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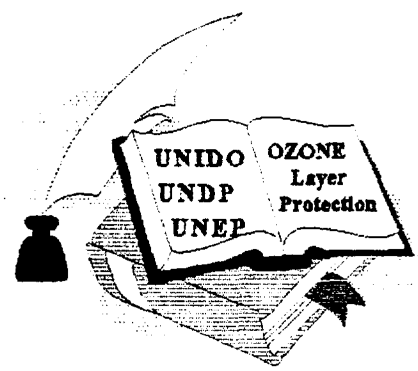
193p. tables

AZMAYESH INDUSTRIAL FACTORIES CO.

Contract No. 96/80P

Design, Calculation & drafting of 24 Prototypes



FINAL REPORT

Project No. MP/IRA96/041

Prepared by: A. Bahmani

August 1996

AZMAYESH INDUSTRIAL FACTORIES CO.

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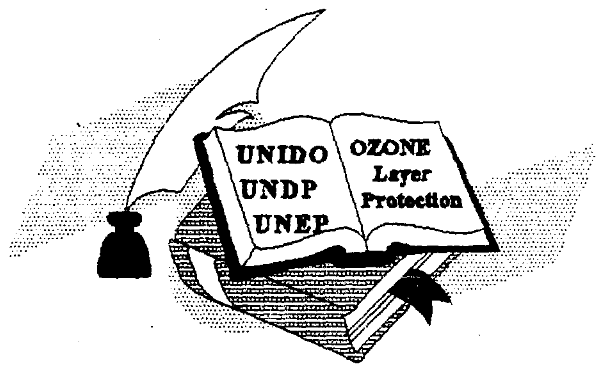

FINAL REPORT

Project No. MP/IRA96/041

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August 1996

AZMAYESH INDUSTRIAL FACTORIES CO.
Electrical / Gas Home Appliances

No. 1015, Tehran-nou Ave., Tehran 17437 Iran, Tel +98 21 741 67 26, Fax + 98 21 7410329

- Gadook Models Load Calculation

  - R280
  - FU280
  - RF350

- Lorestan Models Load Calculation

  - ROM10
  - ROM13
  - ROM14
  - UFM10
  - UFM13
  - RAT13

- Movalled Models Load Calculation

  - F80
  - RF80
  - RF85
  - RF14

- Pars Machine Models Load Calculation

  - PMR6
  - 1070
  - Damavand 15
  - 1072

- Pars Monark Models Load Caculation

  - PMLR12
  - PMKF7
  - PMKF12
  - PMKRF17

AZMAYESH INDUSTRIAL FACTORIES CO.

Electrical / Gas Home Appliances

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Table of Contents

No. 1015, Tehran-nou Ave., Tehran 17437 Iran, Tel +98 21 741 67 26, Fax + 98 21 7410329

Section I

INTRODUCTION

Based on UNIDO's request for proposal no. P. 96/26 and contract no. 96/080/P between UNIDO and Azmayesh co. Provision of services relating to the design, calculation and drafting of 24 Prototype Models of Refrigerators and Freezers of six major refrigerator manufactures consist of Fariz Iran, Lorestan, Gadook, Movalled, Pars Monark and Pars Machine.

The project has been assigned to UNIDO in an agreement with the Executive Committee of the Multilateral Fund for the Implementation of the Montreal Protocol in response to a request from the Government of the Islamic Republic of Iran. The project was *entitled as " Conversion of Domestic Refrigerator Production Facilities to Phase-out* CFC-11 and CFC-12 " of the above mentioned companies.

Azmayesh co. as the pioneer of executing UNIDO's CFC Phase - out project in Iran was selected by UNIDO to implement a part of the project for the second group of the Iranian Refrigerator Manufacturers. The missions that originally were assigned to Azmayesh are mainly referring to convert production models. Azmayesh will assist all these companies to be familiar and accomplish following activities by executing two contracts no. 96/080/P and 96/082/P:

1) Making Prototypes;
2) Testing Prototypes;
4) Calculating Heat Leaks;
5) Being familiar with Montreal Protocol and UNIDO's Projects;
6) Being familiar with aim of the project in Iran;
7) Selecting Components for each models;
9) Preparing Technical Specifications and Characteristics;
10) and other services as mentioned in the subject contracts;

SYNOPSIS

1 - General Background

a) This final report was prepared based on the UNIDO's contract no 96/080/P between UNIDO and Azmayesh for the provision of services related to the design, calculation and drafting of 24 prototype models of Refrigerators and Freezers and relevant terms of reference prepared by UNIDO and the requirement of Islamic Republic of Iran indicated in the country program No. UNEP/OZL. PRO/EX COM/10/24 dated May 1993 prepared by UNDP, the Project Document "Conversion of Second Group of Domestic Refrigerator Production Facilities to phase out CFC11 and CFC12" prepared by UNIDO was presented at the 18th session meeting of the Executive Committee of the Multilateral Fund for the implementation of the Montreal Protocol, was approved.

b) The project will phase out the use of CFC11 and CFC12 for the production of domestic refrigerators in six refrigerator manufacturers in Iran. This project will be implemented in six companies. The testing of the prototypes made by these companies (Gadook, Fariz Iran, Lorestan, Movaled, Pars Machine, and Pars Monarch) and also training the experts is the main concept of this project.

A- Companies Background

1 - FARIZ IRAN

FARIZ IRAN in Tehran is a large manufacturer of home appliances which started manufacturing home appliances 30 years ago. The production of refrigerators started originally under license from General Electric (USA).

The refrigerator and freezer models are based on General Electric's designs. To modernize production machinery, the company purchased the technology of manufacturing "no frost indoor" refrigerators from an Italian company, Merloni.

The company is producing following products and should be converted:

1. Refrigerator 11 cu ft.
2. Refrigerator 13 cu ft
2. Freezer 13 cu ft

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Approximately 1.000.000 units manufactured by this company are still operated in Iran. All refrigerator components are imported.

2 - GADOOK INDUSTRIES CO

GADOOK is a private company. It employs 58 people, and the installed annual production capacity is about 40.000 refrigerator units based on the daily production rate of 120-150 units. The actual production in 1992-1993 was 14,000 refrigerators and freezers in five models in one shift.

The company produces two refrigerator models (12, 15 cu ft) and one freezer model (11,cu ft) per year.

Two Refrigerator models and one Freezer model have been considered to be converted.

3 - LORESTAN REFRIGERATOR MFG. INDUSTRIES

LORESTAN is 100% owned by the Bank of Industry and Mines. It employs 300 people. The company was established in 1987 for a nominal production capacity of 180,000 units per year, based on a daily production rate of 650-750 units. with 15 different models of household refrigerators and freezers from 12 to 21 cu ft. Six models of refrigerators and freezers have been considered to be converted.

4 - MOVALLED HOME APPLIANCES CO

MOVALLED is a private company. It employs 490 people and the installed annual production capacity is about 100,000 units based on the daily production rate of 300-360 units. The actual production in 1992-1993 was 60.000 refrigerators and freezers in three different models. The annual consumption of CFC-12 is 22 mt., including 2 mt. for servicing. The company produces three models of refrigerators and one freezer model. Four models of refrigerators and freezers have to be converted.

5 - PARS MACHINE MFG. CO

PARS MACHINE is 100% owned by the 15th Khordad foundation. It employs 400 people. and was established in 1967. The annual production capacity is 100.000 units per year, based on a daily production rate of 350-450 units.

The actual production in 1992-1993 was 50,000 refrigerators and freezers in four models; the annual consumption of CFC-12 is 20 mt., including 2 mt. for servicing.

The company produces three models of refrigerators (5, 10, 12 cu ft) and one freezer model (11 cu ft), which they should be converted.

6 - PARS MONARK COMPANY

MONARK is a private company and was established in 1984 in Tehran and moved to Yazd in 1989. It employs 45 people, and the installed annual production capacity is about 40,000 refrigerator units; the actual production in 1992-1993 was 14,000 refrigerators and freezers in four different models.

The annual consumption of CFC-12 is 6 mt., including 0.8 mt. for servicing. The consumption of CFC-11 is 12.5 mt. The company produces one refrigerator model (330 l) and three models of freezers (220, 280, 330 l). All products produced consist of four models should be converted.

B- Aim of the Project

The aim of the project is to carry out to the design, calculation and drafting of the 24 prototypes. The purpose of this programme is to enable each company to do necessary design, calculation, redefinition, prototyping, and check and test of converted models. The companies will be familiar with methods of calculation and redefinition of the models and prototypes. 24 prototype models will be redesigned, and calculation and drafting for functionality and performance will be achieved as follow.

1) Fariz Iran	Three prototype models
2) Gadook	Three prototype models
3) Lorestan	Six prototype models
4) Movaled	Four prototype models
5) Pars Machine	Four prototype models
6) Pars Monark	Four prototype models

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Activities

Following activities were accomplished during execution of the contract

1 - Collecting necessary data from each company;
2 - Visiting each company in order to define work process and contract statement.
3 - Measuring Actual Dimension of each model;
4 - Reviewing and evaluating data received from each company;
5 - Performing heat leak calculation for 24 prototypes;
6 - Determining heat loads for 24 prototypes;
7 - Determining product load for 24 prototypes;
8 - Determining heat gain by infiltration;
9 - Preparing data acquisition form;
10 - Preparing product specification for 24 prototypes;
11 - Preparing prototype data summary sheet;
12 - Recommending suitable compressors for each prototypes;
13 - Reviewing more than 30 compressor technical specifications in order to recommend an appropriate compressor, as follow;

a - Danfuss;
TL5G, TLS6F, TLS7F, FR7.5G, FR8.5G, and FR10G

b - Gold Star;
NR45L, NF45N, NR62L, NR52L, VF75N, V75L

c- Matsushita;
SA3C10AX0, QA66C15RAX5, QA77C18RAX5, D66C15RAX5, D77C18RAX5, QA,51C11RAX5, QA91C20RAX5, S43C10KAX0

d - Necchi;
ESC5, ESC7K, ESC7, ESC8.5, ESC8.5K, ESC9, ESC9K,ESC11, ESCHK.

e - Zanussi
GL45AA, GL50AA, GL60AA, GL70AA, GL80AA, GL90AA, GL99AA, GL80AH,

d- Aspera
BP104822, BP1116Z, BP1118Z

Prototypes Data Summary

No	Manufacturer	Type	Model	Total Internal Volume Lit.	Freezer Volume Lit.	Overall Dimension cm.	Wall Thickness mm.	Prototype Heat Load	Compressor Cooling Capacity Watt Requirement	Designated Star Coding
1	Fariz Iran	Refrigerator	FIR11	338	28	143x61x51.5	30	168	202	Two Star
2	Fariz Iran	Refrigerator	FIR13	318	28	157x61x55.6	35	161	193	Two Star
3	Fariz Iran	Freezer	FIF13	-----	290	157x61x55.6	50	156	187	Three Star
4	Gadook	Refigerator	R280	301	30	165x60x65	55	89	107	Two Star
5	Gadook	Freezer	FU280	-----	301	165x60x65	55	143	172	Three Star
6	Gadook	Ref.Freezer	RF350	358	80	175.5x60x65	50	175	210	Three Star
7	Lorestan	Refrigerator	ROM10	280	30	120.7x68.6x70.2	50	79	95	Two Star
8	Lorestan	Refrigerator	ROM13	386	50.5	150.7x51.5x70.2	50	120	144	Two Star
9	Lorestan	Refrigerator	ROM14	390	54	150.7x86x70.2	54	130	156	Two Star
10	Lorestan	Freezer	UFM10	----	280	120.7x68.6x70.2	50	127	152	Three Star
11	Lorestan	Freezer	UFM13	----	368	150.7x68.6x70.2	50	158	190	Three Star
12	Lorestan	Ref.Freezer	RAT13	326	82	150.7x68.6x70.2	50	137	164	Three Star

Prototypes Data Summary

No	Manufacturer	Type	Model	Total Internal Volume Lit.	Freezer Volume Lit.	Overall Dimension cm.	Wall Thickness mm.	Prototype Heat Load Watt	Compressor Cooling Capacity Watt Requirement	Designated Star Coding
13	Movalled	Freezer	F80	----	217	149x54x59.5	30	172	206	Three Star
14	Movalled	Ref.Freezer	RF80	234	19	119x54x59.5	35	146	175	Three Star
15	Movalled	Ref.Freezer	RF85	276	42	119x54x59.5	45	166	199	Three Star
16	Movalled	Ref.Freezer	RF14	304	70	164x54x59.5	45	174	208	Three Star
17	Pars Machine	Refrigerator	PMR6	167	17	92x61x57	40	85	102	Two Star
18	Pars Machine	Refrigerator	1070	289	21	138x61x57	40	106	127	Two Star
19	Pars Machine	Refrigerator	Damavand	280	41	140x61x57.5	40	120	144	Two Star
20	Pars Machine	Freezer	1072	----	290	142x67x57	40	181	217	Three Star
21	Pars Monark	Freezer	PMKF12	280	35	144x63x55	30	160	192	Two Star
22	Pars Monark	Freezer	PMKF7	----	180	98x50x63	60	131	157	Three Star
23	Pars Monark	Refrigerator	PMKR12	280	35	145x55x63	30	70	83	Two Star
24	Pars Monark	Ref.Freezer	PMKRF17	428	91	198x54x69	55	218	262	Three Star

REFRIGERATOR COOLING CAPACITY COMPARISON CHART

FARIZ IRAN			LORESTAN			MOVALLED			PARS MACHINE			PARS MONARK			GADOOK		
Model	Watt	Vol. Lit.	Model	Watt	Vol. Lit.	Model	Watt	Vol. Lit.	Model	Watt	Vol. Lit	Model	Watt	Vol. Lit.	Model	Watt	Volume Lit.
FIF13	156	290	ROM10	79	280	F80	172	217	PMR6	85	167	PMKR12	160	280	R280	90	301
FIR13	161	318	ROM13	120	368	RF80	146	234	1070	106	289	PMKF7	70	180	FU280	143	301
FIR11	168	338	ROM14	130	390	RF85	166	276	Damvand	120	380	PMKF12	131	280	RF350	175	358
			UFM10	127	280	RF14	174	304	1072	181	290	PKRF17	218	428			
			UFM13	158	368												
			RAT12	137	326												

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Section II

Refrigeration Load Calculation

Refrigeration load consist of four individual components:

1- *Transmission load;*
Heat transfer through walls (sides, back panels, top and bottom) and door panel.

2 - Product load;
Heat Removed from and produced by the products which are brought and stored in the refrigerator.

3 - Internal load;
Heat produced by internal sources such as lights, fan or heaters;

4 - Infiltration load
Heat gains associated with air entering the refrigerated space;

In this section , the above mentioned components will be discussed sepratly to analyse and extract the most useful and practical equipments.

Transmision Load

Heat gain through walls of a refrigerated space depend on cabin Temperature, linner, insulation and cabin conductivity and also the surrounded ambient air. In other word, there are four different resistances opposing heat flow between cabin space and ambient air as given in resistance circuit.

$$T_{refrigerator} \longleftarrow R_{liner} + R_{insulation} + R_{cabin} + R_{ambient} \longleftarrow T_{ambient}$$

$$T_{evaporator} \longleftarrow R_{liner} + R_{insulation} + R_{cabin} + R_{ambient} \longleftarrow T_{ambient}$$

Considering the above mentioned resistances, Rl, Rc and Ra are not compareable in magnitude with Ri (Insulation resistance) and so can be neglected in our calculations. Therefore, the resultant circuit and relatdted equations is.

$R = \frac{x}{KA}$ Heat Resistance

$Q_{TL} = \frac{\Delta T}{R}$ Heat Transfer

Where:

x = Insulation Thickness, mm

K = Insulation Conductivity, $Wmm/m^2 \cdot C$

A = Outside Area, m^2

ΔT = Temperature difference ($T_a - T_c$), C

If the insulation thickness of side walls, back panels, top, bottom and door are different, heat transfer for each part can be calculated seperately and then summed for two door refrigerators, due to different cabin temperature of freezer and refrigerator compartments, heat transfer for each compartment should be calculated separately and then added together.

Product Load

Heat removed from products (meat, fruits, vegetables, water and etc.) to reduce temperature from recieving to storage temperature is known as product load. Following steps can be taken to calculated of product loads.

1 - Heat removed from initial temperature (T_i) to storing temperature (T_{rs}) in refrigerator compartment is;

$$Q_{rs} = \dot{M} C (T_i - T_{rs})$$

Where:

$\dot{M}$ = Mass of product, Kg / h

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C = Specific heat of product, Kcal / Kg

2 - Heat removed from intial temperature (Ti) to freezing temperature (Tf) is ;

$$Q_{af} = \dot{M}\ C\ (Ti - Tf)$$

Where :

$\dot{M}$ = Mass of product, Kg / h

C = Specific heat of product above freezing point, Kcal / Kg

3 - Latent heat of fusion for products is equal to;

$$Q_L = \dot{M}\ h$$

Where h = Latent heat of product, Kcal / Kg

4 - Heat removed from freezing temperature (Tf) to final storage temperature (Tfs) is;

$$Q_{bf} = \dot{M}\ C_{bf}\ (Tf - Tfs)$$

Where: Cbf = Specific heat of products below freezing temperature.

For upright freezers or freezer compartment of refrigerators, total product load is

$$Q_{pl} = Q_{af} + Q_l + Q_{bf}$$

For storage products to some lower temperatures above freezing temperature in refrigerator compartment is;

$$Qpl = Qrs$$

Internal Load

Electrical energy dissipated in the refrigerated space such as lights, fan motors, heaters. .... are included in the internal heat load. Due to the little amount of consumption of lightings, the effect of lighting can be negligible and only electrical heaters of two door refrigerators or fan motors (if exist) are considered in our load calculation.

Infiltration Load

Infiltration air load is the heat transfer due to exchanging of refrigerated air with ambient caused by opening of the door or leakage through the gasket area. Infiltration load is one of the most important load components and roughly it is about 20 % of total refrigeration load.

Total Refrigeration load

As it was mentioned before, transmission load (Qtl), product load (Qpl) and internal load (Q il) can be calculated separetely. For infiltration load (air exchange through doorways or gasket leakage), we take into account 25% of sum of the above mentioned components. (transmission load, product load and internal load). Therefore total refrigeration load can be expressed as:

$$Q_{TL} = 1.25 \, (Q_{TL} + Q_{PL} + Q_{IL})$$

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Section III

Equipment Selection

Calculation of refrigeration load is the basis for selecting system equipments. First step is selection of a suitable compressor with cooloing capacity comparable to calculated load, then a cappillary tube should be selected so that the compressor and tube fix a balance point at the desired evaporating temperature, also two evaporator and condenser should be selected to balance compressor capacity.

Compressor selection

Assuming 16 hours daily operating time for the compressor, the calculated refrigeration load will be modified to:

$$Qc = \frac{Q_{TL \times 24}}{16} = 1.5Q_{TL}$$

Where :

Qc = required cooling capacity

For selectionof compressor from manufacturer's catalogue, we have to mention appropriate evaporating temperature;

- In refrigerators with ice compartment mounted inside, maximum evaporating temperature can be selected in order to have - 12 C (Two Stars) inside ice compartment.

- For upright freezers or freezer compartment of two door refrigerators, evaporating temperature should be in order to obtain -18 C (Three Stars) cabin temperature.

Capillary tube

Capillary tube is one of the most important components in refrigerator circuits . capillary acts as a pressure reducing device to meter the flow of refrigerant to the low pressure side (evaporator) of the system. In other word, capaillary tube should be

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capable to pass refrigerant pumped by the compressor and feed it to evaporator at available load and demand conditions.

On the contrary of the R12 or R22 refrigerants, practical equations, charts or graphs are not available for calculation of capillary size in R134a refrigeration circuits. Comparing saturation properties of R134a with R12 at a certain temperature, R134a pressure is less than R12, therefpre, capillary tube for R134a shall be adjusted at low evaporating temperatures in comparison with R12 system. The capillary for R134a refrigeration system must have an increase resistance which can be estimated about 10 - 15% increase in length for a definte bore. However the exact size (bore and length) can be attainable after laboratory performance tests.

Condenser & Evaporator

The statically cooled condenser is designed for use in small refrigeration appliance with sufficient space for the necessary condenser area. These condensers are manufactured either in tube-on-finned plate type or wire-on-tube design. Assuming that compressor casing and tubing will dissipate 80% of the heat equivalant of electrical in put, the condenser should be capable to reject heat absorbed by the refrigerant in the evaporator plus 20% of compressor power input heat equivalant.

The evaporator should balance the selected compressor capacity, not the original calculated load. Most of the refrigerators mainly employ aluminium evaporators produced on the roll-bond principal, where wire-ontube evaporators are usually installed in upright freezers.

Due to the higher latent heat (h_{fg}) of R134a in comparison with R12 and therefore less refrigerant charge in the system, it seems that evaporators and condensers used for R12 are also suitable for R134a refrigeration system. However more detailed information information about role of these two components in the system would be cleared after laboratory performance tests. Therefore partial modifications should be done if needed.

Refrigerant charge

As mentioned in previous sections, R134a latent heat of vaporazation is about 28-30% higher than R12 in temperature range -30 C up to + 10 C. Table 2-2 shpws thermodynamics saturation properties (with respect to a certain temerature) for these two refrigerants. In practice, charging amont of R134a can be 10-15% less than R12 with the same refrigeration load.

R134a is capable to absorb more humidity of the oil in comparison with R12. Therefore, the filter drier selected for R134a should be a drier with 3A desiccant with 20% more molecular seieve (by weight) in comparison with conventional types.

Table 2-2 Saturation Properties Comparison

	R12					R134a				
Temp C	P Kpa	Entholpy Kj/Kg	Entholpy Kj/Kg	Sp.Vol Lit/Kg	Sp.Vol Lit/Kg	P Kpa	Entholpy Kj/Kg	Entholpy Kj/Kg	Sp.Vol Lit/Kg	Sp.Vol Lit/Kg
		hf	hg	Vf	Vg		hf	hg	Vf	Vg
-30	100.41	172.81	338.14	0.672	159.37	84.36	61.51	277.208	0.7100	0.2219
-26	118.72	176.38	339.96	0.677	136.28	101.65	66.56	212.96	0.7171	0.1868
-22	139.53	179.96	341.78	0.682	117.16	121.62	71.63	281.86	0.7243	0.1570
-18	163.04	183.56	343.58	0.688	101.24	144.56	76.72	284.19	0.7318	0.1313
-14	189.50	187.18	345.36	0.694	87.89	170.76	81.84	286.52	0.7396	0.1138
-10	219.12	190.82	347.13	0.700	76.64	200.51	86.98	288.85	0.7475	0.0941
-6	252.14	194.47	348.88	0.706	67.11	234.13	92.162	291.18	0.7558	0.0843
-4	270.01	196.31	349.75	0.709	62.89	252.49	94.76	292.35	0.7600	0.0784
-2	288.82	198.15	350.61	0.712	58.99	271.94	97.377	293.522	0.7643	0.0730
0	308.61	200.00	351.47	0.715	55.38	292.52	100.00	294.68	0.7687	0.0681
2	329.40	201.85	352.33	0.719	52.04	314.27	102.63	295.35	0.7732	0.0635
4	351.24	203.71	353.17	0.722	48.94	337.24	105.28	297.01	0.7777	0.0594
6	374.14	205.57	354.02	0.726	46.07	361.47	107.93	298017	0.7823	0.0555
8	398.15	207.44	354.85	0.729	43.40	387.01	110.60	299.33	0.7870	0.0520
10	423.30	209.32	355.68	0.733	40.91	413.90	113.29	300.49	0.7918	0.0487

Fariz Iran

Product Type	Product Model	Cooling Watt		Internal Volume Lit.	Recommended Compressors											
		Product Cooling Capacity	Comp. Cooling Req. *		Danfuss		Gold Star		Matsushita		Necchi		Zanussi		Aspera	
					Model	watt	Model	watt	Model	watt	Model	watt	Model	watt	Model	watt
Refrigerator	FIR11	168	202	338	FR10G	191	VF75N V75L	194 194	QA91C20RAX5	200	ESC9 ESC9K	205 205	GL80AH	200	BP1118Z	204
Refrigerator	FIR13	161	193	318	FR10G	191	VF75N V75L	194 194	D77C18-RAX5	186	ESC8.5 ESC8.5K	186 186	GL70AH	197		
Freezer	FIF13	156	187	290	FR10G	191	V75L	194	D77C18-RAX5	186	ESC8.5 ESC8.5K	186 186	GL70AH	197		

Selected Compressor Test Condirtion: ASHRAE Standard
Ambient Temperature +43°C
Evaporating Temperature - 23.3°C
Condenseing Temperature + 54.4°C
Suction Temperature +32°C
Sub-Cooling Temperaturer +32°C

*** Copmressor Cooling Capacity Requrement = 1.2 Product Cooling Capacity (for maximum 20 hours compressor operating time per day)**

PRODUCT SPECIFICATION TABLE

Company FARIZ IRAN	Product Type REF.	Product Model FIR11

DIMENSION

Height mm 1430	Width mm 610	Depth mm 515
Evap. Height mm 174	Evap. Width mm 300	Evap. Depth mm 520
Gasket Thickness mm 15	Ref. Wall Thickness mm 30	Freezer Wall Thickness mm 30

Refrigerator Internal Volume Lit. 310	Freezer or Evap. Internal Volume Lit. 28

REFRIGERATION SYSTEM

Condenser Tube Length mm 13540	Evaporator Tube Length mm 14000	Evaporator Surface Sq. mm 400000	Capillary Tube Length mm 3000
Condenser Tube Outer Dim. mm 6.35	Condenser Tube Inner Dim. mm 4.50	Number of on Wire Condenser Tube 126	Capillary Tube Inner Dim. mm 0.78
Max. Evap. Air Temp. -12	Evap. Tube Length mm 14000	Ref. System Internal Volume Lit. 0.2	Refrigerant Weight gr. 175

General Specification

Insulation Thermal Conductivity Factor W/M °K 0.025	Insulation Material Mixture (Polyol+R11)+ Isosynide (100+35)+133	Insulation Type polyurethane	Gasket Type P.V.C

Compressor Type & Model(s) /FNE-125	Compressor Cooling Capacity (watt) 116	Compressor Input Power(Watt) 135
Voltage 165-220	Ampere 1.13A	Frq. 50 HZ

PRODUCT SPECIFICATION TABLE

Company FARIZ IRAN	Product Type REF.	Product Model FIR13

DIMENSION

Height mm 1570	Width mm 610	Depth mm 565
Evap. Height mm 174	Evap. Width mm 300	Evap. Depth mm 520
Gasket Thickness mm 17	Ref. Wall Thickness mm 35	Freezer Wall Thickness mm 35

Refrigerator Internal Volume Lit. 290	Freezer or Evap. Internal Volume Lit. 28

REFRIGERATION SYSTEM

Condenser Tube Length mm 13540	Evaporator Tube Length mm 14000	Evaporator Surface Sq. mm 400000	Capillary Tube Length mm 3000
Condenser Tube Outer Dim. mm 6.35	Condenser Tube Inner Dim. mm 4.5	Number of ...... on Wire Condenser Tube 126	Capillary Tube Inner Dim. mm 0.78
Max. Evap. Air Temp. −12 °C	Evap. Tube Length mm 14000	Ref. System Internal Volume Lit.	Refrigerant Weight gr. 190

General Specification

Insulation Thermal Conductivity Factor W/M°K 0.025	Insulation Material Mixture (Polyol+R11)+ Isosynide (100+35)+133	Insulation Type polyurethan	Gasket Type P.V.C

Compressor Type & Model(s) / FNE-140	Compressor Cooling Capacity (watt) 162	Compressor Input Power(Watt) 175
Voltage 165-220	Ampere 1.35 A	Frq. 50 HZ

PRODUCT SPECIFICATION TABLE

Company FARIZ IRAN	Product Type FRE.	Product Model FIF13

DIMENSION

Height mm 1570	Width mm 610	Depth mm 565
Evap. Height mm	Evap. Width mm 300	Evap. Depth mm 490
Gasket Thickness mm 15	Ref. Wall Thickness mm 50	Freezer Wall Thickness mm 50

Refrigerator Internal Volume Lit. —	Freezer or Evap. Internal Volume Lit. 290

REFRIGERATION SYSTEM

Condenser Tube Length mm 13540	Evaporator Tube Length mm 15630	Evaporator Surface Sq. mm 588000	Capillary Tube Length mm 3000
Condenser Tube Outer Dim. mm 6.35	Condenser Tube Inner Dim. mm 4.50	Number of on Wire Condenser Tube 126	Capillary Tube Inner Dim. mm 0.78
Max. Evap. Air Temp. -25	Evap. Tube Length mm 15630	Ref. System Internal Volume Lit. 0.51	Refrigerant Weight gr. 230

General Specification

Insulation Thermal Conductivity Factor W/M.°K 0.025	Insulation Material Mixture (Polyol÷R11)÷ Isosynide (100+35)+133	Insulation Type polyurethane	Gasket Type P.V.C

Compressor Type & Model(s) /FNE175	Compressor Cooling Capacity (watt) 174	Compressor Input Power(Watt) 175
Voltage 165-220	Ampere 1.15	Frq. 50

Gadook Co.

Product Type	Product Model	Cooling Watt		Internal Volume Lit.	Recommended Compressors											
					Danfuss		Gold Star		Matsushita		Necchi		Zanussi		Aspera	
		Product Cooling Capacity	Comp. Cooling Req. *		Model	watt	Model	watt	Model	watt	Model	watt	Model	watt	Model	watt
Refrigerator	R280	89	107	301	TL5G	104	NR45L NF45N	108 108	QA51 C11R AX5	110	ESC5	101	GL45AA	107	BP1048Z2 2	108
Freezer	FU 280	143	172	301	SC10G	173	NR62L	155	QA77 C18- RAX5	160	ESC8 ESC8K	172 172	GL70A II	166	BP1116Z	158
Ref. Freezer	RF350	175	210	358	FR10G	191	V75L	194	QA91 C20R AX5	200	ESC9 ESC9K	205 205	GL80A II	200	BP1118Z	204

Selected Compressor Test Condirtion: ASHRAE Standard
Ambient Temperature +43°C
Evaporating Temperature - 23.3°C
Condenseing Temperature + 54.4°C
Suction Temperature +32°C
Sub-Cooling Temperaturer +32°C

*** Copmressor Cooling Capacity Requrement = 1.2 Product Cooling Capacity (for maximum 20 hours compressor operating time per day)**

PRODUCT SPECIFICATION TABLE

Company GADOOK	Product Type REF. FR.	Product Model RF-350

DIMENSION

Height mm 1755	Width mm 600	Depth mm 650
Evap. Height mm 350	Evap. Width mm 500	Evap. Depth mm 400
Gasket Thickness mm 16	Ref. Wall Thickness mm 35	Freezer Wall Thickness mm 50
Refrigerator Internal Volume Lit. 278	Freezer or Evap. Internal Volume Lit. 80	

REFRIGERATION SYSTEM

Condenser Tube Length mm 1922	Evaporator Tube Length mm 10000	Evaporator Surface Sq. mm 855000	Capillary Tube Length mm 3150
Condenser Tube Outer Dim. mm 6.35	Condenser Tube Inner Dim. mm 4.95	Number of on Wire Condenser Tube 124	Capillary Tube Inner Dim. mm 0.9144
Max. Evap. Air Temp. -18°C	Evap. Tube Length mm 10000	Ref. System Internal Volume Lit.	Refrigerant Weight gr. 180

General Specification

Insulation Thermal Conductivity Factor W/M °K 0.0181	Insulation Material Mixture (Polyol+R11)+ Isosynide (100+35)+133	Insulation Type FOAM POLYURETHANE	Gasket Type P.V.C
Compressor Type & Model(s) DANFOSS / FR8.5B	Compressor Cooling Capacity (watt) 162	Compressor Input Power(Watt) 185	
Voltage 220	Ampere 1.3	Frq. 50 HZ	

PRODUCT SPECIFICATION TABLE

Company GADOOK	Product Type FREEZER	Product Model FU-280

DIMENSION

Height mm 1650	Width mm 600	Depth mm 650
Evap. Height mm	Evap. Width mm	Evap. Depth mm
PLATE & TUBE 390 x 483 x 12 x 6 PLATES		
Gasket Thickness mm 16	Ref. Wall Thickness mm —	Freezer Wall Thickness mm 55

Refrigerator Internal Volume Lit. —	Freezer or Evap. Internal Volume Lit. 301

REFRIGERATION SYSTEM

Condenser Tube Length mm 19520	Evaporator Tube Length mm 18000	Evaporator Surface Sq. mm 2386152	Capillary Tube Length mm 3150
Condenser Tube Outer Dim. mm 4.762	Condenser Tube Inner Dim. mm 3.5	Number of on Wire Condenser Tube 124	Capillary Tube Inner Dim. mm 0.9144
Max. Evap. Air Temp. -25°C	Evap. Tube Length mm 18000	Ref. System Internal Volume Lit.	Refrigerant Weight gr. 180

General Specification

Insulation Thermal Conductivity Factor W/M.°K 0.0181	Insulation Material Mixture (Polyol+R11)+ Isosynide (100+35)+133	Insulation Type POLYURETHAN	Gasket Type P.V.C

Compressor Type & Model(s) DANFOSS / FR8.5B	Compressor Cooling Capacity (watt) 162	Compressor Input Power(Watt) 185
Voltage 220 V.	Ampere 1.30 A.	Frq. 50 HZ

PRODUCT SPECIFICATION TABLE

Company GADOOK	Product Type REF.	Product Model R-280

DIMENSION

Height mm 1650	Width mm 600	Depth mm 650
Evap. Height mm 230	Evap. Width mm 440	Evap. Depth mm 300
Gasket Thickness mm 16	Ref. Wall Thickness mm 55	Freezer Wall Thickness mm 55

Refrigerator Internal Volume Lit. 271	Freezer or Evap. Internal Volume Lit. 30

REFRIGERATION SYSTEM

Condenser Tube Length mm 12700	Evaporator Tube Length mm	Evaporator Surface Sq. mm 804000	Capillary Tube Length mm 2500
Condenser Tube Outer Dim. mm 4.762	Condenser Tube Inner Dim. mm 3.5	Number of on Wire Condenser Tube 124	Capillary Tube Inner Dim. mm 0.787
Max. Evap. Air Temp. -12°c	Evap. Tube Length mm	Ref. System Internal Volume Lit.	Refrigerant Weight gr. 150

General Specification

Insulation Thermal Conductivity Factor W/M°K 0.0181	Insulation Material Mixture (Polyol+R11)+ Isosynide (100+35)+133	Insulation Type POLYURETHAN	Gasket Type P.V.C

Compressor Type & Model(s) GOLD STAR/VC-52	Compressor Cooling Capacity (watt) 140	Compressor Input Power(Watt) 165
Voltage 220	Ampere 1.1	Frq. 50

Lorestan Industrial Co.

Product Type	Product Model	Cooling Watt		Internal Volume Lit.	Recommended Compressors											
					Danfuss		Gold Star		Matsushita		Necchi		Zanussi		Aspera	
		Product Cooling Capacity	Comp. Cooling Req. *		Model	watt	Model	watt	Model	watt	Model	watt	Model	watt	Model	watt
Refrigerator	ROM 10	79	95	280					S43C 10AX0	95	ESC5	101			BP1048Z22	108
Refrigerator	ROM13	120	144	368	TLS6F FR7.5G	144 145	NR62L	155	QA66- C15R- AX5	138	ESC7K ESC7	147 147	GL60AA	146		
Refrigerator	ROM14	130	156	390	TLS7F	162	NR62L	155	QA77- C18R- AX5	160	ESC7 ESC7K	147 147	GL70AA	165	B1116Z	158
Freezer	UFM10	127	152	280	FR7.5G	145	NR62L	155	D66C- 15RA- X5	151	ESC7K ESC7	147 147	GL60AH	147		
Freezer	UFM13	158	190	368	FR10G	191	V75L VF75N	194 194	D77C- 18RA- X5	186	ESC8.5 ESC8.5K	186 186	GL80AA	197		
Ref. Freezer	RAT13	137	164	326	TLS7F	162	NR62L	155	QA77- C18R- AX5	160			GL60AA GL70AH	165 166		

Selected Compressor Test Condirtion:

ASHRAE Standard
Ambient Temperature 43°C
Evaporating Temperature - 23.3°C
Condenseing Temperature + 54.4°C
Suction Temperature+32°C
Sub-Cooling Temperaturer +32°C

*** Copmressor Cooling Capacity Requrement = 1.2 Product.. Cooling Capacity (for maximum 20 hours compressor operating time per day)**

PRODUCT SPECIFICATION TABLE

Company LORESTAN	Product Type Ref.	Product Model ROM 10

DIMENSION

Height mm 1207	Width mm 686	Depth mm 702
Evap. Height mm 170	Evap. Width mm 515	Evap. Depth mm 360
Gasket Thickness mm 17	Ref. Wall Thickness mm 50	Freezer Wall Thickness mm 50

Refrigerator Internal Volume Lit.	Freezer or Evap. Internal Volume Lit.

REFRIGERATION SYSTEM

Condenser Tube Length mm 10200	Evaporator Tube Length mm –	Evaporator Surface Sq. mm 986400	Capillary Tube Length mm 2800
Condenser Tube Outer Dim. mm 6.35	Condenser Tube Inner Dim. mm 4.95	Number of on Wire Condenser Tube 156	Capillary Tube Inner Dim. mm 0.78
Max. Evap. Air Temp. -12°C	Evap. Tube Length mm –	Ref. System Internal Volume Lit. 0.52	Refrigerant Weight gr. 180

General Specification

Insulation Thermal Conductivity Factor W/M°K [illegible]	Insulation Material Mixture (Polyol+R11)+ Isosynide (100+35)+35 [illegible]	Insulation Type	Gasket Type

Compressor Type & Model(s) [illegible]	Compressor Cooling Capacity (watt) 140	Compressor Input Power(Watt) [illegible]
Voltage 220	Ampere 0.87 A	Frq. 50 HZ

PRODUCT SPECIFICATION TABLE

Company [illegible]	Product Type [illegible]	Product Model ETA12

DIMENSION

Height mm 1507	Width mm 686	Depth mm 702
Evap. Height mm 320	Evap. Width mm 570	Evap. Depth mm 425
Gasket Thickness mm	Ref. Wall Thickness mm 50	Freezer Wall Thickness mm 50
Refrigerator Internal Volume Lit. 249	Freezer or Evap. Internal Volume Lit. 62	

REFRIGERATION SYSTEM

Condenser Tube Length mm 15400	Evaporator Tube Length mm –	Evaporator Surface Sq. mm 1813800	Capillary Tube Length mm 3200
Condenser Tube Outer Dim. mm 6.35	Condenser Tube Inner Dim. mm 4.95	Number of on Wire Condenser Tube 156	Capillary Tube Inner Dim. mm 0.78
Max. Evap. Air Temp. -18 °C	Evap. Tube Length mm –	Ref. System Internal Volume Lit. 0.73	Refrigerant Weight gr. 230

General Specification

Insulation Thermal Conductivity Factor W/M. 0.0195	Insulation Material Mixture (Polyol+R11)+ Isosynide (100+33)+133	Insulation Type polyURETHANE	Gasket Type

Compressor Type & Model(s) Gold Star / NR62	Compressor Cooling Capacity (watt) 176	Compressor Input Power(Watt) 162
Voltage 220 V	Ampere 0.98 A	Frq. 50 Hz

PRODUCT SPECIFICATION TABLE

Company LORESTANE	Product Type REF.	Product Model ROM 13

DIMENSION

Height mm 1507	Width mm 686	Depth mm 702
Evap. Height mm 255	Evap. Width mm 515	Evap. Depth mm 385
Gasket Thickness mm 17	Ref. Wall Thickness mm 50	Freezer Wall Thickness mm —

Refrigerator Internal Volume Lit. 317.5	Freezer or Evap. Internal Volume Lit. 50.5

REFRIGERATION SYSTEM

Condenser Tube Length mm 11700	Evaporator Tube Length mm —	Evaporator Surface Sq. mm 1185800	Capillary Tube Length mm 3200
Condenser Tube Outer Dim. mm 6.35	Condenser Tube Inner Dim. mm 4.95	Number of on Wire Condenser Tube 150	Capillary Tube Inner Dim. mm 0.78
Max. Evap. Air Temp. -12°C	Evap. Tube Length mm —	Ref. System Internal Volume Lit. 0.59	Refrigerant Weight gr. 210

General Specification

Insulation Thermal Conductivity Factor W/M.°K 0.045	Insulation Material Mixture (Polyol+R11)+ Isosynide (100+35)+133	Insulation Type POLYURETHANE	Gasket Type

Compressor Type & Model(s) Gold Star NR02	Compressor Cooling Capacity (watt) 176	Compressor Input Power(Watt) 102
Voltage 220	Ampere 0.98	Frq. 50 HZ

PRODUCT SPECIFICATION TABLE

Company LORESTANE	Product Type REF.	Product Model ROM 14

DIMENSION

Height mm 1507	Width mm 86	Depth mm 702
Evap. Height mm 255	Evap. Width mm 535	Evap. Depth mm 395
Gasket Thickness mm 17	Ref. Wall Thickness mm 45	Freezer Wall Thickness mm –

Refrigerator Internal Volume Lit. 336	Freezer or Evap. Internal Volume Lit. 54

REFRIGERATION SYSTEM

Condenser Tube Length mm 11700	Evaporator Tube Length mm –	Evaporator Surface Sq. mm 1248200	Capillary Tube Length mm 3250
Condenser Tube Outer Dim. mm 6.35	Condenser Tube Inner Dim. mm 4.95	Number of on Wire Condenser Tube 156	Capillary Tube Inner Dim. mm 0.78
Max. Evap. Air Temp. -12 °C	Evap. Tube Length mm –	Ref. System Internal Volume Lit. 0.64	Refrigerant Weight gr. 220

General Specification

Insulation Thermal Conductivity Factor W/M.°K 0.0195	Insulation Material Mixture (Polyol+R11)+ Isosynide (100+33)+133	Insulation Type polyURETHANE	Gasket Type

Compressor Type & Model(s) Gold Star NR62	Compressor Cooling Capacity (watt) 176	Compressor Input Power(Watt) 162
Voltage 220 V	Ampere 0.98 A	Frq. 50 HZ

PRODUCT SPECIFICATION TABLE

Company LORESTAN	Product Type FRE.	Product Model UFM 13

DIMENSION

Height mm 1507	Width mm 686	Depth mm 702
Evap. Height mm —	Evap. Width mm —	Evap. Depth mm —
Gasket Thickness mm 17	Ref. Wall Thickness mm —	Freezer Wall Thickness mm 50
Refrigerator Internal Volume Lit. —	Freezer or Evap. Internal Volume Lit. 368	

REFRIGERATION SYSTEM

Condenser Tube Length mm 15400	Evaporator Tube Length mm 18200	Evaporator Surface Sq. mm 1012840	Capillary Tube Length mm 3250
Condenser Tube Outer Dim. mm 6.35	Condenser Tube Inner Dim. mm 4.95	Number of on Wire Condenser Tube 156	Capillary Tube Inner Dim. mm 0.78
Max. Evap. Air Temp. -24°C	Evap. Tube Length mm 18200	Ref. System Internal Volume Lit. 0.95	Refrigerant Weight gr. 240

General Specification

Insulation Thermal Conductivity Factor W/M °K 0.0195	Insulation Material Mixture (Polyol+R11)+ Isosynide (100+33)+133	Insulation Type POLYURETHANE	Gasket Type
Compressor Type & Model(s) matsushita / FN 77Q	Compressor Cooling Capacity (watt) 191	Compressor Input Power(Watt) 174	
Voltage 220	Ampere 1.17	Frq. 50	

PRODUCT SPECIFICATION TABLE

Company LORESTAN	Product Type FRE.	Product Model UFM-10

DIMENSION

Height mm 1207	Width mm 686	Depth mm 702
Evap. Height mm —	Evap. Width mm —	Evap. Depth mm —
Gasket Thickness mm 17	Ref. Wall Thickness mm —	Freezer Wall Thickness mm 50

Refrigerator Internal Volume Lit. —	Freezer or Evap. Internal Volume Lit. 280

REFRIGERATION SYSTEM

Condenser Tube Length mm 12200	Evaporator Tube Length mm 13500	Evaporator Surface Sq. mm 759630	Capillary Tube Length mm 3100
Condenser Tube Outer Dim. mm 6.35	Condenser Tube Inner Dim. mm 4.95	Number of on Wire Condenser Tube 156	Capillary Tube Inner Dim. mm 0.78
Max. Evap. Air Temp. -24°C	Evap. Tube Length mm 13500	Ref. System Internal Volume Lit. 0.72	Refrigerant Weight gr. 205

General Specification

Insulation Thermal Conductivity Factor W/M.°K 0.0195	Insulation Material Mixture (Polyol+R11)+ Isosynide (100+33)+133	Insulation Type POLYURETHANE	Gasket Type

Compressor Type & Model(s) Gold star / NR 62	Compressor Cooling Capacity (watt) 176	Compressor Input Power(Watt) 162
Voltage 220 V	Ampere 0.98 A	Frq. 50 HZ

Movalled Co.

Product Type	Product Model	Cooling Watt		Internal Volume Lit.	Recommended Compressors											
					Danfuss		Gold Star		Matsushita		Necchi		Zanussi		Aspera	
		Product Cooling Capacity	Comp. Cooling Req. *		Model	watt	Model	watt	Model	watt	Model	watt	Model	watt	Model	watt
Freezer	F80	172	206	217			V75L NF75N	194 194	QA91 C20R AX5	200	ESC11 ESCHK	246 246	GL80AA	200	BP1118Z	204
Ref. Freezer	RF80	146	175	234	SC10G	173			QA77 C18- RAX5	160	ESC8 ESC8K	172 172	GL70AA	165	BP1116Z	158
Ref. Freezer	RF85	166	199	276	FR10G	191	V75L NF45N	194 194	D77C- 18RA- X5	186	ESC8.5 ESC8.5 K	186 186	GL80AA	200	BP1118Z	200
Ref. Freezer	RF14	174	208	304			V75L NF45N	194 194	QA91 C20R AX5	200	ESC9 ESC0K	205 205	GL80AA	200	BP1118Z	200

Selected Compressor Test Condirtion: ASHRAE Standard
Ambient Temperature +43°C
Evaporating Temperature - 23.3°C
Condenseing Temperature + 54.4°C
Suction Temperature +32°C
Sub-Cooling Temperaturer +32°C

*** Copmressor Cooling Capacity Requrement = 1.2 Product Cooling Capacity (for maximum 20 hours compressor operating time per day)**

PRODUCT SPECIFICATION TABLE

Company MCVALED	Product Type REF. FRE.	Product ModeL RF14

DIMENSION

Height mm 1640	Width mm 540	Depth mm 595
Evap. Height mm 370	Evap. Width mm 400	Evap. Depth mm 480
Gasket Thickness mm 20	Ref. Wall Thickness mm 30	Freezer Wall Thickness mm 45

Refrigerator Internal Volume Lit. 234	Freezer or Evap. Internal Volume Lit. 70

REFRIGERATION SYSTEM

Condenser Tube Length mm 1090	Evaporator Tube Length mm 1235	Evaporator Surface Sq. mm 430x1453	Capillary Tube Length mm 2032
Condenser Tube Outer Dim. mm 8	Condenser Tube Inner Dim. mm 6.35	Number of on Wire Condenser Tube 12	Capillary Tube Inner Dim. mm 0.78
Max. Evap. Air Temp. -18	Evap. Tube Length mm —	Ref. System Internal Volume Lit. 1	Refrigerant Weight gr. 180

General Specification

Insulation Thermal Conductivity Factor W/M.°K 0.025	Insulation Material Mixture (Polyol+R11)+ Isosynide (36.3+12.7)+51	Insulation Type polyurethane	Gasket Type PVC

Compressor Type & Model(s) NECCHI/ES.M3HK	Compressor Cooling Capacity (watt) 173	Compressor Input Power(Watt) 180
Voltage 220 V	Ampere 1.3 A	Frq. 50 HZ

PRODUCT SPECIFICATION TABLE

Company MOVALLED	Product Type REF. FRE.	Product Model RF 80

DIMENSION

Height mm 1190	Width mm 540	Depth mm 595
Evap. Height mm 140	Evap. Width mm 280	Evap. Depth mm 480
Gasket Thickness mm 20	Ref. Wall Thickness mm 30	Freezer Wall Thickness mm 45

Refrigerator Internal Volume Lit. 215.7	Freezer or Evap. Internal Volume Lit. 18.8

REFRIGERATION SYSTEM

Condenser Tube Length mm 9000	Evaporator Tube Length mm 1235	Evaporator Surface Sq. mm 480x1213.5	Capillary Tube Length mm 2300
Condenser Tube Outer Dim. mm 8	Condenser Tube Inner Dim. mm 6.35	Number of on Wire Condenser Tube 15	Capillary Tube Inner Dim. mm 0.66
Max. Evap. Air Temp. -18	Evap. Tube Length mm —	Ref. System Internal Volume Lit. 0.585	Refrigerant Weight gr. 120

General Specification

Insulation Thermal Conductivity Factor W.M⁻¹K 0.025	Insulation Material Mixture (Polyol-R11)-Isosynide (36.3+12.7)+51	Insulation Type POLYURETHAN	Gasket Type P.V.C

Compressor Type & Model(s) NECCHI/ES.M5A	Compressor Cooling Capacity (watt) 119	Compressor Input Power(Watt) 140
Voltage 220 V	Ampere 0.7 A	Frq. 50 HZ

PRODUCT SPECIFICATION TABLE

Company MOVALLED	Product Type FRE.	Product Model F80

DIMENSION

Height mm 1190	Width mm 540	Depth mm 595
Evap. Height mm —	Evap. Width mm —	Evap. Depth mm —
Gasket Thickness mm 20	Ref. Wall Thickness mm —	Freezer Wall Thickness mm 35

Refrigerator Internal Volume Lit. —	Freezer or Evap. Internal Volume Lit. 217

REFRIGERATION SYSTEM

Condenser Tube Length mm 9000	Evaporator Tube Length mm 1230	Evaporator Surface Sq. mm —	Capillary Tube Length mm 1600
Condenser Tube Outer Dim. mm 8	Condenser Tube Inner Dim. mm 6.35	Number of on Wire Condenser Tube 15	Capillary Tube Inner Dim. mm 0.78
Max. Evap. Air Temp. -18	Evap. Tube Length mm 8000	Ref. System Internal Volume Lit. 0.67	Refrigerant Weight gr. 240

General Specification

Insulation Thermal Conductivity Factor W/M°K 0.025	Insulation Material Mixture (Polyol+R11)+ Isosynide (36.3+12.7)+51	Insulation Type POLYURETHAN	Gasket Type P.V.C

Compressor Type & Model(s) NECCHI/ESM94K	Compressor Cooling Capacity (watt) 121	Compressor Input Power(Watt) 180
Voltage 220 V	Ampere 1.4A	Frq. 50 HZ

PRODUCT SPECIFICATION TABLE

Company MOVALLED	Product Type REF. FRE	Product Model RF85

DIMENSION

Height mm 1490	Width mm 540	Depth mm 595
Evap. Height mm 220	Evap. Width mm 400	Evap. Depth mm 480
Gasket Thickness mm 20	Ref. Wall Thickness mm 30	Freezer Wall Thickness mm 30

Refrigerator Internal Volume Lit. 234	Freezer or Evap. Internal Volume Lit. 42

REFRIGERATION SYSTEM

Condenser Tube Length mm 9000	Evaporator Tube Length mm 1535	Evaporator Surface Sq. mm 480x1303.5	Capillary Tube Length mm 2035
Condenser Tube Outer Dim. mm 8	Condenser Tube Inner Dim. mm 6.35	Number of on Wire Condenser Tube 15	Capillary Tube Inner Dim. mm 0.71
Max. Evap. Air Temp. -18	Evap. Tube Length mm -	Ref. System Internal Volume Lit. 0.67	Refrigerant Weight gr. 150

General Specification

Insulation Thermal Conductivity Factor W/M °K 0.025	Insulation Material Mixture (Polvol-R11)+ Isosynide(36.3+12.7)+51	Insulation Type POLYURETHAN	Gasket Type P.V.C

Compressor Type & Model(s) NECCHI/E.S.M7HK	Compressor Cooling Capacity (watt) 156	Compressor Input Power(Watt) 160
Voltage 220	Ampere 1.1	Frq. 50 HZ

Pars Machine Co.

Product Type	Product Model	Cooling Watt		Internal Volume Lit.	Recommended Compressors											
					Danfuss		Gold Star		Matsushita		Necchi		Zanussi		Aspera	
		Product Cooling Capacity	Comp. Cooling Req. *		Model	watt	Model	watt	Model	watt	Model	watt	Model	watt	Model	watt
Refrigerator	PMR6	85	102	167	TL5G	104	NR45L NF45N	108 108	S43C10KAX0	95	ESC5	101	GL45AA	107	BP1048Z22	108
Refrigerator	1070	106	127	289	TLS5F	128	NR52L	131	QA57C13-RAX5	122			GL50AA	125	BP1111Z	125
Refrigerator	Damava-nd 15	120	144	280	FR7.5G TLS6F	144 145	NR52L	131	D57C-13RA-X5	141	ESC7 ESC7K	147 147	GL60AA	146	BP1116Z	158
Freezer	1072	181	217	290	FR10G	191	V75L NF45N	194 194	QA91C20RAX5	200	ESC9 ESC0K	205 205	GL80AA	200	BP1118Z	200

Selected Compressor Test Condirtion: ASHRAE Standard
Ambient Temperature +43°C
Evaporating Temperature - 23.3°C
Condenseing Temperature + 54.4°C
Suction Temperature +32°C
Sub-Cooling Temperaturer +32°C

*** Copmressor Cooling Capacity Requrement = 1.2 Product Cooling Capacity (for maximum 20 hours compressor operating time per day)**

PRODUCT SPECIFICATION TABLE

Company PARS MACHINE	Product Type REF.	Product Model PMR6

DIMENSION

Height mm 920	Width mm 610	Depth mm 570
Evap. Height mm 140	Evap. Width mm 270	Evap. Depth mm 460
Gasket Thickness mm 17	Ref. Wall Thickness mm 40	Freezer Wall Thickness mm 40

Refrigerator Internal Volume Lit. 150	Freezer or Evap. Internal Volume Lit. 17

REFRIGERATION SYSTEM

Condenser Tube Length mm 6686	Evaporator Tube Length mm	Evaporator Surface Sq. mm 19930	Capillary Tube Length mm 2600
Condenser Tube Outer Dim. mm 6.80	Condenser Tube Inner Dim. mm 6.35	Number of on Wire Condenser Tube 12	Capillary Tube Inner Dim. mm 0.79
Max. Evap. Air Temp. -12°C	Evap. Tube Length mm	Ref. System Internal Volume Lit.	Refrigerant Weight gr. 95

General Specification

Insulation Thermal Conductivity Factor W/M °K 0.018	Insulation Material Mixture (Polyol+R11)+ Isosynide (37+13)+51	Insulation Type POLYURETANE	Gasket Type P.V.C

Compressor Type & Model(s) /FN43Q90G	Compressor Cooling Capacity (watt) 95	Compressor Input Power(Watt) 97
Voltage 187-242	Ampere 0.67	Frq. 50 HZ

PRODUCT SPECIFICATION TABLE

Company PARS MACHINE	Product Type FRE.	Product Model 1072

DIMENSION

Height mm 1420	Width mm 670	Depth mm 570
Evap. Height mm 1319.6	Evap. Width mm 476	Evap. Depth mm —
Gasket Thickness mm 17	Ref. Wall Thickness mm —	Freezer Wall Thickness mm 40

Refrigerator Internal Volume Lit. —	Freezer or Evap. Internal Volume Lit. 290

REFRIGERATION SYSTEM

Condenser Tube Length mm 10924	Evaporator Tube Length mm —	Evaporator Surface Sq. mm 628129.6	Capillary Tube Length mm 300
Condenser Tube Outer Dim. mm 6.80	Condenser Tube Inner Dim. mm 6.35	Number of on Wire Condenser Tube 20	Capillary Tube Inner Dim. mm 0.91
Max. Evap. Air Temp. -18°C	Evap. Tube Length mm —	Ref. System Internal Volume Lit. —	Refrigerant Weight gr. 270

General Specification

Insulation Thermal Conductivity Factor W/M °K 0.018	Insulation Material Mixture (Polyol-R11)-Isosynide (37+13)+51	Insulation Type POLYURETHANE	Gasket Type P.V.C

Compressor Type & Model(s) 1ESM9HK	Compressor Cooling Capacity (watt)	Compressor Input Power(Watt) 211
Voltage 165-250	Ampere 1.39	Frq. 50

PRODUCT SPECIFICATION TABLE

Company PARS MACHINE Product Type REF. Product Model DAMAVAND 15

DIMENSION

Height mm 1400	Width mm 610	Depth mm 575
Evap. Height mm 260	Evap. Width mm 510	Evap. Depth mm 310
Gasket Thickness mm 17	Ref. Wall Thickness mm 40	Freezer Wall Thickness mm 40

Refrigerator Internal Volume Lit. 339	Freezer or Evap. Internal Volume Lit. 41

REFRIGERATION SYSTEM

Condenser Tube Length mm 11320	Evaporator Tube Length mm —	Evaporator Surface Sq. mm 290700	Capillary Tube Length mm 340
Condenser Tube Outer Dim. mm 6.80	Condenser Tube Inner Dim. mm 6.35	Number of on Wire Condenser Tube 16	Capillary Tube Inner Dim. mm 0.79
Max. Evap. Air Temp. -12 °C	Evap. Tube Length mm —	Ref. System Internal Volume Lit. 20.5	Refrigerant Weight gr. 150

General Specification

Insulation Thermal Conductivity Factor W/M °K 0.018	Insulation Material Mixture (Polyol+R11)+ Isosynide (37+13)+51	Insulation Type POLYURETHANE	Gasket Type P.V.C

Compressor Type & Model(s) ESM7HK	Compressor Cooling Capacity (watt) 140	Compressor Input Power(Watt) 156
Voltage 165-250	Ampere 1.02	Frq. 50

PRODUCT SPECIFICATION TABLE

Company PARS MACHINE	Product Type REF.	Product Model 1070	
DIMENSION			
Height mm 1380	Width mm 610	Depth mm 570	
Evap. Height mm 165	Evap. Width mm 450	Evap. Depth mm 285	
Gasket Thickness mm 17	Ref. Wall Thickness mm 40	Freezer Wall Thickness mm 40	
Refrigerator Internal Volume Lit. 268	Freezer or Evap. Internal Volume Lit. 21		
REFRIGERATION SYSTEM			
Condenser Tube Length mm 9832	Evaporator Tube Length mm	Evaporator Surface Sq. mm 3300	Capillary Tube Length mm 3395
Condenser Tube Outer Dim. mm 6.80	Condenser Tube Inner Dim. mm 6.35	Number of on Wire Condenser Tube 18	Capillary Tube Inner Dim. mm 0.79
Max. Evap. Air Temp. -12°C	Evap. Tube Length mm	Ref. System Internal Volume Lit.	Refrigerant Weight gr. 130
General Specification			
Insulation Thermal Conductivity Factor W/M°K 0.018	Insulation Material Mixture (Polyol-R11)+Isosynide (37+13)+50	Insulation Type POLYURETHAN	Gasket Type P.V.C
Compressor Type & Model(s) /FN51F10G	Compressor Cooling Capacity (watt) 123	Compressor Input Power(Watt) 110	
Voltage(V) 165-250	Ampere 0.94 A	Frq. 50 HZ	

Pars Monark Co.

Product Type	Product Model	Cooling Watt		Internal Volume Lit.	Recommended Compressors											
					Danfuss		Gold Star		Matsushita		Necchi		Zanussi		Aspera	
		Product Cooling Capacity	Comp. Cooling Req. *		Model	watt	Model	watt	Model	watt	Model	watt	Model	watt	Model	watt
Freezer	PMKF12	160	192	280	FR10G	191	VF75N VF75L	194 194	D77C 18RA X5	168	ESC8.5 ESC8.5 K	186 186	GL80AA	197	BP1118Z	204
Freezer	PMKF7	131	157	180	TLS7F FR7.5G	162 145	NR62L	155	D66-C15R-AX5	151	ESC7 ESC7K	147 147	GL70AA	165	BP1116Z	158
REFRIGERATOR	PMKR12	70	83	280			NR45L	108	S43-C10K-AX0	95	ESC5	101	GL40AA	78	BP1048Z22	108
Ref. Freezer	PMKRF17	218	262	428	SC12G	259			D91C-21RA-X5	227			GL99AA	248		

Selected Compressor Test Condirtion: ASHRAE Standard
Ambient Temperature +43°C
Evaporating Temperature - 23.3°C
Condenseing Temperature + 54.4°C
Suction Temperature +32°C
Sub-Cooling Temperaturer +32°C

*** Copmressor Cooling Capacity Requrement = 1.2 Product Cooling Capacity (for maximum 20 hours compressor operating time per day)**

PRODUCT SPECIFICATION TABLE

Company Pars Monir	Product Type REF. FRE	Product Model PMKRF17

DIMENSION

Height mm 1980	Width mm 540	Depth mm 690
Evap. Height mm 350	Evap. Width mm 445	Evap. Depth mm 590
Gasket Thickness mm 20	Ref. Wall Thickness mm 30	Freezer Wall Thickness mm 55

Refrigerator Internal Volume Lit. 334	Freezer or Evap. Internal Volume Lit. 91

REFRIGERATION SYSTEM

Condenser Tube Length mm 13300	Evaporator Tube Length mm 1800	Evaporator Surface Sq. mm 528000	Capillary Tube Length mm 3000
Condenser Tube Outer Dim. mm 6	Condenser Tube Inner Dim. mm 5	Number of on Wire Condenser Tube 24	Capillary Tube Inner Dim. mm 0.31
Max. Evap. Air Temp. -18	Evap. Tube Length mm —	Ref. System Internal Volume Lit. —	Refrigerant Weight gr. 200

General Specification

Insulation Thermal Conductivity Factor W/M.°K 0.018	Insulation Material Mixture (Polyol+R11)+Isosynide (100+12)+100	Insulation Type POLYURETHN	Gasket Type P.V.C

Compressor Type & Model(s) ZANUSSI / EB8101A	Compressor Cooling Capacity (watt) 210	Compressor Input Power(Watt) 225
Voltage 220 V	Ampere 1.2 A	Frq. 50 Hz

PRODUCT SPECIFICATION TABLE

Company pars monark	Product Type FRE	Product Model PMKF12

DIMENSION

Height mm 1450	Width mm 550	Depth mm 630
Evap. Height mm 141.5	Evap. Width mm 47.5	Evap. Depth mm 141.5
Gasket Thickness mm 15	Ref. Wall Thickness mm —	Freezer Wall Thickness mm 50

Refrigerator Internal Volume Lit. —	Freezer or Evap. Internal Volume Lit. 280

REFRIGERATION SYSTEM

Condenser Tube Length mm 13380	Evaporator Tube Length mm 2000	Evaporator Surface Sq. mm 1340x480	Capillary Tube Length mm 3300
Condenser Tube Outer Dim. mm 6	Condenser Tube Inner Dim. mm 5	Number of on Wire Condenser Tube 24	Capillary Tube Inner Dim. mm 0.36
Max. Evap. Air Temp. -18	Evap. Tube Length mm —	Ref. System Internal Volume Lit. 0.7	Refrigerant Weight gr. 250

General Specification

Insulation Thermal Conductivity Factor W/M °K 0.018	Insulation Material Mixture (Polyol+R11)+ Isosynide (100+12)+100	Insulation Type POLYURETHAN	Gasket Type P.V.C

Compressor Type & Model(s) ZANUSSI	Compressor Cooling Capacity (watt) 140	Compressor Input Power(Watt) 152
Voltage 220	Ampere 1.2	Frq. 50HZ

PRODUCT SPECIFICATION TABLE

Company Pars Monark	Product Type FRE.	Product Model PMKF Z

DIMENSION

Height mm 980	Width mm 500	Depth mm 630
Evap. Height mm —	Evap. Width mm 500	Evap. Depth mm 1030
Gasket Thickness mm 15	Ref. Wall Thickness mm 30	Freezer Wall Thickness mm 60

Refrigerator Internal Volume Lit. —	Freezer or Evap. Internal Volume Lit. 180

REFRIGERATION SYSTEM

Condenser Tube Length mm 18000	Evaporator Tube Length mm 1800	Evaporator Surface Sq. mm 515000	Capillary Tube Length mm 3500
Condenser Tube Outer Dim. mm 6	Condenser Tube Inner Dim. mm 5	Number of on Wire Condenser Tube 6	Capillary Tube Inner Dim. mm 0.36
Max. Evap. Air Temp. -18	Evap. Tube Length mm —	Ref. System Internal Volume Lit. —	Refrigerant Weight gr. 200

General Specification

Insulation Thermal Conductivity Factor W/M °K 0.018	Insulation Material Mixture (Polyol-R11)+ Isosynide (100+12)+100	Insulation Type POLYURETHAN	Gasket Type P.V.C

Compressor Type & Model(s) ZANUSSI	Compressor Cooling Capacity (watt) 72	Compressor Input Power(Watt) 95
Voltage 220 V	Ampere 1.2 A	Frq. 50 HZ

PRODUCT SPECIFICATION TABLE

Company Pars [illegible]	Product Type 2SF.	Product Model PMKR12

DIMENSION

Height mm 1440	Width mm 630	Depth mm 550
Evap. Height mm 170	Evap. Width mm 280	Evap. Depth mm 49.5
Gasket Thickness mm 20	Ref. Wall Thickness mm 30	Freezer Wall Thickness mm 30

Refrigerator Internal Volume Lit. 245	Freezer or Evap. Internal Volume Lit. 35

REFRIGERATION SYSTEM

Condenser Tube Length mm 1000	Evaporator Tube Length mm 2000	Evaporator Surface Sq. mm	Capillary Tube Length mm 3300
Condenser Tube Outer Dim. mm 6	Condenser Tube Inner Dim. mm 5	Number of on Wire Condenser Tube 16	Capillary Tube Inner Dim. mm 0.31
Max. Evap. Air Temp. -12	Evap. Tube Length mm —	Ref. System Internal Volume Lit. —	Refrigerant Weight gr. 200

General Specification

Insulation Thermal Conductivity Factor W/M°K 0.018	Insulation Material Mixture (Polyol+R11)+Isosynide (100+12)+100	Insulation Type POLYURETHANE	Gasket Type P.V.C

Compressor Type & Model(s) ZANUSSI	Compressor Cooling Capacity (watt) 159	Compressor Input Power(Watt) 180
Voltage 220 V	Ampere 1.2	Frq. 50 HZ

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Fariz Iran

Upright Refrigerator Model FIR 11

a) Transmission load calculation

Table XIV
Dimensions

Refrigerator Compartment	Dimension Cm.	Area (sq. mt.)	Insulation Thickness	Tempreture Difference
Side Walls	2x(120.6x48.5)	1.17	30	39
Back Panel	143 x 55	0.78	30	39
Bottom Floor	55 x 48.5	0.267	30	39
Door	143 x 55	0.78	30	39
Freezer Compartment	**Dimension Cm.**	**Area (sq. mt.)**	**Insulation Thickness**	**Tempreture Difference**
Side Walls	2x(22.4 x48.5)	0.21	30	55
Top Roof	55 x 48.5	0.267	30	55

Insulation Type: Pu Foam

Thermal Conductivity for Foam: 0.0195 W/ mt. C
Thermal Conductivity for Air at -12 at 1 atm. =0.02367 W mt. C

Temperature Difference Refrigerator Compartment: (ΔT) = 43 - (−4) = 39 C
Ambient Temperature = 43 C
Freezer Air Temperature = - 12 C
Refrigerator Air Temperature = −4 C

Calculation :
Heat Leak For Refrigerator Compartment.

$$Q_{TL} = Q_{SW} + Q_{BP} + Q_{BOTTOM} + Q_{DOOR}$$

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$$Q = U A (T_a - T_r)$$

$$U = \frac{1}{X_1 / K_1 + X_2 / K_2 + \ldots\ldots}$$

Where :

U = Heat Resistance Coefficient Factor

K_1 = Foam Thermal Conductivity

K_2 = Air Thermal Condutivity

X_1 = Foam Thickness

Therefore:

1- $Q_{SideWalls} = [U A (T_a - T_r)]$

T_a = Ambient Temperature
T_r = refrigerator air Temperature

U = 1/(0.030 /0.0195) = 0.65 W/ sq.m C

A = 1.17 Sq. Mt.
T_a = 43 C
T_f = + 4 C

$Q_{SideWalls}$ = 0.65 x 1.17 x 39 = 29.66 Watts

$Q_{SideWalls}$ = 29.66 Watts

2 - $Q_{\text{Back panel}} = [\,U A (T_a - T_r)\,]$

T_a = Ambient Temperature
T_r = Refrigerator air Temperature

$U = 1/(0.030 \;/ 0.0195) = 0.65$ W/ sq.m C
$A = 0.78$ Sq. Mt.
$T_a = 43$ C
$T_r = - 4$ C

$Q_{\text{Back panel}} = 0.65 \times 0.78 \times 39 = 20$ Watts

$Q_{\text{Back panel}} = 20$ Watts

3- $Q_{\text{Door}} = [\,U A (T_a - T_r)\,]$

T_a = Ambient Temperature
T_r = Refrigerator air Temperature

$U = 1/(0.030 \;/ 0.0195) = 0.65$ W/ sq.m C
$A = 0.78$ Sq. Mt.
$T_a = 43$ C
$T_r = - 4$ C

$Q_{\text{Door}} = 0.65 \times 0.78 \times 39 = 20$ Watts

$Q_{\text{Door}} = 20$ Watts

4 - $Q_{\text{Bottom}} = [\,U A (T_a - T_r)\,]$

T_a = Ambient Temperature
T_r = Refrigeratorr air Temperature

$U = 1/(0.030 \;/ 0.0195) = 0.65$ W/ sq.m C
$A = 0.267$ Sq. Mt.

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T_a = 43 C
T_r = - 4 C

Q_{Bottom} = 0.65 x 0.267 x 39 = 6.76 Watts

Q_{Bottom} = 6.76 Watts

Heat Leak Calculation for Freezer Compartment

1 - Q_{Top} = [U A (T_a - T_f)]

T_a = Ambient Temperature
T_f = Freezer air Temperature

U = 1 / [(0.030/0.0195)+(0.020/0.02367)] = 0.42 W/ sq.m C
A = 0.267 Sq. Mt.
T_a = 43 C
T_f = - 12 C

Q_{Top} = 0.42 x 0.267 x 55 = 6.16 Watts

Q_{Top} = 6.16 Watts

2 - $Q_{Side\ walls}$ = [U A (T_a - T_f)]

T_a = Ambient Temperature
T_f = Freezer air Temperature

U = 1 / [(0.030/0.0195)+(0.035/0.02367)] = 0.42 W/ sq.m C
A = 0.21 Sq. Mt.
T_a = 43 C
T_f = - 12 C

$Q_{Side\ walls}$ = 0.42 x 0.21 x 55 = 4.85 Watts

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$$Q_{\text{Side walls}} = 4.85 \text{ Watts}$$

Total Freezer Compartment Heat Leak = 6.16 − 4.85= 11

Total Refrigerator Compartment Heat Leak = 29.66 + 20 + 6.76 + 20 = 76.42W

Total Heat Leaks:

$$Q_{TL} = Q_{\text{freezer compament}} + Q_{\text{refregerator compartment}} = 11 + 76.42 = 87.42 \text{ watts}$$

$$Q_{\text{Total Heat Leaks}} = 87.42 \text{ Watts}$$

b) Product Loads:

Through our knowledge, experience and facts and figures of calculation of more than eight models of Azmayesh products and some Lorestan products we found out that calculation of product loads for each individual model depends upon many factors that we could mention briefly as follows:

- Product design;
- Product style;
- Company policy;
- Useful internal volume;
- Type of evaporator;
- Type of cellar compartment;
- Freezer volume;
- Culture of customer;
- Country of origin and etc.;

Therefore considering 40% to 65% of total heat leaks for total product load depending on size of model and internal volume of the product could be reasonable and practical to calculate. With respect to this fact we calculate our product load as follows:

$$Q_{\text{Product}} = (40\% \text{ to } 65\%) \text{ of } Q_{\text{Total Heat Leaks}}$$

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Product load calculation for Fariz Iran Refrigerator Model is FIR 11:

Product load = 87.42 x 0.6 = 52 Watts

c) Heat gain through infiltration;

Total heat gain through infiltration (door opening, and gasket) are considered to 20 % of total heat gain by conduction and heat removed from products, therefore;

Heat gain by infiltration = 0.2 x (total heat leaks + product loads)

Heat gain by infiltration = 0.2 x (87.42 + 52.45) = 28 Watts

Total Cooling Capacity Required for Model FIR 11 are calculated as follows:

$$Q_{\text{Grand Total}} = Q_{\text{Heat Leaks}} + Q_{\text{Product Loads}} + Q_{\text{infiltration}}$$

$$Q_{\text{Grand Total}} = 87.42 + 52.45 + 28 = 168 \text{ Watts}$$

$Q_{\text{Grand Total}} = 168$ Watts

Heat Load Calculation
Fariz Iran

Upright Freezer Model FIF 13

a) Transmission load calculation

Table VII
Dimensions

	Dimension Cm.	Area (sq. mt.)	Insulation Thickness
Side Walls	2 x (147x51.5)	1.79	50
Back Panel	162 x 51	0.8264	50
Top Roof	51 x 51.5	0.262	50
Bottom Floor	51 x 51.5	0.262	50
Door	147 x 51	0.75	50

Insulation Type: Pu Foam

CP. Foam Thermal Conductivity: 0.0195 W /mt.C

Temperature Difference: $(\Delta T) = 43 - (-18) = 61$ C
Ambient Temperature = 43 C
Freezer Air Temperature = - 18 C

Calculation :

$$Q_{TL} = Q_{SW} + Q_{BP} + Q_{BOTTOM} + Q_{TOP} + Q_{DOOR}$$

$$Q = U A (T_a - T_f)$$

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$$U = \frac{1}{X_1 / K_1 + X_2 / K_2 + \ldots\ldots}$$

Where :

U = Heat Resistance Coefficient Factor

K_1 = Foam Thermal Conductivity

X_1 = Foam Thickness

Therefore:

1- $Q_{SideWalls} = [\,U A (T_a - T_f)\,]$

T_a = Ambient Temperature
T_f = Freezer air Temperature

U = 1/(0.050 /0.0195) = 0.39 W/ sq.m C
A = 1.79 Sq. Mt.
T_a = 43 C
T_f = - 18 C

$Q_{SideWalls}$ = 0.39 x 1.79 x 61 = 42.58 Watts

$Q_{SideWalls}$ = 42.58 Watts

2 - $Q_{Back\ panel} = [\,U A (T_a - T_f)\,]$

T_a = Ambient Temperature
T_f = Freezer air Temperature

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$U = 1/(0.050\ /0.0195) = 0.39$ W/ sq.m C
$A = 0.826$ Sq. Mt.
$T_a = 43$ C
$T_f = -18$ C

$Q_{\text{Back panel}} = 0.39 \times 0.826 \times 61 = 19.65$ Watts

$Q_{\text{Back panel}} = 19.65$ Watts

3 - $Q_{\text{Top}} = [\,U A (T_a - T_f)\,]$

T_a = Ambient Temperature
T_f = Freezer air Temperature

$U = 1/(0.050\ /0.0195) = 0.39$ W/ sq.m C
$A = 0.262$ Sq. Mt.
$T_a = 43$ C
$T_f = -18$ C

$Q_{\text{Top}} = 0.39 \times 0.262 \times 61 = 6.23$ Watts

$Q_{\text{Top}} = 6.23$ Watts

4 - $Q_{\text{Bottom}} = [\,U A (T_a - T_f)\,]$

T_a = Ambient Temperature
[illegible]

$U = 1/(0.050\ /0.0195) = 0.39$ W/ sq.m C
$A = 0.262$ Sq. Mt.
$T_a = 43$ C
$T_f = -18$ C

$Q_{\text{Bottom}} = 0.39 \times 0.262 \times 61 = 6.23$ Watts

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$$Q_{Bottom} = 6.23 \text{ Watts}$$

5 - $Q_{Door} = [\,U\,A\,(T_a - T_f)\,]$

T_a = Ambient Temperature
T_f = Freezer air Temperature

$U = 1/(0.050\ /0.0195) = 0.39$ W/ sq.m C
$A = 0.75$ Sq. Mt.
$T_a = 43$ C
$T_f = -18$ C

$Q_{Door} = 0.39 \times 0.75 \times 61 = 17.84$ Watts

$$Q_{Door} = 17.84 \text{ Watts}$$

Total Heat Leaks;

$Q_{TL} = 42.58 + 19.65 + 6.23 + 6.23 + 17.84 = 94$ watts

$$Q_{\text{Total Heat Leaks}} = 93 \text{ Watts}$$

b) Product Loads;

Through our knowledge, experience and facts and figures of calculation of more than eight models of Azmayesh products and some Lorestan products we found out that calculation of product loads for each individual model depends upon many factors that we could mention briefly as follows:

- Product design;
- Product style;

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- Company policy;
- Useful internal volume;
- Type of evaporator;
- Type of cellar compartment;
- Freezer volume;
- Culture of customer;
- Country of origin and etc.;

Therefore considering 40% to 65% of total heat leaks for total product load depending on size of model and internal volume of the product could be reasonable and practical to calculate. With respect to this fact we calculate our product load as follows;

$$Q_{\text{Product}} = (\,40\% \text{ to } 65\%\,) \text{ of } Q_{\text{Total Heat Leaks}}$$

Product load calculation for Fariz Iran Freezer Model FIF 13 is;

Product load = 93 x 0.40 = 37 Watts

c) Heat gain through infiltration;

Total heat gain through infiltration (door opening, and gasket) are considered to 20 % of total heat gain by conduction and heat removed from products, therefore;

Heat gain by infiltration = 0.2 x (total heat leaks + product loads)

Heat gain by infiltration = 0.2 x (93 + 37) = 26 Watts

Total Cooling Capacity Required for Model FIF 13 are calculated as follows;

$$Q_{\text{Grand Total}} = Q_{\text{Heat Leaks}} + Q_{\text{Product Loads}} + Q_{\text{infiltration}}$$

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$$Q_{\text{Grand Total}} = 93 - 37 + 26 = 158 \text{ Watts}$$

$$\boxed{Q_{\text{Grand Total}} = 156 \text{ Watts}}$$

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Fariz Iran

Upright Refrigerator Model FIR 13

a) Transmission load calculation

Table IIX
Dimensions

Refrigerator Compartment	Dimension Cm.	Area (sq. mt.)	Insulation Thickness	Tempreture Difference
Side Walls	2 x (132.6x53)	1.40	35	39
Back Panel	172 x 54	0.929	35	39
Bottom Floor	54 x 53	0.286	35	39
Door	150 x 54	0.81	35	39
Freezer Compartment	Dimension Cm.	Area (sq. mt.)	Insulation Thickness	Tempreture Difference
Side Walls	2x(19 x52)	0.198	3.5	55
Top Roof	50 x 54	0.27	3.5	55

Insulation Type: Pu Foam

Thermal Conductivity for Foam: 0.0195 W/ mt. C
Thermal Conductivity for Air at -12 at 1 atm. =0.02367 W/mt. C

Temperature Difference Refrigerator Compartment: (ΔT) = 43 - (+4) = 39 C
Ambient Temperature = 43 C
Freezer Air Temperature = - 12 C

Calculation :

Heat Leak For Refrigerator Compartment.

$$Q_{TL} = Q_{SW} + Q_{BP} + Q_{BOTTOM} + {}_{DOOR}$$

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Total Freezer Compartment Heat Leak = 5.62 + 3.76= 9.38

Total Refrigerator Compartment Heat Leak = 30.4 + 20.1 + 6.21 + 17.59 = 74.3 W

Total Heat Leaks;

$$Q_{TL} = Q_{\text{freezer compatment}} + Q_{\text{refregerator compartment}} = 9.38 + 74.3 = 83.68 \text{ watts}$$

$$\boxed{Q_{\text{Total Heat Leaks}} = 83.68 \text{ Watts}}$$

b) Product Loads;

Through our knowledge, experience and facts and figures of calculation of more than eight models of Azmayesh products and some Lorestan products we found out that calculation of product loads for each individual model depends upon many factors that we could mention briefly as follows:

- Product design;
- Product style;
- Company policy;
- Useful internal volume;
- Type of evaporator;
- Type of cellar compartment;
- Freezer volume;
- Culture of customer;
- Country of origin and etc.;

Therefore considering 40% to 65% of total heat leaks for total product load depending on size of model and internal volume of the product could be reasonable and practical to calculate. With respect to this fact we calculate our product load as follows;

$$Q_{\text{Product}} = (\ 40\% \text{ to } 65\%\ ) \text{ of } Q_{\text{Total Heat Leaks}}$$

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$$Q = U\,A\,(T_a - T_r)$$

$$U = \frac{1}{X_1 / K_1 + X_2 / K_2 + \ldots\ldots}$$

Where :

U = Heat Resistance Coefficient Factor

K_1 = Foam Thermal Conductivity

K_2 = Air Thermal Condutivity

X_1 = Foam Thickness

Therefore:

1- $Q_{SideWalls} = [\,U\,A\,(T_a - T_r)\,]$

T_a = Ambient Temperature

T_r = refrigerator air Temperature

$U = 1/(0.035\ /0.0195) = 0.557$ W/ sq.m C

$A = 1.40$ Sq. Mt.

$T_f = + 4$ C

$Q_{SideWalls} = 0.557 \times 1.40 \times 39 = 30.42$ Watts

$$Q_{SideWalls} = 30.42 \text{ Watts}$$

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2 - $Q_{Back\ panel} = [U A (T_a - T_r)]$

T_a = Ambient Temperature
T_r = Refrigerator air Temperature

U = 1/(0.035 /0.0195) = 0.557 W/ sq.m C
A = 0.929 Sq. Mt.
T_a = 43 C
T_r = + 4 C

$Q_{Back\ panel}$ = 0.557 x 0.929 x 39 = 20.1 Watts

$Q_{Back\ panel}$ = 20.1 Watts

3- $Q_{Door} = [U A (T_a - T_r)]$

T_a = Ambient Temperature
T_r = Refrigerator air Temperature

U = 1/(0.035 /0.0195) = 0.557 W/ sq.m C
A = 0.81 Sq. Mt.
T_a = 43 C
T_r = + 4 C

Q_{Door} = 0.557 x 0.81 x 39 = 17.59 Watts

Q_{Door} = 17.59 Watts

4 - $Q_{Bottom} = [U A (T_a - T_r)]$

T_a = Ambient Temperature
T_r = Refrigeratorr air Temperature

U = 1/(0.035 /0.0195) = 0.557 W/ sq.m C
A = 0.286 Sq. Mt.
T_a = 43 C

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$T_r = + 4$ C

$Q_{Bottom} = 0.557 \times 0.286 \times 39 = 6.21$ Watts

$Q_{Bottom} = 6.21$ Watts

Heat Leak Calculation for Freezer Compartment

1 - $Q_{Top} = [\, U A (T_a - T_f) \,]$

T_a = Ambient Temperature
T_f = Freezer air Temperature

U = 1 / [(0.035./0.0195)+(0.020/0.02367)] = 0.378 W/ sq.m C
A = 0.27 Sq. Mt.
$T_a = 43$ C
$T_f = - 12$ C

$Q_{Top} = 0.378 \times 0.27 \times 55 = 5.62$ Watts

$Q_{Top} = 5.62$ Watts

2 - $Q_{Side\ walls} = [\, U A (T_a - T_f) \,]$

T_a = Ambient Temperature
T_f = Freezer air Temperature

U = 1 / [(0.055/0.0195)+(0.035/0.02367)] = 0.378 W/ sq.m C
A = 0.181 Sq. Mt.
$T_a = 43$ C
$T_f = - 12$ C

$Q_{Side\ walls} = 0.378 \times 0.181 \times 55 = 5.08$ Watts

$Q_{Side\ walls} = 3.76$ Watts

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Product load calculation for Fariz Iran Refrigerator Model is FIR 13:

Product load = 83.68 x 0.6 = 50.21 Watts

c) Heat gain through infiltration;

Total heat gain through infiltration (door opening, and gasket) are considered to 20 % of total heat gain by conduction and heat removed from products, therefore;

Heat gain by infiltration = 0.2 x (total heat leaks + product loads)

Heat gain by infiltration = 0.2 x (83.68 + 50.21) = 20.78 Watts

Total Cooling Capacity Required for Model FIR 13 are calculated as follows:

$$Q_{\text{Grand Total}} = Q_{\text{Heat Leaks}} + Q_{\text{Product Loads}} + Q_{\text{infiltration}}$$

$$Q_{\text{Grand Total}} = 83.68 + 50.21 + 26.78 = 161 \text{ Watts}$$

$$\boxed{Q_{\text{Grand Total}} = 161 \text{ Watts}}$$

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Gadook

Upright Refrigerator & Freezer Model RF - 350

a) Transmission load calculation

Table X
Dimensions

Refrigerator Compartment	Dimension Cm.	Area (sq. mt.)	Insulation Thickness	Tempreture Difference
Side Walls	2 x (127x 615)	1.562	35	39
Back Panel	142 x 53	0.75	35	39
Bottom Floor	53 x 61.5	0.326	35	39
Door	127 x 53	0.673	35	39
Freezer Compartment	Dimension Cm.	Area (sq. mt.)	Insulation Thickness	Tempreture Difference
Side Walls	2x(35x40)	0.28	50	61
Back Panel	35x50	0.175	50	61
Top Roof	50 x 40	0.2	50	61
Door	35 x 50	0.175	50	61

Insulation Type: Pu Foam

Thermal Conductivity for Foam: 0.0195 W/ mt. C

Temperature Difference Refrigerator Compartment: (ΔT) = 43 - (+4) = 39 C
Ambient Temperature = 43 C
Freezer Air Temperature = - 18 C
Refrigerator Air Temperature = +4 C

Calculation :

Heat Leak For Refrigerator Compartment.

$$Q_{TL} = Q_{SW} + Q_{BP} + Q_{BOTTOM + DOOR}$$

$$Q = U A (T_a - T_r)$$

$$U = \frac{1}{X_1 / K_1 + X_2 / K_2 + \dots\dots}$$

Where :

U = Heat Resistance Coefficient Factor

K_1 = Foam Thermal Conductivity

X_1 = Foam Thickness

Therefore:

1- $Q_{SideWalls} = [U A (T_a - T_r)]$

T_a = Ambient Temperature
T_r = refrigerator air Temperature

$U = 1/(0.035 / 0.0195) = 0.557$ W/ sq.m C
$A = 1.562$ Sq. Mt.
$T_a = 43$ C
$T_r = + 4$ C

$Q_{SideWalls} = 0.557 \times 1.562 \times 39 = 33.93$ Watts

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$Q_{SideWalls} = 33.93$ Watts

2 - $Q_{Back\ panel} = [\,U A (T_a - T_r)\,]$

T_a = Ambient Temperature
T_r = Refrigerator air Temperature

$U = 1/(0.035\ /0.0195) = 0.557$ W/ sq.m C
$A = 0.75$ Sq. Mt.
$T_a = 43$ C
$T_r = +4$ C

$Q_{Back\ panel} = 0.557 \times 0.75 \times 39 = 16.29$ Watts

$Q_{Back\ panel} = 16.29$ Watts

3- $Q_{Door} = [\,U A (T_a - T_r)\,]$

T_a = Ambient Temperature
T_r = Refrigerator air Temperature

$U = 1/(0.035\ /0.0195) = 0.557$ W/ sq.m C
$A = 0.673$ Sq. Mt.
$T_a = 43$ C
$T_r = +4$ C

$Q_{Door} = 0.557 \times 0.673 \times 39 = 14.61$ Watts

$Q_{Door} = 14.61$ Watts

4 - $Q_{Bottom} = [\,U A (T_a - T_r)\,]$

T_a = Ambient Temperature
T_r = Refrigeratorr air Temperature

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$U = 1/(0.035\ /0.0195) = 0.557$ W/ sq.m C
$A = 0.326$ Sq. Mt.
$T_a = 43$ C
$T_r = +4$ C

$Q_{Bottom} = 0.326 \times 0.326 \times 39 = 7.08$ Watts

$Q_{Bottom} = 7.08$ Watts

Heat Leak Calculation for Freezer Compartment

1 - $Q_{Top} = [U A (T_a - T_f)]$

T_a = Ambient Temperature
T_f = Freezer air Temperature

$U = 1 / (0.050/0.0195) = 0.39$ W/ sq.m C
$A = 0.2$ Sq. Mt.
$T_a = 43$ C
$T_f = -18$ C

$Q_{Top} = 0.39 \times 0.2 \times 61 = 4.76$ Watts

$Q_{Top} = 4.76$ Watts

2 - $Q_{Side\ walls} = [U A (T_a - T_f)]$

T_a = Ambient Temperature
T_f = Freezer air Temperature

$U = 1 / (0.050/0.0195) = 0.39$ W/ sq.m C
$A = 0.28$ Sq. Mt.
$T_a = 43$ C
$T_f = -18$ C

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$Q_{\text{Side walls}}$ = 0.39 x 0.28 x 61 = 6.66 Watts

$Q_{\text{Side walls}}$ = 6.66 Watts

3 - $Q_{\text{Back panel}} = [\, U A (T_a - T_f) \,]$

T_a = Ambient Temperature
T_f = Freezer air Temperature
U = 1/(0.050 /0.0195) = 0.39 W/ sq.m C
A = 0.175 Sq. Mt.
T_a = 43 C
T_f = - 18 C

$Q_{\text{Back panel}}$ = 0.39 x 0.175 x 61 = 4.16 Watts

$Q_{\text{Back panel}}$ = 4.16 Watts

4 - $Q_{\text{Door}} = [\, U A (T_a - T_r) \,]$

T_a = Ambient Temperature
T_f = Freezer air Temperature

U = 1/(0.050 /0.0195) = 0.39 W/ sq.m C
A = 0.175 Sq. Mt.
T_a = 43 C
T_f = - 18 C

Q_{Door} = 0.39 x 0.175 x 61 = 4.76 Watts

Q_{Door} =4.16 Watts

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Total Refrigerator Compartment Heat Leak = 33.93 + 16.29 + 7.08+14.61 = 71.37

Total Freezer Compartment Heat Leak = 6.66 + 4.16 + 4.76 + 4.16 = 19.74 W

Total Heat Leaks;

$$Q_{TL} = Q_{\text{freezer compatment}} + Q_{\text{refrigerator compartment}} = 19.74 + 71.37 = 91.1 \text{ watts}$$

$$Q_{\text{Total Heat Leaks}} = 91.1 \text{ Watts}$$

b) Product Loads:

Through our knowledge, experience and facts and figures of calculation of more than eight models of Azmayesh products and some Lorestan products we found out that calculation of product loads for each individual model depends upon many factors that we could mention briefly as follows:

- Product design;
- Product style;
- Company policy;
- Useful internal volume;
- Type of evaporator;
- Type of cellar compartment;
- Freezer volume;
- Culture of customer;
- Country of origin and etc.;

Therefore considering 40% to 65% of total heat leaks for total product load depending on size of model and internal volume of the product could be reasonable and practical to calculate. With respect to this fact we calculate our product load as follows;

$$Q_{\text{Product}} = (\ 40\% \text{ to } 65\%\ ) \text{ of } Q_{\text{Total Heat Leaks}}$$

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Product load calculation for Gadook Refrigerator Freezer Model RF-350 is:

Product load = 91.1 x 0.60 = 54.66 Watts

c) Heat gain through infiltration:

Total heat gain through infiltration (door opening, and gasket) are considered to 20 % of total heat gain by conduction and heat removed from products, therefore;

Heat gain by infiltration = 0.2 x (total heat leaks + product loads)

Heat gain by infiltration = 0.2 x (91.1 + 54.66) = 29.15 Watts

Total Cooling Capacity Required for Model RF-350 are calculated as follows;

$$Q_{\text{Grand Total}} = Q_{\text{Heat Leaks}} + Q_{\text{Product Loads}} + Q_{\text{Infiltration}}$$

$$Q_{\text{Grand Total}} = 91.1 + 54.66 + 29.15 = 174.9 \text{ Watts}$$

$$\boxed{Q_{\text{Grand Total}} = 175 \text{ Watts}}$$

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Gadook

Upright Refrigerator Model R- 280

a) Transmission load calculation

Table XI
Dimensions

Refrigerator Compartment	Dimension Cm.	Area (sq. mt.)	Insulation Thickness	Tempreture Difference
Side Walls	2 x (131x59.5)	1.56	55	39
Back Panel	180 x 49	0.882	55	39
Bottom Floor	49 x 59.5	0.29	55	39
Door	165 x 49	0.808	55	39
Freezer Compartment	**Dimension Cm.**	**Area (sq. mt.)**	**Insulation Thickness**	**Tempreture Difference**
Side Walls	2x(23x30)	0.138	55	55
Top Roof	44x30	0.132	55	55

Insulation Type: Pu Foam

Thermal Conductivity for Foam: 0.0195 W/ mt. C
Thermal Conductivity for Air at -12 at 1 atm. =0.02367 W/mt. C

Temperature Difference Refrigerator Compartment: $(\Delta T) = 43 - (+4) = 39$ C
Ambient Temperature = 43 C
Freezer Air Temperature = - 12 C
Refrigerator Air Temperature = +4 C

Calculation :

Heat Leak For Refrigerator Compartment.

$$Q_{TL} = Q_{SW} + Q_{BP} + Q_{BOTTOM} + {}_{DOOR}$$

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$$Q = U A (T_a - T_r)$$

$$U = \frac{1}{X_1 / K_1 + X_2 / K_2 + \ldots\ldots}$$

Where :

U = Heat Resistance Coefficient Factor

K_1 = Foam Thermal Conductivity

K2 = Air Thermal Condutivity

X_1 = Foam Thickness

Therefore:

1- $Q_{SideWalls} = [U A (T_a - T_r)]$

T_a = Ambient Temperature
T_r = refrigerator air Temperature

U = 1/(0.055 /0.0195) = 0.354545 W/ sq.m C
A = 1.56 Sq. Mt.
T_a = 43 C
T_f = + 4 C

$Q_{SideWalls}$ = 0.354545 x 1.56 x 39 = 21.57 Watts

$Q_{SideWalls}$ = 21.57Watts

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2 - $Q_{Back\ panel} = [\, U\, A\, (T_a - T_r)\,]$

T_a = Ambient Temperature

T_r = Refrigerator air Temperature

$U = 1/(0.055\ /0.0195\ ) = 0.3545$ W/ sq.m C

A = 0.882 Sq. Mt.

T_a = 43 C

T_r = + 4 C

$Q_{Back\ panel} = 0.3545 \times 0.882 \times 39 = 12.2$ Watts

$Q_{Back\ panel}$ = 12.2 Watts

3- $Q_{Door} = [\, U\, A\, (T_a - T_r)\,]$

T_a = Ambient Temperature

T_r = Refrigerator air Temperature

$U = 1/(0.055\ /0.0195\ ) = 0.3545$ W/ sq.m C

A = 0.808 Sq. Mt.

T_a = 43 C

T_r = + 4 C

$Q_{Door} = 0.3545 \times 0.808 \times 39 = 11.7$Watts

Q_{Door} = 11.7 Watts

4 - $Q_{Bottom} = [\, U\, A\, (T_a - T_r)\,]$

T_a = Ambient Temperature

T_r = Refrigeratorr air Temperature

$U = 1/(0.055\ /0.0195\ ) = 0.3545$ W/ sq.m C

A = 0.29 Sq. Mt.

T_a = 43 C

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$T_r = -4$ C

$Q_{Bottom} = 0.3545 \times 0.29 \times 39 = 4$ Watts

$Q_{Bottom} = 4$ Watts

Heat Leak Calculation for Freezer Compartment

1 - $Q_{Top} = [\, U A (T_a - T_f) \,]$

T_a = Ambient Temperature
T_f = Freezer air Temperature

$U = 1 / [(0.055/0.0195)+(0.020/0.02367)] = 0.2727$ W/ sq.m C
$A = 0.132$ Sq. Mt.
$T_a = 43$ C
$T_f = - 12$ C

$Q_{Top} = 0.2727 \times 0.132 \times 55 = 1.98$ Watts

$Q_{Top} = 1.98$ Watts

2 - $Q_{Side\ walls} = [\, U A (T_a - T_f) \,]$

T_a = Ambient Temperature
T_f = Freezer air Temperature

$U = 1 / [(0.055/0.0195)+(0.035/0.02367)] = 0.2326$ W/ sq.m C
$A = 0.138$ Sq. Mt.
$T_a = 43$ C
$T_f = - 12$ C

$Q_{Side\ walls} = 0.2326 \times 0.138 \times 55 = 1.76$ Watts

$Q_{Side\ walls} = 3.33$ Watts

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Total Freezer Compartment Heat Leak = 1.76 – 1.98 = 3.74

Total Refrigerator Compartment Heat Leak = 21.57 – 12.2 – 4 – 11.7 = 49.5 W

Total Heat Leaks;

$$Q_{TL} = Q_{\text{freezer compatment}} + Q_{\text{refregerator compartment}} = 3.74 + 49.5 = 53.2 \text{ watts}$$

$$\boxed{Q_{\text{Total Heat Leaks}} = 53.2 \text{ Watts}}$$

b) Product Loads:

Through our knowledge, experience and facts and figures of calculation of more than eight models of Azmayesh products and some Lorestan products we found out that calculation of product loads for each individual model depends upon many factors that we could mention briefly as follows:

- Product design;
- Product style;
- Company policy;
- Useful internal volume;
- Type of evaporator;
- Type of cellar compartment;
- Freezer volume;
- Culture of customer;
- Country of origin and etc.;

Therefore considering 40% to 65% of total heat leaks for total product load depending on size of model and internal volume of the product could be reasonable and practical to calculate. With respect to this fact we calculate our product load as follows;

$$Q_{\text{Product}} = (40\% \text{ to } 65\%) \text{ of } Q_{\text{Total Heat Leaks}}$$

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Product load calculation for Gadook Refrigerator Model R-280 is:

Product load = 53.2 x 0.40 = 21.3 Watts

c) Heat gain through infiltration;

Total heat gain through infiltration (door opening, and gasket) are considered to 20 % of total heat gain by conduction and heat removed from products, therefore:

Heat gain by infiltration = 0.2 x (total heat leaks + product loads)

Heat gain by infiltration = 0.2 x (53.2 + 21.3) = 14.9 Watts

Total Cooling Capacity Required for Model R-280 are calculated as follows:

$$Q_{\text{Grand Total}} = Q_{\text{Heat Leaks}} + Q_{\text{Product Loads}} + Q_{\text{infiltration}}$$

$$Q_{\text{Grand Total}} = 53.2 + 21.3 + 14.9 = 89.4 \text{ Watts}$$

$$Q_{\text{Grand Total}} = 89.4 \text{ Watts}$$

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Heat Load Calculation

Gadook

Upright Freezer Model FU280

a) Transmission load calculation

Table XIII
Dimensions

	Dimension Cm.	Area (sq. mt.)	Insulation Thickness
Side Walls	2 x (154x59.5)	1.83	55
Back Panel	154 x 49	0.75	55
Top Roof	49 x 59.5	0.3	55
Bottom Floor	49 x 59.5	0.3	55
Door	154 x 49	0.75	55

Insulation Type: Pu Foam

CP. Foam Thermal Conductivity: 0.0195 W/mt.C

Temperature Difference: $(\Delta T) = 43 - (-18) = 61$ C
Ambient Temperature = 43 C
Freezer Air Temperature = - 18 C

Calculation :

$$Q_{TL} = Q_{SW} + Q_{BP} + Q_{BOTTOM} + Q_{TOP} + Q_{DOOR}$$

$$Q = U A (T_a - T_f)$$

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$$U = \frac{1}{X_1 / K_1 + X_2 / K_2 + \ldots\ldots}$$

Where :

U = Heat Resistance Coefficient Factor

K_1 = Foam Thermal Conductivity

X_1 = Foam Thickness

Therefore:

1- $Q_{SideWalls} = [\, U A (T_a - T_f) \,]$

T_a = Ambient Temperature
T_f = Freezer air Temperature

U = 1/(0.055 /0.0195) = 0.3545 W/ sq.m C
A = 1.83 Sq. Mt.
T_a = 43 C
T_f = - 18 C

$Q_{SideWalls}$ = 0.3545 x 1.83 x 61 = 39.57 Watts

$Q_{SideWalls}$ = 39.57 Watts

2 - $Q_{Back\ panel} = [\, U A (T_a - T_f) \,]$

T_a = Ambient Temperature
T_f = Freezer air Temperature

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$U = 1/(0.055 / 0.0195) = 0.3545$ W/ sq.m C
A = 0.75 Sq. Mt.
$T_a = 43$ C
$T_f = - 18$ C

$Q_{Back\ panel} = 0.3545 \times 0.75 \times 61 = 16.2$ Watts

$Q_{Back\ panel} = 16.2$ Watts

3 - $Q_{Top} = [U A (T_a - T_f)]$

T_a = Ambient Temperature
T_f = Freezer air Temperature

$U = 1/(0.055 / 0.0195) = 0.3545$ W/ sq.m C
A = 0.3 Sq. Mt.
$T_a = 43$ C
$T_f = - 18$ C

$Q_{Top} = 0.3545 \times 0.3 \times 61 = 6.5$ Watts

$Q_{Top} = 6.5$ Watts

4 - $Q_{Bottom} = [U A (T_a - T_f)]$

T_a = Ambient Temperature
T_f = Freezer air Temperature

$U = 1/(0.055 / 0.0195) = 0.3545$ W/ sq.m C
A = 0.3 Sq. Mt.
$T_a = 43$ C
$T_f = - 18$ C

$Q_{Bottom} = 0.3 \times 0.3545 \times 61 = 6.49$ Watts

Q_{Bottom} = 6.49 Watts

5 - $Q_{Door} = [U A (T_a - T_f)]$

T_a = Ambient Temperature
T_f = Freezer air Temperature

U = 1/(0.055 /0.0195) = 0.3545 W/ sq.m C
A = 0.75 Sq. Mt.
T_a = 43 C
T_f = - 18 C

Q_{Door} = 0.3545 x 0.75 x 61 = 16.22 Watts

Q_{Door} = 16.22 Watts

Total Heat Leaks;

Q_{TL} = 39.57 + 16.2 +6.49 + 6.5 + 16.22 = 86.5 watts

$Q_{Total\ Heat\ Leaks}$ = 85 Watts

b) Product Loads:

Through our knowledge, experience and facts and figures of calculation of more than eight models of Azmayesh products and some Lorestan products we found out that calculation of product loads for each individual model depends upon many factors that we could mention briefly as follows:

- Product design;
- Product style;
- Company policy;

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- Useful internal volume:
- Type of evaporator;
- Type of cellar compartment;
- Freezer volume:
- Culture of customer;
- Country of origin and etc.;

Therefore considering 40% to 65% of total heat leaks for total product load depending on size of model and internal volume of the product could be reasonable and practical to calculate. With respect to this fact we calculate our product load as follows;

$$Q_{Product} = (\ 40\% \text{ to } 65\%\ ) \text{ of } Q_{Total\ Heat\ Leaks}$$

Product load calculation for Gadook Model FU 280 is;

Product load = 85 x 0.40 = 34 Watts

c) Heat gain through infiltration;

Total heat gain through infiltration (door opening, and gasket) are considered to 20 % of total heat gain by conduction and heat removed from products, therefore;

Heat gain by infiltration = 0.2 x (total heat leaks + product loads)

Heat gain by infiltration = 0.2 x (85 + 34) = 24 Watts

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Total Cooling Capacity Required for Model FU280 are calculated as follows:

$$Q_{\text{Grand Total}} = Q_{\text{Heat Leaks}} + Q_{\text{Product Loads}} + Q_{\text{Infiltration}}$$

$$Q_{\text{Grand Total}} = 85 + 34 + 24 = 148 \text{ Watts}$$

$$\boxed{Q_{\text{Grand Total}} = 143 \text{ Watts}}$$

Section IV

Refrigeration Load Calculation

Lorestan

Upright Freezer Model UFM 13

a) Transmission load calculation

Table I
Dimensions

	Dimension Cm.	Area (sq. mt.)	Insulation Thickness
Side Walls	2 x (137x60.3)	1.65	55
Back Panel	137 x 68.2	0.934	65
Top Roof	68.2 x 68.3	0.41	55
Bottom Floor	68.2 x 64.2	0.438	60
Door	138 x 68	0.938	47

Insulation Type: Pu Foam

CP. Foam Thermal Conductivity: 0.0195 W /mt.C

Temperature Difference: (ΔT) = 43 - (-18) = 61 C
Ambient Temperature = 43 C
Freezer Air Temperature = - 18 C

Calculation :

$$Q_{TL} = Q_{SW} + Q_{BP} + Q_{BOTTOM} + Q_{TOP} + Q_{DOOR}$$

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$Q_{TL} = Q_{SW} + Q_{BP} + Q_{BOTTOM} + Q_{TOP} + Q_{DOOR}$

$$Q = U A (T_a - T_f)$$

$$U = \frac{1}{X_1 / K_1 + X_2 / K_2 + \ldots\ldots}$$

Where :

U = Heat Resistance Coefficient Factor

K_1 = Foam Thermal Conductivity

X_1 = Foam Thickness

Therefore:

1- $Q_{SideWalls} = [U A (T_a - T_f)]$

T_a = Ambient Temperature
T_f = Freezer air Temperature

U = 1/(0.055 /0.0195) = 0.354545 W/ sq.m . C
A = 1.65 Sq. Mt.
T_a = 43 C
T_f = - 18 C

$Q_{SideWalls}$ = 0.354545 x 1.65 x 61 = 35.68 Watts

$Q_{SideWalls}$ = 35.68 Watts

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2 - $Q_{Back\ panel} = [U A (T_a - T_f)]$

T_a = Ambient Temperature
T_f = Freezer air Temperature

U = 1/(0.065 /0.0195) = 0.3 W/ sq.m ı C
A = 0.934 Sq. Mt.
T_a = 43 C
T_f = - 18 C

$Q_{Back\ panel}$ = 0.3 x 0.934 x 61 = 17.09 Watts

$Q_{Back\ panel}$ = 17.09 Watts

3 - $Q_{Top} = [U A (T_a - T_f)]$

T_a = Ambient Temperature
T_f = Freezer air Temperature

U = 1/(0.055 /0.0195) = 0.354545 W/ sq.m C
A = 0.41 Sq. Mt.
T_a = 43 C
T_f = - 18 C

Q_{Top} = 0.354545 x 0.41 x 61 = 8.87 Watts

Q_{Top} = 8.87 Watts

4 - $Q_{Bottom} = [U A (T_a - T_f)]$

T_a = Ambient Temperature
T_f = Freezer air Temperature

U = 1/(0.060 /0.0195) = 0.325 W/ sq.m C
A = 0.438 Sq. Mt.

$T_a = 43$ C
$T_f = - 18$ C

$Q_{Bottom} = 0.325 \times 0.438 \times 61 = 8.68$ Watts

$Q_{Bottom} = 8.68$ Watts

5 - $Q_{Door} = [\, U A (T_a - T_f) \,]$

T_a = Ambient Temperature
T_f = Freezer air Temperature

U = 1/(0.047 /0.0195) = 0.4148 W/ sq.m C
A = 0.41 Sq. Mt.
$T_a = 43$ C
$T_f = - 18$ C

$Q_{Door} = 0.4148 \times 0.938 \times 61 = 23.74$ Watts

$Q_{Door} = 23.74$ Watts

Total Heat Leaks;

$Q_{TL} = 35.68 + 17.09 + 8.87 + 8.68 \div 23.73 = 94$ watts

$Q_{\text{Total Heat Leaks}} = 94$ Watts

b) Product Loads;

Through our knowledge, experience and facts and figures of calculation of more than eight models of Azmayesh products and some Lorestan products we found out that calculation of product loads for each individual model depends upon many factors that we could mention briefly as follows:

- Product design;
- Product style;
- Company policy;
- Useful internal volume;
- Type of evaporator;
- Type of cellar compartment;
- Freezer volume;
- Culture of customer;
- Country of origin and etc.;

Therefore considering 40% to 65% of total heat leaks for total product load depending on size of model and internal volume of the product could be reasonable and practical to calculate. With respect to this fact we calculate our product load as follows;

$$Q_{\text{Product}} = (\ 40\% \text{ to } 65\%\ ) \text{ of } Q_{\text{Total Heat Leaks}}$$

Product load calculation for Lorestan Freezer Model is;

Product load = 94 x 0.40 = 37.6 Watts

c) Heat gain through infiltration;

Total heat gain through infiltration (door opening, and gasket) are considered to 20 % of total heat gain by conduction and heat removed from products, therefore;

Heat gain by infiltration = 0.2 x (total heat leaks + product loads)

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Heat gain by infiltration = 0.2 x (94 + 37.6) = 26.4 Watts

Total Cooling Capacity Required for Model UFM 13 are calculated as follows;

$$Q_{\text{Grand Total}} = Q_{\text{Heat Leaks}} + Q_{\text{Product Loads}} + Q_{\text{infiltration}}$$

$$Q_{\text{Grand Total}} = 94 + 37.6 + 26.4 = 158 \text{ Watts}$$

$$Q_{\text{Grand Total}} = 158 \text{ Watts}$$

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Lorestan

Upright Refrigerator Model ROM 13

a) Transmission load calculation

Table II
Dimensions

Refrigerator Compartment	Dimension Cm.	Area (sq. mt.)	Insulation Thickness	Tempreture Difference
Side Walls	2 x (104x60.3)	1.254	55	39
Back Panel	137 x 68.2	0.934	65	39
Bottom Floor	68.2 x 64.2	0.438	60	39
Door	138 x 68	0.938	47	39
Freezer Compartment	**Dimension Cm.**	**Area (sq. mt.)**	**Insulation Thickness**	**Tempreture Difference**
Side Walls	2x(33x60.3)	0.397	55	55
Top Roof	68.2x60.3	0.41	55	55

Insulation Type: Pu Foam

Thermal Conductivity for Foam: 0.0195 W/ mt. C
Thermal Conductivity for Air at -12 at 1 atm. =0.02367 W/mt. C

Temperature Difference Refrigerator Compartment: (ΔT) = 43 - (+4) = 39 C
Ambient Temperature = 43 C
Freezer Air Temperature = - 12 C
Refrigerator Air Temperature = +4 C

Calculation :

Heat Leak For Refrigerator Compartment.

$$Q_{TL} = Q_{SW} + Q_{BP} + Q_{BOTTOM} + {}_{DOOR}$$

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$$Q = U A (T_a - T_r)$$

$$U = \frac{1}{X_1 / K_1 + X_2 / K_2 + \ldots\ldots}$$

Where :

U = Heat Resistance Coefficient Factor

K_1 = Foam Thermal Conductivity

K2 = Air Thermal Condutivity

X_1 = Foam Thickness

Therefore:

1- $Q_{SideWalls} = [U A (T_a - T_r)]$

T_a = Ambient Temperature
T_r = refrigerator air Temperature

$U = 1/(0.055 \ /0.0195) = 0.354545$ W/ sq.m C

$A = 1.254$ Sq. Mt.
$T_a = 43$ C
$T_f = +4$ C

$Q_{SideWalls} = 0.354545 \times 1.254 \times 39 = 17.33$ Watts

$Q_{SideWalls} = 17.33$ Watts

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2 - $Q_{Back\ panel} = [\ U\ A\ (\ T_a - T_r\ )\ ]$

T_a = Ambient Temperature
T_r = Refrigerator air Temperature

$U = 1/(\ 0.065\ /0.0195\ ) = 0.3$ W/ sq.m C
$A = 0.934$ Sq. Mt.
$T_a = 43$ C
$T_r = +4$ C

$Q_{Back\ panel} = 0.3 \times 0.934 \times 39 = 10.92$ Watts

$Q_{Back\ panel} = 10.92$ Watts

3- $Q_{Door} = [\ U\ A\ (\ T_a - T_r\ )\ ]$

T_a = Ambient Temperature
T_r = Refrigerator air Temperature

$U = 1/(\ 0.047\ /0.0195\ ) = 0.4148$ W/ sq.m C
$A = 0.938$ Sq. Mt.
$T_a = 43$ C
$T_r = +4$ C

$Q_{Door} = 0.4148 \times 0.938 \times 39 = 15.2$ Watts

$Q_{Door} = 15.2$ Watts

4 - $Q_{Bottom} = [\ U\ A\ (\ T_a - T_r\ )\ ]$

T_a = Ambient Temperature
T_r = Refrigeratorr air Temperature

$U = 1/(\ 0.060\ /0.0195\ ) = 0.325$ W/ sq.m C
$A = 0.438$ Sq. Mt.
$T_a = 43$ C

$T_r = +4$ C

$Q_{Bottom} = 0.325 \times 0.438 \times 39 = 5.55$ Watts

$Q_{Bottom} = 5.55$ Watts

Heat Leak Calculation for Freezer Compartment

1 - $Q_{Top} = [\, U\, A\, (T_a - T_f)\,]$

T_a = Ambient Temperature
T_f = Freezer air Temperature

$U = 1 / [(0.055/0.0195) + (0.020/0.02367)] = 0.2727$ W/ sq.m C
A = 0.41 Sq. Mt.
$T_a = 43$ C
$T_f = -12$ C

$Q_{Top} = 0.2727 \times 0.41 \times 55 = 6.15$ Watts

$Q_{Top} = 6.15$ Watts

2 - $Q_{Side\ walls} = [\, U\, A\, (T_a - T_f)\,]$

T_a = Ambient Temperature
T_f = Freezer air Temperature

$U = 1 / [(0.055/0.0195) + (0.035/0.02367)] = 0.2326$ W/ sq.m C
A = 0.397 Sq. Mt.
$T_a = 43$ C
$T_f = -12$ C

$Q_{Side\ walls} = 0.2326 \times 0.397 \times 55 = 5.08$ Watts

$Q_{Side\ walls} = 5.08$ Watts

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Total Freezer Compartment Heat Leak = 6.15 + 5.08 = 11.22

Total Refrigerator Compartment Heat Leak = 17.33 +10.92 +5.55 + 15.2 = 49 W

Total Heat Leaks;

$$Q_{TL} = Q_{freezer\ compatment} + Q_{refregerator\ compartment} = 11.22 + 49 = 60.22 \text{ watts}$$

$$\boxed{Q_{\text{Total Heat Leaks}} = 60.22 \text{ Watts}}$$

b) Product Loads:

Through our knowledge, experience and facts and figures of calculation of more than eight models of Azmayesh products and some Lorestan products we found out that calculation of product loads for each individual model depends upon many factors that we could mention briefly as follows:

- Product design;
- Product style;
- Company policy;
- Useful internal volume;
- Type of evaporator;
- Type of cellar compartment;
- Freezer volume;
- Culture of customer;
- Country of origin and etc.;

Therefore considering 40% to 65% of total heat leaks for total product load depending on size of model and internal volume of the product could be reasonable and practical to calculate. With respect to this fact we calculate our product load as follows;

$$Q_{\text{Product}} = (\,40\% \text{ to } 65\%\,) \text{ of } Q_{\text{Total Heat Leaks}}$$

Product load calculation for Lorestan Refrigerator Model is ROM 13;

Product load = 60.22 x 0.66 = 39.74 Watts

c) Heat gain through infiltration;

Total heat gain through infiltration (door opening, and gasket) are considered to 20 % of total heat gain by conduction and heat removed from products, therefore;

Heat gain by infiltration = 0.2 x (total heat leaks + product loads)

Heat gain by infiltration = 0.2 x (60.22 + 39.74) = 20 Watts

Total Cooling Capacity Required for Model ROM 13 are calculated as follows;

$$Q_{\text{Grand Total}} = Q_{\text{Heat Leaks}} + Q_{\text{Product Loads}} + Q_{\text{infiltration}}$$

$$Q_{\text{Grand Total}} = 60.22 + 39.74 + 20 = 120 \text{ Watts}$$

$$Q_{\text{Grand Total}} = 120 \text{ Watts}$$

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Lorestan

Upright Refrigerator & Freezer Model RAT 12

a) Transmission load calculation

Table III
Dimensions

Refrigerator Compartment	Dimension Cm.	Area (sq. mt.)	Insulation Thickness	Tempreture Difference
Side Walls	2 x (99.5x60.3)	1.19	55	39
Back Panel	99.5 x 68.2	0.67	65	39
Bottom Floor	68.2 x 64.2	0.44	60	39
Door	96 x 68	0.65	47	39
Freezer Compartment	**Dimension Cm.**	**Area (sq. mt.)**	**Insulation Thickness**	**Tempreture Difference**
Side Walls	2x(37.5x60.3)	0.45	55	61
Back Panel	37.5x68.2	0.26	65	61
Top Roof	68.2x60.3	0.41	55	61
Door	39.5x68	0.27	47	61

Insulation Type: Pu Foam

Thermal Conductivity for Foam: 0.0195 W/ mt. C

Temperature Difference Refrigerator Compartment: (ΔT) = 43 - (+4) = 39 C
Ambient Temperature = 43 C
Freezer Air Temperature = - 18 C
Refrigerator Air Temperature = +4 C

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Calculation :

Heat Leak For Refrigerator Compartment.

$$Q_{TL} = Q_{SW} + Q_{BP} + Q_{BOTTOM} + _{DOOR}$$

$$Q = U A (T_a - T_r)$$

$$U = \frac{1}{X_1 / K_1 + X_2 / K_2 + \ldots\ldots}$$

Where :

U = Heat Resistance Coefficient Factor

K_1 = Foam Thermal Conductivity

X_1 = Foam Thickness

Therefore:

1- $Q_{SideWalls} = [U A (T_a - T_r)]$

T_a = Ambient Temperature
T_r = refrigerator air Temperature

U = 1/(0.055 /0.0195) = 0.354545 W/ sq.m C
A = 1.19 Sq. Mt.
T_a = 43 C
T_r = + 4 C

$Q_{SideWalls}$ = 0.354545 x 1.19 x 39 = 16.45 Watts

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$Q_{SideWalls}$ = 17.33 Watts

2 - $Q_{Back\ panel} = [\,U A\,(T_a - T_r)\,]$

T_a = Ambient Temperature
T_r = Refrigerator air Temperature

$U = 1/(0.065\ /0.0195) = 0.3$ W/ sq.m C
$A = 0.67$ Sq. Mt.
$T_a = 43$ C
$T_r = +4$ C

$Q_{Back\ panel} = 0.3 \times 0.67 \times 39 = 7.84$ Watts

$Q_{Back\ panel}$ = 7.84 Watts

3- $Q_{Door} = [\,U A\,(T_a - T_r)\,]$

T_a = Ambient Temperature
T_r = Refrigerator air Temperature

$U = 1/(0.047\ /0.0195) = 0.4148$ W/ sq.m C
$A = 0.65$ Sq. Mt.
$T_a = 43$ C
$T_r = +4$ C

$Q_{Door} = 0.4148 \times 0.65 \times 39 = 10.5$ Watts

Q_{Door} = 15.2 Watts

4 - $Q_{Bottom} = [\,U A\,(T_a - T_r)\,]$

T_a = Ambient Temperature
T_r = Refrigeratorr air Temperature

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$U = 1/(0.060 \ /0.0195) = 0.325$ W/ sq.m C
A = 0.44 Sq. Mt.
$T_a = 43$ C
$T_r = + 4$ C

$Q_{Bottom} = 0.325 \times 0.44 \times 39 = 5.57$ Watts

$Q_{Bottom} = 5.55$ Watts

Heat Leak Calculation for Freezer Compartment

1 - $Q_{Top} = [U A (T_a - T_f)]$

T_a = Ambient Temperature
T_f = Freezer air Temperature

$U = 1 / (0.055/0.0195) = 0.3545$ W/ sq.m C
A = 0.41 Sq. Mt.
$T_a = 43$ C
$T_f = - 18$ C

$Q_{Top} = 0.3545 \times 0.41 \times 61 = 8.87$ Watts

$Q_{Top} = 6.15$ Watts

2 - $Q_{Side\ walls} = [U A (T_a - T_f)]$

T_a = Ambient Temperature
T_f = Freezer air Temperature

$U = 1 / (0.055/0.0195) = 0.3545$ W/ sq.m C
A = 0.45 Sq. Mt.
$T_a = 43$ C
$T_f = - 18$ C

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$Q_{\text{Side walls}}$ = 0.3545 x 0.45 x 61 = 9.73 Watts

$Q_{\text{Side walls}}$ = 9.73 Watts

3 - $Q_{\text{Back panel}} = [\, U A (T_a - T_f) \,]$

T_a = Ambient Temperature
T_f = Freezer air Temperature
U = 1/(0.065 /0.0195) = 0.3 W/ sq.m C
A = 0.26 Sq. Mt.
T_a = 43 C
T_f = - 18 C

$Q_{\text{Back panel}}$ = 0.3 x 0.26 x 61 = 4.76 Watts

$Q_{\text{Back panel}}$ = 4.76 Watts

4 - $Q_{\text{Door}} = [\, U A (T_a - T_r) \,]$

T_a = Ambient Temperature
T_f = Freezer air Temperature

U = 1/(0.047 /0.0195) = 0.4148 W/ sq.m C
A = 0.27 Sq. Mt.
T_a = 43 C
T_f = - 18 C

Q_{Door} = 0.4148 x 0.27 x 61 = 10.5 Watts

Q_{Door} = 15.2 Watts

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Total Refrigerator Compartment Heat Leak = 17.33 + 7.84 + 5.57 +10.5 = 41.24

Total Freezer Compartment Heat Leak = 9.73 + 4.76 + 8.87 + 6.83 = 30.19 W

Total Heat Leaks;

$$Q_{TL} = Q_{\text{freezer compatment}} + Q_{\text{refrigerator compartment}} = 30.19 + 41.24 = 71.43 \text{ watts}$$

$$\boxed{Q_{\text{Total Heat Leaks}} = 71.43 \text{ Watts}}$$

b) Product Loads;

Through our knowledge, experience and facts and figures of calculation of more than eight models of Azmayesh products and some Lorestan products we found out that calculation of product loads for each individual model depends upon many factors that we could mention briefly as follows:

- Product design;
- Product style;
- Company policy;
- Useful internal volume;
- Type of evaporator;
- Type of cellar compartment;
- Freezer volume;
- Culture of customer;
- Country of origin and etc.;

Therefore considering 40% to 65% of total heat leaks for total product load depending on size of model and internal volume of the product could be reasonable and practical to calculate. With respect to this fact we calculate our product load as follows;

$$Q_{\text{Product}} = (\ 40\% \text{ to } 65\%\ ) \text{ of } Q_{\text{Total Heat Leaks}}$$

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Product load calculation for Lorestan Refrigerator Freezer Model RTA 12is;

Product load = 71.33 x 0.60 = 42.8 Watts

c) Heat gain through infiltration;

Total heat gain through infiltration (door opening, and gasket) are considered to 20 % of total heat gain by conduction and heat removed from products. therefore;

Heat gain by infiltration = 0.2 x (total heat leaks + product loads)

Heat gain by infiltration = 0.2 x (71.33 + 42.8) = 22.83 Watts

Total Cooling Capacity Required for Model RTA 12 are calculated as follows;

$$Q_{\text{Grand Total}} = Q_{\text{Heat Leaks}} + Q_{\text{Product Loads}} + Q_{\text{Infiltration}}$$

$$Q_{\text{Grand Total}} = 71.33 + 42.8 + 22.83 = 137 \text{ Watts}$$

$$Q_{\text{Grand Total}} = 137 \text{ Watts}$$

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Lorestan

Upright Freezer Model UFM 10

a) Transmission load calculation

Table IV
Dimensions

	Dimension Cm.	Area (sq. mt.)	Insulation Thickness
Side Walls	2 x (107x60.3)	1.29	55
Back Panels	95 x 68.2	0.6479	65
Top Roof	68.2 x 60.3	0.4112	55
Bottom Floor	68.2 x 64.2	0.438	60
Door	138 x 68	0.938	47

Insulation Type: Pu Foam

Thermal Conductivity: 0.0195 W mt./Sq. Mt. C

Temperature Difference: (ΔT) = 43 - (-18) = 61 C
Ambient Temperature = 43 C
Freezer Air Temperature = - 18 C

Calculation :

$$Q_{TL} = Q_{SW} + Q_{BP} + Q_{BOTTOM} + Q_{TOP} + Q_{DOOR}$$

$$Q = U A (T_a - T_f)$$

$$U = \frac{1}{X_1 / K_1 + X_2 / K_2 + \ldots\ldots}$$

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$Q_{Back\ panel} = 11.86$ Watts

3 - $Q_{Top} = [\,U A (T_a - T_f)\,]$

T_a = Ambient Temperature
T_f = Freezer air Temperature

$U = 1/(0.055\ /0.0195) = 0.354545$ W/ sq.m C
A = 0.41 Sq. Mt.
T_a = 43 C
T_f = - 18 C

$Q_{Top} = 0.354545 \times 0.41 \times 61 = 8.87$ Watts

$Q_{Top} = 8.87$ Watts

4 - $Q_{Bottom} = [\,U A (T_a - T_f)\,]$

T_a = Ambient Temperature
T_f = Freezer air Temperature

$U = 1/(0.060\ /0.0195) = 0.325$ W/ sq.m C
A = 0.438 Sq. Mt.
T_a = 43 C
T_f = - 18 C

$Q_{Bottom} = 0.325 \times 0.438 \times 61 = 8.68$ Watts

$Q_{Bottom} = 8.68$ Watts

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5 - $Q_{Door} = [U A (T_a - T_f)]$

T_a = Ambient Temperature
T_f = Freezer air Temperature

U = 1/(0.047 /0.0195) = 0.4148 W/ sq.m C
A = 0.7344Sq. Mt.
T_a = 43 C
T_f = - 18 C

Q_{Door} = 0.4148 x 0.7344 x 61 = 18.58 Watts

Q_{Door} = 18.58 Watts

Total Heat Leaks;

Q_{TL} = 27.89 + 11.86 + 8.87 + 8.68 + 18.58 = 75.88 watts

$Q_{Total\ Heat\ Leaks}$ = 76 Watts

b) Product Loads;

Through our knowledge, experience and facts and figures of calculation of more than eight models of Azmayesh products and some Lorestan products we found out that calculation of product loads for each individual model depends upon many factors that we could mention briefly as follows:

- Product design;
- Product style;
- Company policy;
- Useful internal volume;
- Type of evaporator;
- Type of cellar compartment;

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- Freezer volume;
- Culture of customer;
- Country of origin and etc.;

Therefore considering 40% to 65% of total heat leaks for total product load depending on size of model and internal volume of the product could be reasonable and practical to calculate. With respect to this fact we calculate our product load as follows;

$$Q_{Product} = (40\% \text{ to } 65\%) \text{ of } Q_{Total\ Heat\ Leaks}$$

Product load calculation for Lorestan Freezer Model UFM 10 is;

Product load = 76 x 0.40 = 30 Watts

c) Heat gain through infiltration;

Total heat gain through infiltration (door opening, and gasket) are considered to 20 % of total heat gain by conduction and heat removed from products, therefore;

Heat gain by infiltration = 0.2 x (total heat leaks + product loads)

Heat gain by infiltration = 0.2 x (76 + 30) = 21.3Watts

Total Cooling Capacity Required for Model UFM 10 are calculated as follows;

$$Q_{Grand\ Total} = Q_{Heat\ Leaks} + Q_{Product\ Loads} + Q_{Infiltration}$$

$$Q_{Grand\ Total} = 76 + 30 + 21.3 = 127.3 \text{ Watts}$$

$Q_{Grand\ Total} = 127$ Watts

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Lorestan

Upright Refrigerator Model ROM 10

a) Transmission load calculation

Table V
Dimensions

Refrigerator Compartment	Dimension Cm.	Area (sq. mt.)	Insulation Thickness	Tempreture Difference
Side Walls	2 x (86x60.3)	1.037	55	39
Back Panel	95 x 68.2	0.648	65	39
Bottom Floor	68.2 x 64.2	0.438	60	39
Door	108 x 68	0.7344	47	39
Freezer Compartment	**Dimension Cm.**	**Area (sq. mt.)**	**Insulation Thickness**	**Tempreture Difference**
Side Walls	2x(21x60.3)	0.2532	55	55
Top Roof	68.2x60.3	0.41	55	55

Insulation Type: Pu Foam

Thermal Conductivity for Foam: 0.0195 W/ mt. C
Thermal Conductivity for Air at -12 at 1 atm. =0.02367 W/mt. C

Temperature Difference Refrigerator Compartment: (ΔT) = 43 - (+4) = 39 C
Ambient Temperature = 43 C
Freezer Air Temperature = - 12 C
Refrigerator Air Temperature = +4 C

Calculation :

Heat Leak For Refrigerator Compartment.

$$Q_{TL} = Q_{SW} + Q_{BP} + Q_{BOTTOM} + _{DOOR}$$

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$$Q = U A (T_a - T_r)$$

$$U = \frac{1}{X_1 / K_1 + X_2 / K_2 + \ldots\ldots\ldots}$$

Where :

U = Heat Resistance Coefficient Factor

K_1 = Foam Thermal Conductivity

K2 = Air Thermal Condutivity

X_1 = Foam Thickness

Therefore:

1- $Q_{SideWalls} = [U A (T_a - T_r)]$

T_a = Ambient Temperature
T_r = refrigerator air Temperature

U = 1/(0.055 /0.0195) = 0.354545 W/ sq.m C
A = 1.037 Sq. Mt.
T_a = 43 C
T_r = + 4 C

$Q_{SideWalls}$ = 0.354545 x 1.037 x 39 = 14.33 Watts

$$Q_{SideWalls} = 14.33 \text{ Watts}$$

2 - $Q_{Back\ panel} = [U A (T_a - T_r)]$

T_a = Ambient Temperature
T_r = Refrigerator air Temperature

U = 1/(0.065 / 0.0195) = 0.3 W/ sq.m C
A = 0.648 Sq. Mt.
T_a = 43 C
T_r = + 4 C

$Q_{Back\ panel}$ = 0.3 x 0.648 x 39 = 7.6 Watts

$Q_{Back\ panel}$ = 7.6 Watts

3- $Q_{Door} = [U A (T_a - T_r)]$

T_a = Ambient Temperature
T_r = Refrigerator air Temperature

U = 1/(0.047 / 0.0195) = 0.4148 W/ sq.m C
A = 0.7344 Sq. Mt.
T_a = 43 C
T_r = + 4 C

Q_{Door} = 0.4148 x 0.7344 x 39 = 11.9Watts

Q_{Door} = 11.9 Watts

4 - $Q_{Bottom} = [U A (T_a - T_r)]$

T_a = Ambient Temperature
T_r = Refrigeratorr air Temperature

U = 1/(0.060 / 0.0195) = 0.325 W sq.m C
A = 0.438 Sq. Mt.
T_a = 43 C

$T_r = + 4$ C

$Q_{Bottom} = 0.325 \times 0.438 \times 39 = 5.55$ Watts

$Q_{Bottom} = 5.55$ Watts

Heat Leak Calculation for Freezer Compartment

1 - $Q_{Top} = [\, U\, A\, (T_a - T_f)\,]$

T_a = Ambient Temperature
T_f = Freezer air Temperature

$U = 1 / [(0.055/0.0195) + (0.020/0.02367)] = 0.2727$ W/ sq.m C
A = 0.41 Sq. Mt.
T_a = 43 C
T_f = - 12 C

$Q_{Top} = 0.2727 \times 0.41 \times 55 = 6.15$ Watts

$Q_{Top} = 6.15$ Watts

2 - $Q_{Side\ walls} = [\, U\, A\, (T_a - T_f)\,]$

T_a = Ambient Temperature
T_f = Freezer air Temperature

$U = 1 / [(0.055/0.0195) + (0.035/0.02367)] = 0.2326$ W/ sq.m C
A = 0.2532 Sq. Mt.
T_a = 43 C
T_f = - 12 C

$Q_{Side\ walls} = 0.2326 \times 0.2532 \times 55 = 3.33$ Watts

$Q_{Side\ walls} = 3.33$ Watts

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Total Freezer Compartment Heat Leak = 6.15 + 3.33 = 9.48

Total Refrigerator Compartment Heat Leak = 14.33 + 7.6 + 5.55 + 11.9 = 39.4 W

Total Heat Leaks;

$$Q_{TL} = Q_{\text{freezer compament}} + Q_{\text{refregerator compartment}} = 11.22 + 39.4 = 50.62 \text{ watts}$$

$$\boxed{Q_{\text{Total Heat Leaks}} = 40.62 \text{ Watts}}$$

b) Product Loads:

Through our knowledge, experience and facts and figures of calculation of more than eight models of Azmayesh products and some Lorestan products we found out that calculation of product loads for each individual model depends upon many factors that we could mention briefly as follows:

- Product design;
- Product style;
- Company policy;
- Useful internal volume;
- Type of evaporator;
- Type of cellar compartment;
- Freezer volume:
- Culture of customer:
- Country of origin and etc.;

Therefore considering 40% to 65% of total heat leaks for total product load depending on size of model and internal volume of the product could be reasonable and practical to calculate. With respect to this fact we calculate our product load as follows;

$$Q_{\text{Product}} = (40\% \text{ to } 65\%) \text{ of } Q_{\text{Total Heat Leaks}}$$

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Product load calculation for Lorestan Refrigerator Model ROM 10 is;

Product load = 40.62 x 0.60 = 24.8 Watts

c) Heat gain through infiltration;

Total heat gain through infiltration (door opening, and gasket) are considered to 20 % of total heat gain by conduction and heat removed from products, therefore;

Heat gain by infiltration = 0.2 x (total heat leaks + product loads)

Heat gain by infiltration = 0.2 x (40.62 + 24.8) = 13.1 Watts

Total Cooling Capacity Required for Model ROM 10 are calculated as follows;

$$Q_{\text{Grand Total}} = Q_{\text{Heat Leaks}} + Q_{\text{Product Loads}} + Q_{\text{Infiltration}}$$

$$Q_{\text{Grand Total}} = 40.62 + 24.8 + 13.1 = 78.52 \text{ Watts}$$

$$\boxed{Q_{\text{Grand Total}} = 79 \text{ Watts}}$$

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Lorestan

Upright Refrigerator Model ROM 14

a) Transmission load calculation

Table VI
Dimensions

Refrigerator Compartment	Dimension Cm.	Area (sq. mt.)	Insulation Thickness	Tempreture Difference
Side Walls	2 x (104x60.3)	1.254	45	39
Back Panel	125 x 68.2	0.8525	55	39
Bottom Floor	68.2 x 64.2	0.438	60	39
Door	138 x 68	0.938	47	39
Freezer Compartment	**Dimension Cm.**	**Area (sq. mt.)**	**Insulation Thickness**	**Tempreture Difference**
Side Walls	2x(33x60.3)	0.397	45	55
Top Roof	68.2x60.3	0.41	55	55

Insulation Type: Pu Foam

Thermal Conductivity for Foam: 0.0195 W/ mt. C
Thermal Conductivity for Air at -12 at 1 atm. =0.02367 W/mt. C

Temperature Difference Refrigerator Compartment: $(\Delta T) = 43 - (+4) = 39$ C
Ambient Temperature = 43 C
Freezer Air Temperature = - 12 C
Refrigerator Air Temperature = +4 C

Calculation :

Heat Leak For Refrigerator Compartment.

$$Q_{TL} = Q_{SW} + Q_{BP} + Q_{BOTTOM} + _{DOOR}$$

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$$Q = U A (T_a - T_r)$$

$$U = \frac{1}{X_1 / K_1 + X_2 / K_2 + \ldots\ldots}$$

Where :

U = Heat Resistance Coefficient Factor

K_1 = Foam Thermal Conductivity

K2 = Air Thermal Condutivity

X_1 = Foam Thickness

Therefore:

1- $Q_{SideWalls} = [\, U A (T_a - T_r) \,]$

T_a = Ambient Temperature
T_r = refrigerator air Temperature

U = 1/(0.045 /0.0195) = 0.433 W/ sq.m C
A = 1.254 Sq. Mt.
T_a = 43 C
[illegible]

$Q_{SideWalls}$ = 0.433 x 1.254 x 39 = 21.17 Watts

$Q_{SideWalls}$ = 21.17 Watts

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2 - $Q_{Back\ panel} = [U A (T_a - T_r)]$

T_a = Ambient Temperature
T_r = Refrigerator air Temperature

U = 1/(0.055 /0.0195) = 0.3545 W/ sq.m C
A = 0.8525 Sq. Mt.
T_a = 43 C
T_r = + 4 C

$Q_{Back\ panel}$ = 0.3545 x 0.8525 x 39 = 11.79 Watts

$Q_{Back\ panel}$ = 11.79 Watts

3- $Q_{Door} = [U A (T_a - T_r)]$

T_a = Ambient Temperature
T_r = Refrigerator air Temperature

U = 1/(0.047 /0.0195) = 0.4148 W/ sq.m C
A = 0.938 Sq. Mt.
T_a = 43 C
T_r = + 4 C

Q_{Door} = 0.4148 x 0.938 x 39 = 15.2 Watts

Q_{Door} = 15.2 Watts

4 - $Q_{Bottom} = [U A (T_a - T_r)]$

T_a = Ambient Temperature
T_r = Refrigeratorr air Temperature

U = 1/(0.060 /0.0195) = 0.325 W/ sq.m C
A = 0.438 Sq. Mt.
T_a = 43 C

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$T_r = + 4$ C

$Q_{Bottom} = 0.325 \times 0.438 \times 39 = 5.55$ Watts

$Q_{Bottom} = 5.55$ Watts

Heat Leak Calculation for Freezer Compartment

1 - $Q_{Top} = [\, U A (T_a - T_f) \,]$

T_a = Ambient Temperature
T_f = Freezer air Temperature

U = 1 / [(0.055/0.0195)+(0.020/0.02367)] = 0.2727 W/ sq.m C
A = 0.41 Sq. Mt.
$T_a = 43$ C
$T_f = - 12$ C

$Q_{Top} = 0.2727 \times 0.41 \times 55 = 6.15$ Watts

$Q_{Top} = 6.15$ Watts

2 - $Q_{Side\ walls} = [\, U A (T_a - T_f) \,]$

T_a = Ambient Temperature
T_f = Freezer air Temperature

U = 1 / [(0.045/0.0195)+(0.035/0.02367)] = 0.2641 W/ sq.m C
A = 0.398 Sq. Mt.
[illegible]
$T_f = - 12$ C

$Q_{Side\ walls} = 0.26416 \times 0.398 \times 55 = 5.78$ Watts

$Q_{Side\ walls} = 5.78$ Watts

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Total Freezer Compartment Heat Leak = 6.15 + 5.78 = 11.93

Total Refrigerator Compartment Heat Leak = 21.17 + 11.79 + 5.55 + 15.2 = 53.71

Total Heat Leaks;

$$Q_{TL} = Q_{\text{freezer compatment}} + Q_{\text{refregerator compartment}} = 11.93 + 53.71 = 65.64 \text{ watts}$$

$$\boxed{Q_{\text{Total Heat Leaks}} = 65.64 \text{ Watts}}\ .$$

b) Product Loads;

Through our knowledge, experience and facts and figures of calculation of more than eight models of Azmayesh products and some Lorestan products we found out that calculation of product loads for each individual model depends upon many factors that we could mention briefly as follows:

- Product design;
- Product style:
- Company policy;
- Useful internal volume;
- Type of evaporator;
- Type of cellar compartment;
- Freezer volume;
- Culture of customer;
- Country of origin and etc.;

Therefore considering 40% to 65% of total heat leaks for total product load depending on size of model and internal volume of the product could be reasonable and practical to calculate. With respect to this fact we calculate our product load as follows;

$$Q_{\text{Product}} = (\ 40\% \text{ to } 65\%\ ) \text{ of } Q_{\text{Total Heat Leaks}}$$

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Product load calculation for Lorestan Refrigerator Model is ROM 14:

Product load = 65.64 x 0.65 = 42.66 Watts

c) Heat gain through infiltration;

Total heat gain through infiltration (door opening, and gasket) are considered to 20 % of total heat gain by conduction and heat removed from products, therefore;

Heat gain by infiltration = 0.2 x (total heat leaks + product loads)

Heat gain by infiltration = 0.2 x (65.64 + 42.66) = 21.66 Watts

Total Cooling Capacity Required for Model ROM 14 are calculated as follows:

$$Q_{\text{Grand Total}} = Q_{\text{Heat Leaks}} + Q_{\text{Product Loads}} + Q_{\text{infiltration}}$$

$$Q_{\text{Grand Total}} = 65.64 + 42.66 + 21.66 = 130 \text{ Watts}$$

$Q_{\text{Grand Total}} = 130$ Watts

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Movalled

Upright Freezer Model F80

a) Transmission load calculation

Table XXII
Dimensions

	Dimension Cm.	Area (sq. mt.)	Insulation Thickness
Side Walls	2 x (114x57)	1.30	35
Back Panel	114 x 49	0.56	35
Top Roof	49 x 57	0.28	35
Bottom Floor	49 x 57	0.28	35
Door	114 x 49	0.56	35

Insulation Type: Pu Foam

CP. Foam Thermal Conductivity: 0.0195 W /mt.C

Temperature Difference: $(\Delta T) = 43 - (-18) = 61$ C
Ambient Temperature = 43 C
Freezer Air Temperature = - 18 C

Calculation :

$$Q_{TL} = Q_{SW} + Q_{BP} + Q_{BOTTOM} + Q_{TOP} + Q_{DOOR}$$

$$Q = U A (T_a - T_f)$$

$$U = \frac{1}{X_1 / K_1 + X_2 / K_2 + \ldots\ldots}$$

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Where :

U = Heat Resistance Coefficient Factor

K_1 = Foam Thermal Conductivity

X_1 = Foam Thickness

Therefore:

1- $Q_{SideWalls} = [U A (T_a - T_f)]$

T_a = Ambient Temperature
T_f = Freezer air Temperature

U = 1/(0.035 /0.0195) = 0.56 W/ sq.m C
A = 1.30 Sq. Mt.
T_a = 43 C
T_f = - 18 C

$Q_{SideWalls}$ = 0.56 x 1.30 x 61 = 44.4 Watts

$Q_{SideWalls}$ = 44.4 Watts

2 - $Q_{Back\ panel} = [U A (T_a - T_f)]$

T_a = Ambient Temperature
T_f = Freezer air Temperature

U = 1 (0.035 0.0195) = 0.56 W/ sq.m C
A = 0.56 Sq. Mt.
T_a = 43 C
T_f = - 18 C

$Q_{Back\ panel}$ = 0.56 x 0.56 x 61 = 19 Watts

$Q_{Back\ panel}$ = 19 Watts

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3 - $Q_{Top} = [\,U A\,(T_a - T_f)\,]$

T_a = Ambient Temperature
T_f = Freezer air Temperature

U = 1/(0.035 / 0.0195) = 0.56 W/ sq.m C
A = 0.28 Sq. Mt.
T_a = 43 C
T_f = - 18 C

$Q_{Top} = 0.56 \times 0.28 \times 61 = 9.6$ Watts

$Q_{Top} = 9.6$ Watts

4 - $Q_{Bottom} = [\,U A\,(T_a - T_f)\,]$

T_a = Ambient Temperature
T_f = Freezer air Temperature

U = 1/(0.035 / 0.0195) = 0.56 W/ sq.m C
A = 0.28 Sq. Mt.
T_a = 43 C
T_f = - 18 C

$Q_{Bottom} = 0.28 \times 0.56 \times 61 = 9.6$ Watts

$Q_{Bottom} = 9.6$ Watt

5 - $Q_{Door} = [\,U A\,(T_a - T_f)\,]$

T_a = Ambient Temperature
T_f = Freezer air Temperature

U = 1/(0.035 / 0.0195) = 0.56 W/ sq.m C
A = 0.56 Sq. Mt.
T_a = 43 C

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$T_f = -18$ C

$Q_{Door} = 0.56 \times 0.56 \times 61 = 19$ Watts

$Q_{Door} = 19$ Watts

Total Heat Leaks:

$Q_{TL} = 44.4 + 9.6 + 19 + 9.6 + 19 = 101.6$ watts

$Q_{Total\ Heat\ Leaks} = 102$ Watts

b) Product Loads:

Through our knowledge, experience and facts and figures of calculation of more than eight models of Azmayesh products and some Lorestan products we found out that calculation of product loads for each individual model depends upon many factors that we could mention briefly as follows:

- Product design;
- Product style;
- Company policy;
- Useful internal volume;
- Type of evaporator;
- Type of cellar compartment;
- Freezer volume;
- Culture of customer;
- Country of origin and etc.;

Therefore considering 40% to 65% of total heat leaks for total product load depending on size of model and internal volume of the product could be reasonable and practical to calculate. With respect to this fact we calculate our product load as follows:

$$Q_{Product} = (40\% \text{ to } 65\%) \text{ of } Q_{Total\ Heat\ Leaks}$$

Product load calculation for Movalled Model F80 is:

Product load = 102 x 0.40 = 41 Watts

c) *Heat gain through infiltration:*

Total heat gain through infiltration (door opening, and gasket) are considered to 20 % of total heat gain by conduction and heat removed from products, therefore:

Heat gain by infiltration = 0.2 x (total heat leaks + product loads)

Heat gain by infiltration = 0.2 x (102 + 41) = 28.6 Watts

Total Cooling Capacity Required for Model F80 are calculated as follows:

$$Q_{\text{Grand Total}} = Q_{\text{Heat Leaks}} + Q_{\text{Product Loads}} + Q_{\text{infiltration}}$$

$$Q_{\text{Grand Total}} = 102 + 41 + 28.6 = 171.6 \text{ Watts}$$

$Q_{\text{Grand Total}} = 172$ Watts

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Movalled

Upright Refrigerator & Freezer Model RF80

a) Transmission load calculation

Table XVI
Dimensions

Refrigerator Compartment	Dimension Cm.	Area (sq. mt.)	Insulation Thickness	Tempreture Difference
Side Walls	2 x (96x 56.5)	1.08	30	39
Back Panel	96 x 48	0.46	30	39
Bottom Floor	56.5 x 48	0.27	30	39
Door	96 x 48	0.46	30	39
Freezer Compartment	**Dimension Cm.**	**Area (sq. mt.)**	**Insulation Thickness**	**Tempreture Difference**
Side Walls	2x(23x55)	0.25	45	61
Back Panel	23 x 45	0.103	45	61
Top Roof	45 x 55	0.25	45	61
Door	23 x 45	0.103	45	61

Insulation Type: Pu Foam

Thermal Conductivity for Foam: 0.0195 W/ mt. C

Temperature Difference Refrigerator Compartment: $(\Delta T) = 43 - (+4) = 39$ C
Ambient Temperature = 43 C
Freezer Air Temperature = - 18 C
Refrigerator Air Temperature = −4 C

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Calculation :

Heat Leak For Refrigerator Compartment.

$$Q_{TL} = Q_{SW} + Q_{BP} + Q_{BOTTOM} + Q_{DOOR}$$

$$Q = U A (T_a - T_r)$$

$$U = \frac{1}{X_1 / K_1 + X_2 / K_2 + \ldots\ldots}$$

Where :

U = Heat Resistance Coefficient Factor

K_1 = Foam Thermal Conductivity

X_1 = Foam Thickness

Therefore:

1- $Q_{SideWalls} = [U A (T_a - T_r)]$

T_a = Ambient Temperature
T_r = refrigerator air Temperature

$U = 1/(0.030 / 0.0195) = 0.65$ W/ sq.m C
A = 1.08 Sq. Mt.
$T_a = 43$ C
$T_r = - 4$ C

$Q_{SideWalls} = 0.65 \times 1.08 \times 39 = 27.4$ Watts

$Q_{SideWalls} = 27.4$ Watts

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2 - $Q_{Back\ panel} = [\ U\ A\ (\ T_a - T_r\ )\ ]$

T_a = Ambient Temperature
T_r = Refrigerator air Temperature

U = 1/(0.030 /0.0195) = 0.65W/ sq.m C
A = 0.46 Sq. Mt.
T_a = 43 C
T_r = - 4 C

$Q_{Back\ panel}$ = 0.65 x 0.46 x 39 = 11.66 Watts

$Q_{Back\ panel}$ = 11.66 Watts

3- $Q_{Door} = [\ U\ A\ (\ T_a - T_r\ )\ ]$

T_a = Ambient Temperature
T_r = Refrigerator air Temperature

U = 1/(0.030 /0.0195) = 0.65 W/ sq.m C
A = 0.46 Sq. Mt.
T_a = 43 C
T_r = + 4 C

Q_{Door} = 0.65 x 0.46 x 39 = 11.66 Watts

Q_{Door} = 11.66 Watts

4 - $Q_{Bottom} = [\ U\ A\ (\ T_a - T_r\ )\ ]$

T_a = Ambient Temperature
T_r = Refrigeratorr air Temperature
U = 1/(0.030 /0.0195) = 0.65 W/ sq.m C
A = 0.27 Sq. Mt.
T_a = 43 C

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$T_f = -4$ C

$Q_{Bottom} = 0.65 \times 0.27 \times 39 = 6.8$ Watts

$Q_{Bottom} = 6.8$ Watts

Heat Leak Calculation for Freezer Compartment

1 - $Q_{Top} = [U A (T_a - T_f)]$

T_a = Ambient Temperature
T_f = Freezer air Temperature

$U = 1 / (0.045/0.0195) = 0.43$ W/ sq.m C
A = 0.25 Sq. Mt.
$T_a = 43$ C
$T_f = -18$ C

$Q_{Top} = 0.43 \times 0.25 \times 61 = 6.6$ Watts

$Q_{Top} = 6.6$ Watts

2 - $Q_{Side\ walls} = [U A (T_a - T_f)]$

T_a = Ambient Temperature
T_f = Freezer air Temperature

$U = 1 / (0.045/0.0195) = 0.43$ W/ sq.m C
A = 0.25 Sq. Mt.
$T_a = 43$ C
$T_f = -18$ C

$Q_{Side\ walls} = 0.43 \times 0.25 \times 61 = 6.5$ Watts

$Q_{Side\ walls} = 6.5$ Watts

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3 - $Q_{Back\ panel} = [\ U\ A\ (\ T_a - T_f\ )\ ]$

T_a = Ambient Temperature

T_f = Freezer air Temperature

U = 1/(0.045 /0.0195) = 0.43 W/ sq.m C

A = 0.103 Sq. Mt.

T_a = 43 C

T_f = - 18 C

$Q_{Back\ panel}$ = 0.43 x 0.103 x 61 = 2.7 Watts

$Q_{Back\ panel}$ = 2.7 Watts

4 - $Q_{Door} = [\ U\ A\ (\ T_a - T_r\ )\ ]$

T_a = Ambient Temperature

T_f = Freezer air Temperature

U = 1/(0.45 /0.0195) = 0.43 W/ sq.m C

A = 0.103 Sq. Mt.

T_a = 43 C

T_f = - 18 C

Q_{Door} = 0.43 x 0.103 x 61 = 2.7 Watts

Q_{Door} =2.7 Watts

Total Refrigerator Compartment Heat Leak = 27.4 + 11.66 + 6.8 + 11.66 = 57.5

Total Freezer Compartment Heat Leak = 6.5 + 2.7 + 6.5 + 2.7 = 18.4 W

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Total Heat Leaks:

$$Q_{TL} = Q_{freezer\ compartment} + Q_{refrigerator\ compartment} = 18.4 + 57.5 = 75.9 \text{ watts}$$

$$Q_{\text{Total Heat Leaks}} = 75.9 \text{ Watts}$$

b) Product Loads:

Through our knowledge, experience and facts and figures of calculation of more than eight models of Azmayesh products and some Lorestan products we found out that calculation of product loads for each individual model depends upon many factors that we could mention briefly as follows:

- Product design;
- Product style;
- Company policy;
- Useful internal volume;
- Type of evaporator;
- Type of cellar compartment;
- Freezer volume;
- Culture of customer;
- Country of origin and etc.;

Therefore considering 40% to 65% of total heat leaks for total product load depending on size of model and internal volume of the product could be reasonable and practical to calculate. With respect to this fact we calculate our product load as follows:

$$Q_{\text{Product}} = (40\% \text{ to } 65\%) \text{ of } Q_{\text{Total Heat Leaks}}$$

Product load calculation for Movalled Refrigerator Freezer Model RF80 is:

Product load = 75.9 x 0.60 = 45.5 Watts

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c) Heat gain through infiltration;

Total heat gain through infiltration (door opening, and gasket) are considered to 20 % of total heat gain by conduction and heat removed from products, therefore:

Heat gain by infiltration = 0.2 x (total heat leaks + product loads)

Heat gain by infiltration = 0.2 x (75.9 + 45.5) = 24.3 Watts

Total Cooling Capacity Required for Model RF80 are calculated as follows:

$$Q_{Grand\ Total} = Q_{Heat\ Leaks} + Q_{Product\ Loads} + Q_{Infiltration}$$

$$Q_{Grand\ Total} = 75.9 + 45.5 + 24.3 = 145.7 \text{ Watts}$$

$Q_{Grand\ Total}$ = 146 Watts

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Movalled

Upright Refrigerator & Freezer Model RF 85

a) Transmission load calculation

Table XV
Dimensions

Refrigerator Compartment	Dimension Cm.	Area (sq. mt.)	Insulation Thickness	Tempreture Difference
Side Walls	2 x (118x56.5)	1.33	30	39
Back Panel	118 x 48	0.57	30	39
Bottom Floor	56.5 x 48	0.27	30	39
Door	118 x 48	0.57	30	39
Freezer Compartment	Dimension Cm.	Area (sq. mt.)	Insulation Thickness	Tempreture Difference
Side Walls	2x(31x55)	0.34	45	61
Back Panel	31x45	0.14	45	61
Top Roof	45x55	0.25	45	61
Door	31x45	0.14	45	61

Insulation Type: Pu Foam

Thermal Conductivity for Foam: 0.0195 W/ mt. C

Temperature Difference Refrigerator Compartment: (ΔT) = 43 - (−4) = 39 C
Ambient Temperature = 43 C
Freezer Air Temperature = - 18 C
Refrigerator Air Temperature = −4 C

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Calculation :

Heat Leak For Refrigerator Compartment.

$$Q_{TL} = Q_{SW} + Q_{BP} + Q_{BOTTOM} + Q_{DOOR}$$

$$Q = U\,A\,(T_a - T_r)$$

$$U = \frac{1}{X_1 / K_1 + X_2 / K_2 + \ldots\ldots}$$

Where :

U = Heat Resistance Coefficient Factor

K_1 = Foam Thermal Conductivity

X_1 = Foam Thickness

Therefore:

1- $Q_{SideWalls} = [\,U\,A\,(T_a - T_r)\,]$

T_a = Ambient Temperature
T_r = refrigerator air Temperature

$U = 1/(0.030 / 0.0195) = 0.65$ W/ sq.m C
$A = 1.33$ Sq. Mt.
$T_a = 43$ C
$T_r = -4$ C

$Q_{SideWalls} = 0.65 \times 1.33 \times 39 = 33.7$ Watts

$Q_{SideWalls} = 33.7$ Watts

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2 - $Q_{\text{Back panel}} = [\,U\,A\,(T_a - T_r)\,]$

T_a = Ambient Temperature
T_r = Refrigerator air Temperature

$U = 1/(\,0.030\ /0.0195\,) = 0.65$ W/ sq.m C
$A = 0.64$ Sq. Mt.
$T_a = 43$ C
$T_r = +4$ C

$Q_{\text{Back panel}} = 0.64 \times 0.57 \times 39 = 14.22$ Watts

$Q_{\text{Back panel}} = 14.2$ Watts

3- $Q_{\text{Door}} = [\,U\,A\,(T_a - T_r)\,]$

T_a = Ambient Temperature
T_r = Refrigerator air Temperature

$U = 1/(\,0.030\ /0.0195\,) = 0.65$ W/ sq.m C
$A = 0.57$ Sq. Mt.
$T_a = 43$ C
$T_r = +4$ C

$Q_{\text{Door}} = 0.65 \times 0.57 \times 39 = 14.45$ Watts

$Q_{\text{Door}} = 14.45$ Watts

4 - $Q_{\text{Bottom}} = [\,U\,A\,(T_a - T_r)\,]$

T_a = Ambient Temperature
T_r = Refrigeratorr air Temperature
$U = 1/(\,0.030\ /0.0195\,) = 0.65$ W/ sq.m C
$A = 0.27$ Sq. Mt.
$T_a = 43$ C

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$T_f = -4$ C

$Q_{Botom} = 0.65 \times 0.27 \times 39 = 6.8$ Watts

$Q_{Bottom} = 6.8$ Watts

Heat Leak Calculation for Freezer Compartment

1 - $Q_{Top} = [\, U A (T_a - T_f) \,]$

T_a = Ambient Temperature
T_f = Freezer air Temperature

U = 1 / (0.045/0.0195) = 0.43 W/ sq.m C
A = 0.25 Sq. Mt.
T_a = 43 C
T_f = - 18 C

$Q_{Top} = 0.43 \times 0.25 \times 61 = 6.5$ Watts

$Q_{Top} = 6.5$ Watts

2 - $Q_{Side\ walls} = [\, U A (T_a - T_f) \,]$

T_a = Ambient Temperature
T_f = Freezer air Temperature

U = 1 / (0.045/0.0195) = 0.43 W/ sq.m C
A = 0.34 Sq. Mt.
T_a = 43 C
T_f = - 18 C

$Q_{Side\ walls} = 0.43 \times 0.34 \times 61 = 8.9$ Watts

$Q_{Side\ walls} = 8.9$ Watts

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3 - $Q_{Back\ panel} = [\,U\,A\,(T_a - T_f)\,]$

T_a = Ambient Temperature
T_f = Freezer air Temperature
U = 1/(0.045 /0.0195) = 0.43 W/ sq.m C
A = 0.14 Sq. Mt.
T_a = 43 C
T_f = - 18 C

$Q_{Back\ panel}$ = 0.43 x 0.14 x 61 = 3.67 Watts

$Q_{Back\ panel}$ = 3.67 Watts

4 - $Q_{Door} = [\,U\,A\,(T_a - T_f)\,]$

T_a = Ambient Temperature
T_f = Freezer air Temperature

U = 1/(0.045 /0.0195) = 0.43 W/ sq.m C
A = 0.14 Sq. Mt.
T_a = 43 C
T_f = - 18 C

Q_{Door} = 0.43 x 0.14 x 61 = 3.67 Watts

Q_{Door} = 3.67Watts

Total Refrigerator Compartment Heat Leak = 33.7 + 14 + 6.8 + 14.4 = 69

Total Freezer Compartment Heat Leak = 8.9 + 3.67 + 6.5 + 3.67 = 22.74 W

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Total Heat Leaks:

$$Q_{TL} = Q_{\text{freezer compatment}} - Q_{\text{refrigerator compartment}} = 22.74 - 69 = 92 \text{ watts}$$

$$Q_{\text{Total Heat Leaks}} = 92 \text{ Watts}$$

b) Product Loads:

Through our knowledge, experience and facts and figures of calculation of more than eight models of Azmayesh products and some Lorestan products we found out that calculation of product loads for each individual model depends upon many factors that we could mention briefly as follows:

- Product design;
- Product style;
- Company policy;
- Useful internal volume;
- Type of evaporator;
- Type of cellar compartment;
- Freezer volume;
- Culture of customer;
- Country of origin and etc.;

Therefore considering 40% to 65% of total heat leaks for total product load depending on size of model and internal volume of the product could be reasonable and practical to calculate. With respect to this fact we calculate our product load as follows:

$$Q_{\text{Product}} = (\ 40\% \text{ to } 65\%\ ) \text{ of } Q_{\text{Total Heat Leaks}}$$

Product load calculation for Movalled Refrigerator Freezer Model RF85is:

Product load = 92 x 0.50 = 46 Watts

c) Heat gain through infiltration;

Total heat gain through infiltration (door opening, and gasket) are considered to 20 % of total heat gain by conduction and heat removed from products, therefore:

Heat gain by infiltration = 0.2 x (total heat leaks + product loads)

Heat gain by infiltration = 0.2 x (92 + 46) = 27.6Watts

Total Cooling Capacity Required for Model RF85 are calculated as follows;

$$Q_{\text{Grand Total}} = Q_{\text{Heat Leaks}} + Q_{\text{Product Loads}} + Q_{\text{infiltration}}$$

$$Q_{\text{Grand Total}} = 62 + 46 + 27.6 = 166 \text{ Watts}$$

$$\boxed{Q_{\text{Grand Total}} = \mathbf{166} \text{ Watts}}$$

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Movalled

Upright Refrigerator & Freezer Model RF14

a) Transmission load calculation

Table XXIV
Dimensions

Refrigerator Compartment	Dimension Cm.	Area (sq. mt.)	Insulation Thickness	Tempreture Difference
Side Walls	2 x (118x56.5)	1.33	30	39
Back Panel	118 x 48	0.57	30	39
Bottom Floor	56.5 x 48	0.27	30	39
Door	118 x 48	0.57	30	39
Freezer Compartment	Dimension Cm.	Area (sq. mt.)	Insulation Thickness	Tempreture Difference
Side Walls	2x(37x55)	0.4	45	61
Back Panel	37x49.5	0.18	45	61
Top Roof	49.5x55	0.27	45	61
Door	37x49.5	0.18	45	61

Insulation Type: Pu Foam

Thermal Conductivity for Foam: 0.0195 W/ mt. C

Temperature Difference Refrigerator Compartment: $(\Delta T) = 43 - (+4) = 39$ C
Ambient Temperature = 43 C
Freezer Air Temperature = - 18 C
Refrigerator Air Temperature = +4 C

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Calculation :

Heat Leak For Refrigerator Compartment.

$$Q_{TL} = Q_{SW} + Q_{BP} + Q_{BOTTOM} + Q_{DOOR}$$

$$Q = U A (T_a - T_r)$$

$$U = \frac{1}{X_1 / K_1 + X_2 / K_2 + \ldots\ldots}$$

Where :

U = Heat Resistance Coefficient Factor

K_1 = Foam Thermal Conductivity

X_1 = Foam Thickness

Therefore:

1- $Q_{SideWalls} = [U A (T_a - T_r)]$

T_a = Ambient Temperature
T_r = refrigerator air Temperature

U = 1/(0.030 / 0.0195) = 0.65 W/ sq.m C
A = 1.33 Sq. Mt.
T_a = 43 C
T_r = + 4 C

$Q_{SideWalls}$ = 0.65 x 1.33 x 39 = 33.7 Watts

$Q_{SideWalls}$ = 33.7 Watts

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2 - $Q_{\text{Back panel}} = [\,U A (T_a - T_r)\,]$

T_a = Ambient Temperature

T_r = Refrigerator air Temperature

$U = 1/(0.030 \ / 0.0195) = 0.65$ W/ sq.m C

$A = 0.57$ Sq. Mt.

$T_a = 43$ C

$T_r = + 4$ C

$Q_{\text{Back panel}} = 0.65 \times 0.57 \times 39 = 14.45$ Watts

$Q_{\text{Back panel}} = 14.45$ Watts

3- $Q_{\text{Door}} = [\,U A (T_a - T_r)\,]$

T_a = Ambient Temperature

T_r = Refrigerator air Temperature

$U = 1/(0.030 \ / 0.0195) = 0.65$ W/ sq.m C

$A = 0.57$ Sq. Mt.

$T_a = 43$ C

$T_r = - 4$ C

$Q_{\text{Door}} = 0.65 \times 0.57 \times 39 = 14.45$ Watts

$Q_{\text{Door}} = 14.45$ Watts

4 - $Q_{\text{Bottom}} = [\,U A (T_a - T_r)\,]$

T_a = Ambient Temperature

T_r = Refrigeratorr air Temperature

$U = 1/(0.030 \ / 0.0195) = 0.65$ W/ sq.m C

$A = 0.27$ Sq. Mt.

$T_a = 43$ C

$T_r = - 4$ C

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$Q_{Bottom} = 0.65 \times 0.27 \times 39 = 6.8$ Watts

$Q_{Bottom} = 6.8$ Watts

Heat Leak Calculation for Freezer Compartment

1 - $Q_{Top} = [U A (T_a - T_f)]$

T_a = Ambient Temperature
T_f = Freezer air Temperature

U = 1 / (0.045/0.0195) = 0.43 W/ sq.m C
A = 0.27 Sq. Mt.
T_a = 43 C
T_f = - 18 C

$Q_{Top} = 0.43 \times 0.27 \times 61 = 7.1$ Watts

$Q_{Top} = 7.1$ Watts

2 - $Q_{Side\ walls} = [U A (T_a - T_f)]$

T_a = Ambient Temperature
T_f = Freezer air Temperature

U = 1 / (0.045/0.0195) = 0.43 W/ sq.m C
A = 0.4 Sq. Mt.
T_a = 43 C
T_f = - 18 C

$Q_{Side\ walls} = 0.43 \times 0.4 \times 61 = 10.5$ Watts

$Q_{Side\ walls} = 10.5$ Watts

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3 - $Q_{Back\ panel} = [\ U\ A\ (\ T_a - T_f\ )\ ]$

T_a = Ambient Temperature

T_f = Freezer air Temperature

$U = 1/(\ 0.045\ /0.0195\ ) = 0.43$ W/ sq.m C

$A = 0.18$ Sq. Mt.

$T_a = 43$ C

$T_f = -\ 18$ C

$Q_{Back\ panel} = 0.43 \times 0.18 \times 61 = 4.7$ Watts

$Q_{Back\ panel} = 4.7$ Watts

4 - $Q_{Door} = [\ U\ A\ (\ T_a - T_r\ )\ ]$

T_a = Ambient Temperature

T_f = Freezer air Temperature

$U = 1/(\ 0.045\ /0.0195\ ) = 0.43$ W/ sq.m C

$A = 0.18$ Sq. Mt.

$T_a = 43$ C

$T_f = -\ 18$ C

$Q_{Door} = 0.43 \times 0.18 \times 61 = 4.7$ Watts

$Q_{Door} = 4.7$Watts

Total Refrigerator Compartment Heat Leak = 33.7 + 14.45 + 6.8 + 14.45 = 69.4

Total Freezer Compartment Heat Leak = 10.5 + 4.7 + 7.1 + 4.7 = 27 W

Total Heat Leaks;

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$Q_{TL} = Q_{freezer\ compament} + Q_{refrigerator\ compartment} = 27 + 69.4 = 96.4$ watts

$$Q_{Total\ Heat\ Leaks} = 96.4 \text{Watts}$$

b) Product Loads;

Through our knowledge, experience and facts and figures of calculation of more than eight models of Azmayesh products and some Lorestan products we found out that calculation of product loads for each individual model depends upon many factors that we could mention briefly as follows:

- Product design;
- Product style;
- Company policy;
- Useful internal volume
- Type of evaporator;
- Type of cellar compartment;
- Freezer volume;
- Culture of customer;
- Country of origin and etc.;

Therefore considering 40% to 65% of total heat leaks for total product load depending on size of model and internal volume of the product could be reasonable and practical to calculate. With respect to this fact we calculate our product load as follows:

$$Q_{Product} = (40\% \text{ to } 65\%) \text{ of } Q_{Total\ Heat\ Leaks}$$

Product load calculation for Movalled Refrigerator Freezer Model RF14 is:

Product load = 96.4 x 0.50 = 48.2 Watts

c) Heat gain through infiltration:

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Total heat gain through infiltration (door opening, and gasket) are considered to 20 % of total heat gain by conduction and heat removed from products, therefore:

Heat gain by infiltration = 0.2 x (total heat leaks + product loads)

Heat gain by infiltration = 0.2 x (96.4 + 48.2) = 29 Watts

Total Cooling Capacity Required for Model RF12 are calculated as follows;

$$Q_{\text{Grand Total}} = Q_{\text{Heat Leaks}} + Q_{\text{Product Loads}} + Q_{\text{infiltration}}$$

$$Q_{\text{Grand Total}} = 96.4 + 48.2 + 29 = 173.6 \text{ Watts}$$

$$\boxed{Q_{\text{Grand Total}} = \mathbf{173.6} \text{ Watts}}$$

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Pars Machine

Upright Refrigerator Model Damavand 15

a) Transmission load calculation

Table XII
Dimensions

Refrigerator Compartment	Dimension Cm.	Area (sq. mt.)	Insulation Thickness	Tempreture Difference
Side Walls	2 x (104x60.3)	1.235	40	39
Back Panel	125 x 68.2	0.821	40	39
Bottom Floor	68.2 x 64.2	0.283	40	39
Door	138 x 68	0.854	40	39
Freezer Compartment	**Dimension Cm.**	**Area (sq. mt.)**	**Insulation Thickness**	**Tempreture Difference**
Side Walls	2x(33x60.3)	0.161	40	55
Top Roof	68.2x60.3	0.158	40	55

Insulation Type: Pu Foam

Thermal Conductivity for Foam: 0.0195 W/ mt. C
Thermal Conductivity for Air at -12 at 1 atm. =0.02367 W/mt. C

Temperature Difference Refrigerator Compartment: $(\Delta T) = 43 - (+4) = 39$ C
Ambient Temperature = 43 C
Freezer Air Temperature = - 12 C
Refrigerator Air Temperature = +4 C

Calculation :

Heat Leak For Refrigerator Compartment.

$$Q_{TL} = Q_{SW} + Q_{BP} + Q_{BOTTOM} + {}_{DOOR}$$

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$$Q = U A (T_a - T_r)$$

$$U = \frac{1}{X_1 / K_1 + X_2 / K_2 + \ldots\ldots}$$

Where :

U = Heat Resistance Coefficient Factor

K_1 = Foam Thermal Conductivity

K2 = Air Thermal Condutivity

X_1 = Foam Thickness

Therefore:

1- $Q_{SideWalls} = [U A (T_a - T_r)]$

T_a = Ambient Temperature
T_r = refrigerator air Temperature

U = 1/(0.04 /0.0195) = 0.487 W/ sq.m C
A = 1.123 Sq. Mt.
T_a = 43 C
T_f = − 4 C

$Q_{SideWalls}$ = 0.478 x 1.123 x 39 = 20.93 Watts

$Q_{SideWalls}$ = 20.93 Watts

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2 - $Q_{\text{Back panel}} = [\,U A\,(T_a - T_r)\,]$

T_a = Ambient Temperature
T_r = Refrigerator air Temperature

U = 1/(0.050 /0.0195) = 0.478 W/ sq.m C
A = 0.821 Sq. Mt.
T_a = 43 C
T_r = + 4 C

$Q_{\text{Back panel}}$ = 0.478 x 0.821 x 39 = 15.3 Watts

$Q_{\text{Back panel}}$ = 15.3 Watts

3- $Q_{\text{Door}} = [\,U A\,(T_a - T_r)\,]$

T_a = Ambient Temperature
T_r = Refrigerator air Temperature

U = 1/(0.040 /0.0195) = 0.478 W/ sq.m C
A = 0.854 Sq. Mt.
T_a = 43 C
T_r = + 4 C

Q_{Door} = 0.478 x 0.854 x 39 = 15.9 Watts

Q_{Door} = 15.9 Watts

4 - $Q_{\text{Bottom}} = [\,U A\,(T_a - T_r)\,]$

T_a = Ambient Temperature
T_r = Refrigeratorr air Temperature

U = 1/(0.040 /0.0195) = 0.478W/ sq.m C
A = 0.2835 Sq. Mt.
T_a = 43 C

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T_f = + 4 C

Q_{Bottom} = 0.478 x 0.283 x 39 = 5.27 Watts

Q_{Bottom} = 5.27 Watts

Heat Leak Calculation for Freezer Compartment

1 - Q_{Top} = [U A (T_a - T_f)]

T_a = Ambient Temperature
T_f = Freezer air Temperature

U = 1 / [(0.040/0.0195)+(0.020/0.02367)] = 0..34 W/ sq.m C
A = 0..158 Sq. Mt.
T_a = 43 C
T_f = - 12 C

Q_{Top} = 0.34 x 0.158 x 55 = 2.95 Watts

Q_{Top} = 2.95 Watts

2 - $Q_{Side\ walls}$ = [U A (T_a - T_f)]

T_a = Ambient Temperature
T_f = Freezer air Temperature

U = 1 / [(0.040/0.0195)+(0.035/0.02367)] = 0.28 W/ sq.m C
A = 0.161 Sq. Mt.
T_a = 43 C
T_f = - 12 C

$Q_{Side\ walls}$ = 0.28 x 0.161 x 55 = 2.48 Watts

$Q_{Side\ walls}$ = 2.48 Watts

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Total Freezer Compartment Heat Leak = 2.48 + 2.95 = 5.43

Total Refrigerator Compartment Heat Leak = 20.93 + 15.3 + 5.27 + 15.9 = 57.4

Total Heat Leaks;

$$Q_{TL} = Q_{\text{freezer compamment}} + Q_{\text{refregerator compartment}} = 5.43 + 57.4 = 65.64 \text{ watts}$$

$$\boxed{Q_{\text{Total Heat Leaks}} = 62.83 \text{ Watts}}$$

b) Product Loads;

Through our knowledge, experience and facts and figures of calculation of more than eight models of Azmayesh products and some Lorestan products we found out that calculation of product loads for each individual model depends upon many factors that we could mention briefly as follows:

- Product design;
- Product style;
- Company policy;
- Useful internal volume;
- Type of evaporator;
- Type of cellar compartment;
- Freezer volume;
- Culture of customer;
- Country of origin and etc.;

Therefore considering 40% to 65% of total heat leaks for total product load depending on size of model and internal volume of the product could be reasonable and practical to calculate. With respect to this fact we calculate our product load as follows;

$$Q_{\text{Product}} = (40\% \text{ to } 65\%) \text{ of } Q_{\text{Total Heat Leaks}}$$

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Product load calculation for Pars Machine Refrigerator Model Damavand 15 is;

Product load = 62.83 x 0.60 = 37.7 Watts

c) Heat gain through infiltration;

Total heat gain through infiltration (door opening, and gasket) are considered to 20 % of total heat gain by conduction and heat removed from products, therefore;

Heat gain by infiltration = 0.2 x (total heat leaks + product loads)

Heat gain by infiltration = 0.2 x (62.83 + 37.7) = 20.1 Watts

Total Cooling Capacity Required for Model Damavand 15 are calculated as follows;

$$Q_{\text{Grand Total}} = Q_{\text{Heat Leaks}} + Q_{\text{Product Loads}} + Q_{\text{Infiltration}}$$

$$Q_{\text{Grand Total}} = 62.83 + 37.7 + 20.1 = 120 \text{ Watts}$$

$$\boxed{Q_{\text{Grand Total}} = 120 \text{ Watts}}$$

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Pars Machine

Upright Freezer Model 1072

a) Transmission load calculation

Table XIX
Dimensions

	Dimension Cm.	Area (sq. mt.)	Insulation Thickness
Side Walls	2 x (134x53)	1.42	40
Back Panel	134 x 59	0.80	40
Top Roof	53 x 59	0.31	40
Bottom Floor	53 x 59	031	40
Door	134 x59	0.80	40

Insulation Type: Pu Foam

CP. Foam Thermal Conductivity: 0.0195 W/mt.C

Temperature Difference: (ΔT) = 43 - (-18) = 61 C
Ambient Temperature = 43 C
Freezer Air Temperature = - 18 C

Calculation :

$$Q_{TL} = Q_{SW} + Q_{BP} + Q_{BOTTOM} + Q_{TOP} + Q_{DOOR}$$

$$Q = U A (T_a - T_f)$$

$$U = \frac{1}{X_1 / K_1 + X_2 / K_2 + \ldots\ldots}$$

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Where :

U = Heat Resistance Coefficient Factor

K_1 = Foam Thermal Conductivity

X_1 = Foam Thickness

Therefore:

1- $Q_{SideWalls} = [\, U A (T_a - T_f) \,]$

T_a = Ambient Temperature
T_f = Freezer air Temperature

U = 1/(0.040 /0.0195) = 0.4875W/ sq.m C
A = 1.42 Sq. Mt.
T_a = 43 C
T_f = - 18 C

$Q_{SideWalls}$ = 0.4875 x 1.42 x 61 = 42.22 Watts

$Q_{SideWalls}$ = 42.22 Watts

2 - $Q_{Back\ panel} = [\, U A (T_a - T_f) \,]$

T_a = Ambient Temperature
T_f = Freezer air Temperature

U = 1/(0.040/ 0.0195) = 0.4875 W/ sq.m C
A = 0.80 Sq. Mt.
T_a = 43 C
T_f = - 18 C

$Q_{Back\ panel}$ = 0.4875 x 0.80 x 61 = 23.8 Watts

$Q_{Back\ panel}$ = 23.8 Watts

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3 - $Q_{Top} = [\,U\,A\,(T_a - T_f)\,]$

T_a = Ambient Temperature
T_f = Freezer air Temperature

$U = 1/(0.040\ /0.0195) = 0.4875$ W/ sq.m C
$A = 0.31$ Sq. Mt.
$T_a = 43$ C
$T_f = -18$ C

$Q_{Top} = 0.4875 \times 0.31 \times 61 = 9.2$ Watts

$Q_{Top} = 9.2$ Watts

4 - $Q_{Bottom} = [\,U\,A\,(T_a - T_f)\,]$

T_a = Ambient Temperature
T_f = Freezer air Temperature

$U = 1/(0.040\ /0.0195) = 0.4875$ W/ sq.m C
$A = 0.31$ Sq. Mt.
$T_a = 43$ C
$T_f = -18$ C

$Q_{Bottom} = 0.31 \times 0.4875 \times 61 = 9.2$ Watts

$Q_{Bottom} = 9.2$ Watt

5 - $Q_{Door} = [\,U\,A\,(T_a - T_f)\,]$

T_a = Ambient Temperature
T_f = Freezer air Temperature

$U = 1/(0.040\ /0.0195) = 0.4875$ W/ sq.m C
$A = 0.80$ Sq. Mt.
$T_a = 43$ C

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$T_f = -18$ C

$Q_{door} = 0.4875 \times 0.80 \times 61 = 23.8$ Watts

$Q_{door} = 23.8$ Watts

Total Heat Leaks:

$Q_{TL} = 42.22 + 23.8 + 9.2 + 9.2 + 23.8 = 108.22$ watts

$$Q_{\text{Total Heat Leaks}} = 108 \text{ Watts}$$

b) Product Loads:

Through our knowledge, experience and facts and figures of calculation of more than eight models of Azmayesh products and some Lorestan products we found out that calculation of product loads for each individual model depends upon many factors that we could mention briefly as follows:

- Product design;
- Product style;
- Company policy;
- Useful internal volume;
- Type of evaporator;
- Type of cellar compartment;
- Freezer volume;
- Culture of customer;
- Country of origin and etc.;

Therefore considering 40% to 65% of total heat leaks for total product load depending on size of model and internal volume of the product could be reasonable and practical to calculate. With respect to this fact we calculate our product load as follows:

$$Q_{\text{Product}} = (40\% \text{ to } 65\%) \text{ of } Q_{\text{Total Heat Leaks}}$$

Product load calculation for Pars Machine Model 1072 is:

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Product load = 108 x 0.40 = 43.3 Watts

c) Heat gain through infiltration;

Total heat gain through infiltration (door opening, and gasket) are considered to 20 % of total heat gain by conduction and heat removed from products, therefore;

Heat gain by infiltration = 0.2 x (total heat leaks + product loads)

Heat gain by infiltration = 0.2 x (108 + 43.3) = 30.25 Watts

Total Cooling Capacity Required for Model 1072 are calculated as follows;

$$Q_{\text{Grand Total}} = Q_{\text{Heat Leaks}} + Q_{\text{Product Loads}} + Q_{\text{Infiltration}}$$

$$Q_{\text{Grand Total}} = 108 + 43.3 + 30.25 = 181 \text{ Watts}$$

$Q_{\text{Grand Total}} = 181$ Watts

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Pars Machine

Upright Refrigerator Model PMR6

a) Transmission load calculation

Table XVIII
Dimensions

Refrigerator Compartment	Dimension Cm.	Area (sq. mt.)	Insulation Thickness	Tempreture Difference
Side Walls	2 x (70 x 53)	0.74	40	39
Back Panel	84 x 53	0445	40	39
Bottom Floor	53 x 53	0.28	40	39
Door	84 x 53	0.445	40	39
Freezer Compartment	Dimension Cm.	Area (sq. mt.)	Insulation Thickness	Tempreture Difference
Side Walls	2x(22x53)	0.23	40	55
Top Roof	53 x 53	0.28	40	55

Insulation Type: Pu Foam

Thermal Conductivity for Foam: 0.0195 W/ mt. C
Thermal Conductivity for Air at -12 at 1 atm. =0.02367 W/mt. C

Temperature Difference Refrigerator Compartment: (ΔT) = 43 - (+4) = 39 C
Ambient Temperature = 43 C
Freezer Air Temperature = - 12 C
Refrigerator Air Temperature = +4 C

Calculation :

Heat Leak For Refrigerator Compartment.

$$Q_{TL} = Q_{SW} + Q_{BP} + Q_{BOTTOM} + Q_{DOOR}$$

$$Q = U A (T_a - T_r)$$

$$U = \frac{1}{X_1 / K_1 + X_2 / K_2 + \ldots\ldots}$$

Where :

U = Heat Resistance Coefficient Factor

K_1 = Foam Thermal Conductivity

K2 = Air Thermal Condutivity

X_1 = Foam Thickness

Therefore:

1- $Q_{SideWalls} = [U A (T_a - T_r)]$

T_a = Ambient Temperature
T_r = refrigerator air Temperature

$U = 1/(0.04/ \ 0.0195) = 0.487$ W/ sq.m C
A = 0.74 Sq. Mt.
T_a = 43 C
T_r = -- 4 C

$Q_{SideWalls} = 0.478 \times 0.74 \times 39 = 13.8$ Watts

$Q_{SideWalls} = 13.8$ Watts

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2 - $Q_{\text{Back panel}} = [U A (T_a - T_r)]$

T_a = Ambient Temperature
T_r = Refrigerator air Temperature

$U = 1/(0.040 \ / 0.0195) = 0.478$ W/ sq.m C
$A = 0.445$ Sq. Mt.
$T_a = 43$ C
$T_r = + 4$ C

$Q_{\text{Back panel}} = 0.478 \times 0.445 \times 39 = 8.3$ Watts

$Q_{\text{Back panel}} = 8.3$ Watts

3- $Q_{\text{Door}} = [U A (T_a - T_r)]$

T_a = Ambient Temperature
T_r = Refrigerator air Temperature

$U = 1/(0.040 \ / 0.0195) = 0.478$ W/ sq.m C
$A = 0.445$ Sq. Mt.
$T_a = 43$ C
$T_r = + 4$ C

$Q_{\text{Door}} = 0.478 \times 0.445 \times 39 = 8.3$ Watts

$Q_{\text{Door}} = 8.3$ Watts

4 - $Q_{\text{Bottom}} = [U A (T_a - T_r)]$

T_a = Ambient Temperature
T_r = Refrigeratorr air Temperature

$U = 1/(0.040 \ / 0.0195) = 0.478$W/ sq.m C
$A = 0.28$ Sq. Mt.

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$T_a = 43$ C
$T_r = -4$ C

$Q_{Bottom} = 0.478 \times 0.28 \times 39 = 5.22$ Watts

$Q_{Bottom} = 5.22$ Watts

Heat Leak Calculation for Freezer Compartment

1 - $Q_{Top} = [\, U\, A\, (T_a - T_f)\,]$

T_a = Ambient Temperature
T_f = Freezer air Temperature

U = 1 / [(0.040/0.0195)+(0.020/0.02367)] = 0..34 W/ sq.m C
A = 0.28 Sq. Mt.
$T_a = 43$ C
$T_f = -12$ C

$Q_{Top} = 0.34 \times 0.28 \times 55 = 5.2$ Watts

$Q_{Top} = 5.2$ Watts

2 - $Q_{Side\ walls} = [\, U\, A\, (T_a - T_f)\,]$

T_a = Ambient Temperature
T_f = Freezer air Temperature

U = 1 / [(0.040/0.0195)+(0.035/0.02367)] = 0.28 W/ sq.m C
A = 0.23 Sq. Mt.
$T_a = 43$ C
$T_f = -12$ C

$Q_{Side\ walls} = 0.28 \times 0.23 \times 55 = 3.54$ Watts

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$Q_{\text{Side walls}} = 3.54$ Watts

Total Freezer Compartment Heat Leak = 3.54 + 5.2 = 8.74

Total Refrigerator Compartment Heat Leak = 13.8 + 8.3 + 5.22 + 8.3 = 35.62

Total Heat Leaks:

$$Q_{TL} = Q_{\text{freezer compament}} + Q_{\text{refregerator comparment}} = 8.74 + 35.62 = 44.36 \text{ watts}$$

$Q_{\text{Total Heat Leaks}} = 44.36$ Watts

b) Product Loads:

Through our knowledge, experience and facts and figures of calculation of more than eight models of Azmayesh products and some Lorestan products we found out that calculation of product loads for each individual model depends upon many factors that we could mention briefly as follows:

- Product design;
- Product style;
- Company policy;
- Useful internal volume;
- Type of evaporator;
- Type of cellar compartment;
- Freezer volume;
- Culture of customer;
- Country of origin and etc.;

Therefore considering 40% to 65% of total heat leaks for total product load depending on size of model and internal volume of the product could be reasonable and practical to calculate. With respect to this fact we calculate our product load as follows:

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$$Q_{Product} = (\ 40\% \text{ to } 65\%\ ) \text{ of } Q_{Total\ Heat\ Leaks}$$

Product load calculation for Pars Machine Refrigerator Model PMR6 is:

Product load = 44.36 x 0.60 = 26.62 Watts

c) Heat gain through infiltration;

Total heat gain through infiltration (door opening, and gasket) are considered to 20 % of total heat gain by conduction and heat removed from products, therefore:

Heat gain by infiltration = 0.2 x (total heat leaks + product loads)

Heat gain by infiltration = 0.2 x (44.36 + 26.62) = 14.2 Watts

Total Cooling Capacity Required for Model PMR6 are calculated as follows:

$$Q_{Grand\ Total} = Q_{Heat\ Leaks} + Q_{Product\ Loads} + Q_{Infiltration}$$

$$Q_{Grand\ Total} = 44.36 + 26.62 + 14.2 = 85 \text{ Watts}$$

$Q_{Grand\ Total} = 85$ Watts

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Pars Machine

Upright Refrigerator Model 1070

a) Transmission load calculation

Table XVII
Dimensions

Refrigerator Compartment	Dimension Cm.	Area (sq. mt.)	Insulation Thickness	Tempreture Difference
Side Walls	2 x (113.5x53)	1.2	40	39
Back Panel	130 x 53	0.69	40	39
Bottom Floor	53 x 53	0.28	40	39
Door	130 x 53	0.69	40	39
Freezer Compartment	**Dimension Cm.**	**Area (sq. mt.)**	**Insulation Thickness**	**Tempreture Difference**
Side Walls	2x(16.5 x 53)	0.175	40	55
Top Roof	53 x 53	0.28	40	55

Insulation Type: Pu Foam

Thermal Conductivity for Foam: 0.0195 W/ mt. C
Thermal Conductivity for Air at -12 at 1 atm. =0.02367 W/mt. C

Temperature Difference Refrigerator Compartment: (ΔT) = 43 - (+4) = 39 C
Ambient Temperature = 43 C
Freezer Air Temperature = - 12 C
Refrigerator Air Temperature = +4 C

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Calculation :

Heat Leak For Refrigerator Compartment.

$$Q_{TL} = Q_{SW} + Q_{BP} + Q_{BOTTOM} + Q_{DOOR}$$

$$Q = U A (T_a - T_r)$$

$$U = \frac{1}{X_1 / K_1 + X_2 / K_2 + ...}$$

Where :

U = Heat Resistance Coefficient Factor

K_1 = Foam Thermal Conductivity

K2 = Air Thermal Condutivity

X_1 = Foam Thickness

Therefore:

1- $Q_{SideWalls} = [U A (T_a - T_r)]$

T_a = Ambient Temperature
T_r = refrigerator air Temperature

U = 1/(0.040 /0.0195) = 0.49 W/ sq.m C
A = 1.2 Sq. Mt.
T_a = 43 C
T_r = + 4 C

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$Q_{SideWalls} = 0.49 \times 1.2 \times 39 = 22.8$ Watts

$Q_{SideWalls} = 22.8$ Watts

2 - $Q_{Back\ panel} = [\ U\ A\ (\ T_a - T_r\ )\ ]$

T_a = Ambient Temperature
T_r = Refrigerator air Temperature

$U = 1/(\ 0.040\ /0.0195\ ) = 0.49$ W/ sq.m C
A = 0.69 Sq. Mt.
$T_a = 43$ C
$T_r = -4$ C

$Q_{Back\ panel} = 0.49 \times 0.69 \times 39 = 13.1$ Watts

$Q_{Back\ panel} = 13.1$ Watts

3- $Q_{Door} = [\ U\ A\ (\ T_a - T_r\ )\ ]$

T_a = Ambient Temperature
T_r = Refrigerator air Temperature

$U = 1/(\ 0.040\ /0.0195\ ) = 0.49$ W/ sq.m C
A = 0.69 Sq. Mt.
$T_a = 43$ C
$T_r = -4$ C

$Q_{Door} = 0.49 \times 0.69 \times 39 = 13.1$ Watts

$Q_{Door} = 13.1$ Watts

4 - $Q_{Bottom} = [U A (T_a - T_r)]$

T_a = Ambient Temperature
T_r = Refrigeratorr air Temperature

U = 1/(0.040 / 0.0195) = 0.49 W sq.m C
A = 0.28 Sq. Mt.
T_a = 43 C
T_r = − 4 C

Q_{Bottom} = 0.49 x 0.28 x 39 = 5.3 Watts

Q_{Bottom} = 5.3 Watts

Heat Leak Calculation for Freezer Compartment

1 - $Q_{Top} = [U A (T_a - T_f)]$

T_a = Ambient Temperature
T_f = Freezer air Temperature

U = 1 / [(0.040/0.0195)+(0.020/0.02367)] = 0.345 W/ sq.m C
A = 0.28 Sq. Mt.
T_a = 43 C
T_f = - 12 C

Q_{Top} = 0.345 x 0.28 x 55 = 5.3 Watts

Q_{Top} = 5.3 Watts

2 - $Q_{Side\ walls} = [U A (T_a - T_f)]$

T_a = Ambient Temperature
T_f = Freezer air Temperature

U = 1 [(0.055 0.0195)+(0.035 0.02367)] = 0.345 W sq.m C
A = 0.175 Sq. Mt.
T_a = 43 C
T_r = - 12 C

$Q_{\text{Side walls}}$ = 0.345 x 0.175 x 55 = 3.3 Watts

$Q_{\text{Side walls}}$ = 3.3 Watts

Total Freezer Compartment Heat Leak = 3.3 + 5.3 = 8.6

Total Refrigerator Compartment Heat Leak = 22.8 + 13.1 + 5.3 + 13.1 = 54.3 W

Total Heat Leaks:

Q_{TL} = $Q_{\text{freezer compartment}}$ + $Q_{\text{refregerator compartment}}$ = 8.6 + 54.3 = 63 watts

$Q_{\text{Total Heat Leaks}}$ = 63 Watts

b) Product Loads:

Through our knowledge, experience and facts and figures of calculation of more than eight models of Azmayesh products and some Lorestan products we found out that calculation of product loads for each individual model depends upon many factors that we could mention briefly as follows:

- Product design:
- Product style:
- Company policy:
- Useful internal volume:
- Type of evaporator;
- Type of cellar compartment;
- Freezer volume;
- Culture of customer:
- Country of origin and etc.;

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Therefore considering 40% to 65% of total heat leaks for total product load depending on size of model and internal volume of the product could be reasonable and practical to calculate. With respect to this fact we calculate our product load as follows:

$$Q_{\text{Product}} = (\ 40\% \text{ to } 65\%\ ) \text{ of } Q_{\text{Total Heat Leaks}}$$

Product load calculation for Pars Machine Refrigerator Model 1070 is:

Product load = 63 x 0.40 = 25.2 Watts

c) Heat gain through infiltration;

Total heat gain through infiltration (door opening, and gasket) are considered to 20 % of total heat gain by conduction and heat removed from products, therefore;

Heat gain by infiltration = 0.2 x (total heat leaks + product loads)

Heat gain by infiltration = 0.2 x (63 + 25.2) = 17.6 Watts

Total Cooling Capacity Required for Model 1070 are calculated as follows:

$$Q_{\text{Grand Total}} = Q_{\text{Heat Leaks}} + Q_{\text{Product Loads}} + Q_{\text{infiltration}}$$

$$Q_{\text{Grand Total}} = 63 + 25.2 + 17.6 = 106 \text{ Watts}$$

$Q_{\text{Grand Total}} = \mathbf{106}$ Watts

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Pars Monark

Upright Refrigerator & Freezer Model PKRF 17

a) Transmission load calculation

Table IX
Dimensions

Refrigerator Compartment	Dimension Cm.	Area (sq. mt.)	Insulation Thickness	Tempreture Difference
Side Walls	2 x (146x66)	1.97	30	39
Back Panel	99.5 x 68.2	0.67	30	39
Bottom Floor	68.2 x 64.2	0.44	30	39
Door	96 x 68	0.65	30	39
Freezer Compartment	Dimension Cm.	Area (sq. mt.)	Insulation Thickness	Tempreture Difference
Side Walls	2x(35x59)	0.413	55	61
Back Panel	55x44.5	0.244	55	61
Top Roof	44.5x60.3	0.262	55	61
Door	55x44.5	0.244	55	61

Insulation Type: Pu Foam

Thermal Conductivity for Foam: 0.0195 W/ mt. C

Temperature Difference Refrigerator Compartment: (ΔT) = 43 - (+4) = 39 C
Ambient Temperature = 43 C
Freezer Air Temperature = - 18 C
Refrigerator Air Temperature = +4 C

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Calculation :

Heat Leak For Refrigerator Compartment.

$$Q_{TL} = Q_{SW} + Q_{BP} + Q_{BOTTOM + DOOR}$$

$$Q = U\,A\,(T_a - T_r)$$

$$U = \frac{1}{X_1 / K_1 + X_2 / K_2 + \ldots\ldots}$$

Where :

U = Heat Resistance Coefficient Factor

K_1 = Foam Thermal Conductivity

X_1 = Foam Thickness

Therefore:

1- $Q_{SideWalls} = [\,U\,A\,(T_a - T_r)\,]$

T_a = Ambient Temperature
T_r = refrigerator air Temperature

U = 1/(0.030 / 0.0195) = 0.65 W/·sq.m C
A = 1.966 Sq. Mt.
T_a = 43 C
T_r = + 4 C

$Q_{SideWalls}$ = 0.65 x 1.966 x 39 = 49.8 Watts

$Q_{SideWalls} = 49.8$ Watts

2 - $Q_{Back\ panel} = [\,U A (T_a - T_r)\,]$

T_a = Ambient Temperature
T_r = Refrigerator air Temperature

U = 1/(0.030 /0.0195) = 0.65 W/ sq.m C
A = 0.787 Sq. Mt.
T_a = 43 C
T_r = + 4 C

$Q_{Back\ panel} = 0.65 \times 0.787 \times 39 = 19.9$ Watts

$Q_{Back\ panel} = 19.9$ Watts

3- $Q_{Door} = [\,U A (T_a - T_r)\,]$

T_a = Ambient Temperature
T_r = Refrigerator air Temperature

U = 1/(0.030 /0.0195) = 0.65 W/ sq.m C
A = 0.715 Sq. Mt.
T_a = 43 C
T_r = + 4 C

$Q_{Door} = 0.65 \times 0.715 \times 39 = 18.1$ Watts

$Q_{Door} = 18.1$ Watts

4 - $Q_{Bottom} = [\,U A (T_a - T_r)\,]$

T_a = Ambient Temperature
T_r = Refrigeratorr air Temperature

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$U = 1/(0.030\ /0.0195) = 0.65$ W/ sq.m C
$A = 0.317$ Sq. Mt.
$T_a = 43$ C
$T_r = +4$ C

$Q_{Bottom} = 0.65 \times 0.317 \times 39 = 8.03$ Watts

$Q_{Bottom} = 8.03$ Watts

Heat Leak Calculation for Freezer Compartment

1 - $Q_{Top} = [\,U A (T_a - T_f)\,]$

T_a = Ambient Temperature
T_f = Freezer air Temperature

$U = 1 / (0.055/0.0195) = 0.3545$ W/ sq.m C
$A = 0.262$ Sq. Mt.
$T_a = 43$ C
$T_f = -18$ C

$Q_{Top} = 0.3545 \times 0.262 \times 61 = 5.66$ Watts

$Q_{Top} = 5.66$ Watts

2 - $Q_{Side\ walls} = [\,U A (T_a - T_f)\,]$

T_a = Ambient Temperature
T_f = Freezer air Temperature

$U = 1 / (0.055/0.0195) = 0.3545$ W/ sq.m C
$A = 0.413$ Sq. Mt.
$T_a = 43$ C
$T_f = -18$ C

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$Q_{Side\ walls}$ = 0.3545 x 0.413 x 61 = 8.9 Watts

$Q_{Side\ walls}$ = 8.9 Watts

3 - $Q_{Back\ panel}$ = [U A (T_a - T_f)]

T_a = Ambient Temperature
T_f = Freezer air Temperature
U = 1/(0.055 /0.0195) = 0.3545 W/ sq.m C
A = 0.55 Sq. Mt.
T_a = 43 C
T_f = - 18 C

$Q_{Back\ panel}$ = 0.3545 x 0.244 x 61 = 5.29 Watts

$Q_{Back\ panel}$ = 5.29 Watts

4 - Q_{Door} = [U A (T_a - T_r)]

T_a = Ambient Temperature
T_f = Freezer air Temperature

U = 1/(0.055 /0.0195) = 0.3545 W/ sq.m C
A = 0.155 Sq. Mt.
T_a = 43 C
T_f = - 18 C

Q_{Door} = 0.3545 x 0.244 x 61 = 5.2 Watts

Q_{Door} = 5.2 Watts

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Total Refrigerator Compartment Heat Leak = 49.8 + 19.9 + 8.3 + 18.1 = 96.1

Total Freezer Compartment Heat Leak = 8.9 + 5.29 + 5.66 + 5.29 = 25.14 W

Total Heat Leaks;

$$Q_{TL} = Q_{\text{freezer compatment}} + Q_{\text{refrigerator compartment}} = 25.14 + 96.1 = 121.24 \text{ watts}$$

$$\boxed{Q_{\text{Total Heat Leaks}} = 121.24 \text{ Watts}}$$

b) Product Loads;

Through our knowledge, experience and facts and figures of calculation of more than eight models of Azmayesh products and some Lorestan products we found out that calculation of product loads for each individual model depends upon many factors that we could mention briefly as follows:

- Product design;
- Product style;
- Company policy;
- Useful internal volume;
- Type of evaporator;
- Type of cellar compartment;
- Freezer volume;
- Culture of customer;
- Country of origin and etc.;

Therefore considering 40% to 65% of total heat leaks for total product load depending on size of model and internal volume of the product could be reasonable and practical to calculate. With respect to this fact we calculate our product load as follows;

$$Q_{\text{Product}} = (\ 40\% \text{ to } 65\%\ ) \text{ of } Q_{\text{Total Heat Leaks}}$$

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Product load calculation for Pars Monark Refrigerator Freezer Model PKRF17is;

Product load = 121.24 x 0.50 = 60.7 Watts

c) Heat gain through infiltration;

Total heat gain through infiltration (door opening, and gasket) are considered to 20 % of total heat gain by conduction and heat removed from products, therefore;

Heat gain by infiltration = 0.2 x (total heat leaks + product loads)

Heat gain by infiltration = 0.2 x (121.24 + 60.7) = 36.37Watts

Total Cooling Capacity Required for Model PKRF17 are calculated as follows;

$$Q_{\text{Grand Total}} = Q_{\text{Heat Leaks}} + Q_{\text{Product Loads}} + Q_{\text{infiltration}}$$

$$Q_{\text{Grand Total}} = 121.24 + 60.7 + 36.37 = 218.3 \text{ Watts}$$

$$Q_{\text{Grand Total}} = 218 \text{ Watts}$$

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Pars Monark

Upright Freezer Model MNKF12

a) Transmission load calculation

Table XX
Dimensions

	Dimension Cm.	Area (sq. mt.)	Insulation Thickness
Side Walls	2 x (135x58)	1.57	50
Back Panel	135 x 45	0.60	50
Top Roof	58 x 45	0.26	50
Bottom Floor	58 x 45	0.26	50
Door	135 x 45	0.6	50

Insulation Type: Pu Foam

CP. Foam Thermal Conductivity: 0.0195 W /mt.C

Temperature Difference: $(\Delta T) = 43 - (-18) = 61$ C
Ambient Temperature = 43 C
Freezer Air Temperature = - 18 C

Calculation :

$$Q_{TL} = Q_{SW} + Q_{BP} + Q_{BOTTOM} + Q_{TOP} + Q_{DOOR}$$

$$Q = U A (T_a - T_f)$$

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$$U = \frac{1}{X_1 / K_1 + X_2 / K_2 + \ldots\ldots}$$

Where :

U = Heat Resistance Coefficient Factor

K_1 = Foam Thermal Conductivity

X_1 = Foam Thickness

Therefore:

1- $Q_{SideWalls} = [\,U\,A\,(T_a - T_f)\,]$

T_a = Ambient Temperature
T_f = Freezer air Temperature

U = 1/(0.050 /0.0195) = 0.39 W/ sq.m C
A = 1.57 Sq. Mt.
T_a = 43 C
T_f = - 18 C

$Q_{SideWalls}$ = 0.39 x 1.57 x 61 = 37.35 Watts

$Q_{SideWalls}$ = 37.35 Watts

2 - $Q_{back\ panel} = [\,U\,A\,(T_a - T_f)\,]$

T_a = Ambient Temperature
T_f = Freezer air Temperature

U = 1/(0.050/ 0.0195) = 0.39 W sq.m C
A = 0. 6 Sq. Mt.
T_a = 43 C
T_f = - 18 C

$Q_{Back\ panel}$ = 0.39 x 0.6 x 61 = 14.2 Watts

$Q_{Back\ panel} = 14.2$ Watts

3 - $Q_{Top} = [\, U A (T_a - T_f) \,]$

T_a = Ambient Temperature
T_f = Freezer air Temperature

$U = 1/(0.050 \ / 0.0195) = 0.39$ W/ sq.m C
$A = 0.26$ Sq. Mt.
$T_a = 43$ C
$T_f = - 18$ C

$Q_{Top} = 0.39 \times 0.26 \times 61 = 6.2$ Watts

$Q_{Top} = 6.2$ Watts

4 - $Q_{Bottom} = [\, U A (T_a - T_f) \,]$

T_a = Ambient Temperature
T_f = Freezer air Temperature

$U = 1/(0.050 \ / 0.0195) = 0.39$ W/ sq.m C
$A = 0.26$ Sq. Mt.
$T_a = 43$ C
$T_f = - 18$ C

$Q_{Bottom} = 0.26 \times 0.39 \times 61 = 6.2$ Watts

$Q_{Bottom} = 6.2$ Watt

5 - $Q_{Door} = [\, U A (T_a - T_f) \,]$

T_a = Ambient Temperature
T_f = Freezer air Temperature

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$U = 1/(0.050 \ / 0.0195) = 0.39$ W/ sq.m C

A = 0.6 Sq. Mt.
$T_a = 43$ C
$T_f = -18$ C

$Q_{Door} = 0.39 \times 0.6 \times 61 = 14.22$ Watts

$Q_{Door} = 14.22$ Watts

Total Heat Leaks;

$Q_{TL} = 37.35 + 14.2 + 6.2 + 6.2 + 14.2 = 78.15$ watts

$Q_{\text{Total Heat Leaks}} = 78$ Watts

b) Product Loads;

Through our knowledge, experience and facts and figures of calculation of more than eight models of Azmayesh products and some Lorestan products we found out that calculation of product loads for each individual model depends upon many factors that we could mention briefly as follows:

- Product design;
- Product style;
- Company policy;
- Useful internal volume;
- Type of evaporator;
- Type of cellar compartment;
- Freezer volume;
- Culture of customer;
- Country of origin and etc.;

Therefore considering 40% to 65% of total heat leaks for total product load depending on size of model and internal volume of the product could be reasonable and practical to calculate. With respect to this fact we calculate our product load as follows:

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$$Q_{Product} = (40\% \text{ to } 65\%) \text{ of } Q_{Total\ Heat\ Leaks}$$

Product load calculation for Pars Monark Model PMKF12 is:

Product load = 78 x 0.40 = 31.2 Watts

c) Heat gain through infiltration:

Total heat gain through infiltration (door opening, and gasket) are considered to 20 % of total heat gain by conduction and heat removed from products, therefore:

Heat gain by infiltration = 0.2 x (total heat leaks − product loads)

Heat gain by infiltration = 0.2 x (78 − 31.2) = 21.8 Watts

Total Cooling Capacity Required for Model PMKF12 are calculated as follows:

$$Q_{Grand\ Total} = Q_{Heat\ Leaks} + Q_{Product\ Loads} + Q_{infiltration}$$

$$Q_{Grand\ Total} = 78 + 31.2 + 21.8 = 131 \text{ Watts}$$

$Q_{Grand\ Total}$ = 131 Watts

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Pars Monark

Upright Freezer Model PMKF7

a) Transmission load calculation

Table XXI
Dimensions

	Dimension Cm.	Area (sq. mt.)	Insulation Thickness
Side Walls	2 x (86x57)	1.00	60
Back Panel	86 x 38	0.326	60
Top Roof	57 x 38	0.21	60
Bottom Floor	57 x 38	0.21	60
Door	86 x 38	0.326	60

Insulation Type: Pu Foam

CP. Foam Thermal Conductivity: 0.0195 W/mt.C

Temperature Difference: $(\Delta T) = 43 - (-18) = 61$ C
Ambient Temperature = 43 C
Freezer Air Temperature = - 18 C

$$Q_{TL} = Q_{SW} + Q_{BP} + Q_{BOTTOM} + Q_{TOP} + Q_{DOOR}$$

$$Q = U\,A\,(T_1 - T_2)$$

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$$U = \frac{1}{X_1 / K_1 + X_2 / K_2 + \dots\dots}$$

Where :

U = Heat Resistance Coefficient Factor

K_1 = Foam Thermal Conductivity

X_1 = Foam Thickness

Therefore:

1- $Q_{SideWalls} = [\, U A (T_a - T_f) \,]$

T_a = Ambient Temperature
T_f = Freezer air Temperature

$U = 1/(0.060 \;/ 0.0195) = 0.325$ W/ sq.m C
A = 1.00 Sq. Mt.
T_a = 43 C
T_f = - 18 C

$Q_{SideWalls} = 0.325 \times 1.00 \times 61 = 20$ Watts

$Q_{SideWalls}$ = 20 Watts

2 - $Q_{Back\ panel} = [\, U A (T_a - T_f) \,]$

T_a = Ambient Temperature
T_f = Freezer air Temperature

$U = 1/ (0.060 / \; 0.0195) = 0.325$ W/ sq.m C
A = 0.326 Sq. Mt.
T_a = 43 C
T_f = - 18 C

No. 1015, Tehran-nou Ave. , Tehran 17437 Iran, Tel +98 21 741 67 26 , Fax + 98 21 7410329

$Q_{Back\ panel} = 0.325 \times 0.326 \times 61 = 6.5$ Watts

$Q_{Back\ panel} = 6.5$ Watts

3 - $Q_{Top} = [U A (T_a - T_f)]$

T_a = Ambient Temperature
T_f = Freezer air Temperature

$U = 1/(0.060 / 0.0195) = 0.325$ W/ sq.m C
$A = 0.21$ Sq. Mt.
$T_a = 43$ C
$T_f = - 18$ C

$Q_{Top} = 0.325 \times 0.21 \times 61 = 4.2$ Watts

$Q_{Top} = 4.2$ Watts

4 - $Q_{Bottom} = [U A (T_a - T_f)]$

T_a = Ambient Temperature
T_f = Freezer air Temperature

$U = 1/(0.060 / 0 . 0195) = 0.325$ W/ sq.m C
$A = 0.21$ Sq. Mt.
$T_a = 43$ C
$T_f = - 18$ C

$Q_{Bottom} = 0.21 \times 0.325 \times 61 = 4.2$ Watts

$Q_{Bottom} = 4.2$ Watt

5 - $Q_{Door} = [U A (T_a - T_f)]$

T_a = Ambient Temperature

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T_f = Freezer air Temperature

$U = 1/(0.060 / 0.0195) = 0.325$ W sq.m C
A = 0.326 Sq. Mt.
$T_a = 43$ C
$T_f = -18$ C

$Q_{Door} = 0.325 \times 0.326 \times 61 = 6.5$ Watts

$Q_{Door} = 6.5$ Watts

Total Heat Leaks:

$Q_{TL} = 20 + 6.5 + 4.2 + 6.5 + 4.2 = 41.4$ watts

$Q_{\text{Total Heat Leaks}} = 41.4$ Watts

b) Product Loads:

Through our knowledge, experience and facts and figures of calculation of more than eight models of Azmayesh products and some Lorestan products we found out that calculation of product loads for each individual model depends upon many factors that we could mention briefly as follows:

- Product design;
- Product style;
- Company policy;
- Useful internal volume;
- Type of evaporator;
- Type of cellar compartment;
- Freezer volume;
- Culture of customer;
- Country of origin and etc.;

Therefore considering 40% to 65% of total heat leaks for total product load depending on size of model and internal volume of the product could be reasonable and practical to calculate. With respect to this fact we calculate our product load as follows:

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$$Q_{Product} = (40\% \text{ to } 65\%) \text{ of } Q_{Total\ Heat\ Leaks}$$

Product load calculation for Gadook Model FU 280 is:

Product load = 41.4 x 0.40 = 16.6 Watts

c) Heat gain through infiltration:

Total heat gain through infiltration (door opening, and gasket) are considered to 20 % of total heat gain by conduction and heat removed from products, therefore;

Heat gain by infiltration = 0.2 x (total heat leaks − product loads)

Heat gain by infiltration = 0.2 x (41.4 − 16.6) = 11.6 Watts

Total Cooling Capacity Required for Model PMKF7 are calculated as follows:

$$Q_{Grand\ Total} = Q_{Heat\ Leaks} + Q_{Product\ Loads} + Q_{infiltration}$$

$$Q_{Grand\ Total} = 41.4 + 16.6 + 11.6 = 69.6 \text{ Watts}$$

$Q_{Grand\ Total}$ = 69.6 Watts

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Pars Monark

Upright Refrigerator Model PMKR12

a) Transmission load calculation

Table XXIII
Dimensions

Refrigerator Compartment	Dimension Cm.	Area (sq. mt.)	Insulation Thickness	Tempreture Difference
Side Walls	2x(121.x47.5)	1.15	30	39
Back Panel	138 x 57	0.8	30	39
Bottom Floor	57 x 47.5	0.27	30	39
Door	138 x 57	0.8	30	39
Freezer Compartment	**Dimension Cm.**	**Area (sq. mt.)**	**Insulation Thickness**	**Tempreture Difference**
Side Walls	2x(17x47.5)	0.16	30	55
Top Roof	47.5x 57	0.27	30	55

Insulation Type: Pu Foam

Thermal Conductivity for Foam: 0.0195 W/ mt. C
Thermal Conductivity for Air at -12 at 1 atm. =0.02367 W/mt. C

Temperature Difference Refrigerator Compartment: $(\Delta T) = 43 - (-4) = 39$ C
Ambient Temperature = 43 C
Freezer Air Temperature = - 12 C
Refrigerator Air Temperature = -4 C

Calculation :
Heat Leak For Refrigerator Compartment.

$$Q_{TL} = Q_{SW} + Q_{BP} + Q_{BOTTOM} + Q_{DOOR}$$

$$Q = U A (T_a - T_r)$$

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$$U = \frac{1}{X_1 / K_1 + X_2 / K_2 + \ldots\ldots}$$

Where :

U = Heat Resistance Coefficient Factor

K_1 = Foam Thermal Conductivity

K_2 = Air Thermal Condutivity

X_1 = Foam Thickness

Therefore:

1- $Q_{SideWalls} = [\, U\, A\, (T_a - T_r)\,]$

T_a = Ambient Temperature
T_r = refrigerator air Temperature

$U = 1/(0.030\ /0.0195) = 0.65$ W/ sq.m C

A = 1.15 Sq. Mt.
T_a = 43 C
T_f = + 4 C

$Q_{SideWalls} = 0.65 \times 1.15 \times 39 = 29.2$ Watts

$Q_{SideWalls} = 29.2$ Watts

2 - $Q_{Back\ panel} = [\, U\, A\, (T_a - T_r)\,]$

T_a = Ambient Temperature
T_r= Refrigerator air Temperature
$U = 1 / (0.030\ /\ 0.0195) = 0.65$ W/ sq.m C
A = 0.8 Sq. Mt.

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T_a = 43 C

T_r = - 4 C

$Q_{Back\ panel}$ = 0.65 x 0.8 x 39 = 20.3 Watts

$Q_{Back\ panel}$ = 20.3 Watts

3- Q_{Door} = [U A (T_a - T_r)]

T_a = Ambient Temperature

T_r = Refrigerator air Temperature

U = 1/(0.030 / 0.0195) = 0.65 W/ sq.m C

A = 0.8 Sq. Mt.

T_a = 43 C

T_r = - 4 C

Q_{Door} = 0.65 x 0.8 x 39 = 20.3 Watts

Q_{Door} = 20.3 Watts

4 - Q_{Bottom} = [U A (T_a - T_r)]

T_a = Ambient Temperature

T_r = Refrigeratorr air Temperature

U = 1/(0.030 / 0.0195) = 0.65 W/ sq.m C

A = 0.27 Sq. Mt.

T_a = 43 C

T_r = - 4 C

Q_{Bottom} = 0.65 x 0.27 x 39 = 6.8 Watts

Q_{Bottom} = 6.8 Watts

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Heat Leak Calculation for Freezer Compartment

1 - $Q_{Top} = [\, U\, A\, (\, T_a - T_f\,)\,]$

T_a = Ambient Temperature
T_f = Freezer air Temperature

U = 1 / [(0.030/0.0195)+(0.020/0.02367)] = 0.42 W/ sq.m C
A = 0.27 Sq. Mt.
T_a = 43 C
T_f = - 12 C

Q_{Top} = 0.42 x 0.27 x 55 = 6.2 Watts

Q_{Top} = 6.2 Watts

2 - $Q_{Side\ walls} = [\, U\, A\, (\, T_a - T_f\,)\,]$

T_a = Ambient Temperature
T_f = Freezer air Temperature

U = 1 / [(0.030/0.0195)+(0.035/0.02367)] = 0.42 W/ sq.m C
A = 0.16 Sq. Mt.
T_a = 43 C
T_f = - 12 C

$Q_{Side\ walls}$ = 0.42 x 0.16 x 55 = 3.7 Watts

$Q_{Side\ walls}$ = 3.7 Watts

Total Freezer Compartment Heat Leak = 6.2 + 3.7 = 10

Total Refrigerator Compartment Heat Leak = 29.2 + 20.3 + 6.8 + 20.3 = 76.6W

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Total Heat Leaks:

$Q_{TL} = Q_{freezer\ compartment} + Q_{refregerator\ compartment} = 10 + 76.6 = 86.6$ watts

$$Q_{Total\ Heat\ Leaks} = 86.6 \text{ Watts}$$

b) Product Loads:

Through our knowledge, experience and facts and figures of calculation of more than eight models of Azmayesh products and some Lorestan products we found out that calculation of product loads for each individual model depends upon many factors that we could mention briefly as follows:

- Product design;
- Product style;
- Company policy;
- Useful internal volume;
- Type of evaporator;
- Type of cellar compartment;
- Freezer volume;
- Culture of customer;
- Country of origin and etc.;

Therefore considering 40% to 65% of total heat leaks for total product load depending on size of model and internal volume of the product could be reasonable and practical to calculate. With respect to this fact we calculate our product load as follows:

$$Q_{Product} = (40\% \text{ to } 65\%) \text{ of } Q_{Total\ Heat\ Leaks}$$

Product load calculation for Pars Monark Refrigerator Model is PMKR12:

Product load = 86.6 x 0.6 = 52 Watts

c) Heat gain through infiltration:

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Total heat gain through infiltration (door opening, and gasket) are considered to 20 % of total heat gain by conduction and heat removed from products, therefore:

Heat gain by infiltration = 0.2 x (total heat leaks − product loads)

Heat gain by infiltration = 0.2 x (86.6− 52) = 27.7 Watts

Total Cooling Capacity Required for Model PMKR12 are calculated as follows:

$$Q_{Grand\ Total} = Q_{Heat\ Leaks} - Q_{Product\ Loads} - Q_{infiltration}$$

$$Q_{Grand\ Total} = 86.6 - 52 - 27.7 = 166.3 \text{ Watts}$$

$$\boxed{Q_{Grand\ Total} = 166.3 \text{ Watts}}$$