OCCASION

This publication has been made available to the public on the occasion of the 50th anniversary of the United Nations Industrial Development Organisation.

DISCLAIMER

This document has been produced without formal United Nations editing. The designations employed and the presentation of the material in this document do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations Industrial Development Organization (UNIDO) concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries, or its economic system or degree of development. Designations such as "developed", "industrialized" and "developing" are intended for statistical convenience and do not necessarily express a judgment about the stage reached by a particular country or area in the development process. Mention of firm names or commercial products does not constitute an endorsement by UNIDO.

FAIR USE POLICY

Any part of this publication may be quoted and referenced for educational and research purposes without additional permission from UNIDO. However, those who make use of quoting and referencing this publication are requested to follow the Fair Use Policy of giving due credit to UNIDO.

CONTACT

Please contact publications@unido.org for further information concerning UNIDO publications.

For more information about UNIDO, please visit us at www.unido.org

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org

22070

Islamic Co. For Industrialization
siltal
E.S.A.

الشركة الإسلامية للتصنيع
سيلتال
ش.م.م. س.ت : ٥٠٦٧٠ (شرقية)
رأس المال المرخص به ٣٠ مليون جنيه و المصدر ١٨ مليون جنيه

Draft Final Report

Contract No. 98/159
Project No. MP/EGY/95/038

Siltal
To
UNIDO

Mrs. M. LATRECH
Contracts Officer
Purchase And Contracts Section
General Services Branch

Report complied by Technical Director
15/10/98
Eng. Alaa El Din Hosny

AC

القاهرة:٢٠ (أ) شـــارع منشية البكرى ص.ب : ٥٩٨٣ هليوبوليس غرب - رمز بريدى ١١٧٧١ ت: ٢٥٦٦٠٣٣ - ٢٥٨١٦٦٩ - ٢٥٧٠٧٧٠ فاكس : ٢٥٦٩٨٩٧
مصانع: مدينة العاشر من رمضان ١٣٨ش النصر- منطقة الصناعات الثقيلة ت :٤١٠٠٥٧- ٤١٠٠٥٨ - ٠١٥/٤١٠٠٥٩ فاكس:٠١٥/٤١٠٠٦٠ ص.ب:١٩٦ العاشر
Cairo Office : 20 (A) Manshiet El-Bakry St. P.O.Box 5983 Heliopolis West Tel.: 2581669 Fax: 2569897 Cairo - Egypt
Factory : 10th Of Ramadan City - 138 El Nasr St., 2nd Zone Heavy Industrial P.O.box. 196 Fax.: 015/410060 Egypt.
Tel: 015/410057 - 410058 - 410059

Table of Contents

Background:

-The Islamic company for industrialization (trade name: *SILTAL*) is a private company situated in the 10th district of *RAMADAN City* near *Cairo.*

- It is manufacturing 8 models of refrigerator (*Single & Double door*) in the range from 100 to "430" liter & "2" models of chest freezers also one model of upright freezer based on license from *SILTAL-Italy.*

- The company has already been on the market from "eleven" years manufacturing annually "40,000" units on one production line,
- Market share in *EGYPT* is about "10%", the company exports "5%" of the total production to *Africa* region, as well as some *Arab* & *European* countries.

- About "300" workers are involved in the manufacturing process & "40" workers in servicing at "9' service stations of the company.

- The product of quality is good; *SILTAL* is the first company awarded *ISO 9001* quality assessment certification from *1995* & renewal for the next three years to 2001, which applies throughout operations for production of refrigerators & freezers.
- Compressor are imported from *DANFOSS*, *MATSUSHITA*, *ZANUSSI*, *UNIDAD*, *L'UNITE HERMATIQUE* & *DAWOO.* Evaporators & condensers are partially produced locally partially imported.

- Under project *MP/EGY/95/038* phasing out *ODS* at the refrigerator plant, the installation of all machines has been finalized and the production has been converted to *CYCLOPENTANE* and *HFC 134a.*

- The cabinets now being injected with *CYCLOPENTANE* foam and have tested almost a similar performance to cabinets injected with *CFC* foam.

- All the product have already been redesigned for use with *HFC 134 A and the product now is CFC free.*

Project scope:

Redesign and testing of refrigerators and freezers.
The redesign should maintain the present quality of the product.

System design considerations:

From comprehensive tests conducted by refrigerant manufactures and end user it has been concluded that:
HFC 134a is chemically and thermally more stable than *R12* -.

There is no big change in the cooling performance of a system utilizing *134a* in comparison to *R12*.
Specification of refrigerant. 134A (annex) (A)
There are some considerations must be taken during the choice of the *HFC 134 A rfrigeration cycle*:

A- HFC 134a compressor:

Oil: Ester oil
The LBP refrigeration capacity is only "88%" to "90%"
Of *CFC12*
That is mean bigger displacement.

B- Capillary tube:

20-25% reduction of the flow-rate that is mean resistance of the capillary tube (increase the length with the same inside diameter).

C- HFC 134a refrigerant:

The amount refrigerant *HFC 134a* has to be reduced with about "10%".

D- Filter / dryer

As a desiccant a XH7 (union carbide) or a corresponding desiccant with 3$\mathring{A}$ pores has to be used (min. 7.5 grams)

E- Thermostat:

The increase resistance of the capillary tube increase the pressure equalizing time during the stand shall period (modifications of the thermostat differential).

F- Evaporator & condenser:

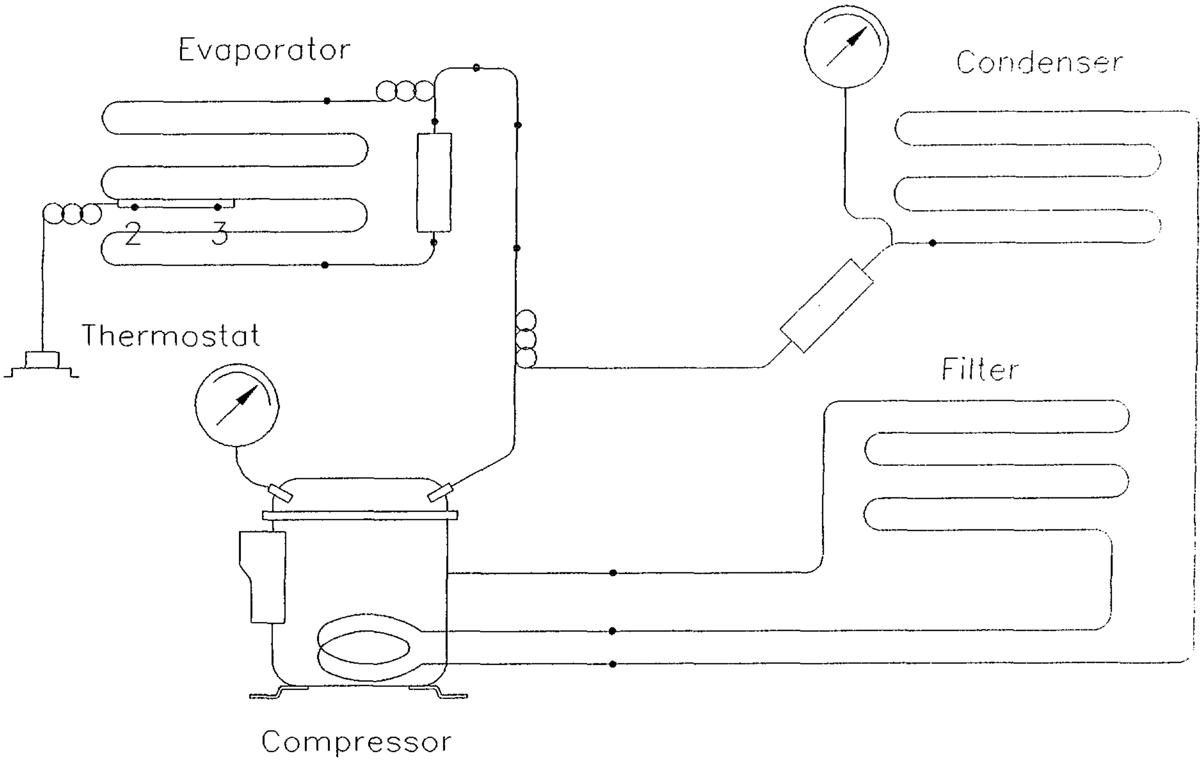
Avoid oil pockets.

G- Purity:

Purity and dryness according to DIN 8964 for all internal surfaces with good evacuation for min, moisture content.

System specification

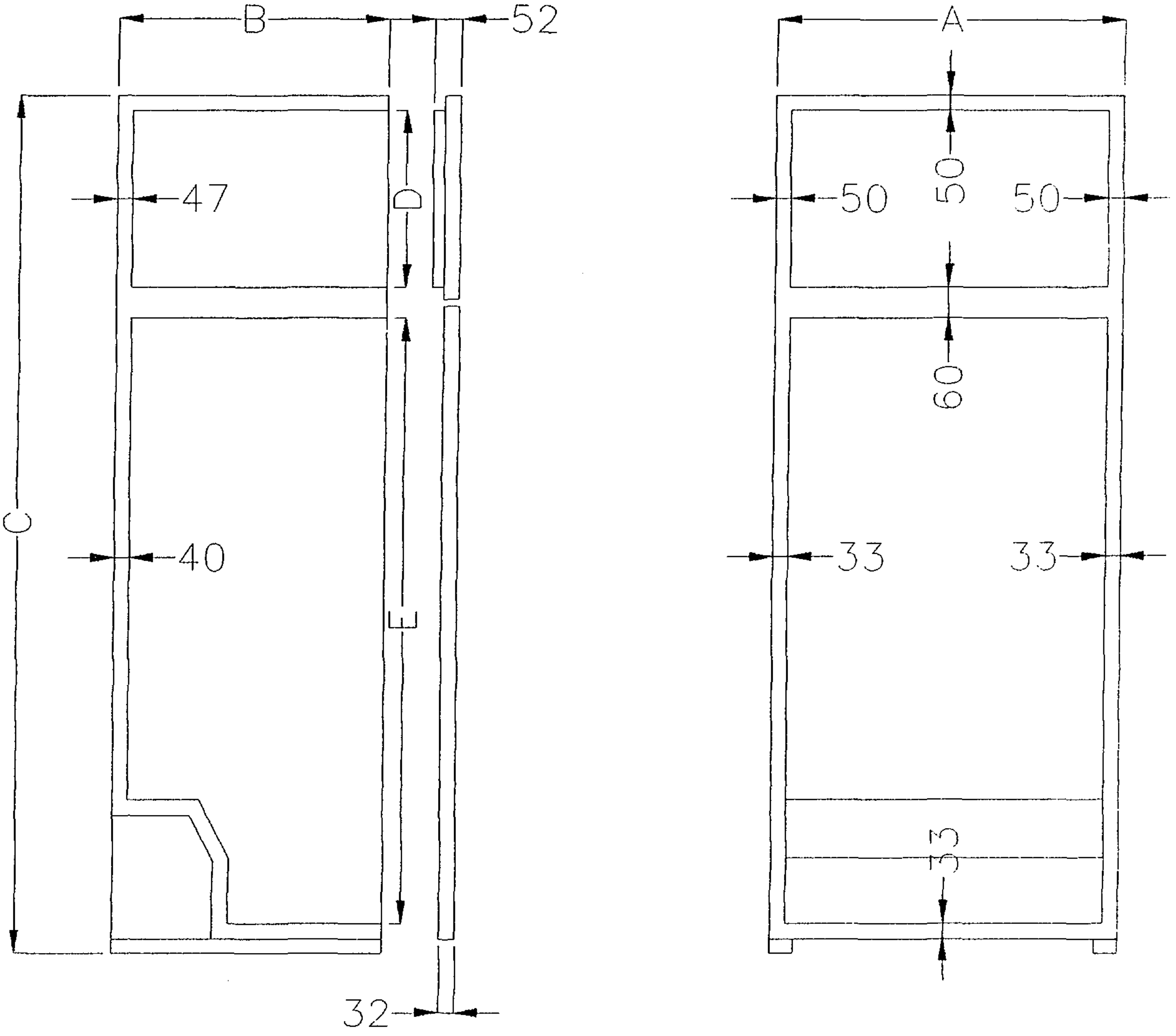
A- Refrigeration cycle.



B- Dimensional drawing for the cabinet.

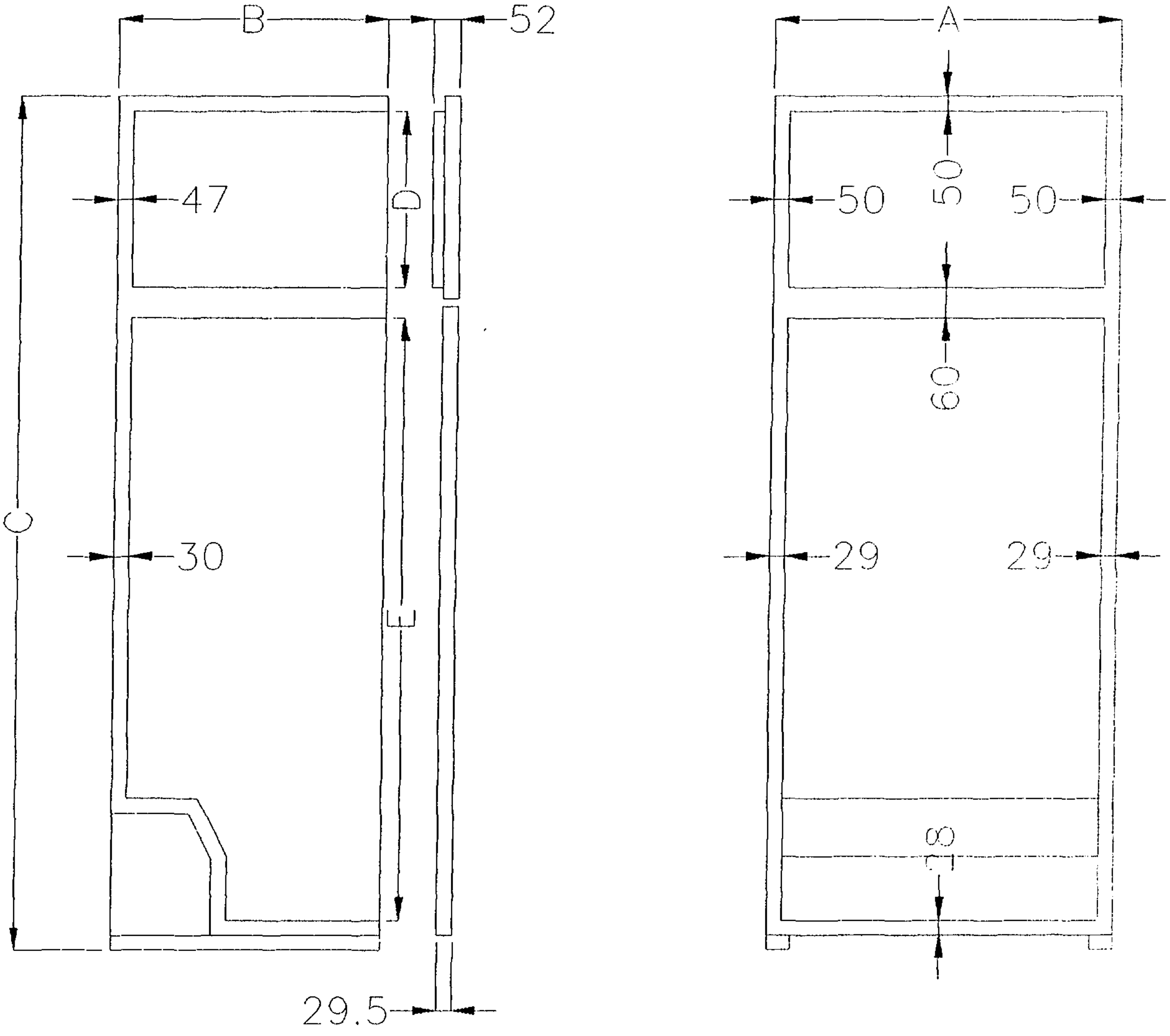
C- Technical data for current redesign models (with etch model test) and also for R12 (annex B).

B/1 Refrigerator (double door)



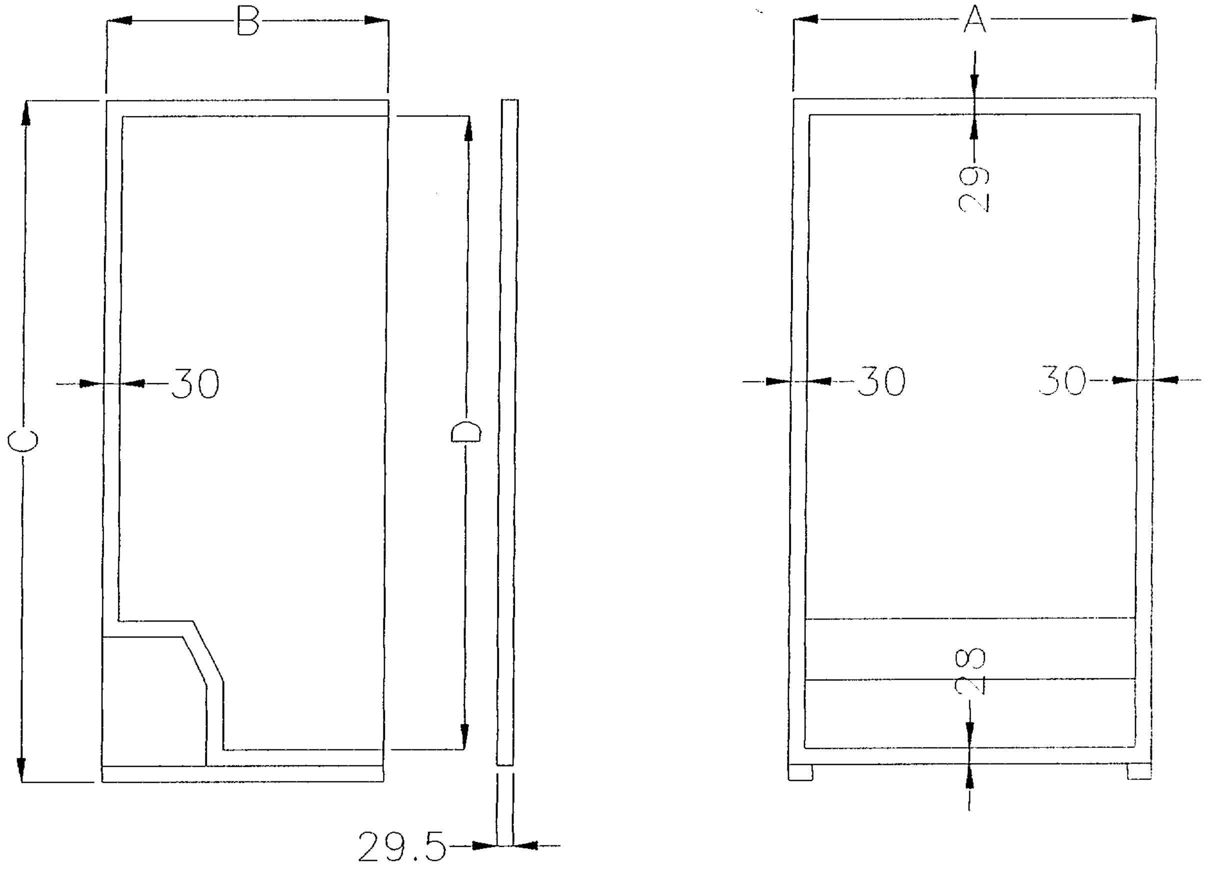
Model	**A**	**B**	**C**	**D**	**E**	**Freezer door**	**Cabinet door**
Fb44	700	528	1692	352	1164	696x415	696x1222
Fb41	700	528	1582	352	1042	696x415	696x1100

***B/2 Refrigerator** (double door)*



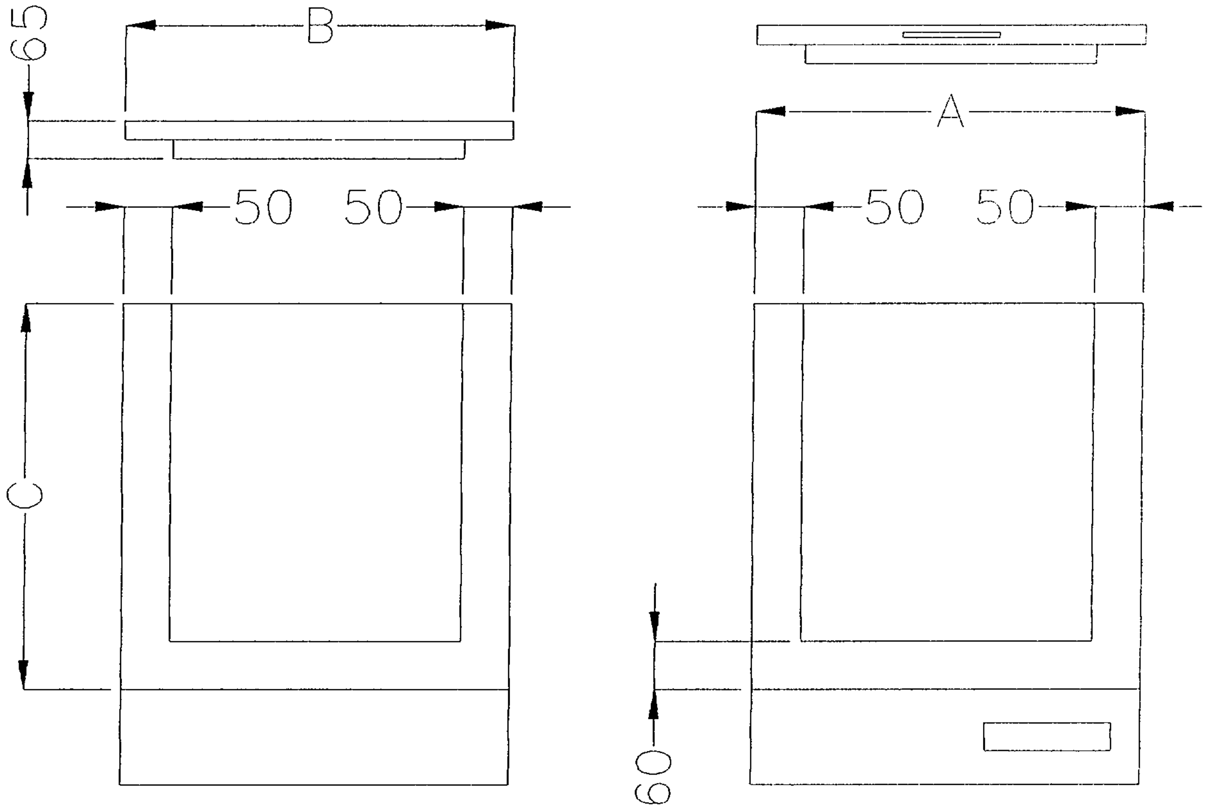
Model	**A**	**B**	**C**	**D**	**E**	**Freezer door**	**Cabinet door**
Fb32	540	474	1670	410	1110	540x480	540x1150
Fb30	540	474	1570	310	1110	540x380	540x1150
SR25	540	474	1374	310	915	540x380	540x955

B/3 Refrigerator *(single door)*



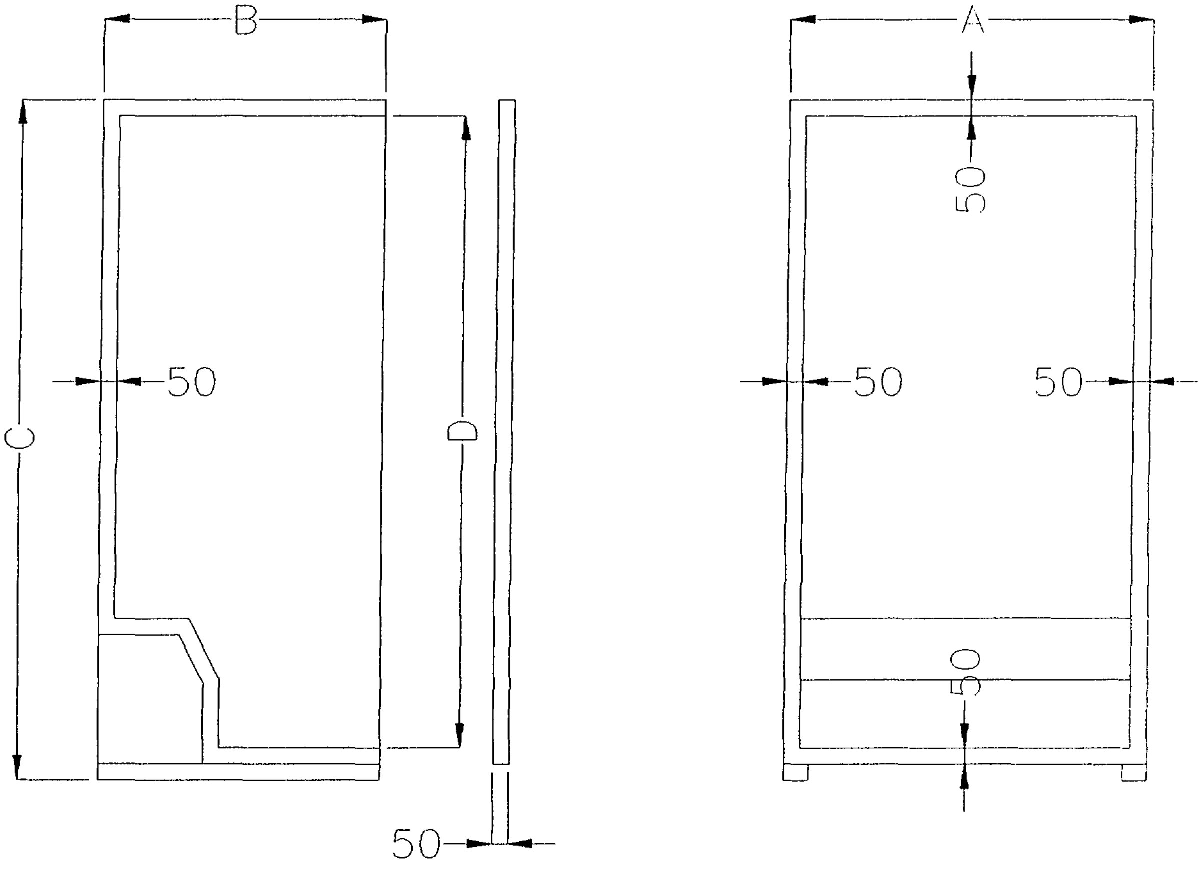
Model	**A**	**B**	**C**	**D**	**Freezer door**	**Cabinet door**
Fb15	540	474	809	718	-	540x776
Fb23	540	474	1195	1110	-	540x1167
Fb19	540	474	1005	913	-	540x975
Fb11	540	474	603	505	-	540x580

B/4 Chest freezer



Model	**A**	**B**	**C**	**D**	**E**	**Freezer door**	**Cabinet door**
Cf130	695	445	595	-	-	445x697	-
Cf180	695	630	595	-	-	630x697	-

B/5 Upright freezer



Model	A	B	C	D	Freezer door	Cabinet door
VF2029	595	500	1372	1175	-	1220x588

Laboratory tests

The tests is performed in a five models of the current refrigerator & freezer:

1-	Refrigerator Fb44-2	430 lit. double door
2-	Refrigerator Fb32-2	320 lit. double door
3-	Refrigerator Fb30-2	290 lit. double door
4-	Upright freezer VF2029	235 lit.
5-	Chest freezer CF180	180 lit.

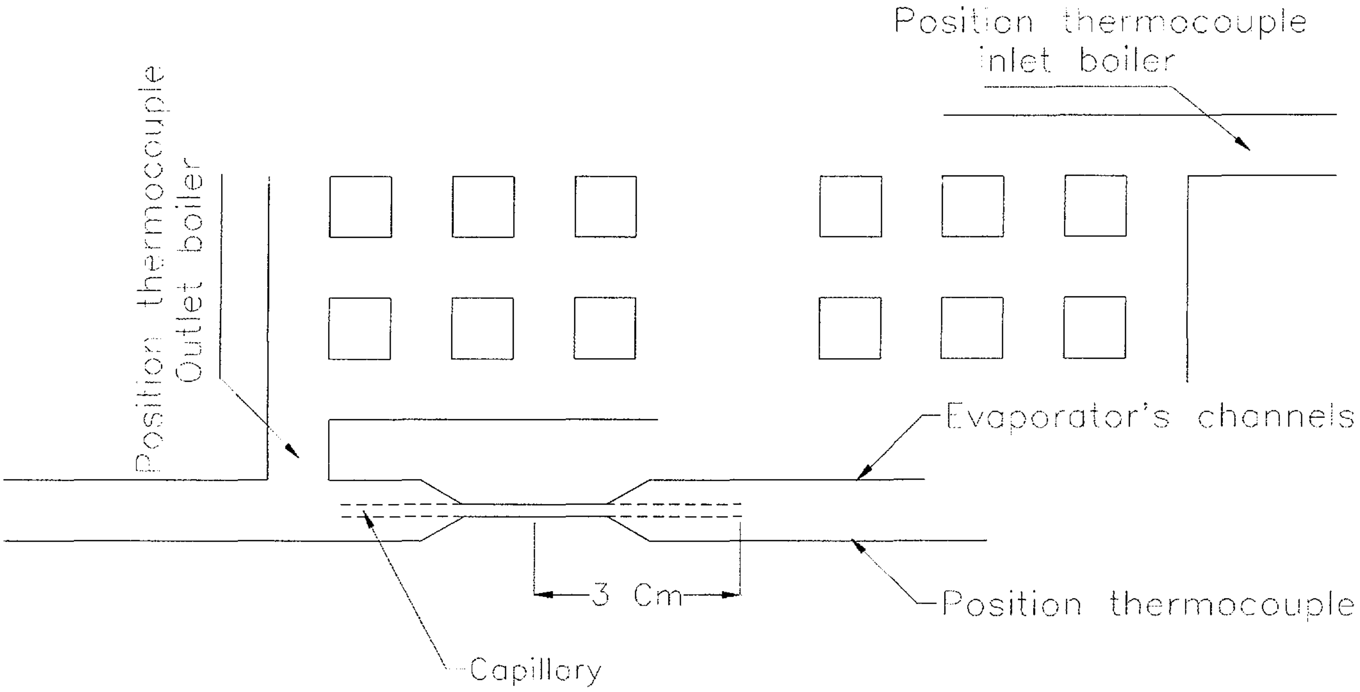
The test involved the following items:

- Charging determination
- Pull down test at 32 °C & 43 °C
- 100% loadless running at 32 °C
- Thermostat control at 16 °C, 25°C, 32°C
- Energy consumption at 25°C
- Storage test at 16°C & 32°C
- Low starting voltage
- Freezing capacity in kWh/24hr at 25°C

All the test according to *ISO 5155*

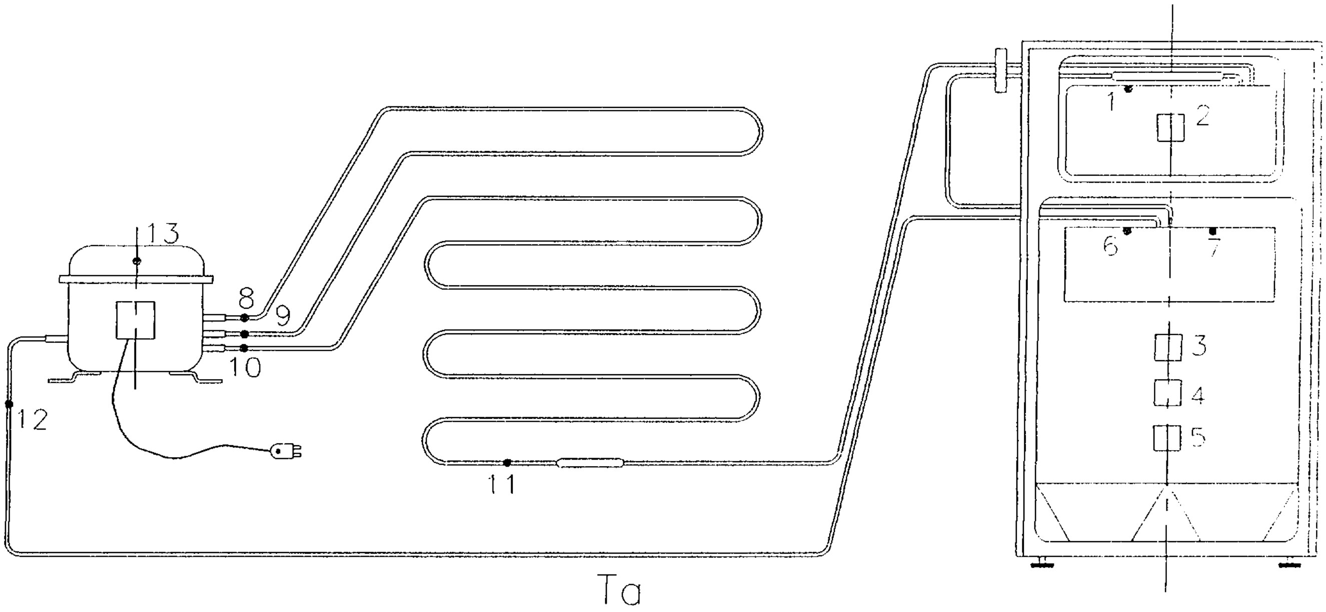
Charging determination method:

- The cooling system assembled to the relative cabinet.
- The system is to be charged with a quantity of refrigerant, which should be equal inferior to what is required normally by the system.
- The thermocouple will be contact with the outlet and inlet of the evaporator as the following drawing:



- After preparing the cabinet it should work continuously at ambient temperature 32C & 43C until stabilization.
- The difference in temperatures between the outlet and inlet should be always between 1&2C this in case the refrigerant charge is correct.

Measurement points



Pos.	Description
Ta	Ambient temp.
T1	Evaporator inlet
T2	Freezer center
T3	Cabinet top
T4	Cabinet center
T5	Cabinet bottom
T6	Thermostat bulb
T7	Evaporator exit
T8	Condenser inlet
T9	Oil cooling inlet
T10	Oil cooling exit
T11	Condenser exit

Pos.	Description
T12	Suction
T13	Compressor shell
T14	Package No.
T15	
T16	
T17	
T18	
T19	
T20	
T21	
T22	
T23	

Refrigerator Fb44
430 Lit.
Double door
4 star

siltal

Technical data:

Model: FB44-2 (430 Lit.)		**Unit**	**R134a**
Refrigerant	Charge	(Gr.)	210
Structure	H x W x D	Cm	170x70x62
	Internal volume freezer	Liters	100
	Internal volume cabinet	Liters	330
	Cabinet insulation thickness	Mm	30
	Freezer insulation thickness	Mm	50
Compressor	Model	Name	QA912CC GAX5
	Nominal power	W	207
	Capacity	Kcal/hr	-
	Displacement	Cc	9.03
	C.O.P.	Kcal/Wh	1.13
Discharge	Length of pipe	Mm	1480
	Dim.(exit/inlet)	Mm	8x6.5
Condenser	Type	Name	Sheet
	Width	Mm	670
	High	Mm	1300
	No. of legs	No.	10
	Length of tube	Mm	13850
	Volume	Cm^3	121
	Anti-Condensate length	Mm	6420xØ4.76
Capillary	N2 Flowrate	L/min	-
	Length	Mm	4500
	Inside diameter	Mm	0.8
Filter	Weight	Grams	12
Refrigerator evaporator	Type	Name	Roll band
	Width	Mm	460
	Height	Mm	380
	Cooling surface	Dm^3	0.384
	Number of pipe	Nr	-
	Length of pipe	Mm	-
	Dim.(exit/inlet)	Mm	8.1x8.1
	Volume	Dm^3	0.054
Freezer evaporator	Type	Name	Foamed in 4 faces
	Width	Mm	352x600
	Height	Mm	352x444
	Area	M^2	0.74
	Number of pipe	Nr	45
	Length of pipe	M	22
	Dim.(exit/inlet)	Mm	6.5x2.2
	Volume	Dm^3	-
Thermostat	type	Danfoss	O77B6222

Charging determination test

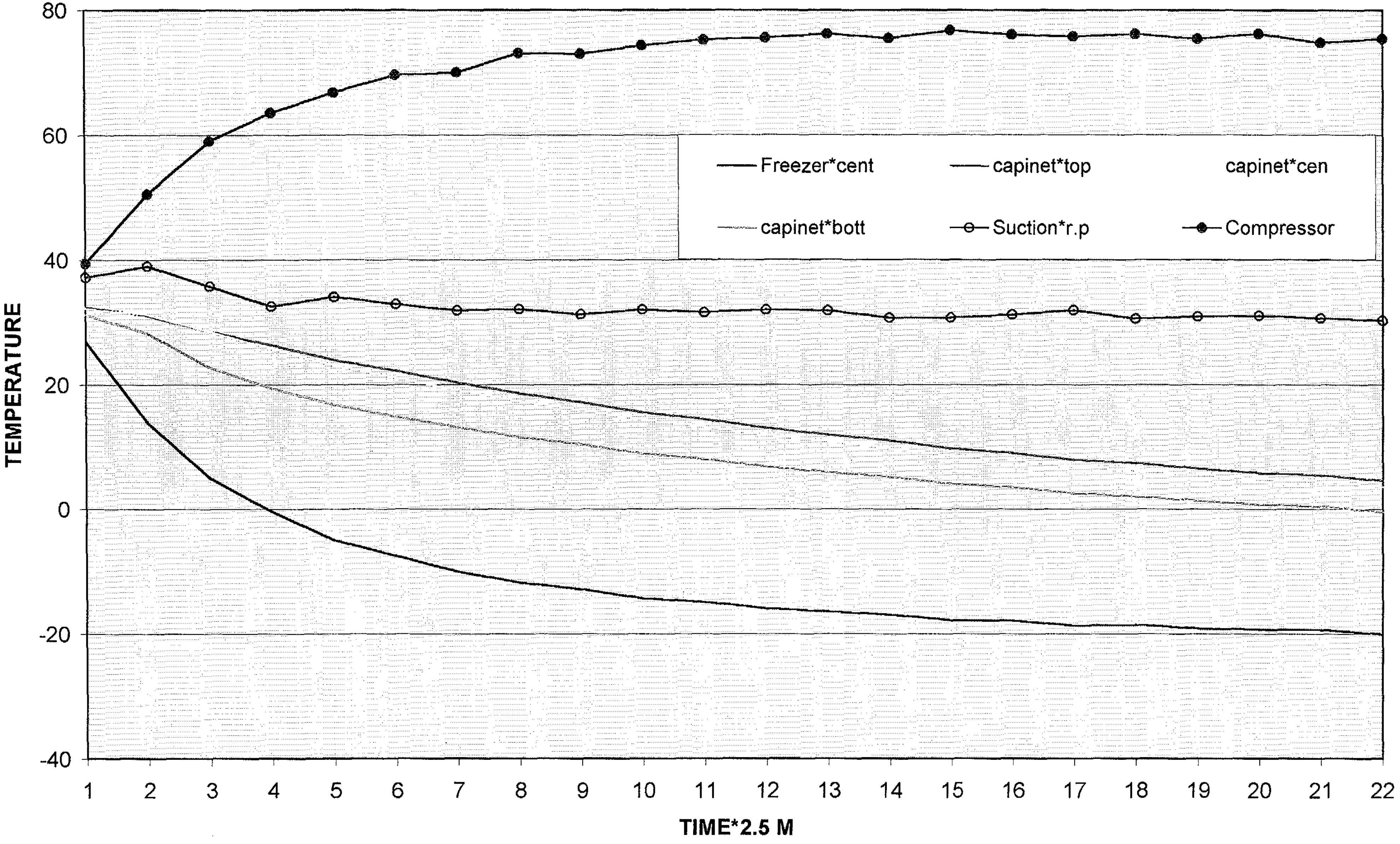
Model: FB44 (430 Lit.)			**Class T**	
Ambient temp.			**32**	**43**
Compressor			**QA91**	
Charged			**230**	
Capillary			**0.9x4500**	
Freezer Center		C	-27.8	-25.2
Thermostat bulb temp.		C	-24.0	-19.1
Evaporator input		C	-28.0	-23.3
Evaporator at exit		C	-28.3	-24.0
Cabinet	**T1**	C	-5.40	1.70
	T2	C	-7.00	0.60
	T3	C	-11.0	-3.90
	TAVG	C	-7.80	-0.50
Condenser	**Input**	C	83	93
	Exit	C	49	56
Suction		C	30.1	34
Compressor shell		C	75	85

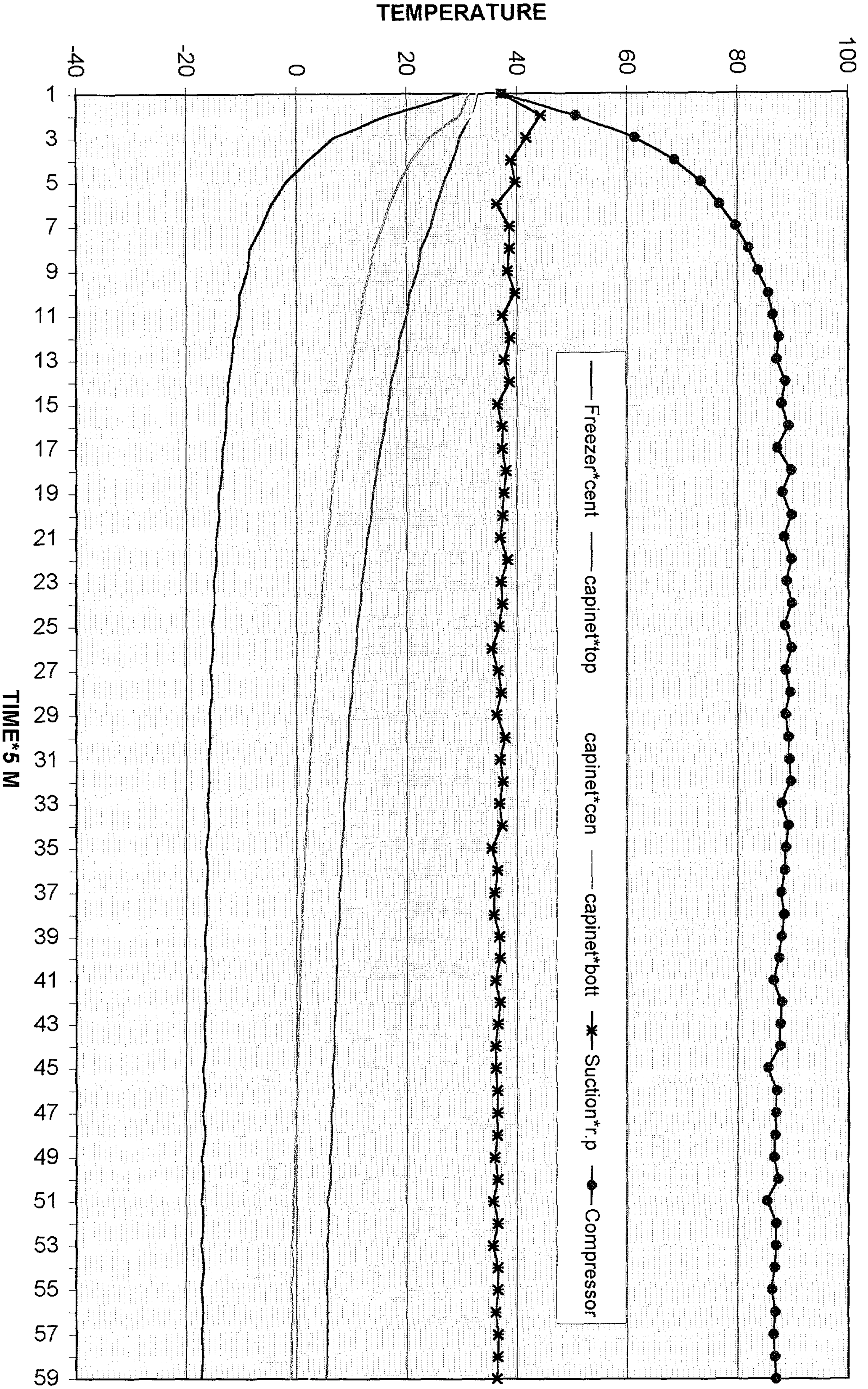
Pull down test

Model: FB44			
Compressor	**QA91**	Refrigerator: 430 Lit.	
Thermostat	**Short**	Charging:210 gr. 134a	
Temperature		°C	
Ambient		**32**	**43**
Freezer	**Center**	-20.9	-17.2
Cabinet	**T1**	4.61	5.17
	T2	3.61	2.91
	T3	-0.43	1.04
	T_{AVG}	2.60	3.20
Suction		30.26	36.0
Condenser	**Inlet**	82.7	94.0
	Outlet	48.5	57.7
Compressor shell		75.96	86.5
Winding temp.		98.8	110.7
Test time	**Min.**	105	240

SILTAL TEST ROOM

(FB44-AMB. TEMP.=32 C- THERMO POS.=MAX)





SILTAL TEST ROOM

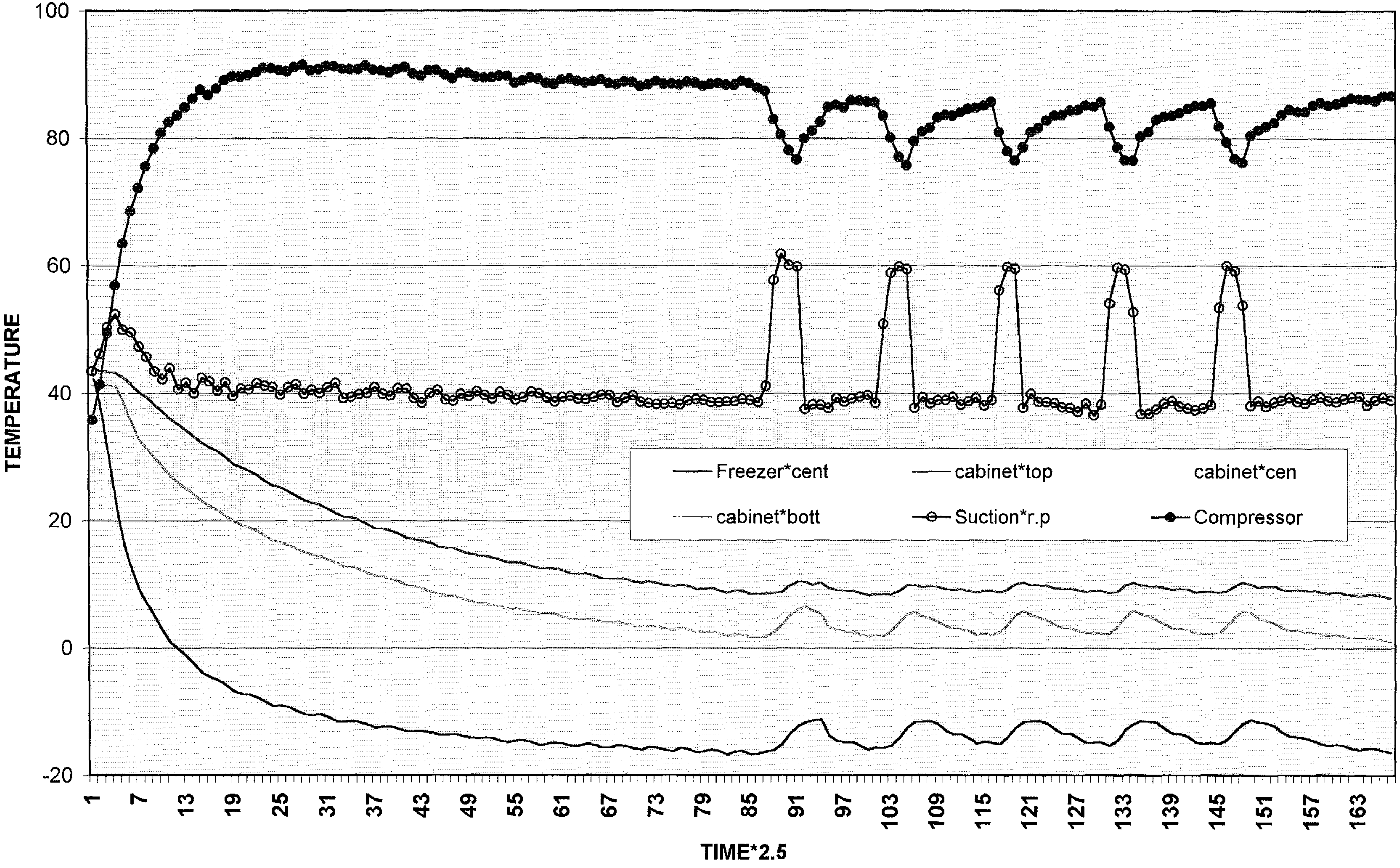
(FB44-QA91-210-R134a-AMB.TEMP.=43C-THERMO. POS.=MAX)

No load & thermostat control test

Model: FB44 (430 Lit.)							*Class T*					
Ambient		**C**	**43**		**38**		**32**		**25**		**18**	
Thermostat setting			**1**		**2**		**3.5**		**4**		**4**	
			OFF	**ON**	**OFF**	**ON**	**OFF**	**ON**	**OFF**	**ON**	**OFF**	**ON**
Freezer center		**C**	-16.2	-12.5	-18.6	-14.6	-20.5	-16.7	-18.01	-16.5	-18.4	-17.5
Thermostat bulb		**C**	-12.7	4.7	-15.4	4.74	-17.4	4.59	-20.16	4.7	-20.57	4.39
Cabinet	**T1**	**C**	8.6	9.9	5.1	7.3	4	6.09	4.17	5.57	2.3	3.3
	T2	**C**	4.5	6.05	1.23	3.6	0.37	3.47	1.9	2.82	0.55	1.3
	T3	**C**	1.8	5.3	-1.52	3.0	-1.9	2.21	0.02	3.8	-0.91	0.67
	T_{AVG}	**C**	**6.0**		**3.1**		**2.4**		**3.1**		**1.2**	
Evaporator	**Outlet**	**C**	-18.8	1.5	-22.1	1.88	-24.1	1.34	-24.6	1.19	-25.4	1.3
	Inlet	**C**	-18.5	1.9	-22.7	2.38	-24.4	2.09	-24.07	1.19	-25.15	1.42
Suction		**C**	41.15	59.5	34.4	52.7	34.8	50.1	23.3	36.7	18.7	27.5
Condenser	***outlet***	**C**	94.2	47.5	87.9	42.9	82.6	36	68.6	33.8	59.2	23.95
	Inlet	**C**	55.3	45.4	51.1	39.8	46.7	34.5	40.3	27.2	36.2	19.2
Compressor		**C**	85.2	75.7	70.1	68.0	72.2	61.1	59.5	50.1	47.8	41.0
Power		**Watt**						175				
Current		**Amp**						1.5				
Energy consumption kWh/24h							2.9					
Running time		**%**	**72%**		**70%**		**68%**		**50%**		**40%**	

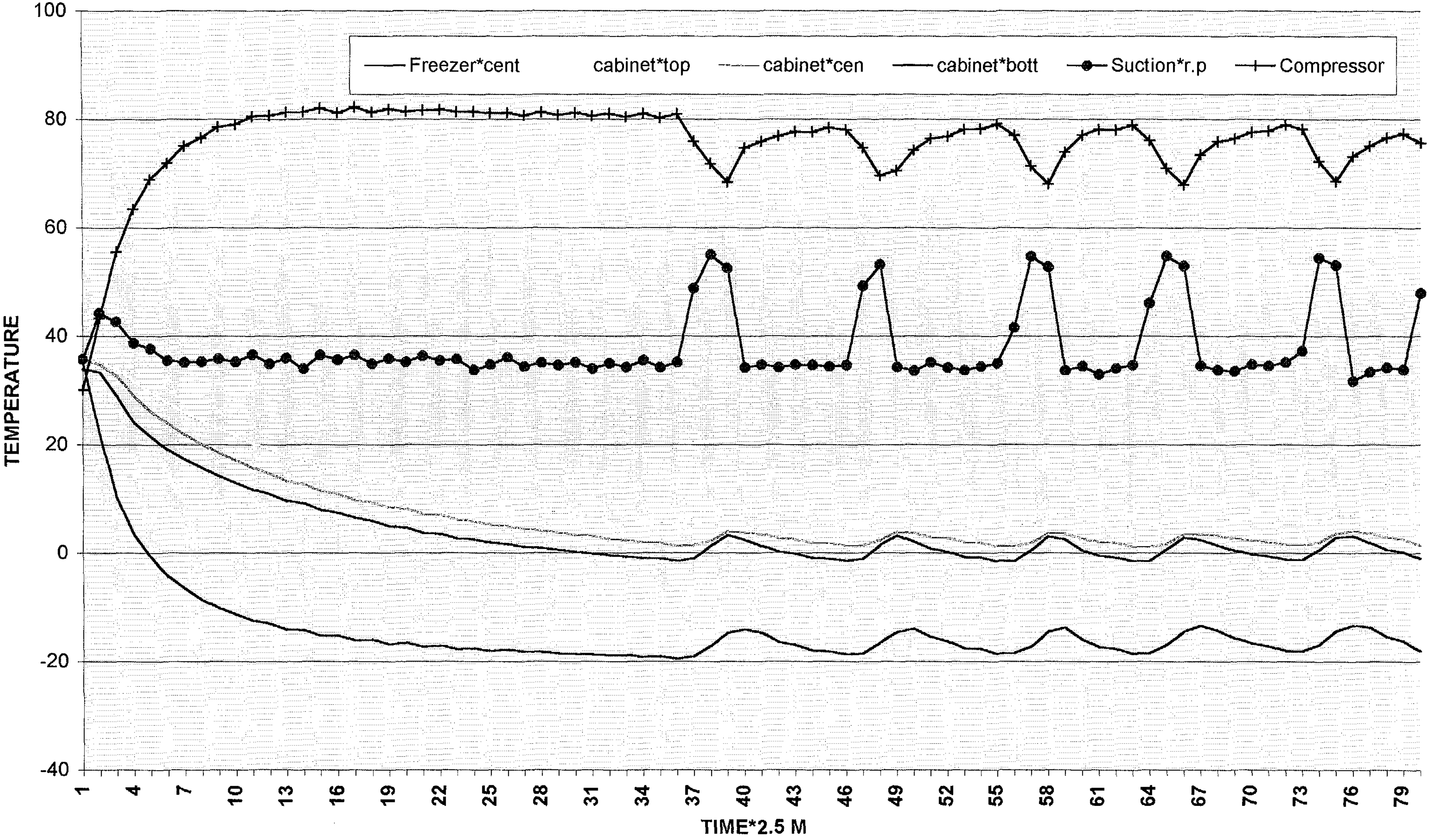
SILTAL TEST ROOM

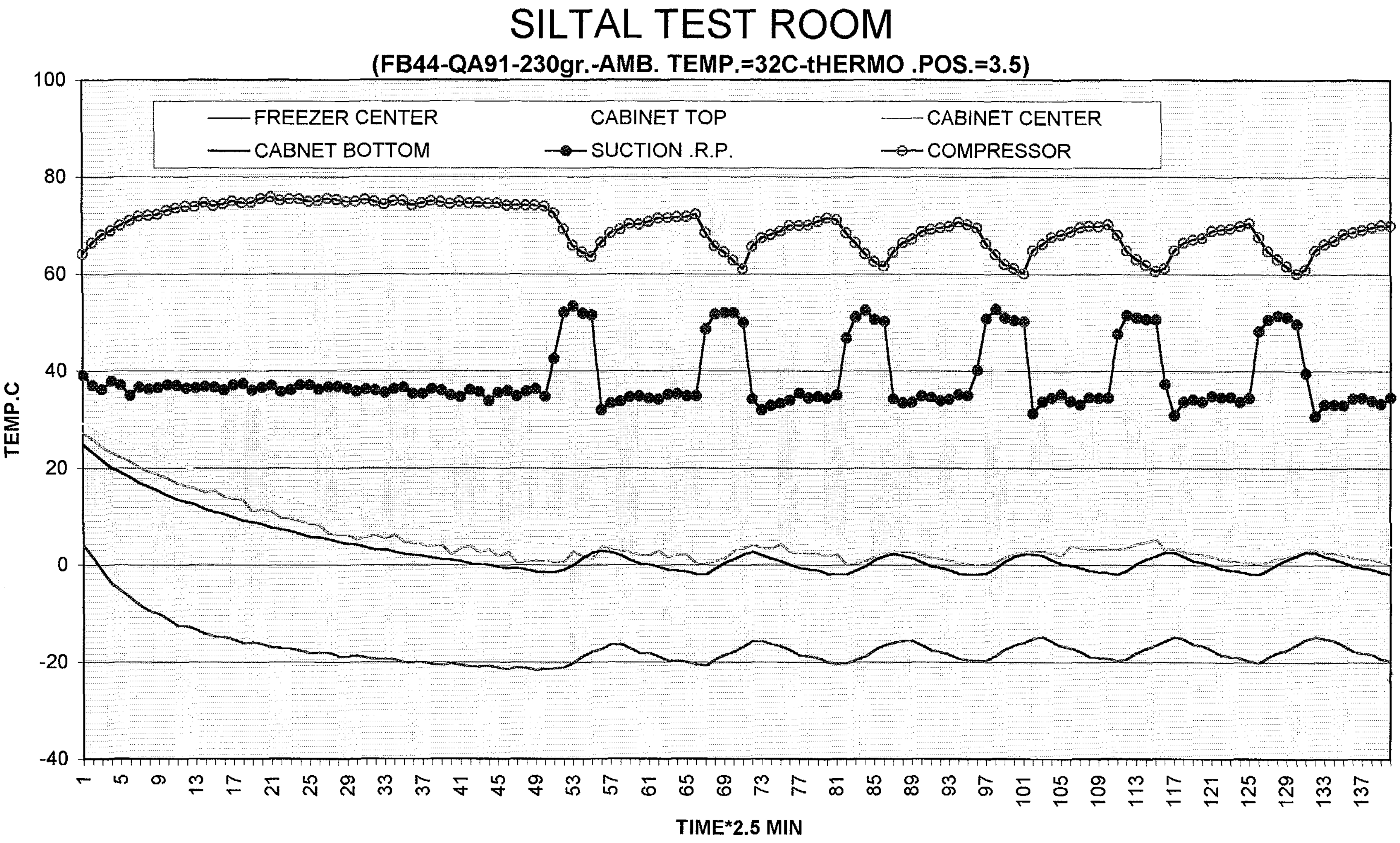
(FB44-AMB. TEMP.=43C-THERMO POS.=1)



SILTAL TEST ROOM

(FB44-QA91-210-R134a-AMB .TEMP.=38C-THERMO. POS.=2



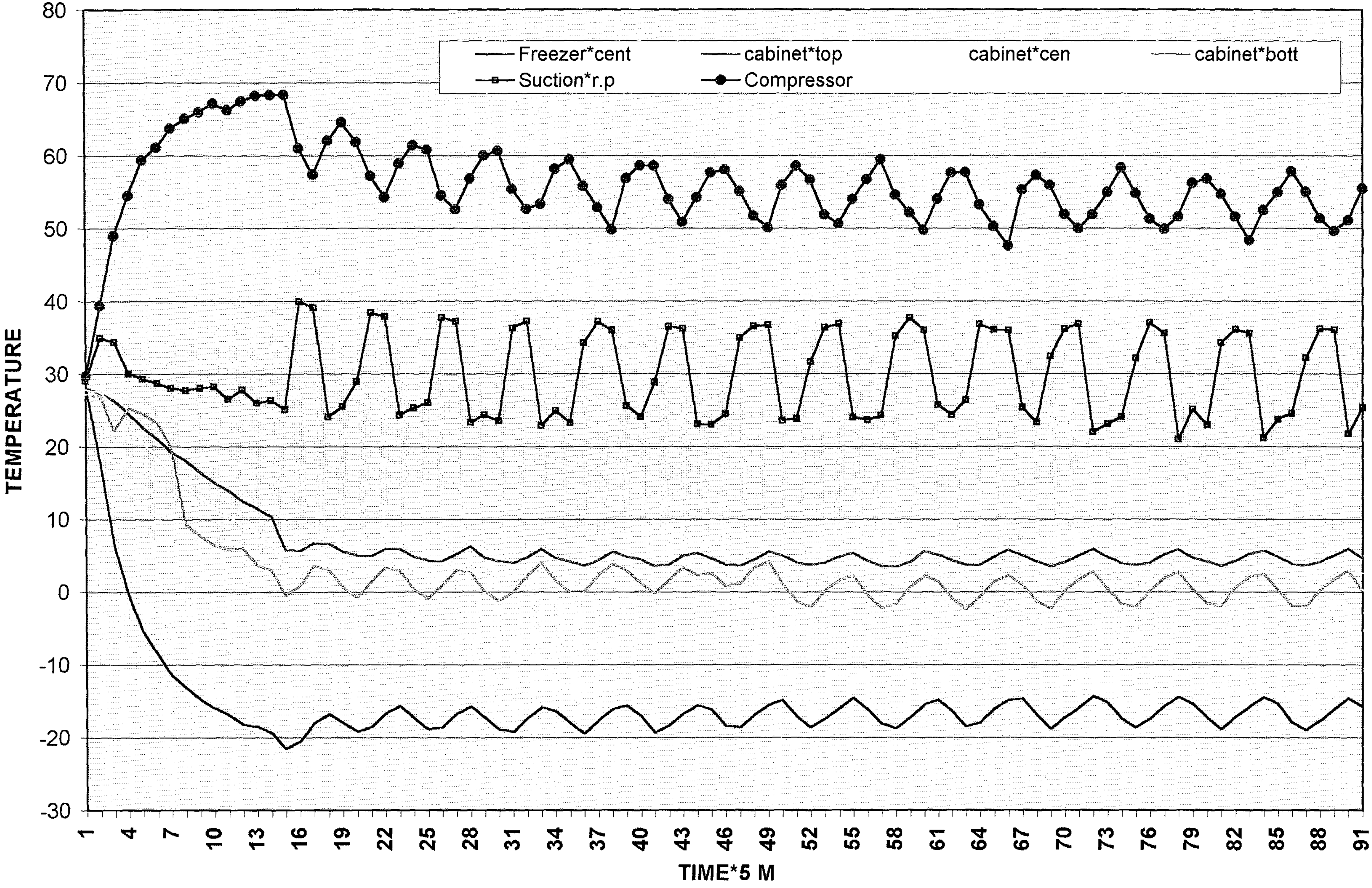


SILTAL TEST ROOM

(FB44-QA91-230gr.-AMB. TEMP.=32C-tHERMO .POS.=3.5)

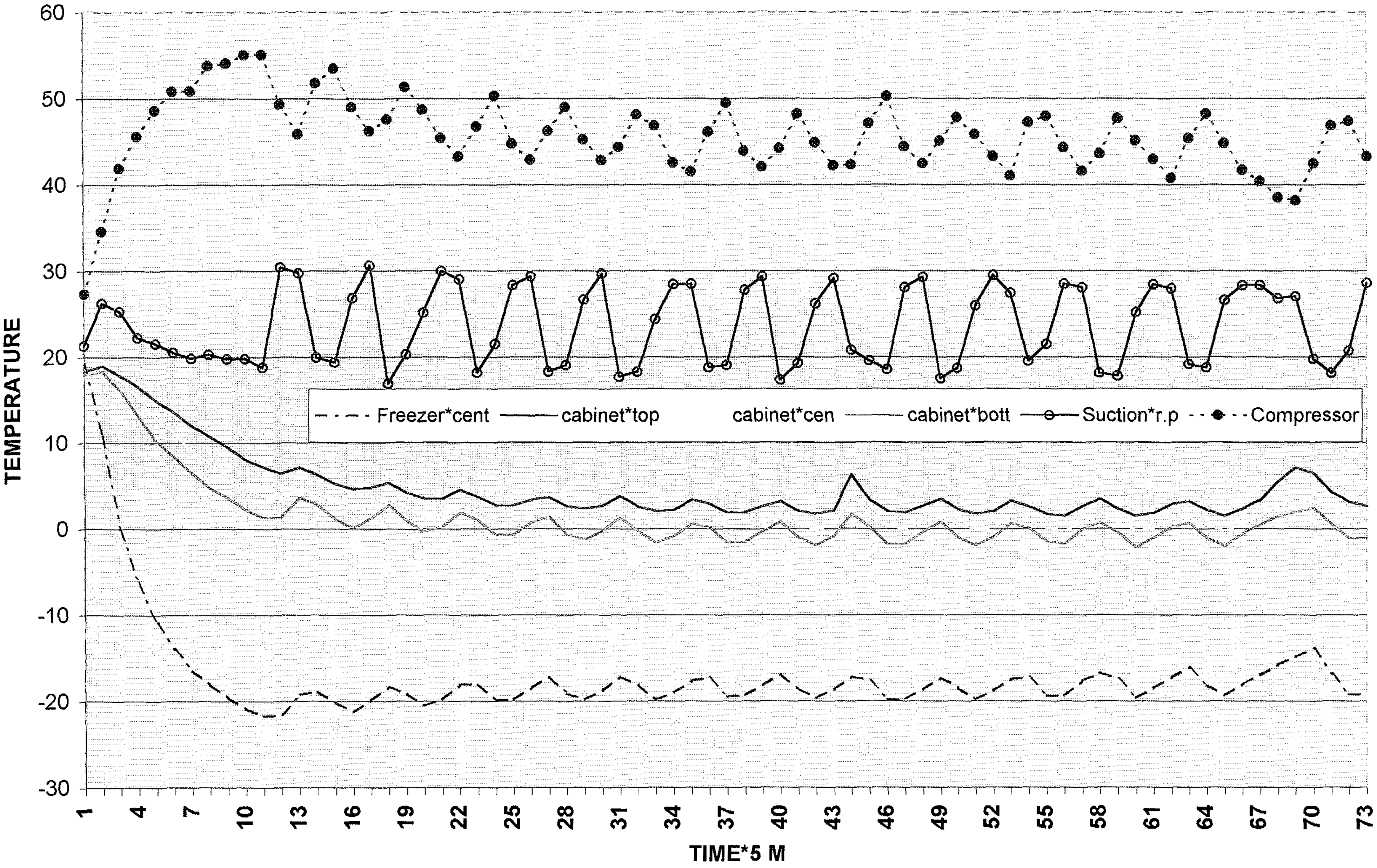
SILTAL TEST ROOM

(FB44-QA91-210-R134a-AMB .TEMP.=25C-THERMO. POS.=4)



SILTAL TEST ROOM

(FB44-QA91-210-R134a-AMB .TEMP.=18C-THERMO. POS.=4

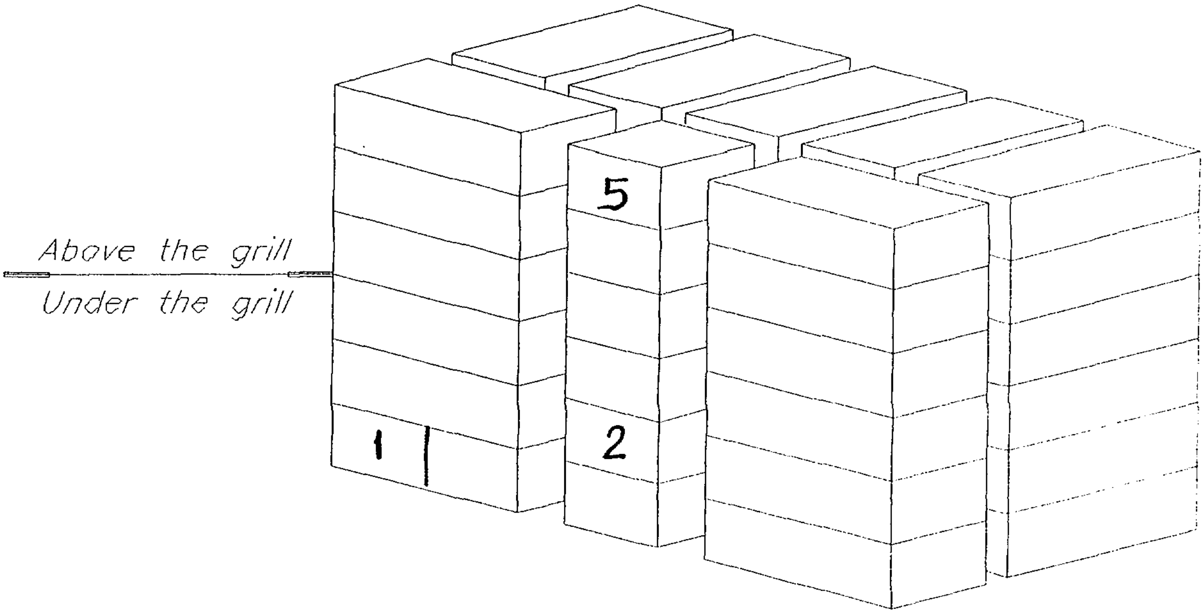


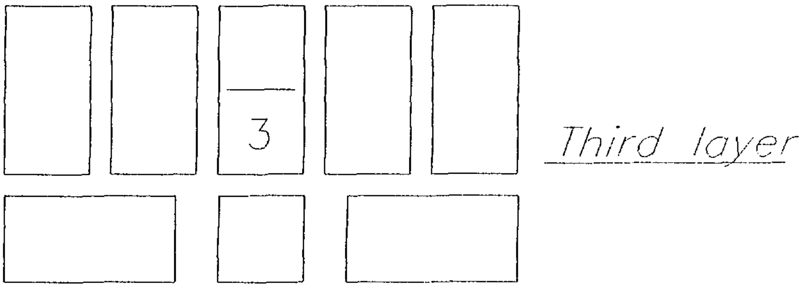
Storage and energy consumption

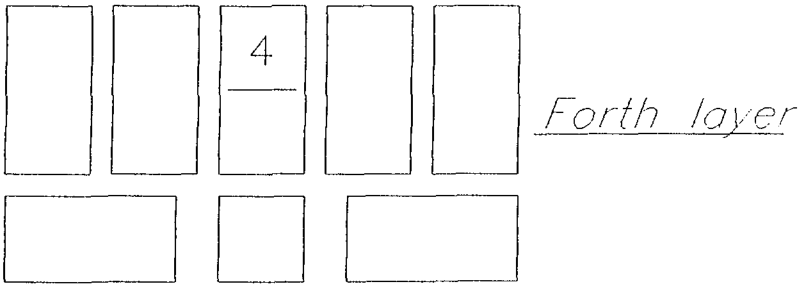
Model: FB44		**Class**					
Ambient		**32**		**25**		**16**	
Thermostat setting		**3.5**		**6**		**6**	
		ON	**OFF**	**ON**	**OFF**	**ON**	**OFF**
Thermostat bulb		4.3	-19.74	42.8	-23.6	4.57	-23.19
Cabinet	**T1**	7.81	2.3	6.9	-1.2	3.32	0.75
	T2	3.81	-3.6	2.20	-2.0	-1.8	3.6
	T3	3.3	-5.7	-1.4	-40	-2.5	-6.0
	TAVG	**1.32**		**0.1**		**-1.64**	
Pac temp.	**1**	-21.9	-20.8	-22.9	-23.0	-20.4	-21.1
	2	-18.6	-17.85	-21.4	-21.6	-18.8	-18.9
	3	-18.5	-17.5	-20.6	-20.6	-18.5	-18.9
	4	-18.5	-18.3	-22.2	-20.0	-18.0	-18.5
	5	-20.9	-19.2	-22.1	-21.9	-18.9	-19.2
	6						
	7						
	8						
Power			170	251	168		160
Current			1.5	1.7	1.4		1.4
Running		**68%**		**53%**		**50%**	
Energy cons. kWh/24h		**2.8**		**2.14**		**-**	

- Energy consumption : 2.8 kWh/24h
- Rising time at ambient temp. 32 °C
- Warmer pack from –18 °C to –9 °C in 14.30 hrs

Storage plane for refrigerator model: FB44



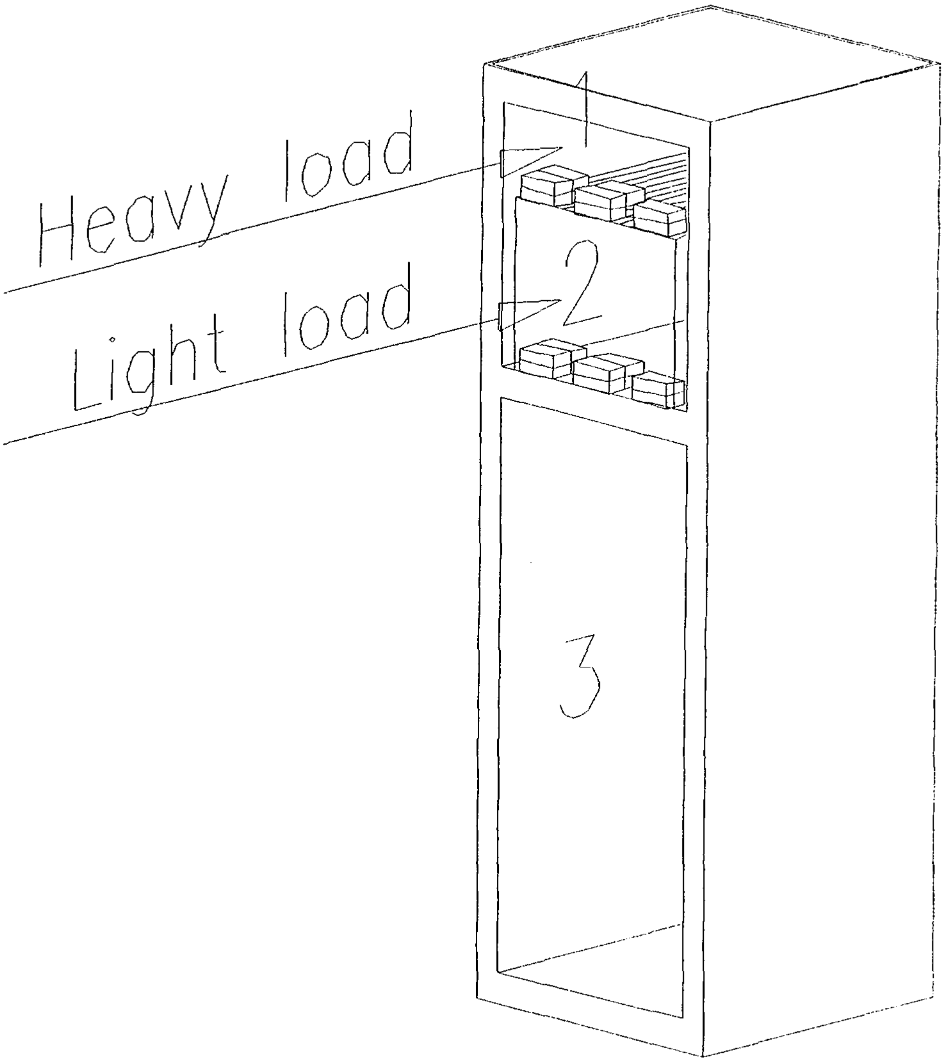




Number of layer	Weight
6	45 Kg.

Freezing test *(model FB44)*

- Continuos running at lowest temp.
- Heavy load (12 Kg.) at -20°C
- Light load (6 Kg.) after (8.08Hr.) at 32°C
- continuos running at hot test packet arrive –18
- Thermostat cycling for complete the test
- The hot test packet –18 arrive after (25 Hr.) from the beginning of the test.



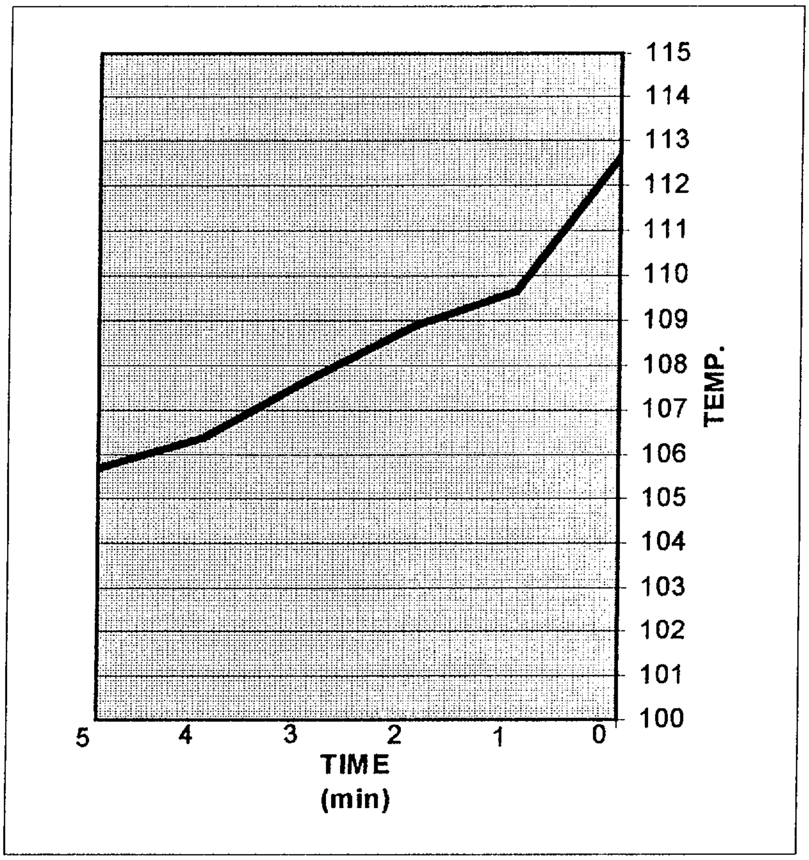
Freezing capacity test at 32 C **(model Fb 44)**

T. Cabinet av.	+ 1.2
T. Freezer av.	-20
Light load weight kg.	6 kg
Heavy load weight kg.	12 kg
Run time before light load	8h. 08'
Freezing time	25.0
Thermostat position	3.5
Warmest pack temp.	-18.2

Temperature rise and low starting test
(for FB44)

-Volt will be 233 at 43 C°
-Measurement of motor winding resistance and temperature

Time/min	0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0
Temp.	112.62	110.63	109.64	109.34	108.84	108.15	107.65	106.66	106.36	105.96	105.66



-After 30 min the starting test will be happen at volt 187
No 3 starting the compressor regular start.

Refrigerator Fb32
320 Lit.
Double door
4 star

siltal

Technical data:

Model: FB32-2 (320 Lit.)		***Unit***	***R134a***
Refrigerant	Charge	(Gr.)	150
Structure	H x W x D	Cm	168x54x55
	Internal volume freezer	Liters	80
	Internal volume cabinet	Liters	230
	Cabinet insulation thickness	Mm	30
	Freezer insulation thickness	Mm	50
Compressor	Model	Name	FB10G
	Nominal power	W	192
	Capacity	Kcal/hr	-
	Displacement	Cc	9.05
	C.O.P.	Kcal/Wh	0.98
Discharge	Length of pipe	Mm	1385
	Dim.(exit/inlet)	Mm	8x6.5
Condenser	Type	Name	Sheet
	Width	Mm	510
	High	Mm	1120
	No. of legs	No.	8
	Length of tube	Mm	7180
	Volume	Cm^3	135
	Anti-Condensate length	Mm	5520xØ4.76
Capillary	N2 Flowrate	L/min	-
	Length	Mm	3600
	Inside diameter	Mm	0.8
Filter	Weight	Grams	12
Refrigerator evaporator	Type	Name	Roll bond
	Width	Mm	400
	Height	Mm	300
	Cooling surface	Dm^3	0.24
	Number of pipe	Nr	-
	Length of pipe	Mm	-
	Dim.(exit/inlet)	Mm	8.1x8.1
	Volume	Dm^3	0.05
Freezer evaporator	Type	Name	Foamed in 4 faces
	Width	Mm	420x450
	Height	Mm	420x410
	Area	M^2	0.72
	Number of pipe	Nr	31
	Length of pipe	M	14.1
	Dim.(exit/inlet)	Mm	6.5x2.2
	Volume	Dm^3	-
Thermostat	type	Danfoss	O77B6222

Charging determination test

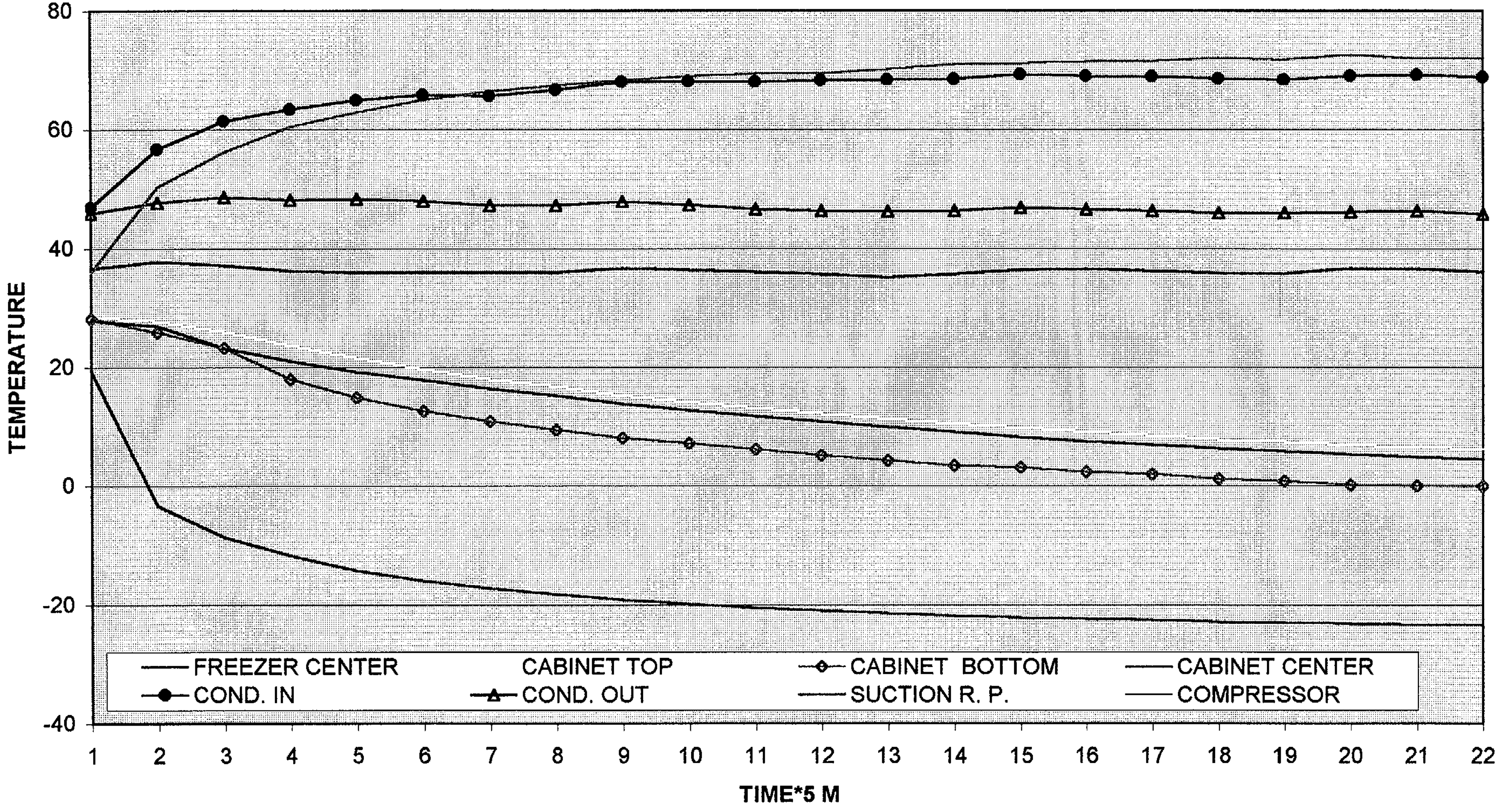
Model: FB32 (320 Lit.)			Class ST	
Ambient temp.			32	43
Compressor			FR10G	
Charged			150	
Capillary			0.8x3600	
Freezer Center		C	-24.0	-17.9
Thermostat bulb temp.		C	-20.0	-14.2
Evaporator input		C	-23.2	-17.8
Evaporator at exit		C	-22.1	-18.9
Cabinet	T1	C	1.70	8.90
	T2	C	1.00	6.10
	T3	C	-0.50	4.80
	TAVG	C	0.70	6.60
Condenser	Input	C	66.9	84.2
	Exit	C	38.1	49.0
Suction		C	30.9	40.5
Compressor shell		C	62.4	75.3

Pull down test

Model: FB32			
Compressor	**FRG10**	Refrigerator: 320 Lit.	
Thermostat	**Short**	Charging:150 gr. 134a	
Temperature		°C	
Ambient		**32**	**43**
Freezer	**Center**	-23.4	-19.8
Cabinet	**T1**	6.20	7.50
	T2	4.50	6.50
	T3	-0.10	6.00
	TAVG	3.50	6.70
Suction		36.0	44.2
Condenser	**Inlet**	68.8	86.3
	Outlet	45.8	53.6
Compressor shell		71.9	78.1
Winding temp.		95.0	113.8
Test time	**Min.**	107	240

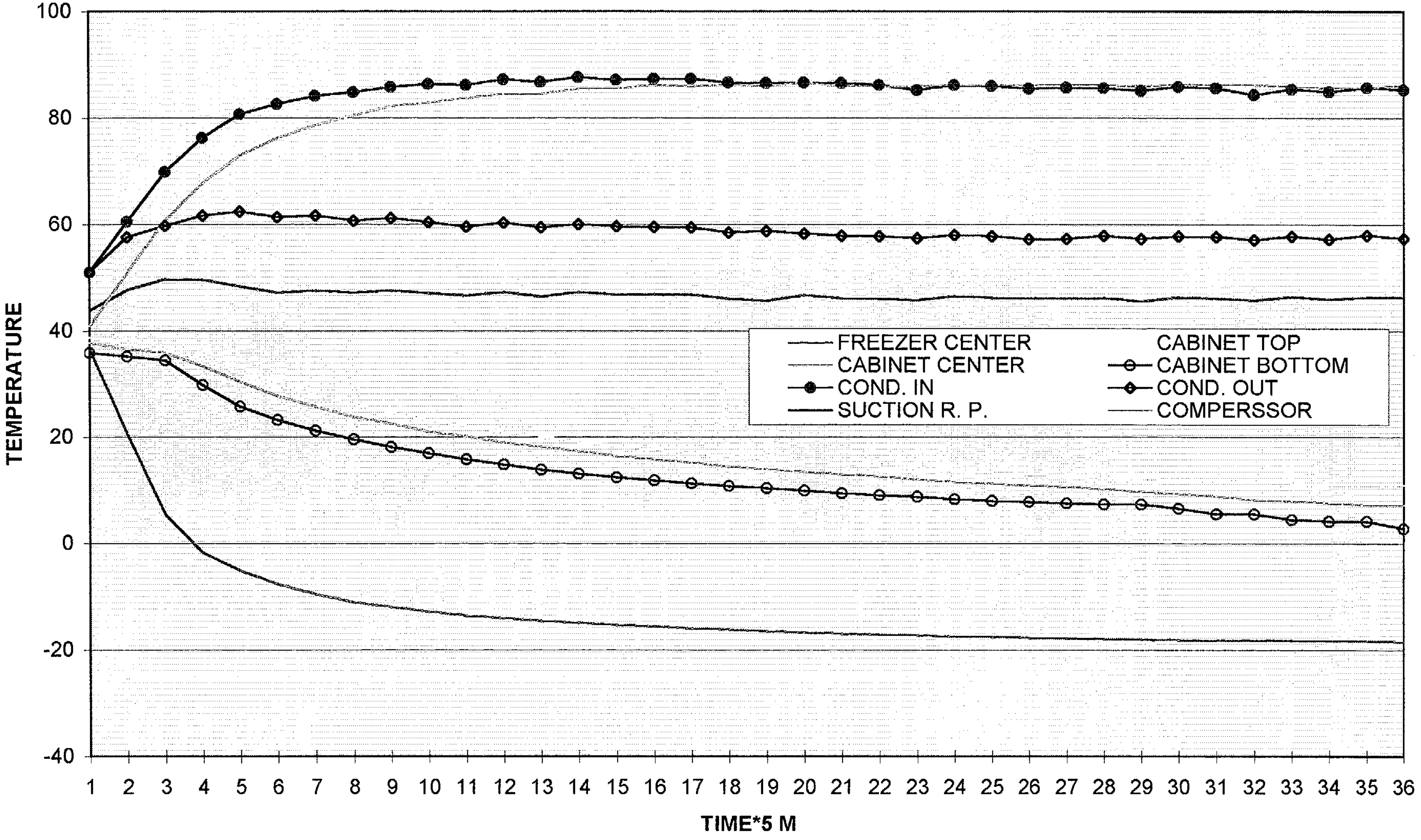
SILTAL TEST ROOM

(FB32-FR10 G-150 gr.-AMB. TEMP.=32 C-THERMO POS.=MAX)



SILTAL TEST ROOM

(FB32-FR10 G-150 gr.-AMB. TEMP.=43 C- THERMO. POS.=MAX)



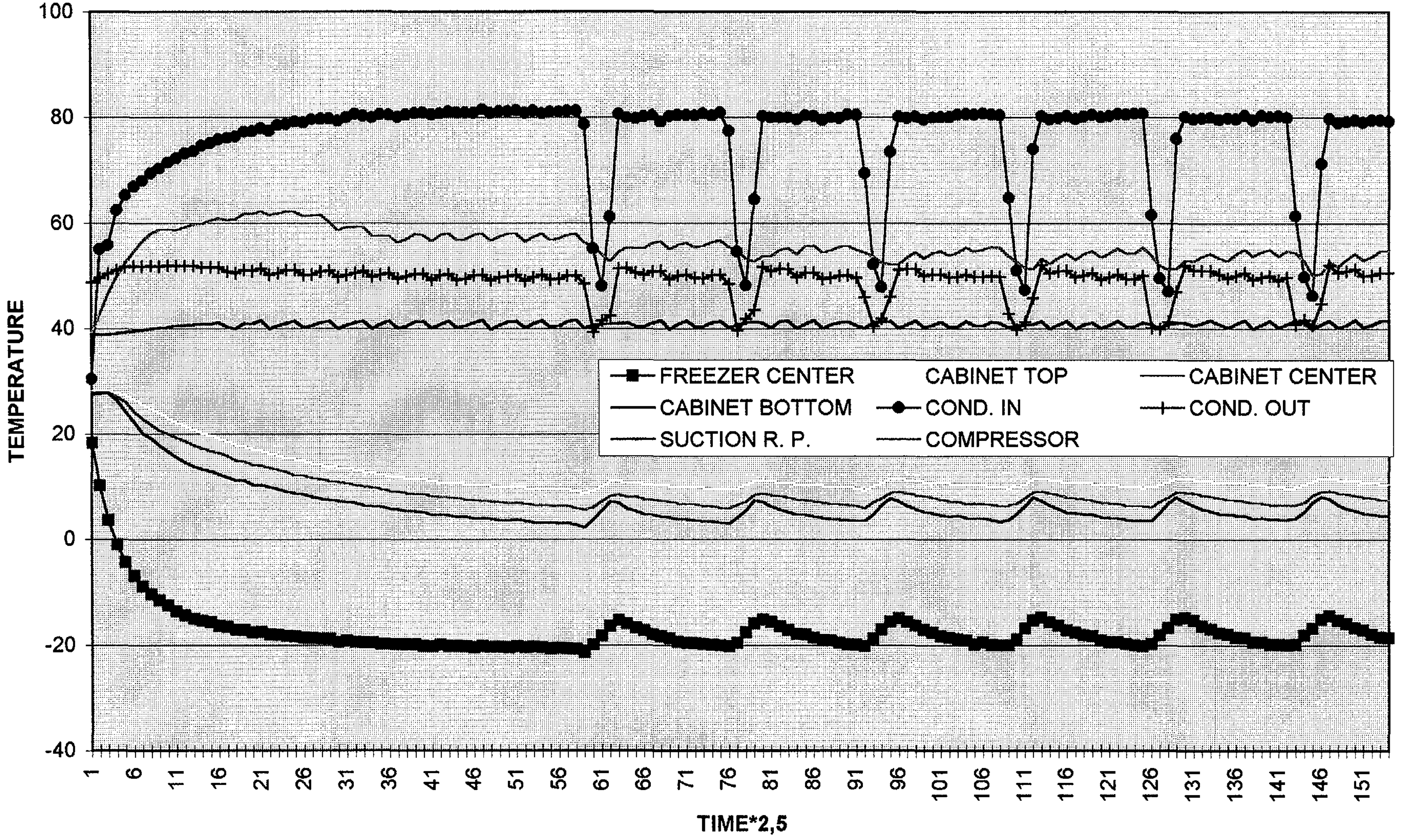
No load & thermostat control test

Model: FB32 (320 Lit.) ***Class ST***

Ambient			**38**		**32**		**25**		**18**		**16**	
Thermostat setting			**-**		**4**		**4**		**5**		**-**	
			OFF	ON	OFF	ON	OFF	ON	OFF	ON	OFF	ON
Freezer center		C	-21.4	-16.9	-23.5	-18.9	-21.6	-18.6	-25	-21.2	-29.8	-23.7
Thermostat bulb		C	-17.1	1.1	-20.5	2.1	-20.3	2.5	-23.5	2.7	-24.4	3.0
Cabinet	**T1**	C	7.9	9.9	5.8	7.6	5.4	7.4	4.7	3.7	1.9	3.4
	T2	C	5.6	8.3	2.5	5.4	3.7	5.7	3.1	2	-1.3	1.1
	T3	C	2.3	7.0	1.6	5.3	-.02	4	-0.3	0.9	-1.2	-0.1
	Tavg	C	**7.1**		**6.2**		**4.3**		**2.4**		**0.63**	
Evaporator	**Inlet**	C	-18.1	1.4	-20.3	2.5	-20.9	2.9	-23.5	2.5	-24.1	3.4
	Outlet	C	-20.2	3.3	-22.9	6.3	22.4	6	25.1	4.1	-26.2	4.9
Suction		C	40	41.1	36	42.3	29.6	33.1	23.2	26	22.6	23.9
Condenser	**Inlet**	C	78.7	46.2	68.6	42.4	55.7	35.7	50.2	23.5	45.9	21.4
	outlet	*C*	48.4	40.6	42	35	36.6	25.7	28.5	19.6	24.6	18
Compressor		C	56.2	50.1	66.8	56.4	49.4	42.7	46.7	36.9	46.6	34.8
Power		Watt	176		169		166		156		145	
Current		Amp	1.5		1.5	-	1.5		1.5		1.5	
Energy cons.							2.27					
Running time		%	**88%**		**71%**		**51%**		**43%**		**33%**	

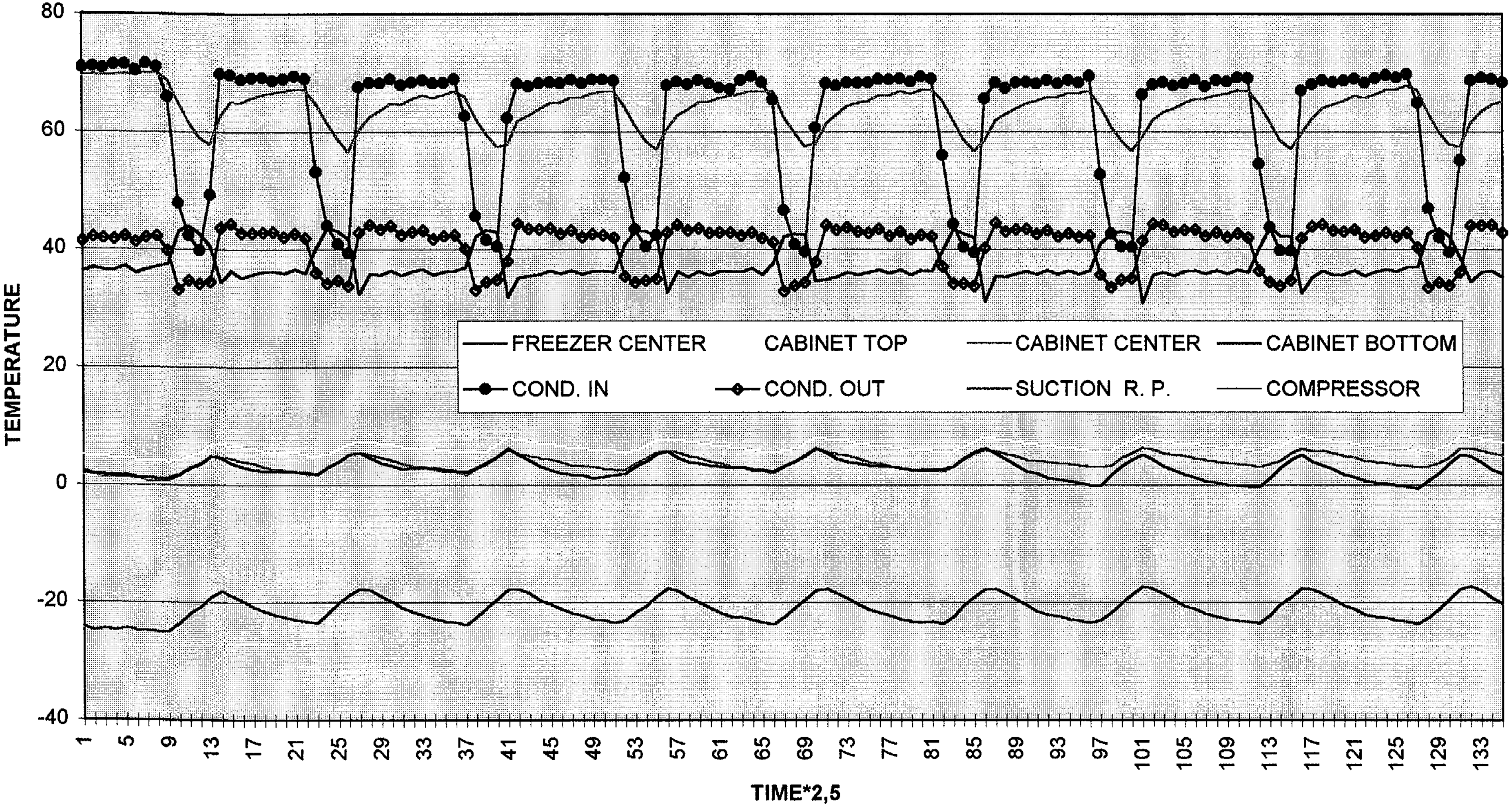
SILTAL TEST ROOM

(FB32-FR10 G-150 gr-AMB. TEMP.=38C-THERMO POS.=2)



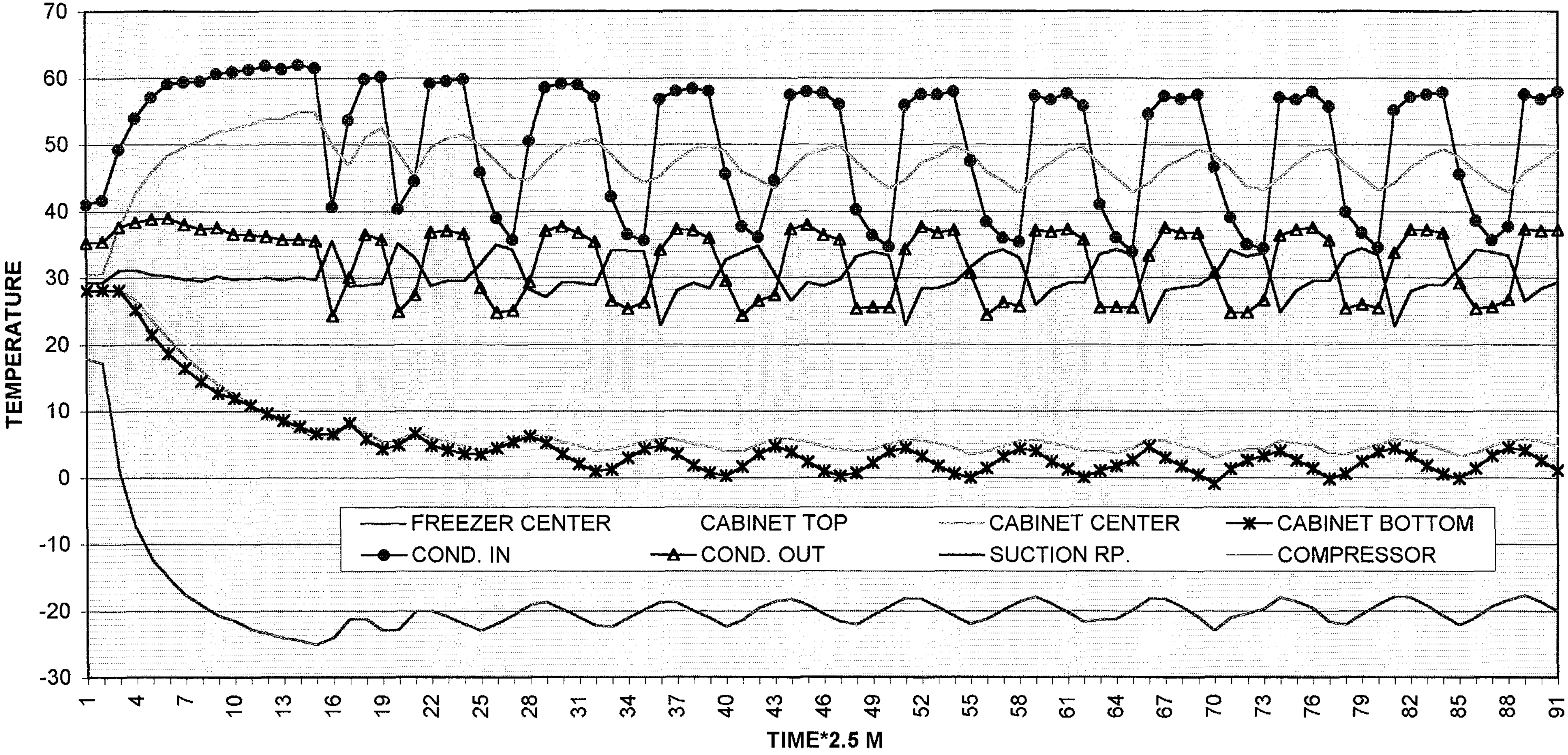
SILTAL TEST ROOM

(FB32-FR10 G-150 gr-AMB. TEMP.=32C-THERMO POS.=4)



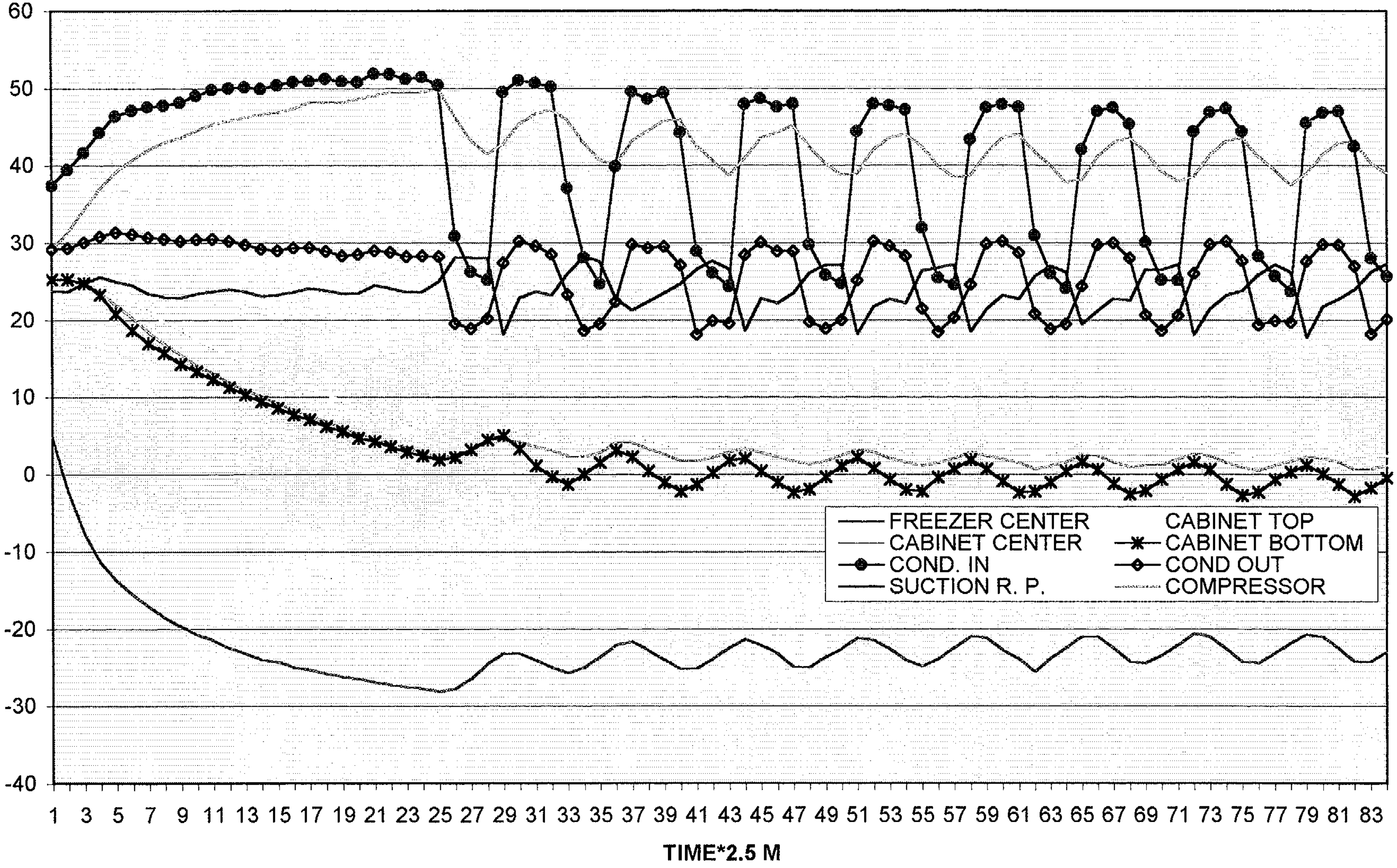
SILTAL TEST ROOM

(FB32-FR10G-150 gr.-AMB. TEMP.=25 C-THERMO POS.=4)



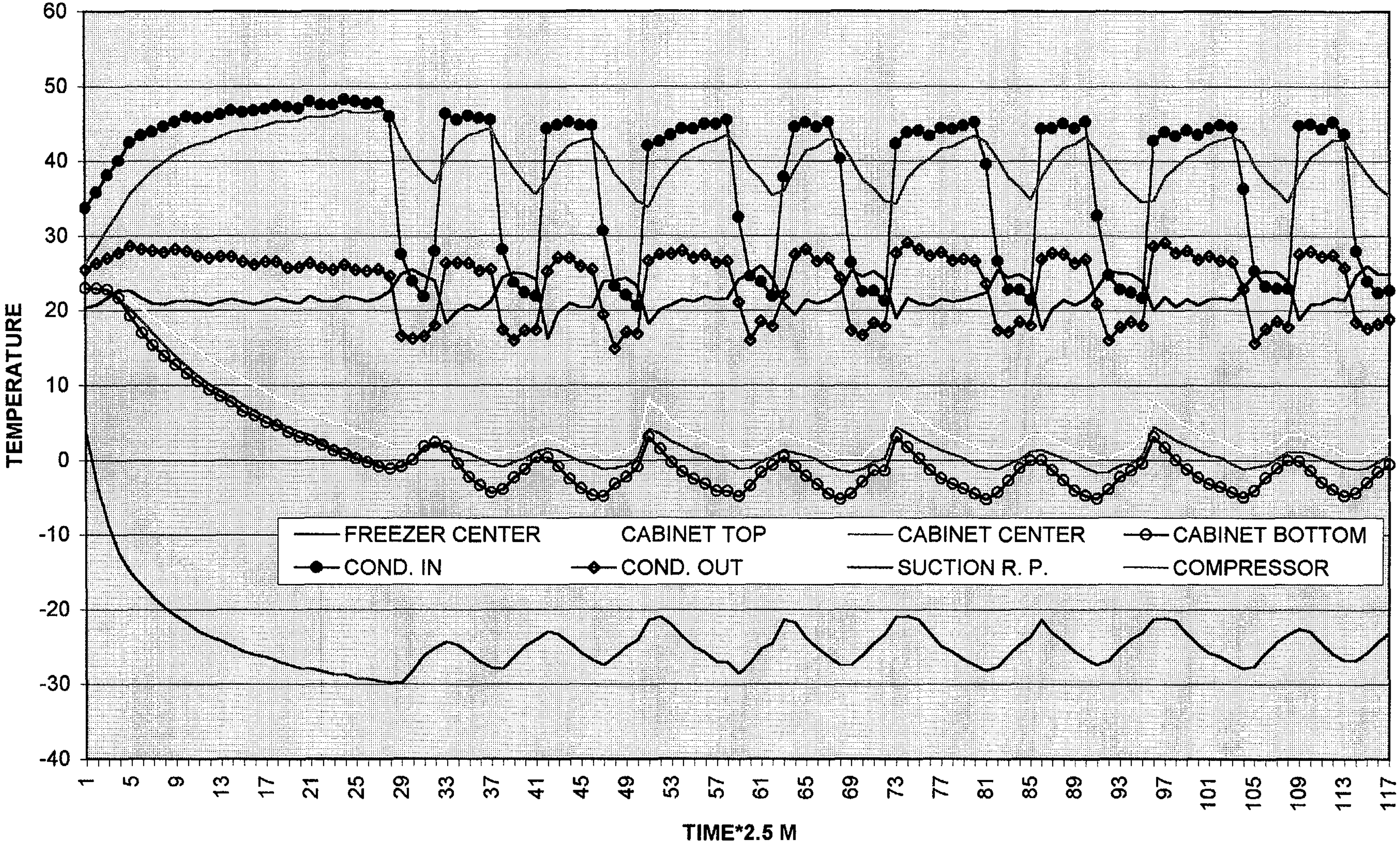
SILTAL TEST ROOM

(FB32-FR10 G-150 gr.-AMB. TEMP.=18C-THERMO. POS.=5)



SILTAL TEST ROOM

(FB32-FR10 G-150 gr.-AMB. TEMP.=16C-THERMO POS.=6)



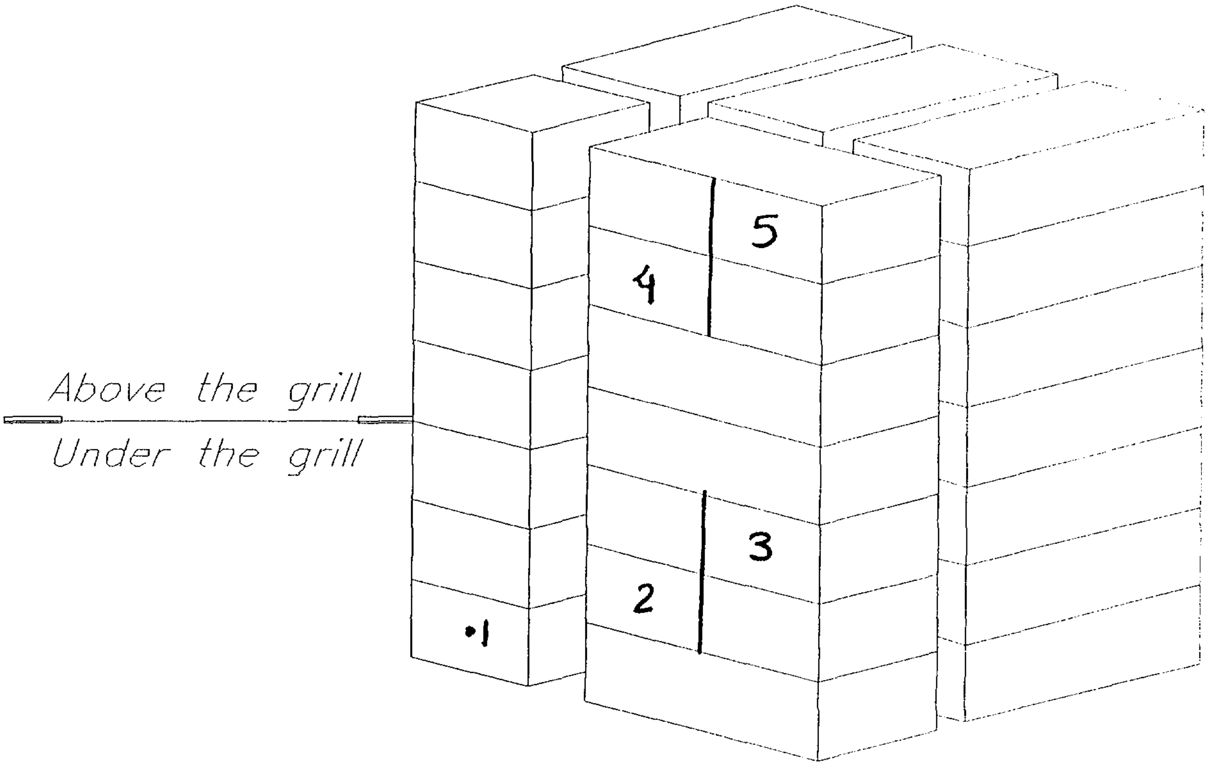
Storage and energy consumption

Model: FB32		**Class ST**					
Ambient		**32**		**25**		**16**	
Thermostat setting		**4**		**5**		**6**	
		ON	**OFF**	**ON**	**OFF**	**ON**	**OFF**
Thermostat bulb		1.8	-20.6	4.4	-24.5	4.8	-23.5
Cabinet	**T1**	7.0	4.8	5.6	-2.3	3.1	-1.6
	T2	5.6	3.0	3.9	-3.5	2.8	-1.9
	T3	4.5	0.9	3.8	-5.7	1.5	-3.0
	TAVG	**4.3**		**0.3**		**0.15**	
Package temp.	**1**	-22.1	-22.1	-25.1	-25.5	-19.4	-19.6
	2	-21.0	-21.3	-23.0	-23.2	-16.6	-16.9
	3	-20.6	-20.7	-21.8	-22.0	-16.9	-16.9
	4	-18.3	-18.5	-17.8	-18.0	-17.4	-17.6
	5	-19.6	-20.5	-18.2	-20.0	-17.7	-18
	6						
	7						
	8						
Power			157		154		151
Current			1.41		1.41		1.51
Running		**74%**		**55%**		**35%**	
Energy cons. kWh/24h		**2.97**		**2.03**		**1.27**	

* Energy consumption : 2.03 Kwh/24h

- Rising time at ambient temp. 25°C
- Warmer packing from –18°C to -9°C in 12 hrs

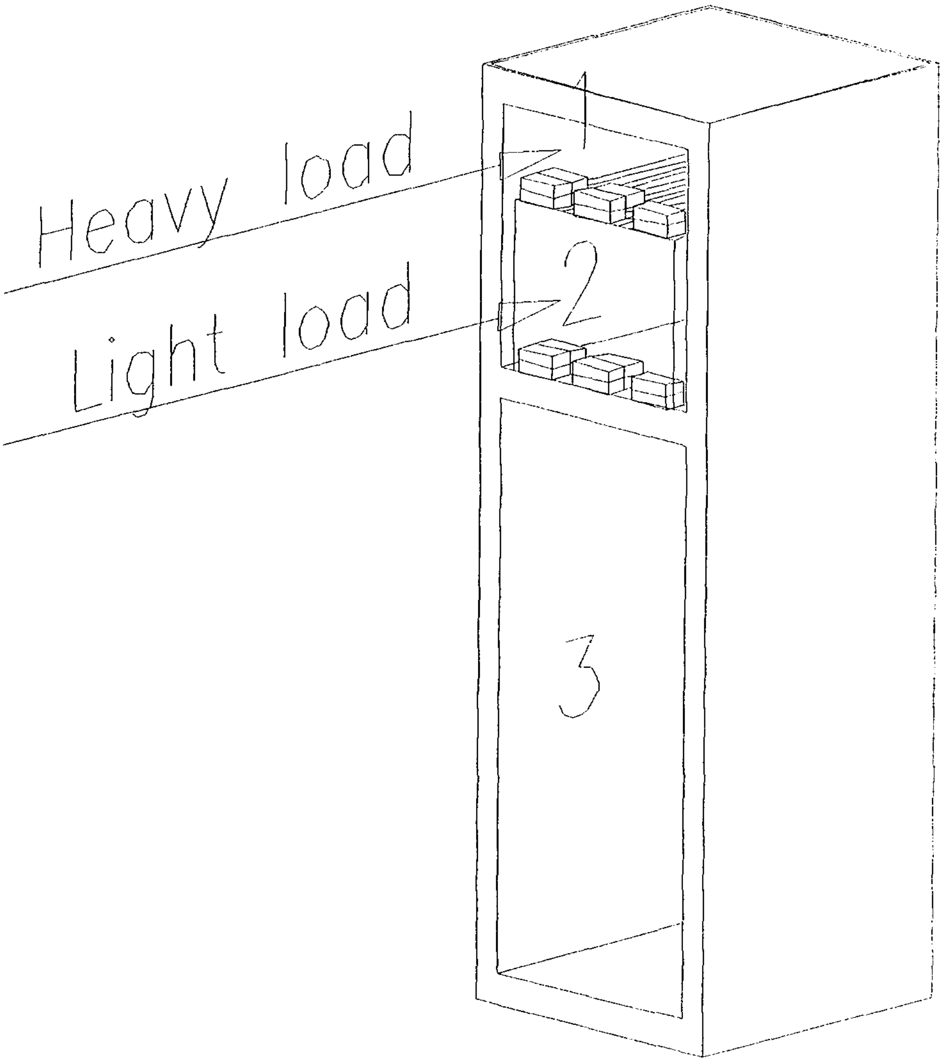
Storage plane for refrigerator model: FB32



Number of layer	Weight
7	31.5

Freezing test *(model FB32)*

- Continuos running at lowest temp.
- Heavy load (7.0 Kg.) at -20°C
- Light load (6.0 Kg.) after (7,30 Hr.) at 25°C
- continuos running at hot test packet arrive –18
- Thermostat cycling for complete the test
- The hot test packet –18 arrive after (24 Hr.) from the beginning of the test.



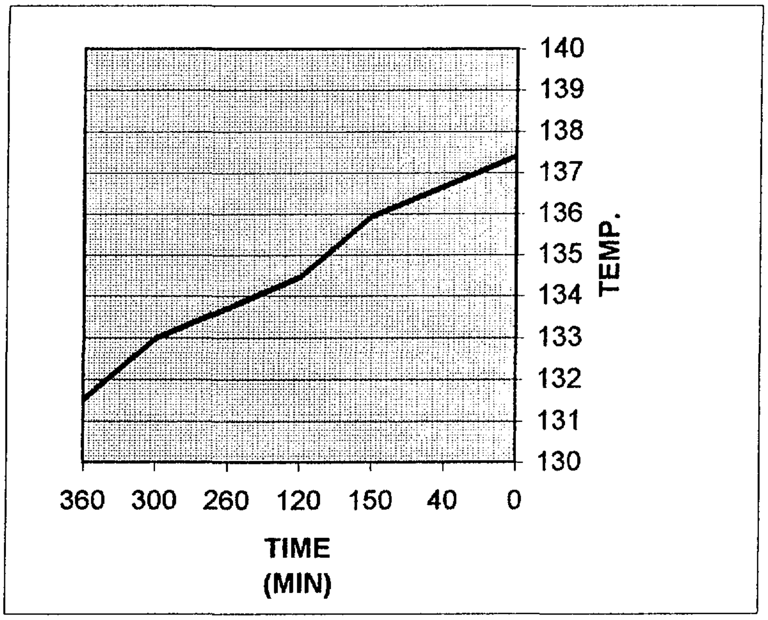
Freezing capacity test at 25 C (model Fb 32)

T. Cabinet av.	2.0
T. Freezer av.	-20.9
Light load weight kg.	6.0
Heavy load weight kg.	7.0
Run time before light load	7hr.30'
Freezing time	24hr
Thermostat position	4
Warmest pack temp.	-18.29

Temperature rise and low starting test
(For FB32)

-Volt will be 233 at 43 C°
-Measurement of motor winding resistance and temperature

Time/min	0	40	150	120	260	300	360
Temp.	137.403	136.665	135.927	134.452	133.714	132.976	131.500



-After 30 min the starting test will be happen at volt 187
No 3 starting the compressor regular start.

Refrigerator Fb30
290 Lit.
Double door
4 star

siltal

Technical data:

Model: FB30-2 (290 Lit.)		***Unit***	***R134a***
Refrigerant	charge	(Gr.)	130
Structure	H x W x D	Cm	158x54x55
	Internal volume freezer	Liters	60
	Internal volume cabinet	Liters	230
	Cabinet insulation thickness	Mm	30
	Freezer insulation thickness	Mm	50
Compressor	Model	Name	QA77
	Nominal power	W	160
	Capacity	Kcal/hr	-
	Displacement	Cc	7.65
	C.O.P.	Kcal/Wh	-
Discharge	Length of pipe	Mm	1385
	Dim.(exit/inlet)	Mm	8x6.5
Condenser	Type	Name	Sheet
	Width	Mm	510
	High	Mm	1120
	No. of legs	No.	8
	Length of tube	Mm	7180
	Volume	Cm^3	135
	Anti-Condensate length	Mm	5370xØ4.76
Capillary	N2 Flowrate	L/min	-
	Length	Mm	3200
	Inside diameter	Mm	0.8
Filter	Weight	Grams	12
Refrigerator evaporator	Type	Name	Roll band
	Width	Mm	400
	Height	Mm	300
	Cooling surface	Dm^3	0.24
	Number of pipe	Nr	-
	Length of pipe	Mm	-
	Dim.(exit/inlet)	Mm	8.1x8.1
	Volume	Dm^3	-
Freezer evaporator	Type	Name	Foamed in 4 faces
	Width	Mm	420x450
	Height	Mm	420x310
	Area	M^2	0.64
	Number of pipe	Nr	27
	Length of pipe	M	12.5
	Dim.(exit/inlet)	Mm	6.5x2.2
	Volume	Dm^3	-
Thermostat	type	Danfoss	O77B6222

Charging determination test

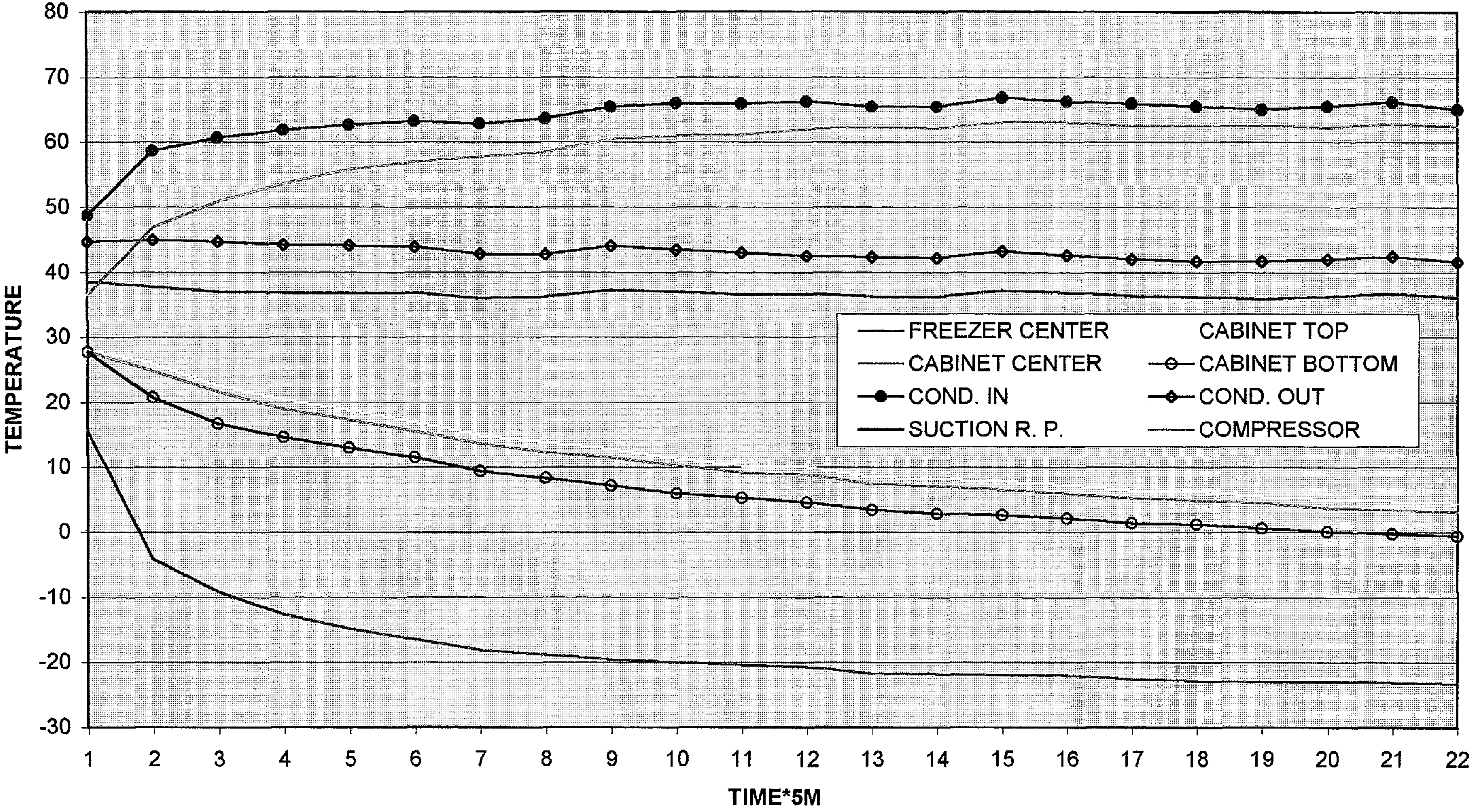
Model: FB30 (290 Lit.)			**Class ST**	
Ambient temp.		C	**32**	**43**
Compressor			**QA77**	
Charged *(134a)*			**130**	
Capillary		Mm	**0.8X3200**	
Freezer Center		C	-24.5	-18.8
Thermostat bulb temp.		C	-20.2	-15.5
Evaporator input		C	-23.9	-18.2
Evaporator at exit		C	-23.8	-19.6
Cabinet	**T1**	C	-0.80	6.50
	T2	C	-2.10	5.00
	T3	C	-3.90	3.40
	TAVG	C	-2.30	5.00
Condenser	**Input**	C	55.1	66.9
	Exit	C	36.6	45.3
Suction		C	30.6	38.9
Compressor shell		C	55.7	72.0

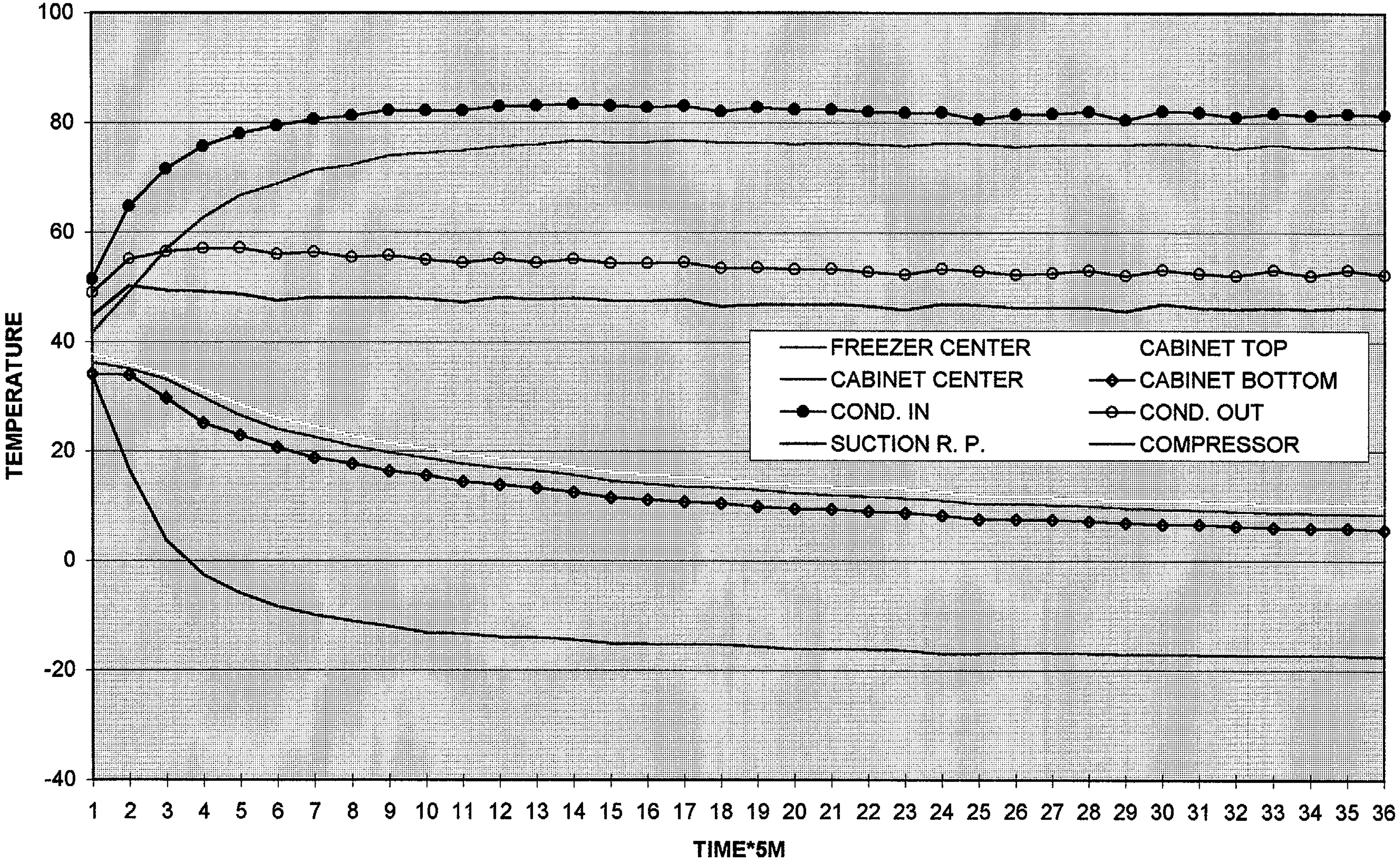
Pull down test

Model: FB30			
Compressor	**QA77**	Refrigerator: 290 Lit.	
Thermostat	**Short**	Charging:130 gr. 134a	
Temperature		°C	
Ambient		**32**	**43**
Freezer	**Center**	-23.1	-20.3
Cabinet	**T1**	4.80	8.80
	T2	3.40	4.90
	T3	-0.20	2.70
	TAVG	2.70	5.50
Suction		36.7	44.8
Condenser	**Inlet**	66.7	78.7
	Outlet	42.4	54.8
Compressor shell		62.4	74.0
Winding temp.		97.0	105.5
Test time	**Min.**	105	240

SILTAL TEST ROOM

(FB30-QA77-130 gr.-AMB. TEMP.=32 C-THERMO. POS.=MAX)





SILTAL TEST ROOM

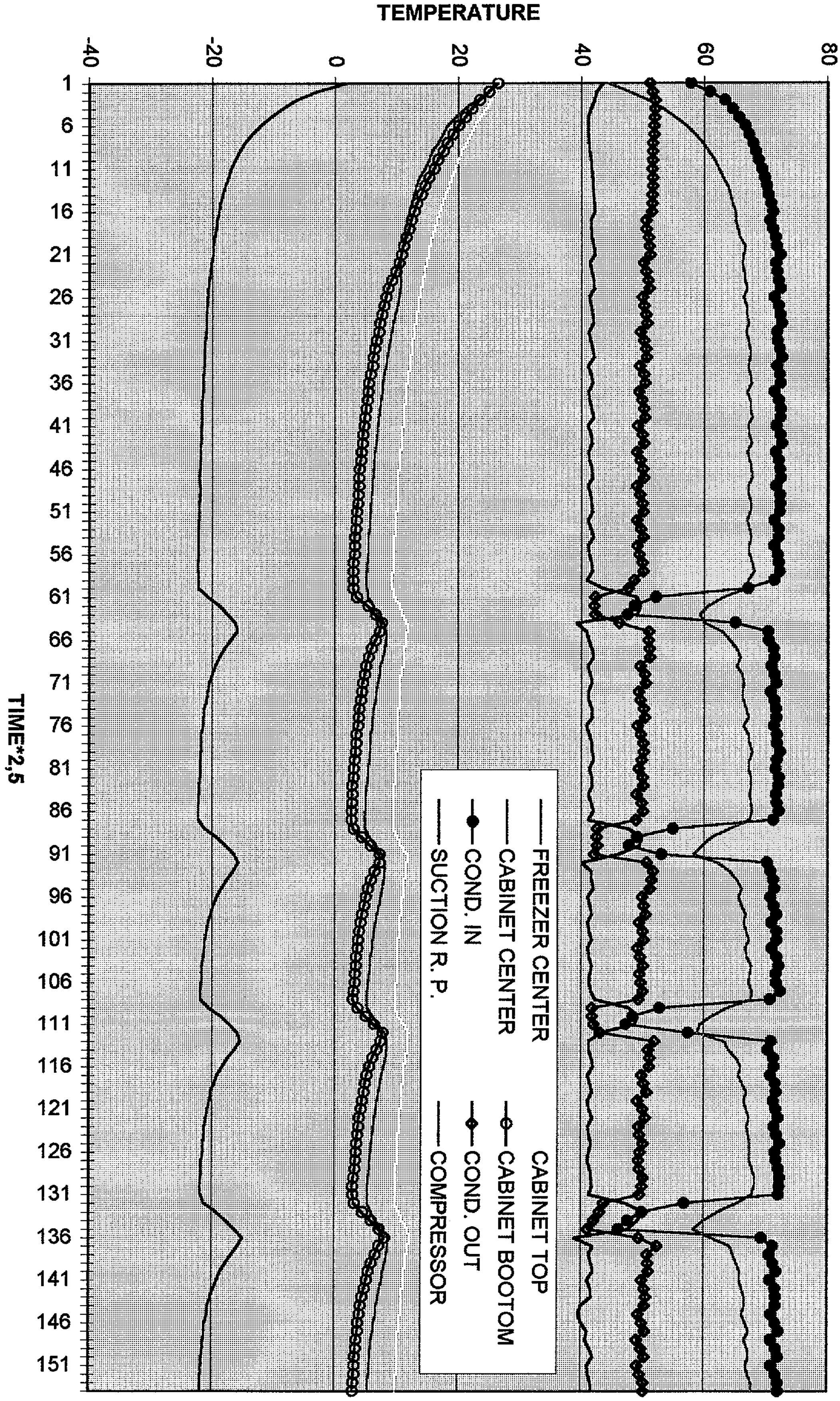
FB30-QA77-130 gr-AMB. TEMP.=43-THERMO POS.=MAX)

No load & thermostat control test

Model: FB30 (290 Lit.)			Class ST									
Ambient		C	38		32		25		18		16	
Thermostat setting			2		4		4		5		6	
			OFF	ON	OFF	ON	OFF	ON	OFF	ON	OFF	ON
Freezer center		C	-22.3	-16.3	-25.1	-18.7	-24.1	-20.2	-28.8	-24.3	-31.2	-22.5
Thermostat bulb		C	-17.2	2.8	-20.4	1.0	-22.3	2.3	-23.1	3.5	-25.2	2.4
Cabinet	T1	C	8.3	9.8	4.5	7.9	3.8	6.4	4.5	5.2	0.5	4.8
	T2	C	5.0	7.7	2.5	5.4	2.9	4.4	2.7	3.9	-1.2	2.4
	T3	C	2.9	7.2	0.5	4.9	-1.2	3.9	0.4	3.0	-3.8	1.8
	Tavg	C	**6.82**		**4.3**		**3.4**		**3.3**		**0.75**	
Evaporator	Inlet	C	-20.6	3.1	-23.9	-0.3	-22.4	2.9	-26.7	1.1	-28.7	1.4
	Outlet	C	-19.7	4.1	-24.3	6.3	-23.6	4.9	-26.7	4.2	-29	6.1
Suction		C	40.9	47.7	34.1	38.4	28.2	31.7	21.6	24	19.2	21.4
Condenser	Inlet	C	71.3	46	60.4	41.3	53.5	31.6	45.8	22.9	43	20.8
	outlet	C	48.6	41.1	42.3	35.3	36.1	27.8	28.5	19.7	25.6	17.7
Compressor		C	67.1	58.2	55.7	47.5	45.8	38.5	40.8	32.5	37.5	28.7
Power		Watt	158		150		140.5		130.7		126.2	
Current		Amp	1.3				1.25		1.24		1.24	
Energy cons.							1.82					
Running time		%	**81%**		**70.5%**		**54%**		**47%**		**43%**	

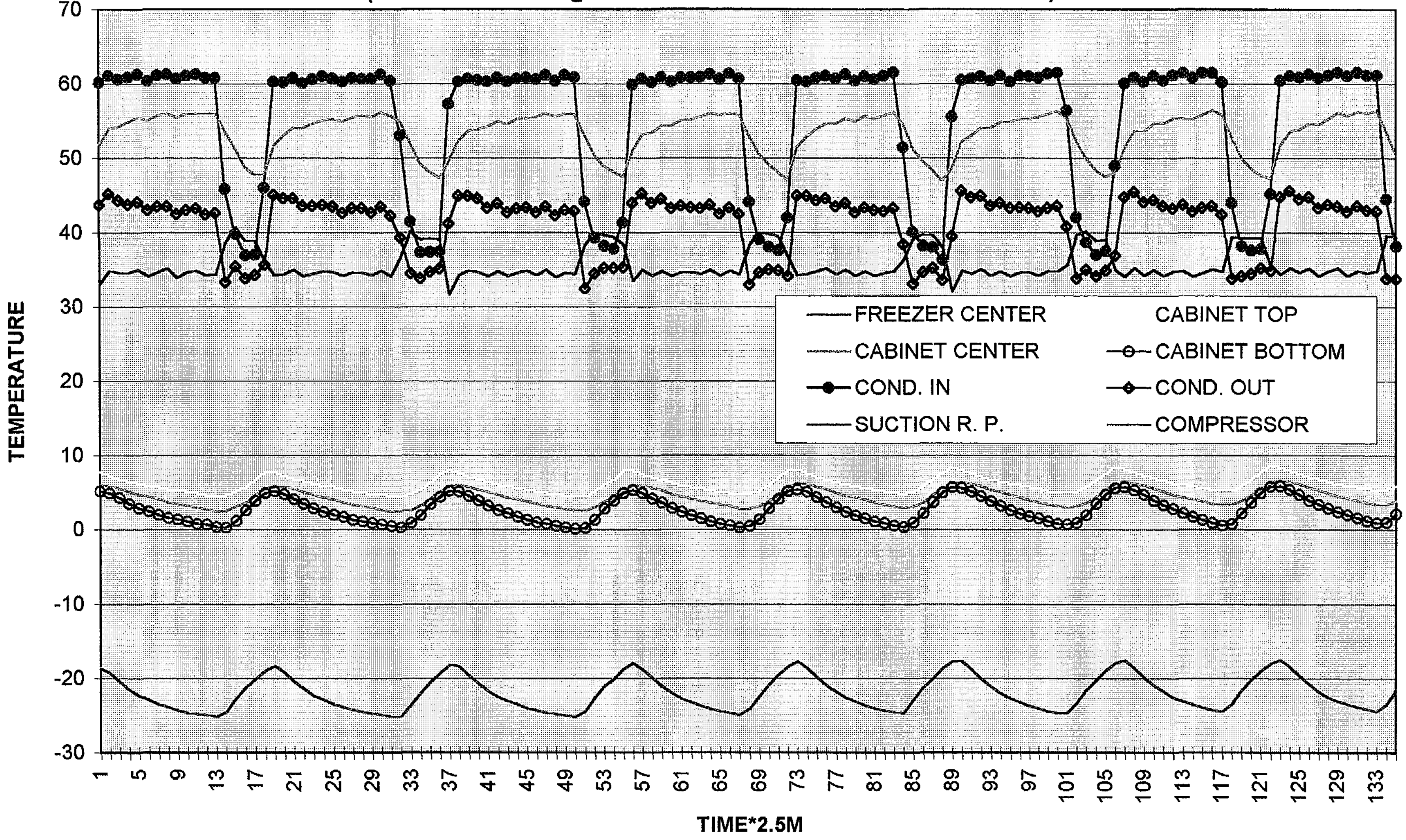
SILTAL TEST ROOM

(FB30-QA77-130 gr.-AMB. TEMP=38C-THERMO POS.=2)



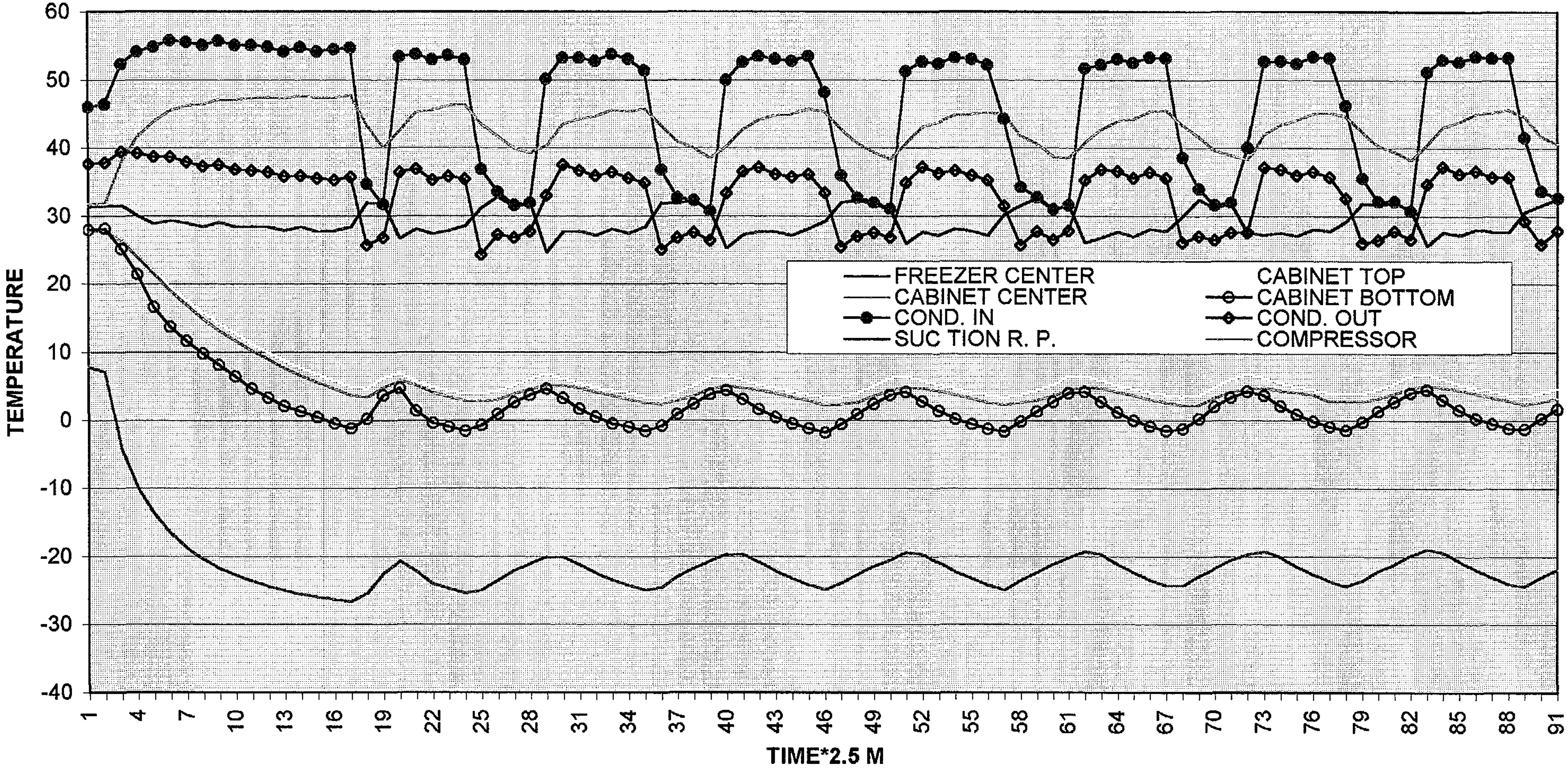
SILTAL TEST ROOM

(FB30-QA77-130 gr.-AMB. TEMP.=32C- THERMO. POS.=4)



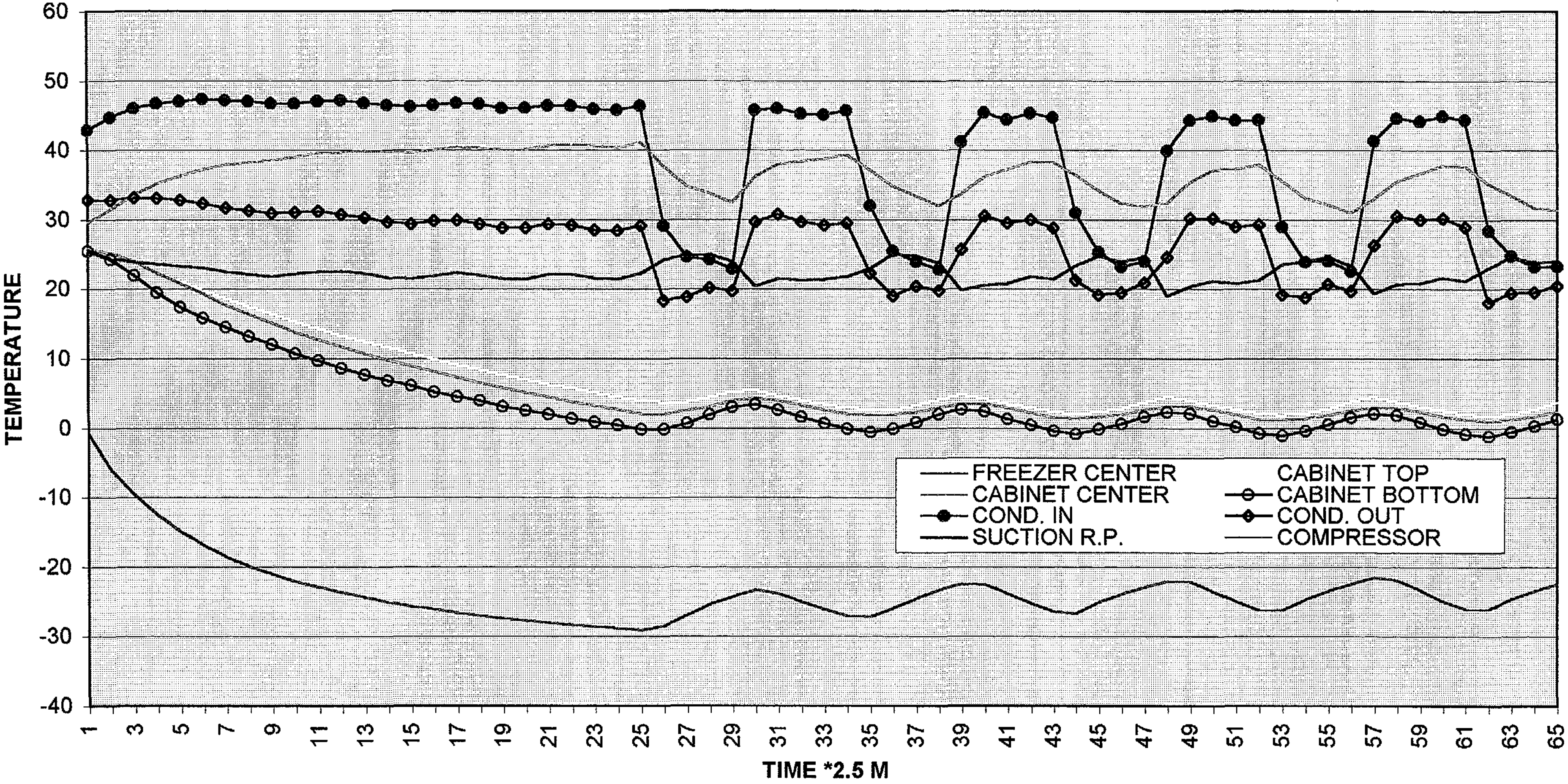
SILTAL TEST ROOM

(FB30-QA77-130 gr.-AMB. TEMP.=25 C-THERMO POS.=4)



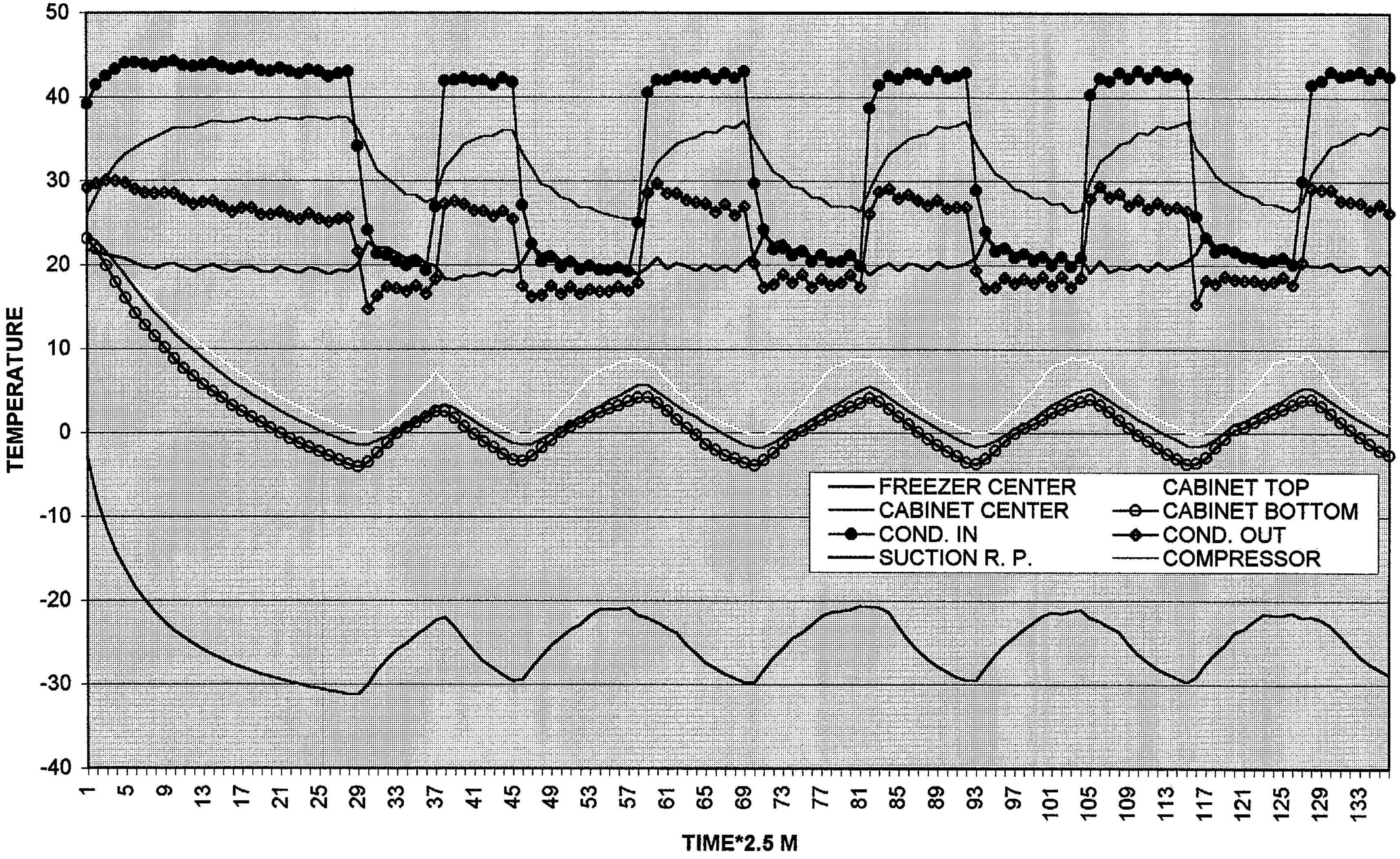
SILTAL TEST ROOM

(FB30-QA77-130 gr.-AMB. TEMP.=18C-THERMO POS.=5)



SILTAL TEST ROOM

(FB30-QA77-130 gr.-AMB. TEMP.=16C- THERMO POS.=6)

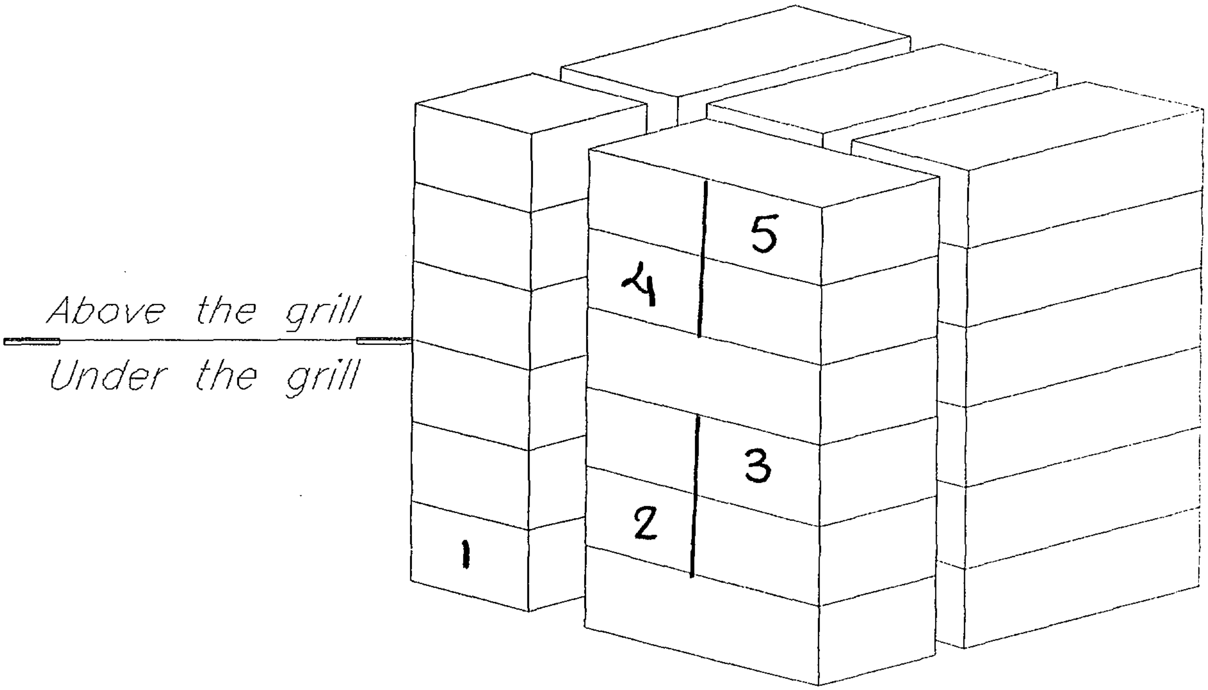


Storage and energy consumption

Model: FB30		Class ST					
Ambient		32		25		16	
Thermostat setting		4.5		5			
		ON	OFF	ON	OFF	ON	OFF
Thermostat bulb		3.5	-20.5	4.9	-24.3	3.9	26.5
Cabinet	T1	8.15	-2.3	5.9	-0.50	4.7	-1.90
	T2	8.9	-3.5	4.4	-1.20	2.3	-2.10
	T3	8.8	-5.7	4.1	-2.20	0.9	-3.10
	T_{AVG}	2.4		1.75		0.1	
Package temp.	1	-25.1	-25.5	-23.5	-23.7	-19.7	-20.4
	2	-23.0	-23.2	-22.2	-22.2	-16.1	-16.7
	3	-21.8	-22.0	-22.1	-22.3	-15.9	-16.7
	4	-17.0	-18.0	-20.5	-21.8	-17.8	-18.1
	5	-18.2	-20.0	-18.3	-19.8	-18.3	-19
	6						
	7						
	8						
Power			154		145		145
Current			1.3		1.3		1.3
Running		68%		61%		50%	
Energy cons. kWh/24h		-		2.1		-	

- Energy consumption : 2.1 K w h / 24h
- Rising time at ambient temp. 25 C .
  Warmer packing from –18 C to 9 C in 13 hrs

Storage plane for refrigerator model: FB30



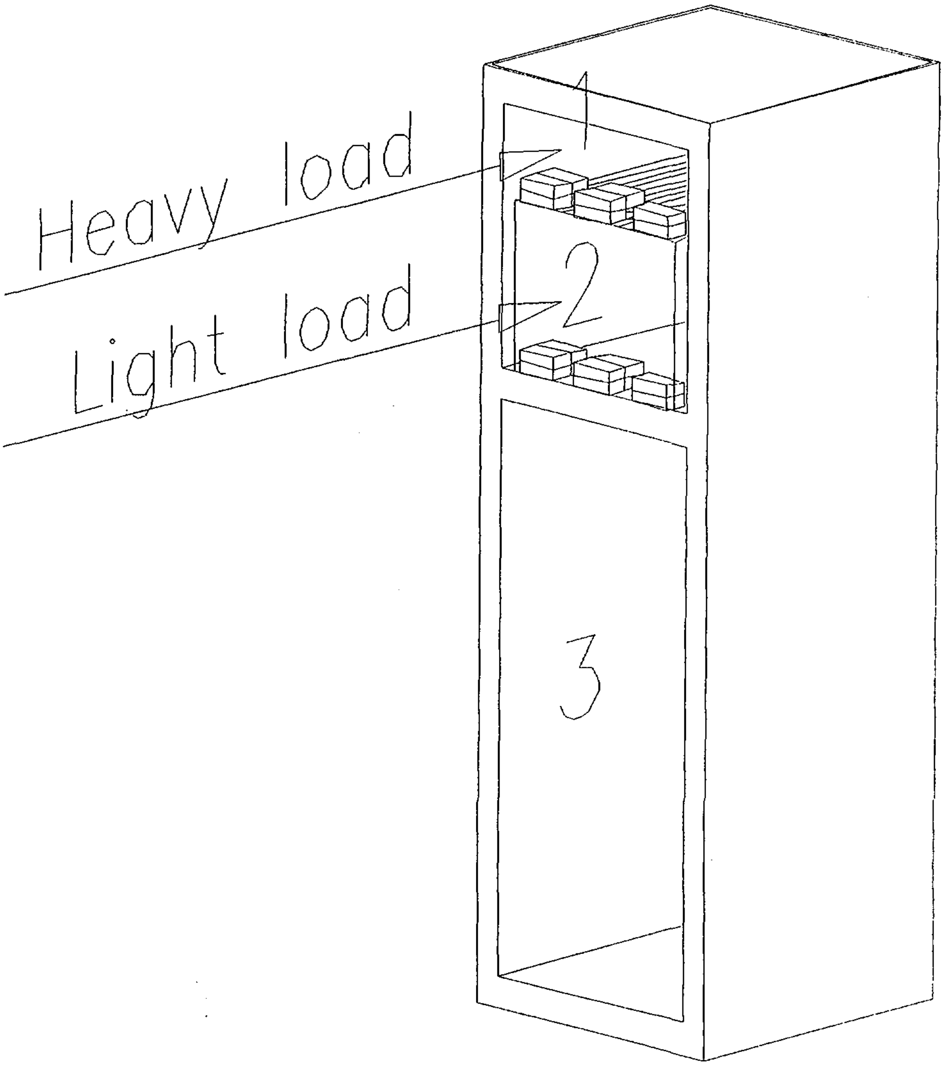
Number of layer	Weight
6	27 Kg.

Freezing capacity test at 25 C (model Fb 30)

T. Cabinet av.	1.67
T. Freezer av.	-19.4
Light load weight kg.	4.0
Heavy load weight kg.	5.0
Run time before light load	7hr. 10′
Freezing time	23 hr
Thermostat position	4.
Warmest pack temp.	-18.43

Freezing test *(model* F830*)*

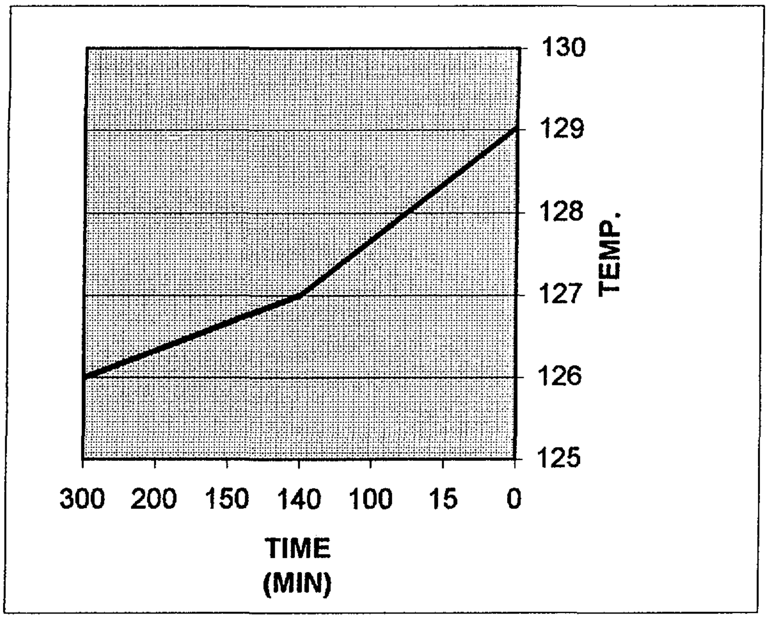
- Continuos running at lowest temp.
- Heavy load (_5__Kg.) at -20°C
- Light load (_4__Kg.) after (_7,10_Hr.) at 25°C
- continuos running at hot test packet arrive –18
- Thermostat cycling for complete the test
- The hot test packet –18 arrive after (_23__Hr.) from the beginning of the test.



Temperature rise and low starting test
(For FB30)

-Volt will be 233 at 43 C°
-Measurement of motor winding resistance and temperature

Time/min	0	15	100	140	150	200	300	320
Temp.	129.027	128.353	127.678	127.004	126.666	126.329	125.992	125.655



-After 300 min the starting test will be happen at volt 187
No 3 starting the compressor regular start.

Upright freezer
235 Lit.
6- Compartment

siltal

Technical data:

Model: VF2029 (235 Lit.)		***Unit***	***R134a***
Refrigerant	Charge	(Gr.)	125
Structure	H x W x D	Cm	-
	Internal volume freezer	Liters	325
	Internal volume cabinet	Liters	-
	Cabinet insulation thickness	Mm	-
	Freezer insulation thickness	Mm	50
Compressor	Model	Name	FR8.5G
	Nominal power	W	160
	Capacity	Kcal/hr	-
	Displacement	Cc	7.95
	C.O.P.	Kcal/Wh	1.07
Discharge	Length of pipe	Mm	-
	Dim.(exit/inlet)	Mm	-
Condenser	Type	Name	Sheet
	Width	Mm	530
	High	Mm	1069
	No. of legs	No.	10
	Length of tube	Mm	11385
	Volume	Cm^3	99.5
	Anti-Condensate length	Mm	-
Capillary	N2 Flowrate	L/min	-
	Length	Mm	3250
	Inside diameter	Mm	0.71
Filter	Weight	Grams	10
Refrigerator evaporator	Type	Name	-
	Width	Mm	-
	Height	Mm	-
	Cooling surface	Dm^3	-
	Number of pipe	Nr	-
	Length of pipe	Mm	-
	Dim.(exit/inlet)	Mm	-
	Volume	Dm^3	-
Freezer evaporator	Type	Name	Tubes - shelf
	Width	Mm	-
	Height	Mm	-
	Area	M^2	-
	Number of pipe	Nr	-
	Length of pipe	M	-
	Dim.(exit/inlet)	Mm	-
	Volume	Dm^3	-
Thermostat	type	Danfoss	O77B26134

Charging determination test

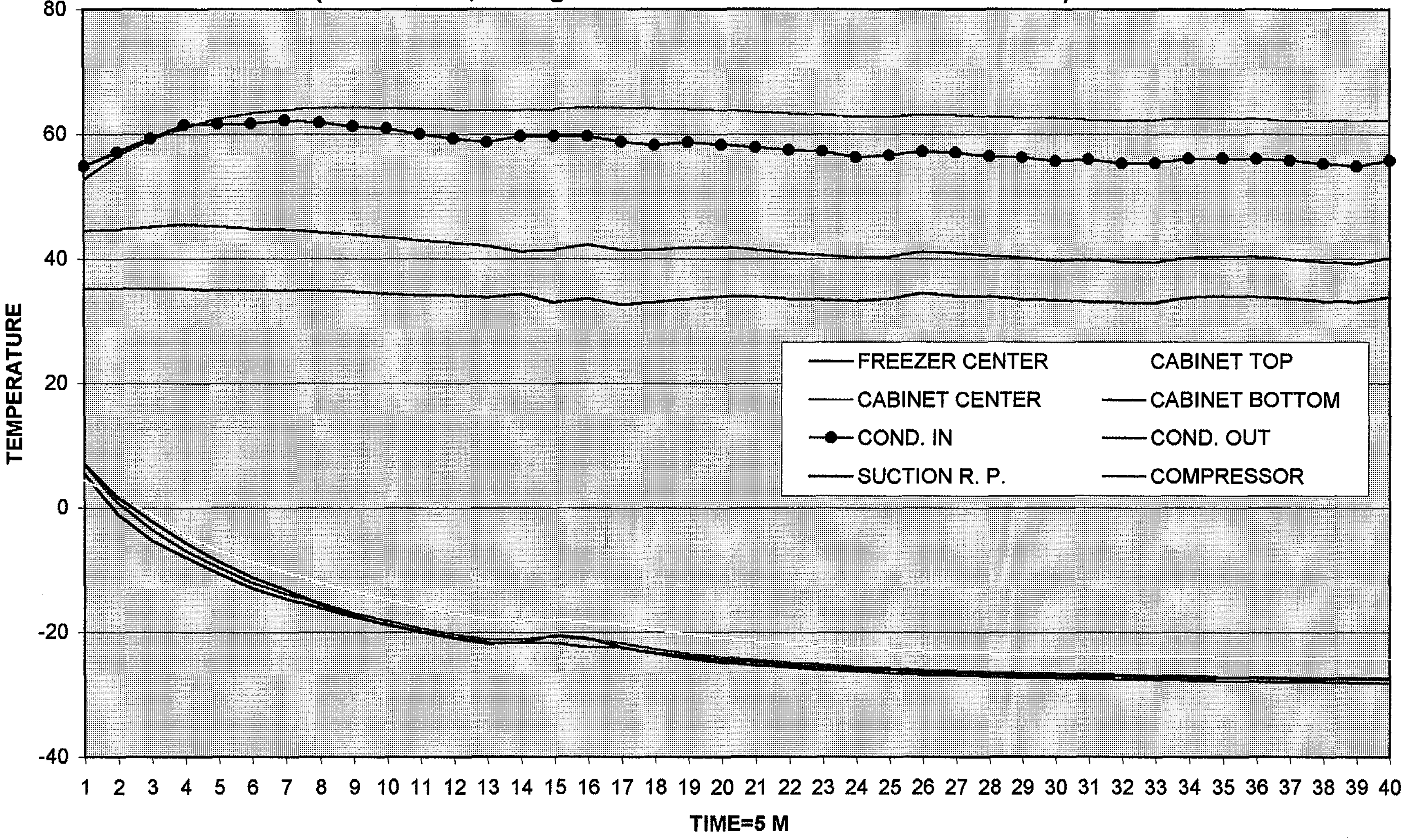
Model: VF2029 (235 Lit.)			Class ST	
Ambient temp.			32	43
Compressor			FR8.5G	
Charged			125	
Capillary			0.7X3250	
Freezer Center		C	-26.8	-21.7
Thermostat bulb temp.		C	-29.2	-24.1
Evaporator input		C	-28.5	-25.3
Evaporator at exit		C	-29.1	-25.8
Cabinet	T1	C	-24.0	-18.5
	T2	C	-26.8	-21.7
	T3	C	-27.7	-22.4
	TAVG	C	-26.2	-20.9
Condenser	Input	C	55.3	69.1
	Exit	C	39.1	50.0
Suction		C	32.6	42.2
Compressor shell		C	61.0	73.0

Pull down test

Model: VF2029			
Compressor	**FR5.8G**	Upright frz.: 235 Lit.	
Thermostat	**Short**	Charging:125 gr. 134a	
Temperature		°C	
Ambient		**32**	**43**
Freezer	**Center**	-21.2	-21.2
Cabinet	**T1**	-18.0	-18.0
	T2	-21.2	-21.2
	T3	-21.9	-22.0
	T_{AVG}	-20.4	-20.4
Suction		33.7	44.3
Condenser	**Inlet**	58.7	73.1
	Outlet	42.0	52.1
Compressor shell		63.7	75.4
Winding temp.		84.8	108.2
Test time	**Min.**	95.0	185

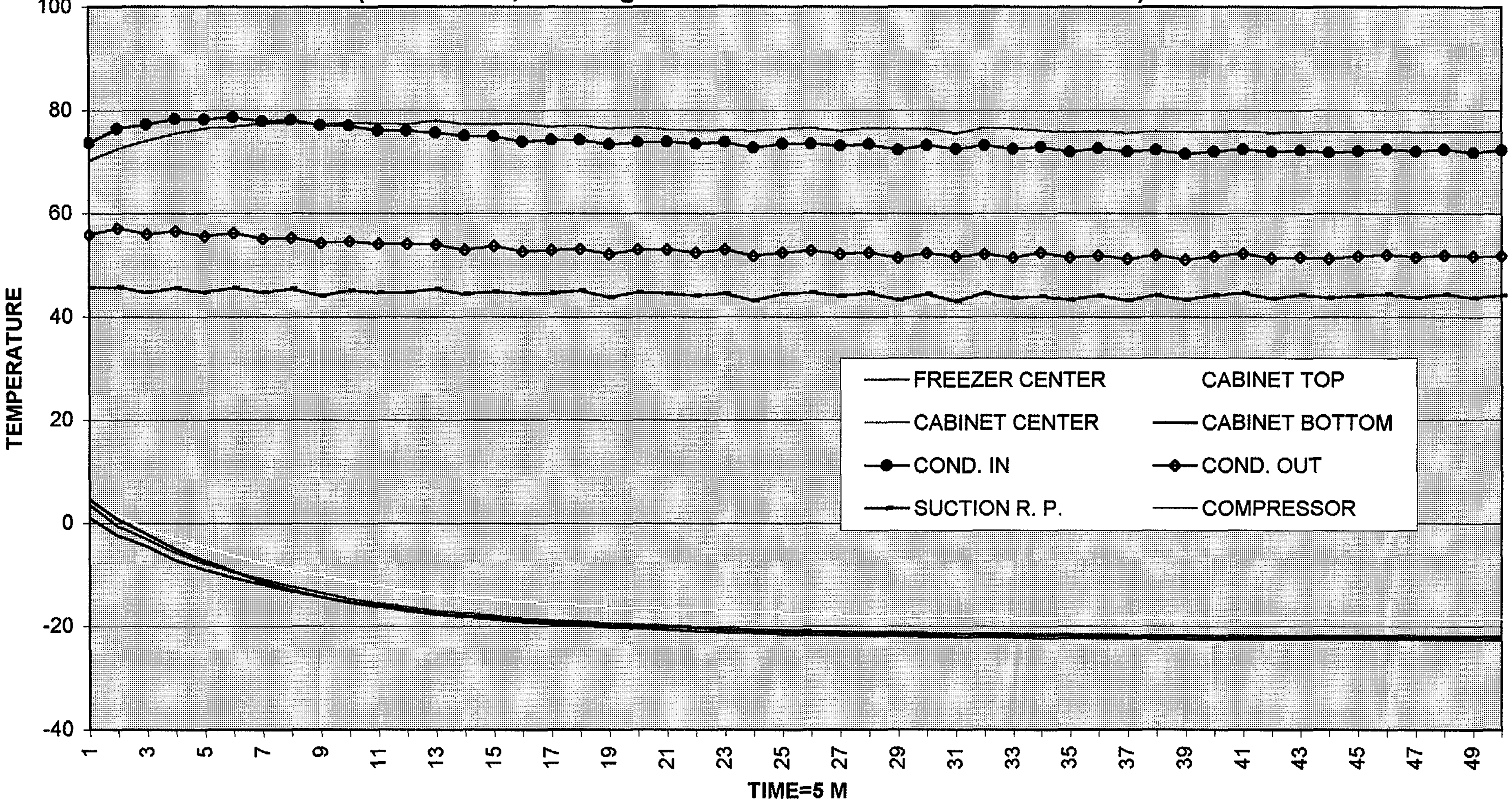
SILTAL TEST ROOM

(VF2029-FR8,5-125 gr.-AMB. TEMP.=32C-THERMO. POS.=MAX)



SILTAL TEST ROOM

(VF2029-FR8,5 G-125 gr.-AMB. TEMP.=43 C-THERMO POS.=MAX)

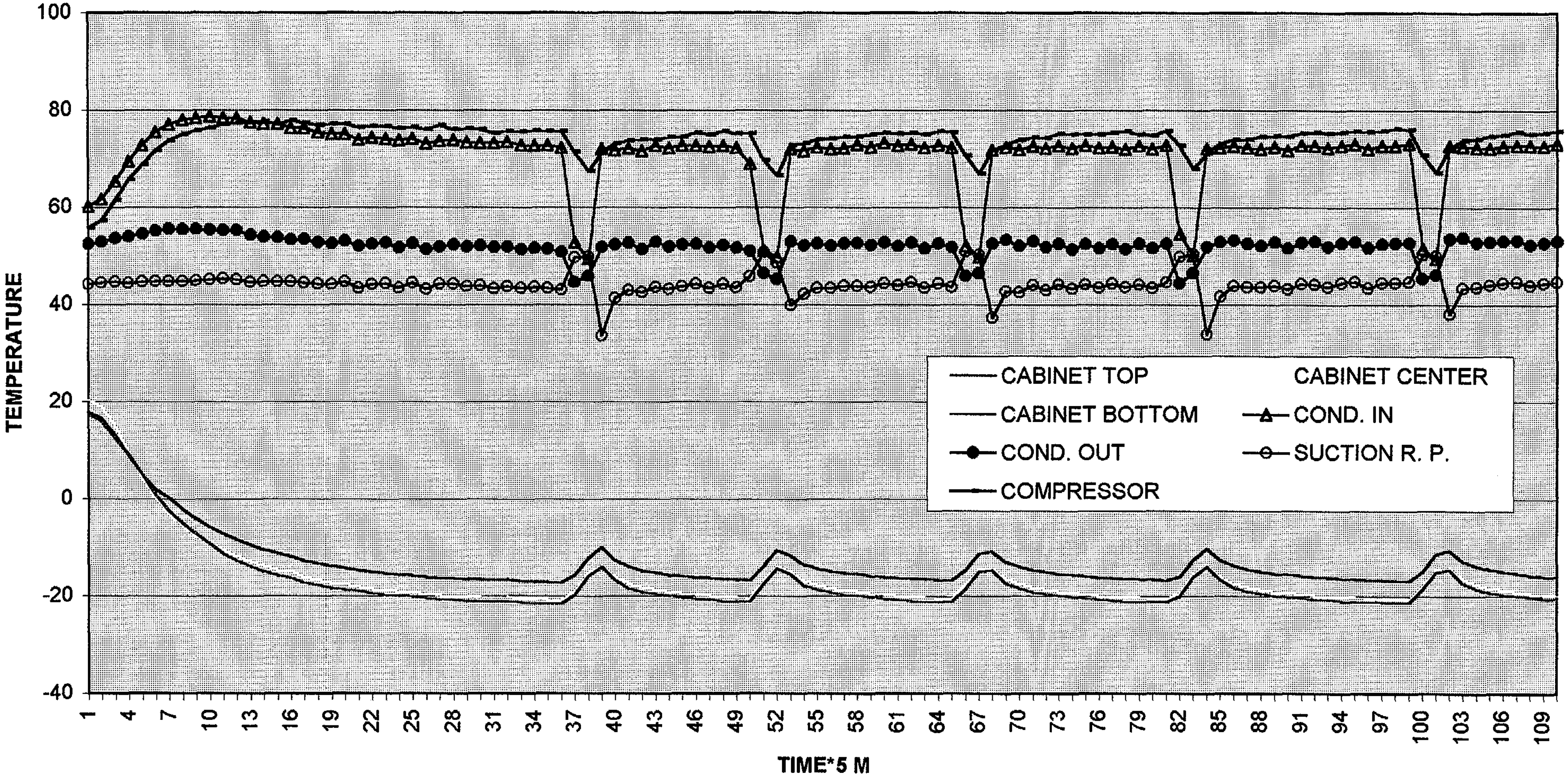


No load & thermostat control test

Model: VF2029 (235 Lit.)							*Class ST*					
Ambient		**C**	**43**		**38**		**32**		**25**		**18**	
Thermostat setting			**1**		**2**		**3**		**5**		**5**	
			OFF	**ON**	**OFF**	**ON**	**OFF**	**ON**	**OFF**	**ON**	**OFF**	**ON**
Freezer center		**C**										
Thermostat bulb		**C**	-22.6	-17.2	-18.2	-23.7	-25.8	-19.9	-26.7	-20.3	-25.2	-24.4
Cabinet	**T1**	**C**	-16.8	-10.1	-18.2	-15.8	-20.2	-18.8	-20.9	-19.7	-22	-22
	T2	**C**	-20.5	-13.6	-21.7	18.3	-22.9	-21.4	-23.5	-22.1	-24.2	-24.1
	T3	**C**	-21.3	-14	-22.2	-19	-24	-22.3	-23.8	-22.9	-24.9	-24
	Tavg	**C**	**-16.1**		**-19.2**		**-21.6**		**-22.2**		**-23.5**	
Evaporator	**Inlet**	**C**	-24.3	-17.5	-25	-20.5	-27.5	-17.4	-28.4	-19.5	-28	-24.1
	Outlet	**C**	-24.8	-10.1	-24.7	-19.6	-28.1	-11.6	-27.6	-11	-28.4	-19.3
Suction		**C**	44.5	33	38.6	44.4	33	37.9	28.4	32.4	27.9	18.7
Condenser	**Inlet**	**C**	72.8	50.1	63.7	46.3	57.9	39.9	51.2	32.9	34.5	23.1
	outlet	***C***	52.5	46.5	46.5	38.2	40.4	32.8	35.1	26.6	24.8	24.5
Compressor		**C**	75.6	71	65.6	61.1	62.7	57.3	57.6	51.2	36	26.7
Power		**Watt**	143		129		134		130		142	
Current		**Amp**	1.23		1.23		1.24		1.2		1.21	
Energy cons.									1.82			
Running time		**%**	**85%**		**80%**		**67%**		**50%**		**33%**	

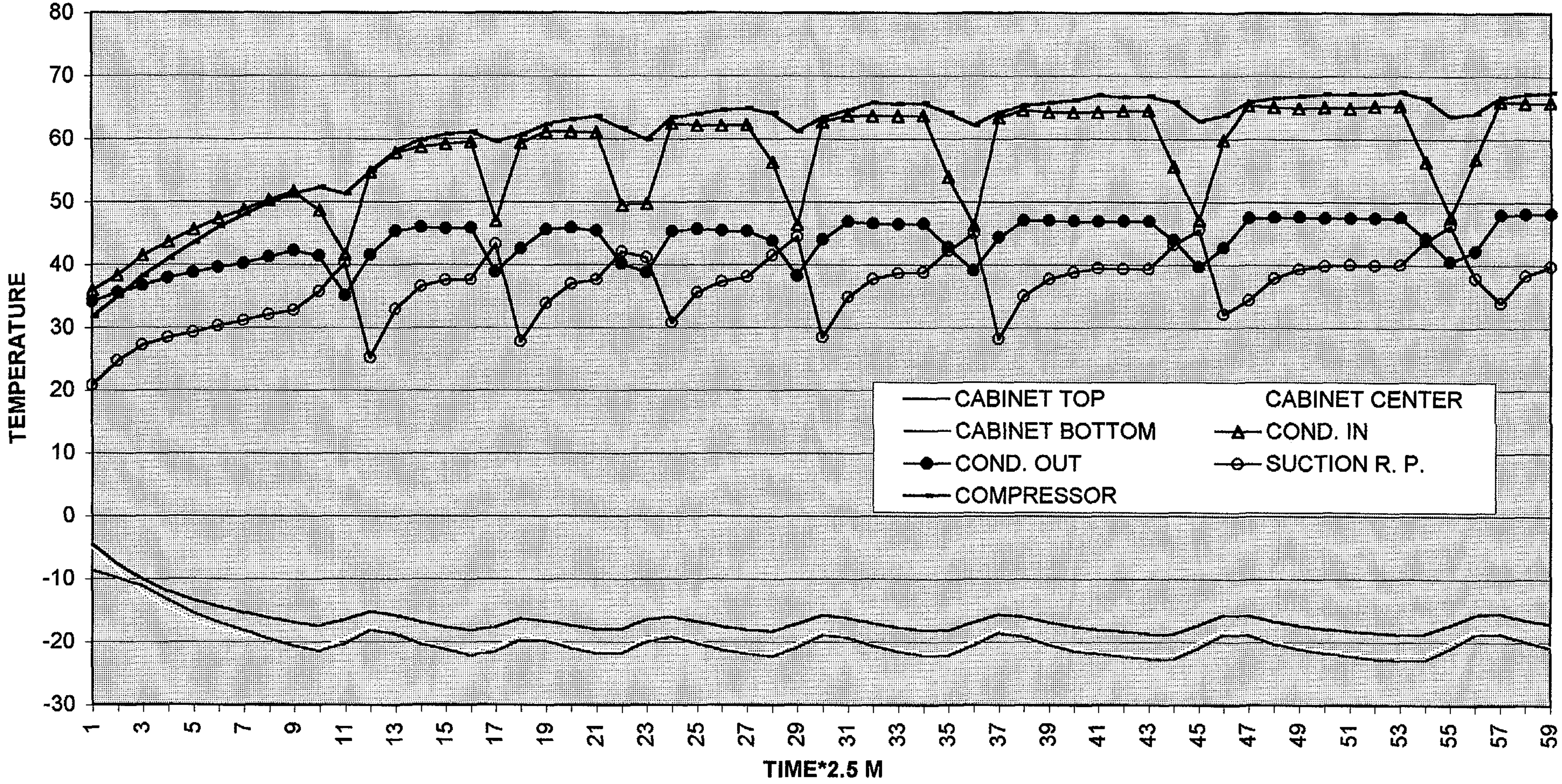
SILTAL TEST ROOM

(VF2029-FR10 G-150 gr.-AMB. TEMP.=43C-THERMO POS.=1)



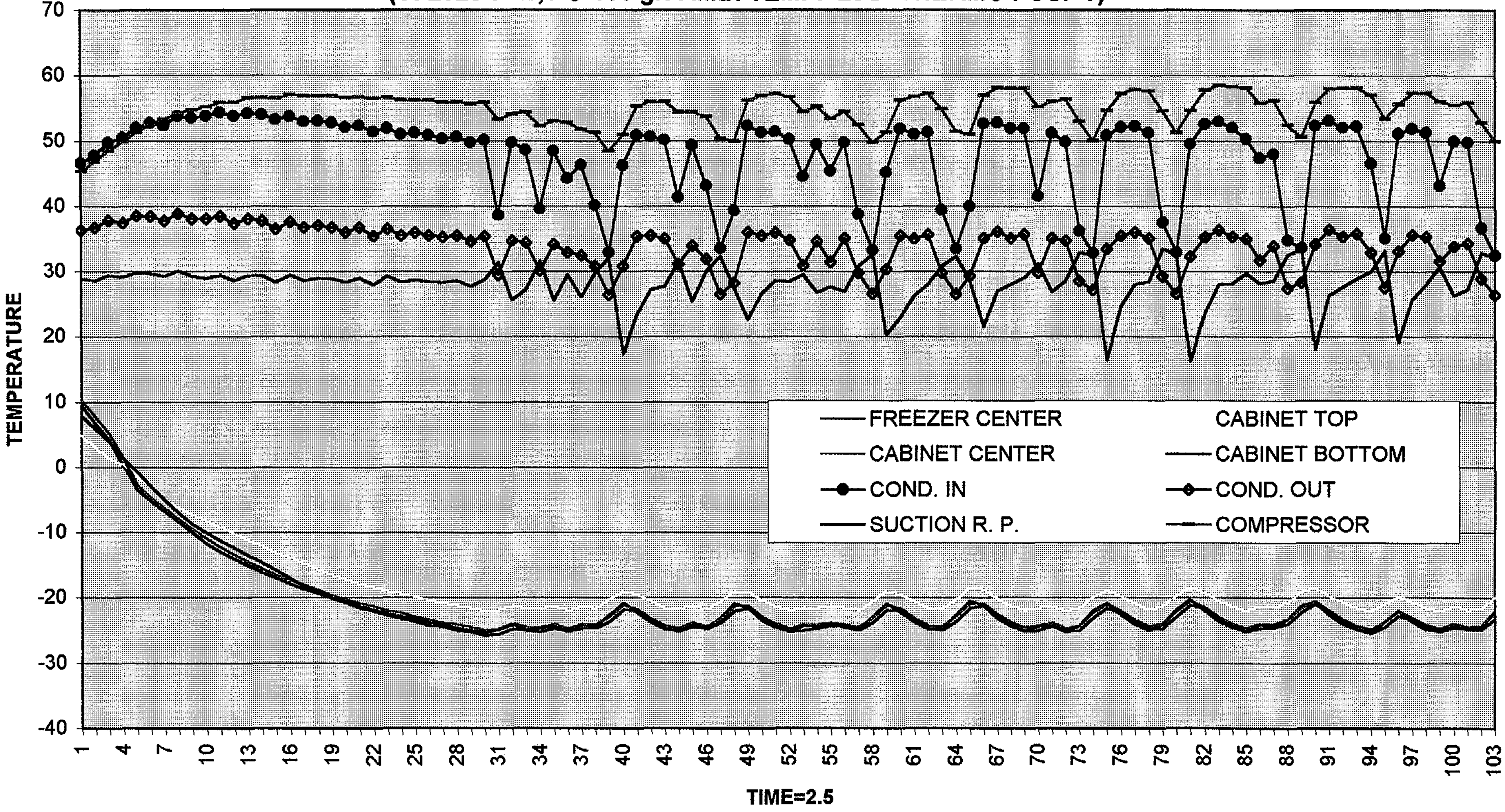
SILTAL TEST ROOM

(VF2029-FR8,5G-125gr.AMB. TEMP.=38C-THERMO POS.=2)



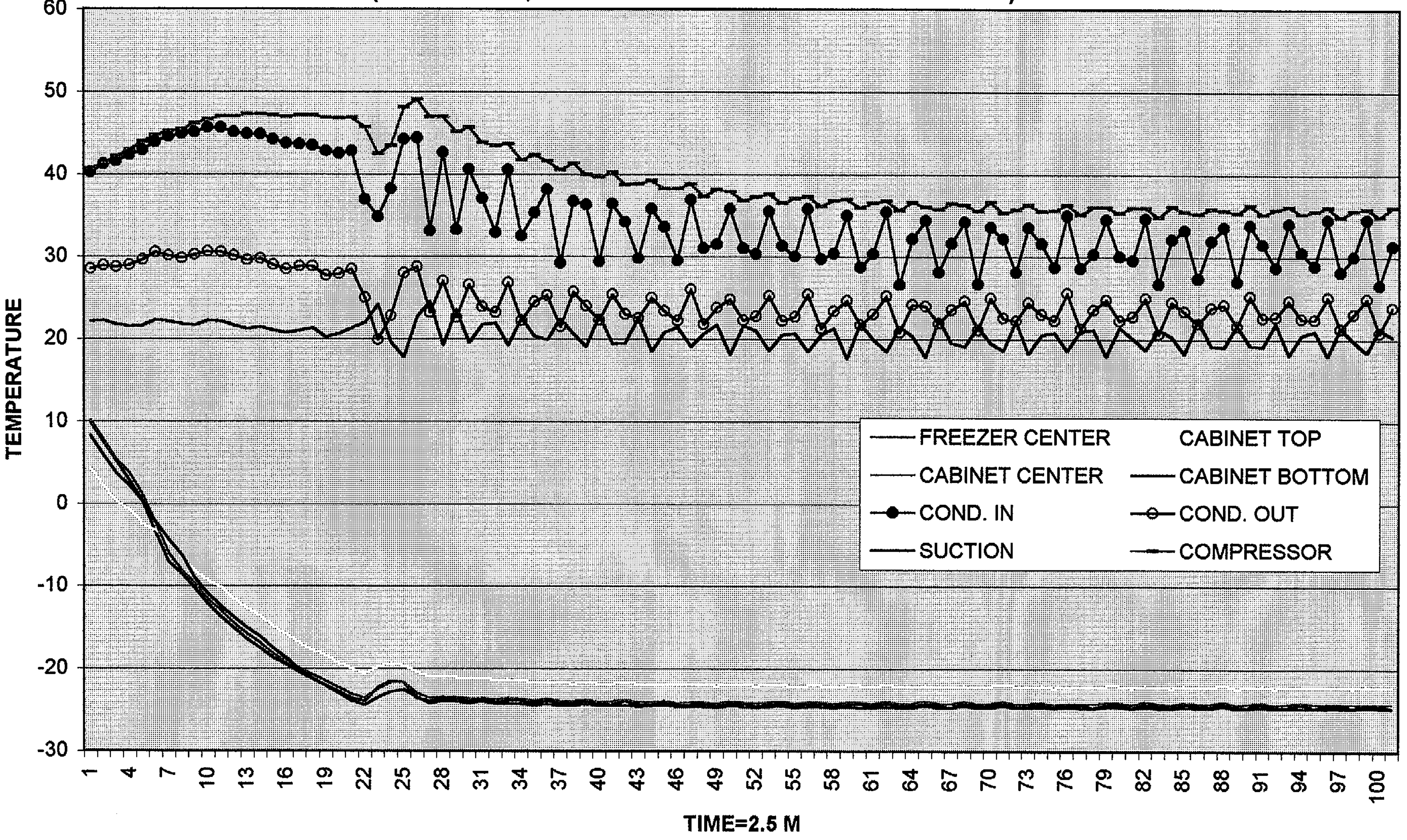
SILTAL TEST ROOM

(VF2029-FR8,5 G-130 gr.-AMB. TEMP.=25C- THERMO POS.=5)



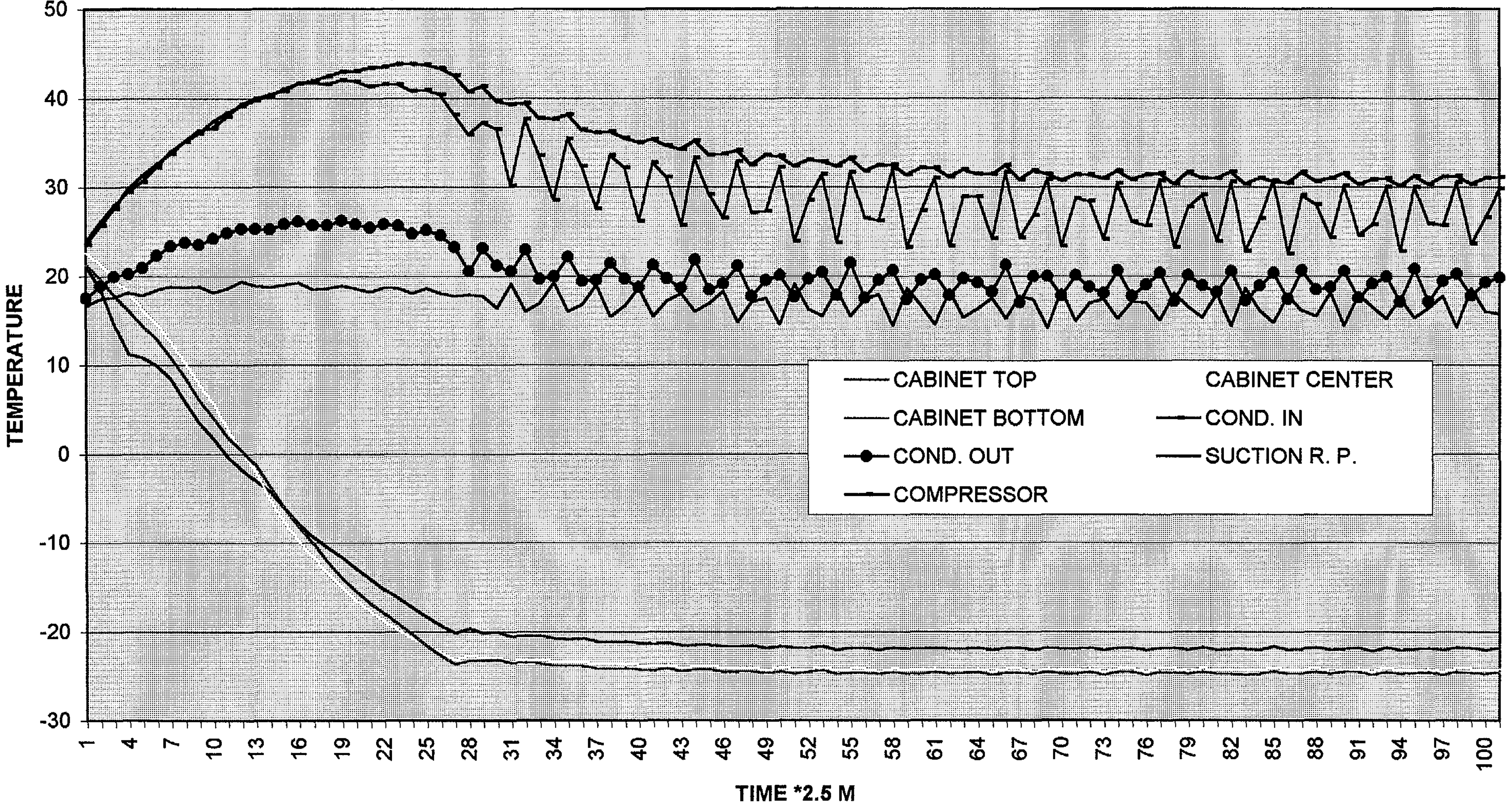
SILTAL TEST ROOM

(VF2029-FR8,5 G-AMB. TEMP.=18C-THERMO POS.=5)



SILTAL TEST ROOM

(VF2029-FR8,5-1250 gr.-AMB. TEMP.=16C-THERMO POS.=5)

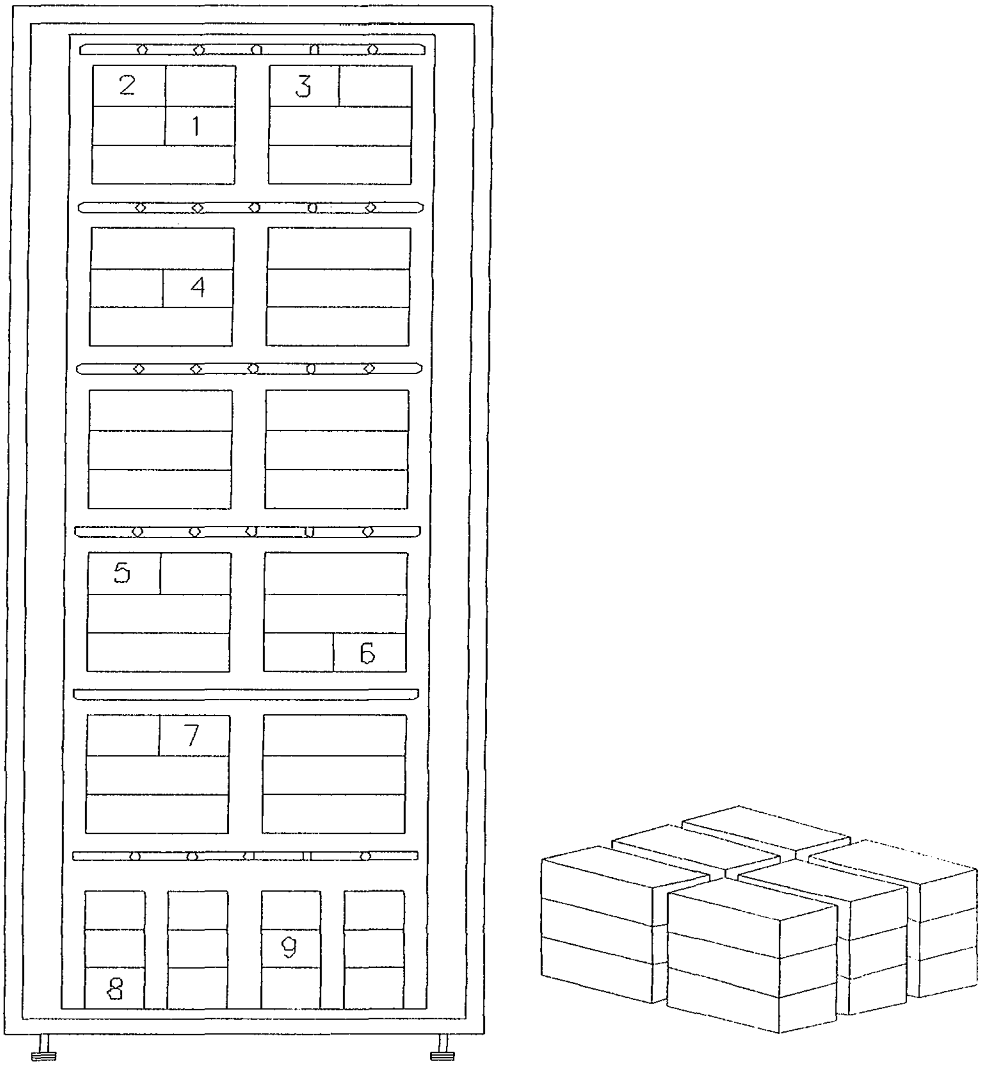


Storage and energy consumption

Model: VF2029		Class ST					
Ambient		32		25		16	
Thermostat setting		4		4		4	
		ON	OFF	ON	OFF	ON	OFF
Thermostat bulb		-20.8	-25.5	-20.7	-25.6	-20.6	-25.3
Cabinet	T1	-	-	-	-	-	-
	T2	-	-	-	-	-	-
	T3	-	-	-	-	-	-
	T_{AVG}	-		-		-	
Package temp.	1	-19.9	-20.5	-20.1	-19.9	-20.9	-21.0
	2	-17.5	-18.6	-18.1	-18.2	-19.4	-19.5
	3	-17.9	-19.5	-18.8	-19.0	-20.1	-20.2
	4	-22.1	-22.5	-21.6	-21.6	-21.8	-21.8
	5	-21.5	-22.2	-21.3	-2.5	-18.9	-19.1
	6	-20.3	-20.4	-19.9	-20.0	-19.4	-19.4
	7	-22.3	-22.5	-21.7	-21.8	-19.8	-19.9
	8	-19.8	-20.1	-19.4	-19.5	-16.5	-16.4
	9	-21.0	-21.0	-20.6	-26.6	-19.5	-19.5
Power			142		146		147
Current			1.25		1.26		1.27
Running		67%		49%		32%	
Energy cons. kWh/24h				1.7			

- Energy consumption 1.7 Kwh / 24h
- Rising time at ambient temp. 25 C
  Warmer pack from –18 C to 9 C in 18 hrs

Storage plane for upright freezer model: VF2029



Number of layer	Weight
3	18 Kg.

Total weight 102 Kg.

Freezing capacity test at 25 C (model VF2029)

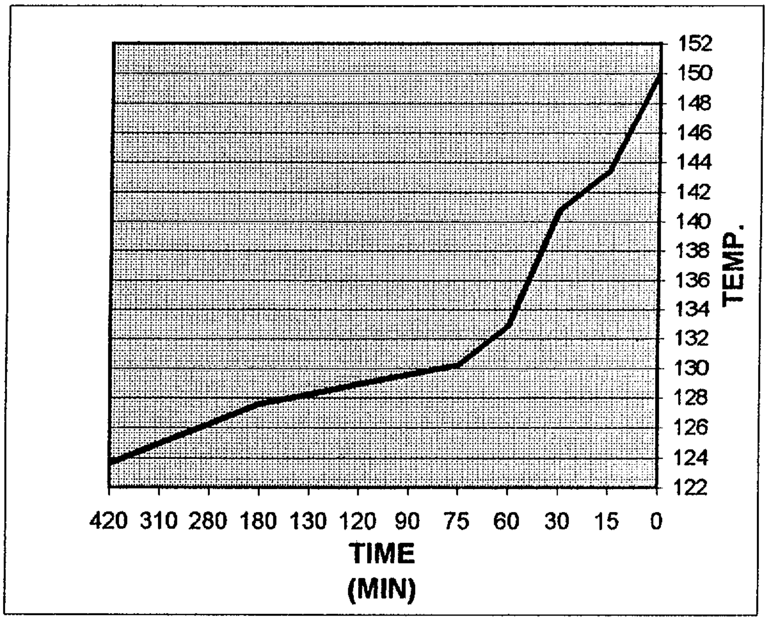
T. Cabinet av.	--
T. Freezer av.	-22.4
Light load weight kg.	12.0
Heavy load weight kg.	22.0
Run time before light load	8hr 50 \
Freezing time	22.30
Thermostat position	5
Warmest pack temp.	-18.4

Temperature rise and low starting test
(For VF2029)

-Volt will be 233 at 43 C°

-Measurement of motor winding resistance and temperature

Time/min	0	15	30	60	75	90	120	130	180	280	310	420
Temp.	150.036	143.429	140.786	132.857	130.214	129.554	128.893	128.232	127.571	126.250	124.929	123.607



-After 30 min the starting test will be happen at volt 187
No 3 starting the compressor regular start.

Chest freezer
180 Lit.

siltal

Technical data:

Model: CF180 (180 Lit.)		**Unit**	**R134a**
Refrigerant	charge	(Gr.)	
Structure	H x W x D	Cm	86x70x57
	Internal volume freezer	Liters	180
	Internal volume cabinet	Liters	-
	Cabinet insulation thickness	Mm	-
	Freezer insulation thickness	Mm	50
Compressor	Model	Name	HLS17
	Nominal power	W	1/6
	Capacity	Kcal/hr	105
	Displacement	Cc	5.7
	C.O.P.	Kcal/Wh	-
Discharge	Length of pipe	Mm	1130
	Dim.(exit/inlet)	Mm	8x6.5
Condenser	Type	Name	Sheet
	Width	Mm	510
	High	Mm	560
	No. of legs	No.	8
	Length of tube	Mm	5260x6.35
	Volume	Cm^3	46.4
	Anti-Condensate length	Mm	-
Capillary	N2 Flowrate	L/min	-
	Length	Mm	36
	Inside diameter	Mm	0.8
Filter	Weight	Grams	10
Refrigerator evaporator	Type	Name	-
	Width	Mm	-
	Height	Mm	-
	Cooling surface	Dm^3	-
	Number of pipe	Nr	-
	Length of pipe	Mm	-
	Dim.(exit/inlet)	mm	-
	Volume	Dm^3	-
Freezer evaporator	Type	Name	Foamed in 4 faces
	Width	Mm	535x600
	Height	Mm	535x530
	Area	M^2	1.12
	Number of pipe	Nr	-
	Length of pipe	M	23
	Dim.(exit/inlet)	Mm	6.5x2.2
	Volume	Dm^3	-
Thermostat	type	Danfoss	K54-L1867

Charging determination test

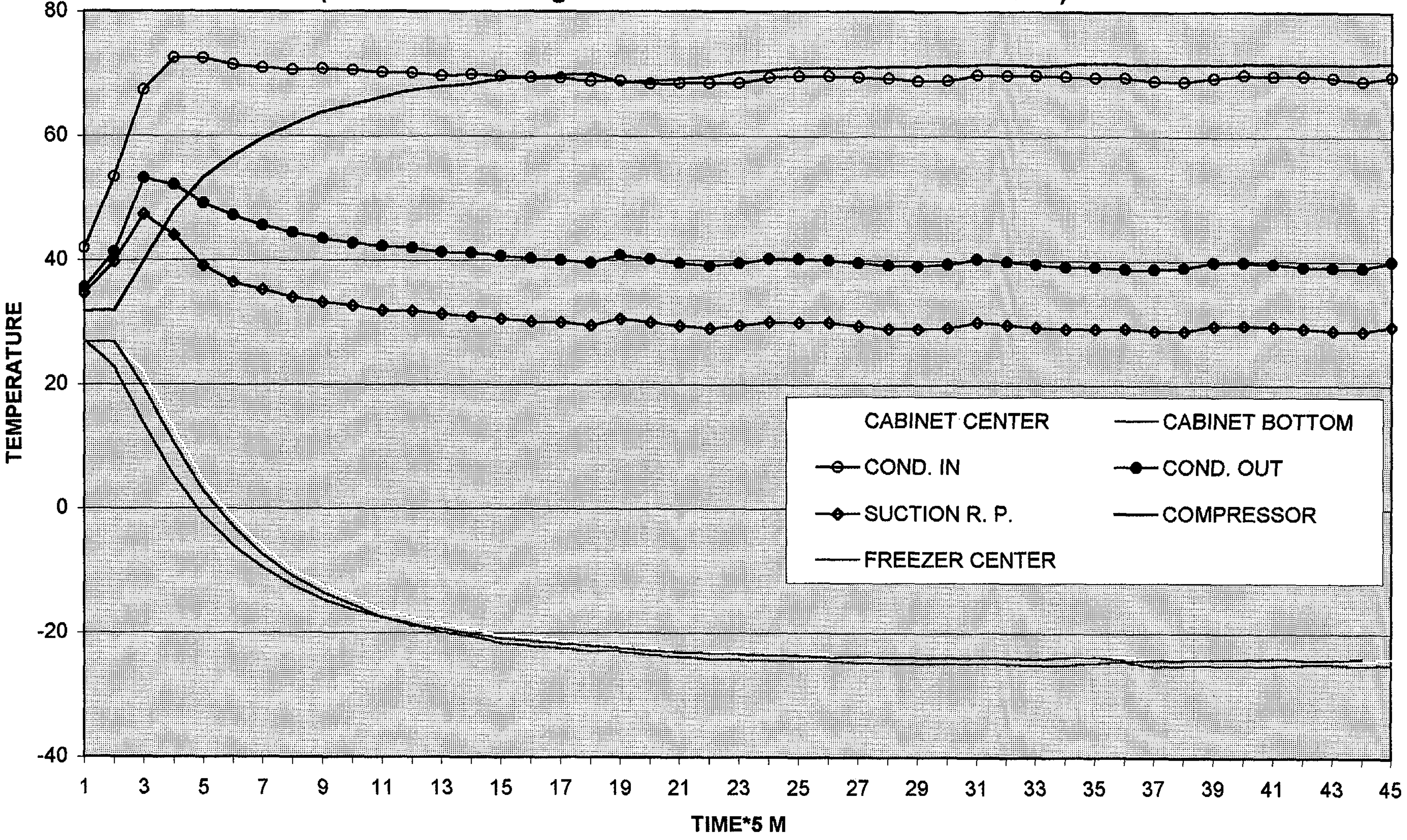
Model: CF180 (180 Lit.)			Class ST	
Ambient temp.			32	43
Compressor			HSL17	
Charged			150	
Capillary			0.8X3600	
Freezer Center		C	-24.5	-21.1
Thermostat bulb temp.		C	-23.0	-18.3
Evaporator input		C	-25.9	-19.1
Evaporator at exit		C	-26.3	-19.6
Cabinet	T1	C	-21.5	-16.1
	T2	C	-24.5	-21.1
	T3	C	-24.9	-21.5
	TAVG	C	-23.6	-19.6
Condenser	Input	C	64.9	87.5
	Exit	C	38.8	50.7
Suction		C	36.3	47.7
Compressor shell		C	64.6	84.1

Pull down test

Model: CF180			
Compressor	**HSL17**	Chest frz.: 180 Lit.	
Thermostat	**Short**	Charging:150 gr. 134a	
Temperature		°C	
Ambient		**32**	**43**
Freezer	**Center**	-20.6	-18.9
Cabinet	**T1**	-18.1	-17.8
	T2	-19.4	-18.9
	T3	-20.6	-20.1
	T_{AVG}	-19.4	-18.9
Suction		30.9	39.7
Condenser	**Inlet**	69.9	85.9
	Outlet	41.1	51.6
Compressor shell		69.1	87.1
Winding temp.		103.2	127.9
Test time	**Min.**	70.0	225

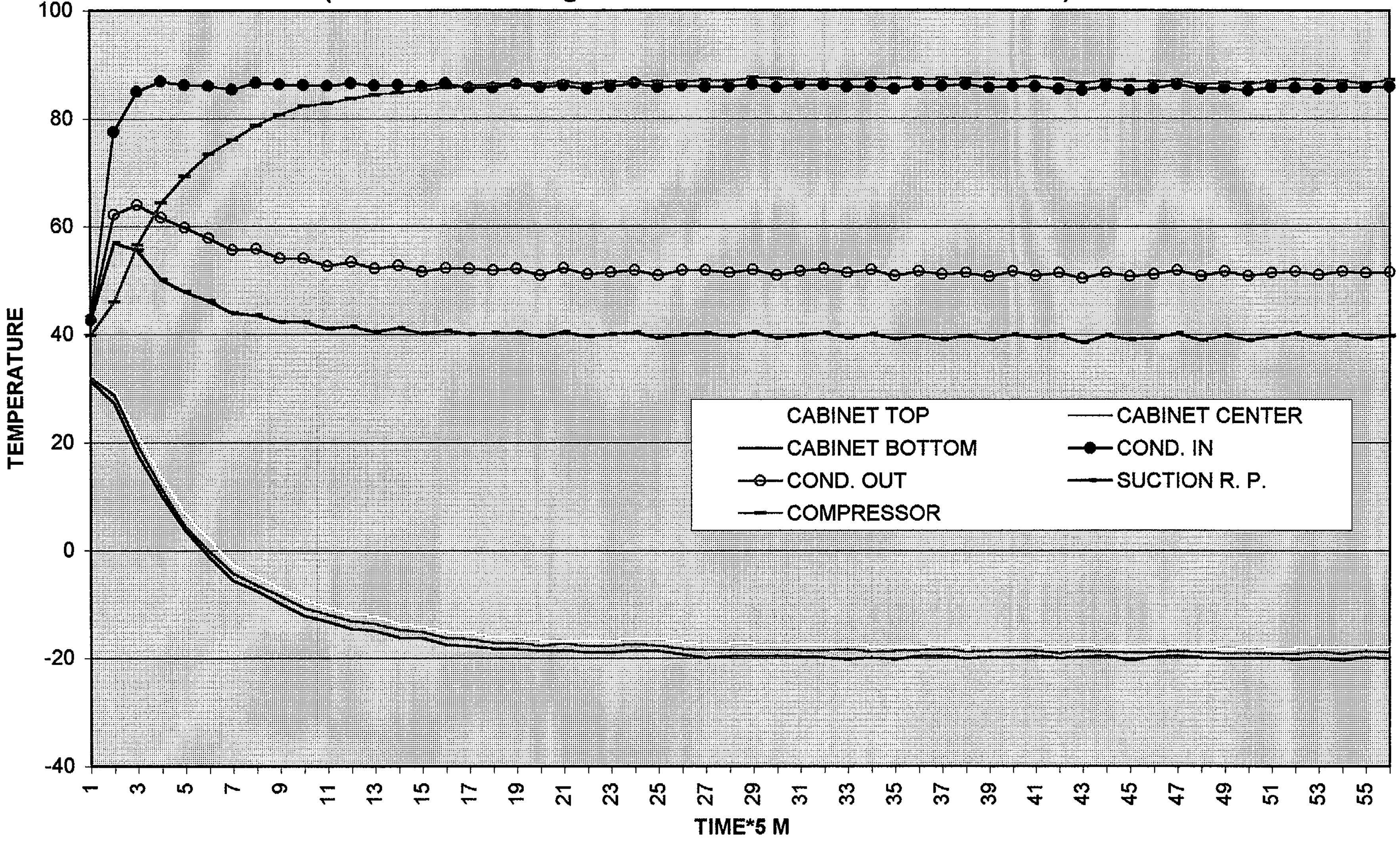
SILTAL TEST ROOM

(CF180-HSL17-150 gr.-AMB. TEMP.=32C-THERMO POS.=MAX)



SILTAL TEST ROOM

(CF180 -HSL17-150 gr-AMB. TEMP.=43C-THERMO POS.=MAX)

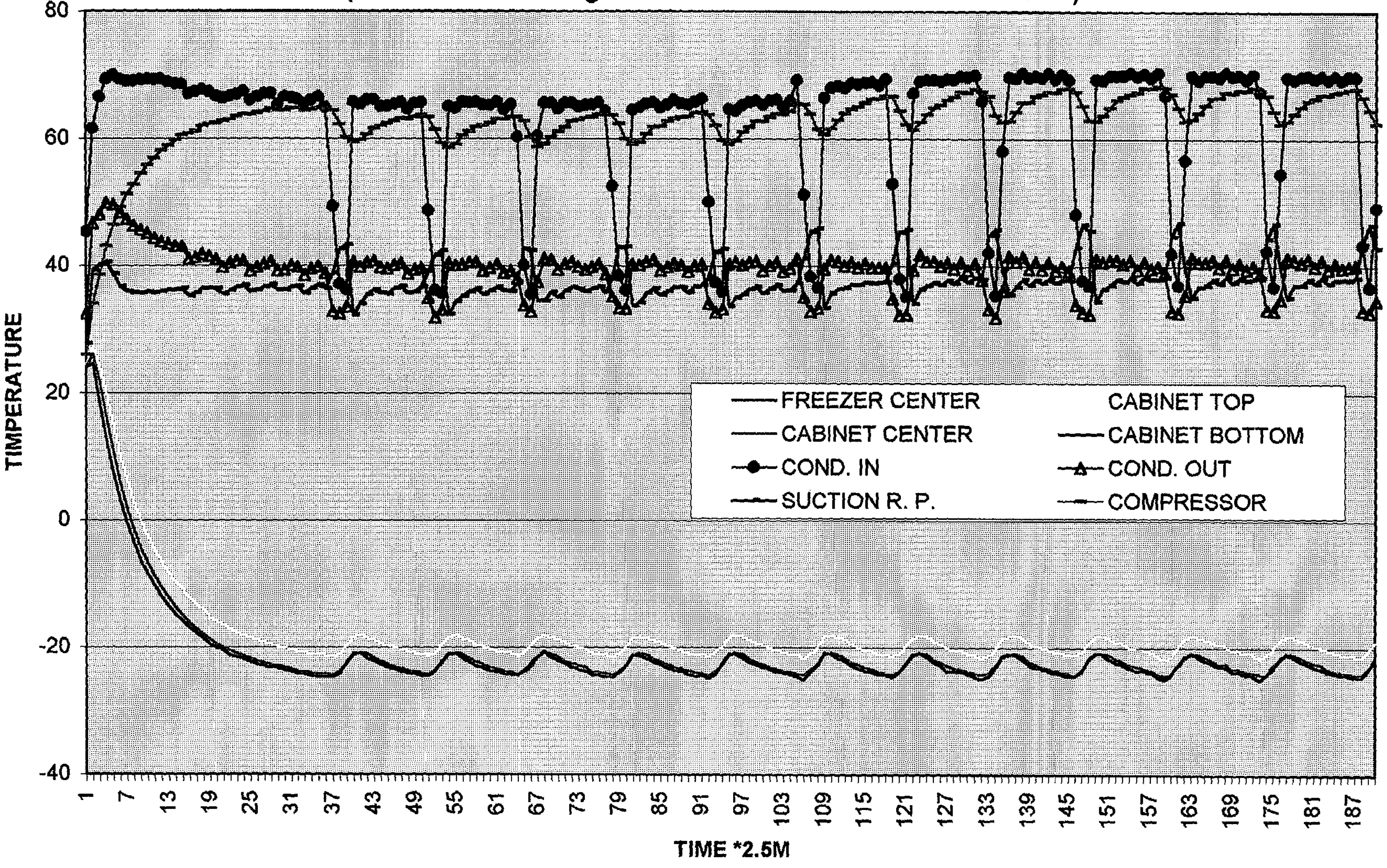


No load & thermostat control test

Model: CF180(180 Lit.)			*Class ST*									
Ambient		**C**	**43**		**38**		**32**		**25**		**18**	
Thermostat setting			**-**		**1**		**3**		**5**		**5**	
			OFF	**ON**	**OFF**	**ON**	**OFF**	**ON**	**OFF**	**ON**	**OFF**	**ON**
Freezer center		**C**	-	-	-	-	-	-	-	-	-	-
Thermostat bulb		**C**	-18.3	-	-21.7	-18.6	-23.9	-20.6	-26.1	-21.9	-25.3	-21.8
Cabinet	**T1**	**C**	-21.5	-	-20.5	-16.87	-21.5	-18.5	-21.4	-19.3	-22.1	-20.6
	T2	**C**	-21.1	-	-18.1	-20.6	-24.5	-21.1	-26.4	-24	-26.2	-24.3
	T3	**C**	-16.1	-	-21.8	-21.4	-24.7	-21.7	-27	-24.7	-26.6	-24.8
	Tavg	**C**	-		-		-		-		-	
Evaporator	**Inlet**	**C**	-19.1	-	-23.8	-20.1	-25.9	-24	-28.5	-23.0	-29	-23
	Outlet	**C**	-19.6	-	-24.3	-20.6	-26.3	-23.8	-28.2	-23.2	-28.9	-23.2
Suction		**C**	47.7	-	33.4	39.4	36.3	43.2	21.5	28.2	17.5	15.9
Condenser	**Inlet**	**C**	87.5	-	70.5	40.7	64.9	36.2	50.4	33.8	47	24
	outlet	**C**	50.7	-	44.1	37.3	38.8	33.5	31.2	27.3	26	17.5
Compressor		**C**	84.1	-	66.1	61.6	64.6	60.1	56.9	51.2	43	37.3
Power		**Watt**			123		112		108		105	
Current		**Amp**			0.9		0.9		0.9		0.9	
Energy cons.									1.74			
Running time		**%**	**100%**		**89%**		**77%**		**67%**		**50%**	

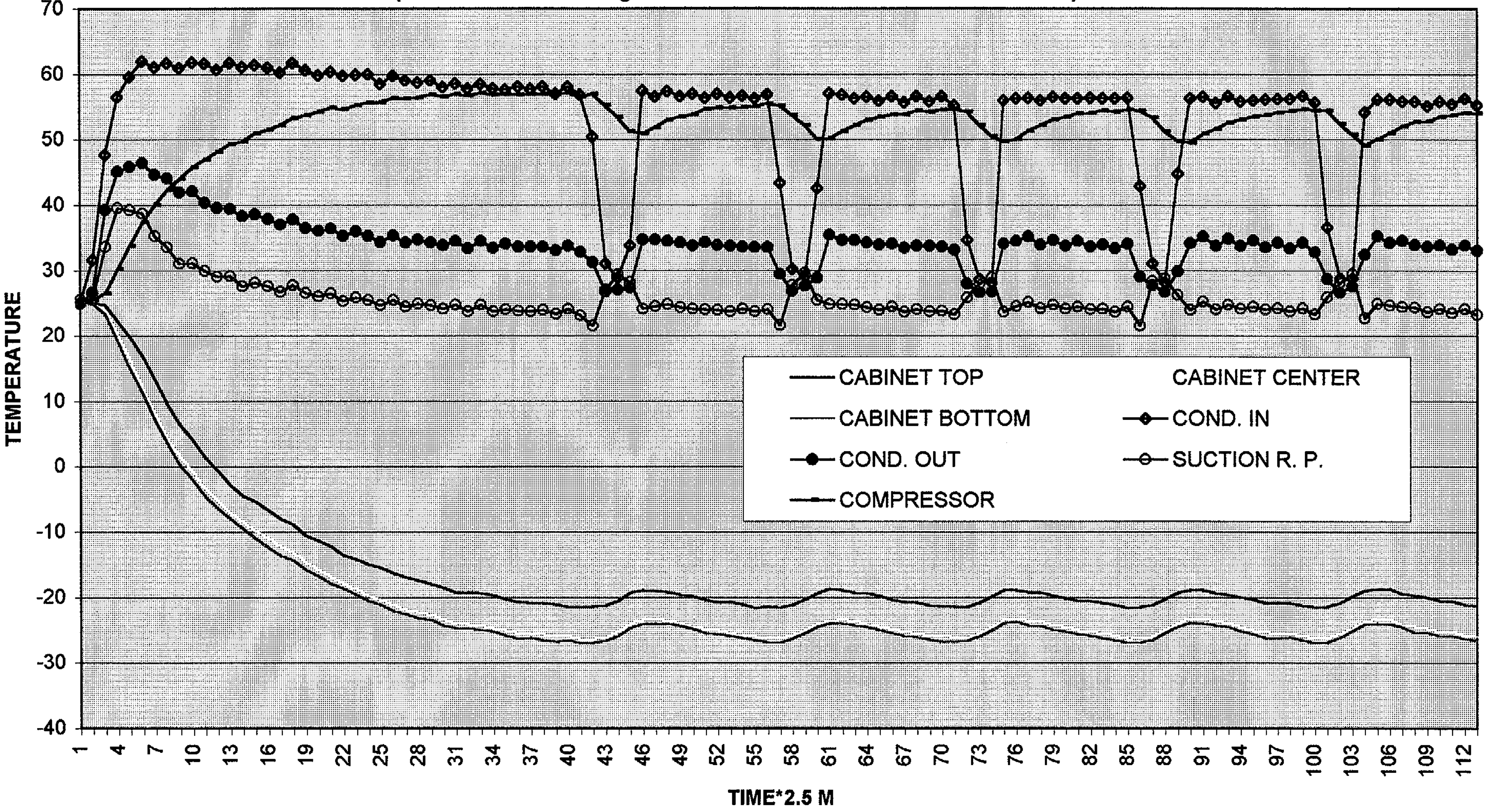
SILTAL TEST ROOM

(CF180-HSL17-150 gr.-AMB. TEMP.=32C-THERMO POS.=3)



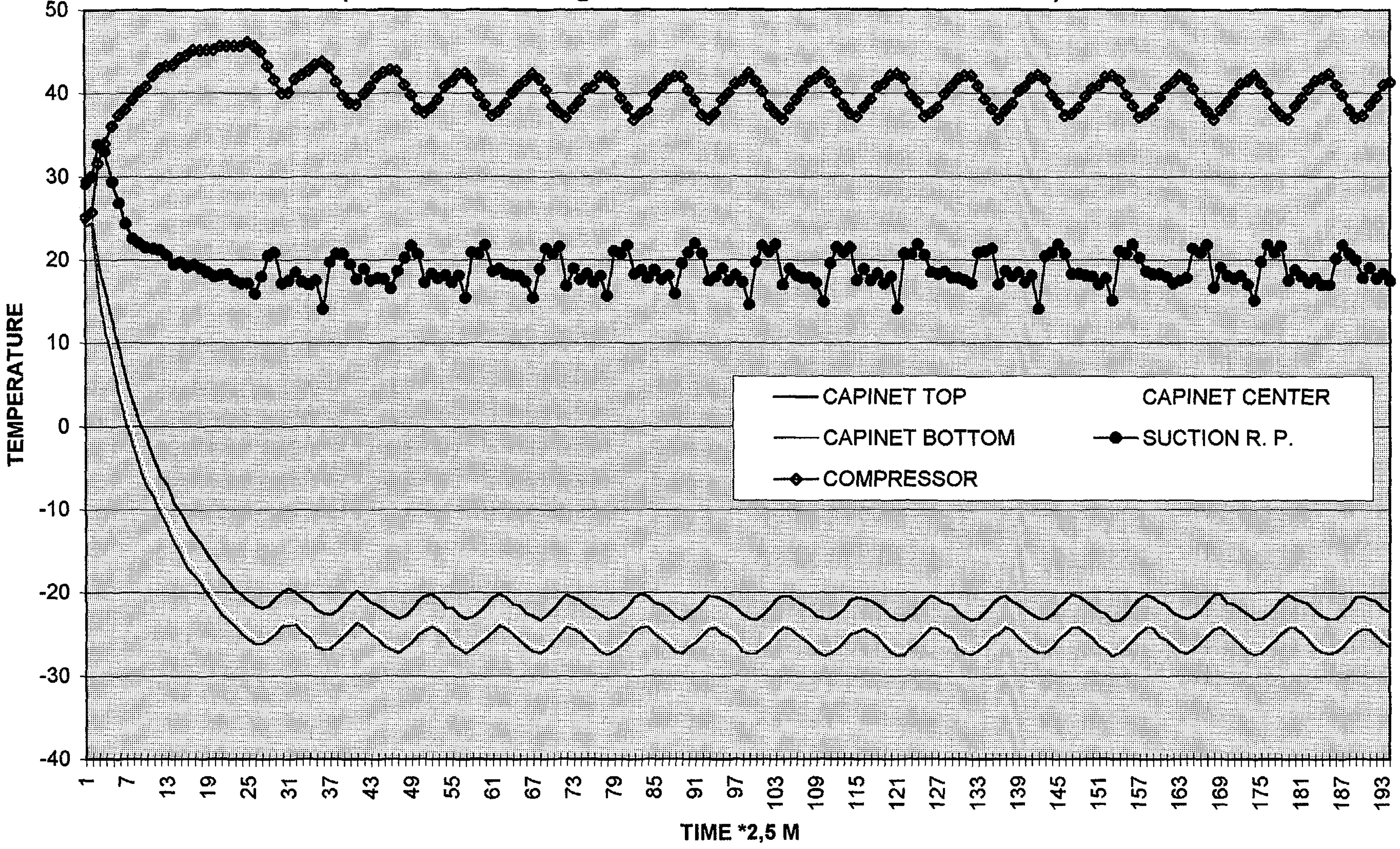
SILTAL TEST ROOM

(CF180-HSL17-150 gr.-AMB. TEMP.=25C-THERMO POS.=4)



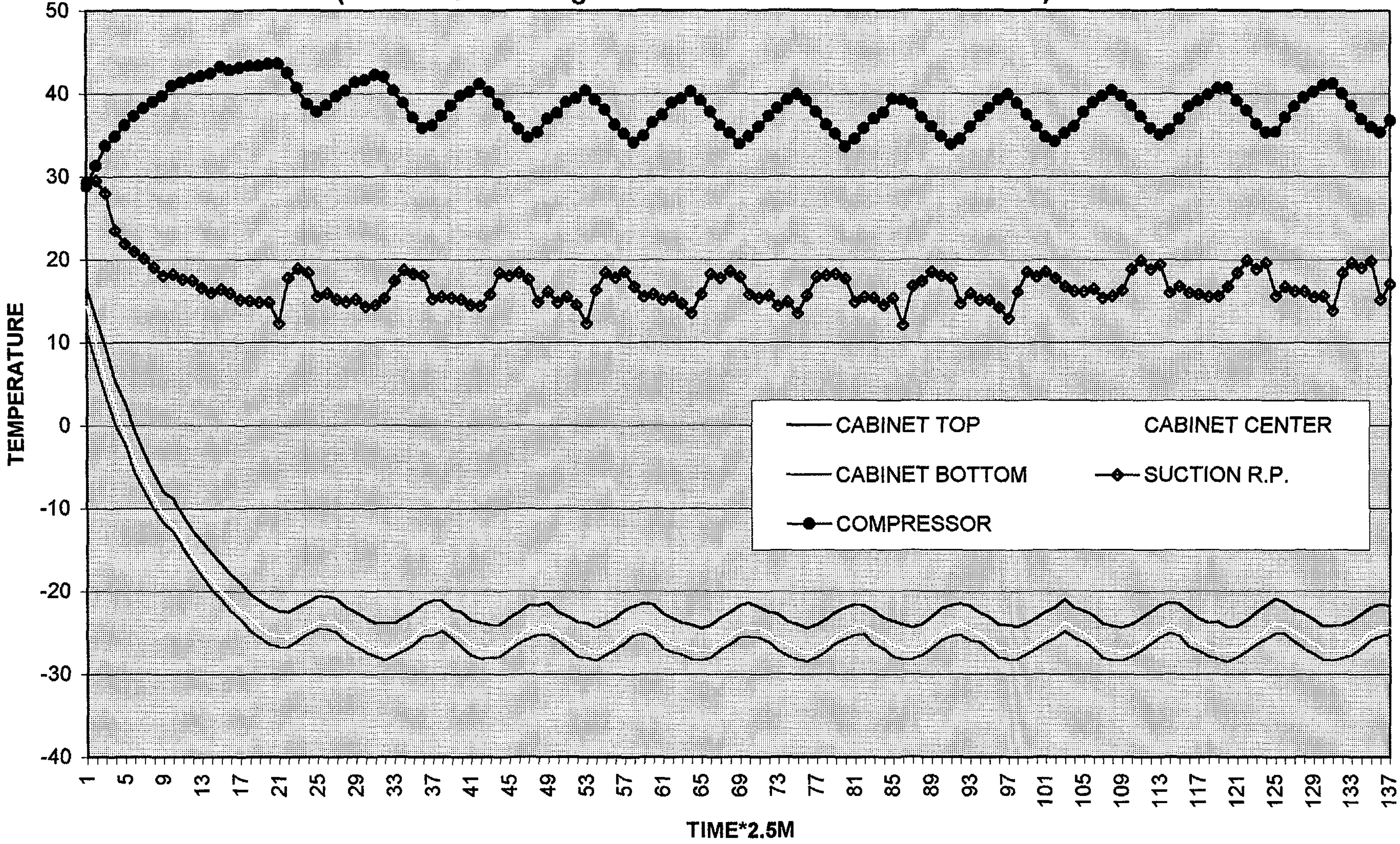
SILTAL TEST ROOM

(CF180-HSL17-150 gr.-AMB. TEMP.=18C-THERMO. POS.=4)



SILTAL TEST ROOM

(CF180-HSL17-150 gr.-AMB. TEMP.=16C-THERMO POS.=4)

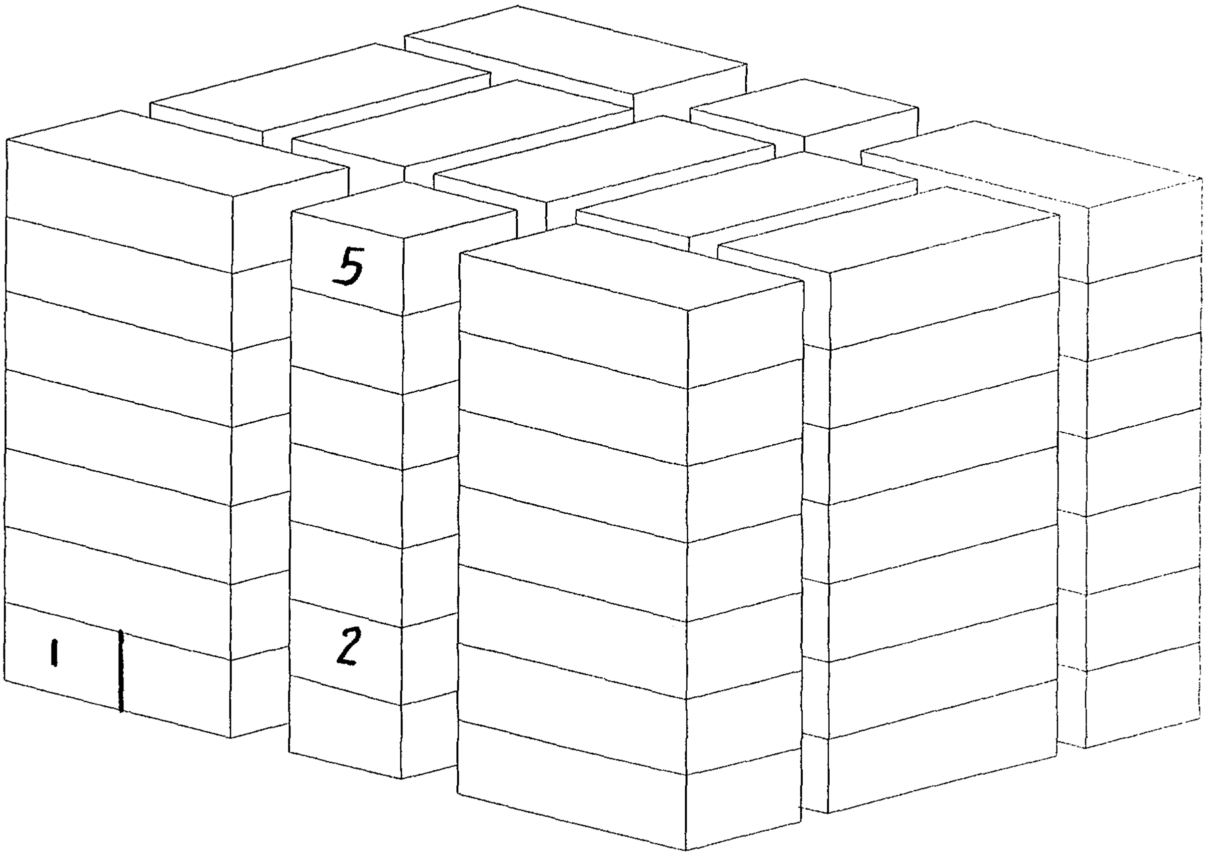


Storage and energy consumption

Model: CF180		**Class ST**					
Ambient		**32**		**25**		**16**	
Thermostat setting		**2**		**2**		**3**	
		ON	**OFF**	**ON**	**OFF**	**ON**	**OFF**
Thermostat bulb		-17.7	-20.8	-18.1	-21.0	-19.4	-22.8
Cabinet	**T1**	-	-	-	-	-	-
	T2	-	-	-	-	-	-
	T3	-	-	-	-	-	-
	TAVG	-		-		-	
Package temp.	**1**	-23.8	-24.1	-23.2	-23.4	-23.4	-23.8
	2	-22.5	-22.8	-21.6	-21.7	-20.1	-20.2
	3	-19.6	-19.7	-18.2	-18.3	-18.1	-18.9
	4	-22	-22.2	-21	-21.1	-19.0	-19.0
	5	-22.4	-22.9	-22	-22.1	-21.8	-22.3
	6	-20.9	-21.3	-20.2	-20.4	-19.1	-19.5
	7						
	8						
	9						
Power			114		112		104
Current			1.02		1.0		0.93
Running		**78%**		**67%**		**55%**	
Energy cons. kWh/24h		**1.80**					

- Rising time at ambient temp. 25 C
  Warmer pack from –18 C to 9 C in 17.30 hrs

Storage plane for chest freezer *model: CF180*



Number of layer	Weight
7	70 Kg.

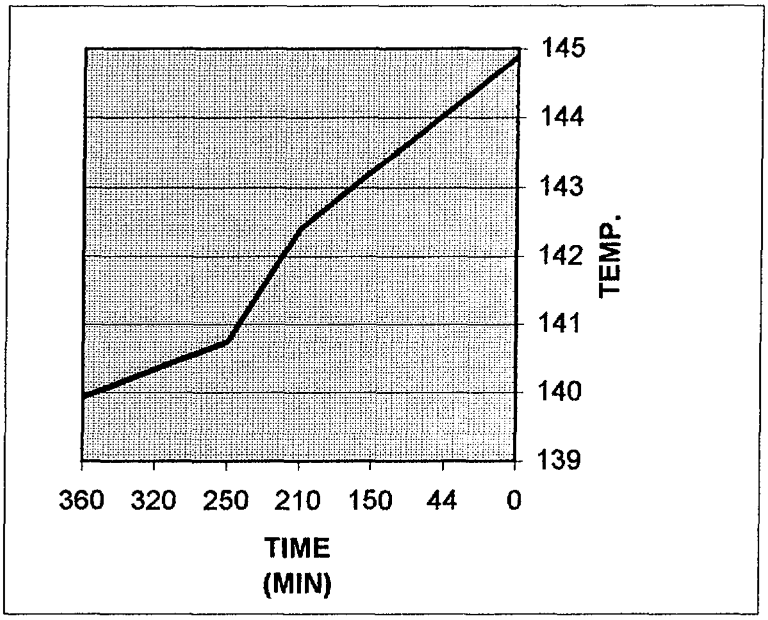
Freezing capacity test at 25 C (model CF 180)

T. Cabinet av.	--
T. Freezer av.	-21
Light load weight kg.	10
Heavy load weight kg.	15
Run time before light load	7 hr 30 \
Freezing time	22.30
Thermostat position	5
Warmest pack temp.	-18.3

Temperature rise and low starting test
(For CF180)

-Volt will be 233 at 43 C°
-Measurement of motor winding resistance and temperature

Time/min	0	44	150	210	250	320	360
Temp.	144.888	144.060	143.231	142.403	140.746	140.332	139.918



-After 30 min the starting test will be happen at volt 187
No 3 starting the compressor regular start.

Annex (A)

HFC-134a
Properties, Uses, Storage and Handling

Table of Contents

Introduction

Background

HFC-134a has been introduced by DuPont as a replacement for chlorofluorocarbons (CFCs) in many applications. CFCs, which were developed over 60 years ago, have many unique properties. They are low in toxicity, nonflammable, noncorrosive and compatible with other materials. In addition, they offer the thermodynamic and physical properties that make them ideal for a variety of uses. CFCs are used as refrigerants; as blowing agents in the manufacture of insulation, packaging and cushioning foams; as cleaning agents for metal and electronic components; and in many other applications.

However, the stability of these compounds, coupled with their chlorine content, has linked them to depletion of the earth's protective ozone layer. As a result, DuPont plans to phase out production of CFCs and introduce environmentally acceptable alternatives, such as hydrofluorocarbon (HFC) 134a.

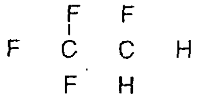
HFC-134a—An Environmentally Acceptable Alternative

HFC-134a does not contain chlorine; therefore, it has an ozone depletion potential (ODP) of zero. Listed below are all generic and DuPont trade names:

Hydrofluorocarbon-134a
HFC-134a
HFA-134a
Suva 134a
Suva 134a (Auto)
Formacel Z-4 (foam blowing agent market)
Dymel 134a /P (aerosol pharmaceutical market)
Dymel 134a (general aerosol market)

The chemical properties of HFC-134a are listed below.

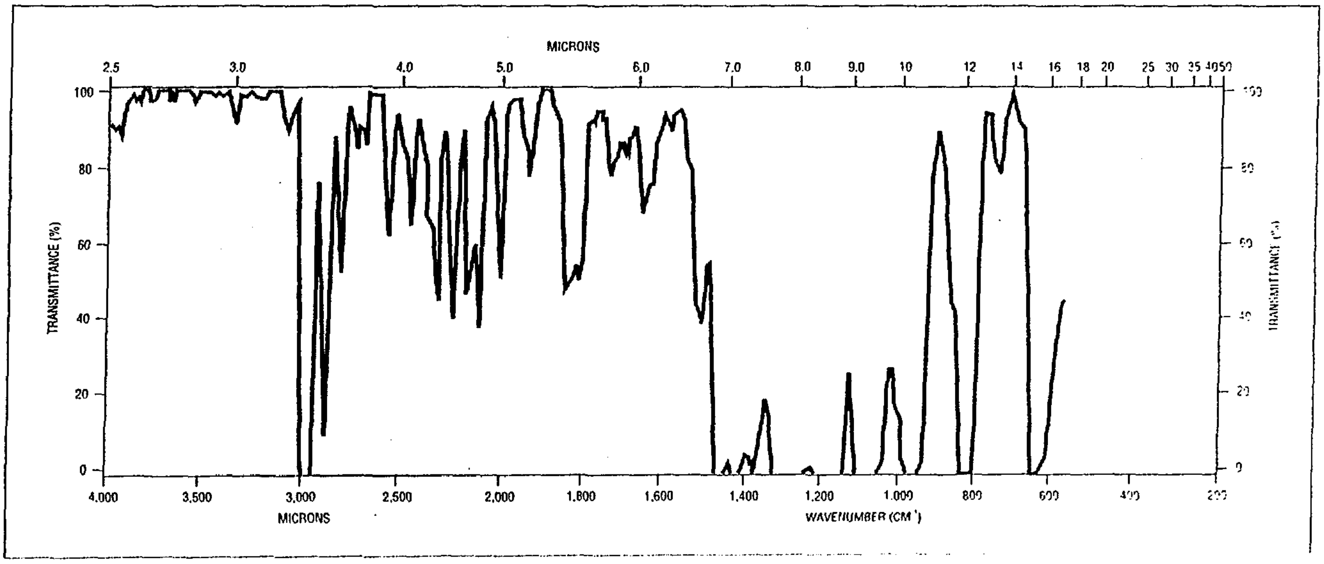
HFC 134a

Chemical Name	1,1,1,2-tetrafluoroethane
Molecular Formula	CH_2FCF_3
CAS Registry Number	811-97-2
Molecular Weight	102.0
Chemical Structure	 $\begin{array}{cccc} & F & F & \\ F & C & C & H \\ & F & H & \end{array}$

Uses

HFC-134a can be used in many applications that currently use dichlorodifluoromethane (CFC-12). These include refrigeration, polymer foam blowing and aerosol products. However, equipment design changes are sometimes required to optimize the performance of HFC-134a in these applications.

Figure 1. Infrared Spectrum of HFC-134a Vapor at 400 mm Hg Pressure (53.3 kPa) in a 10-cm Cell.



The thermodynamic and physical properties of HFC-134a, coupled with its low toxicity, make it a very efficient and safe replacement refrigerant for CFC-12 in many segments of the refrigeration industry, most notably in automotive air conditioning, appliances, small stationary equipment, medium-temperature supermarket cases and industrial and commercial chillers. **Table 1** provides a comparison of the theoretical performance of CFC-12 and HFC-134a at medium-temperature conditions.

Table 1
Theoretical Cycle Comparison of CFC-12 and HFC-134a*

	CFC-12	HFC-134a
Capacity (as % CFC-12)	100	99.7
Coefficient of Performance (COP)	3.55	3.43
Compressor		
Exit Temperature, °C (°F)	86.8 (188.2)	83.1 (181.5)
Exit Pressure, kPa (psia)	1349 (195.6)	1473 (213.7)
Compression Ratio	4.1	4.7

Temperatures were as follows: Condenser, 54.4°C (130.0°F); Evaporator, 1.7°C (35.0°F); Compressor Suction, 26.7°C (80.0°F); Expansion Device, 51.7°C (125.0°F).

As a blowing agent in polymer foams, HFC-134a can be used to replace CFC-12 in many thermoplastic foam applications. Recent developments, however, are also providing new technology that uses HFC-134a as a replacement for CFC-12 in thermoset foams. HFC-134a features properties that are advantageous for high value-in-use products and meets the requirements of safety/environmental issues. HFC-134a is nonflammable, has negligible photochemical reactivity and low vapor thermal conductivity.

HFC-134a is also being developed for use in pharmaceutical inhalers because of its low toxicity and nonflammability. Other aerosol applications may use HFC-134a where these properties are critical. See DuPont Dymel Bulletin ATB-30 for additional information on aerosol applications of HFC-134a.

Physical Properties

Physical properties of HFC-134a are given in **Table 2** and **Figures 2** to **8**. Additional physical property data may be found in other DuPont publications. Bulletin ART-1 (H-43855-1) contains viscosity, thermal conductivity and heat capacity data for saturated liquid and vapor in addition to heat capacity data and heat capacity ratios for both saturated and superheated vapors. Thermodynamic tables in English and SI units are available in Bulletins T-134a-ENG (H-47751-1) and T-134a-SI (H-47752-2). Liquid and vapor densities are included in the thermodynamic tables.

Chemical/Thermal Stability

Thermal Decomposition

HFC-134a vapors will decompose when exposed to high temperatures from flames or electric resistance heaters. Decomposition may produce toxic and irritating compounds, such as hydrogen fluoride. The pungent odors released will irritate the nose and throat and generally force people to evacuate the area. Therefore, it is important to prevent decomposition by avoiding exposure to high temperatures.

Stability with Metals and Refrigeration Lubricants

Stability tests for refrigerants with metals are typically performed in the presence of refrigeration oils. The results of sealed tube stability tests are available for CFC-12/mineral oil combinations, which have shown long-term stability in contact with copper, steel and aluminum in actual refrigeration systems. Polyalkylene glycol (PAG) and polyol ester (POE) lubricants will most likely be used with HFC-134a. Sealed tube tests were, therefore, run to determine the relative long-term stability of HFC-134a/metals in the presence of these lubricants.

The method followed was generally the same as ASHRAE 97 with several minor modifications. A 3-mL volume of refrigerant/lubricant solution was heated in the presence of copper, steel and aluminum strips in an oven for 14 days at 175°C (347°F). Both the neat lubricant and a mixture of lubricant and refrigerant (50/50 volume ratio) were tested. Visual ratings were obtained on both the liquid solutions and the metal coupons after the designated exposure time. The visual ratings ranged from 0 to 5, with 0 being the best and 5 being the worst.

After the visual ratings were obtained, sample tubes were opened and the lubricant and refrigerant (if present) were analyzed. The lubricant was typically checked for halide content and viscosity, while the refrigerant was examined for the presence of decomposition products. **Table 3** summarizes typical data for both HFC-134a and CFC-12. Visual ratings are

Table 2
Physical Properties of HFC-134a

Physical Properties	Units	HFC-134a
Chemical Name	—	Ethane, 1,1,1,2-Tetrafluoro
Chemical Formula	—	CH_2FCF_3
Molecular Weight	—	102.03
Boiling Point at 1 atm (101.3 kPa or 1.013 bar)	°C	–26.1
	°F	–14.9
Freezing Point	°C	–103.3
	°F	–153.9
Critical Temperature	°C	101.1
	°F	213.9
Critical Pressure	kPa	4060
	lb/in.^{2} abs	588.9
Critical Volume	m^3/kg	1.94×10^{-3}
	ft^3/lb	0.031
Critical Density	kg/m^3	515.3
	lb/ft^3	32.17
Density (Liquid) at 25°C (77°F)	kg/m^3	1206
	lb/ft^3	75.28
Density (Saturated Vapor) at Boiling Point	kg/m^3	5.25
	lb/ft^3	0.328
Heat Capacity (Liquid) at 25°C (77°F)	kJ/kg·K	1.44
	or Btu/(lb) (°F)	0.339
Heat Capacity (Vapor at Constant Pressure) at 25°C (77°F) and 1 atm (101.3 kPa or 1.013 bar)	kJ/kg·K	0.852
	or Btu/(lb) (°F)	0.204
Vapor Pressure at 25°C (77°F)	kPa	666.1
	bar	6.661
	psia	96.61
Heat of Vaporization at Boiling Point	kJ/kg	217.2
	Btu/lb	93.4
Thermal Conductivity at 25°C (77°F)		
Liquid	W/m·K	0.0824
	Btu/hr·ft°F	0.0478
Vapor at 1 atm (101.3 kPa or 1.013 bar)	W/m·K	0.0145
	Btu/hr·ft°F	0.00836
Viscosity at 25°C (77°F)		
Liquid	mPa·S (cP)	0.202
Vapor at 1 atm (101.3 kPa or 1.013 bar)	mPa·S (cP)	0.012
Solubility of HFC-134a in Water at 25°C (77°F) and 1 atm (101.3 kPa or 1.013 bar)	wt %	0.15
Solubility of Water in HFC-134a at 25°C (77°F)	wt %	0.11
Flammability Limits in Air at 1 atm (101.3 kPa or 1.013 bar)	vol %	None
Autoignition Temperature	°C	770
	°F	1418
Ozone Depletion Potential	—	0
Halocarbon Global Warming Potential (HGWP) (For CFC-11, HGWP = 1)	—	0.28
Global Warming Potential (GWP) (100 yr. ITH. For CO_2, GWP = 1)	—	1200
TSCA Inventory Status	—	Reported/Included
Toxicity AEL[a] (8- and 12-hr TWA)	ppm (v/v)	1000

[a] AEL (Acceptable Exposure Limit) is an airborne inhalation exposure limit established by DuPont that specifies time-weighted average concentrations to which nearly all workers may be repeatedly exposed without adverse effects.

Note: kPa is absolute pressure.

listed for the neat lubricant, the lubricant/refrigerant solution and the three metals that were present in the lubricant/refrigerant solutions. Viscosity was determined on the unused lubricant, the tested neat lubricant and the lubricant tested in the presence of refrigerant. A percent change was calculated for the two tested lubricants. The decomposition products listed are HFC-143a (the predominant decomposition product for HFC-134a) and fluoride ion. Both species are typically measured in the low parts per million (ppm) range.

As the CFC-12/mineral oil combinations have been proven in actual service, these tests indicate that HFC-134a/PAG and HFC-134a/POE solutions have acceptable chemical stability. In several other tests, results have confirmed that the HFC-134a molecule is as chemically stable as CFC-12.

Figure 2. Solubility of Water in HFC-134a.

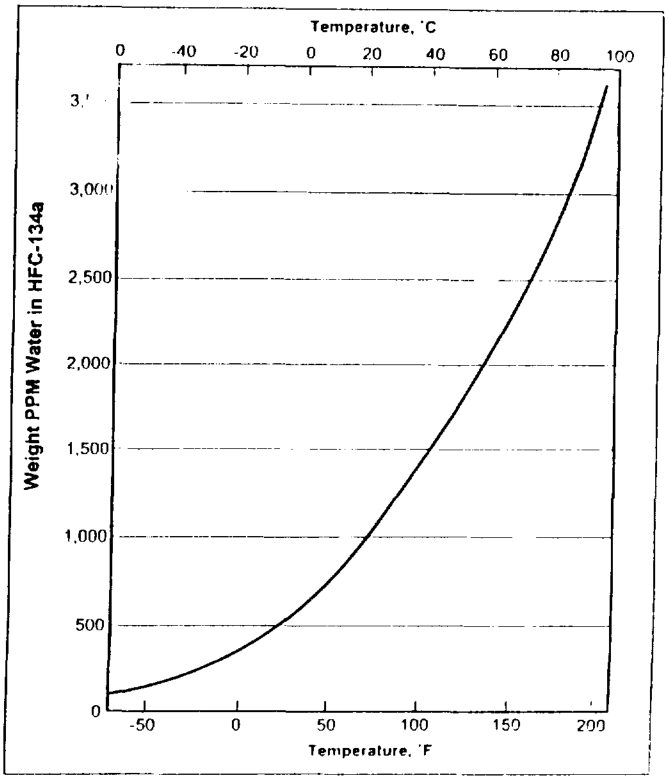


Table 3
Stability of HFC-134a with Metals and Lubricating Oils

Oil	Mineral Oil	Mineral Oil	UCON RO-W-6602[a]	Mobil EAL Arctic 32[b]	Castrol Icematic SW 100[b]
Oil Viscosity, cSt at 40°C (104°F)	30.7	125	134	29.4	108.8
Refrigerant	R-12	R-12	HFC-134a	HFC-134a	HFC-134a
Ratings					
Neat Oil	—	—	0	0	0
Oil/Refrigerant	4	4	0	0	0
Copper	2	2	0	0	0
Iron	3	3	0	0	0
Aluminum	2	2	0	0	0
Viscosity Change					
% Change Neat	ND	ND	<1	-3.1	4.3
% Change with Refrigerant	ND	ND	-12.7	-36.2	-27.1
Decomposition Analysis					
HFC-143a, ppm	ND	ND	<7	<3	<0.3
Fluoride, ppm	ND	420	<0.7	—	<7

[a] Polyalkylene glycol lubricant.
[b] Polyol ester lubricant.
ND = Not determined.

Stability Ratings: 0 to 5
0 = Best
3 = Failed
5 = Coked

Figure 4. Pressure vs. Temperature (SI Units).

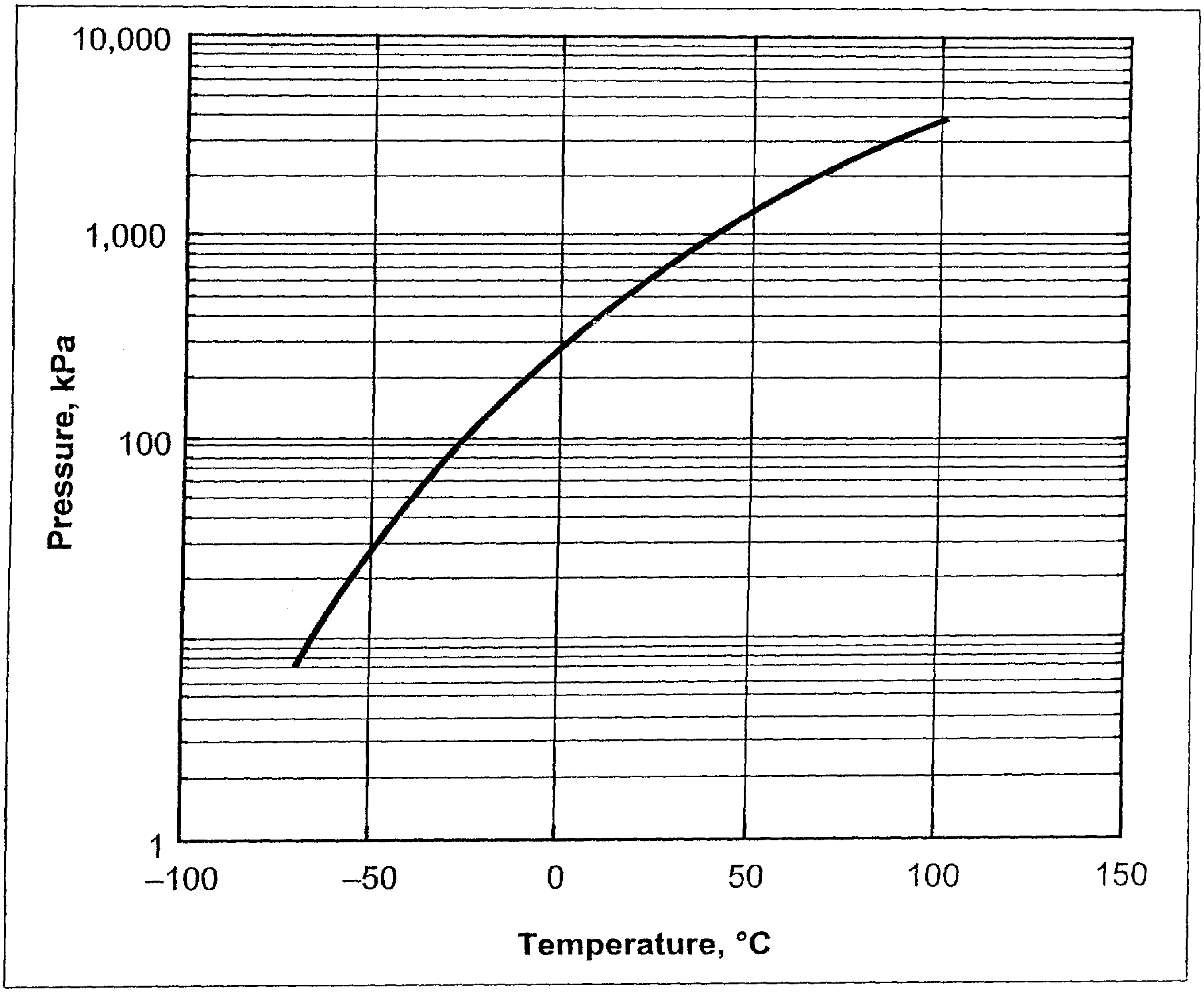


Figure 5. Vapor Thermal Conductivity of HFC-134a at Atmospheric Pressure (English Units).

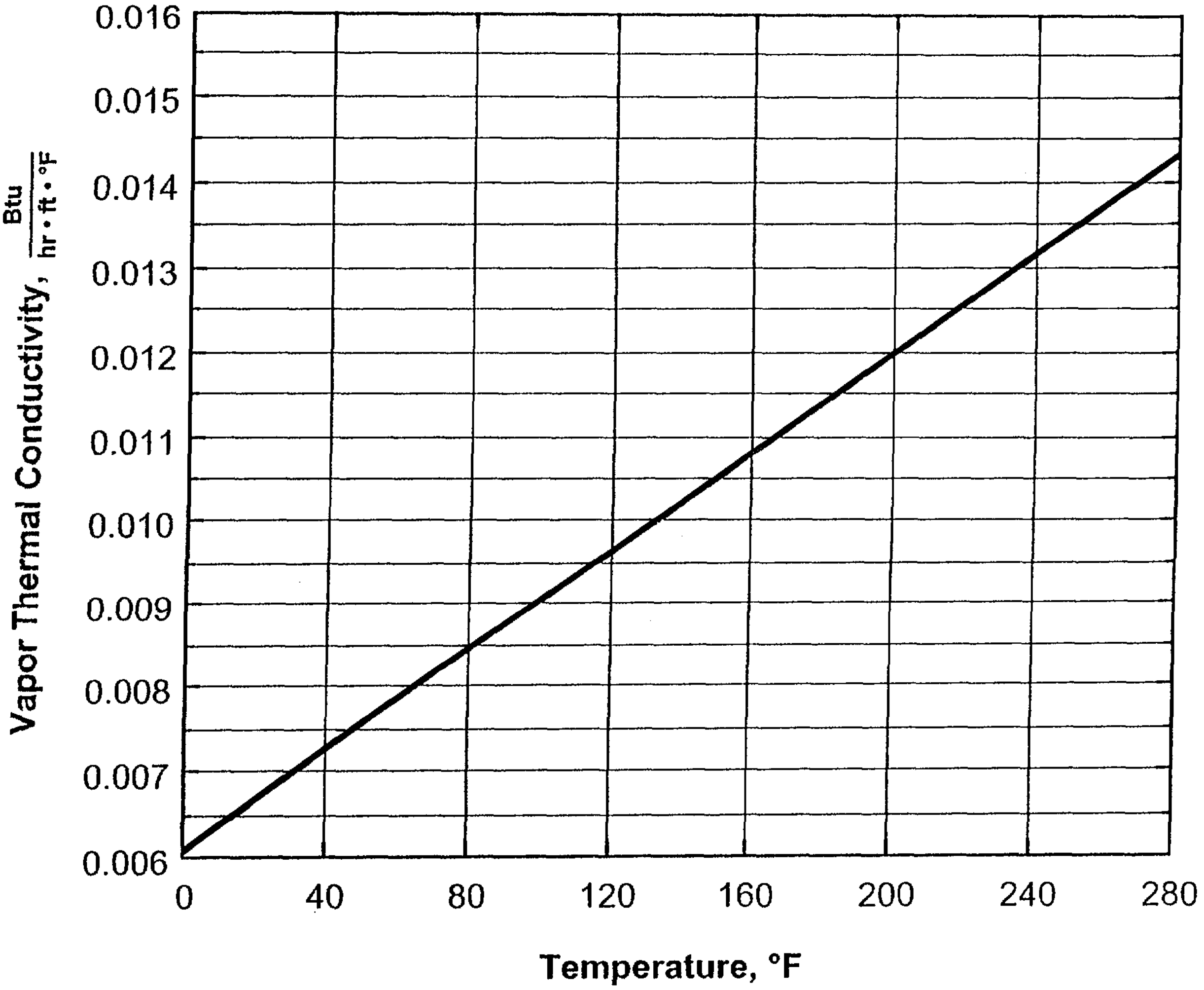
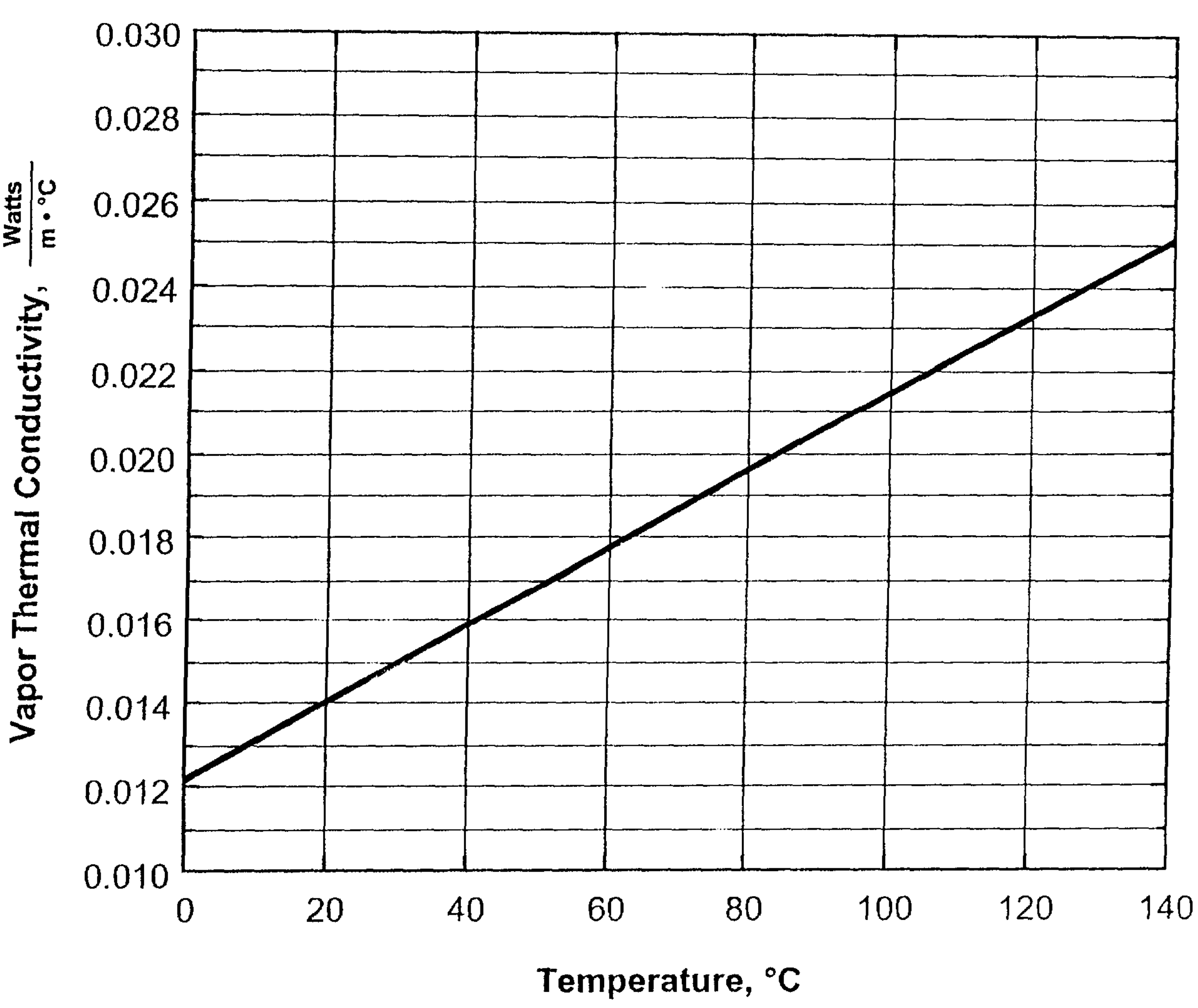


Figure 6. Vapor Thermal Conductivity of HFC-134a at Atmospheric Pressure (SI Units).



Stability with Foam Chemicals

As with other alternative blowing agents, the stability of HFC-134a in foam chemicals (B-side systems) is being studied. The first tests evaluated HFC-134a stability in a sucrose-amine polyether polyol with either an amine catalyst, a potassium catalyst, a tin catalyst or an amine catalyst neutralized with an organic acid. The initial tests, which included analysis of the volatile components, showed no degradation of HFC-134a in any of the systems, even at elevated temperatures. The results are summarized in **Table 4**.

Table 4
Stability of HFC-134a with Foam Chemicals

Catalyst	Degradation, %
Amine	<0.001
Potassium	<0.001
Tin	<0.001
Neutralized Amine	<0.001

Test Conditions:
Six weeks at 60°C (140°F).
25% (wt.) HFC-134a.
Two parts catalyst per 100 parts polyol by weight.
One part water per 100 parts polyol by weight.
Type 1010 steel test coupon.

Compatibility Concerns if HFC-134a and CFC-12 Are Mixed

HFC-134a and CFC-12 are chemically compatible with each other; this means that they do NOT react with each other and form other compounds. However, when the two materials are mixed together, they form what is known as an "azeotrope." An azeotrope is a mixture of two components that acts like a single compound, but has physical and chemical properties different than either of the two components. An example of this is Freon® 502, which is an azeotrope of HCFC-22 and CFC-115. When HFC-134a and CFC-12 are mixed in certain concentrations, they form a high-pressure (low boiling) azeotrope. This means that the vapor pressure of the azeotrope is higher than that of either of the two components by themselves. At 109 psia (752 kPa absolute) the azeotrope contains 46 weight percent HFC-134a. In general, compressor discharge pressures will be undesirably high if refrigeration equipment is operated with a mixture of HFC-134a and CFC-12.

Another characteristic of an azeotrope is that it is very difficult to separate the components once they are mixed together. Therefore, a mixture of HFC-134a and CFC-12 cannot be separated in an on-site recycle machine or in the typical facilities of an off-site reclaimer. Mixtures of HFC-134a and CFC-12 will usually have to be disposed of by incineration.

Materials Compatibility

Because HFC-134a is used in many applications, it is important to review materials of construction for compatibility when designing new equipment, retrofitting existing equipment or preparing storage and handling facilities.

Plastics

Customary industry screening tests, in which twenty-three typical plastic materials were exposed to liquid HFC-134a in sealed glass tubes at room temperature, are summarized in **Table 5**. Observations of weight gain and physical change were used to separate materials meriting further laboratory and/or field testing from materials that appeared unacceptable. The majority of the materials tested merit further evaluation.

Table 5
Plastics Compatibility of HFC-134a

Test Conditions: Plastic specimens exposed to liquid HFC-134a (no lubricant) in sealed glass tubes for two weeks at room temperature.

Chemical Type	Trade Name
Plastic materials meriting further testing:	
ABS	Kralastic®
Acetal	Delrin®
Epoxy	
Fluorocarbons	
PTFE	Teflon®
ETFE	Tefzel®
PVDF	
Ionomer	Surlyn®
Polyamide	
6/6 Nylon	Zytel®
Polyarylate	Arylon®
Polycarbonate	Tuffak®
Polyester	
PBT	Valox®
PET	Rynite®
Polyetherimide	Ultem®
Polyethylene-HD	Alathon®
Polyphenylene Oxide	Noryl®
Polyphenylene Sulfide	Ryton®
Polypropylene	
Polystyrene	Styron®
Polysulfone	Polysulfone®
Polyvinyl Chloride	
PVC	
CPVC	
Plastic materials exhibiting unacceptable change:	
Acrylic	Lucite®
Cellulosic	Ethocel®

Since the performance of plastic materials is affected by polymer variations, compounding agents, fillers, and molding processes, verifying compatibility using actual fabricated parts under end-use conditions is advised.

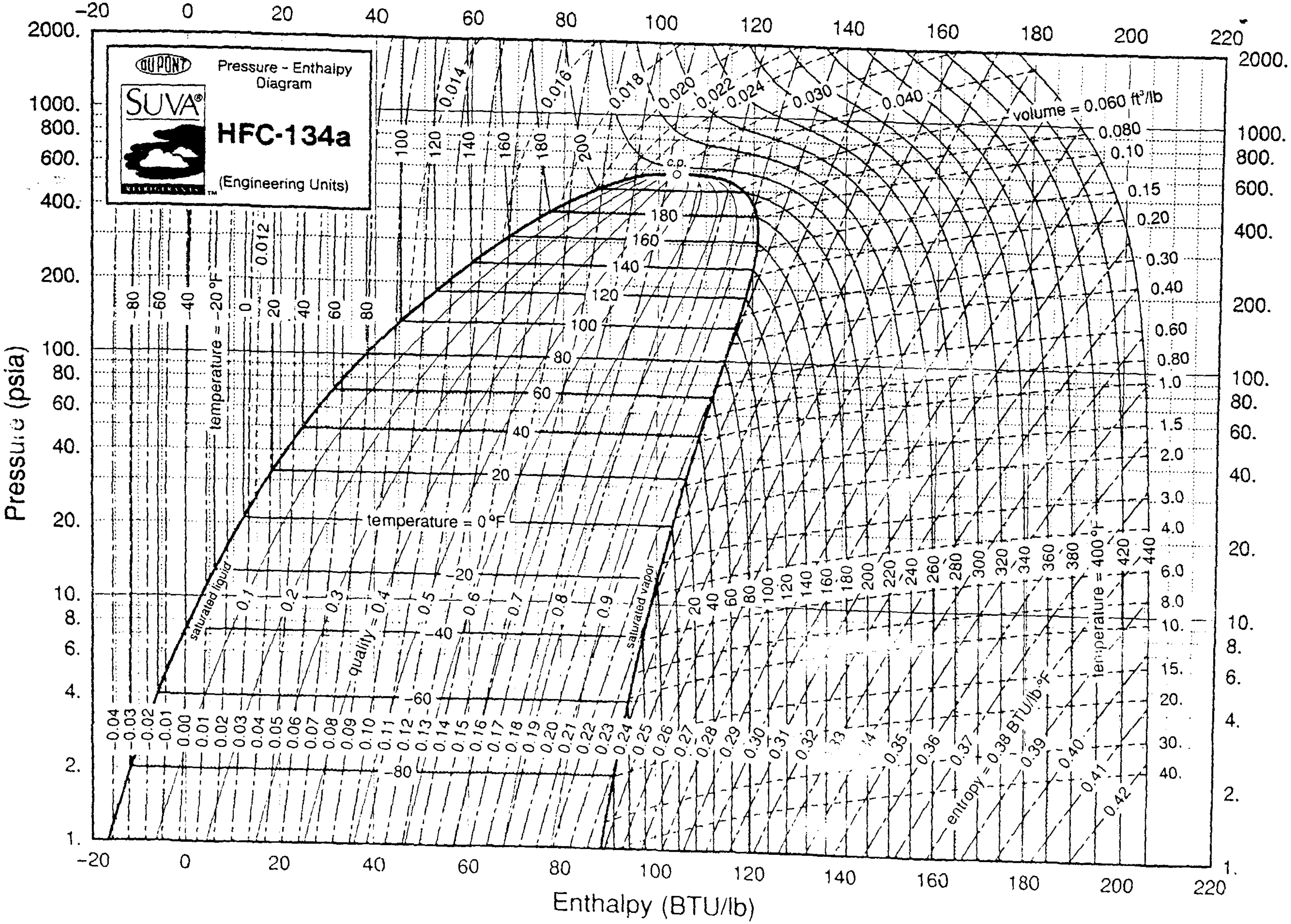


Figure 7. Pressure-Enthalpy Diagram for HFC-134a (English Units).

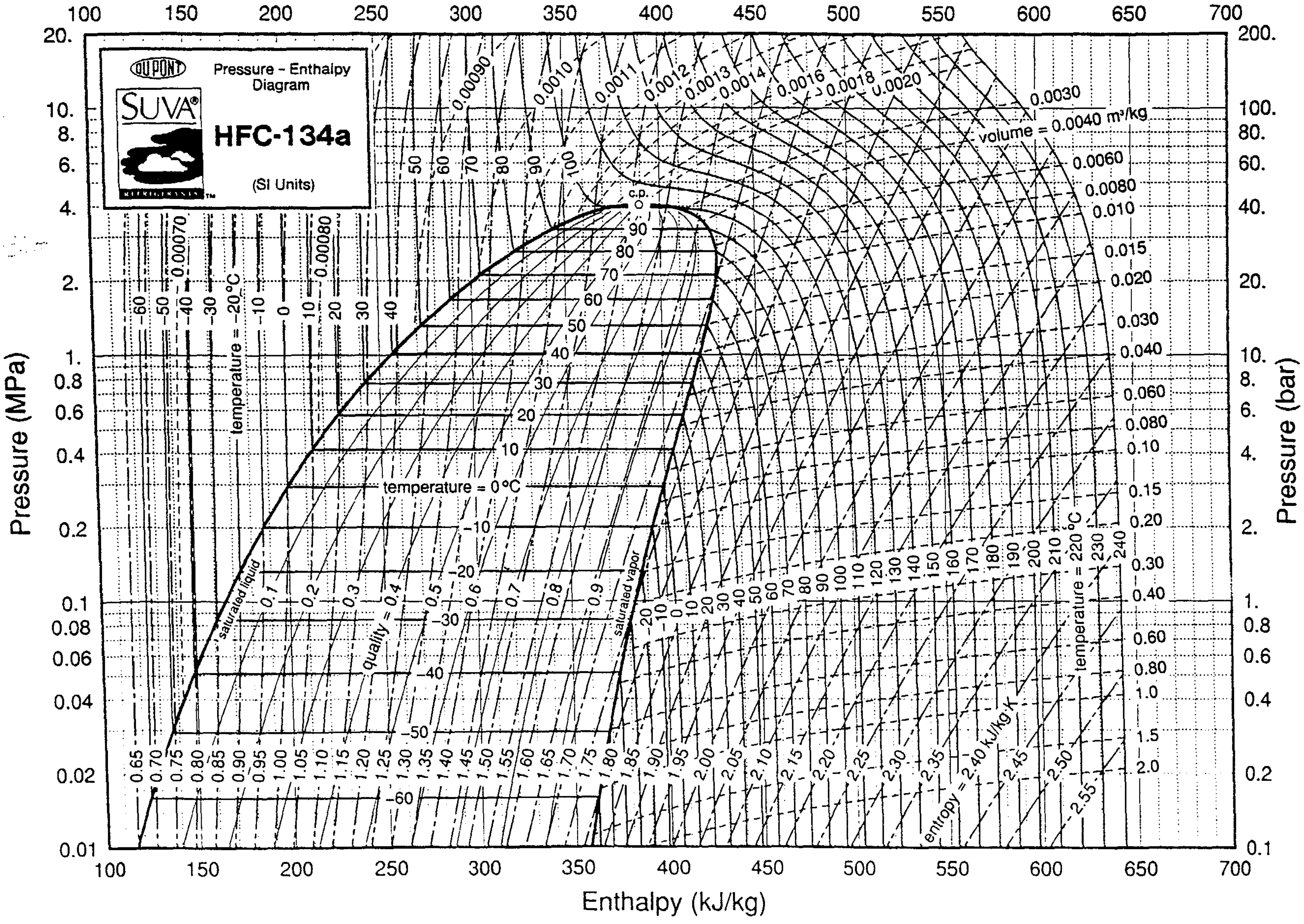


Figure 8. Pressure-Enthalpy Diagram for HFC-134a (SI Units).

Elastomers

Compatibility results for HFC-134a and CFC-12 are compared for 11 typical elastomers in **Tables 6** through **17**. It should be recognized, however, that effects on specific elastomers depend on the nature of the polymer, the compounding formulation used and the curing or vulcanizing conditions. Actual samples should be tested under end-use conditions before specifying elastomers for critical components.

Recommendations, based on the detailed data in **Tables 7** through **17**, are given in **Table 6**. Data on "temporary" elastomer swell and hardness changes were used as the prime determinants of compatibility. The subsequent "final" data were used as a guide to indicate if the seals in a refrigeration system should be replaced after equipment teardown.

Most polymeric materials used in refrigeration equipment are exposed to a mixture of refrigerant and refrigeration oil. Data on the compatibility of elastomers and motor materials with HFC-134a in combination with mineral oils and a PAG lubricant are available in Bulletins ARTD-18 (H-26845) and ARTD-30 (H-32123). Data for nylon and for graphite-filled Teflon fluorocarbon resin are included in ARTD-30.

In addition, DuPont Films has measured the compatibility of Mylar® polyester film with HFC-134a/polyol ester (POE) lubricant systems compared to CFC-12/mineral oil systems. Slot liners, wedges and interphase insulation of Mylar are widely used in hermetic compressor motors for CFC-12 service. Studies indicate that the life of Mylar in systems using HFC-134a will be comparable to film life in CFC-12 systems. In cases where polyester film fails in hermetic systems, the cause is usually traced to unwanted moisture. Too much moisture causes polyester film to hydrolyze and embrittle. Results indicate that the POE lubricants used with HFC-134a tend to pull water from Mylar. This promotes a drier film, which should result in a longer motor insulation life. Since polyester motor insulation is buried beneath windings and can be difficult to dry, this water extraction capability of POE lubricants should be a valuable performance asset. Further information is available from DuPont Films.

Additional materials compatibility data are being developed by equipment manufacturers.

Hose Permeation

Elastomeric hoses are used in mobile air conditioning systems and for transferring HFC-134a in other applications. The permeation rates of HFC-134a and CFC-12 through several automotive A/C hoses were measured as a guide to hose selection.

The studies were run at 80°C (176°F) with an initial 80 volume percent liquid loading of HFC-134a in 76-cm (30-in.) lengths of 15.9-mm (5/8-in.) inside diameter automotive air conditioning hose. Hose construction and permeation rates are summarized in **Table 18**. Based on these tests, hoses lined with nylon, as well as those made of Hypalon® 48, appear to be suitable for use with HFC-134a. Note, however that these rate measurements provide a comparison of the various hoses at a single temperature and should not be used as an indication of actual permeation losses from an operating system.

Desiccants

Driers filled with desiccant are typically used in refrigeration systems and bulk storage facilities. A common molecular sieve desiccant used with CFC-12, UOP's 4A-XH-5, is not compatible with HFC-134a. However, manufacturers have developed other molecular sieve desiccants that perform well with HFC-134a. UOP's XH-7 and XH-9 or Grace's MS 592 or MS 594 desiccants may be used in loose filled driers. Compacted bead dryers, in which the desiccant is compacted by mechanical pressure, may use XH-6 in addition to the desiccants listed above.

In molded core driers, the molecular sieve is dispersed within a solid core. Several manufacturers offer molded core driers that are compatible with HFC-134a. Consult the drier manufacturer for recommendations.

Refrigeration Lubricants

Most compressors require a lubricant to protect internal moving parts. The compressor manufacturer usually recommends the type of lubricant and viscosity that should be used to ensure proper operation and equipment durability. Recommendations are based on several criteria, such as lubricity, compatibility with materials of construction, thermal stability and refrigerant/oil miscibility. To ensure efficient operation and long equipment life, it is important to follow the manufacturer's recommendations.

Current lubricants used with CFC-12 are fully miscible over the range of expected operating conditions, easing the problem of getting the lubricant to flow back to the compressor. Refrigeration systems using CFC-12 take advantage of this full miscibility when considering lubricant return. Refrigerants such as HFC-134a, with little or no chlorine, may exhibit less solubility with many existing mineral oil or alkylbenzene lubricants.

The search for lubricants for use with HFC-134a started with commercially available products. **Table 19** shows solubilities of various refrigerant/lubricant combinations. Current naphthenic, paraffinic and alkylbenzene lubricants have very poor solubility with HFC-134a. PAGs with low viscosity show good solubility but, as viscosity increases, they become less soluble. Polyol ester (POE) lubricants, of which there are many types, generally show good solubility with HFC-134a. When compared to PAGs, ester lubricants are more compatible with hermetic motor components and are less sensitive to mineral oil and CFC-12 remaining in a refrigeration system.

Although HFC-134a and CFC-12 are chemically compatible with each other, such is not the case with CFC-12 and PAG lubricants. Specifically, the chlorine contained in CFC-12 or other chlorinated compounds can react with the PAG and cause lubricant degradation. CFC-11, which is often used as a cleaning or flushing agent, is also incompatible with PAGs. At contaminant levels of 1 percent CFC-11 or 2 to 10 percent residual mineral oil (saturated with CFC-12), the stability of the system is affected enough to cause possible degradation. Lubricant degradation can result in poor lubrication and premature failure. In addition, sludge will be formed that can plug orifice tubes and other small openings.

Table 6
Elastomer Compatibility of HFC-134a

	Ratings					
	CFC-12			HFC-134a		
	25°C (77°F)	80°C (176°F)	141°C (285°F)	25°C (77°F)	80°C (176°F)	141°C (285°F)
Adiprene® L	1	5		2	5	
Buna N	1*	0*	2*	1	0*	1
Buna S	3	4		3	2	
Butyl Rubber	2	4		0	3	
Hypalon 48	1	0	0	1*	0	0
Natural Rubber	4	5		0	2	
Neoprene W	0*	1*		0	2	
Nordel® Elastomer	2*	2*		1	1	
Silicone	5	5		2	2	
Thiokol® FA	1	1		1*	0	
Viton® A	5	5		5	5	

*Recommend elastomer replacement after equipment teardown.

Hypalon, Nordel and Viton are DuPont registered trademarks.
Adiprene is a Uniroyal registered trademark.
Thiokol FA is a Morton Thiokol registered trademark.

Codes: 0 = No change.
1 = Acceptable change.
2 = Borderline change.
3 = Slightly unacceptable change.
4 = Moderately unacceptable change.
5 = Severely unacceptable change.

Table 7
Compatibility of Refrigerants with Adiprene L

Test Conditions: 27 days immersion of the polymer at 25°C (77°F) and 80°C (176°F) in liquid (temporary) plus two weeks drying in air at about 25°C (77°F) (final).

	25°C (77°F)		80°C (176°F)	
	CFC-12	**HFC-134a**	**CFC-12**	**HFC-134a**
Length Change (%)				
Temporary	1.8	5.5	2.1	5.0
Final	0.3	0.1	[a]	−0.5
Weight Change (%)				
Temporary	8.5	20	5.2	20
Final	1.2	0.3	[a]	−0.5
Shore A Hardness				
Original	60	61	60	63
Temporary, Δ SH	−2	−4	[a]	−28
Final, Δ SH	0	1	—	−19
Elasticity Rating				
Temporary	0	0	5[a]	4[b]
Final	0	0	5[a]	5[c]
Visual Rating				
Liquid	0	0	0	0
Polymer				
Temporary	0	0	0	1[d]
Final	0	0	5[a]	2[d]

[a] Sample disintegrated

[b] More elastic

[c] Broke when stretched

[d] Sticky

Table 8
Compatibility of Refrigerants with Buna N

Test Conditions: 27 days immersion of the polymer at 25°C (77°F), 80°C (176°F) and 141°C (285°F) in liquid (temporary) plus two weeks drying in air at about 25°C (77°F) (final).

	CFC-12			HFC-134a		
	25°C (77°F)	80°C (176°F)	141°C (285°F)	25°C (77°F)	80°C (176°F)	141°C (285°F)
Length Change (%) (±0.5)						
Temporary	2	1	2	2	2	3
Final	0	−1	0	0	0	0
Weight Change (%) (±0.5)						
Temporary	7	6	8	8	8	8
Final	0	−1	2	0	0	0
Shore A Hardness						
Original	77	76	72	77	74	75
Temporary, Δ SH	−6	−1	9	−5	−1	−3
Final, Δ SH	7	9	14	5	7	4
Elasticity Rating						
Temporary	0	1	1[a]	0	1	1
Final	0	0	0	0	0	0
Visual Rating						
Liquid	0	0	0	0	0	0
Polymer						
Temporary	0	1	1[b]	0	0	0
Final	0	1	1[b]	0	0	0

[a] More elastic

[b] Surface dulled

Table 9
Compatibility of Refrigerants with Buna S

Test Conditions: 27 days immersion of the polymer at 25°C (77°F) and 80°C (176°F) in liquid (temporary) plus two weeks drying in air at about 25°C (77°F) (final).

	25°C (77°F)		80°C (176°F)	
	CFC-12	HFC-134a	CFC-12	HFC-134a
Length Change (%)				
Temporary	–0.1	1.1	0.7	0.8
Final	–2.5	<0.1	–2.6	0.3
Weight Change (%)				
Temporary	2.8	1.9	2.9	2.5
Final	–6.2	–0.1	–6.2	–0.1
Shore A Hardness				
Original	85	84	83	81
Temporary, Δ SH	–12	–12	–16	–9
Final, Δ SH	8	–2	–9	–2
Elasticity Rating				
Temporary	0	0	0	1(a)
Final	3(b)	1(b)	3(b)	0
Visual Rating				
Liquid	0	0	0	0
Polymer				
Temporary	0	0	0	0
Final	0	0	0	0

(a) More elastic

(b) Less elastic

Table 10
Compatibility of Refrigerants with Butyl Rubber

Test Conditions: 27 days immersion of the polymer at 25°C (77°F) and 80°C (176°F) in liquid (temporary) plus two weeks drying in air at about 25°C (77°F) (final).

	25°C (77°F)		80°C (176°F)	
	CFC-12	HFC-134a	CFC-12	HFC-134a
Length Change (%)				
Temporary	6.3	0.2	7.6	1.3
Final	–1.2	0	–0.8	0.4
Weight Change (%)				
Temporary	34	2.0	36	3.7
Final	–2.6	–0.1	–1.2	0.6
Shore A Hardness				
Original	54	54	57	58
Temporary, Δ SH	–8	–1	–14	–4
Final, Δ SH	–1	–2	–10	–3
Elasticity Rating				
Temporary	1(a)	1(a)	3(a)	0
Final	0	0	2(a)	0
Visual Rating				
Liquid	0	0	3(b)	0
Polymer				
Temporary	0	0	3(c)	4(c)
Final	0	0	1(d)	2(d)

(a) More elastic

(b) White solids in liquid

(c) White deposit on elastomer

(d) White film on elastomer

Table 11
Compatibility of Refrigerants with Hypalon 48

Test Conditions: 27 days immersion of the polymer at 25°C (77°F), 80°C (176°F) and 141°C (285°F) in liquid (temporary) plus two weeks drying in air at about 25°C (77°F) (final).

	CFC-12			HFC-134a		
	25°C (77°F)	80°C (176°F)	141°C (285°F)	25°C (77°F)	80°C (176°F)	141°C (285°F)
Length Change (%) (±0.5)						
Temporary	1	0	1	0	0	1
Final		0	0	0	0	0
Weight Change (%) (±0.5)						
Temporary	7	5	9	0	1	2
Final	2	1	4	0	0	1
Shore A Hardness						
Original	79	81	81	76	82	82
Temporary, Δ SH	−4	0	0	3	1	1
Final, Δ SH	4	2	2	8	1	4
Elasticity Rating						
Temporary	0	0	0	0	0	0
Final	0	0	0	0	0	0
Visual Rating						
Liquid	0	0	0	0	0	0
Polymer						
Temporary	0	1	1[a]	0	0	0
Final	0	1	1[a]	0	0	0

[a] Surface dulled

Table 12
Compatibility of Refrigerants with Natural Rubber

Test Conditions: 27 days immersion of the polymer at 25°C (77°F) and 80°C (176°F) in liquid (temporary) plus two weeks drying in air at about 25°C (77°F) (final).

	25°C (77°F)		80°C (176°F)	
	CFC-12	HFC-134a	CFC-12	HFC-134a
Length Change (%)				
Temporary	14	1.3	14	2.0
Final	−1.1	−0.3	−0.8	0.4
Weight Change (%)				
Temporary	51	4.5	55	5.8
Final	−2.6	−0.5	−2.6	−0.6
Shore A Hardness				
Original	55	56	56	57
Temporary, Δ SH	−9	−1	−17	−8
Final, Δ SH	−5	−4	−8	−4
Elasticity Rating				
Temporary	0	0	1[a]	1[a]
Final	0	0	2[a]	0
Visual Rating				
Liquid	0	0	0	0
Polymer				
Temporary	0	0	0	0
Final	0	0	0	0

[a] More elastic

Table 13
Compatibility of Refrigerants with Neoprene W

Test Conditions: 27 days immersion of the polymer at 25°C (77°F) and 80°C (176°F) in liquid (temporary) plus two weeks drying in air at about 25°C (77°F) (final).

	25°C (77°F)		80°C (176°F)	
	CFC-12	HFC-134a	CFC-12	HFC-134a
Length Change (%)				
Temporary	0.2	0.7	0.9	1.4
Final	−7.6	−0.5	−7.3	−0.3
Weight Change (%)				
Temporary	6.6	2.3	6.8	2.9
Final	−12	−0.6	−13	−1.8
Shore A Hardness				
Original	73	73	73	72
Temporary, Δ SH	−1	0	−5	−7
Final, Δ SH	−10	0	5	−5
Elasticity Rating				
Temporary	2(a)	0	1(b)	0
Final	2(a)	0	2(b)	0
Visual Rating				
Liquid	1(c)	0	1(d)	0
Polymer				
Temporary	0	0	1(e)	0
Final	0	0	0	0

(a) Less elastic
(b) More elastic
(c) Clear, yellow
(d) Hazy
(e) White film

Table 14
Compatibility of Refrigerants with Nordel Elastomer

Test Conditions: 27 days immersion of the polymer at 25°C (77°F) and 80°C (176°F) in liquid (temporary) plus two weeks drying in air at about 25°C (77°F) (final).

	25°C (77°F)		80°C (176°F)	
	CFC-12	HFC-134a	CFC-12	HFC-134a
Length Change (%)				
Temporary	−0.6	0.5	−0.4	0.7
Final	−8.2	−0.2	−8.4	0.4
Weight Change (%)				
Temporary	5.5	2.8	6.1	4.4
Final	−22	<0.1	−22	−0.2
Shore A Hardness				
Original	66	66	65	63
Temporary, Δ SH	−4	−3	0	−6
Final, Δ SH	19	−4	20	0
Elasticity Rating				
Temporary	2(a)	0	2(b)	1(b)
Final	2(a)	0	2(b)	0
Visual Rating				
Liquid	0	0	0	1(d)
Polymer				
Temporary	0	0	0	0
Final	0	0	1(c)	0

(a) Less elastic
(b) More elastic
(c) White film
(d) Hazy

Table 15
Compatibility of Refrigerants with Silicone

Test Conditions: 27 days immersion of the polymer at 25°C (77°F) and 80°C (176°F) in liquid (temporary) plus two weeks drying in air at about 25°C (77°F) (final).

	25°C (77°F)		80°C (176°F)	
	CFC-12	HFC-134a	CFC-12	HFC-134a
Length Change (%)				
Temporary	41	6.1	44	5.5
Final	-0.1	0.1	-0.2	-0.2
Weight Change (%)				
Temporary	173	20	187	20.3
Final	0.7	-0.1	-0.7	-0.3
Shore A Hardness				
Original	60	61	60	58
Temporary, Δ SH	-13	-8	-15	-6
Final, Δ SH	-7	-4	-7	-2
Elasticity Rating				
Temporary	0	1[a]	1[a]	0
Final	0	0	0	0
Visual Rating				
Liquid	0	0	0	0
Polymer				
Temporary	5[b]	0	4[b]	0
Final	0	0	0	0

[a] Less elastic

[b] Swollen

Table 16
Compatibility of Refrigerants with Thiokol® FA

Test Conditions: 27 days immersion of the polymer at 25°C (77°F) and 80°C (176°F) in liquid (temporary) plus two weeks drying in air at about 25°C (77°F) (final).

	25°C (77°F)		80°C (176°F)	
	CFC-12	HFC-134a	CFC-12	HFC-134a
Length Change (%)				
Temporary	1.3	0.8	1.4	-0.2
Final	-0.5	-0.2	-0.5	-0.9
Weight Change (%)				
Temporary	1.9	1.0	3.7	1.9
Final	-0.2	-0.1	-0.8	-0.8
Shore A Hardness				
Original	70	69	74	74
Temporary, Δ SH	-6	-4	-6	0
Final, Δ SH	-5	-6	-1	0
Elasticity Rating				
Temporary	1[b]	1[b]	0	1[b]
Final	0	0	1[a]	2[a]
Visual Rating				
Liquid	0	0	0	0
Polymer				
Temporary	0	0	0	0
Final	0	0	0	0

[a] Less elastic

[b] More elastic

Table 17
Compatibility of Refrigerants with Viton A

Test Conditions: 27 days immersion of the polymer at 25°C (77°F) and 80°C (176°F) in liquid (temporary) plus two weeks drying in air at about 25°C (77°F) (final).

	25°C (77°F)		80°C (176°F)	
	CFC-12	**HFC-134a**	**CFC-12**	**HFC-134a**
Length Change (%)				
Temporary	5.5	13	4.9	12
Final	0.7	-0.1	1.2	0.3
Weight Change (%)				
Temporary	19	48	20	49
Final	1.8	0.7	2.5	1.2
Shore A Hardness				
Original	74	74	73	73
Temporary, Δ SH	-19	-30	-23	-31
Final, Δ SH	-7	-8	-10	-6
Elasticity Rating				
Temporary	2[b]	2[b]	3[a]	3[a]
Final	0	0	0	0
Visual Rating				
Liquid	0	0	0	0
Polymer				
Temporary	0	1[c]	0	0
Final	0	1[d]	0	5[e]

[a] Less elastic
[b] More elastic
[c] Very slightly tacky
[d] Oily sheen
[e] Puffed mounds—5% of surface

Table 18
HFC-134a Permeation Through Elastomeric Hoses

	Permeation Rate, gm/cm·yr (lb/ft·yr)			
	Nylon	**Hypalon 48**	**Nitrile #1**	**Nitrile #2**
CFC-12	4.5 (0.3)	14.9 (1.0)	22.3 (1.5)	28.3 (1.9)
HFC-134a	3.0 (0.2)	3.0 (0.2)	26.8 (1.8)	40.2 (2.7)
Hose Construction:				
Inner Liner	Nylon	Hypalon 48	Nitrile (NBR)	
Second Layer	—	Rayon	Rayon	
Reinforcement	Nylon	2 Braids	2 Braids	
Outer Cover	Chlorobutyl	EPDM	EPDM	

Table 19
Solubilities of HFC-134a in Lubricants

Temperature Range: –50°C to 93°C (–58°F to 199°F)

	Percent Refrigerant in Mixture		
Oil Type	**30%**	**60%**	**90%**
500 SUS Naphthenic	2 phase	2 phase	2 phase
500 SUS Paraffinic	2 phase	2 phase	2 phase
125 SUS Dialkylbenzene	2 phase	2 phase	2 phase
300 SUS Alkylbenzene	2 phase	2 phase	2 phase
165 SUS PAG	–50 to >93[a]	–50 to >93	–50 to +73
525 SUS PAG	–50 to >93	–40 to +35	–23 to –7
100 SUS Ester	–40 to >93	–35 to >93	–35 to >93
150 SUS Ester	–50 to >93	–50 to >93	–50 to >93
300 SUS Ester	–50 to >93	–50 to >93	–50 to >93
500 SUS Ester	–40 to >93	–35 to >93	–35 to >93

[a] One phase in this temperature range, °C.

Safety

Users must have and understand the applicable HFC-134a Material Safety Data Sheets (MSDS).

Inhalation Toxicity

HFC-134a poses no acute or chronic hazard when handled in accordance with DuPont recommendations and when exposures are maintained below recommended exposure limits, such as the DuPont Acceptable Exposure Limit (AEL) of 1,000 ppm, 8- or 12-hour Time-Weighted Average or TWA.

An AEL is an airborne inhalation exposure limit established by DuPont that specifies time-weighted average concentrations to which nearly all workers may be repeatedly exposed without adverse effects. The AEL for HFC-134a has the same value as the Threshold Limit Values (TLVs) established for CFC-12 and HCFC-22. TLVs are established by the American Conference of Governmental and Industrial Hygienists (ACGIH).

However, inhaling high concentrations of HFC-134a vapor may cause temporary nervous system depression with anesthetic effects such as dizziness, headache, confusion, incoordination, and loss of consciousness. Higher exposures to the vapors may cause temporary alteration of the heart's electrical activity with irregular pulse, palpitations, or inadequate circulation. Similar effects are observed in overexposure to CFC-12. Intentional misuse or deliberate inhalation of HFC-134a may cause death without warning. This practice is extremel dangerous.

A person experiencing any of the initial symptom should be moved to fresh air and kept calm. If no breathing, give artificial respiration. If breathing difficult, give oxygen. Call a physician.

Cardiac Sensitization

If vapors are inhaled at a concentration of 75,000 ppm, which is well above the AEL, the heart ma become sensitized to adrenaline, leading to cardi irregularities and, possibly, cardiac arrest. Simil effects are observed with many other halocarbon hydrocarbons. The likelihood of these cardiac p lems increases if you are under physical or emot stress.

Because of possible disturbances of cardiac rhyt catecholamine drugs, such as epinephrine, shoul considered only as a last resort in life-threatenin emergencies.

Skin and Eye Contact

At room temperature, HFC-134a vapors have li no effect on the skin or eyes. However, in liqui HFC-134a can freeze skin or eyes on contact, ca frostbite. If contact with liquid does occur, soak the exposed areas in lukewarm water, not cold or hot. In all cases, seek medical attention immediately.

Always wear protective clothing when there is a risk of exposure to liquid HFC-134a. Where splashing is possible, always wear eye protection and a face shield.

Spills or Leaks

If a large release of vapor occurs, such as from a large spill or leak, the vapors may concentrate near the floor or low spots and displace the oxygen available for breathing, causing suffocation.

Evacuate *everyone* until the area has been ventilated. Use blowers or fans to circulate the air at floor level. Do not reenter the affected area unless you are equipped with a self-contained breathing apparatus or unless an area monitor indicates that the concentration of HFC-134a vapors in the area is below the AEL.

Always use self-contained breathing apparatus or an air-line mask when entering tanks or other areas where vapors might exist. Use the buddy system *and* a lifeline. Refer to the Material Safety Data Sheet (MSDS) for HFC-134a for more information.

HFC-134a vapors have a slightly sweet odor that can be difficult to detect. Therefore, frequent leak checks and the installation of permanent area monitors are necessary in enclosed spaces. Refer to ASHRAE Standards 15-94 and 34 for refrigeration machinery rooms.

To ensure safety when working with HFC-134a in enclosed areas:

1. Route relief and purge vent piping (if present) outdoors, away from air intakes.
2. Make certain the area is well ventilated, using auxiliary ventilation, if necessary, to move vapors.
3. Make sure the area is clear of vapors prior to beginning work.
4. Install air monitoring equipment to detect leaks. (Monitors are discussed in the next section, Monitors and Leak Detection.)

Combustibility of HFC-134a

HFC-134a is *nonflammable* at ambient temperatures and atmospheric pressure. However, tests have shown HFC-134a to be combustible at pressures as low as 5.5 psig (139.3 kPa absolute) at 177°C (350°F) when mixed with air at concentrations generally greater than 60 volume % air. At lower temperatures, higher pressures are required for combustibility. (HCFC-22 is also combustible at pressures above atmospheric in the presence of high air concentrations.) Test results and calculations have shown:

- At ambient temperature, all concentrations of HFC-134a in air are nonflammable at pressures below 15 psig (205 kPa absolute).
- Combustible mixtures of air and HFC-134a will not form when liquid HFC-134a is pumped into a closed vessel if the initial air pressure in the vessel is limited to one atmosphere absolute and the final pressure is limited to 300 psig (2,170 kPa absolute). If the initial air pressure is greater than one atmosphere, combustible mixtures may form as the tank is filled.

Based on the above information, the following operating practices are recommended:

- **Leak Testing**
  - Equipment should **never** be leak tested with a pressurized mixture of HFC-134a and air. HFC-134a may be safely pressured with dry nitrogen.
- **Bulk Delivery and Storage**
  - Tanks should normally be evacuated at the start of filling, and should never be filled while under positive air pressure.
  - Tank pressure should never be allowed to exceed 300 psig (2,170 kPa) when filling with HFC-134a. Relief devices on either the tanks or the HFC-134a supply system usually prevent this.
  - Tank pressures should be monitored routinely.
  - Air lines should never be connected to storage tanks.

- **Filling and Charging Operations**
  - Before evacuating cylinders or refrigeration equipment, any remaining refrigerant should be removed by a recovery system.
  - Vacuum pump discharge lines should be free of restrictions that could increase discharge pressures above 15 psig (205 kPa) and result in the formation of combustible mixtures.
  - Cylinders or refrigeration equipment should normally be evacuated at the start of filling, and should never be filled while under positive air pressure.
  - Final pressures should not exceed 300 psig (2,170 kPa).
  - Filled cylinders should periodically be analyzed for air (nonabsorbable gas or NAG).

- **Refrigerant Recovery Systems**

  Efficient recovery of refrigerant from equipment or containers requires evacuation at the end of the recovery cycle. Suction lines to a recovery compressor should be periodically checked for leaks to prevent compressing air into the recovery cylinder during evacuation. In addition, the recovery cylinder pressure should be monitored, and evacuation stopped in the event of a rapid pressure rise indicating the presence of noncondensable air. The recovery cylinder contents should then be analyzed for NAG, and the recovery system leak checked if air is present. Do not continue to evacuate a refrigeration system that has a major leak.

Monitors and Leak Detection

Service personnel have used leak detection equipment for years when servicing equipment. Leak detectors exist not only for pinpointing specific leaks, but also for monitoring an entire room on a continual basis. There are several reasons for leak pinpointing or area monitoring, including: conservation of HFCs, protection of valuable equipment, reduction of fugitive emissions and protection of employees. ASHRAE (American Society of Heating, Refrigerating, and Air Conditioning Engineers) Standard 15-94 requires area monitors in refrigeration machinery rooms as defined in the standard.

Leak detectors can be placed into two broad categories: leak pinpointers and area monitors. Before purchasing a monitor or pinpointer, several instrumental criteria should be considered, including sensitivity, detection limits and selectivity.

Types of Detectors

Using selectivity as a criterion, leak detectors can be placed into one of three categories: nonselective, halogen-selective or compound-specific. In general, as the specificity of the monitor increases, so does the complexity and cost. Another method used to find leaks is to add fluorescent dyes to the system.

A detailed discussion of leak detection, along with a list of manufacturers of leak detection equipment, is given in Bulletin ARTD-27 (H-31753-2).

Nonselective Detectors

Nonselective detectors are those that will detect any type of emission or vapor present, regardless of its chemical composition. These detectors are typically quite simple to use, very rugged, inexpensive and almost always portable. However, their inability to be calibrated, long-term drift, lack of selectivity and lack of sensitivity limit their use for area monitoring.

Some nonselective detectors designed for use with CFC-12 may have a much lower sensitivity when u with HFC-134a. However, newly designed detecto with good HFC-134a sensitivity are now available. sure to consult with the manufacturer before selecti or using a nonselective detector with HFC-134a.

Halogen-Selective Detectors

Halogen-selective detectors use a specialized senso that allows the monitor to detect compounds contai ing fluorine, chlorine, bromine and iodine without interference from other species. The major advanta of such a detector is a reduction in the number of "nuisance alarms"—false alarms caused by the presence of some compound in the area other than t target compound.

These detectors are typically easy to use, feature higher sensitivity than the nonselective detectors (detection limits are typically <5 ppm when used a area monitor and <0.05 oz/yr [<1.4 gm/yr] when us as a leak pinpointer), and are very durable. In addition, due to the partial specificity of the detector, th instruments can be calibrated easily.

Compound-Specific Detectors

The most complex detectors, which are also the mo expensive, are compound-specific detectors. These units are typically capable of detecting the presence a single compound without interference from other compounds.

Fluorescent Dyes

Fluorescent dyes have been used in refrigeration systems for several years. These dyes, invisible und ordinary lighting, but visible under ultraviolet (UV light, are used to pinpoint leaks in systems. The dy are typically placed into the refrigeration lubricant when the system is serviced. Leaks are detected by using a UV light to search for dye that has escaped from the system.

Recent innovations in dye technology have allowe fluorescent dyes to be used with HFC-134a. Howe before adding dyes to a system, the compatibility o the specific dye with the lubricant and refrigerant should be tested.

Storage and Handling

Shipping Containers in the U.S.

HFC-134a is a liquefied compressed gas. Accordi to the U.S. Department of Transportation (DOT), a nonflammable compressed gas is defined as a nonflammable material having an absolute pressure greater than 40 psi at 21°C (70°F) and or an absol pressure greater than 104 psi at 54°C (130°F).

The appropriate DOT designations are as follows:

Proper shipping name: Liquified Gas, N.O.S. (Tetrafluoroethane)

Hazard class: 2.2

UN No.: 1956

A list of the different types of containers that can be used to ship HFC-134a in the United States, along with their water capacities, dimensions, DOT specifications and the net weights of HFC-134a, are provided in **Table 20**. All pressure relief devices used on the containers must be in compliance with the corresponding Compressed Gas Association (CGA) Standards for compressed gas cylinders, cargo and portable tanks.

The 30-lb and 123-lb cylinders designed for refrigerant applications are a light blue color with labels that bear the name of the product in light blue. The color designation is "Light Blue (Sky)," PMS 2975.

The 30-lb cylinder, known as a "Dispose A Can" (D.A.C.) fits into a box that measures 10 in. × 10 in.× 17 in. Dispose A Can is DuPont's registered trade name for this type of single-use container. When used to ship Suva Cold-MP for the stationary refrigeration market, these 30-lb cylinders have the same outlet fittings as cylinders of CFC-12. However, when used for Suva Trans A/C for the automotive industry, these cylinders have a CGA-167 valve outlet. This fitting was specified by the Society of Automotive Engineers (SAE) to avoid mixing CFC-12 and HFC-134a when servicing mobile air conditioning systems. Additional unique fittings used with HFC-134a in automotive service applications are discussed in Bulletin ART-27 (H-45948-1).

The 123-lb cylinders are equipped with a nonrefillable liquid vapor CGA-660 valve. With this two-way valve, HFC-134a can be removed from the cylinder as either a vapor or as a liquid, without inverting the cylinder. The vapor handwheel is located on the top. The liquid wheel is on the side of the valve and attached to a dip tube extending to the bottom of the cylinder. Each is clearly identified as vapor or liquid.

The 4,400-gal cylinder is known as an ISO tank. The dimensions referenced in **Table 20** represent the frame in which the container is shipped. The tank itself has the same length of 20 ft and an outside diameter of approximately 86 in. ISO tanks are used for export shipments of HFC-134a from the United States.

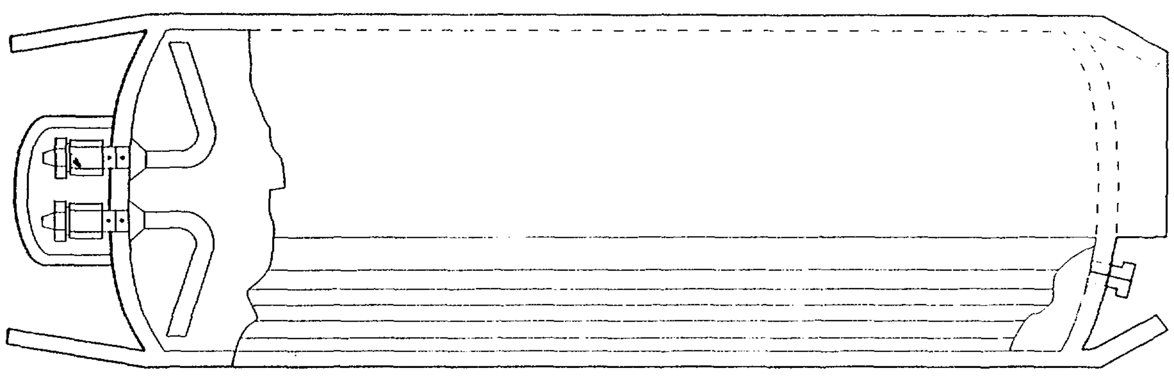
The general construction of a one-ton returnable container is shown in **Figure 9**. Notice that one end of the container is fitted with two valves. When the container is turned so that the valves are lined up vertically, the top valve will discharge vapor and the bottom valve will discharge liquid. The valves are protected by a dome cover.

Ton containers are equipped with two fusible plugs in each end. The fusible metal in the plugs is designed to start melting at 69°C (157°F) and completely melt at 74°C (165°F). Containers should never be heated to temperatures higher than 52°C (125°F). One spring-loaded pressure relief valve is also located in each end of the ton container.

Table 20
Specifications of Shipping Containers for HFC-134a

Water Capacity	Dimensions	DOT Specification	Net Weight (lb) HFC-134a
30 lb Dispose A Can®	10″ × 10″ × 17″ (box)	39	30
123 lb	55″ H × 10″ OD	4BA300	125
1,682 lb	82″ L × 30″ OD	110A500W	1,750
5,000 gal	Tank Truck	MC-330 or -331	40,000
4,400 gal ISO	8′ × 8.5′ × 20′ (frame)	51	30,865
170,000 lb	Tank Rail Car	114A340W	—

Figure 9. One-Ton Returnable Container.



Bulk Storage Systems

DuPont sells storage systems, at cost, to its HFC-134a customers. The systems are prefabricated, tested and ready to install on site. The units are designed to optimize economy, efficiency and safety in the storage and dispensing of HFC-134a. The delivered systems include all components, such as storage tanks, pumps, piping, valves, motors and gauges, as an integrated unit. All systems are equipped with the DuPont F.E.E.D. (Fluorochemical Emission Elimination Delivery) system to prevent emissions during deliveries, and with dual pumps to provide an installed spare. The units are skid-mounted and require only placement on a concrete pad and connection to electrical and process systems.

A typical bulk storage system is shown in **Figure 10**.

Your DuPont Marketing Representative can arrange for guidance on site selection, purchase, installation, start-up and maintenance.

Converting Bulk Storage Tanks from CFC-12 to HFC-134a

Before switching from CFC-12 to HFC-134a, the existing storage equipment must be checked to verify that it is adequate. Storage tanks built to the specifications of the American Society of Mechanical Engineers (ASME) Pressure Vessel Code are required to have a metal nameplate indicating each tank's maximum allowable working pressure (MAWP). This rating must be 185 psig (1377 kPa absolute) or higher for HFC-134a service. In most cases, existing storage tanks that have been properly designed to contain CFC-12 will have an adequate pressure rating for HFC-134a. The set pressure of the relief devices on the top of the tanks must also be verified and changed, if necessary.

We recommend that storage tanks be **completely** emptied of all CFC-12 liquid and vapor before introducing HFC-134a. In general, converting a storage tank from CFC-12 to HFC-134a requires:

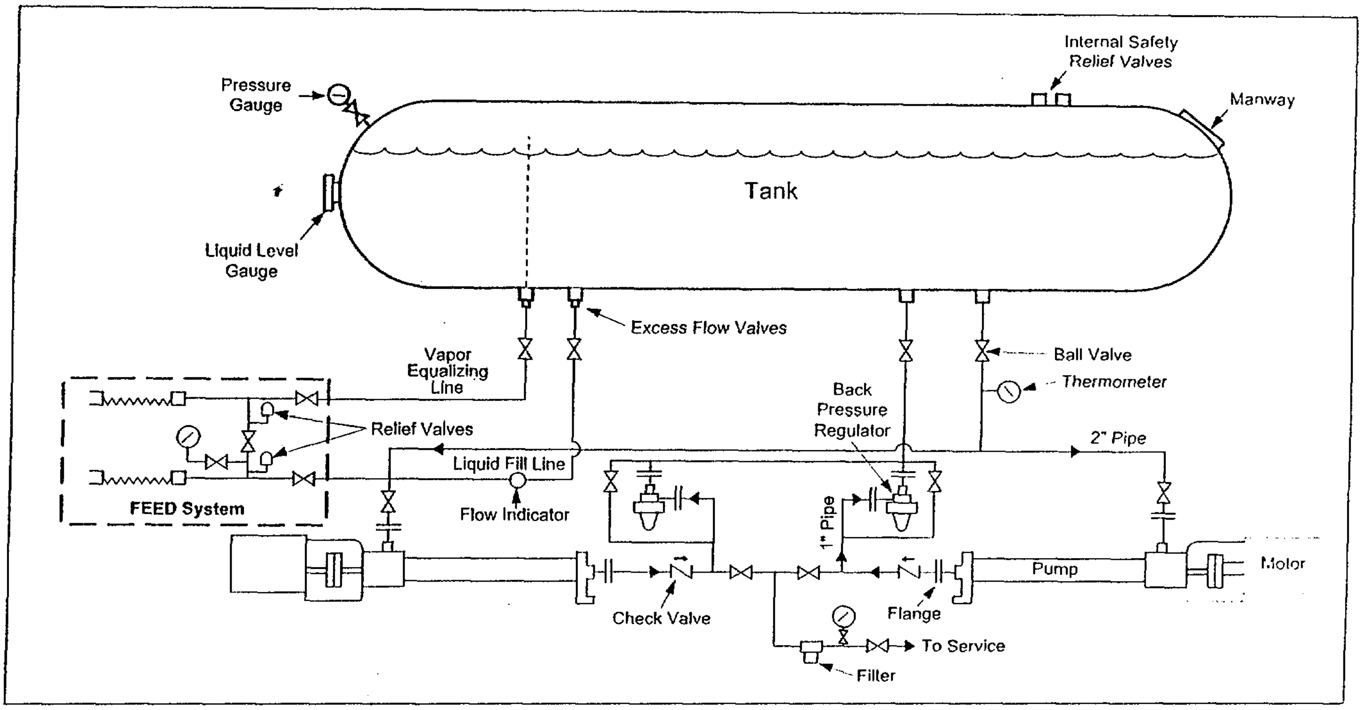
1. Removing CFC-12 from the storage tank, lines and equipment.
2. Evacuating the storage tank to 25 inches of mercury vacuum (16.7 kPa absolute pressure) a purging with compressed dry nitrogen gas.
3. Making necessary repairs to the tank after initial evacuation and purging.
4. Repeating step 2 until CFC-12 and moisture analyses are within acceptable limits.
5. Refilling system with HFC-134a.

The above is a simplified outline of what is actually lengthy procedure. Your DuPont Marketing Representative can assist in obtaining the equipment, instrumentation and technical assistance to safely a effectively make the conversion.

Material Compatibility Concerns

Most metal components suitable for use with CFC-1 are also compatible with HFC-134a, including standard types of carbon steel, aluminum and copp. Some elastomeric or nonmetallic components suitable for CFC-12 may not be adequate. Therefo all elastomeric or nonmetallic components throughout the system must be identified and their compatibility with HFC-134a verified. See Materials Compatibility section. For complete reliability, any component that cannot be properly identified shoul be replaced.

Figure 10. Typical Bulk Storage System.



In a fluorocarbon storage system, elastomers are most commonly found in:

- Packing and seats of manual valves
- Pressure-relief device seats
- Flange and manway gaskets
- Mechanical pump seals
- Wet-end pump gaskets and O-rings
- Filter O-rings
- Sight-flow indicator gaskets
- Back-pressure regulator diaphragms and O-rings.

Handling Precautions for HFC-134a Shipping Containers

The following rules for handling HFC-134a containers are strongly recommended:

- Use personal protective equipment, such as side shield glasses, gloves and safety shoes when handling HFC-134a containers.
- Avoid skin contact with liquid HFC-134a, since it may cause frostbite.
- Never heat a container to a temperature higher than 52°C (125°F).
- Never apply direct flame or live steam to a container or valve.
- Never refill disposable cylinders with anything. The shipment of refilled disposable cylinders is prohibited by DOT regulations.
- Never refill returnable cylinders without DuPont consent. DOT regulations forbid transportation of returnable cylinders refilled without DuPont's authorization.
- Never use a lifting magnet or sling (rope or chain) when handling containers. A crane may be used when a safe cradle or platform is used to hold the container.
- Never use containers as rollers, supports or for any purpose other than to carry HFC-134a.
- Protect containers from any object that will result in a cut or other abrasion in the surface of the metal.
- Never tamper with the safety devices in the valves or containers.
- Never attempt to repair or alter containers or valves.
- Never force connections that do not fit. Make sure the threads on the regulators or other auxiliary equipment are the same as those on the container valve outlets.
- Keep valves tightly closed and valve caps and hoods in place when the containers are not in use.
- Store containers under a roof to protect them from weather extremes.
- Use a vapor recovery system to collect HFC-134a vapors from lines after unloading.

Recovery, Reclamation, Recycle and Disposal

Responsible use of HFC-134a requires that the product be recovered for reuse or disposal whenever possible. DuPont purchases used refrigerants for reclamation through its distributor networks in the United States, Canada and Europe. In the United States, used HFC-134a is accepted as part of this program. Recovery and reuse of HFC-134a makes sense from an environmental and economic standpoint. In addition, the U.S. Clean Air Act will prohibit known venting of HFC-134a in late 1995 during the maintenance, servicing or disposal of refrigeration equipment.

Recovery

Recovery refers to the removal of HFC-134a from equipment and collection in an appropriate external container. As defined by the Air Conditioning and Refrigeration Institute (ARI), a U.S. organization, recovery does not involve processing or analytical testing. HFC-134a may be recovered from refrigeration equipment using permanent on-site equipment or one of the portable recovery devices now on the market. The portable devices contain a small compressor and an air cooled condenser, and may be used for vapor or liquid recovery. At the end of the recovery cycle, the system is evacuated to remove vapors. In the United States, the Environmental Protection Agency (EPA) sets standards for recovery equipment. Before purchasing a specific recovery unit, check with the manufacturer to be sure that it contains elastomeric seals and a compressor oil compatible with HFC-134a.

Reclamation

Reclamation refers to the reprocessing of used HFC-134a to new product specifications. Quality of reclaimed product is verified by chemical analysis. In the United States, HFC-134a is included in DuPont's refrigerant reclamation program. Contact DuPont or one of its authorized distributors for further information.

Reclamation offers advantages over on-site refriger
recycling procedures because these systems cannot guarantee complete removal of contaminants. Puttin
refrigerants that do not meet new product specifications back into expensive equipment may cause damage.

Recycle

Refrigerant recycle refers to the reduction of used refrigerant contaminants using devices that reduce o
water, acidity and particulates. Recycle is usually a field or shop procedure with no analytical testing of refrigerant. HFC-134a may be recycled using one of the devices now on the market. In the United States, the EPA sets standards for these devices. Recycle is becoming the accepted practice in the U.S. mobile ai
conditioning service industry. Consult with the manufacturer before specifying a recycle device for HFC-134a.

Disposal

Disposal refers to the destruction of used HFC-134a. Disposal may be necessary when HFC-134a has become badly contaminated with other products and no longer meets the acceptance specifications of DuPont or other reclaimers. Although DuPont does not presently accept severely contaminated refrigerants for disposal, licensed waste disposal firms are available. Be sure to check the qualifications of any firm before sending them used HFC-134a.

Annex (B)

Annex B technical Data For Current Models

Company Name : SILTAL

DESCRIPTION	UNITS	MODEL 1	MODEL NO. 2	MODEL NO. 3	MODEL NO. 4	MODEL NO. 5	MODEL NO. 6	MODEL NO. 7
		FB44	FB37	FB32	FB30	SR25	FB23	FB15
General		430lit	360lit	310lit	290lit	240	220	140
Internal volume freezer	Liters	100	100	80	60	60	11	9
Internal volume cabinet	Liters	330	260	230	230	180	220	140
Insulation thickness	Mm	30/50	30/50	30/50	30/50	30/50	30	30
Refrigerant charge	Gr	230	200	170	165	165	100	70
R-12 compressor								
Type specification		LBP/LST	LBP/LST	LBP/LST	LBP/LST	LBP/LST	LBP/LST	LBP/LST
Nominal power	Hp/w	(1/3)224	(1/3)200	(1/4)200	(1/5)185	(1/5)185	(1/10)77	(1/10)77
Refrigeration capacity	k.cal/hr	220	190	172	158	158	67	67
Displacement	Cc	10.0	9.05	8.85	8.0	8.0	4.03	4.03
Swept volume		-	-	-	-	-	-	-
Capillary								
Diameter	Mm	0.8	0.8	0.8	0.66	0.66	0.66	0.66
Length	Mm	3200	3600	3000	2600	2600	2600	2600
R-12 drier								
Type		M.S	M.S	M.S	M.S	M.S	M.S	M.S
Specification	Gr	15	15	10	10	10	7.5	7.5
Condenser								
Type		Sheet	Sheet	Wire	Sheet	Sheet	Sheet	Sheet
Width	Mm	670	670	502	510	510	510	510
Hieght	Mm	1300	950	915	810	810	690	450
No tubes legs		10	10	19	8	8	8	8
Tube diameter	Mm	4.76	4.76	4.76	4.35	4.35	4.76	4.76
Anticondensate tube yes/no		Yes	Yes	Yes	Yes	Yes	No	No
Evaporator								
Coil diameter	Mm	8.0	8.0	8.0	8.0	8.0	-	-
L.M.T.D		21 mt	21	14	12	12	-	-
Shelf Evaporator		-	-	-	-	-	-	-
Tube diameter	Mm	-	-	-	-	-	-	-
Number of shelves		-	-	-	-	-	-	-
Roll – bond evaporator								
Yes / no		Yes	Yes	Yes	Yes	Yes	Yes	Yes
Specification panel size	Mm	460x380	460x280	400x300	400x300	400x300	1047x270	516x270
Volume dm3		0.054	0.047	0.050	0.050	0.050	0.195	0.098

Annex B. technical Data For Current Models **Company Name : SILTAL**

		MODEL	MODEL NO.	MODEL NO.	MODEL NO.	MODEL NO.	MODEL NO.	MODEL NO.
DESCRIPTION	**UNITS**	**8**	**9**	**10**				
		FB11	**CF130**	**CF180**				
General		100 lit	130	180				
Internal volume freezer	Liters	9	130	180				
Internal volume cabinet	Liters	100	-	-				
Insulation thickness	Mm	30	50	50				
Refrigerant charge	Gr	55	130	140				
R-12 compressor								
Type specification		LBP/LST	LBP/LST	LBP/LST				
Nominal power	Hp/w	(1/12)55	(1/8)99	(1/6)133				
Refrigeration capacity	k.cal/hr	64	85	115				
Displacement	Cc	2.5	4.5	5.5				
Swept volume								
Capillary								
Diameter	Mm	0.66	0.66	0.66				
Length	Mm	2600	3500	3500				
R-12 drier								
Type		M .S	M . S	M . S				
Specification	Gr	7.5	10	10				
Condenser								
Type		Wire	Sheet	Sheet				
Width	Mm	482	510	510				
Hieght	Mm	203	560	560				
No tubes legs		5	8	8				
Tube diameter	Mm	4.76	6.35	6.35				
Anticondensat tube yes/no		No	No	No				
Evaporator								
Coil diameter	Mm	-	8.0	8.0				
L.M.T.D		-	21.0	26.0				
Shelf Evaporator		-						
Tube diameter	Mm	-	-	-				
Number of shelves		-	-	-				
Roll – bond evaporator		-	-	-				
Yes / no		Yes	No	No				
Specification panel size	Mm	516x270	-	-				
Volume dm3		0.098	-	-				