basin.			
	Such basin isn't existing yet.			
	For the realization of this basin following solution is suggested:			
	– The place, where the truck stands is limited by a barrier (e.g. with concrete and the upper part is round)			
	– For draining away of rainwater a hole should be in this barrier. During pentane unloading this hole must be closed.			
1.3	Surrounding of the tank:			
	The pits in the surrounding of the tank must be filled by sand and closed watertight.			X
2.	Operator instruction:	x		
	The behaviour and the safety measures in the pentane storage area must be described in an operator instruction.			
	This operator instruction must be available in the storage area.			

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	Responsible dkk = dkk PE = PERROS HU = HURARI		
	dkk	PE	HU
3. Pit for the pentane feeding pump:	x		
In case of a leakage on the equipment a big amount of pentane can be in the pit without a possibility to recognize this fault.			
To avoid this dangerous situation a leakage sensor must be installed in the pit (new regulation in the German standards)			
4. Pentane feeding pump to the Ecomix:			
a) The attachment of the pipe must be improved that means additional guy lines are necessary			x
b) The coat of paint for corrosion protection must be improved and completed particularly at the supports of the pipe (rust must be removed before)			x

5.2 Premix station

5.2.1 Brief description of the plant

a. General:

The premix station is located in a room, separated from the production area.

Before the pentane pipe from the storage tank enters the room of the premix station an automatic valve with a function coupling to the safety system is installed.

Two new Ecomix-units, made by Perros are installed in the premix room.

The blend feeding lines of these Ecomix-units run to one Ecodosing unit and to two Ecokit units.

Each Ecomix unit consists of a cabine with the technical equipment inside. The Ecomix-units are equipped with the required pentane safety technique.

A 1000 l-tank for storage of polyol / pentane is planned for this room but presently not existing.

b. Data:

– Ecomix „A“:	EM-20-S 100 P, Part No: M 29.01	
Pentane Tank:	Type SERBATOMO	
	Serial No.:	748
	Temp.:	10/50°C
	Capacity:	100 l
– Ecomix „B“:	EM-20-S 100 P, Part No: M 29.02	
Pentane Tank:	Type SERBATOMO	
	Serial No.:	761
	Temp.:	10/50°C
	Capacity:	100 l

5.2.2 Zone definitions and dimension of the zones

a) Alarm-zone

- The interior of the Ecomix cabins.

b) Explosion zone 2

- The interior of the Ecomix cabins.
- The interior of the exhausting system
- A circle with a radius of 2,00 m around the end of the exhausting system at the open air.

c) Zone of nitrogen inertisation

- The interior of the c5-tanks at the Ecomix units

d) Fire hazard zone

- The whole room with the premix station.

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5.2.3 Measurements and Function tests

- Premix station -

	Plant / Equipment	Measuring result	Function conforming to safety strategy		Remarks
			yes	no	
A	**Function tests**				
1.	Gaswarning system				
	– 15 % LEL		x		
	– 30 % LEL		x		
	– system fault		x		
2.	Emergency push button				
	– pentane emergency push button		x		
	– emergency push button (control panel)		x		
3.	Alarm signalling				
	– signalling in the area		x		
	– signalling to a special place (remote panel)		-	-	the area with the premix station is frequently controlled by guards
4.	Exhausting system				
	– monitoring of air flow (air flux meter)		x		
	– function couplings				
	• 15 % / 30 LEL		x		
	• pentane emergency push button		x		
	– test fog	suction of fog is ok	x		
	– measurements of air speed				
	• Ecomix A ($1^{st}/2^{nd}$ speed)	8 m/s / 11 m/s	x		
	• Ecomix B ($1^{st}/2^{nd}$ speed)	6 m/s / 9 m/s	x		

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	Plant / Equipment	Measuring result	Function conforming to safety strategy		Remarks
			yes	no	
5.	Leakage monitoring for basin and equipment				
	– stirrer / pump		x		
	– collecting basin		x		
6.	C5-tank in Ecomix unit				
	– supermax level		x		
	– N^2-min monitoring		x		
	– safety relief valve		x		
B	**Measurements**				
1-.	Electric circuits/contral panels				
	– insulation resistance (safety relevant circuits)	≥ 30 mega ohm	x		
	– over-current protection	o.k.	x		
2.	Electrical resistance of the floor (conductivity)				
	– 1.00 m araound Ecomix	o.k.5 - 15 kohm	x		
3..	Ground resistance / potential equalisation				
	– Ecomix / equipment	≤ 0,3 ohm	x		
	– surrounding of Ecomix	≤ 0,3 ohm	x		
4.	Electrostatic field strengh:				
	– insulation of c5-tank	0 kV/m	x		
	– cabin walls/window	0 kV/m	x		
5.	Ground / erath resistance				
	– earth system	0.7 ohm	x		

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5.2.4 Detected deficiencies and required actions

- Premix station -

		Responsible dkk	PE	Hu
1.	**Ecomix „A“ und „B“**			
1.1	Blower of exhausting systems:			
	Regarding the declaration for spark-proof of Moro company rings in non-ferrous material are necessay at the blowers			x
	The installation of these rings is started and must be finshed completely.			
1.2	Pressure gauges:			
	The markings of the set-points are missing yet.		x	
2.	**Room of premix station**			
2.1	Emergency light:			
	A lamp, supplied by a circuit of the back up generator, has to be installed in this room.			x
2.2	Fire extinguisher			
	A powder fire extinguisher must be placed in the room.			x

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5.3 Cabinet foaming plants - plant A and plant B

5.3.1 Brief description of the plants

a) General:

The wet part of the cabinet foamin plants consists of two new Perros-Ecokits, one for plant A and the other for plant B.

The polyol / pentane feeding pipe is newly installed and leads from the belonging Ecomix-unit to the Ecokit. The dry parts are accommadated in two cabins. The jigs stand in a row and the foam-injection is carried olut by a mixing head with an automatic carriage system.

Before foam-injection a nitrogen inertisation of the interior of the cabinets via the mixing head is designed.

The jigs are electrically heated and the cores are heated by a blower with an integrated electrical heating.

The electrical equipment at the jigs is completely renewed.

For each plant an own safety control system is existing. The electrical control panels for the dry parts are positioned outside the cabines.

b) Data:

– Ecokit „A“:	Part. No. M 29.03		
Polyol / Pentane Tank:	Type SERBATOMO		
	Serial No.:	771	
	Temp.:		10/50°C
	Capacity:	230 l	
– Ecokit „B“	Part. No. M 29.04		
Polyol / Pentane Tank:	Type SERBATOMO		
	Serial No.:	775	
	Temp.:		10/50°C
	Capacity:	230 l	

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5.3.2 Zone definitions and dimensions of the zones

a) Alarm-zone
   - The interior of the cabins of the wet parts.
   - The interior of the cabins (rooms) of the dry parts.

b) Explosion zone 1
   - The environment of the foam injection hole with a radius of 200 mm while foam rising.
   - The environment of the fixture with a distance of 200 mm while the foam rising.

c) Explosion zone 2
   - The interior of the exhausting system.
   - A circle with a radius of 2.00 m around the end of the exhausting system in the open air

d) Zone of nitrogen inertisation
   - The interior of the polyol/pentane-tanks
   - The interior of the refrigerator cabinet.

e) Fire hazard zone
   - A surrounding of 5.00 m around the wet parts and the dry parts.

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5.3.3 Measurements and Function tests

- Cabinet plants „A“ and „B“ -

	Plant / Equipment	Measuring result	Function conforming to safety strategy		Remarks
			yes	no	
A	**Function tests**				
1.	Gaswarning system				
	– 15 % LEL		x		
	– 30 % LEL		x		
	– system fault		x		
2.	Emergency push button				
	– pentane emergency button		x		the automatic switch-off -function for the dry parts were not realised correctly (see chap. 5.3.4)
	– emergency push button (control panel)		x		
3.	Alarm signalling				
	– signalling in the area		x		
	– signalling to a special place (remote panel)		-	-	the area with the foaming pentane are frequently controlled by guards
4.	Exhausting system				
	– monitoring of air flow (air flux meter)		x		
	– function couplings				
	• 15 % / 30 % LEL		x		
	• pentane emergency push button		x		
	– test fog		x		– dry part plant „A“: the ducts at the jigs were not installed (see chap. 5.3.4)
	– measurements of air speed				
	• Ecomix „B“ (1st / 2nd speed)	4,2 m/s / 7,9 m/s	x		
	• Ecomix „A“ (1st / 2nd speed)	5,7 m/s / 8,1 m/s	x		

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	Plant / Equipment	Measuring result	Function conforming to safety strategy yes	no	Remarks
5.	Leakage monitoring for basin and equipment				
	– stirrer pump		x		
	– collecting basin		x		
6.	C5-tank in Ecokit unit				
	– supermax level		x		
	– N_2-min. monitoring		x		
	– electrical heating		x		
7	Interlocking while foam rising				
	– heatings at the jigs		x		
	– start to open the fixtures		x		
8.	Safety relief valve				
	– polyol / pentane tanks				
	• Ecokit „A"	o.k. (working pressure 6 bar)	x		
	• Ecokit „B"	o.k. (working pressure 6 bar)	x		
B.	**Measurements**				
1.	Electric circuits / contral panels				
	– insulation resistance (safety relevant cirucuits)	≥ 30 mega ohm	x		
	– over-current protection	o.k.	x		
2.	Electrical resistance of the floor (conductivity)				
	– 1.00 m around Ecokits	20-30 kohm	x		
	– dry parts	20-30 kohm	x		
3.	Ground resistance / potential equalisation				
	– Ecokit / equipment	≤ 0,3 ohm	x		
	– surrounding of Ecokit	≤ 0,3 ohm	x		
	– dry parts	≤ 0,3 ohm	x		

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	Plant / Equipment	Measuring result	Function *conforming to* safety strategy yes	Function *conforming to* safety strategy no	Remarks
4.	Electrostatic field strengh: – Ecokit • insulation of tank • windows of cabins – dry parts • lamellas curtains	 0 kV/m 0 kV/m 10 kV/m	 x x x		
5.	Inertisation of cabinets				
5.1	Plant „A“ – 0_2—concentration in the cabinet (value of N_2-working pressure = 4 bar)				
	1st measuring: flushing time 6 sec.	16%-0_2		x	– flushing time must be increased
	2nd measuring: flushing time 10 sec.	11,4 %-0_2	x		
	3rd measuring: flushing time 12 sec.	7,6 %-0_2	x		
5.2	Plant „B“ – 0_2—concentration in the cabinet (value of N_2-working pressure = 4 bar)				
	1st measuring: flushing time 12 sec.	18 %-0_2		x	– the N_2-valve at the mixing head was blocked (see chap. 5.3.4)
	2nd measuring: flushing time 12 sec.	8,5 %-0_2	x		

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5.3.4 Detected deficiencies and required actions

- Cabinet plants - plants „A“ and „B“

	Responsible		
	dkk	PE	HU
1. Cabinet plant „B“			
1.1 Ecokit			
a. Rust at some screws of flange joints must be removed and must be protected against corrosion by a over point.		x	
b. Nitrogren distribution unit (outside of Ecokit)			
1. As N_2-supply pipe a rigid pipe must be used instead of the present proviosionally installed flexible hose			x
2. A label with the remark „only usage of nitrogen is allowed„ must be fixed on the block with the solvenoid valves. The reason for this necessity is, that these solenoid valves belong to the inertisation system of the tank and the refrigerator cabinets and a confusion with oxygen must be prevented.			x
c. Pipes for polyol / pentane and isocyanate: *The pipes must be fixed in a better way before these enter the* Ecokit.			x
d. Pressure gauges: The markings of the set points are missing.		x	
e. After the final change to pentane as blowing agent the presently existing pipes for polyol/R11 have to removed.			x
f. Electrical control box outside Ecokit: The constitution of this box, which belongs to the electrical control sysdtem of the windows, muist be improvend (e.g. introduction of the cables, tighting of holes, improvement of wiring)			x

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	Responsible		
	dkk	PE	HU
1.2 Dry part			
a. Mixing head: The EEx-i-barriers for the intrinsical circuit at the mixing head aren't existing presently.			x
b. Function of 90-sec-interlocking for electrical heatings and movement of the fixtures while foam rising: These safety funtion has to be tested yearly, beause of that these functions having to be integrated in the safte function matrix (checklist)			x
c. N_2-intertisation for the cabinets.			
1. During nitrogen flushing in the cabinets the flow rate must be controlled automatically by a flow meter. An electrical interlocking between this monitoring device and the foam injection has to be realized.		x	x
2. N_2-equipemt at the mixing carriage system:			
– The nitrogen hoses must be connected with suitable clamps.			
– „Nitrogen" markings are necessary along these hoses			
3. The essential safety aspects and rating conditions must be described in an operator instruction (e.g. N_2-flushing time, N_2-working pressure, amount of N_2 per second for the regularly test with a bag, the entire N_2-system must be checked at least yearly)			
2. Cabinet plant „A"			
2.1 Ecokit			
a. Polyol / pentane-test pipe: The end of the test-pipe must be tightened by a blind plug.		x	
b. The following measures, mentioned in the chap. 5.3.4 No. 1.1 are valid also here:			
1. Nitrogen distribution unit (No. 1.1 b.)			x
2. Pipes for ploy ol / pentane and isocyanate (No. 1.1 c.)			x
3. Pressure gauges (No. 1.1. d.)			x
4. Final change (No. 1.1. e.)		x	

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	Responsible		
	dkk	PE	HU
2.2 Dry part			
a. The following measures, mentioned in the chap. 5.3.4 No. 1.2 are valid also here:			
1. Mixing head (No. 1.2 a.)			x
2. Function of 90 sec. Interlocking (No. 1.2 b.)			x
3. N_2-inertisation for the cabinets (No. 1.2 c.)		x	x
b. Exhausting channels:			
– The TÜV-experts agree with the planned position of the channels at the jigs.			
– The channels have still to be installed yet			x
c. Shut down function: In case of 30 %-pentane alarm level the 24 V supply for the dry part must be swiched off automatically. The realisation of this funtion must be carried out in the same way like plant „B".			x
d. Fixtures.			
1. Some plates for covering the electrical heating equipment are missing.			x
2. The provisonal installed fuse box at fixture 2 must be removed before pentane is used as blowing agent.			x
e. Junction box at the mixing head: The holes in the box must be closed.		x	

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Responsible		
dkk	PE	HU

5.4 Door foaming plant

5.4.1 Brief description of the plants

a) General:

The wet part of the door foaming plant consists of a new Perros-Ecodosing unit.

The polyol / pentane feeding pipe is newly installed.

The dry part can be divided into an area for foam injection with foam rising and a steam heated-tunnel.

The foam injection in the door moulds is carried out from the mixing head, which is positioned above the moulds. The moulds are open while pouring.

The fixtures and the moulds are made completely of metal. Before pouring a sheet of paper is put in each mould that means a high potential of electrostatic charge isn't existing.

The area for pouring and foam rising is equipped with an exhausting system and with gas sensors.

For the door plant an own safety control system is exsting:

b) Data:

- Ecodosing:
  Polyol / Pentane Tank:

Part No. Presently missing
Type SERBATOMO
Serial No.: 777
Temp.: 10/50°C
Capacity: 230 l

5.4.2 Zone definitions and dimension of the zones

a) Alarm-zone
   - The interior of the cabin of the wet part
   - The interior of the cabin (enclosure) of the area with the pouring and the foam rising.

b) Explosion zone 1
   - The environment of the moulds while pouring into the open moulds with a distance of 500 mm
   - The environment of the closed moulds with a distance of 200 mm while the foam rising.

c) Explosion zone 2
   - The interior of the exhausting system.
   - A circle with a radius of 2.00 m around the end of the exhausting system in the open air

d) Zone of Nitrogen inertisation
   - The interior of the polyol/pentane-tank

e) Fire hazard zone
   - A surrounding of 5.00 m around the wet part and the dry part.

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5.4.3 Measurements and Function tests

- Door plant -

	Plant / Equipment	Measuring result	Function conforming to safety strategy		Remarks
			yes	no	
A	**Function tests**				
1.	Gaswarning system				
	– 15 % LEL		x		
	– 30 % LEL		x		
	– system fault		x		
2.	*Emergency push button*				
	– pentane emergency button		x		– control panel dry part (Huari): the relay for the switch-off-function wasn't a correct design; a exchange was necessary
	– emergency push button (control panel)		x		
3.	Alarm signalling				
	– signalling in the area		x		
	– signalling to a special place (remote panel)		-	-	– the area with the foaming plants are frequently controlled by guards
4.	Exhausting system				
	– monitoring of air flow (air flux meter)		x		
	– function couplings				
	• 15 % / 30 % LEL		x		
	• pentane emergency push button		x		
	– test fog		x		– the suction isn't efficient enough (see chap. 5.3.4)
	– *measurements of air speed*				
	• plant (1st / 2nd speed)	5,7 m/s /9,2 m/s	x		

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	Plant / Equipment	Measuring result	Function conforming to safety strategy		Remarks
			yes	no	
5.	Leakage monitoring for basin and equipment				
	– stirrer pump		x		
	– collecting basin		x		
6.	C5-tank in Ecodosing unit				
	– supermax level		x		
	– N_2-min. monitoring		x		
	– electrical heating		x		
7.	Safety relief valve				
	– polyol / pentane tanks	o.k. (working pressure 14 bar)	x		
B.	**Measurements**				
1.	Electric circuits / contral panels				
	– insulation resistance (safety relevant circuits)	≥ 30 mega ohm	x		
	– over-current protection	o.k.	x		
2.	Electrical reistance of the foor (conductivity)				
	– 1.00 m around Ecodosing	20-30 kohm	x		
	– dry part	20-30 kohm	x		
3.	Ground resistance / potential equalisation				
	– Ecodosingt / equipment	≤ 0,3 ohm	x		
	– surrounding of Ecodosing	≤ 0,3 ohm	x		
	– dry part	≤ 0,3 ohm	x		
4.	Electrostatic field strengh:				
	– Ecodosing				
	• insulation of tank	0 kV/m	x		
	• windows of cabins	0 kV/m	x		
	– dry part / moulds				
	• closing motion	0 kV/m	x		
	• opening motion	80-100 kV/m	x		
5.	Ground / earth resistance				
	– earth system	0.7 ohm	x		

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5.4.4 Detected deficiencies and required actions

- Door plants -

		Responsible		
		dkk	PE	HU
1.	**Drypart**			
1.1	Ventilation			
	The suction openings in the channels aren't equipped with adustable flaps, that means the suction isn't allotted continously in the dry part area.			x
	In order to improve the suction adjustable flaps are necessary in the channels.			

5.5 General matters / required measures

	Responsible		
	dkk	PE	HU
5.5.1 Documentation			
a. Safety organisation:	x	x	x
Following documentation about the organsation of safety related aspects regarding the usage of pentane must be available:			
1. The organisation in case of alarms (e.g. 15 % / 30 % LEL). The behaviour of the operators, workers, guards, technicians must be fixed and organised.			
2. The organisation for regularly safety checks, inspections and training.			
5.5.2 Safety control panels			
Main switch: Next the main switch al label with themarking like this is necessary:		x	
– „attention, the main switch must be switched on always, only authorised persons are allowed to switch off"			

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	Responsible		
	dkk	PE	HU
5.5.3 Ventilation channels on the roof			
a. The ends of the ventilation channels are positioned next to windows. These windows are used for natural ventilation of the workshop In order to avoid an inflow of pentane vapour in the workshop, the ends of the channels have to be at least 1.00 m above the roof.			X
b. The channels have to be connected with the lightning arrester.			X
5.5.4 Ventilation fans (wet parts / dry parts)			
Regarding the declaration for spark-proof of Moro company rings in non-ferrous material are necessay at the blowers The installation of these rings is started and must be finshed completely.			
5.5.5 Back up generator			
a. The missing fuses for the sypply circuits of the safety control panels were installed during TÜV inspection.			
– The electrical diagram and the markings must be updated			x
b. The escape ways in the workshop with the foaming plants and the surrounding of the safety control panels must be illuminated with emergency lamps supplied by the generator.			x
c. The diesel supply hose must be connected with a hose-clamp instead of the use of wires.			x
5.5.6 Pentane marking on the refrigerator			
Refrigerators with pentane in the foam must have a marking where the use of pentane as blowing agent is recognisable.			
5.5.7 Conversion to pentane			
a. The following situations must be changed before the final conversion for use of pentane:			x
– The gas sensors are presently covered with protection caps.			
– For the working tanks of the foaming machines (Ecokit, Eco-			

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Responsible		
dkk	PE	HU

dosing) compressed-air instead of nitrogen is used.

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6. Safety relevant working conditions of the pentane storaging and foaming plants

6.1 Organisational requests

To run these plants in safe conditions following safety requirements are essential:

- All parts of the machine documentation and operator instructions must be followed
- The safety checks must be done regularly.
  The results of the checks must be recorded.
- The management must follow the pending points
- The management, team leader and technicians which are in charge of the plants must be educated regularly by experienced people.

6.2 Change of units of the plant

Before units or parts of the plants related to safety are changed experienced people must be consulted.

These must be people of the supplier of the machines related to the process and the signed experts related to the safety.

6.3 Regularly inspections

a) General requirements

According to the safety strategy regularly safety inspections, maintenance and function tests must be done.

The aim is to keep the safety related to water protection, fire and explosions on the highest level and run the plants according to the state of the art.

The work must be done by internal experienced technicians (competent people) and by experts.

Competent people (CP)

Experienced people must have a special education of the plant and of the safety issues.

The people should get an appointment to this particular work by the management.

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Experts

The experts are experienced in this field. In addition they have the knowledge of a lot of different plants and also of the accidents that happened. They are undependent and have a special approval by the government.

b) Safety relevant checks, organisation and education

The safety relevant works, which are listed on the following table must be done:

No	Plant	Kind of check	Qualification	Check time
1	Foam plant completely	Visual check	CP	daily
2	Foam plant completely	technical maintenance	CP	monthly
3	Safety equipment e.g. Pentan control system, ventilation, grounding system, fire detection/fighting system, warning signs	visual check	CP	monthly
4	Safety equipment e.g.. gasalarm system, Inertisation, Battery supply (etc.)	technical inspection	CP	monthly
5	Gasalarm system	calibration of sensors	CP	each 6 month
6	Foam plant completely and relevant surrounding	- visual check - function check	CP	yearly
7	– Organisation – Records of check – training of people – Records of changes	check the documents	CP Management	yearly
8	Training	theoretically and practically	CP or Experts	yearly
9	Foam plant completely	check of all safety relevant aspects	Experts	each 3 year
10	Essential changes of the foaming plant or safety parts	check of all safety relevant aspects	Experts	before running the plant again

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6.4 Incidents / accidents

In case of special incidents and especially accidents (fire, explosion, human accident) the signed experts must be informed immediately.

6.5 Regularly information

The carried out TÜV-inspection is valid maximum till 31th, July 2003.

During this time the supervision by the experts will be realised as follows:

- The experts get the yearly record of the internal competent people (CP's) of HUARI
- The experts can visit the factory at any time (e.g. on request of UNIDO)

7. Conclusion

7.1 Safety aspects for the pentane storaging and foaming plants:

a. General

At the TÜV inspection deficiencies and required measures were detected by the TÜV experts and listed up in this report.

The requirements mentioned in the TÜV-Report of the pre-inspections (File-No.: Per/dkk/HUA-PRC/01/99) were considered at the entire scope.

The wet part plants (Ecomix, Eokit, Ecodosing) are, some small points excepted, without safety deficiencies.

The local works under the supervision of HUARI have to be finshed completely.

b. Handling of the deficiencies

1. The detected deficiencies must be rectified.

   Following chapters contain these deficiencies and measures:
   chap. 5.1.4 / chap. 5.2.4 / chap. 5.3.4 / chap. 5.4.4 / chap. 5.5

2. The handling of these deficiencies should be done till 31th, Oct. 2000.

3. The TÜV Süddeutschland, branch Ulm,. needs a report with the confirmations about the handling of the deficiencies.

4. The TÜV-experts will issue the certificate after they received the above mentioned confirmation.

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5. This report is made in a draft-version. Together with the issue of the certificate the draft-version will be changed into the version without draft-marking and an additional chap. 7.3.

7.2 Summary of the TÜV inspection

In general the technical safety requests, regarding the safety strategy for C 4 / C 5.plants are fulfilled.

For this evaluation the rectification of the deficiencies is taken for granted.

The signed TÜV-experts have no safety related doubts for the process with the pentane-plants.

7.3 Remarks together with the issue of the certificate

The experts

E. Mack

R. Schulz

TÜV
SÜDDEUTSCHLAND

REPORT OF A SAFETY TECHNICAL PLANT INSPECTION

Project: – **Isobutane-Charging Plants in HUARI Company**
– **UNIDO-project**

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Ulm, 25.10.00
BBNEG/NDD-ka 25.10.00

Das Dokument besteht aus:
16 Seiten

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Amtsgericht München
HRB 96 869

File-No.:dkk/Hua-PRC/02/00

1st DRAFT-Version
for dkk only
rev. 6.1.1/d

Plants location:	ZHEJING HUARI GROUP Co., LTD JIUBAO, HANGZHOU, CHINA
Plants:	– Isobutane-Charging Plants for the production of refrigerators
Engineering and Manufactorer of the Plants:	1. dkk GEP mbH Group for Engineering and Project management Co. Ltd. 2. A'GRAMKOW, Denmark 3. HUARI, Company , P.R. China
Check-type:	First check before putting the plant into operation
TÜV-Order-No.:	200 364 559
TÜV-Experts:	Dipl.-Ing. Rainer Schulz TÜV BB-ULM, Dep. NDD Dipl.-Ing. (FH) E. Mack TÜV BB-ULM, Dep. NEG Company Group TÜV Süddeutschland
Dates:	• July 12th, 2000 - plant check on location • August 12th, 2000 - completion of the Report
Participants on location:	– Mr. Reh dkk – Mr. Wang Jian Chen - HUARI – Mr. Sun Yong Jian - HUARI – Technicians of Huari Company

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1. Preliminary remark

The HUARI company plans to use in future Isobutane as cooling agent for the production of refrigerators.

As Isobutane is a flammable liquid gas safety technical measures against a possible fire- and explosion danger have to be regarded and realized when this gas is used.

The dkk company engaged TÜV Süddeutschland, branch Ulm, to carry out a safety technical evaluation and check of the Isobutane Charging Plants at the Hefei Meiling Company.

The whole TÜV-check of the Isobutane Charging Plants has been carried out divided into the following partial checks:

- 1st Partial Check:
  - Safety technical evaluation of the documentation of the Isobutane Charging Station made by A'Gramkow.
  - The result of this evaluation is contained in the "TÜV safety Report on Technical Evaluation of Documentation of a HC Charging Station", File No.: 990 338 173, date Nov. 16th, 1999.
- 2nd Partial Check:
  - Coordination and fixing of solutions of problems with the dkk company, which have been assessed in the 1st partial check.
  - The result is contained in the "TÜV Comment on a technical state of affairs", File No.: 990 338 173/-01-, Date February 13th, 2000.
- 3rd Partial Check:
  - The TÜV-check, which has been carried out on location now, contains all the Isobutane (HC)-Charging-Plants consisting of HC-Storaging, HC-Charging Stations, safety-technical evaluation of the plant-peripherals and evaluation of safety relevant aspects of an organizational kind.
  - Other technical equipment not being of any safety-relevance to the HC-plants are not part of this check.
  - The result is contained in the "TÜV Report on a safety-technical plant-check" (being at hand!)
    File No.: 200 364 559/-02-, Date: 12th August, 2000

The TÜV-report at hand is first of all valid specifically for the HC-plants at HUARI company.

As the HC-plants are similar to those of the dkk-projects of Hefei Meiling and Xiling in regard of planning and realized design, this report can also be used as a guideline for Hefei Meiling and Xiling.

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2. Checking principles

2.1 Applicable regulations

- EG directive 94/9/EG (Atex 100 a)
- EN 1127-1 Explosion protection, Fundamentals and Methods
- Druckbehälterverordnung: Germany DruckbehV (decree for pressure vessels)
- Electrotechnical regulations: International: IEC / European: EN / National: DIN VDE e.g.
  IEC 60073, IEC 439-1/A2, IEC 204-1, IEC 1210-2, EN 50054, EN 50054, EN 50013, EN 50020, EN 50081, EN 60529, pr. EN 1050, DIN VDE 0165, EN 349, EN 418, EN 294, EN 954-1
- 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 20, VBG 21, VBG 61, ZH 1/200, ZH 1/255, ZH 1/8, ZH 1/10, ZH 1/134, ZH 1/455
- Technical regulations for combustible liquids and for gases: Germany TRF / TRG e.g. TRF 1996 / TRG 280
- Technical regulations for ventilators in ex-zones: Ex-proof / spark-proof for ventilators: Germany VDMA 23169 Part 1
- Homologation of technical plant and equipment - European: conformity certificates (e.g. PTB, Cesi)
- EN 378, Refrigerating systems and heat pumps, Safety and environmental requirements
- EG machine directive (89/392/EWG, revised edition 91/368/EEC)
- IEC 79-10/EN 60079-10/VDE 0165 Part 101: Electrical apparatus for explosive gas atmospheres - classification of hazardous areas
- IEC/EN/DIN VDE Standards: especially DIN 31000 / VDE 1000, DIN VDE 0116, DIN 57 165 / VDE 0165, EN DIN 50014 / VDE 0170/0171.

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2.2 Applicable documentation

Basis for the report at hand is the following documentation:

a) TÜV-"Safety Report on Technical Evaluation of Documentation of a HC Charging Station"
File-No. 990 338 173, Date Nov. 16th, 1999.

b) TÜV-"Comment on a technical state of affairs"
File-No. 990 338 173/-01-, Date February 13th, 2000

c) TÜV Süddeutschland, branch Ulm, has received from dkk the following technical documents:

1. Documentation of liquid gas storage tank made by Atogen Morgenstern Ltd. including:
   - operating description
   - overhead liquid gas storage tank
   - liquid phase pipelines
   - appendix 1: flow diagram
   - appendix 2: operation instructions
   - appendix 3: alarm plan
   - appendix 4: danger warning plan
   - appendix 5: measures during fires
   - appendix 6: inspection tests reports and certifications
   - appendix 7: tank documents
   - appendix 8: installation instructions
2. Record of the pressure test at the isobutane-supply-pipe

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3. Check extent

3.1 In general

The TÜV-check, that has been carried out, contains the checking and evaluation of the safety-relevant requirements for securing to secure the safety-measurements against fire- and explosion danger.

Those are in detail:

- Pressure-technical and electrotechnical checks and measurements on the plants for HC-storaging and HC-charging.
- Check and evaluation of general safety technical measures on the plants for HC-storaging and HC-charging.
- Check and evaluation of the safety relevant surrounding of HC-storaging and HC-charging.
- Evaluation of safety-relevant organizational measures.
- The check of all safety-relevant aspects in accordance with the requirement of chap. 8 of TÜV - Safety Report - File No.: 990 338 173, Date Nov. 16th, 1999.

3.2 Plant-specific check extent

Following plants, respectively plant-sections are part of this TÜV-check:

- isobutane storaging
- isobutane charging station on refrigerator line A
- isobutane charging station on refrigerator line B
- repair place for refrigerators with isobutane

3.3 Not part of the TÜV-check

Following checks and evaluations are not part of this TÜV-check:

- the refrigerators in regard of suitability for Isobutane
- the modifications in using refrigerators with Isobutane as cooling-agent. (e.g. operator manual, requirements for repairs).

4. Short description of the HC-plants

4.1 HC-storaging / HC-supply

a) General:

The storaging of Isobutane takes place in a tank above ground with a contents of 4.850 l.

This tank is coupled with an Isobutane pump-station by which the HC-charging station on the assembly line A and B is supplied with HC.

The Isobutane-tank and the Isobutane pump-station are located in a separate room bordering on the workshop.

In the outside-wall a ventilator for exhausting and a opening for air-inlet with a grid are existing.

The Isobutane-supply of the HC-charging stations is starting at the pump-station via a pipe.

b) Data of the technical equipment:

- HC-pump-station:

Producer:	A'Gramkow
Series no.:	182 000 27 - 74 977
Manufactured:	98-04-21
Refrigerant supply:	R 600a
Working pressure: 19 bar, design pressure: 21 bar	
Electrical control panel:	182 00027 / 74 977

- HC-storage tank:

Producer:	Berth Gommers Behälter-Apparate- und Tankbau
Series no.:	13 397
Year of Production:	1998
Approval No.:	ZU 407/1 - ZU A 407/01
Volume:	4 850 l
Design pressure:	15,6 bar
Design temperature:	40°C
Max. level	85 % / DIN 51 622
Safety relief valve:	SV-95-755-24-6-0,44-p/20380/1" NPT-PM 25

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4.2 HC-charging stations

a) General

On the refrigerator lines A and B there are two HC-charging stations, produced by A'Gramkow.

The cooling-circuits of the refrigerators are evacuated by this charging station and filled with Isobutane.

After the HC-charging process the cooling circuits are closed by an ultrasonic-system.

The HC-charging station and the HC-charging place are equipped with a technical ventilation system and an automatic gas-detector-system.

On the HC-charging station of line A a bubble memory-unit is installed. This unit is equipped with a liquid-basin and an artificial exhausting.

b) Dates of the HC-charging station:

– HC-charging station	Line A
Producer:	A'Gramkow, Type Max 95
– HC-charging station	Line B
Producer:	A'Gramkow, Type Max 95

4.3 Repair place for refrigerators with HC

According to dkk the repair place isn't contained in the project.

Nevertheless, for safety reasons a basical evaluation has been carried out by TÜV.

On the presently planned repair place a technical ventilation (suction) is installed.

Further equipment isn't existing.

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5. Inspection

- Measurements and function tests -

	Plant-components/ Measurement / Function test	Result of measurement	Function conforming to safety strategy		Remarks
			yes	no	
1.	HC-storaging / HC-supply				
	a. Function-coupling with safety monitoring panel			x	– function coupling isn't realised (terminals are bridged) - see chap. 6
	b. Emergency push button		x		– use of the emergency push button of the control panel
	c. Monitoring of ventilation		-	-	– a function coupling with a gas sensor is planned - see chap. 6
	d. Measurement				
	– electrical resistance of the floor	≤ 10 k ohm	x		
	– ground resistance	400 ohm		x	– the resistance in too high - see chap. 6
	– resistance of grounding/ potential equalisation	general ≤ 0,3 ohm	x		
	– effectiveness of ventilation (test fog)	o.K.	x		
2.	HC-charging area-Line A + B				
	a. Emergency push button		x		
	b. Gas monitoring				
	– pre-alarm (15% LEL)		x		
	– alarm (30 % LEL)		x		
	– fault		x		

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Plant-components/ Measurement / Function test	Result of measurement	Function conforming to safety strategy		Remarks
		yes	no	
c) Ventilation system				
– effectiveness of ventilation (test fog)	o.k.	x		
– monitoring of suction		x		
– air speed				
• Line A	9 m/s	x		
• Line B	10 m/s	x		
d) Pressure switches for HC-charging		x		
e) Measurement				
– electrical resistance of the floor	≤ 10 k ohm	x		
– electrical resistance of grounding /potential equilizatton	general: ≤ 0,3 ohm partly: >0,3 ohm	x	x	– the resistance to the charging gun is too high- see chap. 6
– effectiveness of ventilation (test fog)	o.k.	x		

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6. Deficiencies and required measures

	Responsible dkk	Responsible HUARI
6.1 HC—storage / HC-supply		
6.1.1 HC-storage room		
a) On the front side (along the factory-street) of the room, the wall isn't fire-retardant because openings of the ventilation are existing. With that it's necessary to close the windows on the left side of the HC-storage room (seen from the factory-street) with a material for 90-minutes-fire-retardance (e.g. bricks).		x
b) The opening in the wall for the ventilation exhausting is positioned near the water drain, i.e. in case of a gas-leakage in the storage room, gas can escape into the water drain system. A gas tight wall around this water drain-shaft in a height at least of 1.50 m is necessary to avoid an inflow of gas into the waterdrain systm.		x
c) At the entrance door the warning sign regarding the fire and explosion danger is missing.		X
d) Regarding the statement of the HUARI technicians a gas sensor is still foreseen in the HC-storage room. A function coupling with the fan motor should be realized in this case. Notice: Based on technical regulations a gassensor isn't required in the HC-storage room if special safety conditions in the storage room and in the surrounding of the storage room are fulfilled. Such special safety conditions are for example: explosion zone 1 in the storage room; the storage room is technicaly ventilated constantly, the end of the ventilation is in a suitable area (the ventilation fulfilled the requirements of IEC-79-10); only special authorized people can go into the storage room. The special safety conditions have to be evaluated by an expert. Regarding the general safety strategy for HC-plants gasmonitoring in the HC-storage room is recommended.	X	x
6.1.2 Technical equipment for storage room		
a) The electrical resistance of the ground/earth-system, measured 400 ohm, is too high.		X

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		Responsible dkk	Responsible HUARI
	A reduction of this resistance till ≤ 2.0 ohm is necessary.		
	b) The isobutane tank must be connectly direct with the grounding system.		X
	c) Blow-off pipe on the roof: The end of the tank-blow-off pipe must be changed in this way, that the blow -off direction is to the open air of the roof away from the windows.		x
	d) Safety function coupling: The safety function coupling between the control panel of the HC supply equipment and the control panel "Safe 5" doesn't function presently.	x	x
6.2	**HC-charging station - assembly line A**		
6.2.1	HC-charging gun ("Hansen"-coupling): The electrical resistance of the ground connection at the end of the charging gun is too high (measured 10 k/ohm, standard value 0.3 ohm).	x	
6.3	**HC-charging station - assembly line B**		
6.3.1	The isobutane supply pipe behind the charging unit must get a protection against mechanical stress.		x
6.4	**HC-charging stations at line A and B**		
6.4.1	Ventilation channels on the roof: The ends of the ventilation channels are positioned near to windows. These windows are used for natural ventilation of the workshops. In order to avoid an inflow of isobutane gas into the workshop, the ends of the channels have to be at least 1.00 m above the roof.		x
6.4.2	The CH-charging areas must be marked with warning signs considering danger of fire and explosion (e.g. use of hanged-up signs).	x	x
6.4.3	Remarks		

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Responsible	
dkk	HUARI

Before use of isobutane following changes have to be considered:

a. The gas sensor for monitoring of the charging place (assembly line)must be positioned under the hole of the accumulation basin.

b. For closing the cooling circuit at the refrigerators the ultrasonic system must be used instead on soldering.

7. Further measures

7.1 Repair place for HC-refrigerators x

a) The repair place was not equipped completely.
A design and description for the whole safety aspects is necessary.

Following aspects must be considered thereby:

- procedure for discharging (operator instruction)
- use of a suitable equipment for discharging (e.g. explosion proof vacuum pump according EN 1012-2; flexible hoses; ground connection)
- suitability of the ventilation system for Ex Zone 2
- monitoring of the ventilation system
- monitoring of the area by a gas sensor
- warning signs and definition of a dangerous area depending on the ventilation and gas monitoring
- equipment for fire fighting

b) After the completion of the repair places a safety inspection must be carried out by an expert.

8. Summary

8.1 Responsibilities

a. General:

According to the statements of the participants the planning and engineering of HC-plants is generally divided into

- HC-storage, HC-pipelines, repair places
  ⇒ responsibility: HUARI company (local works)
- HC-supply, HC-charging, HC-safety equipment
  ⇒ responsibility: dkk

b. Responsibility dkk

The measures still to be realized by dkk are basically listed in TÜV "Comment on a technical state of affairs" (File No.: 990 338 173/-01-) and agreed upon with the TÜV experts.

The realization of these measures was checked by the TÜV experts in connection with this plant inspection.

The final result here of is that this plant part now agreed with the related technical standards.

c) Responsibility Hefei/Meiling

The measures still to be realized by HUARI are listed in the TÜV-report at hand.

Carrying out these measures is regarded as necessary before the HC-plants are put into operation.

Having done away with the assessed deficiencies and after the required measures have been realized the HC-plants are in a safety technically correct condition.

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8.2 Handling of the deficiencies and measures

a. The detected deficiencies and required measures must be rectified. Following chapters contain these: chap. 6, chap. 7.

b. The handling of these deficiencies and measures should be done till 31th, October 2000.

c. The TÜV Süddeutschland, branch Ulm, needs a report with the confirmation about the handling of the deficiencies and measures.

d. The TÜV experts will issue the certificate after they received the above mentioned confirmation.

e. This report is made in a draft-version. Together with the issue of the certificate the draft-version will be changed to the version without draft marking and an addional chap. 8.5.

8.3 Safety relevant working conditions of the HC-storaging and HC-charging

The safety related requirements for operations in the HC-plants are contained in the "TÜV safety Report on Technical Evaluation of Documentation of a HC Charging Station", File-No: 990 338 173, date Nov. 16th, 1999.

Particularly the following states of affairs have be paid attention to

- organisational requests (e.g. behaviour of the workers in case of alarms)
- regular inspections (e.g. maintenance, calibrations, safety function test, technical safety inspections, safety training)

8.4 Some other regulations

a. Validity of this report.
The carried out TÜV-inspection is valid till 31th July 2003.

b. Information under the safety point of view:

During the validity of this TÜV inspection the supervision by the experts will be realised as follow:

- In case of special incidents and especially accidents (e.g. fire, explosion, human accident) the signed experts must be informed immediately.

- The experts recieve the yearly safety record of the internal competent people (CP's) of HUARI.

c. Special request:

The experts can visit the factory at any time e.g. on a request of UNIDO.

8.5 Remarks together with the issue of the certificate

The experts

E. Mack R. Schulz