December 1997

RECOMMENDATION FOR ENERGY CONSUMPTION EVALUATION OF REMOTE REFRIGERATED DISPLAY CABINETS

This recommendation has been prepared by the Eurovent/Cecomaf Working Group 14 in order to confirm the industry commitment to energy savings and to propose an improvement to the rules defined in the Stimeck pilot project in the Netherlands.

The WG 14 will continue to work on this issue in 1998 in order to provide additional criteria (foodstuff lighting, net volume, ...) and to give the opportunity to European users to choose combined parameters for functionality.

This document introduces two tools for evaluation :
TEC = Total Energy Consumption
TDA = Total Display Area,

Average figures of the ratio TEC/TDA on European market are also presented.

E U R O V E N T / C E C O M A F

EUROPEAN COMMITTEE OF
AIR HANDLING, AIR CONDITIONNING AND REFRIGERATION
EQUIPMENT MANUFACTURERS

TEC = Total Energy Consumption

METHOD TO COMPARE THE ENERGY CONSUMPTION OF REFRIGERATED DISPLAY CABINETS WHEN THE CONDENSING UNIT IS REMOTE FROM THE CABINET

IN TEST ROOM CLIMATE CLASS : 3 (25 °C ; 60 % RH)

AND FOR M-PACKAGE TEMPERATURE CLASS : _ _ _

1 The calculation of the Direct electrical Energy Consumption DEC in kWh/24h, shall be based on test results according to EN 441-9, taking into account the Eurovent/Cecomaf recommendation for test report model.

	The power	**the running time within 24 h**
. fans	P_V = _ _ _ W	t_V = _ _ _ h
. heaters	P_H = _ _ _ W	t_H = _ _ _ h
. defrost heaters	P_D = _ _ _ W	t_D = _ _ _ h
. lighting (t_L = 12 h for open cabinets, 14 h for closed cabinets)	P_L = _ _ _ W	t_L = _ _ _ h
. accessories	P_A = _ _ _ W	t_A = _ _ _ h

$$\mathbf{DEC = [(P_V \times t_V) + (P_H \times t_H) + (P_D \times t_D) + (P_L \times t_L) + (P_A \times t_A)] \times 10^{-3}}$$

NOTE : If, for technical reasons, it is too difficult to measure separately the component powers, it is possible to use the DEC directly measured according to EN 441-9.

2 The heat extraction rate Φ_0 in kW and the refrigerant evaporating temperature T_0 in K, shall be based on test results according to EN 441-12 with 24h lighting.

3 The heat extraction rate shall be transformed in Refrigeration electrical Energy Consumption REC as follows :

$$\mathbf{REC = t_R \times \Phi_0 \times (T_C - T_0) / (0{,}34 \times T_0)}$$

where :

. t_R = 24 h - (defrost periods in h) ;

. T_C is a conventional condensing temperature, established at 308,18 K (+35 °C) for European comparisons ;

. the average value 0,34 reflects the Carnot efficiency of refrigerating systems used in Commercial Refrigeration and established in the TNO report R95-164.

NOTE : For cabinets supplied by secondary refrigerant, the pump energy consumption must be taken into account, using the method described in clause 5.4 of the TNO report R95-164.

4 The Total Energy Consumption TEC is :

TEC = DEC + REC in kWh/24 h

TDA = Total Display Area

METHOD TO COMPARE THE VISIBILITY OF FOODSTUFF LOADED INTO REFRIGERATED DISPLAY CABINETS

1 Definition

1.1 The total display area is determined by the sum of vertical and horizontal projected areas from visible foodstuff, in m².

1.2 Where foodstuff is visible through a glazing surface, the **light transmission T_g** is taken into account as follows :

. single glass :	90 %
. double glass or 2 single glasses :	81 %
. triple glass without coating :	73 %
. specific glass with reflective or heater face(s) :	figure obtained by measurement according to ISO 9050

1.3 The opaque areas from the **frames or hand rails are deducted**. Examples : counters, graduated and glass door cabinets (see figures).

1.4 For **multi-deck and graduated** cabinets, the horizontal projected area is measured from a plan located at 1,55 m from the ground in order to take into account the visible foodstuff located in the **front part of the shelves** (see figures).

2 The Total Display Area is calculated as follows :

$$\mathbf{TDA = (H_o \times L_{oh}) + (H_g \times T_{gh} \times L_{gh}) + (V_o \times L_{ov}) + (V_g \times T_{gv} \times L_{gv})}$$

Where :

H = Horizontal projection, in m

V = Vertical projection, in m

o = open surface

g = glazing surface

T_{gh} = light Transmission through the glazing surface for horizontal projection

T_{gv} = light Transmission through the glazing surface for vertical projection

L = cabinet Length, in m

L_{oh} = horizontal open Length

L_{ov} = vertical open Length

L_{gh} = horizontal glazing Length

L_{gv} = vertical glazing Length

NOTE : As an example, the glazing surface may be different for the front (T_{gv}) and for the lid (T_{gh})

Encl. : 7 figures

The average figures of TEC/TDA

The following table gives average figures for European Market of the ratio TEC/TDA taking into account the cabinets manufactured in Finland, France, Germany, Italy, Sweden, United Kingdom, in 1997.

The figures were established for the M-package temperature classes defined in laboratory. WG14 specifies that, for the time being, the relationship between M-package temperature in laboratory and foodstuff temperature in store is not clearly established.

Based on the field experience and 1997 manufacturing, WG14 decided to give these average figures only for the main market needs either for families or temperature classes.

** = WG14 introduced, for open cabinets only, the L3 class (-15 °C ; -12 °C) where -15 °C is the lower temperature of the warmest M-package (instead of -18 °C for L2 class).

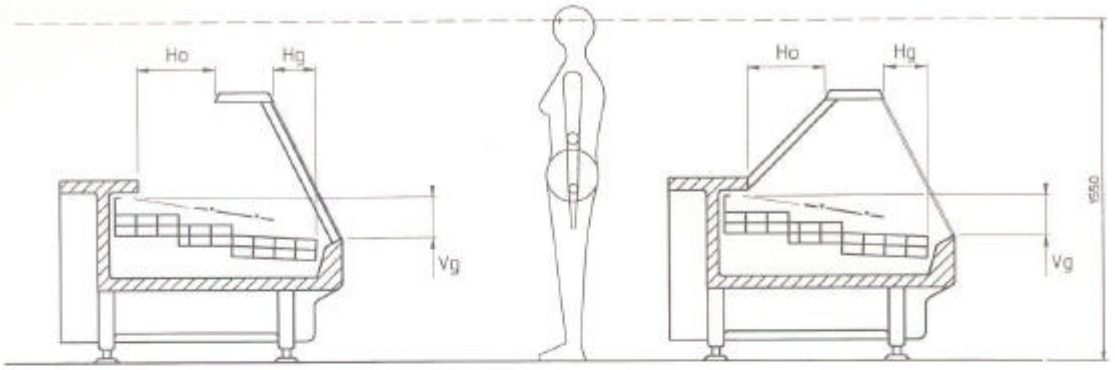
Average European figures TEC/TDA in kWh/24h.m²

Cabinet family	Remote cabinet type	Cabinet classification in laboratory according to EN 441-6	TEC/TDA
12	Counters	3H	6,2
12	Counters	3M2	6,7
11, 13	Chest positive temp.	3H	5,5
11, 13	Chest positive temp.	3M2	5,8
14, 15	Multi-deck	3H	10,1
14, 15	Multi-deck	3M2	12,3
17	Roll-in	3H	13,8
20	Combined negative temp.	3L3 **	29,0
21, 23	Chest negative temp.	3L3 **	13,0
26	Glass door	3L1	28,5

REC 05

For more information contact
Sule BECIRSPAHIC
Eurovent/Cecomaf Technical Secretariat
62 Boulevard de Sébastopol
75003 Paris
Tel 33 1 49 96 69 95
Fax 33 1 49 96 45 10

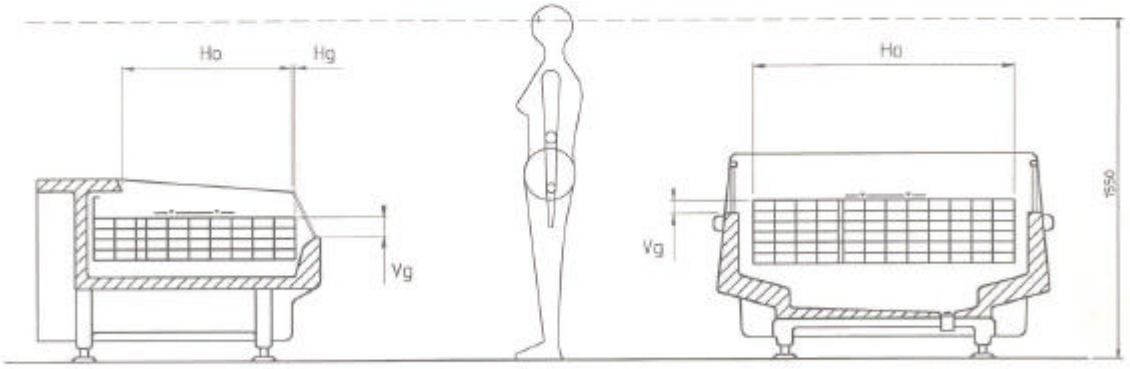
TDA calculation : examples with 2,5m length cabinets



	Loh = 2,50	Ho	0,350
Tgh = 90%	Lgh = 2,40	Hg	0,194
	Lov = 2,50	Vo	0
Tgv = 90%	Lgv = 2,40	Vg	0,185
TDA=(Ho*Loh)+(Hg*Tgh*Lgh)+(Vo*Lov)+(Vg*Tgv*Lgv)			1,694

	Loh = 2,40	Ho	0,350
Tgh = 90%	Lgh = 2,50	Hg	0,194
	Lov = 2,50	Vo	0
Tgv = 90%	Lgv = 2,50	Vg	0,185
TDA=(Ho*Loh)+(Hg*Tgh*Lgh)+(Vo*Lov)+(Vg*Tgv*Lgv)			1,693

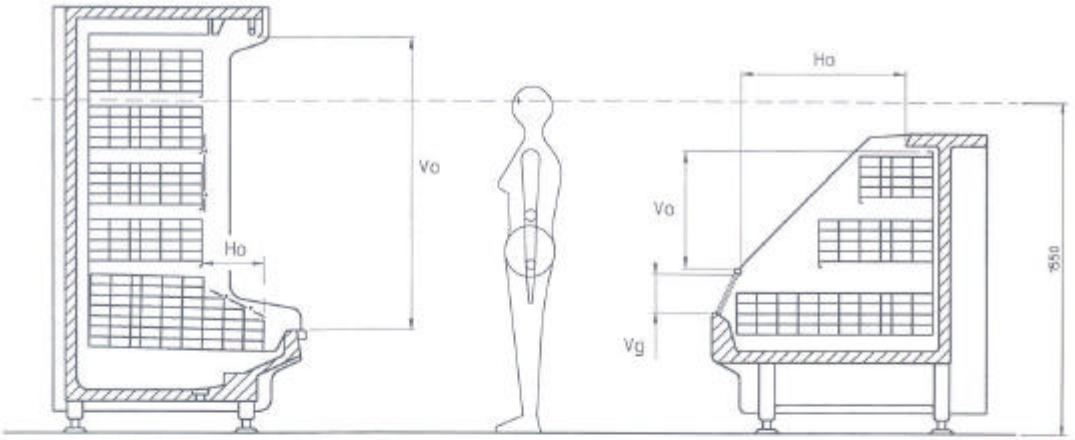
12 Counters **TDA-fig1**



	Loh = 2,50	Ho	0,770
Tgh = 90%	Lgh = 2,50	Hg	0,012
	Lov = 2,50	Vo	0
Tgv = 90%	Lgv = 2,50	Vg	0,090
TDA=(Ho*Loh)+(Hg*Tgh*Lgh)+(Vo*Lov)+(Vg*Tgv*Lgv)			2,155

	Loh = 2,50	Ho	1,176
Tgh = 100%	Lgh = 2,50	Hg	0
	Lov = 2,50	Vo	0
Tgv = 81%	Lgv = 2,40	Vg	0,058
TDA=(Ho*Loh)+(Hg*Tgh*Lgh)+(Vo*Lov)+(Vg*Tgv*Lgv)			3,053

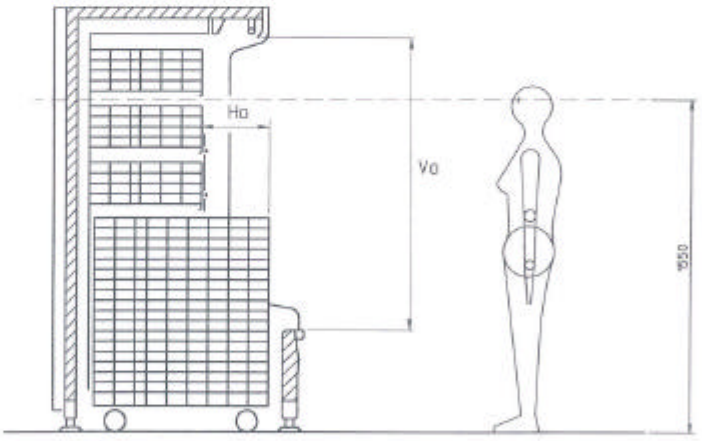
11, 13 Chest positive temperature (wall, island) **TDA-fig2**



	Loh = 2,50	Ho	0,291
Tgh = 100%	Lgh = 2,50	Hg	0
	Lav = 2,50	Va	1,367
Tgv = 100%	Lgv = 2,50	Vg	0
TDA=(Ho*Loh)+(Hg*Tgh*Lgh)+(Va*Lav)+(Vg*Tgv*Lgv)			4,145

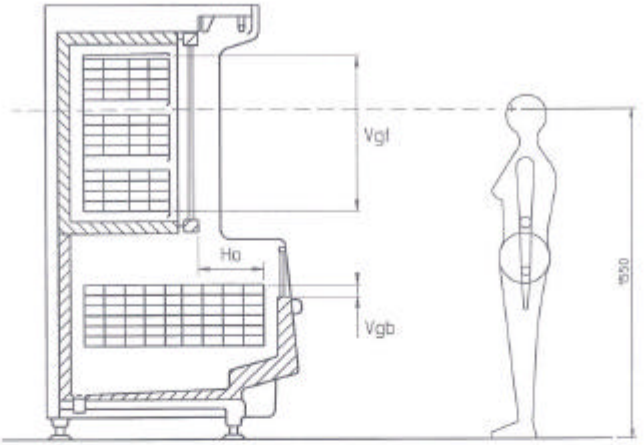
	Loh = 2,50	Ho	0,761
Tgh = 100%	Lgh = 2,50	Hg	0
	Lav = 2,50	Va	0,546
Tgv = 81%	Lgv = 2,40	Vg	0,175
TDA=(Ho*Loh)+(Hg*Tgh*Lgh)+(Va*Lav)+(Vg*Tgv*Lgv)			3,608

14, 15 Multi-deck (and graduated) TDA-fig3



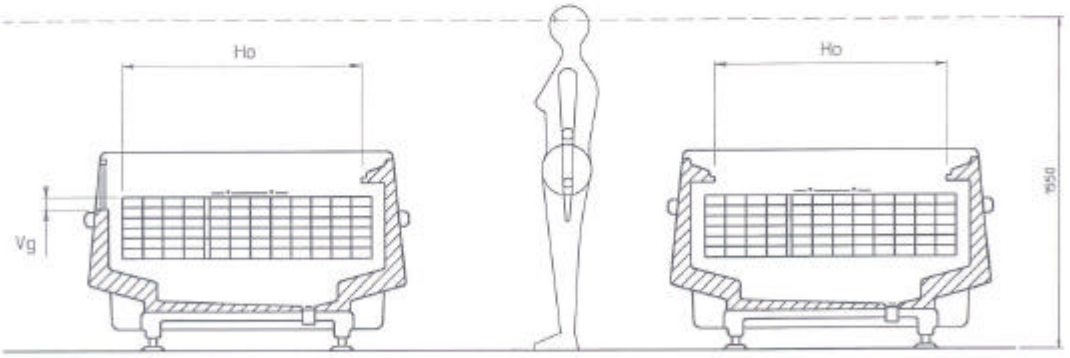
	Loh = 2,50	Ho	0,321
Tgh = 100%	Lgh = 2,50	Hg	0
	Lav = 2,50	Va	1,367
Tgv = 100%	Lgv = 2,50	Vg	0
TDA=(Ho*Loh)+(Hg*Tgh*Lgh)+(Va*Lav)+(Vg*Tgv*Lgv)			4,220

17 Roll-in TDA-fig4



	Loh = 2.50	Ho	0.306
Tgh = 100%	Lgh = 2.50	Hg	0
	Lov = 2.50	Vo	0
Tgvt = 73%	Lgv = 2.25	Vgt	0.731
Tgvb = 73%	Lgv = 2.40	Vgb	0.058
TDA=(Ho*Loh)+(Hg*Tgh*Lgh)+(Vo*Lov)+(Vg*Tgv*Lgv)			2.067

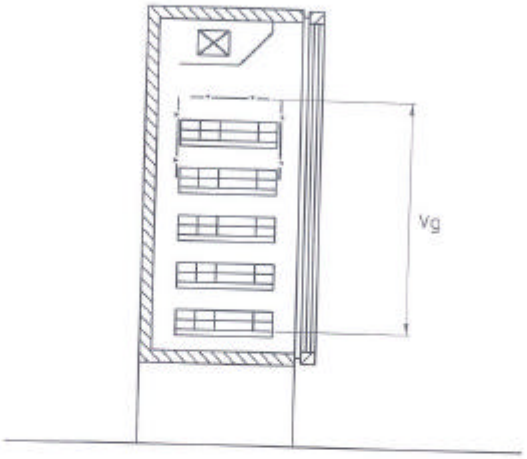
20 Combined negative temperature TDA-fig5



	Loh = 2.50	Ho	1.130
Tgh = 100%	Lgh = 2.50	Hg	0
	Lov = 2.50	Vo	0
Tgv = 73%	Lgv = 2.40	Vg	0.058
TDA=(Ho*Loh)+(Hg*Tgh*Lgh)+(Vo*Lov)+(Vg*Tgv*Lgv)			2.927

	Loh = 2.50	Ho	1.084
Tgh = 100%	Lgh = 2.50	Hg	0
	Lov = 2.50	Vo	0
Tgv = 100%	Lgv = 2.50	Vg	0
TDA=(Ho*Loh)+(Hg*Tgh*Lgh)+(Vo*Lov)+(Vg*Tgv*Lgv)			2.710

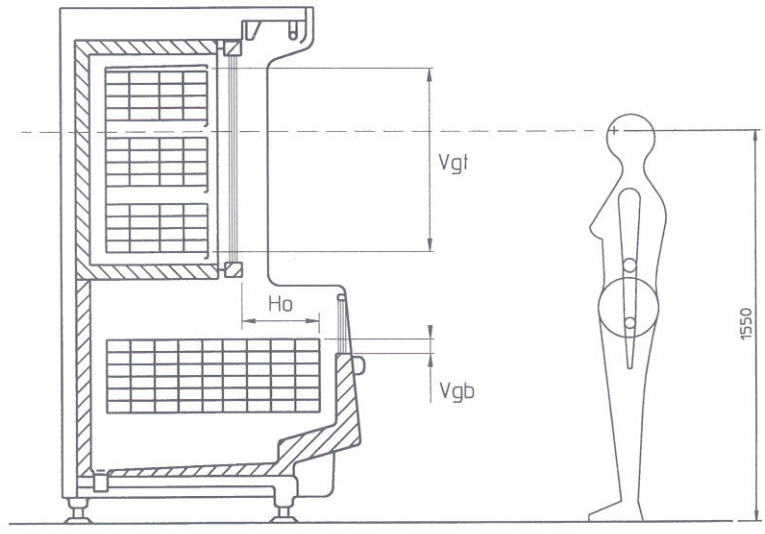
21, 23 Chest negative temperature (wall, island) TDA-fig6



	Loh = 2.50	Ho	0
Tgh = 100%	Lgh = 2.50	Hg	0
	Lov = 2.50	Vo	0
Tgv = 64%	Lgv = 2.25	Vg	1.053
TDA=(Ho×Loh)+(Hg×Tgh×Lgh)+(Vo×Lov)+(Vg×Tgv×Lgv)			1.516

26 Glass door

TDA-fig7



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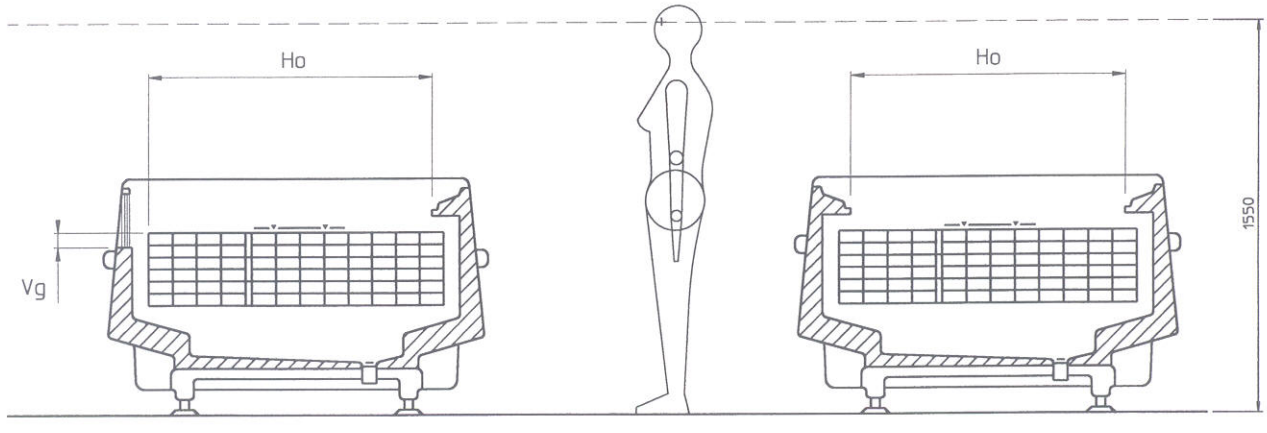
20 Combined negative temperature **TDA-fig5**



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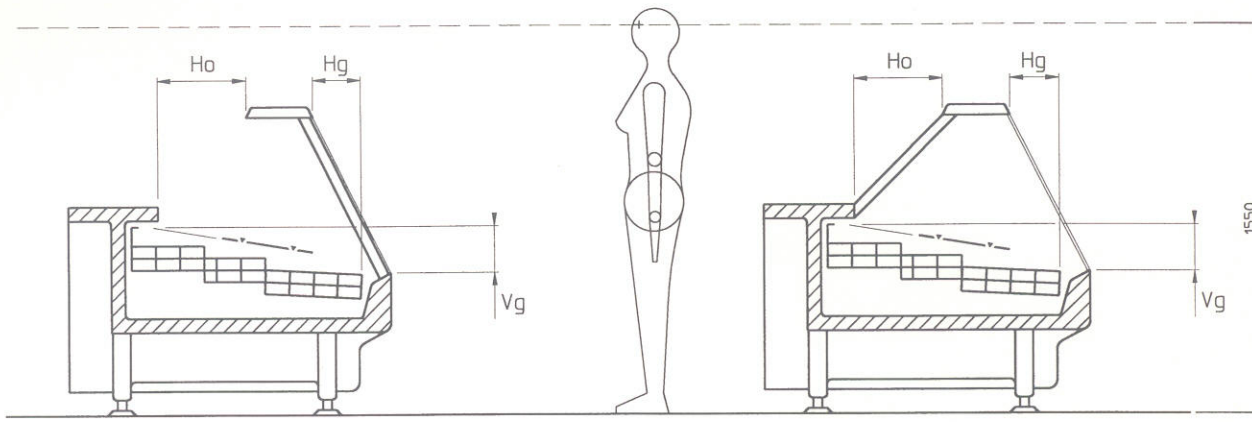
21, 23 Chest negative temperature (wall, island) **TDA-fig6**

TDA calculation : examples with 2,5m length cabinets



	Loh = 2,50	Ho	0,350
Tgh = 90%	Lgh = 2,40	Hg	0,194
	Lov = 2,50	Vo	0
Tgv = 90%	Lgv = 2,40	Vg	0,185
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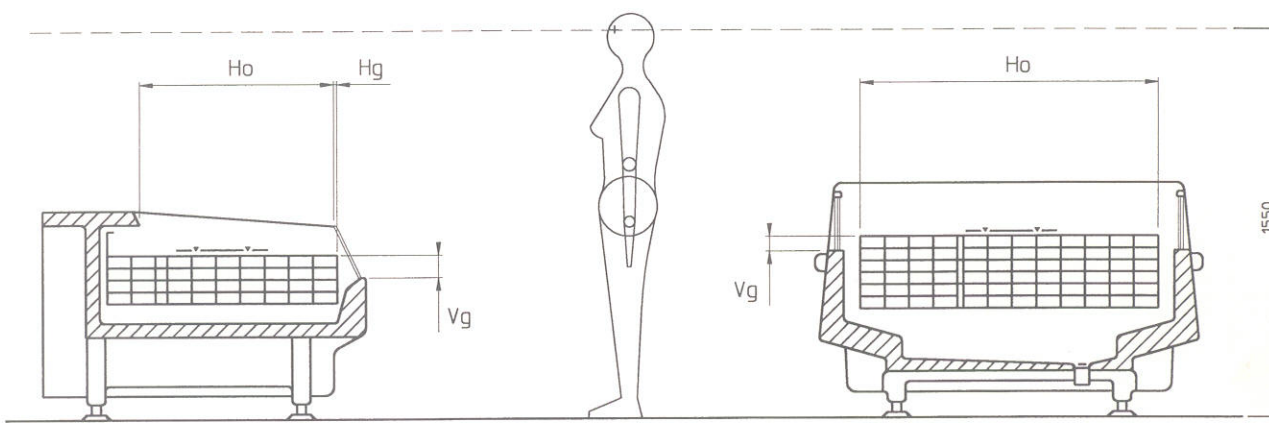

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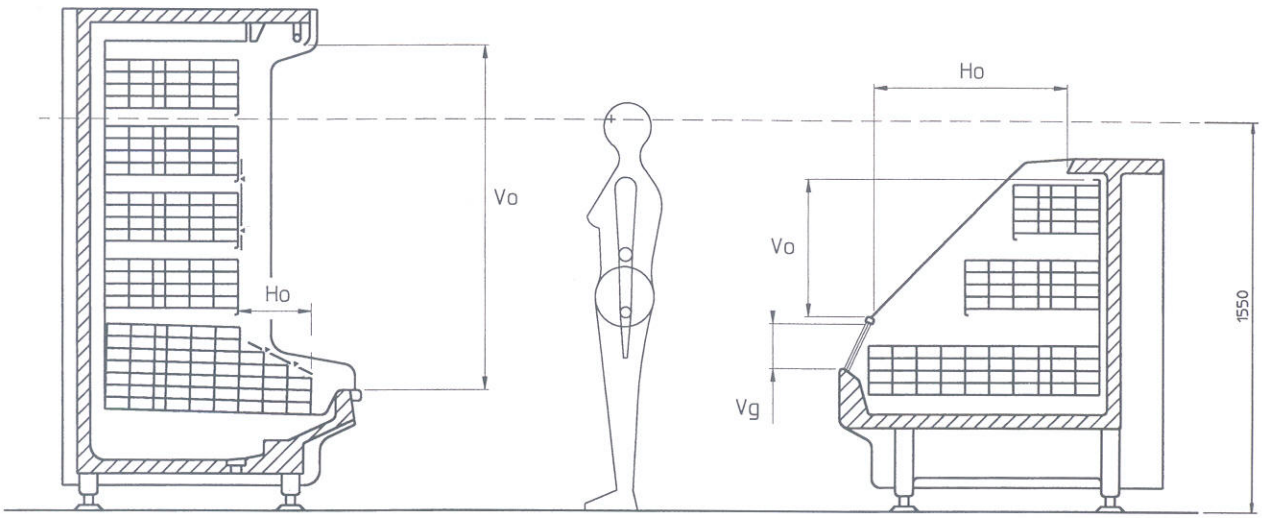

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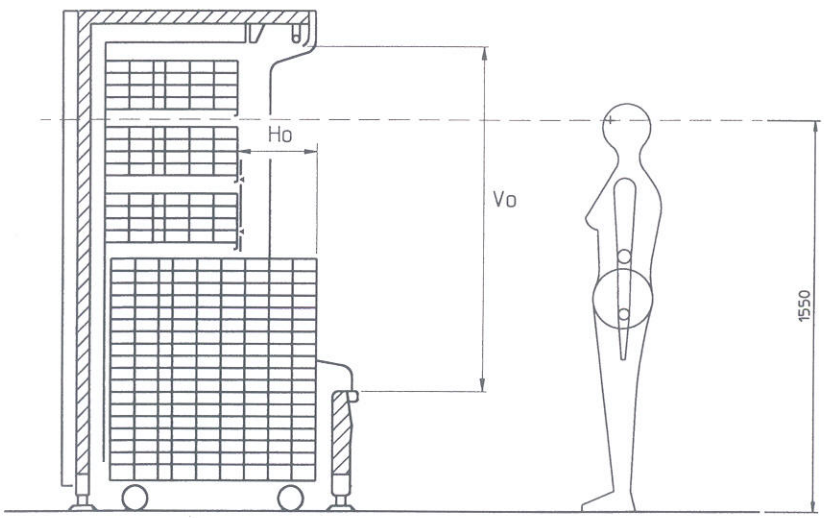

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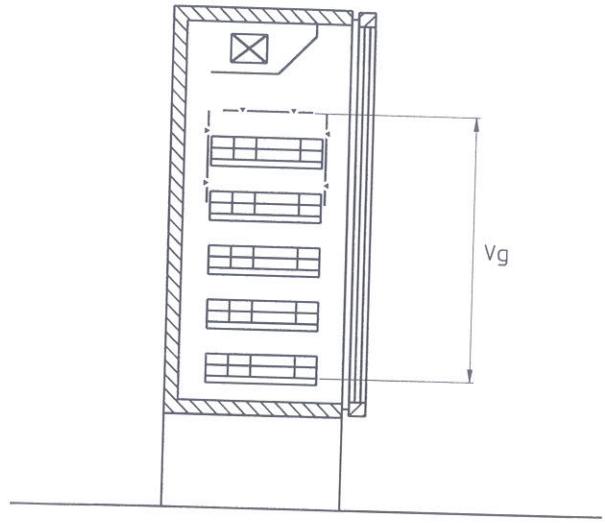
17 Roll-in **TDA-fig4**



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26 Glass door

TDA-fig7