

# **Technical Reference on Harmonization of Energy Efficiency Test Methods of Refrigerators towards the NEW IEC 62552 among APEC Region (Test report)**

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## Technical Reference



# Results analysis



## 1. Upright refrigerator

Main differences of these four standards in test conditions

Test standards Elements	IEC 62552:2015	IEC 62552:2007	Australia	USA
Room test ambient temperature	16.0°C and 32.0°C	25.0°C	32.0°C	32.2°C
Target temperature of fresh-food comp.	Average: 4.0°C	Average: 5.0°C Min.: 0°C, Max.: 10°C	Average: 3.0°C	Average: 3.9°C
Temperature sensor	Cylinder2 with 15.2mm diameter and 15.2mm long	Cylinder3 with 25mm diameter and 25mm long	Cylinder4 with 29mm diameter and 29mm long	Cylinder2 with 15.2mm diameter and 15.2mm long
Storage plan of fresh-food comp. storage temperature sensor				
Calculated daily energy consumption	$P \cdot 24, E_{\text{Daily}16C}, E_{\text{Daily}32C}$	Tested energy consumption express in kWh per 24hrs, $E_{24h}$		
Calculated annual energy consumption, kWh/year	$\text{Day}_{16} \cdot E_{\text{Daily}16C} + \text{Day}_{32} \cdot E_{\text{Daily}32C} + \Delta E_{\text{processing-annual}}$	$E_{24h} \cdot 365$		

# Results analysis



## 1. Upright refrigerator

### Test data

Item	Unit	IEC 62552:2015				IEC 62552:2007		Australia		USA	
		16	5	5.9	5.7	4	5	4.8	6	4.5	8
Ambient temperature	°C	16		32		25		32		32.2	
Temperature control settings		5.5	5	5.9	5.7	4	5	4.8	6	4.5	8
Temperature in fresh food storage compartment	°C	3.3	5.1	3.7	4.9	6.1	3.8	4.3	2.4	5.8	-1.5
Steady state power	W	10.8	9.3	36.4	32.8	N/A	N/A	N/A	N/A	N/A	N/A
Energy consumption per 24h	kWh/24h	0.259	0.223	0.874	0.787	0.441	0.490	0.733	0.906	0.7	1.205
Energy consumption by interpolation	kWh/24h	0.245		0.852		0.464		0.864		0.832	
Standard energy consumption	kWh/24h	0.533				0.464		0.864		0.832	
Total Energy consumption	kWh/24h	0.567				0.464		0.864		0.832	

# Results analysis

1. Upright refrigerator



# Influences?

# What are the factors?


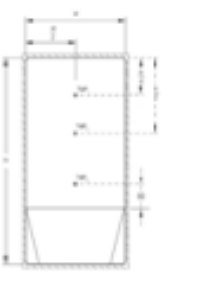
# Results analysis



## 1. Upright refrigerator

These impact factor's influences on last test results(calculating with the deviation method ):

### 1.1 Ambient test temperature

Elements	standards	IEC 62552:2015	IEC 62552:2015
Room test ambient temperature		Different (16.0°C)	Different(32.0°C)
Target temperature of fresh-food comp.		Same(4.0°C)	Same(4.0°C)
Storage plan of fresh-food comp. storage temperature sensor		Same 	Same 
Tested daily energy consumptions, kWh/24h		0.245	0.852
<b>Deviation:</b>		$(0.852-0.245)/0.852*100\%=71.2\%$	

when the ambient temperature increases 1 K, the energy consumption will increase 4.5%

# Results analysis



## 1. Upright refrigerator

These impact factor's influences on last test results(**calculating with the deviation method**):

### 1.2 Target temperature of fresh-food compartment

Item	Unit	IEC 62552:2015	
Ambient temperature	°C	16	
Temperature control settings		5.5	5
Temperature in fresh food storage compartment	°C	3.3	5.1
Energy consumption per 24h	kWh/24h	0.259	0.223
Energy consumption by interpolation (Target=5°C)	kWh/24h	0.225	
Energy consumption by interpolation (Target=4°C)	kWh/24h	0.245	
Additional energy consumption ratio for target temperature change	%	8.9%	

The additional energy consumption is 8.9% at 16°C ambient temperature for 4°C target temperature compared with 5°C target temperature

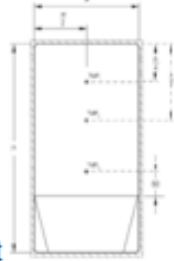

# Results analysis



## 1. Upright refrigerator

These impact factor's influences on last test results(**calculating with the deviation method**):

### 1.3 Storage plan and temperature sensor of fresh-food comp.

Elements standards	IEC 62552:2015	USA
Room test ambient temperature	Similar (32.0°C)	Similar (32.2°C)
Target temperature of fresh-food comp.	Similar (4.0°C)	Similar (3.9°C)
Storage plan of fresh-food comp. storage temperature sensor	Different 	Different 
Tested daily energy consumptions, kWh/24h	0.852	0.832
Deviation	$(0.852-0.832)/0.852*100\%=2.3\%$	

The deviation of test results 2.3% is due to storage plan of fresh-food comp., storage temperature sensor




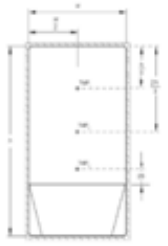
# Results analysis



## 1. Upright refrigerator

These impact factor's influences on last test results(**calculating with the deviation method**):

### 1.4 Two tests at different ambient temperatures

Elements standards	IEC 62552:2015	IEC 62552:2007
Room test ambient temperature	Similar (16°C and 32°C)	Similar (25°C)
Target temperature of fresh-food comp.	Different (4.0°C)	Different (5.0°C)
Storage plan of fresh-food comp. storage temperature sensor	Different 	Different 
Standard energy consumption, kWh/24h	0.533	0.464
Total deviation (target temperature, storage plan and temperature sensor, two tests at different ambient temperatures)	$(0.533-0.464)/0.533*100\%=12.9\%$	
Deviation of target temperature of fresh-food comp.	9%	
Deviation of storage plan and temperature sensor of fresh-food comp.	2.3%	
Deviation of two tests at different ambient temperatures	Almost same( $12.9-2.3-9$ )=1.6%	

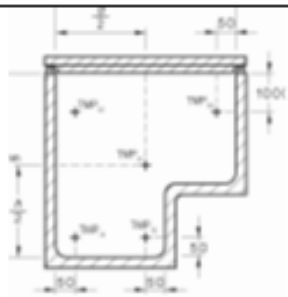
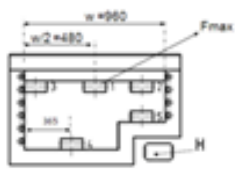
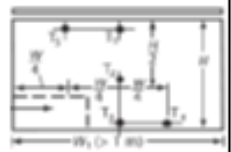
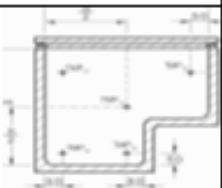
The deviation of two tests at different ambient temperatures from the 25°C ambient temperature is 1.6%

# Results analysis



## 2. Chest freezer

Main differences of these four standards in test conditions

Test standards Elements	IEC 62552:2015	IEC 62552:2007	USA	Australia
Room test ambient temperature	16.0°C and 32.0°C	25.0°C	32.2°C	32.0°C
Target temperature of frozen-food comp.	Average: -18.0°C	Max.: -18.0°C	Average: -17.8°C	Average: -15.0°C
Storage plan of frozen-food comp. storage temperature sensor				
Frozen-food comp. storage temperature sensor	Cylinder with 18mm diameter and long	M-packages	M-packages	Cylinder with 25mm diameter and long
Calculated daily energy consumption	$P*24, E_{Daily16C}, E_{Daily32C}$	Tested energy consumption express in kWh per 24hrs, $E_{24h}$		
Calculated annual energy consumption, kWh/year	$Day_{16} * E_{Daily16C} + Day_{32} * E_{Daily32C} + \Delta E_{processing-annual}$	$E_{24h} * 365$		

# Results analysis



## 2. Chest freezer

### Test data

Item	Unit	IEC 62552:2015				IEC 62552:2007		Australia		USA	
		16	32	32	32	25	25	32	32	32.2	32.2
Ambient temperature	°C	16		32		25		32		32.2	
Temperature control settings		3.7	3.4	3.5	3	5	4	2	1.5	4	1
Temperature in frozen food storage compartment	°C	-18.7	-17.8	-18.4	-17.7	-19.2	-17.0	-15.5	-14.5	-18.1	-12.0
Steady state power	W	28.8	27.7	55.4	53.9	N/A	N/A	N/A	N/A	N/A	N/A
Energy consumption per 24h	kWh/24h	0.691	0.665	1.330	1.294	1.106	1.004	1.067	1.037	0.963	0.754
Energy consumption by interpolation	kWh/24h	0.671		1.309		1.050		1.052		0.952 (1.36*)	
Standard energy consumption	kWh/24h	0.973				1.050		1.052		0.952	
Total Energy consumption	kWh/24h	1.138				1.050		1.052		0.952	

# Results analysis

## 2. Chest freezer



# Influences?

# What are the factors?

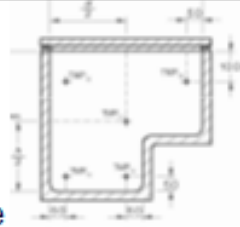
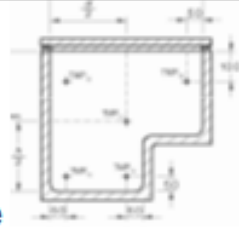
# Results analysis



## 2. Chest freezer

These impact factor's influences on last test results(**calculating with the deviation method**):

### 2.1 Ambient temperature

Elements	standards	IEC 62552:2015	IEC 62552:2015
Room test ambient temperature		Different (16.0°C)	Different(32.0°C)
Target temperature of frozen-food comp.		Same(-18.0°C)	Same(-18.0°C)
Storage plan of frozen-food comp. storage temperature sensor		Same 	Same 
Frozen-food comp. storage temperature sensor		Same(Cylinder)	Same(Cylinder)
Tested daily energy consumptions, kWh/24h		0.671	1.309
Deviation:		$(1.309-0.671)/1.309*100\%=48.7\%$	

When the ambient temperature increases 1 K, the energy consumption will increase 3.0%

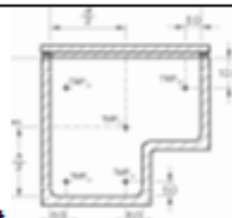

# Results analysis



## 2. Chest freezer

These impact factor's influences on last test results(**calculating with the deviation method**):

### 2.2 Empty load and storage temperature sensor of frozen-load comp.

Elements	standards	IEC 62552:2015	USA
Room test ambient temperature		Similar(32.0°C)	Similar(32.2°C)
Target temperature of frozen-food comp.		Similar(-18.0°C)	Similar(-17.8°C)
Empty load of frozen-food comp. storage temperature sensor		 <p>Different</p>	 <p>Different</p>
Frozen-food comp. storage temperature sensor		Different(Cylinder)	Different(M-packages)
Tested daily energy consumptions, kWh/24h		1.309	1.36
Deviation		$(1.309-1.36)/1.309*100\%=-3.9\%$	

Because of effect of empty load of frozen-food comp. and storage temperature sensor, the energy consumption according to IEC 62552:2015 (at 32°C) is less 3.9% than DOE

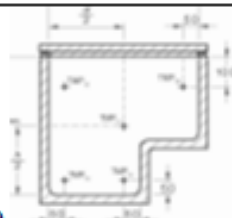
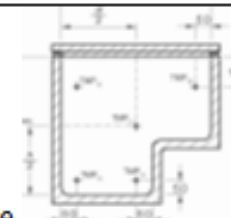
# Results analysis



## 2. Chest freezer

These impact factor's influences on last test results(**calculating with the deviation method**):

### 2.3 Target temperature of frozen-food compartment

Elements standards	IEC 62552:2015	AU
Room test ambient temperature	Same (32.0°C)	Same (32.0°C)
Target temperature of frozen-food comp.	Same(-18.0°C)	Different (-15.0°C)
Storage plan of frozen-food comp. storage temperature sensor	Same 	Same 
Frozen-food comp. storage temperature sensor	Same(Cylinder)	Same(Cylinder)
Tested daily energy consumptions, kWh/24h	1.309	1.052
Deviation:	$(1.309-1.052)/1.309*100\%=19.6\%$	

The additional energy consumption ratio for target temperature change is 6.5% for frozen-compartment

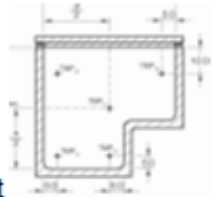
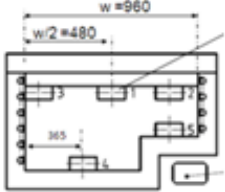
# Results analysis



## 2. Chest freezer

These impact factor's influences on last test results(**calculating with the deviation method**):

### 2.4 Determination of frozen-food compartment temperature

Elements	standards	IEC 62552:2015	IEC 62552:2007
Room test ambient temperature		Similar(16°C and 32.0°C)	Similar(25°C)
Target temperature of frozen-food comp.		same(-18.0°C)	same (-18.0°C)
Empty load of frozen-food comp. storage temperature sensor		 Different	 Different
Frozen-food comp. storage temperature sensor		Different(Cylinder)	Different(M-packages)
Determination of target temperature		Average of temperature sensors	The maximum of temperature sensors
Standard energy consumption, kWh/24h		0.973	1.050
Total deviation (empty load and storage temperature sensor, determination of frozen-food compartment temperature)		$(0.973-1.050)/0.973 *100\%=-7.9\%$	
Deviation of empty of frozen-food comp. storage temperature sensor		-3.9%	
Deviation of determination of frozen-food compartment temperature		$-7.9\%-(-3.9\%)=-4.0\%$	

The effect of maximum of M package of frozen-food compartment is -4.0% on energy consumption for frozen-food compartment



# Results analysis



## 3. Upright refrigerator-freezer

Main differences of these four standards in test conditions

Test standards Elements	IEC 62552:2015	IEC 62552:2007	Australia	USA
Room test ambient temperature	16.0°C and 32.0°C	25.0°C	32.0°C	32.2°C
Target temperature of fresh-food comp.	Average: 4.0°C	Average: 5.0°C Min.: 0°C, Max.: 10°C	Average: 3.0°C	Average: 3.9°C
Target temperature of frozen-food comp.	Average: -18.0°C	Max.: -18.0°C	Average: -15.0°C	Average: -17.8°C
Storage plan of fresh-food comp. storage temperature sensor				
Storage plan of frozen-food comp. storage temperature sensor				
Frozen-food comp. storage temperature sensor	Cylinder with 18mm diameter and long	M-packages	Cylinder with 25mm diameter and long	M-packages
Fresh-food comp. storage temperature sensor	Cylinder1 with 18mm diameter and 18mm long	Cylinder2 with 15.2mm diameter and 15.2mm long	Cylinder3 with 25mm diameter and 25mm long	Cylinder4 with 29mm diameter and 29mm long
Calculated daily energy consumption	$P*24, E_{Daily16C}, E_{Daily32C}$	Tested energy consumption express in kWh per 24hrs, $E_{24h}$		
Calculated annual energy consumption, kWh/year	$Day_{16} * E_{Daily16C} + Day_{32} * E_{Daily32C} + \Delta E_{processing-annual}$	$E_{24h} * 365$		

# Results analysis



## 3. Upright refrigerator-freezer

### Test data

Item	Unit	IEC 62552:2015				IEC 62552:2007		Australia		USA	
		16	32	25	32	32.2					
Ambient temperature	°C	16	32	25	32	32.2					
Temperature control settings	°C	5	4.1	4.9	4.6	4.3	4.8	4.5	4.9	3	5
Temperature in fresh food storage compartment	°C	3.6	4.1	3.7	4.9	3.9	2.1	4.6	2.4	8.9	1.3
Temperature in frozen food storage compartment	°C	-20.9	-19.3	-21.6	-20.4	-17.1	-18.7	-20.0	-22.2	-14.6	-25.7
Energy consumption per 24h	kWh/24h	0.475	0.432	0.739	0.679	0.5	0.587	0.689	0.803	0.497	0.88
Energy consumption by interpolation	kWh/24h	0.441		0.724		0.549	0.772	0.750			
Standard energy consumption	kWh/24h	0.575				0.549	0.772	0.750			
Total Energy consumption	kWh/24h	0.653				0.549	0.772	0.750			

## Results analysis

3. Upright refrigerator-freezer



# Influences?

## What are the factors?



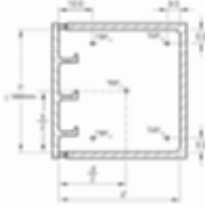
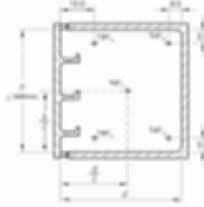
# Results analysis



## 3. Upright refrigerator-freezer

These impact factor's influences on last test results(**calculating with the deviation method**):

### 3.1 Ambient temperature

Elements	standards	IEC 62552:2015	IEC 62552:2015
Room test ambient temperature		Different (16.0°C)	Different(32.0°C)
Target temperature of fresh-food comp.		Same(4.0°C)	Same(4.0°C)
Target temperature of frozen-food comp.		Same(-18.0°C)	Same(-18.0°C)
Storage plan of fresh-food comp. storage temperature sensor		Same 	Same 
Storage plan of frozen-food comp. storage temperature sensor		Same 	Same 
Frozen-food comp. storage temperature sensor		Same(Cylinder)	Same(Cylinder)
Tested daily energy consumptions, kWh/24h		0.441	0.724
Deviation:		$(0.724-0.441)/0.724*100\%=39.1\%$	

When the ambient temperature increases 1 K, the energy consumption will increase 2.4%



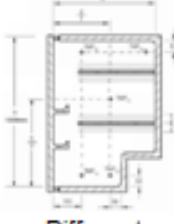
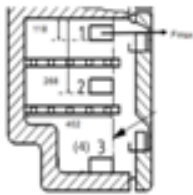
# Results analysis



## 3. Upright refrigerator-freezer

These impact factor's influences on last test results (calculating with the deviation method):

### 3.2 Two tests at different ambient temperatures

Elements standards	IEC 62552:2015	IEC 62552:2007
Room test ambient temperature	Similar (16°C and 32°C)	Similar (25°C)
Target temperature of fresh-food comp.	Different (4.0°C) Interpolation comp.	Different (5.0°C)
Target temperature of frozen comp.	Same (-18.0°C)	Same (-18.0°C) Interpolation comp.
Storage plan of fresh-food comp. storage temperature sensor	 Different	 Different
Storage plan of frozen-food comp. storage temperature sensor	 Different	
Determination of target temperature of fresh-food comp.	Same (average of temperature sensors)	Same (average of temperature sensors)
Determination of target temperature of frozen-food comp.	Different (Average of temperature sensors)	Different (The maximum of temperature sensors)
Standard energy consumption, kWh/24h	0.575	0.549

Total deviation:  
 $(0.575 - 0.549) / 0.575 * 100\% = 4.5\%$

Deviation of determination of frozen-food compartment temperature: -4.0%

Deviation of empty load in the frozen-food comp.: -3.9%



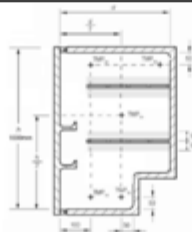
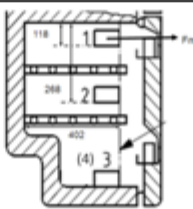
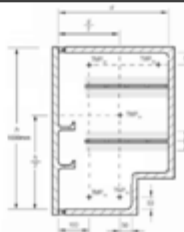
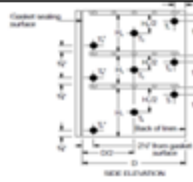
Deviation of two tests at different ambient temperatures:  
 $(4.5 - (-4.0) - (-3.9)) = 12.4\%$

# Results analysis



## 4. Upright frost-free refrigerator-freezer

Main differences of these four standards in test conditions

Test standards	IEC 62552:2015	IEC 62552:2007	Australia	USA
Elements				
Room test ambient temperature	16.0°C and 32.0°C	25.0°C	32.0°C	32.2°C
Target temperature of fresh-food comp.	Average: 4.0°C	Average: 5.0°C Min.: 0°C, Max.: 10°C	Average: 3.0°C	Average: 3.9°C
Target temperature of frozen-food comp.	Average: -18.0°C	Max.: -18.0°C	Average: -15.0°C	Average: -17.8°C
Storage plan of fresh-food comp. storage temperature sensor				
Storage plan of frozen-food comp. storage temperature sensor				
Frozen-food comp. storage temperature sensor	Cylinder with 18mm diameter and long	M-packages	Cylinder with 25mm diameter and long	Cylinder with 25.4mm diameter and long
Calculated daily energy consumption	$P \cdot 24, E_{\text{Daily}16C}, E_{\text{Daily}32C}$	Tested energy consumption express in kWh per 24hrs, $E_{24h}$		
Calculated annual energy consumption, kWh/year	$\text{Day}_{16} \cdot E_{\text{Daily}16C} + \text{Day}_{32} \cdot E_{\text{Daily}32C} + \Delta E_{\text{processing-annual}}$	$E_{24h} \cdot 365$		

# Results analysis



## 4. Upright frost-freezer refrigerator-freezer

### Test data

Item	Unit	IEC 62552:2015				IEC 62552:2007		Australia		USA	
		R:4 F:-18	R:5 F:-16	R:4 F:-17	R:5 F:-16	R:5 F:-18	R:4 F:-20	R:3 F:-16	R:5 F:-16	R: 5 F:-20	R: 2 F:-24
Ambient temperature	°C	16		32		25		32		32.2	
Temperature control settings		R:4 F:-18	R:5 F:-16	R:4 F:-17	R:5 F:-16	R:5 F:-18	R:4 F:-20	R:3 F:-16	R:5 F:-16	R: 5 F:-20	R: 2 F:-24
Temperature in fresh food storage compartment	°C	2.9	5.6	3.6	4.7	5.2	4.1	4.7	1.9	4.3	0.2
Temperature in frozen food storage compartment	°C	-19.3	-17.2	-19.1	-18	-16.2	-18.1	-17.9	-18.4	-22.4	-25.3
Steady state power	W	22.5	19.7	41.3	39.7	N/A	N/A	N/A	N/A	N/A	N/A
Energy consumption per 24h	kWh/24h	0.583	0.515	1.079	1.041	0.701	0.765	1.009	1.071	1.078	1.404
Energy consumption by interpolation	kWh/24h	0.555		1.065		0.738		1.047		1.111	
Standard energy consumption	kWh/24h	0.797				0.738		1.047		1.111	
Total Energy consumption	kWh/24h	0.890				0.738		1.047		1.111	

## Results analysis



4. Upright frost-free refrigerator-freezer

# Influences?

## What are the factors?

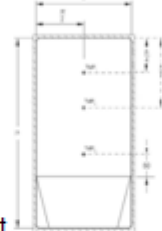

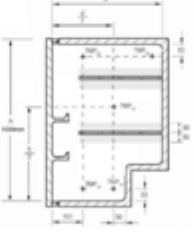
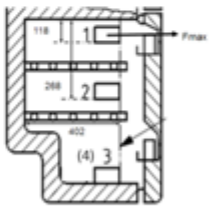


# Results analysis



## 4. Upright frost-free refrigerator-freezer

These impact factor's influences on last test results (calculating with the deviation method):

Elements standards	IEC 62552:2015	IEC 62552:2007
Room test ambient temperature	Similar (16°C and 32°C)	Similar (25°C)
Target temperature of fresh-food comp.	Different (4.0°C) Interpolation comp.	Different (5.0°C) Interpolation comp.
Target temperature of frozen comp.	Same (-18.0°C) Interpolation comp.	Same (-18.0°C) Interpolation comp.
Storage plan of fresh-food comp. storage temperature sensor	 Different	 Different
Storage plan of frozen-food comp. storage temperature sensor	 Different	
Determination of target temperature of fresh-food comp.	Same (average of temperature sensors)	Same (average of temperature sensors)
Determination of target temperature of frozen-food comp.	Different (Average of temperature sensors)	Different (The maximum of temperature sensors)
Standard energy consumption, kWh/24h	0.797	0.738

Total deviation:  
 $(0.797 - 0.738) / 0.797 * 100\% = 7.4\%$

Deviation of determination of frozen-food compartment temperature: -4.0%

Deviation of target temperature of fresh-food comp.: 9%

Deviation of empty load in the frozen-food comp.: -3.9%

Deviation of Storage plan of fresh-food comp.: 2.3%

Deviation of two tests at different ambient temperatures:  $(7.4 - 9 - 2.3 - (-4.0) - (-3.9)) = 4.0\%$



*Summary  
influences?*

*Factors?*

# Results analysis



## 5. Summary of the main impact factors on energy consumption

Impact factor	Compartment or appliance	Result	Compared standards
Ambient temperature <sup>1)</sup>	refrigerator	+4.5% by 1K increase	IEC 62552:2015 (16°C-32°C)
	freezer	+3.0% by 1K increase	
	refrigerator-freezer	+2.4% by 1K increase	
Target temperature <sup>2)</sup>	fresh-food comp.	+9% by 1K decrease	IEC 62552:2015 (interpolation)
	frozen-food comp.	-6.5% by 1K increase	IEC 62552:2015-Australia
Storage temperature sensor and storage plan <sup>3)</sup>	fresh-food comp.	+2.3%	IEC 62552:2015(at 32°C) -USA
Storage temperature sensor (cylinder instead of M package) and empty load <sup>4)</sup>	frozen-food comp.	-3.9%	IEC 62552:2015(at 32°C) -USA
Determination of frozen-food compartment temperature (average temperature instead of maximum M package) <sup>5)</sup>	frozen-food comp.	-4.0%	IEC 62552:2015-IEC 62552:2007
Two tests at different ambient temperatures	refrigerator	+1.6%	IEC 62552:2015-IEC 62552:2007
	refrigerator-freezer(single temperature control)	+13.2%	IEC 62552:2015-IEC 62552:2007
	frost-free refrigerator-freezer	+5.2%	IEC 62552:2015-IEC 62552:2007

# Technical Reference on Harmonization towards the IEC 6255:2015



*What are the rationalities of  
IEC 62552:2015?*

# Technical Reference on Harmonization towards the IEC 6255:2015



## Rationalities on energy consumption testing :

- Appliances are tested in empty condition
- Tests are to be performed at two ambient temperatures
- The fresh food compartment temperature is reduced to 4°C
- Using cylinder is easy and fast to get measurement results
- A new adaptive test algorithm is introduced in energy consumption testing

# Technical Reference on Harmonization towards the IEC 6255:2015



*How to harmonize?*

# Technical Reference on Harmonization towards the IEC 6255:2015



## Important factors:

- The ambient temperature
- Target temperature
- Storage temperature sensor and storage plan
- Storage temperature sensor (cylinder instead of M package) and empty load
- Determination of frozen-food compartment temperature (average temperature instead of maximum M package)
- Two tests at different ambient temperatures

# Thank You!

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