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FINAL REPORT
according to UNIDO-Contrat Nr. 95/043
FINAL REPORT

according to UNIDO-Contract Nr. 95/043

1. Declarations and shaping for the realized working plan of Iranian experts

2. Measurements on the refrigerator model AR08 according to DIN 8950

2.1. Test on a continuous run

2.2. Test on a cyclic run

3. Determination of the cabinet constant C on Model AR08 of Azmayesh Ind. Co.

4. Test on refrigerator models VC 52 AJG and NR 58 LAEG of Arj Co.

5. Summary of the test results

6. Evaluation of the test results and suggestions for further tests

7. Layouts

Scharfenstein, on 16 03 95

Wieczorek

Dr Salem
1. Declarations and shaping for the realized working plan of Iranian experts

27.02.95 - Greeting and presentation of each firm

28.02.95 - Visit of the factory of Refrigerators manufacturing of FORON "Hausgeräte GmbH"

- Carrying out of the test "continuous run" for the first refrigerator model

01.03.95 - Evaluation and discussion of the first test results and explanation of further steps

- Seminar about Experience of FORON-Hausgeräte GmbH according to refrigerant change over from CFC 12 through HFC 134a to hydrocarbons

02.03.95 - Visit of the factory for washing machine manufacturing of FORON "Hausgeräte GmbH"

03.03.95 - Evaluation of present test results and explanation of further steps

- Common check of Total Load calculations of Refrigerator models according to the given data for determining of refrigerating cycle components

06.03.95 - Evaluation of present test results

- Description of the procedure for practical determining of cabinet constant C

07.03.95 - Visit of the factory for compressor manufacturing of FORON "Hausgeräte GmbH"

- Evaluation of present test results

- Theoretical view to thermodynamic refrigerating cycle

08.03.95 - Preparation of experimental tests for further refrigerator models

- Seminar about using of FORON computer simulation program relative to calculation and selection of refrigerating cycle components

09.03.95 - Evaluation of present test results

- Demonstration by video about KS-refrigerator manufacturing of FORON

10.03.95 - Evaluation of present test results

- Evaluation and discussion of the provisional report

- Seminar about experience of FORON in refrigerator service by using the different refrigerants CFC 12, HFC 134a and hydrocarbons
13.03.95 - Evaluation of present test results
- Product load calculations and descriptions for further tests

14.03.95 - Evaluation of present test results
- An additional Seminar to the same topic of 01.03.95

15.03.95 - Calculations for design of refrigerating devices
- Visit of refrigerator production line and cyclopentane plant of FORON Co.

16.03.95 - Evaluation of present results
- Evaluation and discussion of final report
2. Measurements on refrigerator model AR08 of Azmayesh Co., according to DIN 8950

This model AR08 was prepared for testing by joined activities of "dkk" and "Azmayesh" Firms.

The following preparatory work was carried out:

(1) According to the valid technical security in Germany the following activities were carried out:
   - Connection of a new mains supply cable with protection
   - Binding the refrigerator housing to the protected connection system
   - Carrying out of technical test according to DIN 57700/ VDE 0700

(2) Arrangement of thermoelements for temperature recording according to DIN 8950
2.1. Test on a continuous run for climate class T

Test conditions: - Proof test of power efficiency on continuous run
   (Thermostat adjustment at position 8)
   - ambient temperature \( t_a = 43 \, ^\circ C \)
   - Distance condenser/Wall about 1 cm

2.1.1. Without test packages

Test results:
   - Temperature in cooling compartments \( t_m \): +4,9 °C
   - two stars freezer compartment \( t^{**} \): -11,4 °C
   - celler compartment \( t_{cm} \): +9,9 °C
   - Power input \( P_1 \): 113 W
   - voltage/ frequency: 220 V/ 50Hz

2.1.2. With test packages

Test results:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>actual value</th>
<th>rated value</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Temperature in cooling compartments, ( t_m )</td>
<td>+6,4 °C</td>
<td>( \leq +5 , ^\circ C )</td>
</tr>
<tr>
<td>- two stars freezer compartment, ( t_{pw} ) (Temperature of the warmest test package)</td>
<td>-9,0 °C</td>
<td>( \leq -12 , ^\circ C )</td>
</tr>
<tr>
<td>- celler compartment, ( t_{cm} )</td>
<td>+11,4 °C</td>
<td>( +8 , ^\circ C \leq t_{cm} \leq 14 , ^\circ C )</td>
</tr>
<tr>
<td>- Power input, ( P_1 )</td>
<td>113 W</td>
<td></td>
</tr>
</tbody>
</table>
2.2. Test on cyclic run

2.2.1 Ambient temperature $t_a = + 43 \, ^\circ C$

Test conditions:  
- Thermostat adjustment on position 3,5  
- Test package according to DIN 8950  
- Distance condenser/Wall 1 cm

Test results:  
- Temperature in cooling compartment $t_m$: +8,1 °C  
- Temperature in the warmest test package $t_{\text{vp}}$: - 6,8 °C

Relative switch time running time ~ 85 %  
total measuring time

Temperature difference between condenser (third turn) and Filter dryer $\Delta t$: 2,5 K

2.2.2 Ambient temperature $t_a = + 32 \, ^\circ C$

a) Thermostat adjustment at position 4.0
   Test conditions:  
   - Test packages according to DIN 8950  
   - Distance condenser/Wall about 5 cm

Test results

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Actual value</th>
<th>Rated value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temp. in cooling compartments, $t_m$</td>
<td>6,1 °C</td>
<td>5 °C ± 0,5</td>
</tr>
<tr>
<td>Temp. of the warmest test package $t_{\text{vp}}$</td>
<td>-5,2 °C</td>
<td>≤ - 12 °C</td>
</tr>
<tr>
<td>Cellar compartment $t_{cm}$</td>
<td>9,2</td>
<td>+ 8 °C ≤ $t_{cm}$ ≤ 14 °C</td>
</tr>
<tr>
<td>Energy consumption</td>
<td>1,1 kWh</td>
<td>-</td>
</tr>
<tr>
<td>Relative switch time</td>
<td>45 %</td>
<td>-</td>
</tr>
</tbody>
</table>

b) Thermostat adjustment at position 6.0
   Test conditions refer to a)

Test results

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Actual value</th>
<th>Rated value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temp. in cooling compartments, $t_m$</td>
<td>4,6 °C</td>
<td>5 °C ± 0,5</td>
</tr>
<tr>
<td>Temp. of the warmest test package $t_{\text{vp}}$</td>
<td>-7,4 °C</td>
<td>≤ - 12 °C</td>
</tr>
<tr>
<td>Cellar compartment $t_{cm}$</td>
<td>9,2 °C</td>
<td>+ 8 °C ≤ $t_{cm}$ ≤ 14 °C</td>
</tr>
<tr>
<td>Energy consumption</td>
<td>1,17 kWh</td>
<td>-</td>
</tr>
<tr>
<td>Relative switch time</td>
<td>39,6 %</td>
<td>-</td>
</tr>
</tbody>
</table>
3. Determination of the cabinet constant C

Conditions:
- The refrigerator is standing in the air conditioned room at ($t_a$)
- Installation of electrical heater of (P) inside the refrigerator cabinet for getting inside temperature ($t_i$)
- The difference ($t_i - t_a$) should be equal ~ 20 K

Cabinet constant C: 

$$ C = \frac{P}{(t_i - t_a)} $$

P in W
($t_i - t_a$) in K

Example: AR08

P = 20 W
$t_i$ = 37,86 °C
$t_a$ = 25,43 °C

$$ C = \frac{P}{(t_i - t_a)} = \frac{20}{(37,86 - 25,43)} = 1,61 \text{ W/K} $$

The cabinet constant of refrigerator model AR08 is 1,61 W/K.

The practical overall heat transfer coefficient (K) can be found from C as follows:

$$ K = \frac{C}{A} \text{ units for C in W/K and A in m}^2 \text{ } A: \text{ effective heat transmission area} $$

Simple derivation for separate cabinet constant of freezer compartment and refrigerator compartment (cooling compartment enclosing celler compartment) can be found as follows:

$$ C_1 = K \cdot A_1 \text{ } A_1: \text{ effective heat transfer area of two stars freezer compartment} $$

$$ C_2 = K \cdot A_2 \text{ } A_2: \text{ effective heat transfer area of cooling compartment enclosing celler compartment} $$
Simple calculation of Transmission heat $Q_T$

$$Q_T = Q_{T1} + Q_{T2}$$

$Q_{T1} = \text{Transmission heat relative to two stars freezer compartment}$

$$Q_{T1} = C_1 \cdot \Delta t_1$$

$Q_{T2} = \text{Transmission heat relative to cooling compartment enclosing celler compartment}$

$$Q_{T2} = C_2 \cdot \Delta t_2$$

$$\Delta t_1 = t_a - t_{i1}$$

$$\Delta t_2 = t_a - t_{i2}$$

$t_{i1} = -12 \, ^\circ C$

$t_{i2} = +5 \, ^\circ C$

$t_a = +43 \, ^\circ C$
4. Test on refrigerator models VC 52 ATG and NR 58 LAEG of Arj co.

4.1. Determination of cabinet constant

Determination of the constants is corresponding to the method explained in item no. 3

Results:

<table>
<thead>
<tr>
<th>Model</th>
<th>Cabinet constant</th>
</tr>
</thead>
<tbody>
<tr>
<td>VC 52 AJG</td>
<td>1.37 W/K</td>
</tr>
<tr>
<td>NR 58 LAEG</td>
<td>1.56 W/K</td>
</tr>
</tbody>
</table>

4.2. Test on model VC 52 AJG

Test on continuous run

Conditions:
- ambient temperature $t_a = +43^\circ C$
- Distance condenser/ wall is about 5 cm
- without test packages
- Voltage/ frequency: 220 V~/ 50 Hz

Results:
- Temperature of the cooling compartment, $t_m = -3.7^\circ C$
- Temperature of two stars compartment, $t^{**} = -19.7^\circ C$
- Temperature of celler compartment, $t_{cm} = +0.8^\circ C$
5. Summary of test results for climate class T

5.1. Model AR 08 of Azmayesh co.

<table>
<thead>
<tr>
<th>Test</th>
<th>Parameter</th>
<th>actual value</th>
<th>rated value</th>
</tr>
</thead>
<tbody>
<tr>
<td>- continuos run with test packages at $t_a = +43 , ^\circ C$</td>
<td>- Temperature in the cooling compartment, $t_m$</td>
<td>$+6,4 , ^\circ C$</td>
<td>$\leq +5 , ^\circ C$</td>
</tr>
<tr>
<td></td>
<td>- Temperature of the warmest test package, $t_{wp}$</td>
<td>$-9,0 , ^\circ C$</td>
<td>$\leq -12 , ^\circ C$</td>
</tr>
<tr>
<td></td>
<td>- Temperature of celler compartment, $t_{cm}$</td>
<td>$+11,4 , ^\circ C$</td>
<td>$+8 , ^\circ C \leq t_{cm} \leq 14 , ^\circ C$</td>
</tr>
<tr>
<td>- cyclic run at $t_a = +32 , ^\circ C$ Thermostat adjustment (Position 4.0) and distance condenser/wall of 5 cm</td>
<td>- Temperature in the cooling compartment, $t_m$</td>
<td>$+6,1 , ^\circ C$</td>
<td>$+5, ^\circ C \pm 5$</td>
</tr>
<tr>
<td></td>
<td>- Temperature of the warmest package, $t_{wp}$</td>
<td>$-5,2 , ^\circ C$</td>
<td>$\leq -12 , ^\circ C$</td>
</tr>
<tr>
<td></td>
<td>- Temperature of celler compartment, $t_{cm}$</td>
<td>$+9,2 , ^\circ C$</td>
<td>$+8 , ^\circ C \leq t_{cm} \leq 14 , ^\circ C$</td>
</tr>
<tr>
<td>- cyclic run at $t_a = +32 , ^\circ C$ Thermostat adjustment (Position 6.0) and distance condenser/wall of 5 cm</td>
<td>- Temperature in the cooling compartment, $t_m$</td>
<td>$+4,6 , ^\circ C$</td>
<td>$+5, ^\circ C \pm 5$</td>
</tr>
<tr>
<td></td>
<td>- Temperature of the warmest package, $t_{wp}$</td>
<td>$-7,4 , ^\circ C$</td>
<td>$\leq -12 , ^\circ C$</td>
</tr>
<tr>
<td></td>
<td>- Temperature of celler compartment, $t_{cm}$</td>
<td>$+8,1 , ^\circ C$</td>
<td>$+8 , ^\circ C \leq t_{cm} \leq 14 , ^\circ C$</td>
</tr>
<tr>
<td></td>
<td>- Energy consumption</td>
<td>1,1 kWh</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>- relative switch time</td>
<td>45 %</td>
<td>-</td>
</tr>
</tbody>
</table>

5.2 Model VC 52 AIG working on CFC 12 of Arj Co.

<table>
<thead>
<tr>
<th>Test</th>
<th>Parameter</th>
<th>actual value</th>
<th>rated value</th>
</tr>
</thead>
<tbody>
<tr>
<td>- continuos run without test packages at $t_a = +43 , ^\circ C$</td>
<td>- Temperature in the cooling compartment, $t_m$</td>
<td>$-3,7 , ^\circ C$</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>- Temperature of two stars freezer compartment, $t_{**}$</td>
<td>$-19,7 , ^\circ C$</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>- Temperature of celler compartment, $t_{cm}$</td>
<td>$+0,8 , ^\circ C$</td>
<td>-</td>
</tr>
</tbody>
</table>
6. Evaluation of results and suggestions for further tests

6.1. Model AR 08 of Azmayesh co.

- With the present construction the demands will not be attainable for climate class T according to DIN 8950.

- On consideration of the calculated total load of 107 W and the selected compressor of Aspera, type BP 1084 with a capacity (Q₀) of 77 W at evaporating temperature (t₀) of -25 °C the demands will not be fulfilled according to DIN 8950.

- With the present mounted compressor the following temperature measurements (according to item 2.2.2. b) were recorded:
  
  - warmest test package, tₜₚ = -7.4 °C
  
  - temperature in cooling compartment, tₘ = +4.6 °C

- It is necessary to have a suitable compressor with a higher capacity to achieve the minimal required temperature of the warmest test package (tₜₚ) of -12 °C.

  On the one hand the attainable cooling capacity at this replaceable compressor can insure the required minimal temperature (tₜₚ), on the other hand the temperature in the cooling compartment (tₘ) will decrease down to non-valid temperatures.

Following suggestions for further steps:

1. Application of a compressor with a minimal cooling capacity Q₀ of 107 W at evaporating temperature t₀ of -25 °C

2. Optimization of the refrigerant charge

3. Test according to DIN 8950

4. An improvement of coordination between two stars compartment and cooling compartment to ensure the required temperatures of the warmest test package (tₜₚ) and of the cooling compartment (tₘ).

5. At further negative test results optimization of refrigerating cycle components should start

6. An improvement of energy levels according to EU-guideline 92/75/EWG is a vailable by an improvement of the cabinet insulation.
6.2. Model VC 52 AJG

The recorded results from the test on continuous run without test packages at an ambient temperature $t_a = +43 \, ^\circ\text{C}$ show, that the present cooling capacity should be available for further classification.

Following suggestions for further steps:

- Optimization of the refrigerant charge
- Carrying out of the test according to DIN 8950 (ISO/ DIS 7371)
- Evaluation of energy levels according to EU-guideline 92/75/EWG
- Preparation of suggestions to improve energy levels on base of their actual values

7. Layouts

- Test reports
### Leistungsprüfung

<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>230 l</td>
<td></td>
<td></td>
<td>Aspera BP40612</td>
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**Klassifizierung:** T

**Subklasse:**

**Bemerkung:**

10.3.95
### DIN 8350

**Leistungsprüfung**

<table>
<thead>
<tr>
<th>Anordnung der Temperaturmessstellen</th>
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<td><img src="image" alt="Diagram" /></td>
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<th>Prüfungsklasse</th>
<th>Position 1</th>
<th>Position 2</th>
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<tr>
<td>2.2.2. a)</td>
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<table>
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<tr>
<th>Anzahl</th>
<th>230 l</th>
<th>Rispera BP43842</th>
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<tr>
<td>32°C</td>
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<td>31°C</td>
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<th>Klassifizierung</th>
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<th>Schrank Nr.</th>
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<thead>
<tr>
<th>Brutto-Volumen</th>
<th>Rispera BP43842</th>
</tr>
</thead>
<tbody>
<tr>
<td>230 l</td>
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</table>

<table>
<thead>
<tr>
<th>Preparaations</th>
<th>27°C</th>
<th>6.05</th>
<th>48</th>
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</thead>
</table>

| Prüfungsklasse | Viskosität | Viskosität 
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>2.2.2. a)</td>
<td>1.2</td>
<td>3.4</td>
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<table>
<thead>
<tr>
<th>Prüfungsklasse</th>
<th>Leistung</th>
<th>Leistung</th>
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<tbody>
<tr>
<td>2.2.2. a)</td>
<td>1.41 (kWh)</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Prüfungsklasse</th>
<th>Prüfungsergebnis</th>
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</thead>
<tbody>
<tr>
<td>2.2.2. a)</td>
<td>1.2 3.4 5.6 7.8</td>
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</tbody>
</table>

**Bemerkung:** 30.3.95
### Anordnung der Temperaturmessstellen

<table>
<thead>
<tr>
<th>E1</th>
<th>E2</th>
<th>E3</th>
</tr>
</thead>
<tbody>
<tr>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>x</td>
<td>x</td>
<td>x</td>
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</table>

### Wassertemperaturen

<table>
<thead>
<tr>
<th>Schenkelt</th>
<th>T°C</th>
<th>T°C</th>
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<tbody>
<tr>
<td>1</td>
<td>23</td>
<td>24</td>
<td>25</td>
</tr>
<tr>
<td>2</td>
<td>26</td>
<td>27</td>
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</table>

### Leistungsprüfung

#### Prüfung Nr.
- 2.2.2. b)
- 2301

#### Armatur Nr.
- Aspera BP 40842

#### Klassifizierung
- 60

#### Klimaklasse
- T

#### Rücksicht auf die Schraubverbindungen
- Klemmen für Schraubverbindungen

#### Bemerkung
- 10.3.95

### Bemerkung
- 1,05
- 1,17
Anlage 4

DIN 8950 Leistungsprüfung 4.2.0

Anordnung der Temperatureinflüssen

<table>
<thead>
<tr>
<th>R2</th>
<th>R2</th>
</tr>
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<tbody>
<tr>
<td>.2</td>
<td>.1</td>
</tr>
<tr>
<td>.7</td>
<td>.4</td>
</tr>
</tbody>
</table>

Prüfflange Nr.: 43C
Schrank Nr.: PUR
Brutto-Inhalt: R12
Netto-Inhalt: R12
Erd. Heizk.:
Anzeigetyp: PUR
Anzeige: 280 C
Klimaklasse: T
Dauerlauf ohne Testpackung

8

24

24

100%

Bemerkung: 16/3.95 Post

I. H. 1