IN FROM THE COLD

Strategies to increase the energy efficiency of non-domestic refrigeration in Australia & New Zealand

BACKGROUND TECHNICAL REPORT VOLUME 1

30 October 2009

This paper has been prepared for the Equipment Energy Efficiency Committee under the auspices of the Australian and New Zealand Ministerial Council for Energy.

October 2009

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Foreword

This report is one of two technical support documents associated with ***In from the Cold***, the 10 year strategic plan to promote energy efficiency in the non-domestic refrigeration sector in Australia and New Zealand.

Volume 1 of the technical support documents deals with refrigerated cabinets, including display cabinets.

Volume 2 of the technical support documents deals with other sectors and technologies in the non-domestic refrigeration sector.

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Acknowledgements

The authors would like to thank the following who have providing invaluable information and advice during the course of preparing the draft strategic plan for non-domestic refrigeration.

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Glossary

Alternative refrigerants:	Alternative to those commonly used in the Commercial Refrigeration Industry e.g. (R744-CO2 and R717-ammonia).
Ammonia refrigerant:	Refrigerant - R717 (NH_3). Ammonia's thermodynamic properties, make it very effective as a refrigerant, and is widely used in industrial refrigeration applications because of its high energy efficiency and relatively low cost. Ammonia is used less frequently in commercial applications, such as in grocery store freezer cases and refrigerated displays due to its toxicity.
ARCTICK:	Australian Refrigeration Council's authorised business symbol.
Carbon Pollution Reduction Scheme:	The CPRS is a proposed Australian Government initiative which places a limit, or cap, on the amount of carbon pollution industry in Australia can emit. It will require the largest businesses (approximately the top 1,000) to buy a 'pollution permit' for each tonne of carbon they emit.
Cascade refrigeration system:	A cascade system is made up of two separate but connected refrigeration systems, each of which have a primary refrigerant where refrigerants work in concert to reach the desired temperature. Cascade system in operation today in Australia are R404A/R744(CO2); R134a/R744 and R717(ammonia)/R744.
CFCs (R12 and R502):	Refrigerants that are in the chlorofluorocarbons group and known as CFCs, are now in a process of complete elimination from use, as it is both illegal to release into the atmosphere, and removal from existing systems must be undertaken in an approved manner for disposal in the event of system decommissioning. Alternative approved products are available as substitutes.
CO_2 refrigerant R 744:	A widely used Industrial and Process refrigerant with high thermodynamic properties suitable for refrigeration use, but due to its high pressure operating levels in typical commercial refrigeration ranges, less applications are in common use. More systems are now being designed as components such as compressors and other line equipment are available.
Cold food chain:	The cold food chain is part of the food value chain, which involves transport, storage, distribution and retailing of chilled and frozen foods.
Compressor:	A device in the refrigeration circuit which compresses refrigerant vapour, and circulates that refrigerant through to its phases of condensation and evaporation, in order to produce refrigeration effect. The compressor is available in many forms such as piston, scroll, or screw.

Compressor rack:	The machine assembly which accommodates the main high pressure components of a refrigeration circuit in a single structure, allowing off site connection to associated pipe work and vessels.
EN:	European Standard denotation.
EN ISO:	European Standard based on International Standard.
HCFCs refrigerant (R22):	A refrigerant which has predominant use in the air conditioning industry, and is being phased out. As components become available, particularly compressors, its general replacement may be R410A.
Heat transfer fluids:	Any fluid which is used to transport its heat content to another location within a process, for either removal or adding to, or storage for subsequent use.
HFC refrigerant:	HFCs (R404A/R507 and R134a) refrigerants used as replacements for those in the now illegal CFC range.
Integral RDCs:	Refrigerated display cabinet with its refrigerating machinery contained integrally within the structure.
K-value:	The k-value, or heat transfer coefficient, is the measured value of the heat flow which is transferred through an area of 1 m^2 at a temperature difference of 1 K. The units of measure are watts per square meter per temperature difference (W/m^2K). K-value = energy / (area x temperature difference x time).
R-value:	Is a measure of thermal resistance, commonly used in the building and construction industry. Under uniform conditions it is the ratio of the temperature difference across an insulator and the heat flux (heat flow per unit area) where the bigger the number, the better the building insulation's effectiveness. R-value is the reciprocal of U-value. The R-value can be expressed in SI units, typically m^2K/W (or equivalently to $m^2°C/W$) or in the United States, R-values are given in units of $ft^2°F/Btu$. The conversion between SI and US units of R-value is 1 $h·ft^2°F/Btu$ = 0.176110 $K·m^2/W$, or 1 $K·m^2/W$ = 5.678263 $h·ft^2·°F/Btu$.
Low temperature:	Typically temperatures lower than -18^{o}C.
Medium temperature:	Typically temperatures higher than -5^{o}C.
PIR:	Polyiscyanurate (PIR), an insulating foam product, has a higher thermal rating than Expanded Polystyrene (EPS).
Remote RDC:	Refrigerated display cabinet with its refrigerating machinery sited remote from the cabinet structure.
Screw compressor:	A rotary screw compressor is a type of gas compressor which uses a rotary type positive displacement mechanism; either a single screw or two counter rotating Helical Screws.
Scroll compressor:	A Scroll compressor uses two interleaved scrolls to pump, compress, or pressurize fluids such as liquids and gases.

Secondary loop refrigeration system:	A system which is so designed with two basic loops of refrigerating fluid flow, the primary one may be a conventional direct expansion of a phase change refrigerant, cooling a liquid flow that is pumped to the secondary loop. The primary loop utilises considerably less refrigerant in the closed short circuit, generally restricted to the plant room location. The secondary loop may consist of a Heat Transfer fluid being circulated to all of the heat exchange sites.
Self-contained RDCs:	A refrigerated display cabinet with its refrigerating machinery contained integrally within the structure.
Semi-hermetic compressor:	A compressor which is connected to its driving motor within an accessible enclosure. The enclosure is hermetically sealed to retain the refrigerant and oil contents, along with the electrical stator windings of the motor.
Test packs:	ISO type M packages for temperature testing as detailed in AS1731-4.2003 Clause 5.2
Walk-in coolroom (WIC):	A walk-in coolroom is a structure formed by an Insulated enclosure of walls and ceiling, having a door through which personnel can pass through and close behind them. The floor space occupied by this structure, may or may not be insulated, depending on the operating temperature level.

Abbreviations

AUD	Australian dollar
BaU	Business as usual
BCA	Building Code of Australia
CO2-e	Carbon dioxide equivalent units
COP	coefficient of performance
CPRS	Carbon Pollution Reduction Scheme (Australia)
E3	Equipment Energy Efficiency Committee (Australia & New Zealand)
EC	European Commission
EPS	expanded polystyrene
GHG	greenhouse gas
GW	gigawatt (1 watt x 10^9)
GWh	gigawatt-hour (1 watt x 10^9)
HEPS	high efficiency performance standards
IEA	International Energy Agency
IEC	International Electrotechnical Commission
ISO	International Standards Organisation
kW	kilowatt (1 watt x 10^3)
kWh	kilowatt-hour
kWr	kilowatts of refrigeration
MCE	Ministerial Council on Energy
MEPS	minimum energy performance standards
Mt	megatonne (ie million tonnes)
NPV	net present value
NZD	New Zealand dollar
OBPR	Office of Best Practice Regulation (Australia)
PIR	polyiscyanurate insulation
RDC	refrigerated display cabinet
RSC	refrigerated service cabinet
RIS	regulatory Impact statement
t	tonnes
TEC/TDA	total energy consumption (kW/day)/Total Display Area (m^2)
TWh	terawatt-hours (1 watt-hour x 10^{12})
Wh	watt-hour
WIC	walk-in coolroom
VA	voluntary agreement

1 Introduction

Minimum energy performance standards (MEPS) for refrigerated display cabinets (RDCs) have been in force in Australia and New Zealand from 1 October 2004, in accordance with AS 1731:2003. This standard contains the method of test in Parts 1-13, and minimum energy performance (MEPS) levels and high efficiency levels in Part 14.

The test method contained in AS 1731 was originally based on the European standard EN441, which has since been revised and published as ISO 23953:2005 in two parts.

In 2005, some minor changes were introduced to AS 1731 by the Australia Standards committee ME-008, which has oversight for AS 1731.

A recommendation prior to the introduction of MEPS for refrigerated display cabinets was that the efficiency levels be re-examined no later than 2008. This has not yet been completed, although there is evidence that technology and markets have developed to a stage which warrants an updating of the MEPS levels.

This, together with improvements to international test methods, and the introduction and update of energy efficiency policies targeting RDCs by several countries outside Australia and New Zealand, led to the publication of a review in June 2008. This review spanned issues relating to the test method, MEPs levels and those concerning the implementation of the regulation.

Of the 14 responses from industry there was little negative comment on the ten recommendations and the majority related to the implementation of the RDC MEPS regime rather than the more technical issues.

These responses (summarised in Attachment 1) are consistent with issues reported by regulators and consultants who have been assisting industry to register and meet the regulatory requirements since 2004. In general they suggest some changes are needed to make the requirements more transparent and therefore easier to comply with. In doing so, there is the potential to also expand the coverage of the current scheme to include other types of refrigeration equipment thereby achieving increased energy savings. At the same time, changes need to be in-line with Australia and New Zealand's trading partners to ensure that industry has access to international markets.

This document addresses the major issues raised previously as well as introducing additional items.

Section 2 contains a summary of major recommendations made in this report. Section 3 analyses RDC registrations and discusses the potential to improve the classification system for RDCs used by the current regulations. Issues concerning industry are also highlighted and recommendations made.

Section 4 compares a number of test methods for RDCs and explains the history of the AS 1731 series used in Australia and New Zealand. The benefits and mechanisms for increasing international test method harmonisation are explained.

Section 5 examines the potential to update MEPS levels for RDCs in Australia and New Zealand, including comparison with thresholds used by overseas energy efficiency programs. Section 6 looks at issues relating to the inclusion of non-retail refrigerated cabinets within the scope of energy efficiency regulations. This includes the identification of appropriate test methods, energy performance metrics and MEPS levels.

Section 7 discusses the possible introduction of a deemed to comply option as an alternative means to comply with regulations. Section 8 raises issues concerning compliance and enforcement and makes a number of recommendations.

Section 9 provides a number of new definitions which could be adopted within appropriate parts of AS 1731, most of which relate to the recommendations made in this report. The treatment of energy management systems during testing for MEPS compliance is also discussed.

2 Summary of recommendations

The following section identifies the major recommendations for refrigerated cabinets as part of the 10 Year Strategic Plan for the non-domestic refrigeration sector being developed by the Equipment Energy Efficiency Committee. These recommendations are summarised in the Draft Strategic Plan '***In from the Cold***', to be finalised in the first half of 2010.

Following consultation with industry and other stakeholders, the measures adopted in the Strategic Plan will be implemented in stages over the next 10 years. The work plan for the first three years will be agreed as part of the Strategic Plan, with further three-yearly work plans developed over the course of the strategy. A review of the work plans will be conducted in the final year.

2.1 Energy performance test method

- The contents of AS 1731 Part 1 to Part 13 (inclusive) should be replaced by the two parts of EN ISO 23953 (2005);
- AS 1731.14 Part 14 should be revised to cover RDCs only, making reference to the use of test methods outlined in EN ISO 23953 (2005);
- Energy performance requirements for any other types of refrigeration equipment to be tested according to EN ISO 23953 should be specified in new additional parts of the revised AS 1731.

2.2 The classification of RDCs

- A common system of classification should be introduced for all RDCs within the scope of AS 1731, for the purpose of setting energy performance thresholds;
- This classification system adopted should be harmonized with classifications used in ISO 23953:2005;
- Appropriate changes to AS 1731 should be implemented as soon as appropriate MEPS levels have been agreed and allowing a reasonable transition period for industry.

2.3 RDC energy efficiency levels

- Energy performance thresholds for remote and integral retail display cabinets, both open and with glass doors, should be set on the basis of TEC/TDA, as is currently specified in AS 1731:14.;
- Energy performance thresholds for remote and integral retail display cabinets should be applied to categories of RDCs specified in EN ISO 23953 (2005);
- Current MEPS and high efficiency levels should be made more stringent to reflect the performance of equipment in the market, best international thresholds for equivalent programs and cost-effective technological potential;
- Proposals regarding the treatment of all cabinets with solid doors are presented in Section 2.4.

2.4 Refrigerated service cabinets (RSCs)

- The scope of energy efficiency regulations in Australia and New Zealand should be expanded to include non-retail cabinets used in the commercial sector, called refrigerated service cabinets;
- For these products MEPS and high efficiency levels should be established based on electricity consumption per unit of refrigerated volume, where electricity consumption is measured according to EN ISO 23953 (2005);

- It is recommended that the initial MEPS levels should be harmonized with the US MEPS levels to be introduced in January 2010, and implemented in Australia and New Zealand at a date to allow industry adequate time for preparation;
- MEPS levels and high efficiency levels for RSCs should be included in a new part of AS 1731, together with appropriate definitions and explanatory illustrations.

2.5 Deemed to comply facility

- To accommodate refrigeration equipment within the scope of regulations that is installed in-situ or produced in small quantities, MEPS may be complied with by the use of components and construction elements which meet minimum energy performance specifications;
- Products which demonstrate that specified components and construction elements have been incorporated will be deemed to comply with regulations;
- The performance levels used for this provision should be no less stringent than those required to meet MEPs levels applied to an equivalent RDC or RSC;
- The use of the deemed to comply provision should not remove the obligation for product registration, and suppliers choosing this option may be required to provide additional information at the time of registration to demonstrate compliance.

2.6 Compliance and enforcement

- Market surveillance activities should be undertaken at regular intervals to monitor the requirement for regulated equipment to be registered with one of the Australian regulators or the New Zealand regulator;
- Where regulated equipment is found not be registered, suppliers should be contacted promptly, followed up, and enforcement processes initiated;
- The number of products subjected to verification testing should be increased, and efforts made to improve the targeting of those products most at risk of failing;
- Where equipment fails Stage 1 verification testing, the appropriate enforcement processes should be initiated promptly;
- The E3 Committee should review the availability of independent test laboratories and if deemed necessary take steps to increase capacity.

2.7 Energy management systems

- When testing for MEPS compliance for RDCs, any energy management system must be disabled during the energy consumption/temperature test.

3 Summary of classification system and registrations

3.1 Existing classification system

Currently Australian Standard AS 1731.14 defines and classifies remote and integral RDCs intended for the sale and display of foodstuffs into a variety of 'types' representing family classifications and sub-classes.

The classifications are based on the intended application, location of condensing unit or compressor, storage temperature and configuration of the cabinet. Each general classification is then identified by a coded designation as a 'type' such as 'RS1, RS2, HC1, HC2.'

A remote RDC has a condensing unit or compressor separate or remote from the cabinet while an integral RDC has the condensing unit or compressor incorporated in the cabinet. The designation for a remote is 'R' and for an integral cabinet is 'I'.

In the case of a number of remote RDCs, dimensional limits are applied that relate to overall dimensions of the cabinet or to the size of the air-curtain.

Table A1 of AS 1731.14 names and describes medium temperature types of remote RDC while Table A2 of AS 1731.14 names and describes low temperature types.

Table A3 of AS 1731.14 lists the application of medium and low temperature types of integral RDCs.

Integral RDCs are further categorised into storage or M-package temperature classes relating to a storage temperature range or performance level that the cabinet can maintain in normal operation. 'M1, M2, L1, L2...'

Both remote and integral cabinets are also classified by Climate Class which is a numeral indicating the climatic class of the appliance as specified in ISO 23953.2. i.e. '0, 1, 2, 3, 4....'. These climate classes specify the dry bulb temperature conditions and Relative Humidity for which the cabinet is designed to be used in. A cabinet may be intended to operate in more than one climatic condition.

Tables A1, A2 and A3 of AS 1731.14 Appendix A follow:

Table 1: TABLE A1 of AS 1731.14:2003 APPENDIX A: TYPE OF REMOTE REFRIGERATED CABINETS (MEDIUM TEMPERATURE)

Name	Type	Description	Subclass	
High open multideck	RS 1	Medium temperature multideck, length of air curtain 1.5–1.9 m. Cabinet height 2.2–2.5 m and depth of 0.6–1.2 m	Lit shelves	Unlit shelves
Medium open multideck	RS 2	Medium temperature multideck, length of air curtain 1.0–1.5 m. Cabinet height 1.8–2.19 m and depth 0.6–2.1 m	Lit shelves	Unlit shelves
Low open multideck	RS 3	Medium temperature multideck, length of air curtain 0.8–1.2 m. Cabinet height 0–1.79 m depth 0.6–1.2 m	Lit shelves	Unlit shelves
Self service and storage closed cabinet	RS 4	*Requires detailed definition*	Solid door	Glass door
Self service and storage closed cabinet counter	RS 5	*Requires detailed definition*	Solid door	Glass door

Flat glass-fronted—single deck	RS 6	Medium temperature single tier cabinet with a flat front glass and a sliding door service access to the rear. Cabinet height 1.25–1.4 m, depth 0.8–1.2 m. Cabinets are divided into two subgroups on the basis of their evaporator coil arrangements	Gravity coil	Fan coil	
Flat glass-fronted—2 tier or more	RS 7	Medium temperature two or more tier cabinet with a flat front glass and a sliding door service access to the rear. Cabinet height 1.25–1.4 m, depth 0.8–1.2 m. Cabinets are divided into two subgroups on the basis of their evaporator coil arrangements	Gravity coil	Fan coil	
Curved glass-fronted—single deck	RS 8	Medium temperature single tier cabinet with a curved front glass and a sliding door service access to the rear. Cabinet height 1.25–1.4 m, depth 0.8–1.2 m. Cabinets are divided into two subgroups on the basis of their evaporator coil arrangements	Gravity coil	Fan coil	
Curved glass-fronted—2 tier or more	RS 9	Medium temperature two or more tier cabinet with a curved front glass and a sliding door service access to the rear. Cabinet height 1.25–1.4 m, depth 0.8–1.2 m. Cabinets are divided into two subclasses on the basis of their evaporator coil arrangements	Gravity coil	Fan coil	
Island/Walk around merchandiser	RS 10	High, cabinet height 2.2–2.5 m Medium, cabinet height 1.8–2.19 m Low, cabinet height 1.0–1.79 m	High	Medium	Low

Table 2: TABLE A2 of AS 1731.14:2003 APPENDIX A: TYPE OF REMOTE REFRIGERATED CABINETS (LOW TEMPERATURE)

Name	Type	Description	Subgroup	
Medium open multideck	RS 11	Low temperature multideck, length of air curtain 1.0–1.5 m. Cabinet height 1.8–2.19 m and depth 0.6–1.2 m	*No subgroup*	
Low open multideck	RS 12	Low temperature multideck, length of air curtain 0.6–1.0 m. Cabinet height 1.0–1.79 m and depth 0.6–1.2 m	*No subgroup*	
Well-type, single width cabinet	RS 13	Low temperature, well-type self service cabinet, open with horizontal air curtain, length of air curtain 0.75–0.85 m	Solid sided	Glass sided
Well-type, double width cabinet	RS14	Low temperature, well-type self service cabinet, open with horizontal air curtain, length of air curtains 2 ' 0.75–0.85 m	Solid sided	Glass sided
High self service and storage closed cabinet	RS 15	Low temperature, cabinet height 2.2–2.8 m, depth 0.6–1.2 m	Solid door	Glass door
Medium self service and storage closed cabinet	RS 16	Low temperature, cabinet height 1.8–2.10 m, depth 0.6–1.2 m	Solid door	Glass door
Low self service and storage closed cabinet	RS 17	Low temperature, cabinet height 0–1.79 m, depth 0.6–1.2 m	Solid door	Glass door
Combination glass door over and well under	RS 18	*Requires detailed definition*	*No subclass*	
High self service island closed cabinet	RS 19	Low temperature, cabinet height 2.2–2.8 m, depth 1.9–2.1 m. Glass door	*No subclass*	
Medium self service island closed cabinet	RS 20	Low temperature, cabinet height 1.8–2.19 m, depth 1.9–2.1 m. Glass door	*No subclass*	

Table 3: TABLE A3 of AS 1731.14:2003 APPENDIX A TYPES OF SELF-CONTAINED REFRIGERATED CABINETS

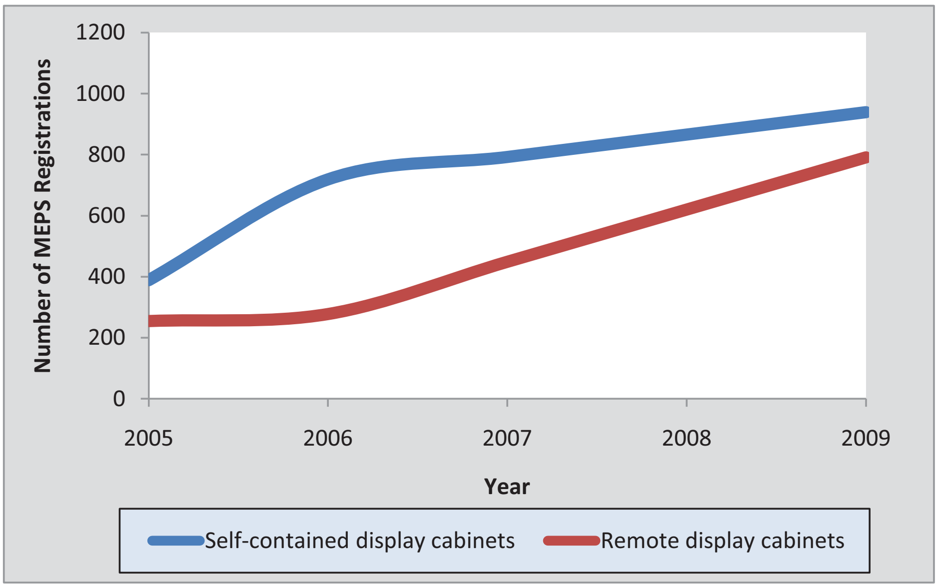
Application	**Medium temperature**		**Low temperature**	
To be used for	**Chilled (non-frozen) foodstuffs**		**Frozen, quick frozen foodstuffs and ice cream**	
Horizontal	Chilled, serve-over counter	HC1	Frozen, serve-over counter	HF1
	Chilled, serve-over counter with integrated storage	HC2		
	Chilled, open top wall site	HC3	Frozen, open top wall site	HF3
	Chilled, open top island	HC4	Frozen, open top, island	HF4
	Chilled, glass top, wall site	HC5	Frozen, glass top, wall site	HF5
	Chilled, glass top, island	HC6	Frozen, glass top, island	HF6
Vertical	Chilled, semi-vertical	VC1	Frozen, semi-vertical	VF1
	Chilled, multi-deck	VC2	Frozen, multi-deck	VF2
	Chilled, roll in	VC3		
	Chilled, glass and solid door	VC4	Frozen, glass and solid door	VF4
Combined	Chilled, open top, open bottom	YC1	Frozen, open top, open bottom	YF1
	Chilled, open top, closed bottom	YC2	Frozen, open top, closed bottom	YF2
	Chilled, glass door top, open bottom	YC3	Frozen, glass door top, open bottom	YF3
	Chilled, glass door top, closed bottom	YC4	Frozen, glass door top, closed bottom	YF4
	Multi-temperature, open top, open bottom			YM5
	Multi-temperature, open top, closed bottom			YM6
	Multi-temperature, glass door top, open bottom			YM7
	Multi-temperature, glass door top, closed bottom			YM8

NOTE: Serve-over counters are primarily in assisted service but may be in self service. Chilled multi-deck cabinets are primarily in self service but may be assisted service.

3.2 RDC registrations

As shown in Figure 1, the numbers of RDCs registered for MEPS has grown continuously since the introduction of regulations. The equipment currently registered is analysed in detail in the following sections.

Figure 1: All registrations (MEPS) for remote and self-contained RDCs, 2005-2009



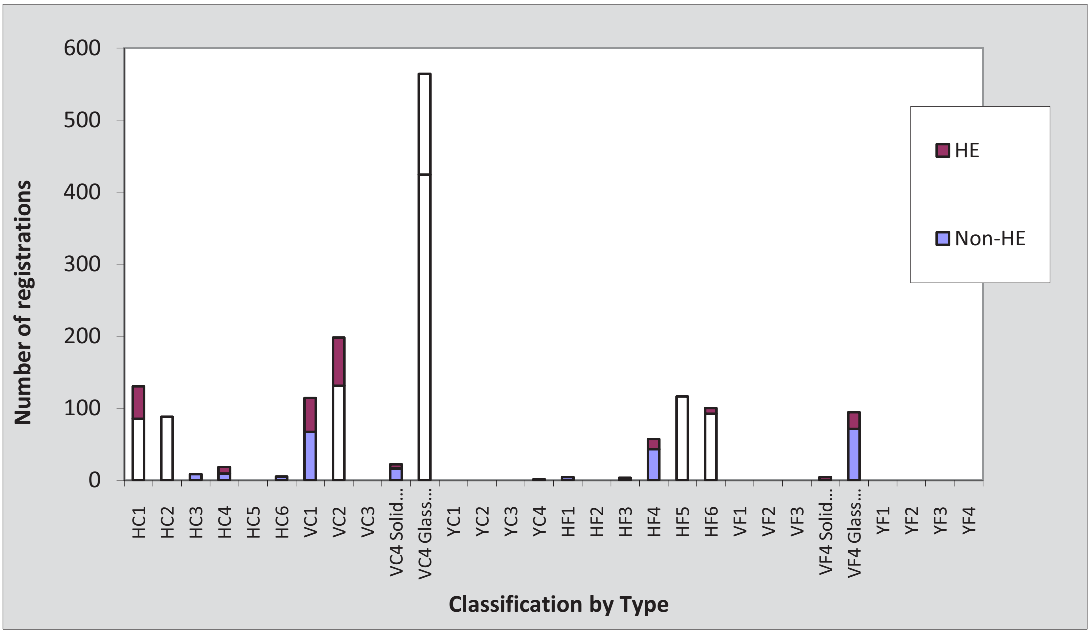
3.2.1 Integral RDCs registration summary

Table 4: Registrations for integral refrigerated display cabinets (RDCs), May 2009

Medium Temperature RDCs				Low Temperature RDCs			
Type	Total Registrations			Type	Total Registrations		
	Min Eff	HE	Total		Min Eff	HE	Total
IHC1	85	45	130	**IHF1**	0	0	4
IHC2	0	0	88	**IHF2**	0	0	0
IHC3	0	0	8	**IHF3**	0	0	3
IHC4	9	9	18	**IHF4**	43	14	57
IHC5	0	0	0	**IHF5**	0	0	116
IHC6	0	0	5	**IHF6**	92	8	100
IVC1	67	47	114	**IVF1**	0	0	0
IVC2	131	67	198	**IVF2**	0	0	0
IVC3	0	0	0	**IVF3**	0	0	0
IVC4 Solid door	16	6	22	**IVF4 Solid door**	1	3	4
IVC4 Glass door	424	140	564	**IVF4 Glass door**	71	23	94
IYC1	0	0	0	**IYF1**	0	0	0
IYC2	0	0	0	**IYF2**	0	0	0
IYC3	0	0	0	**IYF3**	0	0	0
IYC4	0	0	1	**IYF4**	0	0	0
Total Registrations	**732**	**314**	**1148**	**Total Registrations**	**207**	**48**	**378**

Note: No registrations values shaded

Figure 2: Registrations for integral refrigerated display cabinets (RDCs), May 2009



- A total of 1526 products are currently registered or listed on the Energy Rating website as integral RDCs. Of these 362 are shown as being registered as high efficiency (HE). It should be noted that significantly higher numbers of product are more efficient than the HE Level; however the option of having these listed as high efficiency has not been taken up. In some cases where there is a close margin this would appear to be due to a safety factor to take into account product variability however where others have a wide margin there does not appear to be a logical explanation;
- A number of the designated cabinet families or 'types' have very few registrations. As an example IVF4 Solid Door shows 4 products. This compares with IVC4 Glass with 564 products listed with 140 of these meeting the requirements for high efficiency. A number of 'types' that do not have any MEPS values also have numbers of products listed. The most significant being IHC2 with 88 products and IHF5 with 116 products registered. Notably IVC1, IVC2 and IHC1 all have high percentages of high efficiency registrations with these being over a third of the total number in two of the types. Some types have a wide variety of product with large variances in TEC and TDA while others are tightly grouped. There are also clearly wide variations in efficiency between similar types of products;
- A possible issue arises where groups of products are registered as 'families' with identical TDA and TEC for a variety of products. Various interpretations of the current definition appear to have caused some confusion since products with widely differing TDA and TECs are then grouped together apparently having the same efficiency. This makes it impossible to determine the energy efficiency level of the individual products in that group. While these products appear to be all from a particular model range they do not share the same efficiency characteristics. This is addressed elsewhere in the documents under "Definitions";
- Certain family classifications show up with significant trends;
- Listed below is a brief summary of all those classifications with MEPS values along with others that are notable for various reasons.

3.2.2 Integral RDC registration summary by classification (type)

- IHC1 – 130 products registered with 35% being shown as eligible for high efficiency;
- IHC2 - 88 products registered but no MEPS levels established as yet;
- IHC4 – 18 products registered, all except two eligible for high efficiency. If the HE level became the minimum Efficiency level two products would be affected;
- IVC1 – 114 products registered. Shows a large variation of TDA and TEC;
- IVC2 – 198 products registered. Shows a large variation of TDA and TEC;
- IVC4 Solid – 22 products registered. Both the Minimum Efficiency Level and high efficiency Levels could be made more onerous with little impact on existing registrations;
- IVC4 Glass – 564 products registered. Of these 25 % are eligible for high efficiency. Large variation of TDA and TEC;
- IHF4 – 57 products registered. Of these 25 % are eligible for high efficiency;
- IHF5 – 116 products registered but no MEPS levels established as yet;
- IHF6 – 100 products registered. Of these 8 % are eligible for high efficiency;
- IVF4 Solid Door – 4 products registered;
- IVF4 Glass – 94 products registered. Of these 25 % are eligible for high efficiency. Large variation in TDA and TEC.

3.2.3 Remote RDCs registration summary

Table 5: Registrations for remote refrigerated display cabinets (RDCs), May 2009

Medium Temperature RDCs				Low Temperature RDCs			
Type	**Total Registrations**			**Type**	**Total Registrations**		
	Max	HE	Total		Max	HE	Total
RS1 lit	102	0	102	**RS11**	4	0	4
RS1 Unlit	122	3	125	**RS12**	0	0	0
RS2 Lit	136	0	136	**RS13 Solid sided**	10	0	10
RS2 Unlit	204	5	209	**RS13 Glass sided**	25	0	25
RS3 Lit	30	4	34	**RS14 Solid Sided**	13	0	13
RS3 Unlit	38	2	40	**RS14 Glass Sided**	23	0	23
RS4 Solid Door	0	0	0	**RS15 Solid Glass**	0	0	0
RS4 Glass Door	7	0	7	**RS15 Glass Door**	4	13	17
RS5 Solid Door	0	0	0	**RS16 Solid Door**	0	0	0
RS5 Glass Door	0	0	0	**RS16 Glass Door**	8	20	28
RS6 Gravity	7	0	7	**RS17 Solid Door**	0	0	0
RS6 Fan	1	2	3	**RS17 Glass Door**	0	0	0
RS7 Gravity	0	0	0	**RS18**	5	6	11
RS7 Fan	6	5	11	**RS19**	0	0	0
RS8Gravity	14	2	16	**RS20**	0	0	0
RS8 Fan	10	15	25				
RS9 Gravity	0	0	0				
RS9 Fan	17	3	20				
RS10 High	0	0	0				
RS10 Medium	0	0	0				
RS10 Low	5	4	9				
Total Registrations	699	45	744	**Total Registrations**	92	39	131

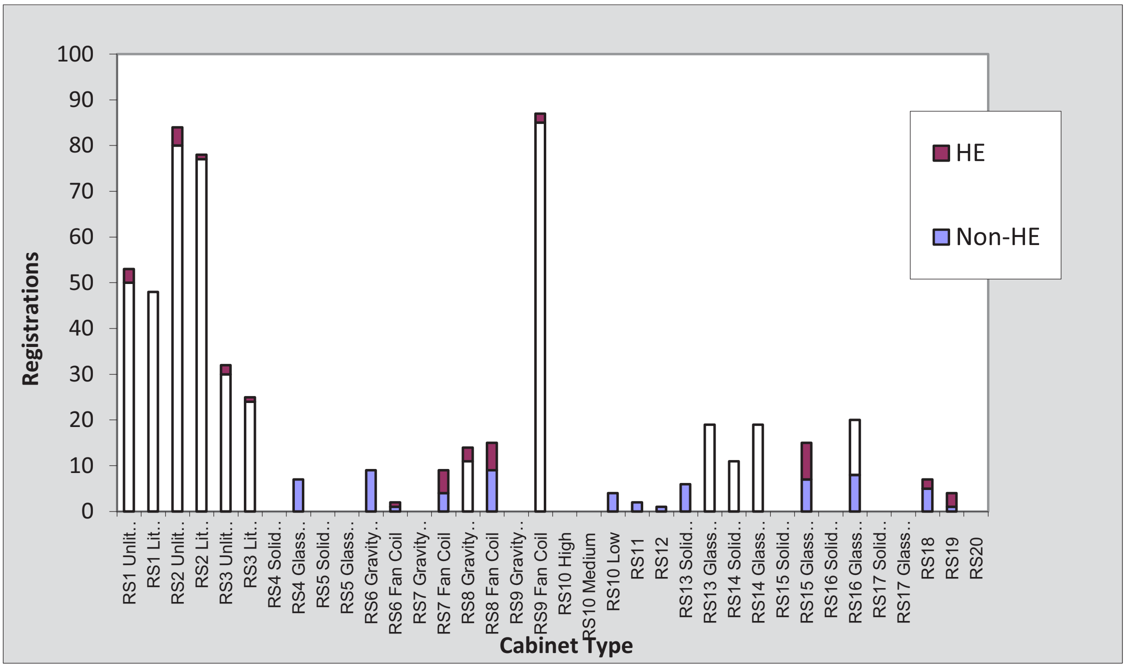
Note: No registrations values shaded

- A total of 875 products are currently registered or listed on the Energy Rating website as remote RDCs. Of these 84 are shown as being registered as high efficiency. Again it should be noted that higher numbers of product are more efficient than the high efficiency Level however the option of having these listed as high efficiency has not been taken up;
- A number of the designated cabinet families or 'types' have very few registrations. As an example RS6 Fan shows 3 products. This compares with RS2 Unlit with 209 products listed;
- Significantly there are number of classifications with very few products eligible for high efficiency. Notably RS1 Lit, RS1 Unlit and RS2 Unlit. However there are also classifications such as RS15 Glass Door and RS16 Glass Door where very high numbers are eligible for meeting high efficiency, both with over 70%;
- Because of the nature of remote products they tend to be very closely grouped as regards TDA;
- The same possible issue arises where groups of products are registered as 'families' as with the integral products. However the solution is possibly different from the integral products as the remote products tend to be manufactured in linear lengths of various standard dimensions

whereas integral products are often individual items installed separately. This is also addressed elsewhere in the documents under "Definitions";

- Again certain family classifications show up with significant trends;

Figure 3: Registrations for remote refrigerated display cabinets (RDCs), May 2009



- Listed below is a brief summary of all those classifications with MEPS values along with others that are notable for various reasons.

3.2.4 Remote RDC registration summary by classification (type)

- RS1 Lit – 102 products registered. It would appear none are eligible for high efficiency;
- RS1 Unlit – 125 products registered. Very few are eligible for high efficiency;
- RS2 Lit – 136 products registered. It would appear a significant number (40) are eligible for high efficiency although none are registered as such;
- RS2 Unlit- 209 products registered. Very few are eligible for high efficiency;
- RS3 Lit - 34 products registered;
- RS3 Unlit – 40 products registered;
- RS4 Glass Door - 7 products registered;
- RS6 Gravity Coil – 7 products registered;
- RS6 Fan - 3 products registered;
- RS7 Fan Coil – 11 products registered;
- RS8 Gravity – 16 products registered;
- RS8 Fan - 25 products registered. Levels could be lowered with minor effect;
- RS9 Fan – 20 products registered;
- RS10 Low- 9 products registered;

- RS11 - 4 products registered;
- RS12 - No registrations;
- RS13 Solid - 10 products registered;
- RS13 Glass – 25 products registered;
- RS14 Solid – 13 products registered. None are eligible for high efficiency;
- RS14 Glass – 23 products registered. Levels could be lowered with little or no effect on current registrations;
- RS15 Glass - 17 products registered. Levels could be lowered with no effect on current registrations;
- RS16 Glass – 28 products registered. All are eligible for high efficiency. The Minimum Efficiency level could be lowered with no effect on current registrations and the high efficiency level lowered with minor effect on existing registrations;
- RS18 - 11 products registered. Levels could be lowered with no effect on current registrations;
- RS19 – No registrations.

3.3 Industry feedback

The majority of questions that arise in relation to compliance issues generally relate to the determination of which family cabinet classification or 'type' a certain RDC or refrigerated product should be categorised as.

While some display cabinets are clearly classified as certain types others are not and it can be a complex matter to establish which type they should be related to.

Tables A1, A2 and A3 of Appendix A of AS 1731 name the types and offer 'informative' descriptions. Also Table F1 of Appendix F relates the diagrams in Appendix D to the cabinet types in Appendix A although this basically relates to the method for the determination of the total display area (TDA).

Cabinets that fall outside of the dimensional limitations contained in the 'informative' descriptions in Table A1 and A2 for remote RDCs and the 'informative' definitions in Table F1 therefore become problematic. They may fit the broad description but fall outside the dimensional limitations.

In a different manner Table A3 for integral cabinets which is split into three applications; **Horizontal**, **Vertical** and **Combined**, does not contain any dimensions or detailed descriptions other than a generic product type. However Table F1 does then introduce the dimensional parameters, as used for remote cabinets but relates to the parameters for calculation of TDA.

As a consequence similar product can be registered in different family classifications or as a different 'type'. There is also some confusion where an integral cabinet is covered by MEPS but the same cabinet with a remote condenser system is not.

A broadening of the descriptions and definitions of the family classifications together with amalgamation of some of the 'types' will mean a clearer means of identification of display cabinets in the market for all stakeholders.

3.4 Conclusions on the classification of RDCs

The wide diversity of product in the market is shown by the large number of registrations of different models of RDCs and the extreme range of efficiency levels/energy consumption.

The majority of registrations are integral types representing 64% and the balance, 36% are remote types.

Remote RDCs are divided into 36 separate cabinet families and sub-classes or 'types' although only 24 of these categories have MEPS levels set. Each of these have a minimum efficiency level or maximum energy consumption per square metre of display area specified as well as an additional high efficiency level set.

- 74% of all remotes registrations are in six 'type' cabinet classifications the other 30 'types' represent 26% of all remote registrations;
- 9.6% of all remote registrations are high efficiency.

There is potential to simplify these categories either by combining a number of the remote display cabinet family classifications and sub-classes into larger classifications or with common MEPS levels for a number of family classifications that have similar efficiency levels. Aligning with the family classifications for remote RDCs, as used in Europe and defined in Appendix A of EN ISO 23953, and also integral RDC classification, would make it easier to correctly identify the appropriate class for any individual RDC. In addition it would rectify issues where an integral version of an RDC is covered by MEPS and a remote version of the same product is not.

Integrals RDCs are divided into 30 different families and sub-classes or 'types' which are then each split into M1 and M2 temperature classes. Of these only ten categories have a minimum efficiency level specified and each of these then has a high efficiency category.

- 84% of all integral registrations are in eight 'type' classifications the other 22 'types' represent just 16% of all integral registrations;
- 24% of all integral registrations are high efficiency.

With integral display cabinets there is also good opportunity to combine a number of the cabinet family classifications or 'types' into larger classifications, and to review the effect of having more than one temperature classification which currently in some cases have identical MEPS levels.

Overall it is concluded that the introduction of a more easily understood system of RDC classification used for the allocation of energy performance levels which is consistent across remote and integral cabinets will facilitate compliance.

The classification of integral cabinets is currently harmonised with the international test method, ISO 23953:2005, and with increased trade in RDCs, the adoption of this system for all RDCs in Australia and New Zealand is the most rational approach.

These classifications should then be used for the allocation of energy performance levels in Part 14 of AS 1731 (further discussed in Section 5). This would bring a wider range of RDCs within the ambit of regulations, since 32 of the 66 current classifications do not have MEPS levels specified, making the energy efficiency programme more effective and equitable.

3.5 Recommendations on the classification of RDCs

In order to increase the effectiveness of energy efficiency regulations for RDCs in Australia and New Zealand it is recommended that:

- A common system of classification should be introduced for all RDCs within the scope of AS 1731, for the purpose of setting energy performance thresholds;
- The classification system adopted should be harmonized with classifications used in ISO 23953:2005;
- Appropriate changes to AS 1731 should be implemented as soon as appropriate MEPS levels have been agreed and allowing a reasonable transition period for industry.

4 International alignment of RDC test methods

4.1 Background to the development of AS 1731

The publications that form the basis of the MEPS for Australia and New Zealand are based on the test methods contained within the thirteen parts of Australian Standard AS 1731: Refrigerated Display Cabinets.

Mandatory energy performance levels are contained in Part 14 of AS 1731, and apply to both remote and integral RDCs either open or closed. This standard also refers to the applicable test methods as specified in the other parts of AS 1731 and specifies classifications of equipment into various family 'types' such as origin. The key milestones in the development of AS 1731 may be recorded as follows:

- The Australian standard was based on a British Standard and originally published as AS B220-1966.
- Revised and recorded as AS 1731-1983, the standard was devised to outline the basis of testing procedure, and was directed only at low temperature retail merchandisers.
- Manufacture or compliance to the standard was not a legal requirement, and the ISO test packs nominated were those as used in domestic refrigerator testing. These are also as specified in AS 2605:1983 Freezer Test Packages.
- In 2003 a changes introduced included the lighting regime during the test, an additional part of the test required if night blinds are fitted, and the use of UNSW filler packs. Also the position of temperature measurement sensor in the test room was altered in relation to product under test. Part 14 was also added at this time, to specific MEPS and high efficiency level.
- Further amendments in the way of clarifications were made to each individual part of AS 1731 in 2005.
- A further review was made to make the standard a clone of EN ISO 23593, but it should be stated that this is only in consideration of the testing method, as the European standard does not contain any MEPS levels.

4.2 Summary of different test methods for RDCs

The purpose of the performance tests that are carried out on RDCs and service cabinets is to simulate as close as possible actual operating conditions and to classify and compare cabinets under defined conditions. For these reasons specific climate classes and loadings are defined for the tests to be carried out in a test room or laboratory in a controlled environment.

A number of countries use energy efficiency test methods for RDCs, and these have been analysed to confirm that the methodology used in Australia is as far as practical in keeping with overseas practice. Table 6 provides a comparison of the key test method parameters used in AS 1731 with those used in the main overseas standards.

While there may be good reasons to explain differences between regional test methods, one issue raised by industry has been the difficulties these variations present for registering products in Australia and New Zealand which have been tested to methods other than AS 1731.

The majority of tests for performance and energy consumption of commercial display cabinets utilise a simulated cabinet load to represent actual use. The most common simulated load is the long established ISO style test filler package, which is especially true of European based test methods.

While Mexico specifies liquid filled cans for medium temperature cabinets they still use the ISO Packages for low temperature cabinets. ASHRAE and ARI use a similar pack but with a different filler material. AS 1731 also specifies the use of ISO filler packs but provides an option to use an alternative type of pack designed and produced by the University of NSW in order to increase availability to local markets. Differences in the specification of filler packs are summarised in Attachment 10.

Door openings for those cabinets fitted with doors that are based on the European standards specify a door opening period of 12 hours each 24 hours while the ASHRAE and ARI specify an 8 hour period. Mexico does not specify any door openings however they have introduced a pull-down test as a further performance measure and condition.

Test room illumination levels are generally specified so as to give a consistent radiation effect from lighting which may affect the measured temperatures of stored or displayed food product.

Cabinet illumination in AS 1731 calls for 24 hour operation in a closed cabinet unless the lighting is controlled by some means of automatic means whereas EN ISO 23953 specifies 12 hours of lighting for each 24 hours of operation. Where night covers are supplied as a permanent fixture of an open cabinet the test is to be conducted with night covers removed and lighting switched on for a period of 12 hours followed by a period of 12 hours with the night covers on and cabinet lighting switched off (AS 1731.9 Clause 4.3(b)). This is similar to other European based tests, while other programmes simply measure energy consumption over a 24 hour period with all electrical components energised.

The specifications for the test room temperature and relative humidity vary depending on the local climate and the likely operating environment. Europe tends to employ the manufacturers declared climate class, the UK ECA for Display Cabinets is 25°C and 65% RH (Climate Class 3) while North America specify 24°C and the equivalent of 55% RH. Mexico and the UK ECA Service Cabinet energy consumption test specify 32°C, 65% RH and 30°C, 55%RH respectively. AS 1731.9 (and AS 1731.12 for remote cabinets) specifies that energy consumption is measured in accordance with at Climate Class 3 conditions.

The requirement for the cabinet internal temperatures vary with the European test methods having a range of different temperatures due to the Classes specified in the classifications according to temperature. North America and Mexico on the other hand operate a more basic system with an average of 3.3°C for all medium temperature cabinets.

In conclusion, while Australian Standard AS 1731 is currently not identical to any of the overseas test methods it closely follows the European/International Standard EN ISO 23953:2005 in the way it relates to refrigerated display cabinets. Therefore where a standard other than Australian Standard AS 1731 is being used as the basis for compliance, 'top-up' testing (or calculation) may be required to make an estimate of energy performance which accurately reflect testing to AS 1731.

Further issues relate to how energy performance values determined through tests are presented. The MEPS efficiency in Australia and New Zealand is determined by calculating the total energy consumption per square metre of total display area (TEC/TDA) and is expressed as kWh/day/m^2. While this is also used by many programs as an appropriate metric for RDCs, there are still variations, for example in the treatment of glazing areas and allowances in closed cabinets. This issue if discussed in Section 4.

The version of AS 1731 published in 2003 represented a major improvement on previous versions and was developed in order to overcome perceived deficiencies in all other available test methods for RDCs at the time. As noted, there is now an international test method which has addressed many of the shortcomings with the European method, not least through integrating some of the features in AS 1731. Given that ISO 23953:2005 now represents a robust test method which is suitable for supporting the regulations for RDCs in Australia and New Zealand, the need for a separate test standard for Australia and New Zealand would seem unwarranted.

The benefits of harmonising with the international standard include the reduction of effort in maintaining AS 1731, and reduced compliance costs for products tested to the ISO standard. The practical steps of harmonisation are discussed in the following section.

4.3 Harmonisation with ISO test method

With the 2005 publication of ISO 23953-1 Refrigerated display cabinets – Part 1: Vocabulary and ISO 23953-2 Refrigerated display cabinets – Part 2: Classification, requirements and test methods improved the standard structure by consolidating thirteen parts of EN 441.1 to .13 Refrigerated display cabinets into two sections.

Australian Standard AS 1731 Refrigerated Display Cabinets was itself based on the EN 441 series of standards with 13 parts but with the addition in 2003 of a Part 14 that contained the descriptions of the various 'type' classifications and specified the mandatory Australian and New Zealand MEPS levels.

Currently the Australian standard comprises the following parts:

- AS 1731.1-2003 incl Amdt 1-2005 Refrigerated display cabinets – Terms and definitions;
- AS 1731.2-2003 incl Amdt 1-2005 Refrigerated display cabinets – General mechanical and physical requirement;
- AS 1731.3-2003 incl Amdt 1-2005 Refrigerated display cabinets- Linear dimensions, areas and volume;
- AS 1731.4-2003 incl Amdt 1-2005 Refrigerated display cabinets- General test conditions;
- AS 1731.5-2003 incl Amdt 1-2005 Refrigerated display cabinets- Temperature test;
- AS 1731.6-2003 incl Amdt 1-2005 Refrigerated display cabinets- Classification according to temperatures;
- AS 1731.7-2003 incl Amdt 1-2005 Refrigerated display cabinets- Defrosting test. AS 1731.8-2003 incl Amdt 1-2005 Refrigerated display cabinets- Water vapour condensation test;
- AS 1731.9-2003 incl Amdt 1-2005 Refrigerated display cabinets- Electrical energy consumption test;
- AS 1731.10-2003 incl Amdt 1-2005 Refrigerated display cabinets- Test for absence of odour and taste;
- AS 1731.11-2003 incl Amdt 1-2005 Refrigerated display cabinets- Installation, maintenance and user guide;
- AS 1731.12-2003 incl Amdt 1-2005 Refrigerated display cabinets- Measurement of the heat extraction rate of the cabinets when the condensing unit is remote from the cabinet;
- AS 1731.13-2003 incl Amdt 1-2005 Refrigerated display cabinets- Test report;
- AS 1731.14-2003 incl Amdt 1-2005 Refrigerated display cabinets- Minimum energy performance standard (MEPS) requirements.

In order to align the Australian standard with the current international standard for refrigerated display cabinets, ISO 23953, and to streamline the standards process, a similar system to that used internationally with the EN standards could be implemented. Typically in Europe they are numbered as an XX EN ISO 23953: such as BS EN ISO 23953 for the UK, and DIN EN ISO 23953 for Germany. In some cases the only difference is a national 'Forward' added to a reprinted EN version.

The two parts of ISO 23953 could be adopted intact, as they stand and any local deviations published as the AS standard.

Both Australia and New Zealand have input into the international process of standardisation from which ISO standards originate therefore there should be no reason why any local technical deviations with merit cannot be incorporated into ISO 23953.

The proposed Australian Standard might then become:

- AS XXXX.1.1:20XX - Refrigerated Cabinets – Glass doors, glass lids or open display - Test Methods. Which would call up as the applicable test method:
  - ISO 23953-1 Refrigerated display cabinets – Part 1: Vocabulary, and;
  - ISO 23953-2 Refrigerated display cabinets – Part 2: Classification, requirements and test methods.
  - Any deviations from the ISO 23953 necessary for Australia and New Zealand.
- Alternatively, it could become AS EN ISO 23953. AS XXXX.1.2:20XX- Refrigerated Cabinets – Glass doors, glass lids or open display - Minimum performance requirements and labelling. Which would be a revised AS 1731.14

With EN 441 having been superseded in Europe there will no longer be any maintenance carried out on it by CENELEC as the work has moved to EN ISO 23953. Therefore in order to maintain the content of the thirteen parts of AS 1731 that are based on EN 441 any work would need to take into account changes made overseas to the two parts of EN ISO 23953.

However a more cost-effective method would be for Standards Australia to use a similar system to that used by other standards organisations such as the EN model and to allow the adoption of EN ISO 23953 Parts 1 and 2 to replace Parts 1 to 13 of AS 1731. This would also assist with international alignment and simplify the layout of the standard.

The amended AS 1731 version would only contain the deviations to the ISO standard that are necessary for Australia and/or New Zealand, and would be read in conjunction with EN ISO 23953.

This could mean that Standards Australia only need to publish the deviations to ISO 23953 and any amendments rather than republish reworded versions. They would not be responsible for producing cut-in version as is currently the case with AS 1731 and its thirteen parts. The Part 14 which contains the MEPS levels would become a new standard possibly linked to other 'Refrigerated Equipment and Components' standards.

4.4 Recommendations

In order to ensure that the test method for RDCs used in Australia and New Zealand remains closely aligned to international test methods, it is recommended that:

- AS 1731 Part 1 to Part 13 (inclusive) are replaced by the two parts of EN ISO 23953 (2005);
- AS 1731.14 Part 14 is revised to cover RDCs only, making reference to the use of test methods outlined in EN ISO 23953 (2005);
- Energy performance requirements for any other types of refrigeration equipment to be tested according to EN ISO 23953 should be specified in new additional parts of the revised AS 1731.

Table 6: Summary of test methods

SUMMARY OF TEST METHODS									
Standard (Country)	**Climate**	**Airflow**	**Test Room Lighting**	**Power Supply**	**Product load**	**Test Period - Open cabinets**	**Test Period - Closed cabinets**	**Cabinet test temperature**	**Efficiency Metric**
EN 441 (Europe)	Manufacturers declared Climatic Class	0.2 m/s +0/-0.1 m/s	600 ± 100 lux at 1 m above floor and on continuously	± 2%	ISO type M-Packages and ISO type Filler/Test packages	First test: Cabinet lighting on for 24 hours and night covers removed. Second test: Night covers removed and cabinet lighting on for 12 h followed by night covers fitted and cabinet lighting off for 12 h	48 h with doors and lids opened cyclically for 12 h of each 24 h period. Lighting on 2 h longer than door opening cycles if switchable or otherwise continuously.	Manufacturers declared M-package temperature	Not applicable, However TDA is reported.
AS 1731 (Australia and New Zealand)	Climatic Class 3 ($25^{o}C$ 60% RH)	0.2 m/s +0/-0.1 m/s	600 ± 100 lux at 1 m above floor and on continuously	± 2% of nominal value of marked rating	ISO type M-Packages MECHLAB Filler/Test packages or 480 ± 80 kg/m^3 filler packs	First test: Cabinet lighting on for 24 hours and night covers removed. Second test: Night covers removed and cabinet lighting on for 12 h followed by night covers fitted and cabinet lighting off for 12 h	Closed cabinet 48 h with doors and lids opened cyclically for 12 h of each 24 h period. Cabinet Lighting on continuously unless automatically controlled	Manufacturers declared M-package temperature.	TEC/TDA
EN ISO 23953 (Europe)	Manufacturers declared Climatic Class	0.2 m/s +0/-0.1 m/s	600 ± 100 lux at 1 m above floor and on continuously	± 2% of nominal value of marked rating	ISO type M-Packages and ISO type Filler/Test packages	First test: Cabinet lighting on for 24 hours and night covers removed. Second test: Night covers removed and cabinet lighting on for 12 h followed by night covers fitted and cabinet lighting off for 12 h	First test: Cabinet lighting on for 24 hours Second test: Cabinet lighting on for 12 h followed by cabinet lighting off for 12 h.	Manufacturers declared M-package temperature.	Not applicable
ANSI/ASHRAE 72-2005 (USA)	Dry Bulb $24^{o}C$ ± $1.0^{o}C$ Wet Bulb 18oC ± $1.0^{o}C$	< 0.25 m/s across display opening	Not less than 800 lux in relation to display opening	± 4% of rated voltage	Test Packages and Filler Packages	24 h with all electrical components energised.	8 h with doors opened cyclically starting 3 hours after defrost. All electrical	Not directly specified	Volume

							components energised.		
ARI 1200:2002 (USA)	Dry Bulb 24°C ± 1.0°C Wet Bulb 18oC ± 1.0°C	< 0.25 m/s across display opening	Not less than 800 lux in relation to display opening	± 4% of rated voltage	Test Packages and Filler Packages	24 h with all electrical components energised.	8 h with doors opened cyclically starting 3 hours after defrost. All electrical components energised.	Low temperature: Average -18°C ± 1.1°C. Medium temperature: 3.3°C ± 1.1°C Ice Cream: -26°C ± 1.1°C	Volume
AS/NZS 4471.1 (AS/NZS Household Refrigeration)	32°C ± 0.5°C for energy consumption	< 0.25 m/s	Not specified	230 V ± 1%	Temperature sensors in air	Dependent on type of defrost used.	No door openings	Refrigerators: +3°C. Freezers: -15°C	Refrigerated Volume
NOM-022-ENER/SCFI-2008 (Mexico)	32°C ± 1.5°C and 65% ± 5% RH	< 0.254 m/s	Not specified	230 V ± 1 V 115 V ± 1 V 60 Hz	Medium temperature: 355 ml cans Low temperature: ISO type test packages.	Pull down test. Minimum 24 h test period. All electrical components energised.	Pull down test. Minimum test period 24 h without door openings. All electrical components energised.	Medium temp: with fan - Max 7.2°C, Min 0°C, Av 3.3°C. Cold plate – Max 10°C, Min -1°C, Av ≤ 5°C. Freezers: Max - 18oC.	Refrigerated Volume.
ECA RDCs (UK)	Climatic Class 3 (25°C 60% RH)	0.2 m/s +0/-0.1 m/s	600 ± 100 lux at 1 m above floor and on continuously	± 2% of nominal value of marked rating	ISO type M-Packages and ISO type Filler/Test packages	Night covers removed and cabinet lighting on for 12 h and off for 12 h.	Closed cabinet 48 h with doors and lids opened cyclically for 12 h of each 24 h period. Cabinet Lighting on continuously.	Manufacturers declared M-package temperature	Total Display Area
ECA Service Cabinets (UK)	Climatic Class 4(30°C 55% RH)	0.2 m/s +0/-0.1 m/s	600 ± 100 lux at 1 m above floor and on continuously	± 2% of nominal value of marked rating	ISO type M-Packages and ISO type Filler/Test packages	N/A	48 h with doors and lids opened cyclically for 12 h of each 24 h period.	M1 (-1°C to +5°C) L1 (-15°C to - 18°C)	Refrigerated Volume

5 Minimum energy efficiency levels

The original minimum energy efficiency levels (maximum energy consumption in relation to total display area (TDA)) for Australia and New Zealand were based on a limited amount of data gained from product testing of submitted equipment, information provided by manufacturers and stakeholders as well as information available from overseas. For some 'type' classifications little if any data was available and in these cases efficiency levels were not able to be established resulting in a number of categories having 'No Value' and thus not subject to MEPS.

However, with MEPS for RDCS having now been in place since 2004 there is a considerable amount of data available from the products that have been registered as well as additional data available from overseas efficiency programs. These can be used to propose reasonable new MEPS levels.

A further consideration is that the recommendation to the adopt ISO classification for all RDCs for allocating energy performance levels has ramifications for the setting of any new MEPS level.

In this section, the potential to allocate the same MEPS levels across several ISO categories is discussed and recommendations made. Following this, the issue of appropriate new MEPS levels is tackled, leading to some further proposals.

5.1 Combining categories for allocating MEPs

Table 7 presents the ISO classification system, which is proposed to be adopted for all RDCs in Australia and New Zealand.

Table 7: Designation of refrigerated display cabinet families

Application	Temperature positive		Temperature negative	
To be used for	**Chilled foodstuffs**		**Frozen, quick frozen foodstuffs and ice cream**	
Horizontal	Chilled, serve-over counter open service access	HC1	Frozen, serve-over counter open service access	HF1
	Chilled, serve-over counter with integrated storage open service access	HC2		
	Chilled, open, wall site	HC3	Frozen, open, wall site	HF3
	Chilled, open, island	HC4	Frozen, open, island	HF4
	Chilled, glass lid, wall site	HC5	Frozen, glass lid, wall site	HF5
	Chilled, glass lid, island	HC6	Frozen, glass lid, island	HF6
	Chilled, serve-over counter closed service access	HC7	Frozen, serve-over counter closed service access	HF7
	Chilled, serve-over counter with integrated storage closed service access	HC8		
Vertical	Chilled, semi-vertical Open	VC1	Frozen, semi-vertical	VF1
	Chilled, multi-deck Open	VC2	Frozen, multi-deck	VF2

	Chilled, roll-in Open	VC3		
	Chilled, glass door	VC4	Frozen, glass door	VF4
Combined	Chilled, open top, open bottom	YC1	Frozen, open top, open bottom	YF1
	Chilled, open top, glass lid bottom	YC2	Frozen, open top, glass lid bottom	YF2
	Chilled, glass door top, open bottom	YC3	Frozen, glass door top, open bottom	YF3
	Chilled, glass door top, glass lid bottom	YC4	Frozen, glass door top, glass lid bottom	YF4
	Multi-temperature, open top, open bottom			YM5
	Multi-temperature, open top, glass lid bottom			YM6
	Multi-temperature, glass door top, open bottom			YM7
	Multi-temperature, glass door top, glass lid bottom			YM8
R Remote condensing unit ***I Incorporated condensing unit*** ***A Assisted service*** ***S Self service*** ***H Horizontal***			***V Vertical*** ***Y Combined*** ***C Chilled*** ***F Frozen*** ***M Multi-temperature***	
General classification can be used as follows: HC1, VF1, YM5. When necessary, the classification can be more precise for example, RHC1A, IVF1S				
NOTE Serve-over counters are primarily in assisted service but can be in self-service. Chilled multi-deck cabinets are primarily in self-service but can be in assisted service				

Where different types of cabinets have similar energy performance, or where there is no rationale to justify different energy performance between types of cabinets, these categories can have the same allocated MEPS level. This will further assist understanding and compliance.

Table 8 presents a number of proposals for allocating MEPS levels, showing where sufficient similarities exist across categories for these to share the same values. It also shows the relationship between the ISO categories (new) and the existing types for remote cabinets.

All figures presented are extracted from examples in ISO 23953-2:2005 documentation.

Table 8: Proposals for the allocation of MEPS levels by ISO categories

Type	Registrations 2009	Illustration	Existing MEPS value	Proposal
HC1	130	Figure 5 (remote)	Yes	Same MEPS value
HC2	88		No	
HC3	26	Figure 4 & Figure 6 (remote)	No	Same MEPS value
HC4			Yes	
HC5	5	Figure 7 (integral)	No	Same MEPS value
HC6			No	
HC7	0		No	Same MEPS value

HC8	0		No	
VC1	74 (remote) 114 (integral)	Figure 8 (remote)	Yes	Combine with RS3 Lit and Unlit shelf
VC2	572 (remote)	Figure 9 (remote)	Yes	Combine with RS1 & RS2 Lit and Unlit
VC3	0	Figure 10 (remote)	No	New MEPS value
VC4	>600 (remote & integral)		Yes	Combine with RS4
HF3	3 (integral)		Yes	Same MEPS value Combine with RS13 & RS14
HF4	57 (integral)		Yes	
HF5	116 (integral)		No	Combine
HF6	100 (integral)		Yes	
VF2	0		Yes	Combine with RS11
VF4	139 (remote & integral)		Yes	Combine with RS15, RS16 & RS17

Figure 4: Diagram of typical HC3 RDC

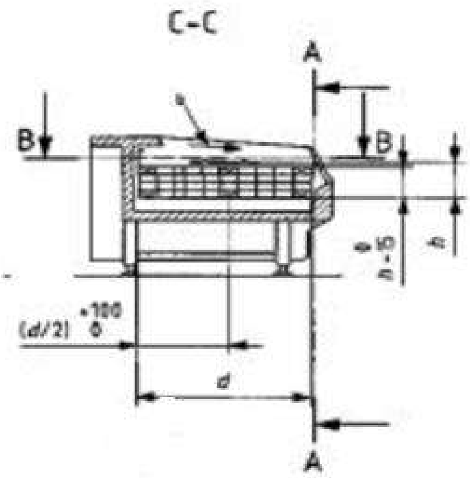


Figure 5: Diagram of typical HC1 RDC

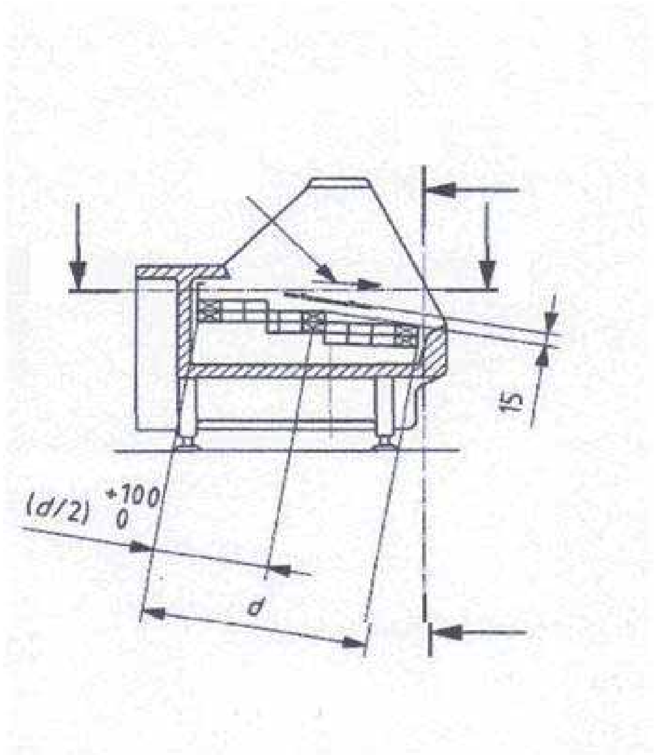


Figure 6: Diagram of typical HC4 RDC

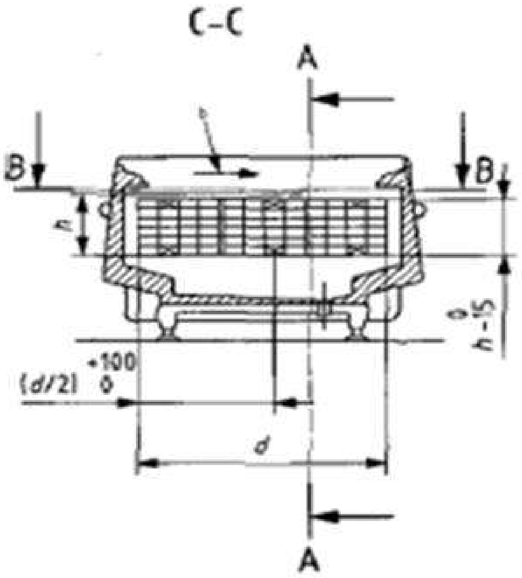


Figure 7: Diagram of typical HC6 RDC

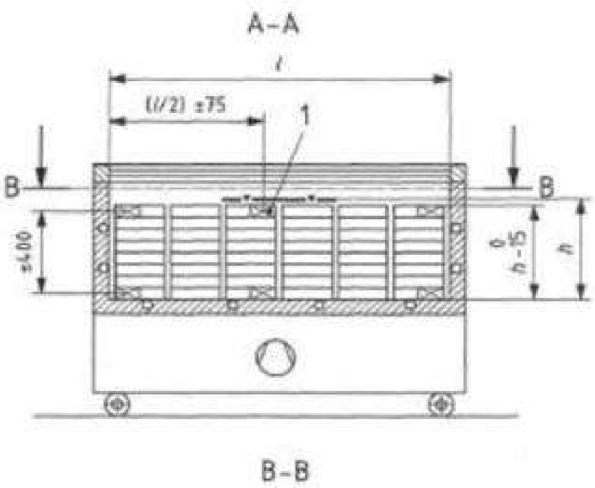


Figure 8: Diagram of typical VC1 RDC

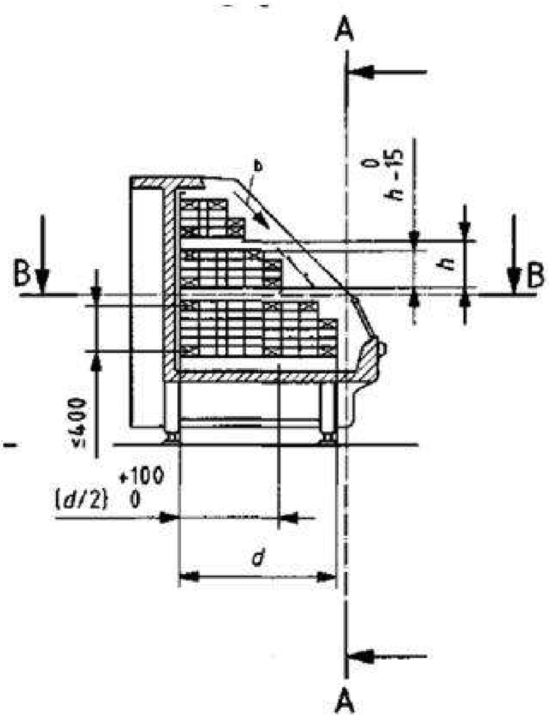


Figure 9: Diagram of typical VC2 RDC

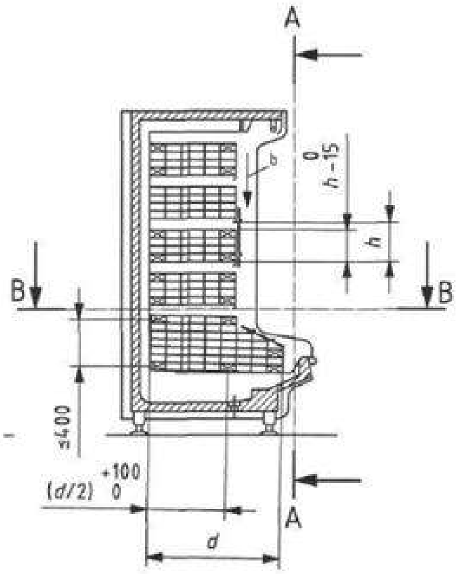


Figure 10: Diagram of typical VC3 RDC

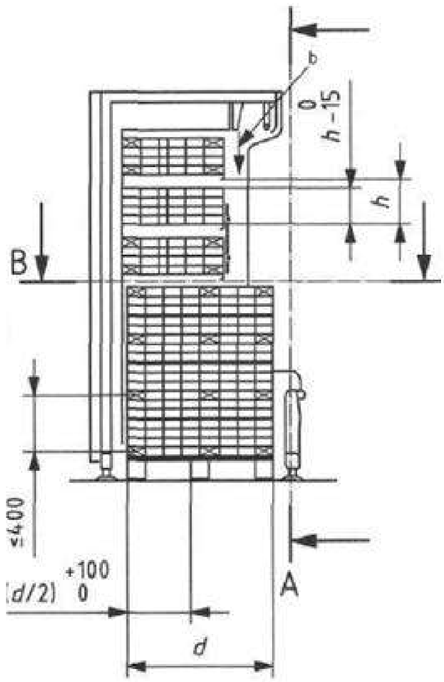
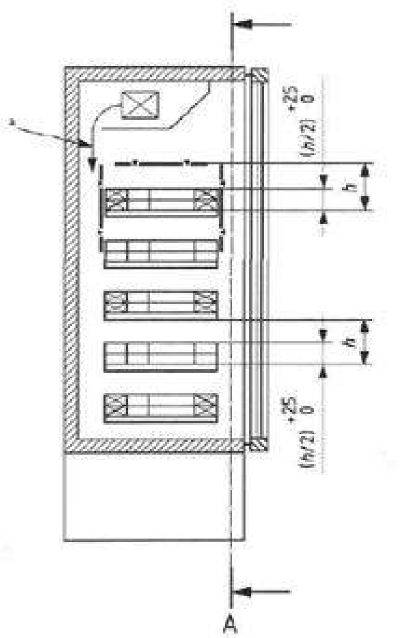


Figure 11: Diagram of typical VC4 RDC



5.2 Setting new MEPS levels

An intention of any MEPS program is to improve the overall efficiency of products in the market by removing the worst performing products. Setting an appropriate level is a balance between current technology and market conditions, and an assessment of the rate at which cost-effective technological advancements is available. Consequently, in the history of the Australia and New Zealand MEPS program, the impact of new MEPS levels has varied amongst different categories of appliances and equipment, and over time. For example, the initial MEPS levels for RDCs were intentionally set at a modest level to minimise disruption to an industry which had no prior experience of energy efficiency regulations and required time to adjust and build capacity. On the other hand, the MEPS levels for domestic refrigerators agreed in 2003 for introduction in 2005 were set at a level which could be met by less than 1% of products available in the market in 2003.

The data available from the current registrations indicate that there is now scope to make the Australian and New Zealand minimum efficiency levels more onerous and thus improve the energy efficiency of product coming on to the Australian and New Zealand markets.

The registration data shows that a number of categories have very significant numbers of registered products whereas others have very few. In some categories there is also a large spread in the energy consumption data whereas with others this is not so obvious. This can relate to the frequency of certain sizes and dimensional trends or to widespread variations in products included in a certain classification. These factors will need to be taken into account when MEPS levels are proposed.

Figure 12 to Figure 14 show some examples of the spread of energy performance characteristics in some categories, clearly indicating that more stringent MEPS levels could be introduced. Similar Figures for all categories with registration data are included in Attachments 11 and 12.

Figure 12: Energy performance of products registered as IHC4

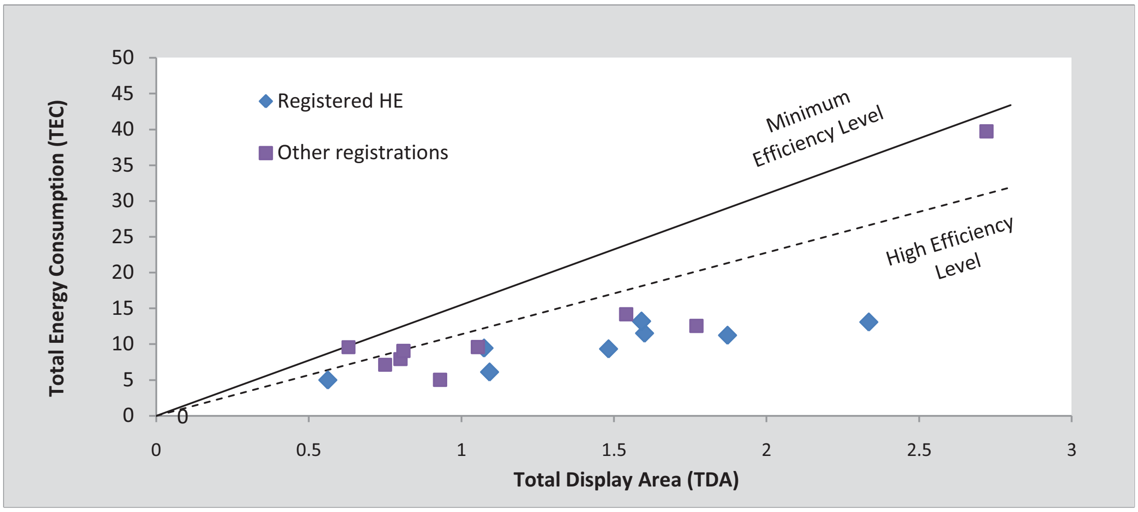


Figure 13: Energy performance of products registered as IVC4 Glass Door M1

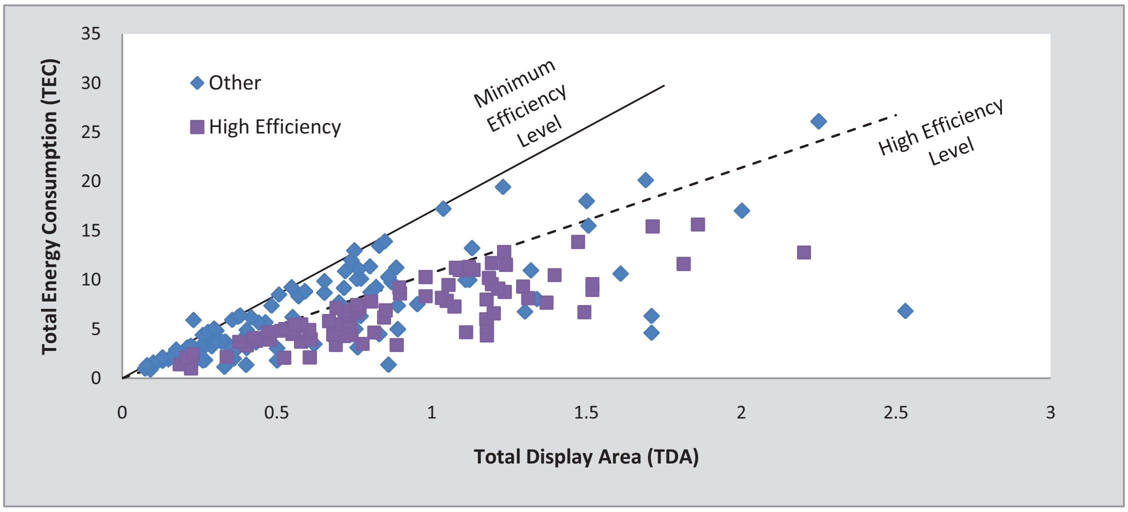
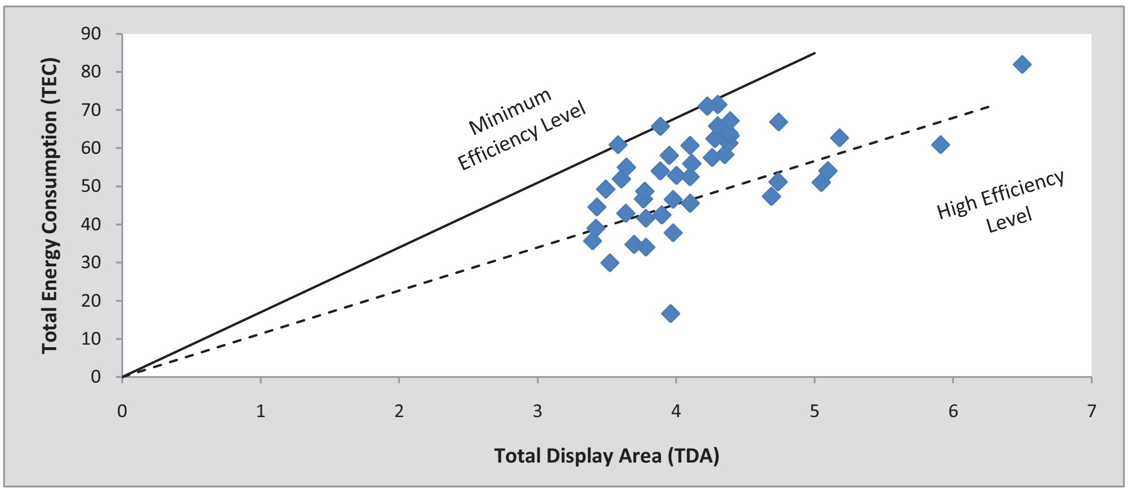


Figure 14: Energy performance of products registered as RS2 Lit



5.2.1 Allowance for different temperature classes

Another factor to be taken into account is that each of the classifications for the integral products is divided into temperature classifications i.e. M1 and M2 or L1 and L2. In theory the more onerous temperature conditions will require a greater allowance for energy consumption as is done in the UK with the ECA scheme. However there are some inconsistencies in the current AS/NZ levels, for instance where the more onerous temperature classification has a lower MEPS level than a higher temperature. This requires rectifying. One solution is to simply have one efficiency level, irrespective of the temperature classification, as is the case with the remote types but factor in an allowance for each other temperature class. The introduction of a further temperature class (M0), as suggested by some industry stakeholders, may complicate this, however it would then still be possible to specify a maximum level and a percentage less for the less onerous temperature classes.

e.g.

MEPS level for M0 = X

MEPS level for M1 = X – 1%

MEPS level for M2 = X - 2%

5.2.2 International comparison

Some comparisons of the Australian and New Zealand MEPS levels can be made with overseas energy efficiency programs, for example with the thresholds used in the UK ECA scheme, shown in Table 9. However, when such comparisons are made attention needs to be given to compare thresholds amongst programs that have similar aims, i.e. some thresholds are intended to differentiate the best performing products, while others are designed to remove the worst.

Table 9: EEI performance thresholds for integral and remote display cabinets, UK ECA

Classification according to temperature	EEI performance threshold (kWh/day/m^2)	
	Integral Type	**Remote Type**
M0	<=12.50	<=11.75
M1	<=11.95	<=11.45
M2	<=10.55	<=10.85
H1	n/a	<=8.00
H2	<=9.20	<=9.20
L1	<=19.10	<=23.50
L3	n/a	<=21.00
<= means "less than or equal to"		
Where the Energy Efficiency Index (EEI) is defined as the ratio of the product's Total Energy Consumption (TEC) to Total Display Area (TDA) i.e. EEI = TEC/TDA, and: *TEC is calculated according to BS EN ISO 23953-2:2005 section 5.3.6.3.4.* *TDA is calculated according to BS EN ISO 23953-2:2005 Annex A.*		
For the avoidance of doubt, test data should be presented to 2 decimal places. As an example, a Remote type M0 cabinet with an EEI performance threshold of 11.76 would be deemed to be a fail		

A range of performance thresholds for energy efficiency programs that targeting non-domestic refrigerators in countries outside Australia and New Zealand are shown in Figure 15 to Figure 25 below. See also Attachments 3 to 9 for further details.

A significant program not identified here is the European EcoDesign program which is in the process of establishing MEPS for a wide range of energy using products (EuPs). To date a number of regulations have been finalised, however the negotiated requirements for RDCs have not yet been completed, although the technical report was completed in 2007. It is likely that the eventual program will be highly relevant to the Australian and New Zealand MEPS program, since it will apply to products entering this market from Europe, and be based on the international test method for RDCs.

It should be noted that not all thresholds shown are applicable to RDCs; some are applied to refrigerated service cabinets (SRDs). As a result, many thresholds are based on refrigerated volume rather than total display area, and therefore a conversion factor needs to be used to convert TDA to volume and vice versa.

In terms of where the current overseas benchmarks are for energy efficiency regulations of refrigerated equipment, the US Department of Energy (DOE) would seem to be setting the standard benchmark.

ENERGY STAR is setting more onerous goals, however since this a voluntary program designed to provide an incentive to develop improved equipment, this level is more appropriately compared to the AS/NZ high efficiency levels.

Mexico would appear to have the most complex algorithms for calculating energy consumption limits with product split into a number of categories determined by refrigerated volume.

Figure 15: DOE - Refrigerators - Maximum consumption limits

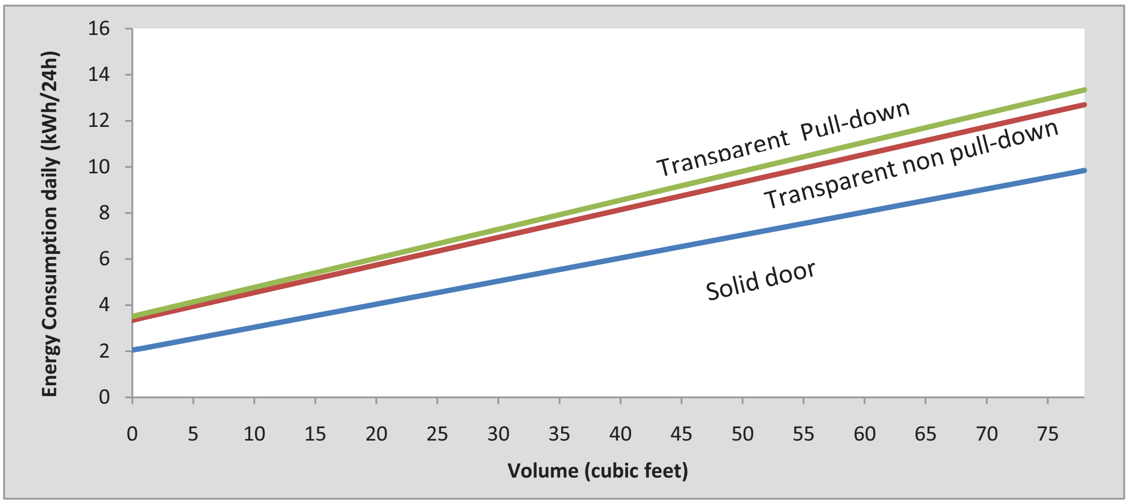


Figure 16: DOE - Freezers - Maximum consumption limits

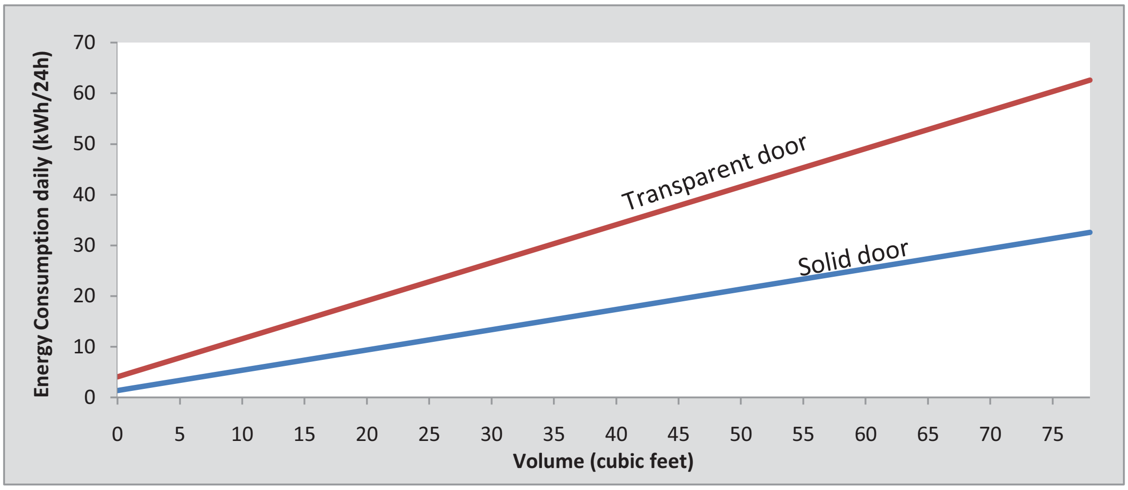


Figure 17: NRCan Refrigerators Glass Door MEPS levels

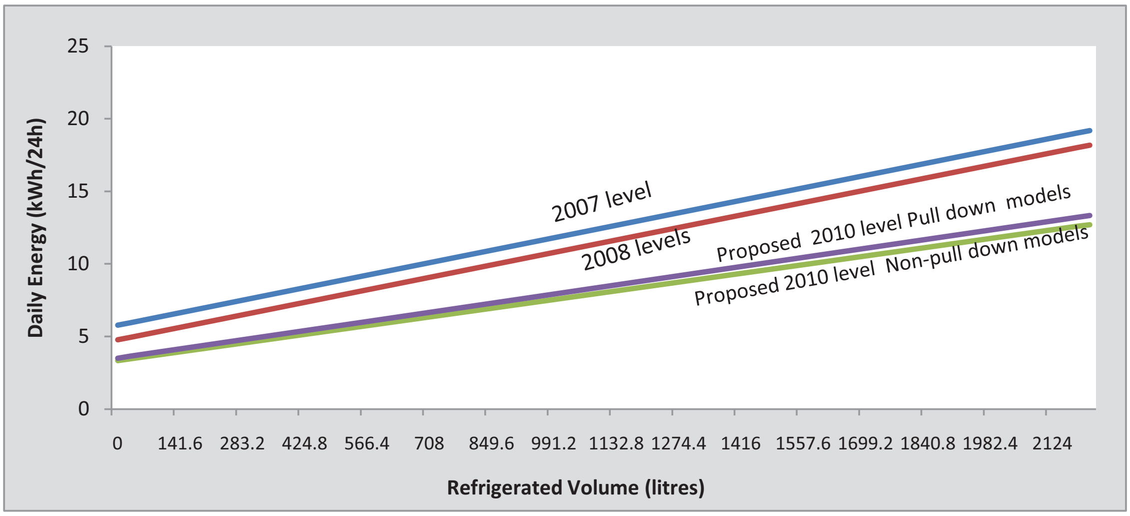


Figure 18: NRCan Freezers Solid Door MEPS levels

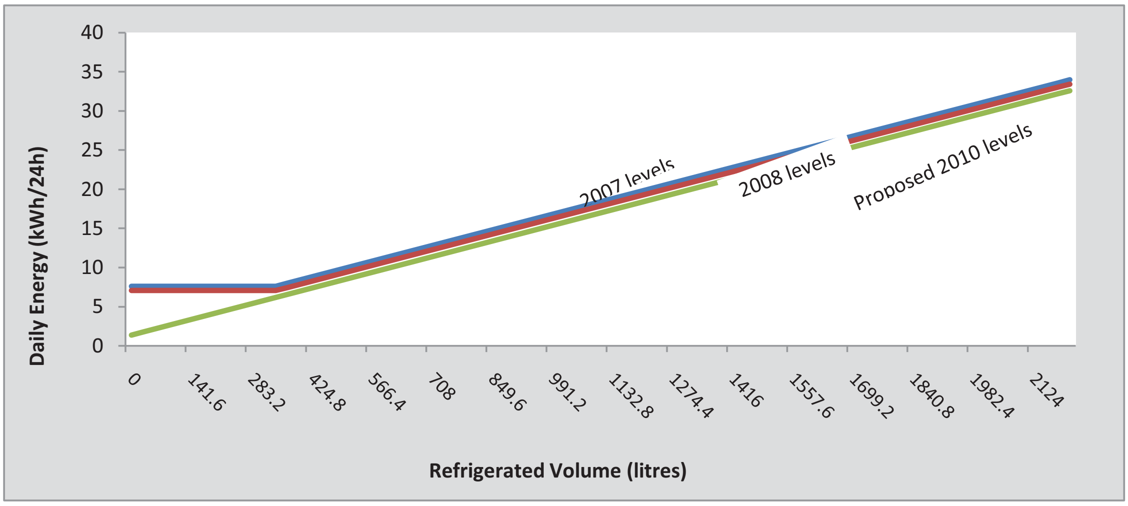


Figure 19: ENERGY STAR® Refrigerator energy limits compared

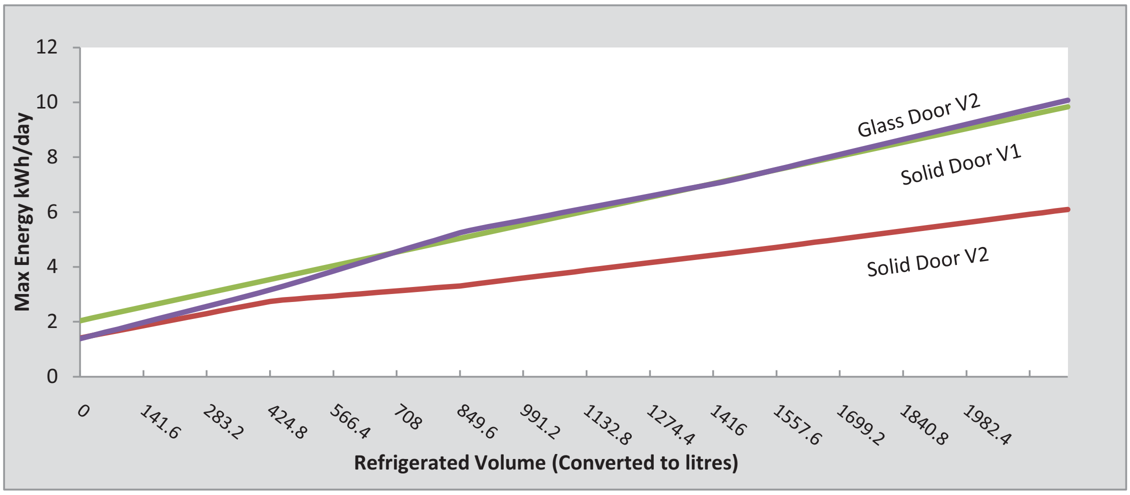


Figure 20: ENERGY STAR® Freezer energy limits compared

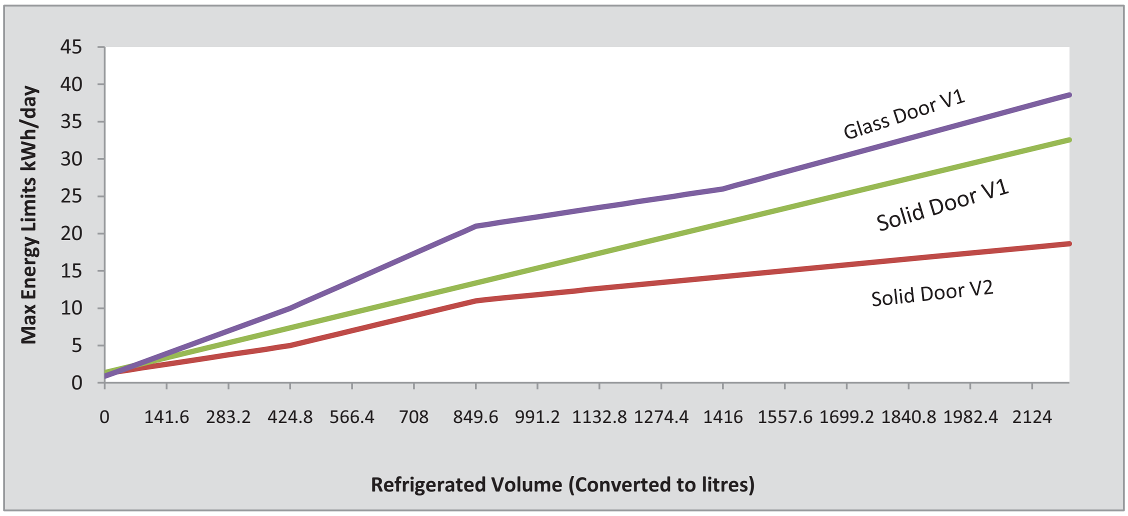


Figure 21: Chest Cabinets - ENERGYSTAR® V2 Limits

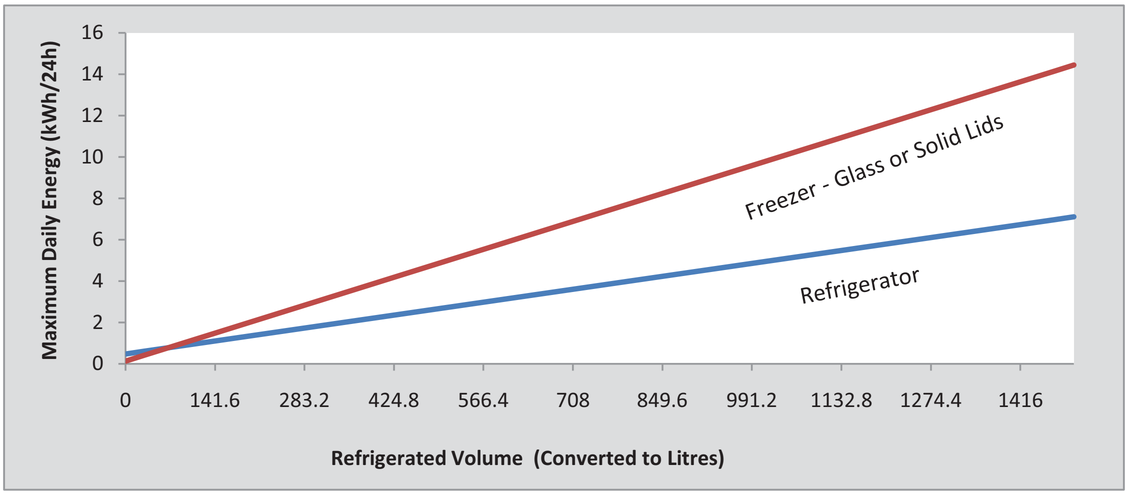


Figure 22: ECA Remote RDCs - Limits

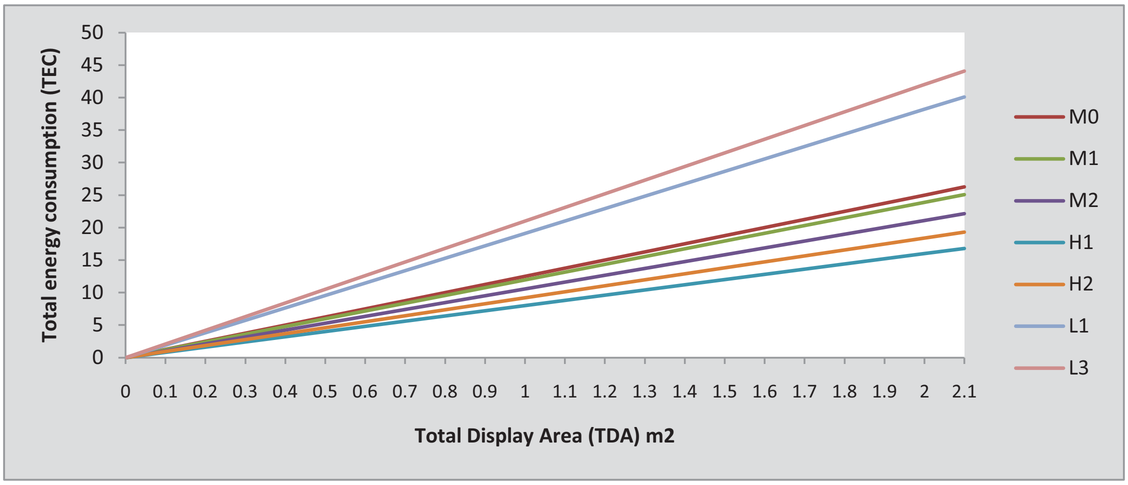


Figure 23: ECA Integral RDCs - Limits

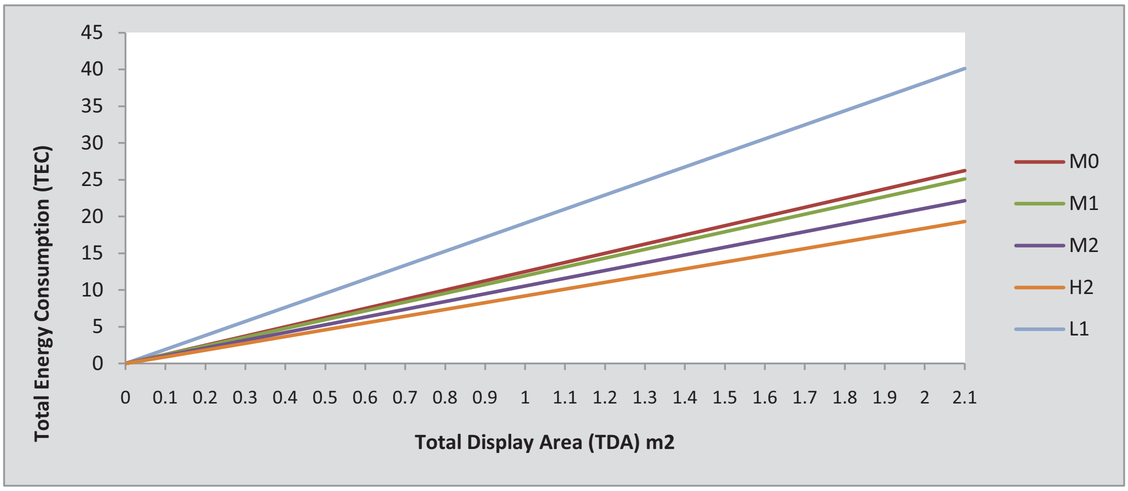


Figure 24: CEE Refrigerator Tier Levels compared

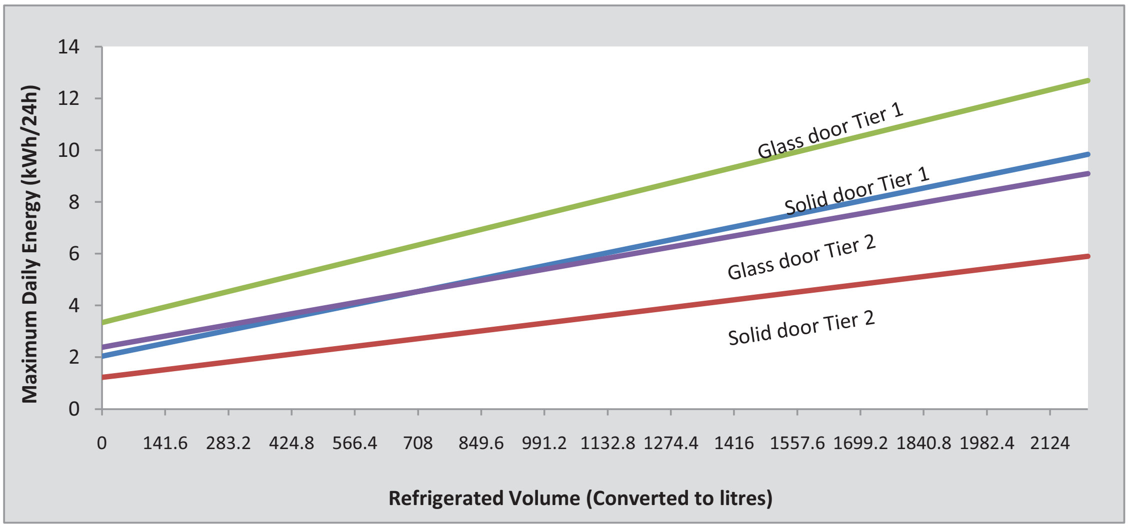
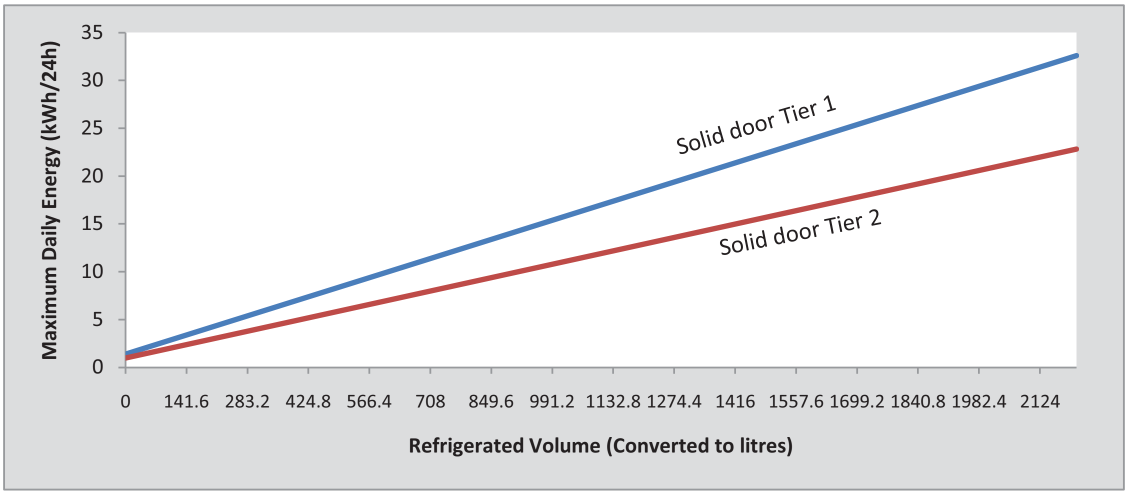


Figure 25: CEE Freezer Tier Levels compared



5.3 High efficiency levels

High efficiency levels for RDCs were created to set achievable goals significantly better than average efficiency levels that in time could become the minimum efficiency levels. There are a number of ways that relationships between minimum efficiency levels and high efficiency levels can be determined. It can be a direct relationship between the 'Tiers'; where the HE levels are based on a certain percentage reduction in energy consumption from the minimum efficiency level, or it can be based on taking a percentage of products in the current market. For example, ENERGY STAR® thresholds are typically set to ensure that the top 15% of products in the market meet the eligibility criteria.

Analysing the current Australian New Zealand sets of values (Table 10 and Table 11) shows that for the majority of levels there is a consistent relationship between the minimum efficiency levels and the high efficiency levels for each of the type classifications, however there are a number of anomalies.

For remote RDCs, high efficiency levels are typically between 67% and 70% of the minimum efficiency level, although RS18 and RS 19 are set at 82%.

For integral RDCs, high efficiency levels are typically 74% of the minimum efficiency level, although values range from 42% (VC4 Solid) to 83% (VF4 Glass Door). By making use of the current registration data the suitability of these levels can now be re-evaluated.

Table 10: Relationship between MEPS and high efficiency values for remote RDCs, AS1731

Medium Temperature RDCs				Low Temperature RDCs			
AS 1731 Energy Efficiency levels				AS 1731 Energy Efficiency levels			
Type	**Min Eff**	**HE**	**% Min**	**Type**	**Min Eff**	**HE**	**% Min**
RS1 Unlit	12.55	8.37	67%	**RS11**	38.13	26.52	70%
RS1 Lit	17.76	10.66	60%	**RS12**	66.33	46.14	70%
RS2 Unlit	12.73	8.49	67%	**RS13 Solid sided**	19.48	12.99	67%
RS2 Lit	16.98	11.32	67%	**RS13 Glass sided**	19.58	13.62	70%
RS3 Unlit	14.84	10.32	70%	**RS14 Solid Sided**	15.49	11.45	74%
RS3 Lit	18.39	12.26	67%	**RS14 Glass Sided**	19.29	12.86	67%

RS4 Glass Door	9.73	6.77	70%	**RS15 Glass Door**	37.08	27.41	74%
RS6 Gravity Coil	14.21	9.88	70%	**RS16 Glass Door**	40.56	29.98	74%
RS6 Fan Coil	14.16	9.85	70%	**RS18**	48.58	39.75	82%
RS7 Fan Coil	14.79	9.86	67%	**RS19**	36.15	29.57	82%
RS8 Gravity Coil	12.25	8.52	70%				
RS8 Fan Coil	13.19	9.17	70%				
RS9 Fan Coil	12.09	8.06	67%				
RS10 Low	18.67	12.99	70%				

Table 11: Relationship between MEPS and high efficiency values for integral RDCs, AS1731

Medium Temperature RDCs							**Low Temperature RDCs**						
AS 1731 Energy Efficiency levels							**AS 1731 Energy Efficiency levels**						
Type	**M1**			**M2**			**Type**	**L1**			**L2**		
	Min	**HE**	**% of Min**	**Min**	**HE**	**% of Min**		**Min**	**HE**	**% of Min**	**Min**	**HE**	**% of Min**
IHC1	11.5	8.5	74%	11.5	8.5	74%							
IHC4	15.5	11.4	74%	15.5	11.4	74%	**IHF4**	26.5	19.5	74%	26.5	19.5	74%
							IHF6	8.0	5.9	74%	8.0	5.9	74%
IVC1	37.5	27.6	74%	28.0	20.6	74%							
IVC2	27.0	19.9	74%	25.5	18.8	74%							
IVC4 Solid	17.0	7.30	43%	17.5	7.30	42%	**IVF4 Solid**	44.0	32.4	74%	39.0	28.7	74%
IVC4 Glass	17.0	10.7	63%	17.5	10.7	61%	**IVF4 Glass**	44.0	32.4	74%	39.0	28.7	74%

The only other program that appears to have a tiered specification using a percentage reduction is the North American Consortium for Energy Efficiency (CEE) Commercial Kitchens Initiative. The Tier 1 levels for Solid Door cabinets are based on ENERGY STAR® with the Tier 2 levels then being a percentage more onerous than the Tier 1 level. For Glass Door cabinets, the establishment of the levels is based on taking a percentage of field data and then a percentage improvement in energy reduction.

Table 12: CEE commercial kitchen initiative

Product	Equipment Type	Specification	Corresponding Base Specification	Maximum Daily Energy Consumption (kWh)
Solid Door	Refrigerator	CCE Tier 1	ENERGY STAR®	0.10V + 2.04
		CCE Tier 2	ENERGY STAR® + 40%	0.6V + 1.22
	Freezer	CCE Tier 1	ENERGY STAR®	0.40V + 1.38
		CCE Tier 2	ENERGY STAR® + 30%	0.28V + 0.97
Glass Door	Refrigerator	CCE Tier 1	25% of top-performing products	0.12V + 3.34
		CCE Tier 2	28% more efficient than Tier 1	0.086V + 2.39

5.4 Recommendations for RDC energy efficiency levels

With respect to MEPS and high efficiency levels for in Australia and New Zealand, the following recommendations are made:

- Energy performance thresholds for remote and integral retail display cabinets, both open and with glass doors, should be set on the basis of TEC/TDA, as is currently specified in AS 1731:14.;
- Energy performance thresholds for remote and integral retail display cabinets should be applied to categories of RDCs specified in EN ISO 23953 (2005);
- Current MEPS and high efficiency levels should be made more stringent to reflect the performance of equipment in the market, best international thresholds for equivalent programs and cost-effective technological potential;
- Proposals regarding the treatment of all cabinets with solid doors are presented in Section 0.

6 Widening the scope of regulations

6.1 Refrigerated service cabinets (RSCs)

Originally with the introduction of the MEPS regime in Australia in 2004, coverage was limited to refrigerated display cabinets intended for the sale and/or display of food products including beverages (see discussion of scope below).

Refrigerated cabinets intended for use in catering and similar non-retail applications or 'service cabinets' were not subject to the regulations. Considerable numbers of these service cabinets are in use throughout Australia and New Zealand in bars, restaurants, cafes, hotels and catering establishments. Conservative estimates made as part of this review suggest that these service cabinets are responsible for between 12% to 14% (1300GWh) of the total non-domestic refrigeration electricity consumption in Australia and New Zealand.

Not including RSCs within the scope of energy efficiency regulations represents a lost opportunity for energy savings, and also increases the confusion within industry, as evidenced by the number of queries regarding cabinets which might be classified as RSCs. While many cabinets are readily differentiated between 'retail' and 'non-retail' applications, there are some which span the boundary. Furthermore it is clearly not equitable that regulations apply to some cabinets while other similar cabinets are not covered by MEPS.

As a result it is recommended that the scope of regulations is expanded to include RSCs. Questions relating to definitions, appropriate test methods, energy performance metrics and thresholds are discussed below.

6.2 Current scope of test methods

The history of the test methods that now form the basis of AS 1731 show that throughout their development, the intent of the scope of these standards has always been solely directed at refrigerated cabinets for the sale or display of food products. EN ISO 23953 goes further in stating that it does not cover the choice of the types of foodstuffs chosen to be displayed in the cabinets.

Generally excluded as well are refrigerated vending machines and cabinets intended for use in catering and similar non-retail applications.

Amendment 1 2005 to AS 1731 amends the scope, adding commercial freezers while excluding ice-makers. It also specifies that beverages are included as food products.

Regulatory Ruling 0003B published in October 2004 provided clarification that the term 'non-retail application' should mean RDCs essentially used for holding foodstuffs which then require some preparation or processing before sale to the end customer and that a retail cabinet was one which holds product on display for sale directly to customers in a public place.

The current scope of AS 1731 therefore is still applicable to RDCs and is in keeping with those used in Europe and internationally for the relevant refrigerated equipment.

The precise terminology used in these test methods is shown below.

6.2.1 Scope of ISO 1992

'This International Standard specifies general conditions for type testing of commercial refrigerated cabinets intended for the sale and/or display of food products.'

6.2.2 Scope of EN 441-1:1994

'This standard specifies terminology, general mechanical and physical requirements, test conditions as well as maintenance and a user's guide for RDCs for the sale and/or display of food products.

EN 441-1:1994 does not cover refrigerated vending machines or cabinets intended for use in catering or similar non-retail applications'

6.2.3 Scope of ISO 23953:2005

'This part of ISO 23953 specifies requirements for the construction, characteristics and performance of refrigerated display cabinets used in the sale and display of foodstuffs. It specifies test conditions and methods for checking that the requirements have been satisfied, as well as classification of the cabinets, their marking and the list of their characteristics to be declared by the manufacturer. It is not applicable to refrigerated vending machines or cabinets intended for use in catering or similar non-retail applications; nor does it cover the choice of the types of foodstuffs chosen to be displayed in the cabinets.'

6.2.4 Scope of AS 1731

6.2.4.1 Original version (2000)

'This Standard specifies terminology, general mechanical and physical requirements, test conditions as well as installation and maintenance, including a user's guide, for refrigerated display cabinets for the sale or display, or both, of food products.

This Standard does not cover refrigerated vending machines, cabinets intended for use in catering and similar non-retail applications, or food service cabinets.'

6.2.4.2 AS 1731 Amended version (December 2005): current

'This Standard specifies terminology, general mechanical and physical requirements, test conditions as well as installation and maintenance, for commercial refrigerators and freezers used for the sale or display of food products including beverages. This Standard does not cover refrigerated vending machines, ice-makers, cabinets intended for use in catering and similar non-retail applications.'

6.2.4.3 Regulatory ruling: definition of "non retail applications"

'That the term "Non Retail Applications" shall mean refrigerated display cabinets essentially used for holding foodstuffs which then require some preparation or processing before sale to the end customer. A retail cabinet is one which holds products on display for sale directly to customers in a public place.'

6.3 Application of AS 1731 and ISO 23953 for RSCs

The methodology contained in the specified tests in AS 1731 and EN ISO 23953, while aimed at RDCs, is also well able to be applied to service cabinets or storage cabinets. For example, the UK the Enhanced Capital Allowance (ECA) Scheme for Service Cabinets currently calls up test methods from BS EN 441-5:1996 and BS EN 441-9:1995 to demonstrate compliance and thus be eligible for listing on the Energy Technology Product List (ETPL). These standards have now been replaced by BS EN ISO 23953-2:2005 although the test methods remain basically unchanged and will still be almost identical to those in AS 1731.5:2004 and AS 1731.9:2004.

If necessary an alternative Climate Class could be specified to better suit conditions found in kitchens. Cabinet illumination on service cabinets is usually controlled by door switches so is not an issue. Door openings may still give an indication of cabinet performance. Should a volume metric be used as the basis to determine the energy efficiency rather than total display area then this can be added into the requirements for Service Cabinets as a separate stand alone part of the standard.

Therefore if the recommendation to include non-retail or food service cabinets in the Australia and New Zealand MEPS programme is accepted suitable test methods are already established in the current standard AS 1731. The same applies if ISO 23953 is adopted.

6.4 Energy performance of service cabinets

In order to bring RSCs under MEPS it is necessary to introduce an appropriate energy efficiency metric applicable to a wide range of diverse products.

The primary function of a refrigerated display cabinet is to display refrigerated food or beverages therefore the display area is a key design parameter. Due to the heat losses associated with open and glazed display areas, the energy performance of display cabinets is directly related to the size and type of display area. As a result, the applicable test methods used in Europe and then adopted with some modifications in Australia and New Zealand, as the AS 1731 series of standards, calls for the measurement and calculation of the Total Display Area. To enable an efficiency value to be calculated, AS 1731.14 adopts the method of relating total electrical energy use (TEC) to the total display area (TDA). Regulations specify the maximum amount of energy that is permitted to be used for every square metre of display over a 24 hour time frame. This method can also be applied to both open display cabinets and glass-door display cabinets which, due to their construction, generally have vastly different heat loads and therefore dissimilar electrical energy requirements.

Refrigerated cabinets used in catering and non-retail applications are primarily intended to refrigerate and store product and not to display the product and therefore are either constructed with solid doors or solid doors with small viewing windows to enable easier selection. Cabinets are arranged either vertically or horizontally and in some cases doors are replaced with drawers to allow easier physical access. Multiple door and multiple drawer versions are widely available with combinations of the two being common.

It is therefore not as appropriate to use the total display area as a metric for determining the efficiency level of a non-retail cabinet.

For non-retail cabinets, refrigerated volume generally has a direct relationship with the refrigeration load, and is therefore a more useful metric. As an example, internationally, where household or domestic refrigerators and freezers are regulated, efficiency is related to refrigerated volume without exception. It then becomes logical to use the refrigerated volume as the metric for determining the efficiency of service cabinets.

Mexico, Canada, California, UK ECA Scheme covering Service cabinets and ENERGYSTAR all use volume based metrics when applied to non-retail or service cabinets.

Therefore an additional benefit of adopting a volume metric will be that it will facilitate direct and accurate comparisons with overseas best practice.

Where volume-related efficiency metrics are used for service cabinets, the ‘refrigerated volume’, as opposed to gross volume, is used as the basic metric for determining the energy efficiency.

To a great extent refrigerated volume or useable volume is easier to associate with both storage capacity and refrigeration performance. It also alleviates some of the issues involved in defining and calculating a volume ‘metric’ that can arise with the use of gross volume since it is more closely related to actual shelf area or useable product storage area. There are not the issues present that occur with household refrigerators that have product stored in recesses in the doors, together with separate compartments and ice boxes. The Mexican NOM-022 -ENER/SCFI has some very good diagrams defining refrigerated volume which appear to almost fully cover any interpretation issues. Adaptations of these diagrams are reproduced in Attachment 2.

It is therefore proposed that with the introduction of MEPS to cover refrigerated 'service' cabinets such as non-retail cabinets, catering cabinets and food service cabinets, a new metric based on refrigerated volume be introduced. In conjunction with this, new MEPS levels will need to be established.

6.5 Definitions for use with RSCs

The inclusion of RSCs within AS 1731 requires some additional definitions which are currently not part of AS 1731.

For example, while AS 1731 contains simply definitions of *Net volume* (Clause 4.3.6) and of *Refrigerated shelf area* (Clause 4.3.10) these are probably inadequate if Volume is to be used as the basis of the energy efficiency metric.

Therefore as part of the test method for non-retail cabinets, adequate definitions and diagrams will be required to ensure that there will not be any interpretation issues. A number of new definitions are proposed in Section 9.1, some of which relate to RSCs. Attachment 2 contains examples of type of illustrations which would also be required to be published in an amended Standard.

6.6 Energy efficiency performance levels

Of all the performance threshold presented for RSCs, the values set by the US Department of Energy (DOE) for introduction in January 2010 are most directly applicable to the Australasian market (see Table 13). This is because, as in Australia and New Zealand, they are designed as minimum performance levels with identical aims. Other thresholds, for example, those set by ENERGY STAR, are more appropriately considered at equivalent to the high efficiency levels.

Table 13: US MEPS levels

Product	Door or Drawer Type	Maximum Daily Energy Consumption (kWh)
Refrigerators	Solid	0.10V + 2.04
	Transparent	0.12V + 3.34
	Transparent designed for pull-down temperature application	0.126V + 3.51
Freezers	Solid	0.40V + 1.38
	Transparent	0.75V + 4.10
Refrigerator-freezers	Solid	0.70 or 0.27AV - 0.71
Note: V = Internal Volume in ft^3		
AV = Adjusted Volume = (1.63 x freezer volume in ft^3*) + refrigerator volume in* ft^3		

For solid door SDCs, these requirements translate into the following MEPS levels in SI units:

- 1,105 litres		5.9 kWh/24hrs
- 1,300 litres		6.6 kWh/24hrs
- 1,500 litres		7.2 kWh/24hrs

6.7 Recommendations for RSCs

The following recommendations are made with respect to RSCs:

- The scope of energy efficiency regulations in Australia and New Zealand should be expanded to include non-retail cabinets used in the commercial sector;
- For these products MEPS and high efficiency levels should be established based on electricity consumption per unit of refrigerated volume;
- It is recommended that the initial MEPS levels should be harmonized with the US MEPS levels to be introduced in January 2010, and implemented in Australia and New Zealand at a date to allow industry adequate time for preparation;
- MEPS levels and high efficiency levels for RSCs should be included in a new part of AS 1731, together with appropriate definitions and explanatory illustrations.

7 Deemed to comply provision

Currently all refrigerated equipment that is classified as one of the types of RDC listed in AS 1731.14 and that has a MEPS Standard specified in AS 1731.14, must meet the requirements of MEPS regulations. This means all such cabinets must be registered and comply with the specified MEPS limits prior to being offered for sale. There are no exemption mechanisms or allowances for items produced as one-offs, prototypes or assembled in situ at the premises of customers.

It is recognised that, while the current regulatory regime is applicable to the vast majority of refrigerated display cabinets, it is less suitable for cabinets that are custom-built on site, since laboratory testing is not possible for these units. This issue has been a significant factor against expanding the scope of regulations in Australia and New Zealand to cover all types of refrigerated cabinets, as a considerable proportion of service type cabinets are custom designed and built.

The problems associated with not including service cabinets within the scope of regulations are discussed elsewhere, and these, together with the opportunity to increase energy and greenhouse gas savings has led to recommendations to introduce regulations for service cabinets.

The proposed solution is to introduce an alternative means of compliance for commercial refrigeration cabinets in the form of a design standard or 'Deemed to Comply' facility.

There are substantial benefits of this approach for both suppliers and regulators. For suppliers it provides a means of complying with energy performance regulations which does not involve the testing of complete cabinets and the associated costs which may be high for small production runs and one-off designs. For regulators it enables a visual check to be done on built-in cabinets in the customer's premises.

Under the proposed revised requirements, it will mandatory for all products to be registered with one of the regulators in Australia or 'listed' in New Zealand. At the point of registration, suppliers will be required to nominate whether they comply with either the overall minimum energy performance standards or the Deemed to Comply option. Regulators will check compliance on the basis of this nomination.

The proposal is based on building these refrigeration cabinets with components that are in themselves highly energy efficient. This covers the major electrical energy consuming items such as compressors, fan motors and lighting, and also other major sources of heat load such as insulation and, where appropriate, glazing.

It is also important that any well designed 'Deemed to Comply' product should not be any less efficient than the same product built as a mass produced product that is required to meet the minimum energy performance standards for that classification or type of product.

It is recommended that a Deemed to Comply requirement would include the following elements:

7.1 Components subject to minimum efficiency requirements

7.1.1 Compressors

- All compressors shall meet the high efficiency thresholds proposed in Background Technical Report Volume 2.

7.1.2 Fan motors

- All fan motors shall meet the MEPS requirements proposed in Background Technical Report Volume 2.

7.1.3 Lighting

Any internal or external illumination associated with refrigerated display cabinets shall be of the following types:

- T5 or T8 fluorescent lamps with electronic ballasts; or
- A lighting system that has no fewer lumens per watt than a system using T5 or T8 lamps with electronic ballasts;
- Fitted with manually operated light switch or time clock, smart sensor or similar automatic device.

Currently linear fluorescent lamps over 550 mm long and with a nominal rating of 16W or more are subject to regulation by MEPS. In addition the energy efficiency of ferromagnetic and electronic ballasts used in conjunction with linear fluorescent lamps of from 10W to 70W are regulated.

However because the illumination of the equipment is a secondary function rather than a primary function, as in luminaries, it is felt that the overall efficiency of refrigerated equipment can be significantly improved by introducing more stringent design controls on the lighting.

7.1.4 Insulation

Closed cabinets shall have the following thermal insulation properties:

- Freezers (low temperature) - insulation have thermal properties equivalent or better than 75 mm polyurethane foam;
- Refrigerators (medium temperature) – insulation have thermal properties equivalent or better than 50 mm polyurethane foam.

7.1.5 Glass Doors

All glazing on closed cabinets to be no less than insulated double glazed Low E or insulated triple glazed with R values at centre of glass of R= 0.5 m^2 K/W or better.

7.1.6 Defrost Condensate Evaporation

Preferably disposal of condensate is carried out by methods other than electrical heating elements.

Possible methods that can be employed:

Medium Temperature applications:	Evaporation heat dissipation from compressor, Evaporation by liquid line sub cooling, Evaporation by discharge line.
Low Temperature applications:	Hot gas injection (controlled), Combination of main defrost action

7.1.7 Performance

The cabinet must be capable of maintaining stored product at a Temperature Classification as defined in AS 1731.6 when tested in accordance with AS 1731.5 at the nominated Climate class as defined in AS 1731.4.

7.1.8 Temperature Control

It is suggested that controls with a certain minimum accuracy be prescribed.

7.1.9 Design Calculations

A practical method of showing that the equipment has been designed to operate efficiently in its intended use would provide an assurance to purchasers that some sort of design process had taken place. Having to submit a copy of the design calculations for the refrigeration load with all applications may not be a practical option. However compliance with the 'deemed to comply' option in itself does not guarantee a well designed, energy efficient product. Comparison with a mass produced product may not be possible or practical but a report form showing the equipments installed estimated performance would be desirable.

8 Compliance and enforcement issues

8.1 Assisting compliance

Regulators, Department of the Environment, Water, Heritage and the Arts (DEWHA) staff and DEWHA consultants have provided advice to suppliers on issues of registration and compliance, since the introduction of regulations for RDCs. Many of the recommendations in this report are aimed at making the regulations more easily understood and complied with, thereby reducing the need for individual advice.

8.2 Verification testing

Of the 31 checktests which have been conducted since 2004, 17 of the available results demonstrate a pass; while 8 products failed a screening test (see Table 14).

Table 14: Summary of checktesting results, 2004-2008

Status			Screening test	
Finalised	12		17	Pass
Cost Recovery	3			
Admin Referral	7		8	Fail
Product disposal	3			
Testing	3		*No results*	
Deleted	3		*No results*	

This rate is of non-compliance is lower than found for other appliance and equipment categories, which may reflect higher rates of compliance or poor targeting. Without a larger sample it is difficult to determine conclusively whether these results are indicative of overall compliance rates or the need to improve practices for the identification of potential non-compliance products.

Australian and New Zealand Governments have recently agreed to devote nearly AUD$1.5 million to electrical product verification testing during the 2009-2010 financial year to support the end-use energy efficiency regulations in Australia and New Zealand (E3, 2009).

Verification testing has been hampered by the lack of independent test facilities, particularly for larger RDCs, and this remains a limitation. While the expansion of regulations to include RSCs will increase the demand for test facilities able to perform verification tests, it should be noted that many suppliers will choose to use the deemed to comply facility.

8.3 Market surveillance

To date market monitoring activities have been sporadic and have included visits to trade shows, reviewing published catalogues and responding to information provided by competitors.

During 2009, the Equipment Energy Efficiency Committee (E3) has the Australian Refrigeration Council Ltd (ARC) to assist existing regulatory staff undertake market surveillance activities throughout Australia. With 12 trained investigators operating in the field, ARC has recently completed a survey of retail outlets and checked that over 25,000 whitegoods have been correctly labelled and registered.

ARC is already well known in the refrigeration and air conditioning industry as a licensing body administering the air conditioning and refrigeration regulations under the Ozone Protection and

Synthetic Greenhouse Gas Management Act 1989. ARC staff therefore have a good understanding of the refrigeration market and technologies, and through September and October 2009 ARC will be focussing on RDCs to identify products which are not registered.

8.4 Recommendations on compliance

While reasonable efforts have been made by the E3 Committee to enforce the current regulations in order to protect investments made by industry and preserve the integrity of the program, improvements can be made. Many of the recommendations made in this report are design to facilitate compliance and enforcement. The following additional actions are recommended:

- Market surveillance activities should be undertaken at regular intervals to monitor the requirement for regulated equipment to be registered with one of the Australian regulators or the New Zealand regulator;
- Where regulated equipment is found not be registered, suppliers should be contacted promptly, followed up, and enforcement processes initiated;
- The number of products subjected to verification testing should be increased, and efforts made to improve the targeting of those products most at risk of failing;
- Where equipment fails Stage 1 verification testing, the appropriate enforcement processes should be initiated promptly;
- The E3 Committee should review the availability of independent test laboratories and if deemed necessary take steps to increase capacity.

9 Definitions and treatment of energy management systems

9.1 Key definitions for standardisation

9.1.1 Refrigerated service cabinet

Commercial refrigerated service cabinets are products that are specifically designed to store, but not to display for sale, chilled and/or frozen foodstuffs.

They are normally fitted with predominantly solid faced lids, drawers or doors that:

- Are normally kept closed, but can be opened to access the contents;
- Obscure the majority of the contents of the cabinet from view when closed;
- Enable users to access the contents of any part of the interior without stepping inside the refrigerated space.

9.1.2 Refrigerated display cabinet

Refrigerated display cabinets are products that are specifically designed to store and display for sale chilled and/or frozen foodstuffs.

They allow the foodstuff stored in the cabinet to be either directly viewed through an opening in the cabinet or through transparent doors, lids or covers that:

- Are normally kept closed, but can be opened to access the contents;
- Allow the contents of the cabinet to be viewed when closed;
- Enable users to access the contents of any part of the interior without stepping inside the refrigerated space.

9.1.3 Representative model

Replaces current definition of a ‘Family of models’ (AS 1731.14 Cl 1.5.1)

Rules for selecting the representative model for performance testing

<u>Cosmetic differences to the exterior</u>: Any model may be selected to be the representative model.

<u>Heaters (door, trim etc.), fans, defrosts, lighting and other accessories</u>: The model with the greatest energy consumption must be the representative model.

<u>Temperature level:</u> The model with the lowest temperature setting must be the representative model.

<u>Length</u>: The representative model must be either 2.44 or 2.5 metres in length. This length of model can only be used to represent models between 1.8m and 5m in length; and separate data must be submitted for each model outside of these limits.

<u>Shelves</u>: The model with the lowest number of shelves must be the representative model.

<u>Shelf angle:</u> The model with the highest shelf angle (taken from horizontal) must be the representative model.

Front-opening height (throat): - The model with the largest front-opening height (throat) must be the representative model.

Lighting: The model with the greatest lighting energy consumption must be the representative model.

Refrigerants: The model with the greatest energy consumption must be the representative model where cabinets have the same refrigeration system components but different refrigerants.

Two or more of the above variations: The rules set out above must be combined when selecting the representative model

It should be noted that:

- If a manufacturer voluntarily removes the representative model from Registration then other products linked with that representative model may or may not be permitted to remain on the Registration website;
- If any product submitted under these representative model rules is later found not to meet the performance criteria when independently tested; then all products based on the same representative model may be removed from the Registration website.

9.1.4 Temperature classification

The temperature of the stored product for which the cabinet is designed, according to the temperatures of the warmest and coldest M-Package during the temperature test as defined in ISO 23953.1 (AS 1731.6:2003) and determined in the test of ISO 23953.2 (AS 1731.5:2003).

9.1.5 Climate/climatic class

The temperature and relative humidity of the test room climate for which the cabinet is intended, as defined in ISO 23953.2 (AS 1731.4:2003)

9.1.6 Family classifications

The classification of refrigerated display cabinets by 'type' as listed in Table A.1 in Annex A of ISO 23953 or AS 1731.14:2003

9.1.7 Refrigerated volume (Mexico Nom-022-ENER/SCFI – 2008)

The useful volume for refrigerated equipment intended to accommodate and cool the product and calculated in accordance with Attachment 2.

9.1.8 Gross internal volume (ECA commercial service cabinets - performance threshold)

The gross internal volume is defined as the volume within the inside walls of the cabinet without internal fittings and with all doors (and drawers closed).

9.1.9 Refrigerated shelf area (ISO 23953-1 Cl 4.1)

Refrigerated display area where the vertical clearance above any shelf or base deck is greater than or equal to 100 mm, measured perpendicularly above the plane of the shelf or base deck and within the bounds of any load limit.

9.1.10 Sensitive foodstuffs

Requires further definition.
(Currently not defined, but referred to in ISO 23953 Cl 5.3.2.3.2 (c)(AS 1731.5 Cl 4.3(d)).
Suggested definition:

Foodstuffs, sensitive to temperature and not intended to be stacked in multiple layers, or product that is shrink-wrapped and subject to heat amplification.

Product with a temperature classification of M0 is intended for sensitive foodstuffs.

May require further input from commentators involved in food safety.

9.1.11 Total display area TDA (ISO 23953-1 Cl 4.10)

Total visible foodstuffs area, including visible area through glazing, defined by the sum of horizontal and vertical projected surface areas of the net volume.

9.1.12 Gross volume (ISO 23953-1 Cl 4.9)

Volume within the inside walls of the cabinet or compartment, excluding internal fittings, doors or lids, if any, with these being closed, and with the load limit being taken into account if the cabinet has no door or lid.

9.1.13 Energy management system

An automated control device or set of automated control devices that allow for adjustment of the operation of the refrigerated cabinets depending on environmental and other operational variables in the vending machine (AS/NZS 4864.1 Cl 2.4 equivalent).

9.1.14 Low power mode

A mode of operation where the energy management system automatically adjusts the normal operation of the refrigerated cabinet by methods such as the reduction of lighting or refrigeration cycles and/or settings (AS/NZS 4864.1 Cl 2.8 equivalent).

9.1.15 Miscellaneous alternative definitions

9.1.15.1 Net volume (ECA energy efficiency index)

Net volume (m^3) equals: shelf (or drawer base) area x loading height

9.1.15.2 Net Volume (ISO 23953-1 Cl 4.8)

Volume containing foodstuffs within the load limit

9.1.15.3 Determination of usable refrigerated volume (Mexico NOM-022-ENER/SCFI-2008)

See Attachment 2.

9.2 Treatment of energy management systems

Energy management systems (EMS) fitted to refrigerated display cabinets offer benefits in reducing the amount of electrical energy consumed by equipment during times of low usage.

These controls or systems can take several forms either in the case of preset usage patterns or learned usage patterns or combinations of the two and by employing enhanced control systems offer major advantages over simple temperature controls, such as mechanical thermostats.

A preset usage pattern can be used to reduce the load on the refrigeration system by such methods as turning off illumination, raising cabinet temperature, reducing fan operation, reducing compressor capacity and controlling any other electrical energy using components during low usage times such as at night.

A learned usage pattern can be used to map the operation of the equipment over a learning period which may be several days by monitoring the frequency of door openings or localised movement in the vicinity of the equipment and then applying this pattern to electrical energy using components.

In order to satisfy the overall market as well as various specialised segments, facilities are often built in to the controls to provide optional/optimum settings. Thus users or installers can modify the learning patterns and or settings to suit the particular application. Different settings may result in differences in energy consumption which may be unknown to the user. There is also the potential for the safety of certain foodstuffs to be compromised should the storage temperature alter during hours of low use and this must be taken into account.

The Australia New Zealand Refrigerated Beverage Vending Machine Standard contains useful definitions of these systems and their use:

Energy Management System

An automated control device or set of automated control devices that allow for adjustment of the operation of RVBMs depending on environmental and other operational variables in the vending machine (AS/NZS 4864.1 Cl 2.4).

Low power mode

A mode of operation where the energy management system automatically adjusts the normal operation of the machine by methods such as the reduction of lighting or refrigeration cycles and/or settings (AS/NZS 4864.1 Cl 2.8).

While the benefits of these systems can be considerable in terms of reduced energy usage, they can introduce complications to a testing regime designed to determine the minimum efficiency level of equipment by testing under stable conditions in a controlled environment.

The principle generally applied to measurement of energy efficiency for any product or appliance is that it is carried out under steady state conditions or simulated operating conditions to produce valid equipment comparisons and repeatable conditions in any test laboratory meeting the test requirements set out in the test method.

Therefore a control system that offers variable storage temperature control and that adapts to the specific test conditions may circumvent the repeatability of the simulated operating environment and give certain products unfair advantages.

As an example in the case of the Refrigerated Beverage Vending Machine Standard these types of controls must be disabled to allow a stable operation during the test period.

4.2 Energy management systems and low power modes.

In addition to the test method specified in AS/NZS 4864.1, the refrigerated beverage vending machine shall be tested under the control of the internal temperature sensor(s) only. All automatic and manually set energy management systems that may activate low power mode functions or usage pattern learning shall be disabled for the duration of the test. Any light fittings which are intended to be supplied with the product shall be switched on (AS/NZS 4864.2 Cl 4.2).

The aim of MEPS is to establish that only those products that meet the <u>minimum</u> efficiency levels under certain test criteria can be put into the market. Therefore the most onerous conditions for an energy efficiency performance/temperature test are with any energy management system or low power mode disabled rather than operational. Products that also meet the high efficiency levels offer another level of performance in terms of energy efficiency.

Products fitted with energy management systems must, like all products, meet the mandatory minimum efficiency requirements but they may well exceed both these requirements and those of the high efficiency requirements.

Manufacturers should be able to make use of this by way of advertising .....*that the product exceeds the minimum efficiency requirements or high efficiency levels by XX% with the energy management system in operation....*etc.

However in terms of trade practices they may well have to qualify their claim as to under what specific conditions of operation these results are achieved, whether it be by a low power mode due to reduced usage or some other means such as an automatic timer function raising the overnight storage temperature.

Therefore the recommendation is that while there are benefits in terms of energy efficiency by using energy management systems, in order to establish the minimum efficiency of a product, any energy management system must be disabled during the energy consumption/temperature test.

10 Data sources used in modelling

10.1 MEA modelling estimates

Modelling undertaken to estimate total energy consumption and greenhouse gas emissions, and the savings due to implementation of policy measures, is based on a variety of sources, many of which are discussed in the Background Technical Reports, Volumes 1 and 2 and referenced. These include data on the market penetration of technologies, average efficiency or performance levels and typical usage patterns.

The modelling also uses data from ***Cold Hard Facts***, published in 2007. In some cases this data has been corrected using more up-to-date or accurate information where available. ***Cold Hard Facts*** together with the source data is available from:
http://www.environment.gov.au/atmosphere/ozone/publications/cold-hard-facts.html

The initial background research for these reports was focused on the Australian market and therefore no bottom-up data has been collected at this stage for New Zealand. The energy consumption and greenhouse gas emissions for segments of the non-domestic refrigeration sector in New Zealand have been calculated on a pro-rata basis from the Australian estimates according to the relative populations of the two countries. The exception is milk vats, where the total energy consumption for this segment has been estimated based the quantity of milk produced in New Zealand and industry information on the energy intensity of milk production.

10.2 Greenhouse gas intensity

The following greenhouse gas coefficients have been used in order to calculate greenhouse gas emissions from electricity consumption in accordance with advice from E3.

Table 15: Electricity fuel cycle emission factors (t CO2-e/MWh delivered)

Year	Australia (1)	New Zealand (2)	Year	Australia	New Zealand
2005	-	0.6			
2006	1.036	0.6	**2016**	0.883	0.4
2007	1.021	0.6	**2017**	0.865	0.4
2008	1.007	0.6	**2018**	0.847	0.4
2009	0.993	0.6	**2019**	0.829	0.4
2010	0.980	0.6	**2020**	0.811	0.4
2011	0.964	0.6	**2021**	0.794	0.4
2012	0.948	0.4	**2022**	0.777	0.4
2013	0.932	0.4	**2023**	0.761	0.4
2014	0.916	0.4	**2024**	0.744	0.4
2015	0.901	0.4	**2025**	0.727	0.4

Source: http://naeeec.energyrating.com.au/reports/household-greenhouse.xls

(1) Average fuel cycle emission factors (2) Marginal fuel cycle emission factors (updated 23/07/2009)

10.3 Electricity tariffs

Unless stated, the consumer price of electricity is assumed to be AUD$0.16/kWh in Australia and NZD$0.1519/kWh in New Zealand, in accordance with advice from E3.

11 References

ANSI/ASHRAE 72-2005	American Society of Heating Refrigerating and Air-Conditioning Engineers, Inc. Standard 72-2005 Method of Testing Commercial Refrigerators and Freezers.
ARI 1200:2008	ARI Standard 1200. Air-Conditioning and Refrigeration Institute. 2008 Standard for Performance Rating of Commercial Refrigerated Display Merchandisers and Storage Cabinets.
AS 1731	Australian Standard AS 1731 Series of standards relating to Refrigerated display cabinets Australian Standard AS 1731.1-2003 to AS 1731.13-2003, Refrigerated display cabinets, Parts 1 to 13 inclusive. Australian Standard AS 1731.14-2003. Refrigerated display cabinets, Part 14: Minimum energy performance standard (MEPS) requirements.
AS1731 Technical Discussion Paper	Review of Standard AS 1731:2003 and Amendments, Report No 2008/02, June 2008 Indicating Issues and their suggested solutions Prepared by Tony Fairclough of Thermatek Consultancy (Australia)and Rod King Design Services (N Z). www.energyrating.gov.au/library/details200802-rf-display-technical.html
AS/NZS 4471.1	Australia New Zealand Standard AS/NZS 4474.1:2007. Performance of household electrical appliances - Refrigerating appliances - Energy consumption and performance.
CEE, Consortium for Energy Efficiency	CEE is a consortium of efficiency program administrators from across the U.S. and Canada who work together on common approaches to advancing efficiency. Through joining forces, the individual efficiency programs of CEE are able to partner not only with each other, but with other industries, trade associations, and government agencies. By working together at CEE, administrators leverage the effect of their funding dollars, exchange information on effective practices and, by doing so, achieve greater energy efficiency for the public good. www.cee1.org
DOE, US Department of Energy	The Department of Energy's overarching mission is to advance the national, economic, and energy security of the United States; to promote scientific and technological innovation in support of that mission; and to ensure the environmental cleanup of the national nuclear weapons complex. The Department's strategic goals to achieve the mission are designed to deliver results along five strategic themes of: Energy Security, Nuclear Security, Scientific Discovery and Innovation, Environmental Responsibility and Management

	Excellence. www.energy.gov
ECA, Enhanced Capital Allowance	The Enhanced Capital Allowance (ECA) scheme is a key part of the UK Government's programme to manage climate change, and is designed to encourage businesses to invest in energy-saving equipment. Managed by the Carbon Trust on behalf of the Department of Climate Change and HM Revenue and Customs. www.eca.gov.uk
ECODESIGN Study	Lot 12: Commercial Refrigerators and Freezers, Preparatory Study for EcoDesign Requirements of EuPs for European Commission DG TREN, by BIO Intelligent Services, Final Report, August 2007.
EN 441	European Standard EN 441 Series of standards now superseded relating to Refrigerated display cabinets. Refrigerated display cabinets. Series of standards relating to test methods.
EN ISO 23953.1	European Standard EN ISO 23953-1:2005. Refrigerated display cabinets – Part 1: Vocabulary.
EN ISO 23953.2	European Standard ISO 23953-2:2005. Refrigerated display cabinets – Part 2: Classifications, requirements and test conditions.
Energy Rating website	CRIPL 2008 Commercial Refrigeration – Interactive Product List. www.energyrating.com.au
ENERGY STAR	ENERGY STAR is a joint program of the U.S. Environmental Protection Agency and the U.S. Department of Energy helping us all save money and protect the environment through energy efficient products and practices. www.energystar.gov
ISO 1992	International Standard ISO 1992 series of standards now superseded relating to Commercial refrigerated cabinets.
ISO 23953	International Standard ISO 23953-1:2005. Refrigerated display cabinets – Part 1: Vocabulary.
ISO 23953	International Standard ISO 23953-2:2005. Refrigerated display cabinets – Part 2: Classifications, requirements and test conditions.
NOM-022-ENER/SCFI-2008	Norma Oficial Mexicana NOM-022-ENER/SCFI-2008 Eficienca Energetic Y Requisitos de Seguridad Al Usuario Para Aparatos de Refigeracion Commercial Autocontenidos. Limites, Metodos de Prueba Y Etiquetado. Loosely translated it is: National Standard of Mexico for Energy Efficiency and safety requirements for self-contained commercial refrigeration. Limits test methods and labelling.
NRCan, National Resources	Natural Resources Canada champions innovation and expertise

Canada	in earth sciences, forestry, energy and minerals and metals to ensure the responsible and sustainable development of our nation's natural resources. Office of Energy Efficiency, Energy Efficiency Regulations Self-Contained, Commercial Refrigerators, Freezers and Refrigerator-Freezers Bulletin on Amending the Standards - June 2009. www.nracn-rncan.gc.ca

Attachment 1: AS1731 Technical Review Paper

Submissions on the AS 1731 Technical Discussion document published in June 2008 were received from fourteen organisations, three of these being Australian respondents and the remainder New Zealand respondents.

A large amount of the comment related to the RDC MEPS regime rather than actual comment on the technical paper itself.

While there were a number of common themes throughout the comments there was a great deal of diverse comment relating to a wide variety of issues.

In general there was little negative comment on the ten recommendations in the Technical Discussion document. The greatest amount of comment received related to custom product and short runs. Some of the strongest comment related to resources and enforcement of the regulations.

This section paraphrases the responses to the Technical Discussion Paper recommendations and then lists other issues that were raised.

A list of submitters and a summary of the main points of the submissions are set out below.

Table 16: Submissions from respondents on AS 1731 Technical Paper

Submissions from respondents on AS 1731 Technical Review Paper				
Respondent organisation	**Location**	**Respondent**	**Contact Details**	**Response**
Orford Refrigeration	Toowoomba, QLD, Australia	Kerron Martin	KerronMartin@orford.com.au	Comments
Frigrite Refrigeration Pty Ltd	Cheltenham, VIC, Australia	Sarathy	sarathy@frigrite.com.au	Comments
Roband Australia	Cromer, NSW, Australia	Mal Johnston	mal.johnston@roband.com.au	Comments
Cossiga Ltd	Auckland, NZ	Mike Brougham	mike.brougham@nzimpact.co.nz	Comments
Festive Ltd	Christchurch, NZ	Gavin Holley	gavin@festive.co.nz	Comments
Skope Industries Ltd	Christchurch, NZ	Craig Eustace	craig.eustace@skope.co.nz	Comments
Coolrite Refrigeration	Christchurch, NZ	Jonathan Baker	johanathan.baker@coolrite.co.nz	Comments
Climatech	Auckland, NZ	Barry smart	bsmart@climatech.co.nz	Comments
Arneg (NZ)	Auckland, NZ	Matthew Darby	matthew.darby@arneg.co.nz	Comments
Coolroom Components Ltd	Auckland, NZ	Brian Parr	sales@coolcomps.co.nz	Comments
Future Products Group (FPG)	Auckland, NZ	Ross Mepham	Rmepham@fpgworld.com	Comments
Refrigerated Displays Ltd	Auckland, NZ	Grant Stainton	refrigdisplays@ihug.co.nz	Comments
Macdonald Refrigeration Ltd	Auckland, NZ	Ian Macdonald	macdonald@vodafone.net.nz	Comments
McAlpine Hussman Ltd	Auckland, NZ	Brian Rees	Brian_Rees@ap.irco.com	Comments

The following list summarises the major areas covered by comments on the review:

Test facilities

- Lack of testing facilities;
- Cost of test facilities;
- Excessive cost of testing;

- Simplified testing regime;
- Cost of testing prohibitive for small production runs.

Low volume products

- Implement a MEPS waiver on models with small annual volumes (less than 50 units sold in any calendar year);
- Dispensation for small runs/special cabinets but that use conforming materials;
- Introduce a simpler testing regime for custom/small volume production to reduce costs and allow them to be commercially viable products;
- Deemed to Comply;
- Custom manufacture issues – exemption for small runs;
- Dispensation for small runs/special cabinets but that use conforming materials;

Test Methods

- Add M0 (-1°C to +4°C) temperature classification;
- CO_2 Standard Rating Procedure required;
- Test voltage and Frequency need to be specified. AS 1731.4 only specifies tolerance on supply i.e. 230V 50 Hz to ensure that all product is tested under the same conditions of supply;
- Door openings excessive;
- Delete VPA from AS 1731 and ISO 23953;
- Family registration definitions and interpretation;
- Require a standard rating procedure for CO_2 (R744) as the current standard does not cover this refrigerant;
- Calculation of REC is currently not relevant to Australian conditions and does not reflect the actual efficiencies achieved by the newer refrigerants such as R507A and R404A;

Test Packages

- Australian specification for density of Filler Packs is incorrect at 480 ± 80 kg/m^3. European packs are 1000 kg/m^3;
- Need alternative suppliers for test packages that are reasonably priced.

Registrations

- Deemed to comply;
- Cabinets registered with 'no-value';
- Unregistered products – re-branded product is not registered separately;
- Large numbers of un-registered product in the market;
- Likelihood that unregistered cabinets are probably less efficient while those that are registered are further ahead with high efficiency. So percentages of registrations may be biased;
- Refurbished or re-manufactured products by pass MEPS;

- Re-manufactured cabinets should be re-listed at point of resale if they have been modified from what was originally supplied;

TDA/VPA

- Light Transmission Factors for TDA. Illogical for penalising double glazing, etc;
- Current TDA does not give a direct comparison of the visible product between open cabinets and closed (glass door) cabinets;
- Do away with TDA basis and align with North American standards;
- North America are considering using TDA for glass doors and open cabinets;
- Use volume for storage cabinets but remain with TDA for display cabinets;
- TDA is not applicable to serve over counters as it penalises single tier displays, non-transparent counter tops and double and insulated triple glass due to then Tg factor;
- Remove reference to VPA;
- Review display area calculations to cover interpretation issues (perhaps a volume based calculation would be a better basis).

Non-retail cabinets

- Non- retail should be covered but regulators need to show they can enforce current MEPS products;
- Volumetric approach should be used for non retail equipment;
- Use of volume based method to cover non-retail equipment;
- Gross Volume and Net Volume should be reported in applications for registration;
- Use Volume for Storage cabinets but remain with TDA for display cabinets;
- Closer alignment with overseas standards;

Types

- Rationalise ‘types’;
- Adopt ISO 23953 ‘types’ for remote and integral;
- Remotes have Lit and Unlit Shelf categories. Integrals do not have any differentiation of whether they are lit or not. Combine into single category;
- Simplify the number of ‘types’;
- The number of types and means of definition cause difficulties;
- Add MEPS ‘Values’ where there are currently none;
- Cover Drugs and Pharmaceutical refrigerators should be included;
- Remotes vs integrals. One is required to be registered the other identical model is not;

More onerous MEPS levels

- Too soon to review efficiency levels;
- Increase high efficiency requirements in some cases but maybe not others;

- High efficiency levels should be realistic and more achievable;
- High efficiency levels be reviewed to ensure that the top 20% of product are able to gain this status;

AS 1731

- Test Reports should be a requirement of registration;
- All cabinet types should be required to be registered whether or not they have a MEPS value;
- Creates a valuable data base for future establishment of levels;
- M2 should be lower MEPS level than an M1. If M2 uses more energy than an M1 it is inefficient. Especially for IVC4 Solid and Glass door where reverse has been applied;
- Test Reports should show compliance with all claimed Climatic Class Classifications;
- Closer alignment with international standards so that unnecessary retesting be minimized;
- Door opening frequency and initial 3 minute opening for each door appear to be excessive when compared to actual normal operation observed in stores;
- Is there an intention to add 3M0 which is referred to by some customers.

Marking and Labelling

- Labelling should be brought in;
- Temperature class i.e. M1, M2, L1, L2 etc marking on all cabinets should be mandatory;

Miscellaneous

- Re-manufactured RDCs should be covered.

Attachment 2: Definition of usable refrigerated volume

The following sections are taken from the Mexican NOM-022-ENER/SCFI-2008

Coolers and freezers both vertical and horizontal:

- The parameters that define the usable refrigerated capacity of the refrigeration equipment in terms of volume are illustrated below;
- The sum of the volumes is determined by the location of different types of shelves or surfaces where product is placed, multiplied by the height corresponding to the level marked by the **load limit** or the ceiling, next shelf, the top of the diffuser, lamp, panel, switches, air diverters or any component that limits the arrangement of product;
- In the case of cabinet interiors that have built-in moulded shelf supports or the shelves are slid into slots in the liner, the distance between walls that accommodate the stored product is taken as the limiting dimension;
- If any component inside the cabinet occupies volume (e.g. diffuser, air deflector, duct or ceiling), it must be subtracted from the total calculated volume in accordance with the preceding paragraphs. In cases where this obstacle prevents the accommodation of a can or a test filler package of 100 x 100 x 50 mm (e.g. switch, drainage, thermostat), this volume shall be subtracted from the total volume.

Figure 26: Volume of vertical cabinet

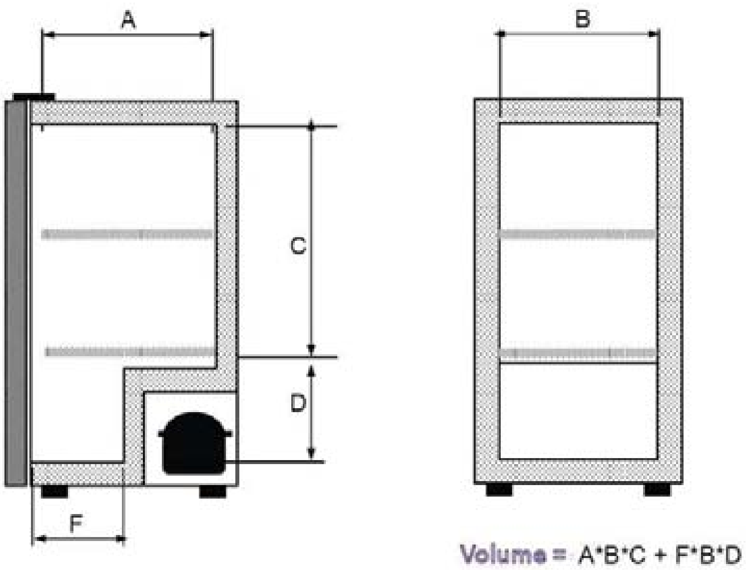


Figure 27: Volume of vertical cabinet

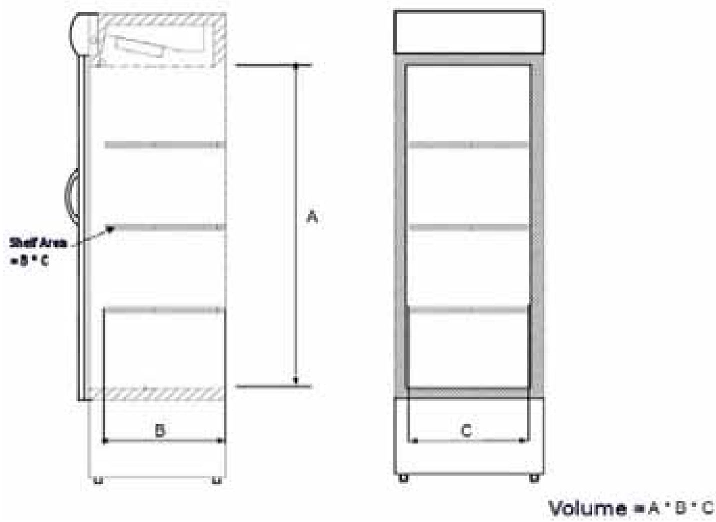


Figure 28: Volume of horizontal cabinet

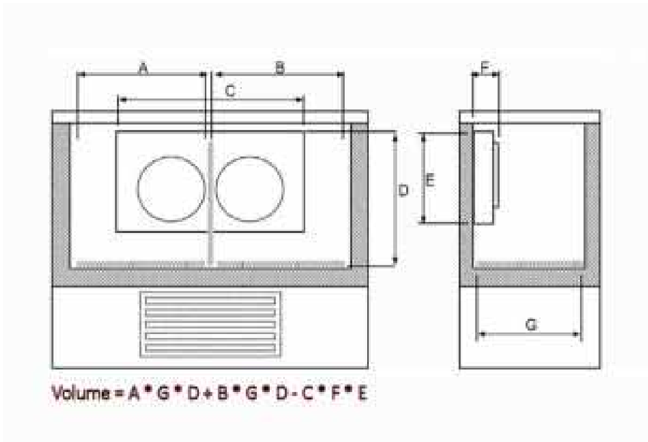


Figure 29: Volume of horizontal cabinet

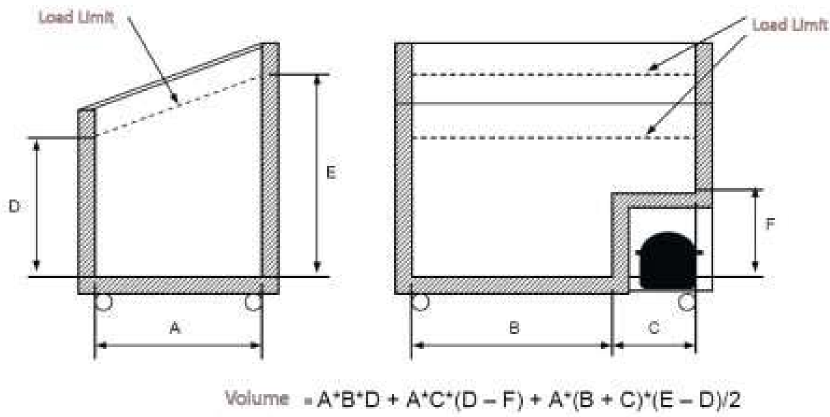


Figure 30: Volume of vertical cabinet

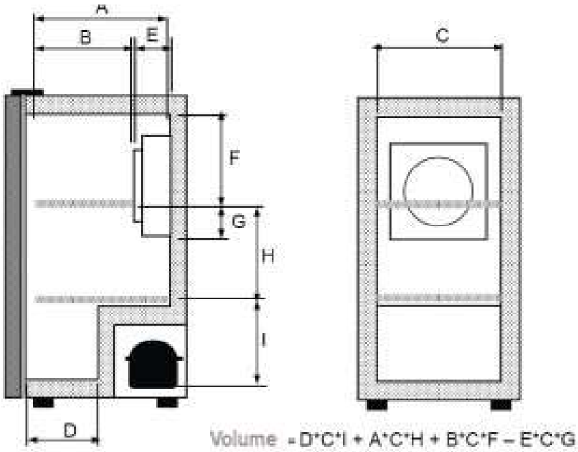
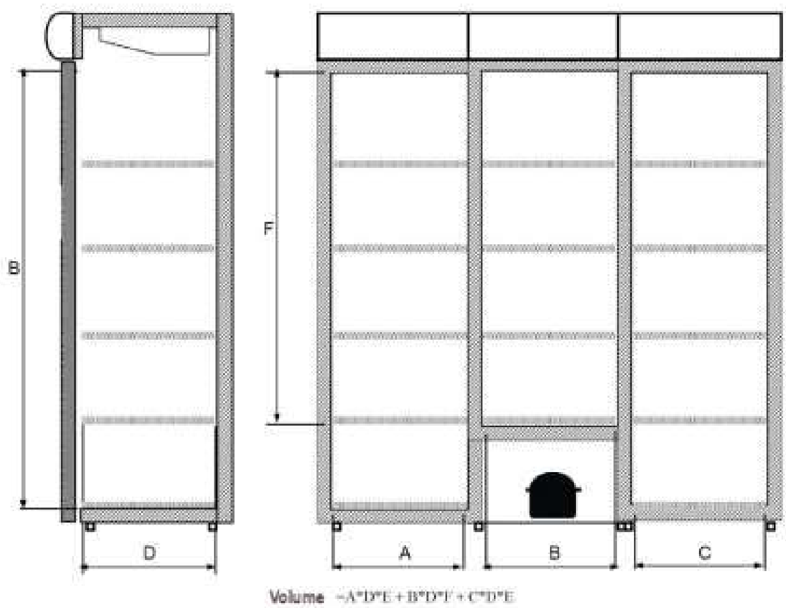


Figure 31: Volume of vertical cabinet



Showcases (serve over counters)

1 The parameters that define the usable refrigerated capacity of the refrigeration equipment in terms of volume are illustrated below:

2 The sum total of the volumes determined in each area of grids, or areas where displayed product is placed (e.g. the apparatus floor, drawer condenser unit), multiplied by the height taken corresponding to the geometric centre of the grill or displayed product in line to the level of load limit marked by the manufacturer or any limitation that may be the next shelf, displayed product, glass, evaporator, lamp, panel, switches, air diverters or any component that limits the accommodation product.

3 If any component inside the cabinet occupies volume (e.g. drainage, pipe cooling, electrical products), it must be subtracted from the total estimate, according to paragraph above. In cases where this obstacle prevents the accommodation of a test filler package of 100 x 100 x 50 mm (e.g. switch, drainage, thermostat), this volume shall be subtracted from the total volume.

Figure 32: Volume of showcase

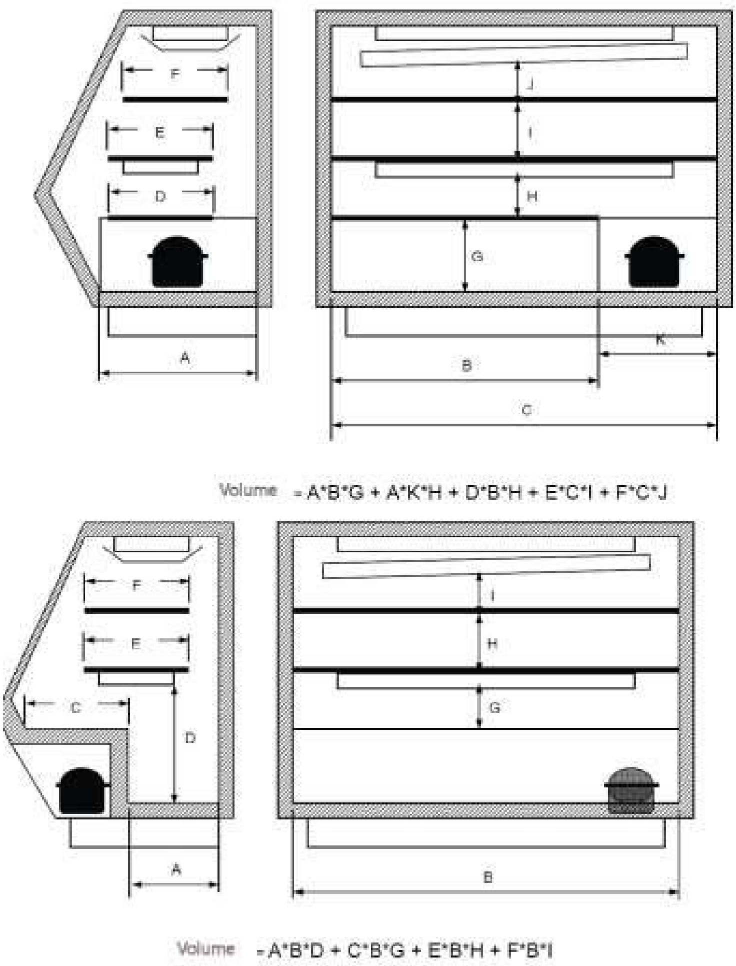
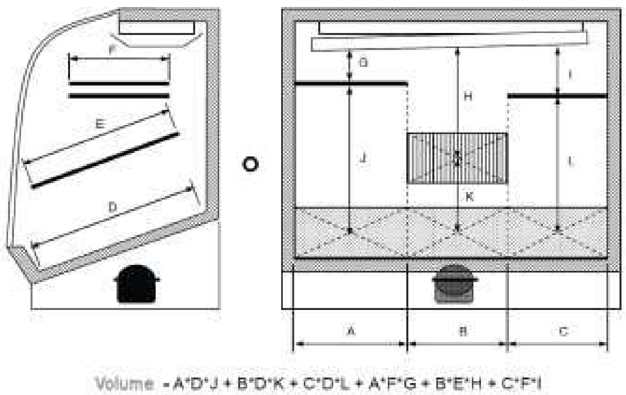


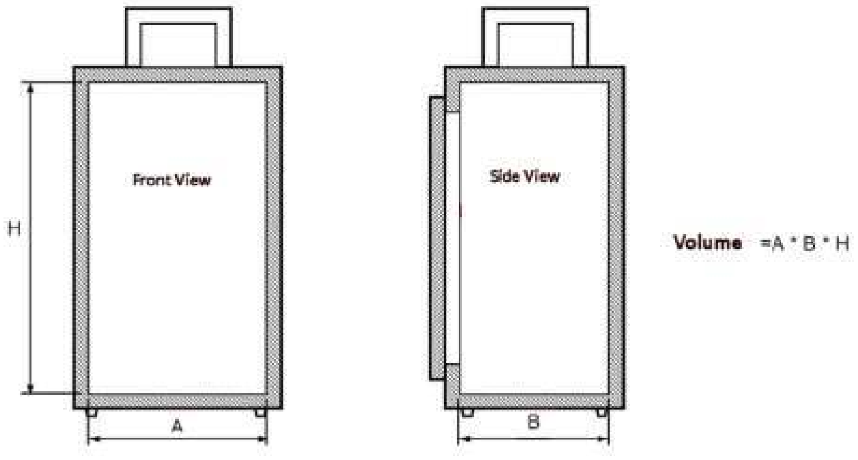
Figure 33: Volume of showcase



Bagged ice storage cabinets

- The parameters that define the usable refrigerated capacity of the refrigeration equipment in terms of volume are illustrated below;
- It is determined by multiplying the area of the internal floor by the dimension to the ceiling.

Figure 34: Volume of bagged ice storage cabinet



Attachment 3: US MEPS for refrigeration equipment

Table 17: Proposed levels for product manufactured after 1 January 2010

Product	Door or Drawer Type	Maximum Daily Energy Consumption (kWh)
Refrigerators	Solid	0.10V + 2.04
	Transparent	0.12V + 3.34
	Transparent designed for pull-down temperature application	0.126V + 3.51
Freezers	Solid	0.40V + 1.38
	Transparent	0.75V + 4.10
Refrigerator-freezers	Solid	0.70 or 0.27AV - 0.71
Note: V = Internal Volume in ft^3		
AV = Adjusted Volume = (1.63 x freezer volume in ft^3*) + refrigerator volume in* ft^3		

Attachment 4: Canadian MEPS for refrigeration equipment

Table 18: NRCan previous levels (effective April 1, 2007)

Product	Door or drawer type		Maximum E daily (kWh/day)	
			April 1, 2007 - December 31, 2007	On or after January 1, 2008
Self-contained commercial refrigerators	opaque doors or drawers		0.00441 V + 4.22	0.00441 V + 2.76
	transparent doors		0.00607 V + 5.78	0.00607 V + 4.77
	other*		N/A	N/A
Self-contained commercial freezers	opaque doors	V < 340	7.62	7.07
		V >= 340	0.0141 V + 2.83	0.0141 V + 2.28
	transparent doors		0.0332 V + 5.10	0.0332 V + 5.10
	other*		N/A	N/A
Self-contained commercial refrigerator-freezers	opaque doors		0.00964 AV + 2.63	0.00964 AV + 1.65
	other*		N/A	N/A
** Product has no energy efficiency performance requirements but must meet all other regulatory requirements*				
V is the refrigerator volume measured in litres				
AV (adjusted volume) is equal to the refrigerator volume plus 1.63 times the freezer volume.				

Table 19: June 2009 levels (effective January 1, 2010)

Product	Door or Drawer Type	Maximum Daily Energy Consumption (kWh)
Refrigerators	Solid	E_{daily} = 0.00353V + 2.04
	Transparent not designed for pull-down temperature application	E_{daily} = 0.00424V + 3.34
	Transparent designed for pull-down temperature application	E_{daily} = 0.00445V + 3.51
Refrigerator-freezers	Solid	E_{daily} = 0.00953AV - 0.71
Freezers	Solid	E_{daily} = 0.01413V + 1.38
	Transparent	E_{daily} = 0.02649V + 4.10
V is the refrigerator volume measured in litres		
AV (adjusted volume) is equal to the refrigerator volume plus 1.63 times the freezer volume.		
E_{daily} = maximum daily energy consumption (kWh)		
Note: To be considered a transparent door or drawer unit, at least 75% of the front surface area must be transparent (e.g. glass).		

Attachment 5: California Energy Commission - 2008 Appliance Efficiency Regulations - Part B, Draft Regulations - CEC-400-2008-014-SD

Table 20: Standards for Self-contained Commercial Refrigerators, Refrigerator Freezers and Freezers manufactured on or after 1 January 2010

Appliance	Doors	Maximum Daily Energy Consumption (kWh)
		1-Jan-10
Refrigerators	Solid	0.10V + 2.04
	Transparent	0.12V + 3.34
Freezers	Solid	0.40V + 1.38
	Transparent	0.75V + 4.10
Refrigerator/freezers	Solid	The greater of 0.27AV-0.71 or 0.70
Refrigerators designed for pull-down applications		0.126V +3.51
V = refrigerated volume measured using ANSI/AHAM HRF-1:2004		
Appliance	**Doors**	**Maximum Daily Energy Consumption (kWh)**
		Jan 1, 2010
Reach-in cabinets, pass through cabinets, and roll-in or roll-through cabinets that are refrigerators; and wine chillers that are not consumer products	Solid	0.10V + 2.04
	Transparent	0.12V + 3.34
Reach-in cabinets, pass through cabinets, and roll-in or roll-through cabinets that are freezers (except ice cream freezers)	Solid	0.40V + 1.38
	Transparent	0.75V + 4.10
Reach-in cabinets, pass through cabinets, and roll-in or roll-through cabinets that are freezers that are ice cream freezers	Solid	0.39V + 0.82
	Transparent	0.88V + 0.33
Reach-in cabinets that are refrigerator - freezers and that have an adjusted volume (AV) of 5.19 ft^3 or greater	Solid	0.27AV - 0.71
Reach-in cabinets that are refrigerator - freezers and that have an adjusted volume (AV) of less than 5.19 ft^3	Transparent	0.70
V = refrigerated volume measured using ANSI/AHAM HRF-1:2004		

Attachment 6: US Energy Star Program

Table 21: Specification for ENERGY STAR® Qualified Commercial Solid Door Refrigerators and Freezers, version 1.1 September 2001

Product Type	Energy Consumption under test conditions (kWh/day)
Refrigerators	≤ 0.10V + 2.04
Freezers	≤ 0.40V + 1.38
Refrigerator Freezer	≤ 0.27AV - 0.71
Ice-Cream Freezer	≤ 0.39V + 0.82
Note: V = Internal Volume in ft^3	
AV = Adjusted Volume = (1.63 x freezer volume in ft^3) + refrigerator volume in ft^3	

Table 22: Requirements for ENERGY STAR® Qualified Commercial Food-grade Refrigerators and Freezers version 2.0 final version April 2009

Maximum Daily Energy Consumption (MDEC)		
Product Volume (cu ft)	**Refrigerator**	**Freezer**
Vertical Configuration		
Solid Door Cabinets		
0 < V < 15	≤ 0.089V + 1.411	≤ 0.250V + 1.250
15 ≤ V < 30	≤ 0.037V + 2.200	≤ 0.400V - 1.00
30 ≤ V < 50	≤ 0.056V + 1.635	≤ 0.163V + 6.125
50 ≤ V	≤ 0.060V + 1.416	≤ 0.158V + 6.333
Glass Door Cabinets		
0 < V < 15	≤ 0.118V + 1.382	≤ 0.607V + 0.893
15 ≤ V < 30	≤ 0.140V + 1.050	≤ 0.733V - 1.000
30 ≤ V < 50	≤ 0.088V + 2.625	≤ 0.250V + 13.500
50 ≤ V	≤ 0.110V + 1.500	≤ 0.450V + 3.500
Chest Configuration		
Solid or Glass Door Cabinets	≤ 0.125V + 0.475	≤ 0.270V + 0.130
Note V = AHAM volume, as defined in Section 1, in cubic feet (ft^3)		

Attachment 7: Mexican MEPs

Table 23: Requirements for integral commercial refrigeration equipment NOM-022-ENER/SCFI/ECOL-2000

Type of Apparatus	Capacity Intervals (litres)	Consumption (kWh/l per 24 h)
Vertical Cooler	10 - 50	0.042
	51 - 99	0.041
	100 - 150	0.04
	151 - 300	0.036
	301 - 450	0.028
	451 - 850	0.02
	> 850	0.018
Horizontal Cooler		
a) Forced air circulation	110 - 150	0.03
	151 - 250	0.024
	251 - 360	0.02
	> 360	0.015
b) Cold Plate	110 - 150	0.034
	151 - 250	0.024
	251 - 360	0.028
	> 360	0.018
Vertical Freezer		
a) Fan circulation and glass doors	50 - 100	0.05
	101 - 200	0.045
	>200	0.04
	200 - 600	0.034
	601 – 1,000	0.018
	>1,000	0.012
Horizontal freezer		
a) With solid door	110 - 200	0.013
	201 - 400	0.01
	> 400	0.009
b) With glass door	110 - 200	0.02
	201 - 400	0.018
	> 400	0.016
Showcase		
a) Medium temperature	200 - 600	0.056
	601 – 1,000	0.05
	> 1,000	0.044
b) Low Temperature	200 - 600	0.063
	601 – 1,000	0.056
	> 1,000	0.049

Table 24: Requirements for integral commercial refrigeration equipment, NOM-022-ENER/SCFI-2008

Type of Apparatus		Consumption Limit	Capacity Categories	Consumption Limits outside Capacity Categories [(1)]
		kWh/l/24 h	litres	(kWh/l/24 h)
Upright Cooler				
a)	Fan forced air circulation	$C = 0.2463*(V)^{-0.4537}$	50 – 1,200	0.0099
b)	Cold plate	$C = 1.0489*(V)^{-0.8763}$	50 – 1,200	0.0021
Horizontal Cooler				
a)	Fan forced air circulation	$C = 4.5922*(V)^{-1.0162}$	100 - 500	0.0083
b)	Cold plate	$C = 1.0489*(V)^{-0.8763}$	100 - 500	0.0045
Upright Freezer				
a)	Glass door forced air circulation	$C = 0.0725*(V)^{-0.1136}$	100 - 500	0.0358
b)	Glass door and cold plate	$C = 0.2378*(V)^{-0.4189}$	200 – 1,500	0.0111
Horizontal Freezer				
a)	Solid door	$C = 0.0353*(V)^{-0.2142}$	100 - 700	0.0087
b)	Solid door pharmacy cabinet [(2)]	$C = 0.0767*(V)^{-0.2839}$	100 - 700	0.0119
c)	Glass Door	$C = 0.0767*(V)^{-0.2839}$	100 - 500	0.0131
Showcase				
a)	Medium temperature	$C = 0.1555*(V)^{-0.2915}$	200 – 1,200	0.0197
b)	Low temperature	$C = 0.103*(V)^{-0.1228}$	200 – 1,200	0.0431
Bagged ice storage cabinets				
		$C = 0.2245*(V)^{-0.5674}$	250 – 2,500	0.0026
Notes: (1) Set values for product that is outside the stated capacity category				
(2) This product is tested at 40°C and 65% RH				

Attachment 8: UK Enhanced Capital Allowance scheme

Table 25: 16: EEI performance thresholds for integral and remote display cabinets

Classification according to temperature	EEI performance threshold (kWh/day/m^2)	
	Integral Type	Remote Type
M0	<=12.50	<=11.75
M1	<=11.95	<=11.45
M2	<=10.55	<=10.85
H1	n/a	<=8.00
H2	<=9.20	<=9.20
L1	<=19.10	<=23.50
L3	n/a	<=21.00
<= means "less than or equal to"		
Where the Energy Efficiency Index (EEI) is defined as the ratio of the product's Total Energy Consumption (TEC) to Total Display Area (TDA) i.e. EEI = TEC/TDA, and: *TEC is calculated according to BS EN ISO 23953-2:2005 section 5.3.6.3.4.* *TDA is calculated according to BS EN ISO 23953-2:2005 Annex A.*		
For the avoidance of doubt, test data should be presented to 2 decimal places. As an example, a Remote type M0 cabinet with an EEI performance threshold of 11.76 would be deemed to be a fail		

Table 26: EEI performance thresholds for commercial service cabinets

Type	Energy Efficiency Index performance threshold		
	(kWh/48hrs/m^3)		
	Gross internal volume (litres)	Chilled (M1)	Frozen (L1)
Single door	400 and 600 (+/-15%)	EEI <= 16.0	EEI <= 38.0
Double door	1,300 (+/-15%)	EEI <= 12.0	EEI <= 34.0
Under counter and counter cabinets with solid doors or drawers	150 to 800 (+/-15%)	EEI <= 21.6	EEI <= 40.0
<= means "less than or equal to"			
Where the EEI (Energy Efficiency Index) is defined as the Total Electrical Energy Consumption (in kWh) of the product over a 48 hour test period divided by the product's Net Volume (in m^3), and: *Net Volume equals: shelf (or drawer base) area x loading height.* *Total Electrical Energy Consumption is as defined in BS EN 441-9:1995.*			
For the avoidance of doubt, test data should be presented to 1 decimal place. As an example, an EEI of 38.1 for a Frozen-Single Door commercial service cabinet would be deemed to be a fail.			

Attachment 9: CEE commercial kitchens initiative

Table 27: CEE commercial kitchens initiative effective date of 01/01/2006

Product	Equipment Type	Specification	Corresponding Base Specification	Maximum Daily Energy Consumption (kWh)
Solid Door	Refrigerator	CEE Tier 1	ENERGY STAR ®	0.10V + 2.04
		CEE Tier 2	ENERGY STAR ® + 40%	0.06V + 1.22
	Freezer	CEE Tier 1	ENERGY STAR ®	0.40V + 1.38
		CEE Tier 2	ENERGY STAR ® + 30%	0.28V + 0.97
Glass Door	Refrigerator	CEE Tier 1	25% of top-performing products	0.12V + 3.34
		CEE Tier 2	28% more efficient that Tier 1	0.086V + 2.39

V is the refrigerator volume measured in ft^3 as determined by HRF1-1979

Definitions:

Commercial Refrigerator: A cabinet designed for storing food or other perishable items at temperatures above 32oF but no greater than 40°F.

Commercial Freezer: A cabinet designed for storing food or other perishable items at temperatures of 0°F or below.

Non-domestic refrigeration Cabinet: A refrigerator or freezer for storing food products or other perishable items at specified temperatures and designed for use by commercial or institutional facilities.

Note: To be considered a transparent door or drawer unit, at least 75% of the front surface area must be transparent (e.g. glass)

Attachment 10: Summary of test pack and filler pack specifications

Table 28: Test package and filler package survey

TEST PACKAGE AND FILLER PACKAGE SURVEY			
Standard (Country)	**Temperature sensing package**	**Filler Package**	**Additional Filler Packages**
EN 441 (Europe)	M-Package (ISO)(1): 50 x 100 x 100 mm x 500 g fitted with thermocouple	ISO Packages(1): 25 x 50 x 100 mm x 125 g, 50 x 100 x 100 mm x 500 g, 50 x 100 x 200 mm x 1000g, 25 x 100 x 200 mm x 500 g and 37.5 x 100 x 200 mm x 750 g. Density equates to 1000 kg/m^3.	For roll-in cabinets and certain multi-deck cabinets additional filler material in the form of wood loading is permitted.
AS 1731 (Australia and New Zealand)	M-Package (ISO) (1): 50 x 100 x 100 mm x 500 g fitted with thermocouple	MECHLAB Plastic packages (2): 25 x 100 x 200 mm, 25 x 50 x 100 mm, 37.5 x 100 x 200 mm, 50 x 100 x 100 mm, 50 x 100 x 200 mm. Density of 480 ± 80 kg/m^3.	For roll-in cabinets and certain multi-deck cabinets additional filler material in the form of wood loading is permitted.
EN ISO 23953 (Europe)	M-Package (ISO)(1): 50 x 100 x 100 mm x 500 g fitted with thermocouple	ISO Packages(1): 25 x 50 x 100 mm x 125 g, 50 x 100 x 100 mm x 500 g, 50 x 100 x 200 mm x 1000g. Density equates to 1000 kg/m^3	ISO Packages(1): 25 x 100 x 200 mm x 500 g and 37.5 x 100 x 200 mm x 750 g. For roll-in cabinets and certain multi-deck cabinets additional filler material in the form of wood loading is permitted.
ANSI/ASHRAE 72-2005 (USA)	Test Simulator: A plastic container of at least 473 ml volume, 50 x 95 x 95 mm containing natural or artificial sponge and saturated with 50/50 ±2% distilled water and glycol with a thermocouple	Packages containing a filler material consisting of water, or a 50/50 mixture ±2% of distilled water and propylene glycol or wood blocks with an overall density not less than 480 kg/m^3.	
ARI 1200:2002 (USA)	Test Simulator: A plastic container of at least 473 ml volume 50 x 95 x 95 mm containing natural or artificial sponge and saturated with 50/50 ±2% distilled water and glycol with a thermocouple	Packages containing a filler material consisting of water, or a 50/50 mixture ±2% of distilled water and propylene glycol or wood blocks with an overall density not less than 480 kg/m^3.	
AS/NZS 4471.1 (Australia/New Zealand Household Refrig)	Air temperature sensors with a metallic mass equivalent to between 2.3 g and 20 g of water. (Meets ISO 2.3 g and AHAM < 20g water equivalent).	None required for energy consumption test	
NOM-022-ENER/SCFI-2008 (Mexico)	Medium Temperature: 355 ml aluminium can containing glycol and fitted with a thermocouple. Low temperature: M-Package (ISO)(1)50 x 100	Medium Temperature: 355 ml aluminium cans containing soda water. Low temperature: ISO Packages(1): 25 x 50 x 100 mm x 125 g, 50 x 100 x 100 mm x 500 g,	Low temperature: ISO Packages(1): 25 x 100 x 200 mm x 500 g and 37.5 x 100 x 200 mm x 750 g.

	x 100 mm x 500 g fitted with thermocouples.	50 x 100 x 200 mm x 1000 g. Densities equate to 1000 kg/m^3.	
ECA RDCs (UK)	M-Package (ISO)[1] 50 x 100 x 100 mm x 500 g fitted with thermocouples.	ISO Packages[1]: 25 x 50 x 100 mm x 125 g, 50 x 100 x 100 mm x 500 g, 50 x 100 x 200 mm x 1000g	ISO Packages[1]: 25 x 100 x 200 mm x 500 g and 37.5 x 100 x 200 mm x 750 g.
ECA Service Cabinets (UK)	M-Package (ISO)[1]: 50 x 100 x 100 mm x 500 g fitted with thermocouples.	ISO Packages[1]: 25 x 50 x 100 mm x 125 g, 50 x 100 x 100 mm x 500 g, 50 x 100 x 200 mm x 1000g	ISO Packages[1]: 25 x 100 x 200 mm x 500 g and 37.5 x 100 x 200 mm x 750 g.

Notes:

(1) ISO filling material (per 1000g) : 230.0 g oxyethylmethylcellulose;

764.2 g of water;

5.0 g sodium chloride; and

0.8 g of para-chlorometa-cresol.

(2) MECHLAB filled with water soaked into natural, plastic or cellulose sponge.

Attachment 11: Energy performance of integral RDCs

Figure 35: Energy performance of products registered as IHC1

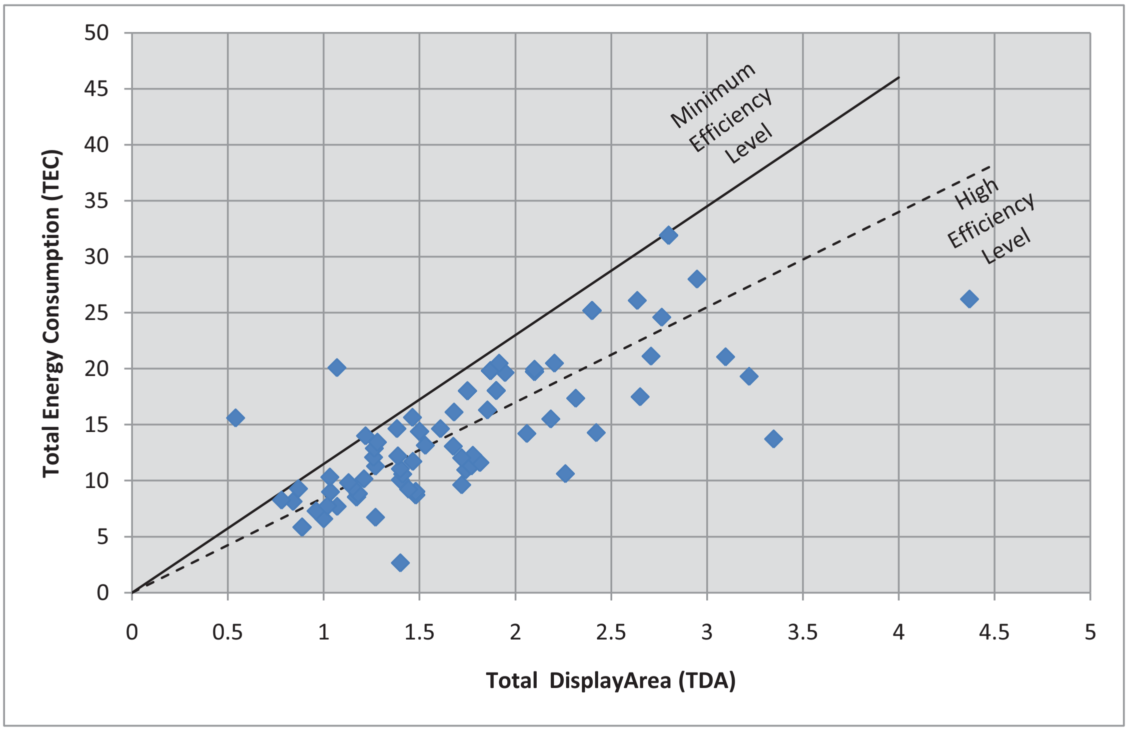


Figure 36: Energy performance of products registered as IHC4

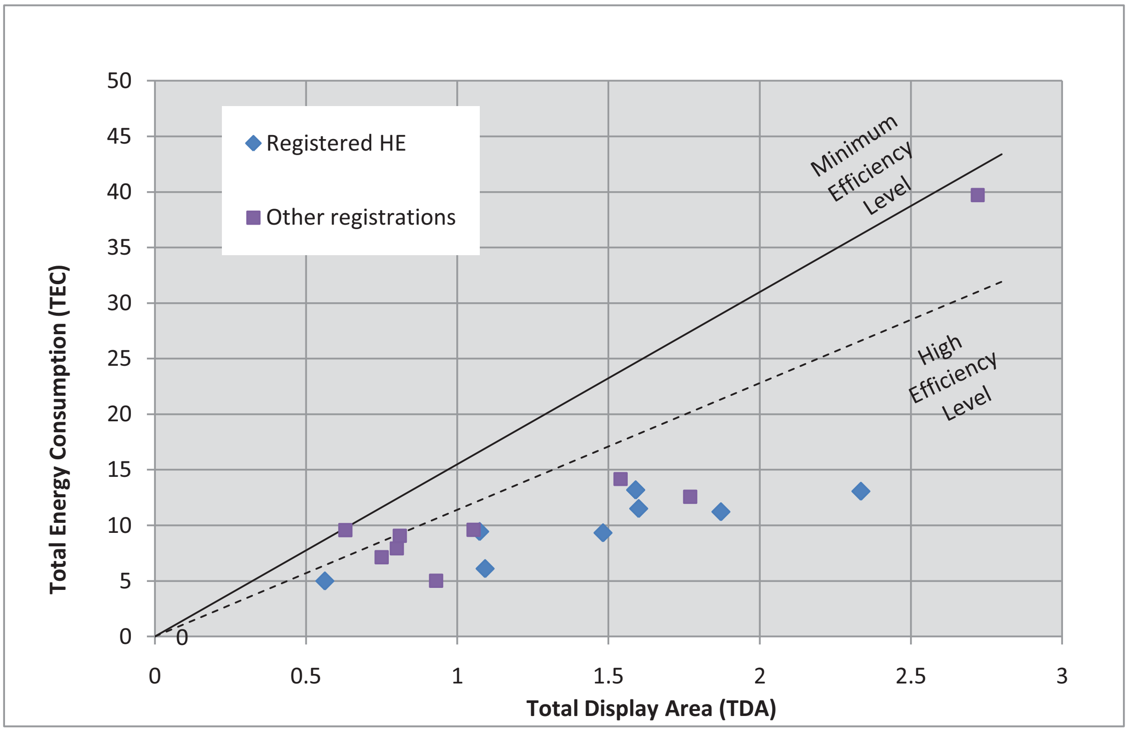


Figure 37: Energy performance of products registered as IVC1

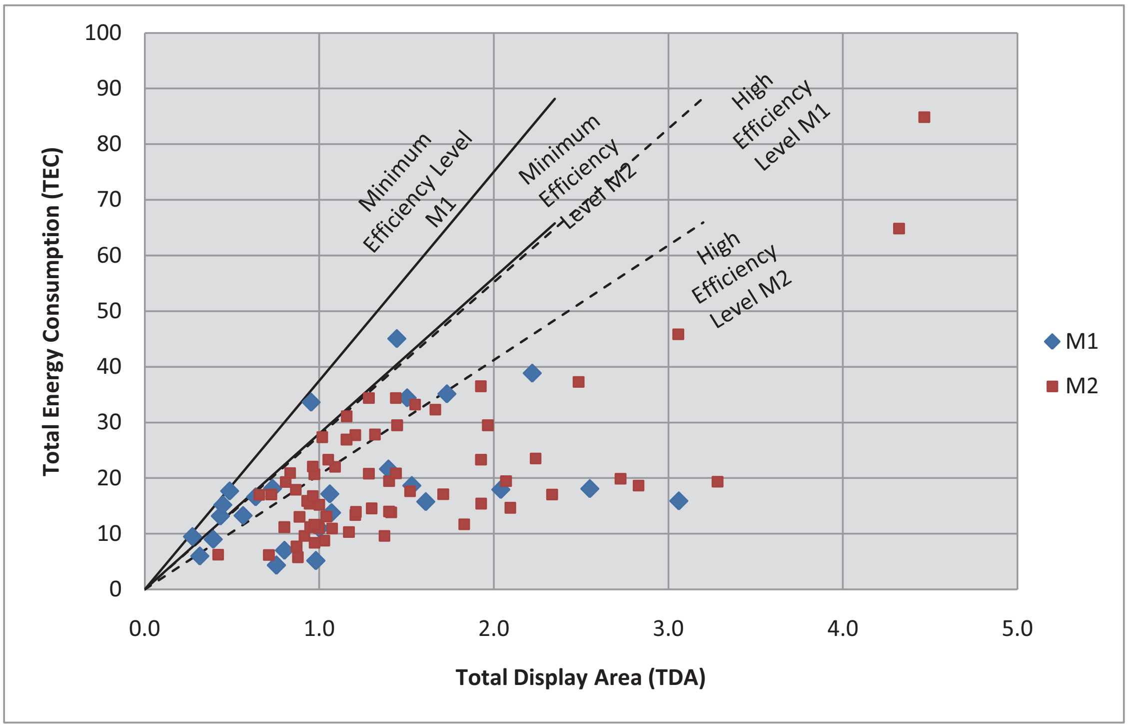


Figure 38: Energy performance of products registered as IVC2

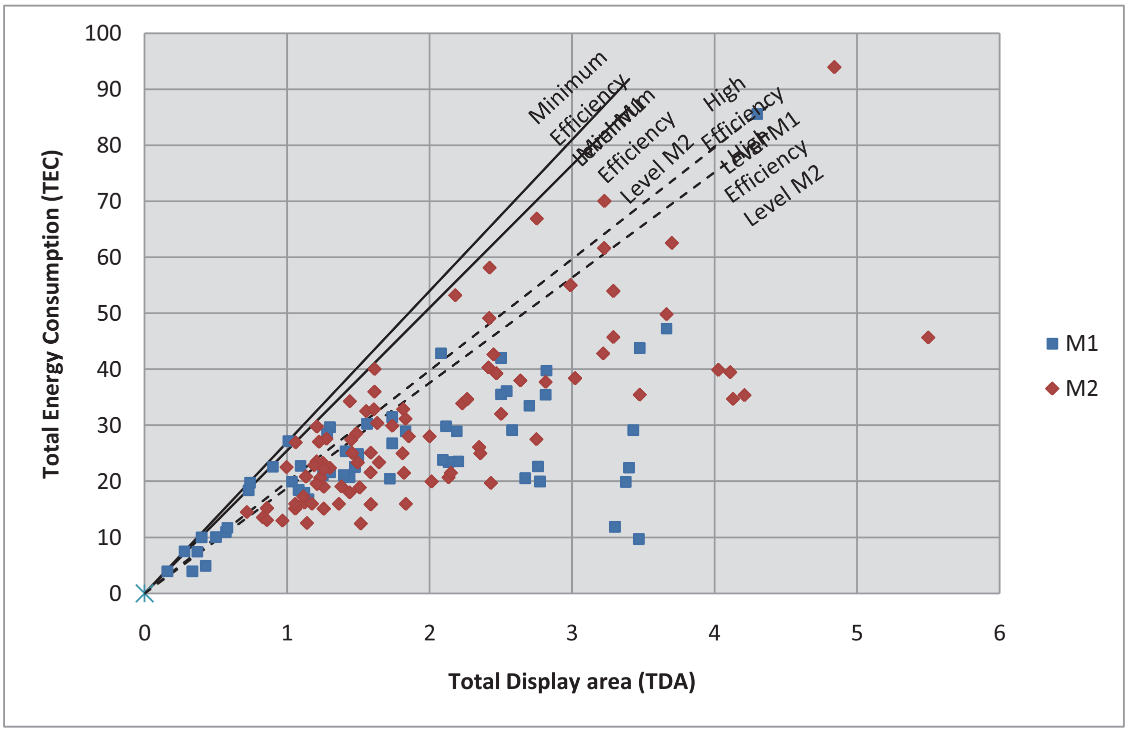


Figure 39: Energy performance of products registered as IVC4 Glass Door M1

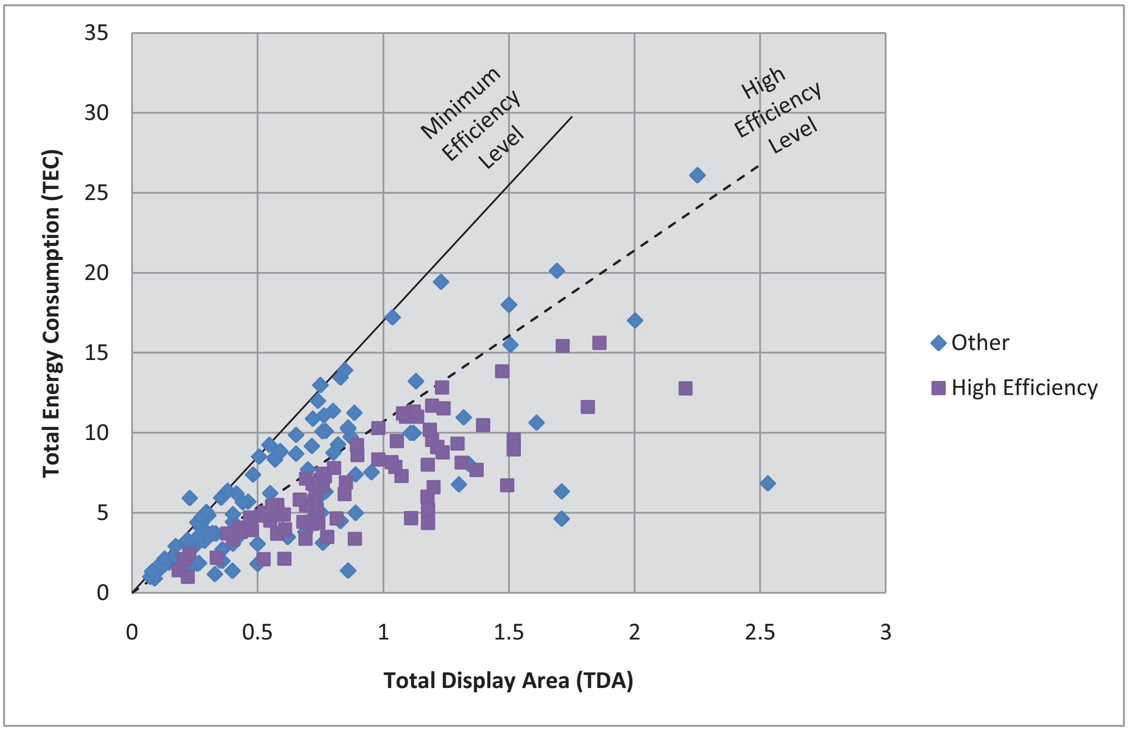


Figure 40: Energy performance of products registered as IVC4 Glass Door M2

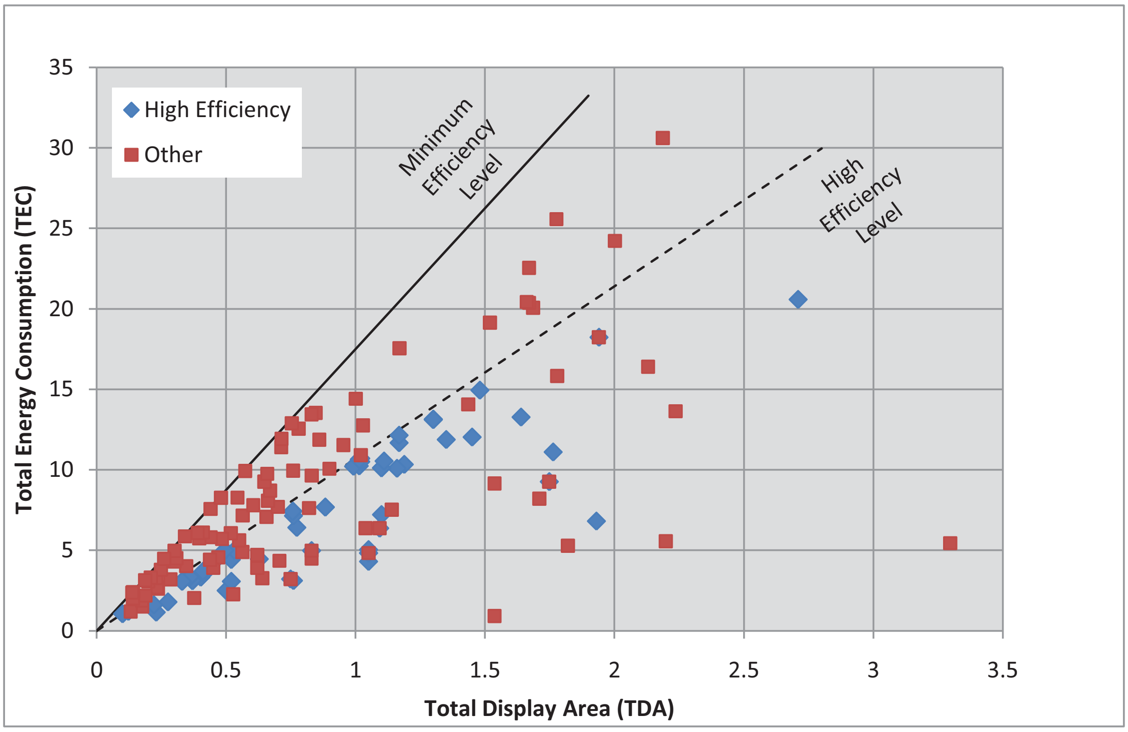


Figure 41: Energy performance of products registered as IHF4

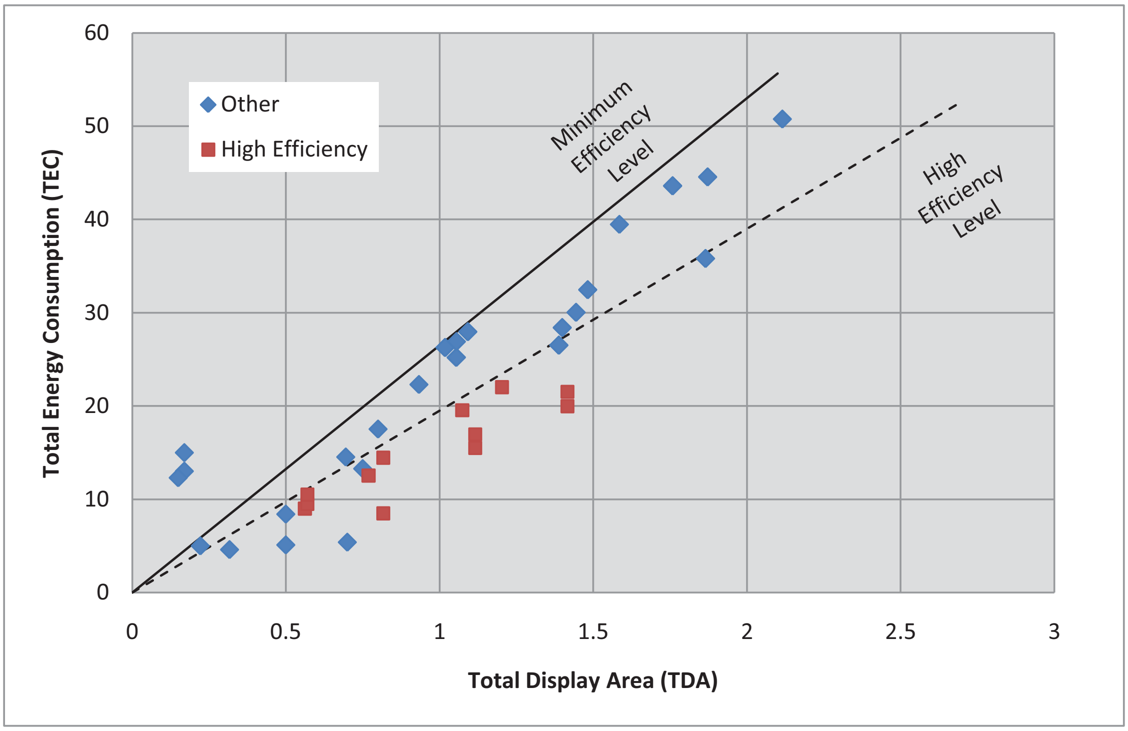


Figure 42: Energy performance of products registered as IHF6

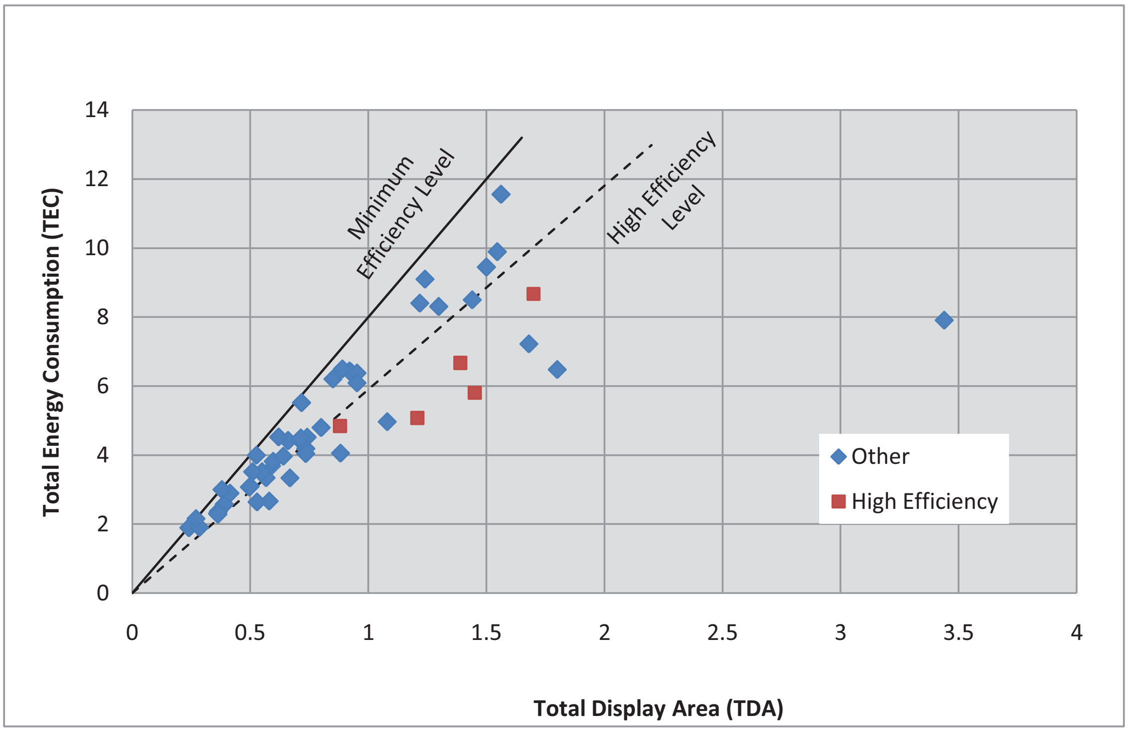
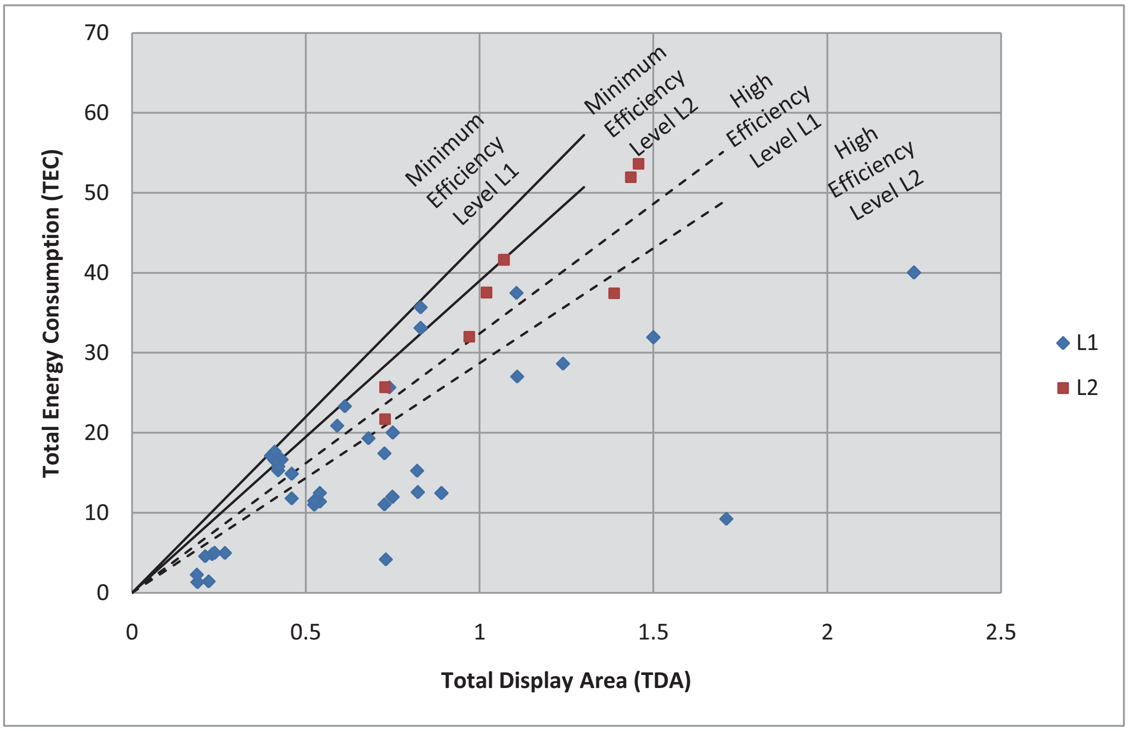


Figure 43: Energy performance of products registered as IVF4 Glass Door



Attachment 12: Energy performance of remote RDCs

Figure 44: Energy performance of products registered as RS2 Unlit

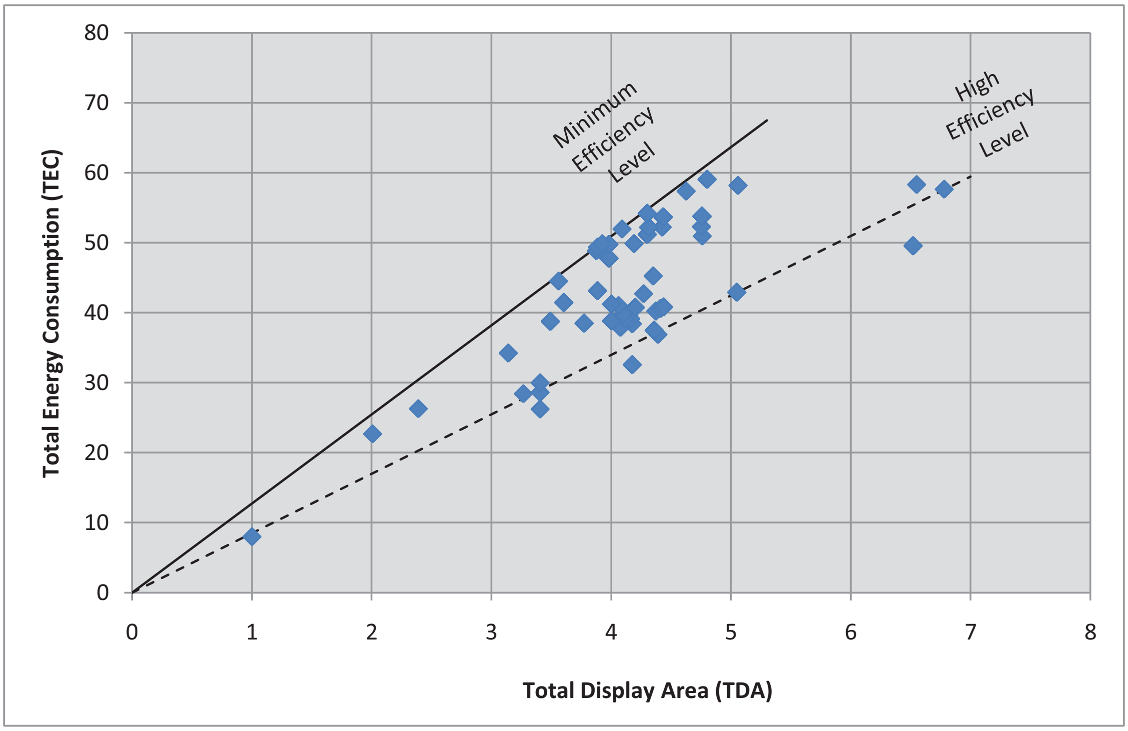


Figure 45: Energy performance of products registered as RS2 Lit

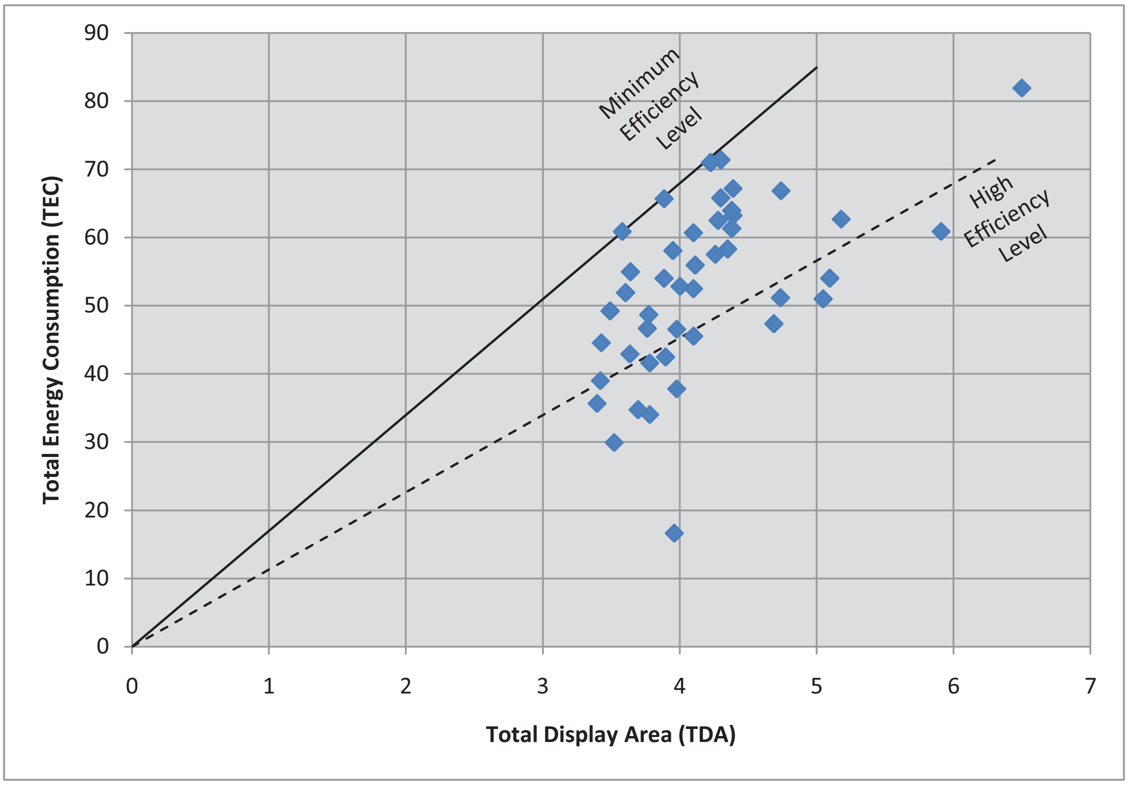


Figure 46: Energy performance of products registered as RS3 Unlit

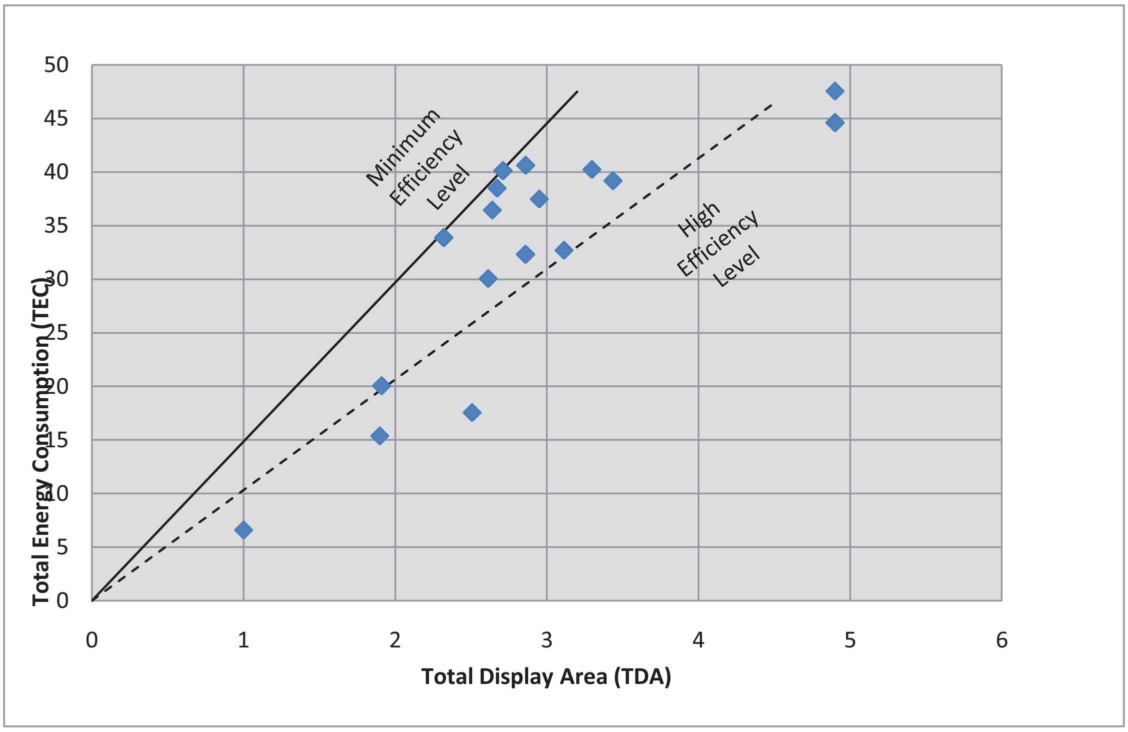


Figure 47: Energy performance of products registered as RS3 Lit

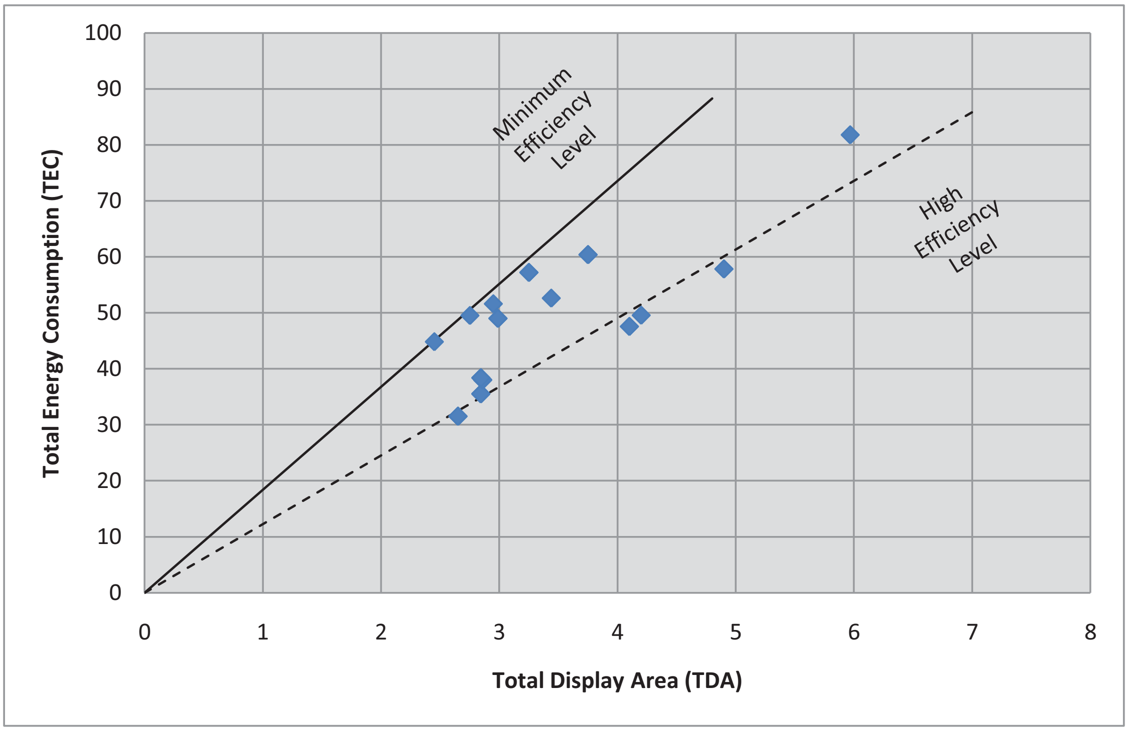


Figure 48: Energy performance of products registered as RS8 Gravity Coil

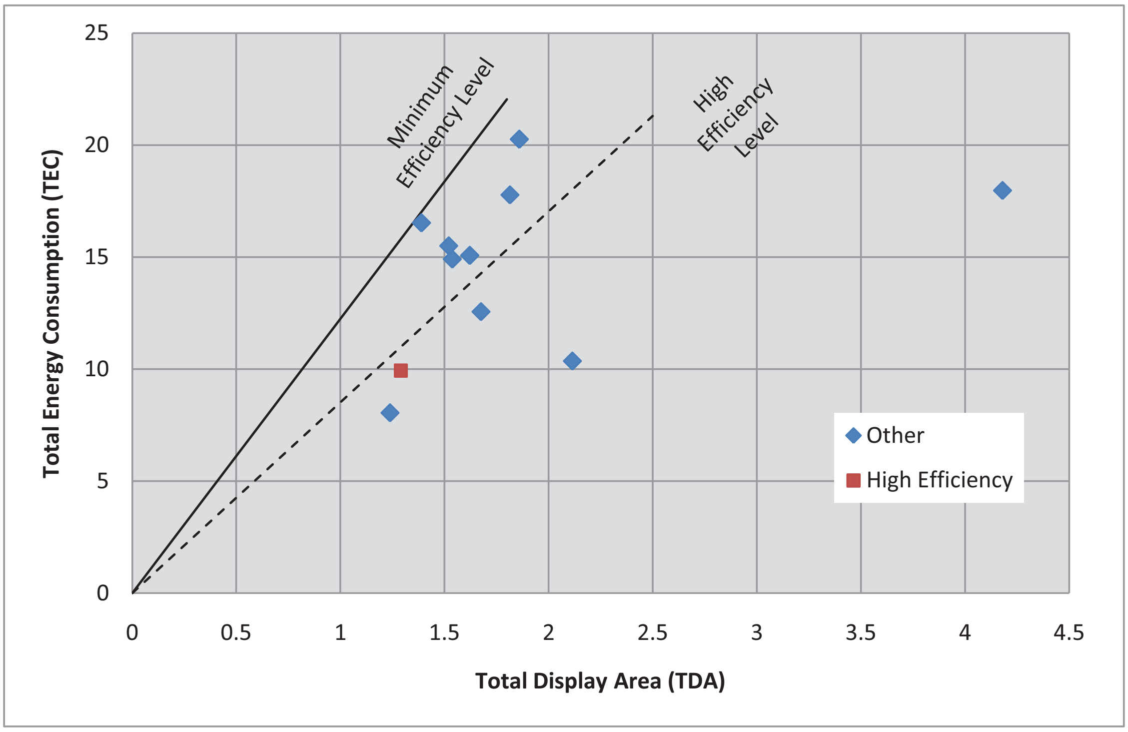


Figure 49: Energy performance of products registered as RS8 Fan Coil

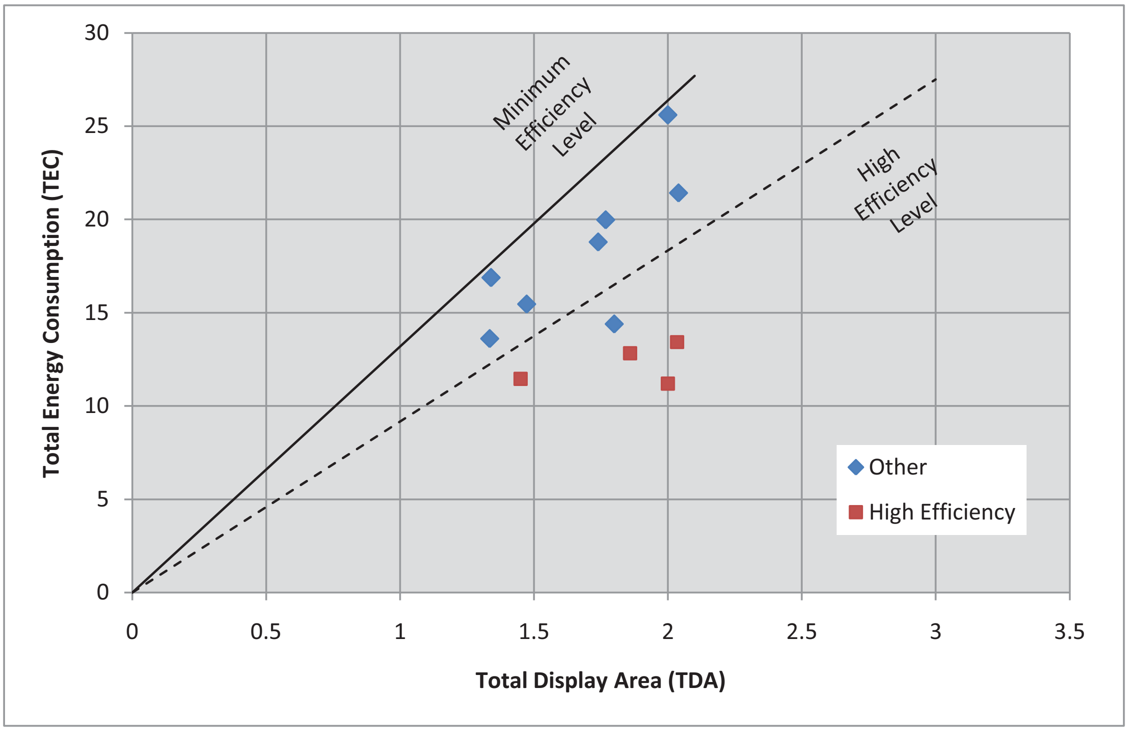


Figure 50: Energy performance of products registered as RS13 Solid Sided

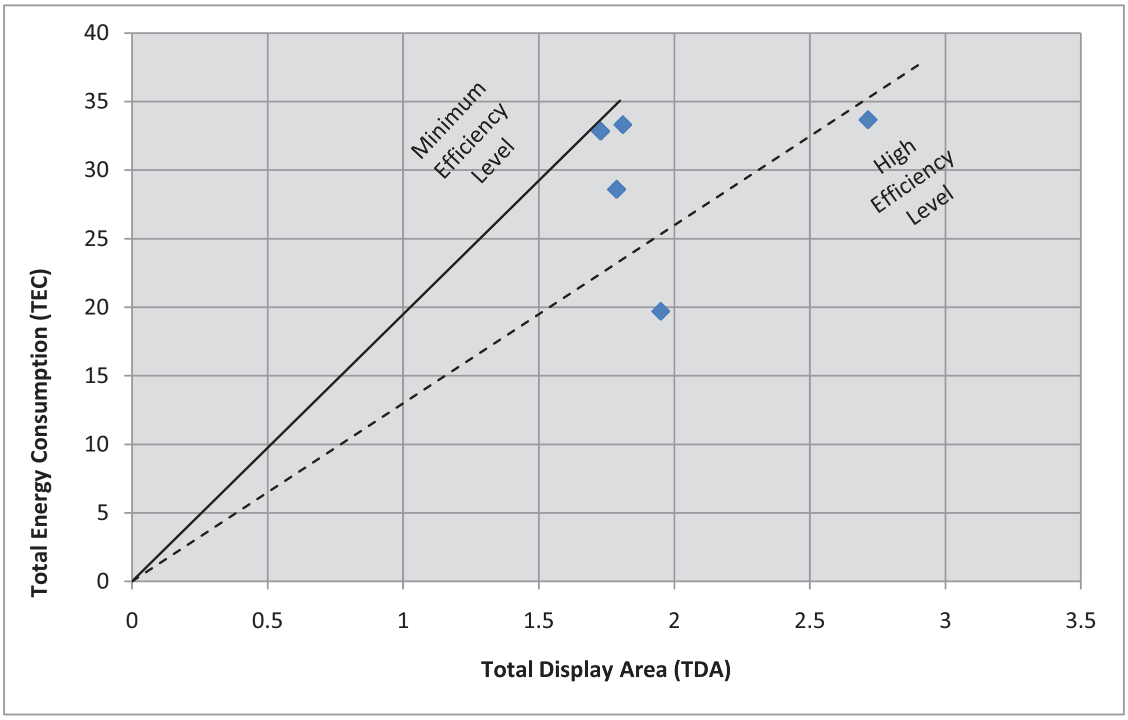


Figure 51: Energy performance of products registered as RS13 Glass

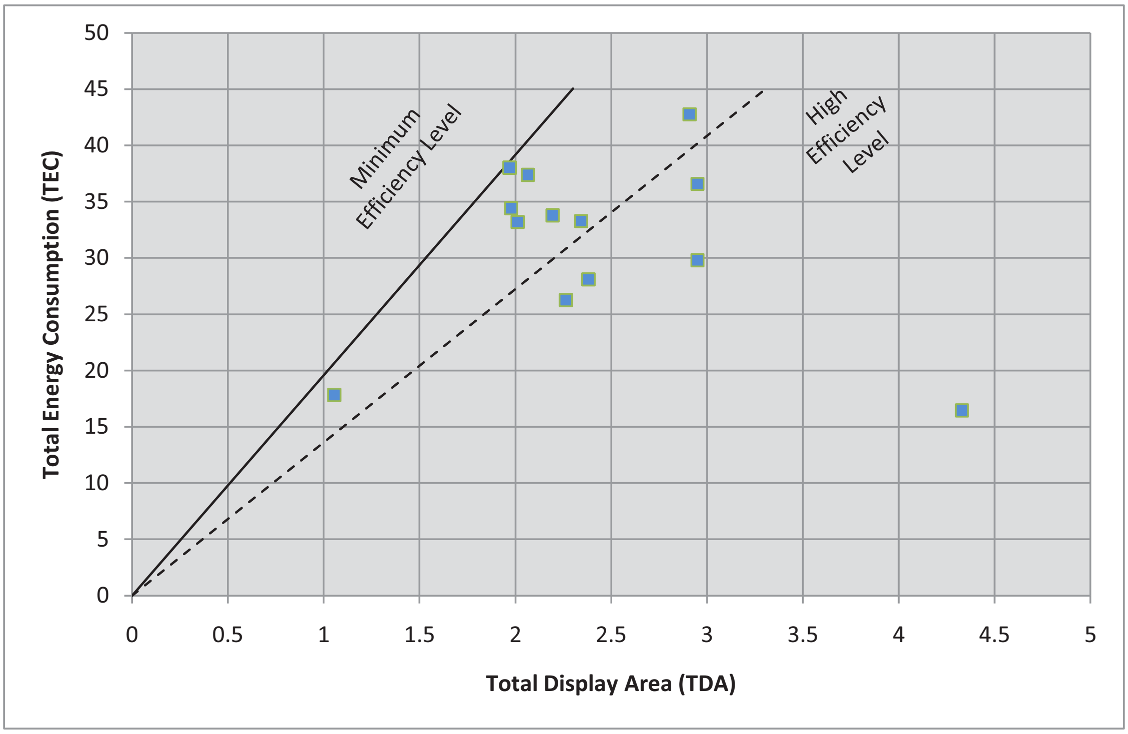


Figure 52: Energy performance of products registered as RS14 Solid Sided

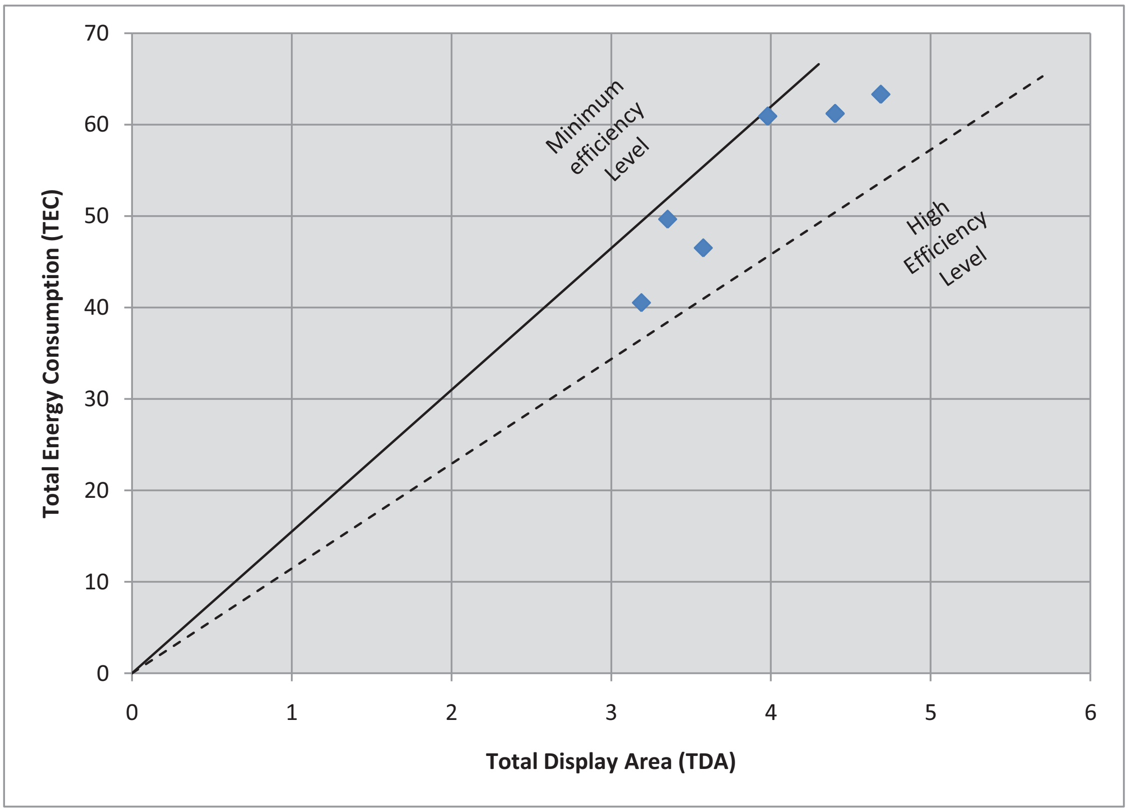


Figure 53: Energy performance of products registered as RS14 Glass

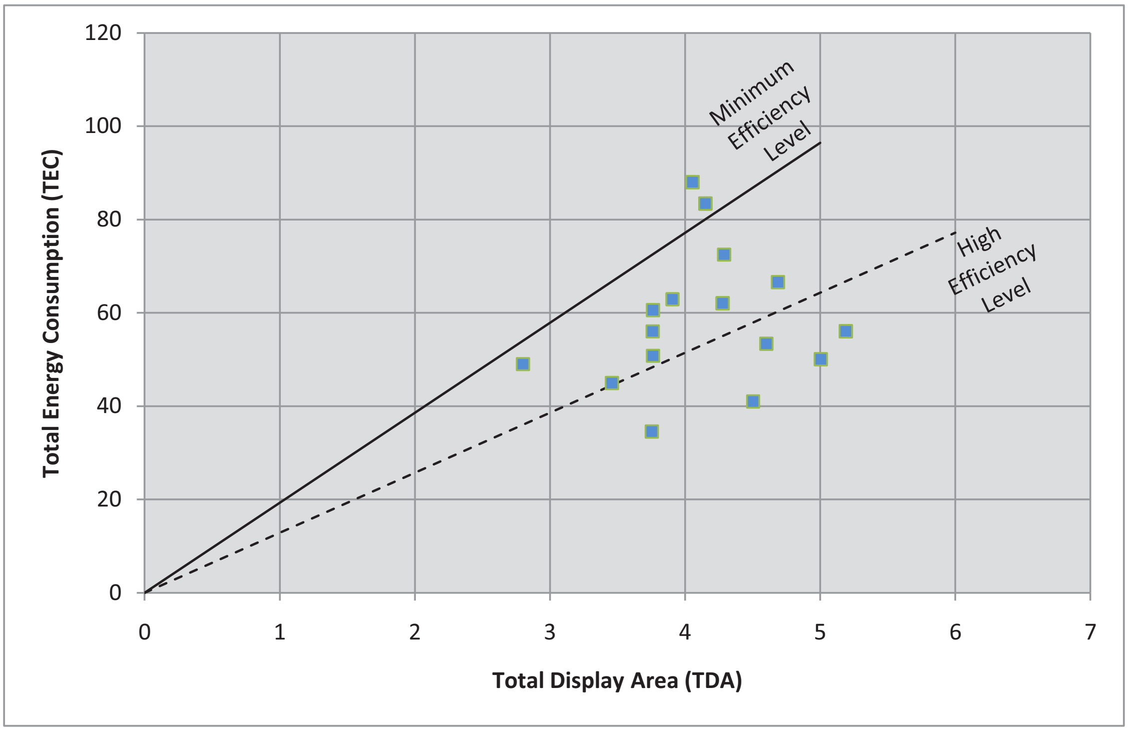


Figure 54: Energy performance of products registered as RS16 Glass Door