National Appliance and Equipment Energy Efficiency Program

Analysis of Potential for Minimum Energy Performance Standards

for

Remote Commercial Refrigeration

Prepared for the Australian Greenhouse Office

by

Mark Ellis & Associates

Final Draft Report

March 8th, 2000

MARK **E**LLIS & Associates
44 Albert Street
Wagstaffe, NSW 2257, Australia
Tel: 02 4360 2931
Fax: 02 4360 2714
email: ellism@ozemail.com.au

This study was funded by the Energy Management Task Force, organised through the National Appliance and Equipment Energy Efficiency Committee and managed by the Australian Greenhouse Office.

The study was undertaken by Mark Ellis of Mark Ellis & Associates. We would also like to acknowledge the assistance provided by Roger Hurley of Enginuity Pty Ltd, Lloyd Harrington of Energy Efficient Strategies and Matin Poole. In addition, we thank members of the refrigeration industry for their assistance.

Mark Ellis & Associates is a consultancy service specialising in the design, management and evaluation of sustainable energy policies and programs. MEA brings over 17 years experience in Europe and Australasia to the following areas of expertise:

- energy and greenhouse policy
- greenhouse modelling
- design of energy efficiency strategies
- implementation and management of energy efficiency programs
- energy information and advisory services
- green pricing schemes
- energy sector micro-economic reform
- low energy planning and building design
- environmental impacts of energy generation technologies and fuels

CONTENTS

Glossary

Air-Cooled Condenser.

A refrigeration system component which condenses refrigerant vapour by rejecting heat to air mechanically circulated over its heat transfer surface causing a rise in the air temperature. Desuperheating and sub-cooling of the refrigerant may occur as well.

Air-Cooled Heat Reclaim Condenser.

A heat transfer device which condenses refrigerant vapour, in the process of rejecting the heat of condensation to air, causing a rise in the air temperature. Desuperheating and/or sub-cooling of the refrigerant may occur as well. This condenser may be a separate condenser, the same as, or a portion of the air-cooled condenser.

Bubble Point.

Refrigerant liquid saturation temperature at a specified pressure.

Compressor Saturated Discharge Temperature.

For single component and azeotrope refrigerants, it is the saturated temperature corresponding to the refrigerant pressure at the compressor discharge. For zeotropic refrigerants, it is the arithmetic average of the dew point and bubble point temperatures corresponding to refrigerant pressure at the compressor discharge. It is usually taken at or immediately downstream of the compressor discharge service valve (in either case on the downstream side of the valve seat), where discharge valves are used.

Dew Point.

Refrigerant vapour saturation temperature at a specified pressure.

Coefficient of Performance (COP)[W/W].

A ratio of the cooling capacity in Watts [W], to the total power input in Watts [W] at any given set of rating conditions.

Energy Efficiency Ratio (EER).

A ratio of the cooling capacity in Btu/h [W] to the total power input in watts [W] at any given set of rating conditions.

Evaporatively-Cooled Condenser.

A refrigeration system component which condenses refrigerant vapour by rejecting heat to a water and air mixture mechanically circulated over its heat transfer surface, causing evaporation of the water and an increase in the enthalpy of the air. Desuperheating and sub-cooling of the refrigerant may occur as well.

Heat Reclaim Coefficient of Performance (COP).

A ratio calculated by dividing the net heat reclaim capacity (W) by the total power input to the unit.

Integrated Part Load Value (IPLV).

A single number part-load efficiency figure of merit calculated per the method described in 5.3 referenced to Standard Rating Conditions.

Net Heat Reclaim Capacity.

A quantity defined as the mass flow rate of the condenser water multiplied by the difference in enthalpy of water entering and leaving the heat reclaim condenser, expressed in Btu/h [kW].

Net Refrigerating Capacity.

A quantity defined as the mass flow rate of the evaporator water multiplied by the difference in enthalpy of water entering and leaving the cooler, expressed in Btu/h or tons [kW].

Non-Standard Part Load Value (NPLV).

A single number part-load efficiency figure of merit calculated per the method described in 5.3 referenced to conditions other than IPLV conditions. (For units that are not designed to operate at ARI Standard Rating conditions.)

Power Input per Ton (kW/Ton).

A ratio of the total power input to the unit, including controls, in kW to the net refrigerating capacity in tons at any given set of rating conditions. 1 ton refrigeration (TR) = 3.52kW.

Published Ratings.

A statement of the assigned values of those performance characteristics, under stated rating conditions, by which a unit may be chosen to fit its application. Such ratings shall be based on a series of tests that support the applicable range of the product with the refrigerant specified in the ratings. Published ratings consist of the standard rating(s), part load ratings and application ratings, whether published in catalogues or by computer output and shall apply to all units of like nominal size and type (identification) produced by the same manufacturer.

Water-Chilling Package.

A factory-designed and prefabricated assembly (not necessarily shipped as one package) of one or more compressors, condensers and evaporators, with interconnections and accessories, designed for the purpose of cooling water. It is a machine specifically designed to make use of a vapour compression refrigeration cycle to remove heat from water and reject the heat to a cooling medium, usually air or water. The refrigerant condenser may or may not be an integral part of the package.

Water-Cooled Condenser.

A heat transfer device, which utilises refrigerant-to-water heat transfer means, causing the refrigerant to condense and the water to be heated. Desuperheating and sub-cooling of the refrigerant may occur as well.

Water-Cooled Heat Reclaim Condenser.

A heat transfer device, which utilises refrigerant-to-water heat transfer means, causing the refrigerant to condense and the water to be heated. Desuperheating and sub-cooling of the refrigerant may occur as well. This condenser may be a separate condenser, the same as, or a portion of the water-cooled condenser.

EXECUTIVE SUMMARY

This report covers major 'remote' commercial refrigeration technologies and products currently used in Australia. These are systems comprising compressors and condensing equipment for cooling rooms or large spaces, such as cool storage rooms, or for providing refrigeration services to other locations, for example supermarket display cases. This category includes the following:

- Walk-in storage and freezer rooms, and display cases, for example in supermarkets and other food retail and beverage outlets;
- Cool Rooms in clubs, pubs & hotels, butchers, and other food preparation and service industries;

The scope of this study has not included industrial refrigeration equipment such as that used in food processing, abattoirs and dairies.

Self-contained Systems are covered in an additional report [MEA, 2000]. These are systems which have integral components and are designed to plug into an available electricity supply. They are typically mass produced rather than designed for a specific end-user. This category includes refrigerator vending machines, deli cases, food and beverage merchandisers, ice machines and water coolers.

Market Profile

The following table shows the estimated of annual sales and the existing population of the various technologies covered in this report.

Table E1: Market Data for Remote Commercial Refrigeration Products

PRODUCT	ANNUAL MARKET	EXISTING STOCK	Life Span (years)
Cool Rooms	23,500	240,000	10
Display Cases	6,000	36,000	6

There are approximately 260 refrigeration suppliers in Australia with most specialising in a small number of sub markets. A large quantity of components and finished products are imported, primarily from the following countries.

Table E2: Countries of Origin for Imports of Remote Commercial Refrigeration Products and Components

Product/component	Source Countries
Compressors	Brazil, Korea & Singapore
Refrigerator & freezing chests, cabinets & displays *	China, Denmark, Hong Kong Italy, Thailand, USA

(* Note this category includes some self-contained refrigeration products)

Summary of Energy Consumption by Business Type

Remote commercial refrigeration is estimated to consume approximately 4,380 GWh in 2000. The distribution of this by business type is shown below.

Table E1: Distribution of Energy Consumption from Remote Commercial Refrigeration, by Business Type.

Business Type	Total Energy Consumption
Supermarkets: Lg	32%
Supermarkets: Md	8%
Supermarkets: Sm	1%
Clubs:Lg	9%
Clubs:Sm	2%
Grocery Stores	3%
Service Stations: Lg	9%
Bottle Shops	2%
Fresh Meat, Fish & Poultry	6%
Pubs	6%
Café's Restaurants	13%
Other	9%

Standards

The Current Australian Standard AS 1731 – 1983, which is in the process of being revised, only covers frozen food retail cabinets. The new draft standard is based on the British Standard BS EN 441 and it is our understanding that it will not cover:

- supermarket equipment, excluding cabinets;
- walk-in storage (cool rooms) and freezer rooms;

Canada, the United States, Europe and South Africa all have existing test methodologies for remote display cabinets, although only Canada and South Africa have adopted minimum energy performance standards to date. The Canadian standard deals most comprehensively with the performance of remote systems, while South Africa has a single energy performance standard for all refrigerated display cabinets. Minimum energy performance standards for commercial refrigeration products are being actively considered in Europe and the US.

While there are many pre-existing standards for refrigeration cabinets, there appears to be no standards detailing a methodology for the measurement, or a MEPS for coolrooms.

Several countries have voluntary programs covering remote technologies. In Europe, a refrigeration cabinet certification program is run by the industry association, and a labelling program has been proposed for supermarket cabinets. In Holland there is a subsidy program to encourage efficient supermarket refrigeration, while in the UK operate an 'enhanced capital allowance scheme' has been launched to allow the full value of investment in energy efficient commercial refrigeration to be set against tax in the first year. In the US, the Energy Star Program is soon to launch a program for reach-in refrigerators and freezers.

A number of countries are currently examining strategies to reduce energy consumption from commercial refrigeration, including the development of energy performance standards.

Recommendations

Commercial refrigeration is estimated to currently consume 6,400GWh of electricity per year, projected to be increasing by 4.8% per annum. This represents greenhouse emissions of over 6.3 Mt CO_2-e in 2000, rising to 11.6 Mt CO_2-e in 2015.

Energy consumption by **remote** commercial refrigeration technologies is estimated at approximately 4,380 GWh in 2000, with greenhouse emissions of nearly 4.37 Mt CO_2-e. By 2015, consumption is estimated to have grown to 9,700 GWh, and emissions to 8.7 Mt CO_2-e.

Key features of the market for remote commercial refrigeration technologies are:

- Remote refrigeration technologies are estimated to contribute up to 64% of total refrigeration energy consumption. In a 'business as usual' scenario, consumption is estimated to grow by an average of 5.3% from 2000 to 2015.

- Consumption in remote units is spread across over 55,000 users. However 9,000 of the largest users account for 57% of total consumption.
- A large proportion of finished refrigeration products are imported. Most Australian made products use imported components, such as compressors. There are significant developments in the United States and Europe to increase the efficiency of display cabinets and other remote technologies. MEPS for display cabinets are already in force in Canada and South Africa.
- Technically feasible improvements with a payback under 5 years could save nearly 20% of commercial refrigeration consumption, with large savings available at very small additional costs to the manufacturer. Further savings are possible with longer payback periods.
- However many users make purchasing decisions on the basis of 'first cost' and have little awareness or information of the savings potential available. Information on energy efficiency is not required to be provided on refrigerated display cabinets.
- Remote technologies generally comprise a number of components which are designed and assembled to form a refrigeration system which suits the customer's requirements. Although some display cabinets are custom built, they are typically semi-standard products. Compressors, condensers, pipework, valves and other components are sized and assembled to meet the overall refrigeration requirements of the customer.
- In terms of the potential for energy efficiency measures with a payback under five years, it is estimated that approximately 55% of total savings would result from improvements to display cases. The remaining 45% of savings would be due to improvements to all the other components, and to the design of the refrigeration system and the refrigerated spaces.

Given the large and growing contribution to greenhouse emissions made by commercial refrigeration, of which more than half come from remote technologies, and the considerable potential for cost effective efficiency improvements, there is reason for Government to play a role in this sector.

MEPS are most appropriate when applied to standard manufactured products, where sample products can be tested and periodically checked. As a result, we do not recommend MEPS for refrigeration systems which are designed and assembled for individual customers, including walk-in storage and freezer rooms.

We also do not consider that it is practical at this stage to introduce MEPS for individual components of systems, other than display cabinets.

We do however believe that MEPS could be applied effectively to display cabinets and we note that this is the area where most international attention in being focussed at present.

Commercial Refrigerated Display Cabinets and Merchandisers

It is recommended that Australian MEPS are based on the Canadian standard C657-95, which prescribes the maximum energy consumption per unit length for a range of refrigerated cabinet types. For remote equipment, an additional allowance is made.

It is also recommended that the new Australian standard (based on BS EN 441) is adopted as the test methodology. The following table shows the SEC values contained in C657-95 translated to the approximate equivalent values under the new Australian test conditions, for climate class 3.

Table E3: Recommended Energy Performance Standard for Refrigerated Display Cabinet and Merchandisers

Class	Description	Evaporating Temp.(°C)	Specific Energy Consumption
			Proposed Australia (kWh/m/day)
Class 1:	low temperature multideck, two or more air curtains	-35	38.6
		-30	38.0
Class 2:	medium temperature multideck, single air curtain, length of air curtain 1.0-1.5m. Cabinet height 1.9-2.1m and depth 0.8-1.2m.	-10	22.6
		-5	19.5
Class 3:	medium temperature multideck, single air curtain, length of air curtain	-10	15.6

	0.8-1.0m. Cabinet height 1.0-1.4m and depth 1.0-1.2m.	-5	12.8
Class 4:	low or medium temperature closed multideck, single air curtain behind glass door. Cabinet height 2.0-2.1m and depth 1.0-1.2m.	-30	22.6
		-5	17.8
Class 5:	low temperature, well type self service cabinet, open or closed, with horizontal air curtain, length of air curtain 0.75-0.85m or 1.0-1.2m. Product loading depth 0.3-0.45m	-35	20.9
		-30	17.5
Class 6:	medium temperature single deck self service cabinet with single air curtain, length of air curtain 0.75-0.9m. Cabinet height 0.8-1.01m at the back and 0.7-0.9m at the front. Depth 1.0-1.2m.	-10	11.7
		-5	9.2
Class 7:	medium temperature single deck wall or island type self service cabinet with a perforated product shelf. Class 7 cabinets are dividing into three subclasses on the basis of the width of the display area:		
	a. narrow: 0.75-1.02m	-10	12.4
		-5	9.6
	b. medium: 1.03-1.27m	-10	17.3
		-5	14.6
	c. wide: 1.28-1.65m	-10	18.4
		-5	15.3
Class 8:	low or medium temperature cabinet with a flat or curved front glass and a sliding door service access to the rear. Height 1.25-1.4m, depth 0.95-1.2m. Class 8 cabinets are dividing into two subclasses on the basis of their evaporator coil arrangements:		
	a. fan coil.	-25	17.5
		-5	6.0
	b. gravity coil.	-10	6.4
		-5	3.2

- In line with C657-95, **for remote equipment**, the minimum energy performance standard shall be the total power input to the cabinet plus an allowance for the remote condensing equipment (R_{EC}).

Table E4: Recommended Energy Efficiency Rate for Remote Condensing Equipment

EER Values for R-404a at constant condensing temp of 32.2 C	
Evaporating Temp (C)	EER Value, W
-40	5.2
-35	5.9
-30	6.7
-25	7.6
-20	8.9
-15	10.7
-10	12.4
-5	14.5
0	17.1

The current Australian test applies to cabinets with integral and remote condensers. However, it provides no methodology for calculating the total refrigeration load. It may therefore be appropriate to use the methodology described in ASHRAE 72 and 117.

It is recommended that further investigation should be undertaken during the formulation of the Australian standard to determine appropriate classes in the Australian market, and appropriate equivalent energy performance standards.

In addition, consideration should be given as to whether the test methodology should be simplified to include only one class, eg. Class 3 which equates to the design conditions for most stores.

Adjustment for Australian Electrical Supply Conditions

The standards recommended above are based on those currently used in Canada, where electricity supply has a nominal voltage of 115 volts. To ensure equivalent standards, it is recommended that Australian MEPS levels should be raised by 6% in order to account for the supply voltage of 240 volts.

Additional Activities

Other types of programs may also be appropriate to target those technologies not covered by MEPS, or to achieve higher levels of greenhouse reductions.

Consideration should be given to types of programs which provide information to specifiers and end-users of refrigeration products in order to stimulate the selection of energy efficient products.

Information Programs: Display Cabinets

Currently there is no information provided on refrigerated display cabinets which indicate their energy performance to specifiers and end-users of refrigeration products. This is despite advice from industry sources that there is considerable variation in performance between products.

It is therefore recommended that:

- the Government proceed with the intention of developing an information or labelling program.
- the industry is asked to operate a publicly available listing for remote commercial display cabinets;
- a cost-benefit analysis is undertaken of labelling and information options.

Information Programs: Design and Construction of Cool Rooms

It is recommended that a best practice information program is implemented, including design guidelines, performance yardsticks and case studies, which targets key sectors using cool rooms. It is suggested that this is undertaken through a joint approach with appropriate sectorial trade and industry associations, in order to ensure wide-scale and focussed dissemination.

Financial Incentives

It is recommended that the UK capital allowance facility should be monitored once it is operational to determine whether a similar approach could be taken in Australia in due course, particularly if other programs prove insufficiently effective.

Greenhouse Gas Reduction Potential

By 2015 the total greenhouse emissions attributable to remote commercial refrigeration are estimated to rise to 8.7 Mt CO_2-e per annum. Some benefit will be gained by the introduction of MEPS on lighting ballasts, due for implementation in 2002, estimated at 170 kt CO_2-e per annum by 2015.

Based on the technical potential examined during this study, the additional greenhouse gas reduction potential is 2.1 Mt CO_2-e per annum by 2015.

To estimate the impact of the proposed MEPS on greenhouse emissions requires information on the performance of the range of products currently available on the market, however sufficient information has been unobtainable. After consideration of overseas experience, it has been assumed that MEPs will achieve 30% of the technical potential savings, ie. approximately 630 kt CO_2-e by 2015.

1. PURPOSE

The Australian Greenhouse Office as part of the National Appliance and Equipment Energy Efficiency Program (NAEEEP) has commissioned this report. The purpose of this report is to explore the potential for energy and greenhouse savings through improvements to remote commercial refrigerating equipment used in retail and service businesses in Australia.

2. SCOPE

This report describes the major commercial refrigeration technologies and products currently used in Australia and their characteristics. Only technologies which are defined as 'remote' are covered by the report. These are systems comprising compressors and condensing equipment for cooling rooms or large spaces, such as cool storage rooms, or for providing refrigeration services to other locations, for example supermarket display cases. This category includes the following:

- Walk-in storage and freezer rooms, and display cases, for example in supermarkets and other food retail and beverage outlets;
- Cool Rooms in Clubs, Pubs & Hotels, Butchers, and other food preparation and service industries.

Not included are refrigeration equipment used in processing industries, such as abattoirs and dairies.

The report examines the current market for these technologies and identifies developments which may have a significant influence on energy consumption and greenhouse emissions. It describes existing energy standards applying to remote commercial refrigeration technologies in Australia, and those in force overseas, together with relevant test methodologies. Significant programs other than regulation, such as labelling, are also identified.

Based on these findings, the report makes recommendations for Australian minimum energy performance standards for the following products:

- Remote Commercial Refrigerated Display Cabinets and Merchandisers.

3. PRODUCT DESCRIPTION

For the purposes of this study, there are two major categories of commercial refrigeration systems. This report focuses on **Remote Systems**: those comprising compressors and condensing equipment for cooling rooms or large spaces, such as cool storage rooms, or for providing refrigeration services to other locations, for example supermarket display cases. A feature of these systems is that they are designed for the specified task and comprise a number of components which are selected and purchased individually.

The second category is **Self-contained Systems:** those which have integral components and are designed to plug into an available electricity supply. They are typically mass produced rather than designed for a specific end-user. This category includes refrigerator vending machines, deli cases, food and beverage merchandisers, ice machines and water coolers. This category is the subject of a separate report [MEA, 2000], and is not considered in depth in this report. However, information is provided where appropriate for the purpose of comparison.

The following section describes in more detail the major product categories with remote refrigeration systems. While this is not exhaustive, it covers those products responsible for the majority of refrigeration energy consumption within this category in Australia.

3.1 Applications

Major applications for remote systems include supermarkets, food preparation and vending premises, clubs, hotels and pubs. In most of these, additional refrigeration is provided in the form of self-contained units, however the large majority of refrigeration energy consumption is provided by remote systems. Supermarkets account for a substantial proportion of commercial refrigeration, and are therefore described separately from other applications using remote technologies, below.

3.2 Large supermarkets

Supermarkets generally have on-site storage facilities for foodstuffs, including facilities to stock delivered refrigerated and frozen foods prior to transfer to the store. Within the store, customers use a variety of display cases for self-service.

3.2.1 Storage

These are walk-in rooms designed for low temperature storage and generally comprise insulated walls and door sealing to maintain temperatures. They may be designed to provide direct access to the rear of in-store merchandisers to facilitate stocking.

3.2.2 Display Cases

Types of display cases include:

- Glass door merchandisers;
- Open shelved units;
- Floor level coffin or aisle fridges and freezers;
- Deli display cases.

These cases include an expansion valve, one or more evaporators and evaporator fans for circulating cold air and/or providing an air curtain in open cases. Many evaporators require periodic defrosting, usually done by an electric resistance heater.

Display cases usually include insulation in exterior panels, between 1.5 – 2 inches thick (37 – 50 mm), and where glass doors are used, these may have two or three layers of glass to reduce heat transfer. Doors may be fitted with anti-sweat heaters to prevent frozen door seals and glass heaters to reduce condensation. Most cases include lighting, typically fluorescent, to illuminate products on display.

3.2.3 Refrigeration Equipment

Most supermarkets have a number of compressors, from 10 to 20, in the 3 hp to 15 hp range (2.2 kW - 11.2 kW) designed to handle part-load conditions efficiently. The system will include one or more condensers, often roof mounted, and a heat recovery heat exchanger, connected to the supermarket's HVAC system. Air-cooled condensers are used in the majority of cases, although some systems use water-cooled or evaporative condensers. Refrigerant is pumped through the system and to the display cases in the store.

3.2.4 Energy consumption

According to industry sources, the average annual consumption for a large supermarket in Australia is 937 MWh. Of this, compressors and condensers typically account for nearly 60%, display cases account for approximately 35% and the remainder is used in self-contained units.

Table 1: Average Energy Consumption for Large Supermarkets

Large Supermarkets	KWh/a
Central System	551,893
Display Cases	338,257
Self-contained	46,850
Total	*937,000*

The distribution of annual energy consumption in display cases is shown in the following table.

Table 2: Distribution of Energy Consumption in Supermarket Display Cases

Supermarket		Evap. Fans	Antisweat Heaters	Electric Defrost	Lights
Cases	-	-	-	-	-
Medium Temp Cases	Multideck Meat	48%	18%	13%	21.0%
	Other Multideck	41%	-	-	59%

Low Temp Cases	Reach-In	15%	53%	6%	26%
	Single Level Open	24%	56%	20%	0%
Medium Temp Walk-ins	Meat Coolers	74%	-	16%	10%
	Other Coolers	83%	-	-	17%
Low Temp Walk-ins	-	70%	-	21%	9%

Source: US DoE, 1996

3.3 Walk-in Cool Rooms/Freezers in Clubs, Pubs & Hotels, Butchers, etc

Facilities with walk-in cool rooms generally have dedicated refrigeration systems. The scale of system will depend upon the type of application and size of operation. For example, the systems required for large clubs and catering facilities will be considerable larger than those for butchers and pubs. In some cases, complete warehouses or research laboratories may be constructed as a walk-in cool room, using standard components, although this is rare in Australia in the commercial sector. Generally systems start with a compressor size of approximately 1.5 hp and range up 5 hp (1.1 kW – 3.7 kW).

Typically, walk-ins, comprise a compartment with a condenser, compressor, evaporator and controls, and this is often housed within an existing building. This type of system is limited to those with a compressor size less than 3 hp (2.2 kW).

Walk-ins may be standard packages or designed and constructed to suit the customers, based on standard components. Larger walk-ins may use a split system, with the condenser and compressor located outdoors in order to minimise heat and noise. Lower ambient outdoor temperatures, also make this configuration more efficient.

Wall and ceilings are typically insulated with three to four inches (75 mm to 100 mm)of blown polyurethane foam and, in freezers, insulation is often included in the floor. Freezers usually have anti-sweat heaters on the doors. Where one wall provides access to merchandisers, glass doors are constructed of several layers of glazing. Most walk-ins have lighting inside, although the quantity will depend upon the application.

Most end-users will also have some self-contained units to provide additional refrigeration. For example, this might include glass door merchandisers or reach-in fridges.

3.3.1 Energy consumption

Typical walk-in freezers are estimated to consume approximately 15,500 kWh per year, and typical walk-in refrigerators approximately 42,300 kWh/yr. The distribution of this consumption by component is shown in the following table.

Table 3: Distribution of Energy consumption in Walk-in Cool Rooms

-	-	Compressor	Evap. Fans	Condenser Fans	Anti-sweat Heaters	Electric Defrost	Lights
Walk-in Freezer	Storage only	57%	10%	13%	13%	4%	2%
Walk-in Cooler	Merchandiser	53%	17%	20%	6%	-	4%

Source: US DoE, 1996

4. ENERGY CONSUMPTION SUMMARY: ALL PRODUCTS

This section summarises the total energy consumption by remote commercial refrigeration systems in Australia. In the absence of authoritative data, a number of approaches have been taken to estimate total consumption for this study.

Typical energy consumption from remote products has been estimated for each business type, and this has been multiplied by the number of each category of business in Australia. The assumptions used are shown in Table 4. In addition, to account for other businesses which have a minor refrigeration load, a further 10% of all refrigeration consumption has been added. This method provides an estimated total consumption of 4,000 GWh/yr.

It should be noted that the total energy consumed by remote products is estimated to be approximately 64% of the total commercial refrigeration consumption, including self-contained technologies.

The second method used is based on the stock of remote refrigeration systems. Estimates of typical consumption per product have been made (see previous Section), and these multiplied by the total stock of each product provided by industry sources where possible. As above, in order to account for other remote system products, a further 10% of all remote system refrigeration consumption has been added. This method provides an estimated total consumption of 4,400 GWh/yr.

4.1 By Business Type

It is estimated that many business types within the food services industry use remote refrigeration units. The average consumption by business type is provided below. The number of business types is derived from information provided by ABS and a number of trade associations [ABS, 2000]

Table 4: Total Energy Consumption by Business Type, Remote Commercial Refrigeration

	Av Energy Consumption per Business	Total Energy Consumption Per Business Type	% of Total Commercial Refrigeration (self-contained and remote)
	kWh/a	**GWh/a**	**%**
Supermarkets: Lg	890,150	1,247.8	95.0%
Supermarkets: Md	223,316	313.1	70.0%
Supermarkets: Sm	31,041	43.5	55.4%
Clubs:Lg	175,014	372.4	90.0%
Clubs:Sm	46,670	99.3	60.0%
Grocery Stores	23,281	140.2	72.1%
Take-aways	0	0.0	0.0%
Service Stations: Lg	90,670	363.1	60.0%
Service Stations: Sm	0	0.0	0.0%
Bottle Shops	45,620	84.9	70.0%
Fresh Meat, Fish & Poultry	43,368	239.1	82.8%
Pubs	42,653	245.8	70.0%
Café's Restaurants	23,000	494.3	48.8%
Institutions	0	0.0	0.0%
Other	0	364.4	63.9%
	148,617	**4,007.9**	**63.9%**

It should be noted that consumption is spread over approximately 55,000 individual businesses across Australia. Particularly intensive categories include large and medium sized supermarkets, large service stations and large clubs. As shown in the table below, these 9,000 businesses account for 2,300 GWh, or 58% of the total consumption.

Table 5: Total Energy Consumption by Business Type, Remote Commercial Refrigeration

Business Type	Total Energy Consumption (GWh/a)
Supermarkets: Lg	32%
Supermarkets: Md	8%

Supermarkets: Sm	1%
Clubs:Lg	9%
Clubs:Sm	2%
Grocery Stores	3%
Service Stations: Lg	9%
Bottle Shops	2%
Fresh Meat, Fish & Poultry	6%
Pubs	6%
Café's Restaurants	13%
Other	9%

4.2 By System Type

Remote refrigeration systems have been classified in types, ie by size of condenser, or by element, eg. display cases. The average energy consumption for each element has been calculated based on industry sources. Multiplied by the stock, this provides an estimate of total energy consumption, broken down by major elements. See table below.

Table 6: Total Energy Consumption by Product Type, Remote Commercial Refrigeration

Product Type	Total Energy Consumption
Compressors - up to 2.5HP	39%
Display Cases	35%
Compressors - 3015HP	15%
Fans	3%
Packaged systems - up to 2HP	2%
Other remote systems	6%

4.3 By End-Use Refrigeration Components

Based on examples from the US for the allocation of consumption by product type to components within refrigeration systems, the total consumption of components used in Australia for remote systems has been calculated. Compressors account for nearly half of all consumption, with condenser and evaporator fans accounting for over 35%. Lighting uses approximately 12% of total consumption. This information is summarised below.

Table 7: Total Energy Consumption by Refrigeration Components

Component Type	Total Energy Consumption
Compressors	46%
Evap Fans	18%
Condenser Fans	18%
Lights	12%
Antisweat Heaters	4%
Electric Defrost	2%

4.4 Energy Consumption Trends by Product

Section 3 of this report includes information on average energy consumption by product category in 2000.

Since no authoritative historical information has been forthcoming on previous consumption trends, it has not been possible to estimate future trends on this basis. It is noteworthy that a recent study for the UK Government suggested that there was little reason to factor in future savings due to naturally occurring technology improvements [Tait, 2000]. While we have no firm evidence to dispute this assumption, we consider that the high level of imported products in Australia is more likely to lead to in increased product efficiency. This may, for example, occur as a result of overseas regulations stimulating technological improvements imported into Australia.

As a result, we have assumed an annual efficiency improvement of 0.5% for each product category for the period 2000 to 2015. We recognise that this approach may underestimate the total energy consumption due to commercial refrigeration, and the impact of energy saving measures.

5. SCOPE FOR ENERGY EFFICIENCY

5.1 Working Fluids

Refrigerants are the *working fluids* in refrigeration systems. They absorb heat from one space, such as a cold room, and reject heat into another space, such as the outdoors. The absorption and rejection processes are generally evaporation and condensation respectively.

CholoroFluoroCarbons (CFC's) and HydroCholoroFluoroCarbons (HCFC's) have been the dominating working fluids in refrigeration systems since the 1950's. Due to the ozone depleting properties of these and other man-made fluids containing chlorine and/or bromine the Montreal Protocol was established in 1987 to effect an schedule for the reduction and phase-out in production and consumption of ozone depleting substances. In recent years the most pressing issue has been the search for new and environmentally acceptable working fluids that can replace the CFC's and HCFC's. Ammonia, a natural working fluid, has had a continuing use in the industrial and commercial refrigerant market because of its known properties and ability for cold room applications but needs competent specialist to install, operate and maintain

Most of the alternative working fluids are new, *synthetic compounds*, namely HydroFluoroCarbons (HFC's), which have little or no ozone-depleting potential (ODP). Although these new compounds have been extensively tested with regard to toxicity, flammability etc., they are foreign to nature. Widespread use of these fluids will always include *a risk* of unforseen global environmental effects, as has already been experienced with the CFCs and HCFCs. The HFCs have relatively strong greenhouse gases with Greenhouse Warming Potentials (GWP) ranging from 1,300 to 3,800 for the most common HFCs.

Natural working fluids – The main alternative to the HFCs is to apply naturally occurring and ecologically safe substances, such as ammonia, hydrocarbons, carbon dioxide, water and air. As a result, all uncertainties and potential negative effects on the global environment will be eliminated. However, some of the natural working fluids are either flammable or toxic, and the growing acceptance of the TEWI (Total Equivalent Warming Impact) as the measure of a working fluid's contribution to global warming, is placing greater emphasis on applying natural working fluids are to build safe and reliable systems which are able to compete with conventional HFC systems with regard to energy efficiency and first costs.

5.2 Supermarket Remote Equipment

The following measures apply to the remote condensers and compressors used in large supermarkets.

- ***Evaporative Condensers***

Using evaporative condensers, to replace air-cooled condensers, results in a lower heat sink temperature. This allows a lower head pressure or a smaller condenser. However compared to conventional condensers, these products have a higher capital cost, require more maintenance and water consumption.

- ***Floating Head and Very Low Head Pressure***

Use of electronic expansion valves allow a reduction of head pressure, allowing lower condensing temperatures.

- ***Ambient and Mechanical Subcooling***

Cooling of the condensed high-pressure refrigerant increases the capacity of the refrigerant, thereby reducing the flow-rate required and the compressor load.

- ***Variable Speed Drives***

Variable speed drives for compressors allow for greater flexibility in meeting part refrigeration loads.

- ***Engine-Driven Compressors***

Switching from electric motors to engine-driven open compressors may also achieve savings, depending upon the size and configuration of the project. Where gas fuelled engines are used, there may also be substantial savings in greenhouse emissions.

It should be noted that installation and maintenance costs for engines tend to favour larger installation. Current practice is to use racks of smaller electric motor compressors in order to meet part-loads efficiently. Engines, however, have good variable-speed capabilities.

5.2.2 Display Cases

The following measures apply to supermarket display cases.

- ***High Efficiency Fan Motors***

Most fans used are of the single-phase shaded-pole type, which are relatively inefficient compared to permanent split capacitor (PSC) or electronically commutated (ECM) types. As shown in the table below, switching from shaded-pole type to PSC type motors can result in savings of 50% - 60%. Savings of 70% - 80% can be achieved by switching to ECM type motors.

Table 8: Comparative Energy Consumption of Different Types of Electric Motors

Motor Output (W)	Shaded-Pole (W)	PSC (W)	ECM (W)
6	40	15	8.5
9	53	21	12.5
15	75	33	20.5
20	90	42	27
25	110	51	33

Source: US DoE, 1996

It should be noted that there is a significant cost increase associated with ECM motors at the present time, which make them prohibitive. Since PSC type motors are considerable cheaper, and the bulk of savings can be gained from switching from shaded pole to PSC motors, this appears a more feasible development.

In addition to reduced consumption on fans, switching to more efficient motors reduces the compressor load leading to further energy savings, estimated to be approximately 60% of the motor savings.

- ***High Efficiency Fan Blades***

Typical fan blades used in refrigeration systems have an efficiency rating of around 40%. This could be improved by better design, resulting in savings of approximately 15% of fan power at low additional cost.

- ***Hot Gas Defrost***

Instead of using an electric resistance coil to ensure evaporator coils do not get covered in ice layers, the discharge gas from the compressor is piped through to the evaporator.

- ***Anti-Sweat Heater Controls***

Use of anti-sweat heaters, in order to prevent condensation build-up and freezing of door gaskets, can be controlled by switches responding to local dewpoint or humidity conditions. Appropriately placed sensors enable dewpoint measurement, and the heater to be switched off when not required.

- ***Liquid Suction Heat Exchangers***

Use of a heat exchanger in order to cool the refrigerant flow to the evaporator may also achieve savings. Gas leaving the evaporator is passed through the heat exchanger, providing subcooling to the entering liquid.

- ***Insulation***

Reduced thermal losses through the cases can be achieved by increasing the thickness of the insulation used and by using better insulating materials. Increases to the overall case dimensions are often limited by available space, so that any increase in the thickness of insulation will impact on the interior storage space available for storage.

Alternative or additional reductions may be achieved by replacing the blown polyurethane with better insulation material or improving the blowing techniques.

- ***Lighting***

Units typically use 38mm fluorescent lamps and magnetic ballasts. Heat emitted from lighting adds to the refrigeration loads, therefore by reducing lighting losses, compressor loads can also be reduced. It should be noted that MEPS for ballasts are to be introduced in 2002, which will lead to reductions in lighting consumption estimated to be equivalent to between 10% and 15%. Additional savings due to lower compressor loads will also result [US DOE 1996]. Further savings could be achieved by using T-8 or T-5 tubes.

5.3 Walk-in Cool Rooms

The following measures are generally applicable to all walk-in cool rooms, ie. both refrigeration and freezer units. The general principles of these have been described above. One additional measure is described here.

- Hot Gas Defrost (see above for description);
- Increased Insulation (see above for description);
- Floating Head Pressure (see above for description);
- Ambient Subcooling (see above for description);
- High Efficiency Fan Blades (see above for description);
- High Efficiency Fan Motors (see above for description);
- Anti-Sweat Heating Control (see above for description);
- Hot Gas Anti-Sweat Defrost (see above for description);
- External Heat Rejection (see below for description);

- ***External Heat Rejection***

Where cool-rooms are installed within a building and waste heat rejected into the building interior, savings can be achieved by relocating the condenser unit on the exterior of the building. The lower external ambient temperature improves the performance of the condenser and further potential saving in HVAC energy consumption in the building are made because the source of heat gain within the building is removed.

5.4 Summary of Energy Saving Potential

The following table shows the estimated energy saving potential by product (the "technical potential"), based on overseas experience and discussions with the industry in Australia. This is not necessarily the maximum potential saving, but is limited to measures with a probable payback equal or under five years.

Table 9: Summary of Energy Saving Potential

Technology	Maximum Energy Saving Potential (%)
Large Supermarket Remote Equip	15%
Large Supermarket Cases	21%
Walk-ins	35%

It should be noted that industry sources indicate that the most efficient display cabinets do cost more than basic models, and this is similar for some of the other components in remote systems. However, good system design does not necessarily require additional costs. Many customers in this market currently tend to purchase on the basis of 'first cost', rather than looking at the returns available through investment in efficient technology. While this may be partly due to competition for capital, it is likely that the low level of information available to customers and specifiers at the time of purchase is also a contributory factor.

6. IDENTIFICATION OF STAKEHOLDERS

This section identifies organisations which are considered stakeholders in commercial refrigeration. Those stakeholders which are common to all applications and products are listed first. Stakeholders for particular products are then listed separately. Contact details for stakeholders are provided in Appendix H.

6.1 All Categories

- Electricity utilities;
- Site owners;
- Commercial Refrigerators Manufacturers Association;
- Australian Retailers Association;
- Retail Confectionery and Mixed Business Associations;
- Australian Supermarket Institute;
- Australian Association of Convenience Stores;
- National Association of Retail Grocers of Australia (representing small operators);
- Refrigeration Air Conditioning Contractors Association (RACCA);
- Australian Soft Drink Association;
- Commonwealth/State/Territory energy agencies.

6.2 Display Cases, Glass Door Merchandisers & Refrigerated Food Displays

Supermarket Chains

Manufacturers

- Austral;
- Orford;
- Williams;
- Spillsbury Windsall;
- Arcus (WA);
- Fridgright;
- McAlpine Hussmann.

Importers

- Skope (NZ);
- Kingloc (Caravelle, Ital);
- Comcool;
- Bakers (WA).

Hospitality providers

Installers

7. MARKET PROFILE

There are approximately 260 refrigeration suppliers in Australia with most specialising in a small number of sub markets. In addition, a large quantity of components and finished products are imported. These are discussed further in the Industry Links section. This section provides information on the current stock, and the market for refrigeration products in Australia.

7.1 Cool-Room Condensers

Industry sources suggest that the market for condensing units up to 15 hp (11.2 kW) for remote installations is around 23,500 units, the majority of which will be used to supply refrigeration services to cool-rooms. Some additional specialised units are also sold, although the numbers are small in comparison.

Table 10: Annual Market for Condensing Units

Description	Size	Annual Market
Condensing Units	Up to 2.5 hp (1.8 kW)	19,700
	3 to 15 hp (2.2 – 11.2 kW)	2,500
Package Systems	Up to 2 hp (1.5 kW)	1,400

Source: Industry

Based on an average lifespan of 10 years, the stock is estimated to be approximately 240,000 units.

7.2 Display Cases

Little information is available on the market for remote display cases, however, based on the number of businesses where they are installed, an annual market of 6,000 units is estimated. Display cases tend to be replaced before the natural lifespan for cosmetic reasons, and industry sources estimate an average lifespan of six years. This suggests a total stock of 36,000 units.

Display case manufacturers include:

- Austral;
- Fridgright;
- McAlpine Hussmann.

7.3 Sales Trends

Most industry sources confirm that sales have grown substantially over the past 5-10 years and consider it likely this trend will continue.

The estimated rate of both historical and projected growth varies between different product categories however there is considerable agreement on the factors that are currently causing increases in sales. The relative impact of these factors varies for each product type, and in some cases there are geographical or other issues which play a role. In general, the drivers for increased sales include:

- Growth in the overall volume of refrigerated food sales;
- An increase in the choice of refrigerated foods (product lines) available on the market. A specific example is the advent of the flavoured milk market;
- An increase in the number of producers of refrigerated foods;
- An increased focus on health issues in food retail, including an increase in policing of existing regulations regarding the temperature for storage and display of foodstuffs.

Further issues which may have a future impact on refrigeration consumption include developments by foodstuff product manufacturers to:

- Expand the number of frozen products generally available;

- Supply chilled bottled drinks in supermarkets.

Industry sources suggest that these factors will continue to drive increases in sales for most commercial refrigeration products by at least 10% per annum. Ice makers, vending machines and ice cream displays may be approaching saturation and their growth is estimated to be substantially lower. The table below shows the estimates used for product sales growth in the period 2001-2015, divided into two periods. It is considered likely that growth will tend to slow towards the end of this period, as available outlets and space becomes constrained.

Table 11: Estimated Growth Rates, 2001-2010

Technology	Growth Rate 2001-2009	Growth Rate 2010-2015
Large Supermarket Remote Equip	8%	5%
Large Supermarket Cases	9%	6%
Walk-ins	9%	6%

These estimates are similar, though slightly more conservative, to those produced by the UK Government for refrigerated retail display cabinets [Tait, 2000]. Annual growth from 1985 to 1995 was recorded at over 25% in the UK; and is predicted to fall from 15% pa in 1997 to 2% by 2010.

8. INDUSTRY LINKS

8.1 Compressors, 1999 Imports

We estimate that the annual market for condensers is around 23,500 units. The market for compressors is assumed to be a similar number, the majority of which will have a power rating below 3.75 kW and are imported. Data on the country of origin of this category of compressor, provided by ABS based on statistics provided by Australian customs classification, is provided in the table below. (It should be noted that the majority of products in this category were used in production of domestic refrigerators, freezers and air conditioners).

Table 12: County of Origin for Major Supplies of Imported Compressors *(Sealed motor type compressors of a kind used in refrigerating equipment (excl. for automotive air conditioners) not exc 3.75 kW)*

Country	Percentage
Brazil	39%
Korea, Republic of	8%
Singapore	42%

8.2 Other refrigeration Products, 1999 Imports

Data on other refrigeration products imported during 1999 is presented in the table below. Note this includes some self-contained products.

Table 13: Number of Imported Commercial Refrigeration Products

Category	Quantity
Refrigerator freezing chests, cabinets, display counters, show-cases and similar refrigerating or freezing furniture	5,977
Refrigerating or freezing chests, cabinets, display counters, show-cases and similar refrigerating or freezing furniture (excl. refrigerators)	6,657
Other refrigerating or freezing chests, cabinets, display counters, show-cases and similar refrigerating or freezing	21,367

furniture

Based on information on the estimated market in Australia for each product type, the proportion of imports has been calculated and is shown in the following table.

Table 14: Estimated Proportion of Imported Commercial Refrigeration Products

Category	Total Sales	Imports (1999)	% Imports
Refrigerator & freezing chests, cabinets and displays	50,750	34,001	67%

8.3 Country of Origin and historical Trends for Imports

The following tables show the major country of origin for imported products, together with import supply trends, for most product categories [ABS 1999].

Table 15: Country of Origin for Imported Refrigerator Freezing Chests, Cabinets, Display Counters, Show-cases and similar Refrigerating or Freezing Furniture.

Country	Percentage
China	23%
Finland	6%
Germany	9%
Italy	11%
New Zealand	29%
Thailand	6%

Table 16: Country of Origin for Imported Refrigerating or Freezing Chests, Cabinets, Display Counters, Show-cases and similar Refrigerating or Freezing Furniture (excl. Refrigerators)

Country	Percentage
Denmark	69%
Italy	8%
USA	16%

Table 17: Country of Origin for Other Imported Refrigerating or Freezing Chests, Cabinets, Display Counters, Show-cases and similar Refrigerating or Freezing Furniture

Country	Percentage
China	13%
Denmark	39%
Hong Kong	5%
Italy	17%
Thailand	6%
USA	6%

Table 18: Import Trends for Commercial Refrigeration Cabinets

Year	Totals
1989	3897
1990	5637
1991	20935
1992	20665
1993	11987
1994	8337
1995	10590
1996	12304
1997	11278
1998	14592

9. STANDARD DEVELOPMENT

9.1 Current Australian Standards

Standards Australia advises that there are no standards applying to refrigeration technologies or products which currently include an energy performance standard.

AS 1731-1983, “Frozen Food Retail Cabinets” applies to refrigerated cabinets for the retail sale of packaged frozen foods. It provides for two climate classes, for use where the ambient temperature will not exceed 25°C (e.g. a naturally mild climate or a fully and continuously air-conditioned store) and for use where the ambient temperature may exceed 25°C but will not exceed 32°C. It specifies requirements for construction and performance and prescribes uniform procedures for determining the performance and capacities of such cabinets. Further details are included in Appendix A.

This Standard is currently being re-drafted by Standards Australia/Standards New Zealand Committee ME/8, *Refrigerated Display Cabinets*. It has been put forward to the International Standards Organisation (ISO) that they should similarly adopt this Standard.

The current drafts are made up of a twelve-part series, based on British Standards BS EN 441 (see Appendix B), and covers retail chiller cabinets as well as retail freezer cabinets, using either self-contained or remote refrigeration technologies. It is our understanding that, without further extension of its scope, it will not cover:

- Supermarket equipment, excluding cabinets;
- walk-in storage (cool rooms) and freezer rooms;

The draft standard prescribes a methodology for undertaking energy consumption tests for units with or without integral condenser units (Part 9). It provides for six climate classes. However, no energy performance standard is prescribed for either remote or self contained cabinets.

Part 2 describes the information requirements of the marking plate, to be attached to each cabinet. There is currently no requirement to include energy consumption information with each product.

The current drafting process of this standard provides an opportunity to include requirements for energy performance standards and consumption information for these important categories of products.

We have found no specific regulations in place in Australia governing the design of cool rooms, which might encourage energy efficiency. Industry sources suggest that guides, such as those produced by ASHRAE, are often used as a reference.

9.2 Summary of International Standards and other Programs

A number of countries have implemented standards for commercial refrigeration products.

9.2.1 Canadian Standards

Canada has standards applicable to the following remote products:

- Commercial Refrigerated Display Cabinets and Merchandisers (C657-95),

This prescribes a minimum energy performance standard and test methodology, with reference to ASHRAE testing methods. The energy standard is expressed in terms of energy consumption over a day, per unit length or volume. More details on the Canadian Standards are provided in Appendix D.

9.2.2. United States

Although the United States does not currently have minimum energy performance standards, there are a number of national standards applicable to commercial refrigeration technologies, which provide energy consumption test methodologies. These have been developed by the American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE) and the American National Standards Institute (ANSI), and cover open and closed refrigerated cabinets and beverage vending machines.

See Appendix E for further information.

It is understood that energy performance standards for commercial refrigeration products are being considered in the United States.

9.2.3 South African

South Africa has a standard applicable to remote and self-contained commercial refrigerated food display cabinets (SABS 1406:1998), including frozen food storage (Type A), fresh food and liquids (Type B) and ice-cream storage (Type C). The standard sets a test methodology and a minimum energy performance standard, based on the gross capacity of the cabinet. The same energy performance standard applies to all cabinet types. See Appendix F for further details.

9.2.4 European and International Standards

EN441 (1995, updated in 1999) has now been issued as a Europe-wide standard for the comprehensive testing of refrigerated display cabinets, and is very widely used throughout the industry. This Standard specifies terminology, general mechanical and physical requirements, test conditions as well as installation, maintenance and users guide for refrigerated display cabinets for the sale and/or display of food products. This Standard does not cover refrigerated vending machines or cabinets intended for use in catering or similar non-retail appliances.

Part 9 of EN 441 specifies the method of measuring the consumption of electrical energy for refrigerated display cabinets. See Appendix B for further details. This Standard and its associated series are currently being used as the bases for the draft to replace the current Australian Standard AS 1731—1975.

Other test methodologies for commercial refrigerated cabinets include ISO 1992-6, which is summarised in Appendix C.

It should be noted that the EC has indicated that commercial refrigeration equipment will be the subject of minimum energy performance standards or negotiated agreements for energy efficiency [CEC, 2000]. No details are currently available on which of these approaches will be adopted but there is a commitment to proceed with standards if voluntary programs are not agreed with the industry.

9.3 Voluntary Programs

9.3.1 European Labelling & Financial Incentive Programs

A technical methodology to determine energy labels for integral and remote cabinets has been defined, drawing upon data generated by the existing operational EN441 testing standard. This has been proposed as the basis for a Europe-wide labelling scheme. EUROVENT, the industry organisation in

Europe, operates a voluntary certification program for remote display cabinets, providing data on key characteristics participating products. Tested according to EN441, energy information provided includes the Refrigeration Electrical Energy Consumption (REC kWh/day) and Direct Electrical Energy Consumption (DEC with 12 hour lighting kWh/day).

The Dutch Government has an operational subsidy scheme for retail refrigeration called STIMECK, which gives subsidies towards cabinets achieving A or B ratings according to the assessment method described above.

The Dutch subsidy scheme covers supermarket refrigeration, including the cooling plant and cabinets. The scheme was set up by three electricity distribution companies, together with NOVEM (the Dutch Energy Agency).

The distributors to subsidise energy saving by DFL 150 (A$ 207) per ton of CO_2 saved (one year basis), which amounts to about DFL 0.08 (A$ 0.11) per kWh.

The whole scheme is now regionally administered. Requests for subsidy must be made by supermarkets to the energy distribution companies. Each energy distribution company will select the ten best requests in their region (with the help of TNO), and subsidise these. Each distribution company has set aside a budget of about DFL 150.000 (A$ 206,850) for this pilot phase.

The UK Government has recently announced an enhanced capital allowance scheme for introduction in 2001, for application to a range of energy efficiency improvements including commercial refrigeration. Under the scheme, companies investing in eligible energy efficiency technologies are able to claim 100% of expenditure against tax in the first year of investment.

Further information is contained in Appendix B.

9.4 Alternative Greenhouse Impact Test Methodologies

The Total Equivalent Warming Impact (TEWI) has been developed as a method of quantifying the total global warming effect of a refrigeration system. TEWI can be used to provide an indication of which of two or more options for refrigeration systems is the most environmentally-friendly in terms of global warming, for the same application. TEWI is not appropriate for comparing refrigeration systems for different applications.

To calculate a 'TEWI factor', the direct impact of any released refrigerant is added to the indirect effect from the energy consumed over the lifetime of the plant. A key point raised by TEWI analysis is thus that the energy consumption of a refrigeration system is usually as, if not more, significant than the effects of the refrigerant itself on the environment.

9.2.6 Summary

There are several well-established national and international test methodologies for energy consumption of refrigerator and freezer cabinets (both self-contained and remote).

Apart from Canada, few other countries have as yet applied minimum energy performance standards to remote commercial refrigeration products, although these are being actively considered in Europe and the United States.

In addition, there is a trend towards voluntary standards, information, marketing and incentive programs for a wide range of commercial refrigeration products.

Evidently at the present time there is a thorough examination of ways to reduce energy consumption from commercial refrigeration technologies, being undertaken worldwide. It is considered that this will result in the development of energy performance standards over the next year or so, which would at that time represent world's 'best practice'. While this should not delay the initiation of a development process for Australian standards, this process should include the monitoring of overseas initiatives in the field of commercial refrigeration.

10. APPROPRIATE MEPS FOR AUSTRALIA

10.1 Background

It is estimated that energy consumption due to all commercial refrigeration is currently at least 6,370 GWh in Australia, and predicted to rise by an average of 4.8% per annum to 2015. This represents greenhouse emissions of over 6.3 Mt CO_2-e in 2000, rising to 11.6 Mt CO_2-e in 2015, and considerable expenditure by Australian businesses.

Energy consumption by remote commercial refrigeration technologies is estimated at approximately 4,380 GWh in 2000, with greenhouse emissions of nearly 4.37 Mt CO_2-e. By 2015, consumption is estimated to have grown to 9,700 GWh, and emissions to 8.7 Mt CO_2-e.

Key features of the market for remote commercial refrigeration technologies are:

- Remote refrigeration technologies are estimated to contribute up to 64% of total refrigeration energy consumption. In a 'business as usual' scenario, consumption is estimated to grow by an average of 5.3% from 2000 to 2015.
- Consumption in remote units is spread across over 55,000 users. However 9,000 of the largest users account for 57% of total consumption.
- A large proportion of finished refrigeration products are imported. Most Australian made products use imported components, such as compressors. There are significant developments in the United States and Europe to increase the efficiency of display cabinets and other remote technologies. MEPS for display cabinets are already in force in Canada and South Africa.
- Technically feasible improvements with a payback under 5 years could save nearly 20% of commercial refrigeration consumption, with large savings available at very small additional costs to the manufacturer. Further savings are possible with longer payback periods.
- However many users make purchasing decisions on the basis of 'first cost' and have little awareness or information of the savings potential available. Neither the existing Australian Standard (AS 1731-1983), nor the proposed standard (Standards Australia/Standards New Zealand Committee ME/8, *Refrigerated Display Cabinets),* require information on energy efficiency to be provided on refrigerated display cabinets.
- Remote technologies generally comprise a number of components which are designed and assembled to form a refrigeration system which suits the customer's requirements. Although some display cabinets are custom built, they are typically semi-standard products. Compressors, condensers, pipework, valves and other components are sized and assembled to meet the overall refrigeration requirements of the customer.
- In terms of the potential for energy efficiency measures with a payback under five years, it is estimated that approximately 55% of total savings would result from improvements to display cases. The remaining 45% of savings would be due to improvements to all the other components, and to the design of the refrigeration system and the refrigerated spaces.

Given the large and growing contribution to greenhouse emissions made by commercial refrigeration, of which more than half come from remote technologies, and the considerable potential for cost effective efficiency improvements, there is reason for Government to play a role in this sector.

MEPS are most appropriate when applied to standard manufactured products, where sample products can be tested and periodically checked. As a result, we do not recommend MEPS for refrigeration systems which are designed and assembled for individual customers.

We also do not consider that it is practical at this stage to introduce MEPS for individual components of systems, other than display cabinets, such as compressors and condensers. These components are available in large numbers from a wide variety of sources, and are used in many applications, some of which would not be classed as commercial refrigeration. As a result the policing and enforcement tasks involved in implementing a MEPS on these components would be extremely onerous and potentially expensive.

MEPS could be applied effectively to display cabinets and this is the area where most international attention in being focussed at present. The evidence that many customers purchase on the basis of 'first costs', despite the availability of products in the marketplace which would provide lower total costs over a short period, suggests that the market is not operating efficiently. As a result, we consider that MEPS on these products would be an appropriate means of removing the worst performing products from the marketplace over time.

Other types of programs may also be appropriate to target those technologies not covered by MEPS, or to achieve higher levels of greenhouse reductions. These are discussed in Section 13.

10.2 Approach to Setting MEPS

The strong international market in commercial refrigeration products and design services suggest that the levels of energy performance adopted by Australia should be approximately equivalent to those used in major markets elsewhere. By moving towards harmonisation, any cost implication should be minimised.

Where new energy performance standards are to be based on overseas levels, and there exist an Australian test methodology, the levels will need to be adjusted to take into account any differences between the test methodology used overseas, and that used here.

Where no Australian test methodology currently exists in Australia, both the energy performance level and test methodology should be based on overseas practices.

Further adjustment may need to be made to energy performance levels adopted by Australia to account for differences in the voltage and frequency of electricity supply between Australia and other countries.

10.3 Recommendations for Remote Commercial Refrigeration

The following energy performance standard and test methodology are recommended for adoption in Australia:

10.3.1 Commercial Refrigerated Display Cabinets and Merchandisers

The recommended minimum energy performance standard is based on the Canadian standard C657-95.

Refrigerated display cabinets are categorised into 8 classes as shown in the table below. For each class, values for the specific energy consumption (SEC) are provided at two evaporating temperatures, where the SEC is the total daily energy consumption associated with operating a unit length of the cabinet (the unit is 1 ft = 0.3048 m).

This establishes a boundary line, and conforming products must have a performance which exceeds the levels indicated by this line.

The test methodologies specified in C657-95 are ANSI/ASHRI 117 for closed cabinets and ANSI/ASHRI 72 for open cabinets, tested at ambient temperatures 23.9 C dry bulb, 17.8 C wet bulb. Specified operating temperatures for tests are -20 C for low-temp applications and 2 C for med-temp applications.

The existing Australian Standard AS 1731-1983 is currently being re-written to cover the equivalent products to C657-95, and provides an energy consumption test methodology. The SEC values contained in C657-95 and shown below are therefore required to be translated to the approximate equivalent values under Australian test conditions.

A preliminary translation has been undertaken and is included in Appendix J. The column presenting the proposed Australian standards in the following tables, show the values for Climate Class 3 only. Information relating to other climate classes is contained in Appendix J.

Table 19: Energy Performance Standard for Refrigerated Display Cabinet and Merchandisers

Class	Description	Evaporating Temp.(^{o}C)	Specific Energy Consumption	
			Canadian (kWh/ft/day)	Proposed Australia (kWh/m/day)
Class 1:	low temperature multideck, two or more air curtains, length of air curtain 1.0-1.3m	-35	11.3	38.6
		-30	11.1	38.0
Class 2:	Medium temperature multideck, single air curtain, length of	-10	6.4	22.6

	air curtain 1.0-1.5m. Cabinet height 1.9-2.1m and depth 0.8-1.2m.	-5	5.5	19.5
Class 3:	Medium temperature multideck, single air curtain, length of air curtain 0.8-1.0m. Cabinet height 1.0-1.4m and depth 1.0-1.2m.	-10	4.4	15.6
		-5	3.6	12.8
Class 4:	low or medium temperature closed multideck, single air curtain behind glass door. Cabinet height 2.0-2.1m and depth 1.0-1.2m.	-30	6.6	22.6
		-5	5	17.8
Class 5:	low temperature, well type self service cabinet, open or closed, with horizontal air curtain, length of air curtain 0.75-0.85m or 1.0-1.2m. Product loading depth 0.3-0.45m	-35	6.1	20.9
		-30	5.1	17.5
Class 6:	Medium temperature single deck self service cabinet with single air curtain, length of air curtain 0.75-0.9m. Cabinet height 0.8-1.01m at the back and 0.7-0.9m at the front. Depth 1.0-1.2m.	-10	3.3	11.7
		-5	2.6	9.2
Class 7:	Medium temperature single deck wall or island type self service cabinet with a perforated product shelf. Class 7 cabinets are dividing into three subclasses on the basis of the width of the display area:			
	a. narrow: 0.75-1.02m	-10	3.5	12.4
		-5	2.7	9.6
	b. medium: 1.03-1.27m	-10	4.9	17.3
		-5	4.1	14.6
	c. wide: 1.28-1.65m	-10	5.2	18.4
		-5	4.3	15.3
Class 8:	low or medium temperature cabinet with a flat or curved front glass and a sliding door service access to the rear. Height 1.25-1.4m, depth 0.95-1.2m. Class 8 cabinets are dividing into two subclasses on the basis of their evaporator coil arrangements:			
	a. fan coil.	-25	5.1	17.5
		-5	1.7	6.0
	b. gravity coil.	-10	1.8	6.4
		-5	0.9	3.2

In line with C657-95, **for remote equipment**, the minimum energy performance standard shall be the total power input to the cabinet plus an allowance for the remote condensing equipment (R_{EC}). Where:

- R_{EC} = Q/ERR x 24/1000
- Q = total refrigeration load per foot (W/ft)
- EER = average energy efficiency of condensing unit, W (See table below)

Table 20: Energy Efficiency Rate for Remote Condensing Equipment

EER Values for R-404a at constant condensing temp of 32.2 C	
Evaporating Temp (C)	EER Value, W
-40	5.2
-35	5.9
-30	6.7
-25	7.6
-20	8.9
-15	10.7
-10	12.4
-5	14.5
0	17.1

The current Australian test applies to cabinets with integral and remote condensers. However, it provides no methodology for calculating the total refrigeration load. It may therefore be appropriate to use the methodology described in ASHRAE 72 and 117.

It should be noted that the class descriptions provided above are based on common products in the Canadian market. Further investigation should be undertaken during the formulation of the Australian standard to determine appropriate classes in the Australian market, and appropriate equivalent energy performance standards.

In addition, consideration should be given as to whether it is appropriate to maintain six climate classes within the test methodology, or whether this should be simplified to the one class, eg. Class 3 which equates to the design conditions for most stores.

10.3.2 Adjustment for Australian Electrical Supply Conditions

The standards recommended above are based on those currently used in Canada, which has a nominal electricity supply voltage of 115 volts. Products designed for use in Australia operate at a nominal supply voltage of 240 volts.

Commercial refrigeration products operating at 240 volts result in fewer losses than the same products operating at 115 volts, and therefore some adjustment should be made to the levels used in Canada in order for the standards to be equivalent.

Enginuity Pty Ltd has calculated that Australian standards should be raised by approximately 6% in order to account for the difference in electricity supply voltages. See Appendix I for an example of calculations.

There will also be some difference resulting from the different frequency of supply in Australia (50Hz) and Canada (60Hz). The impact of these differences will vary for each mechanical device (compressor), and it has not been possible at this stage to quantify the effect without considerable product testing. We therefore suggest that no adjustment is made to the proposed standards to account for frequency differences.

11. GREENHOUSE REDUCTION POTENTIAL

11.1 Greenhouse Emissions

The total greenhouse emissions in 2000 due to remote commercial refrigeration are estimated to be 4.37 Mt CO_2-e. Assuming average sales growth rates and average energy consumption per product category described in previous sections, emissions due to commercial refrigeration is estimated to rise to 8.7 Mt CO_2-e by 2015, as shown in the following table.

The introduction of minimum energy performance standards for lighting ballasts in 2002 will have some impact on direct consumption. Lights currently consume over 560 GWh per annum in all commercial refrigeration products, and it is estimated that ballasts will reduce lighting consumption in products entering the market after 2002 by 10% to 15%. There will be an additional in-direct impact due to reduced heat losses from lights in commercial refrigeration, and an overall reduction in lighting consumption of 20% has been assumed in order to account for this in-direct effect.

The impact of this is estimated to be a reduction of annual emissions in 2015 by 170 kt CO_2-e in remote refrigeration technologies, as shown in the table below.

MEPS on motors apply to three-phase units and are not stringent for smaller products, such as those used in commercial refrigeration systems. Since three-phase motors comprise only a small part of the market in the refrigeration sector, the impact of MEPS on motors is considered negligible.

Table 21: Business As Usual Greenhouse Emissions, and Reduction due to Lighting Ballast MEPS, Remote Commercial Refrigeration

Year	Business As Usual (BAU) CO2-e (kt CO2-e)	BAU with Ballast MEPS CO2-e (kt CO2-e)
2000	4,367.8	4367.8
2001	4,413.6	4413.6

2002	4,494.9	4487.9
2003	4,610.1	4595.8
2004	4,758.3	4736.1
2005	4,938.8	4908.2
2006	5,151.2	5111.7
2007	5,395.4	5346.4
2008	5,671.6	5612.6
2009	5,980.4	5910.6
2010	6,322.4	6241.1
2011	6,715.5	6621.7
2012	7,146.2	7039.1
2013	7,616.2	7494.8
2014	8,127.5	7990.8
2015	8,682.4	8529.3

11.2 Potential for Greenhouse Savings

Based on the technical potential for energy efficiency described in previous sections, should all new sales by 2005 switch to products which provide this level of savings the estimated annual greenhouse reduction would be 134 kt CO_2-e. By 2015 the total estimated reduction in annual emissions would be approximately 2,100 kt CO_2-e, as shown in the following table.

Table 22: Technical Potential for Greenhouse Gas Reduction, Remote Commercial Refrigeration

Year	Business As Usual (BAU) Less Technical Potential for Savings Kt CO2-e	BAU with Ballast MEPS Kt CO2-e)
2000	4,367.8	4367.8
2001	4,413.6	4413.6
2002	4,487.9	4487.9
2003	4,595.8	4595.8
2004	4,736.1	4736.1
2005	4,773.6	4908.2
2006	4,833.9	5111.7
2007	4,916.2	5346.4
2008	5,020.1	5612.6
2009	5,145.4	5910.6
2010	5,291.8	6241.1
2011	5,473.3	6621.7
2012	5,677.5	7039.1
2013	5,904.8	7494.8
2014	6,156.2	7990.8
2015	6,432.6	8529.3

The approximate allocation of these potential savings between the display cases and all other components in remote refrigeration systems is shown below. In this case, "Compressors, etc" stands for energy savings in all components that are not Display Cases.

Table 23: Distribution of Estimated Technical Potential Greenhouse Savings, Remote Commercial Refrigeration

	Percentage
Displays Cases	56%
Compressors, etc.	44%

11.3 Estimated Impact of Minimum Energy Performance Standards

The previous section identified the technical potential for savings in the commercial refrigeration sector. The minimum energy performance standards recommended are not designed to meet this technical potential, but to ensure that the worst performing products are naturally replaced by products with an improved performance.

To estimate the impact of the proposed standards on greenhouse emissions requires information on the performance of a range of products currently available on the market, tested under the proposed test conditions. Since most products are not required to undergo energy performance tests in Australia, this information is not available.

In the absence of this information, and after consideration of overseas experience, it has been assumed that MEPS will achieve 30% of the technical potential savings, ie. approximately 630 kt CO_2-e by 2015 (see table below). There is potential for further emission reduction through more stringent MEPS.

Table 24: Annual Greenhouse Savings, Estimated Impact of MEPS, Remote Commercial Refrigeration

Year	BAU - MEPS (est) kt CO2-e	BAU with Ballast MEPS kt CO2-e
2000	2,185.9	2185.9
2001	2,175.1	2175.1
2002	2,168.7	2168.7
2003	2,176.0	2176.0
2004	2,196.0	2196.0
2005	2,195.4	2228.0
2006	2,204.7	2271.5
2007	2,223.3	2326.1
2008	2,251.0	2391.6
2009	2,287.4	2467.8
2010	2,323.8	2545.2
2011	2,366.9	2631.1
2012	2,410.8	2719.3
2013	2,456.3	2810.7
2014	2,503.2	2905.2
2015	2,552.3	3003.5

Further examination of the level of savings likely to be achieved would be possible with the supply of product specific information from the industry. Alternatively, sample products could be independently tested. It is recommended that the scope for information sharing be pursued during the consultation process with the refrigeration industry in Australia.

12. ECONOMIC IMPLICATIONS

Information received from suppliers of refrigeration systems and units indicates a very low demand for the higher energy efficient equipment. This makes manufacturers of current generation high-energy efficient components reluctant to invest resources to obtain further efficiency gains. In part this is due to the fact that many units are not owned by the purchasing organisations. Until demand is stimulated, business as usual advances in energy efficiency are likely to be lower than required by the Government.

At the same time, considerable savings are feasible, often with minimal additional cost and achieving excellent payback periods. As a result, Australian businesses and consumers are currently being disadvantaged by bearing considerable energy costs over and above those which would be expected in an efficiently operating market.

These circumstances would appear to justify Government market intervention in the form of mandatory minimum energy performance standards for the various types of commercial refrigeration equipment.

In view of the fact that a large proportion of products are imported, either as components for finished products, and the international trend towards greater efficiency in refrigeration products, the impact on manufacturers is likely to be low, particularly given sufficient lead times to adapt.

13. OTHER PROGRAMS

MEPS are designed to remove the worst performing products from the market, however they do not in themselves promote ‘best practice’. In view of the substantial greenhouse savings to be made through adoption of the best performing technologies currently in the marketplace, it is recommended that programs in addition to MEPS are considered.

13.1 Information Programs: Display Cabinets

Currently there is no information provided on refrigerated display cabinets which indicate their energy performance to specifiers and end-users of refrigeration products. This is despite advice from industry sources that there is considerable variation in performance between products.

In Europe, Eurovent, the industry association, operates a certification program, based on EN441 (the standard which is in the process of being adopted in Australia) and a labelling scheme has been developed although it has not been implemented to date (also based on EN441). The Eurovent certificates provide customers with information on the refrigeration electrical energy consumption (REC), and the direct electrical energy consumption (DEC) of tested products.

In the United States, an Energy Star program is being developed for commercial refrigeration products, although this is initially focussed on ‘reach-in’ solid door refrigerators and freezers, which are usually self-contained. An Energy Star program for remote refrigeration systems is unlikely to be developed in the near future.

In general terms, the options for Australia with regard to refrigerated display cabinets appear to include the following:

1. The development of a mandatory labelling program for all products, which takes the proposed MEPS as the lowest level and includes a number of steps.
2. The development of a voluntary labelling program, as above, which is likely to be adopted by manufacturers which have the most energy efficient products.
3. The development of a simplified labelling program, similar to Energy Star, which defines and identifies ‘high efficiency’ products. Such a program could be mandatory or voluntary.
4. The development of a listing of the performance of products measured using the Australian standard, and made available to customers, for example via a website in much the same manner as the EUROVENT information.

5. Waiting for the implementation of a labelling program elsewhere, on which we could base an Australian program.

There are clearly cost ramifications to each of these options, although without a cost-benefit analysis we are not in a position to comment on this issue. However, we make the following general observations:

- In addition to variations in costs of each proposal, the distribution of costs amongst stakeholders may also vary for each proposal.
- A mandatory program will require the development of standard procedures and algorithms, and enactment in legislation. A voluntary program would require the same framework to be developed but would not require legislation.
- Because any program implemented overseas is likely to need to be 'Australianised', option five is more likely to defer costs, rather than save them. In view of this, and the potential level of savings, we do not favour this option.

Option 4 is equivalent to the Eurovent program and is similar to the approach currently taken by the Australian Gas Association (AGA) with respect to domestic gas water heaters in Australia. There is little information available in order to determine whether either program has accelerated the energy performance of products faster than the rate of technological improvements. In our view, option 4 represents a 'minimal' position, however it is also likely to cost the least.

Options 1-3 require considerably more development (than option 4) before they can be implemented. This applies to both voluntary and mandatory programs. We estimate that the long-term impact of implementing a labelling program with a range of ratings would be greater than that resulting from a simplified system like Energy Star. The tasks involved are likely to be only marginally more complicated and lengthy. As a result, if a labelling program is pursued, we recommend a scheme which includes a number of steps, as is the case for domestic refrigeration products.

A further consideration in deciding the way forward is the response from industry to these options. In the process of this study, the industry has not been formally consulted with respect to labelling or information programs. However, it is unlikely that option 4 would be feasible without the co-operation and active participation of industry representative organisations, such as the Commercial Refrigerators Manufacturers Association.

In view of the discussion above, the following recommendations are made:

- That the Government proceed with the intention of developing an information or labelling program.
- That the industry is asked to respond to the specific proposal of operating a listing for remote commercial display cabinets, providing information on energy consumption under standard test conditions. This listing would be undertaken by the industry and promoted on an appropriate website. We note that links could be made with www.energyrating.com.au.
- That a cost-benefit analysis is undertaken of the labelling and information options identified above, (excluding option 4 if the industry provides a negative response) together with any further options put forward by the industry.

13.2 Information Programs: Design and Construction of Cool Rooms

Section 10.1 provides the rationale for not implementing MEPS for remote technology components other than display cabinets. However, these other components contribute significantly towards greenhouse emissions and should therefore be the target for focussed activity.

The design and construction of cool rooms is one area where significant improvement can be obtained, and where many consumers lack information. Purchasers include many medium to small scale food and beverage retail outlets which do not currently have access to information on options regarding the efficiency or running costs of the products they buy.

We recommend that a best practice information program is implemented which targets key sectors using cool rooms. This could include design guidelines, performance yardsticks and case studies. Examples of information provided to professionals and customers include design guides published by ASHRAE in the United States [ASHRAE 1998] and the UK Best Practice Program [EEO 1995].

It is further recommended that this is undertaken through a joint approach with appropriate sectorial trade and industry associations, in order to ensure wide-scale and focussed dissemination.

13.3 Financial Incentives

The Dutch STIMECK scheme and the UK capital allowance facility (to be implemented in 2001) are the only programs we are aware of which provide financial incentives for investment in the commercial refrigeration area.

The STIMICK scheme is operated by the Electricity Utilities partly in recognition of the benefits for load management which can be obtained through improvement to commercial refrigeration. In Australia many areas face network constraints during the summer daytime due to loads from commercial customers. In some cases, refrigeration makes a significant direct and indirect contribution to these loads. As network operators become increasingly aware of these constraints and the costs of augmenting the network, the option of meeting demand through demand management is a strategy being actively considered by network operators and electricity retailers.

We suggest that further exploration of the potential for utilities to provide incentives for demand management activities in general, and in the field of commercial refrigeration in particular, is warranted. One approach would be the Government to work with the Electricity Supply Association of Australia (ESAA) or individual utilities on a trial program to assess the costs and benefits to all parties in refrigeration load management. Such a trial could also involve a major supermarket chain.

Clearly there is no evidence yet of the effectiveness of the proposed capital allowance facility, and it should be noted that commercial refrigeration products are only one set of eligible products amongst many. The changes to the tax system which would be required to implement this program, and similar programs, are unlikely to be cost-effective for less than a number of product categories. At this stage we do not recommend a similar approach, although we suggest that the UK program should be monitored once it is operational to determine whether a similar approach could be taken in Australia in due course, particularly if other programs prove insufficiently effective.

14. IMPLEMENTATION

14.1 MEPS Timetable

It is understood that NAEEEC proposes to recommend to ANZMEC the following target timeframe for the introduction of MEPS, giving industry an appropriate period of notice to undertake any necessary modifications to production procedures. This proposed timeframe may be modified to take into account specific circumstances that may arise not foreseen at this time.

14.1.1 Development Stage	Timetable
Following the publication of this initial plan and a desk-top review of the energy impacts of mandatory and / or voluntary measures, the following steps will occur: An industry expert will work to refine the initial MEPS proposals. Cost/benefit analysis of potential legislative options. Industry and stakeholder consultation on potential legislative proposals. Development of Australian and New Zealand Standards for inclusion in regulations. Ministerial approval required before introduction of any new regulations.	Commenced from July 2000 and completed by July 2002

14.1.2 Notification Stage

Period of notification will depend on the level of manufacture undertaken in Australia. Longer periods would apply if Australian industry required to undertake substantial development or re-tooling	The Australian standard will be published by July 2002 containing the MEPS levels and the MEPS will come into effect from July 2005

14.1.3 Duration Stage

This is the 'stability period' in which no changes to regulations are made (ie MEPS levels unchanged).	Commenced from July 2005 and scheduled for reconsideration by July 2010

14.2 Strategy for public consultation

We understand that stakeholder participation in the process will be mainly through having representation on the project steering committee that NAEEC has established, together with involvement in the normal consultation process undertaken during the Regulatory Impact Statement process.

15. REFERENCES

ABS, 1999 — *Refrigeration products imported from 1989-1999.*

ABS, 2000 — pers.com. Information provided on number of businesses by type.

ASHRAE, 1998 — 1998 ASHRAE Refrigeration Handbook (SI).

BIS, 2000 — *Market Analysis of Refrigerators and Freezers.* Commissioned for NAEEEC.

CEC, 2000 — *Action Plan to Improve Energy efficiency in the European Community*. Communication from the Commission to the Council, The European Parliament The Economic and Social Committee and the Committee of the Region. Brussels, June 26th 2000.

EEO, 1995 — Introduction to Energy Efficiency in Catering Establishments. Published by the UK Energy Efficiency Office, July 1995. See also the following Good Practice Guides: 13, 44, 46, 48, 49, 53, 55, 57, 58, 148, 150, 153, 156.

Elefson, 1995 — *Energy Labelling of Supermarket Refrigerated Cabinets.* TNO Institute of Environmental Sciences, Energy Research and Process Innovation, The Netherlands report R95-164.

MEA, 2000 — *Analysis of Potential for Minimum Energy Performance Standards for Self-Contained Commercial Refrigeration*. Prepared for the Australian Greenhouse Office and the National Appliance and Equipment Energy Efficiency Program by Mark Ellis & Associates. October 2000.

Tait, 2000 — *Overview of Commercial Refrigeration in the United Kingdom*. A sector review paper on Projected Energy Consumption for the Department of the Environment, Transport and the Regions.

US DOE 1996. — *Energy Savings Potential for Commercial Refrigeration Equipment – Final Report*. Produced by Arthur D Little Inc.

APPENDIX A: AUSTRALIAN STANDARD

A.1 AS 1731-1983: Frozen food retail cabinets

A.1.1 Scope

This Standard specifies requirements for frozen food retail cabinets, as defined in Clause 1.4.5. It specifies requirements for construction and performance and prescribes uniform procedures for determining the performance and capacities of such cabinets.

A.1.2 Abstract

Applies to refrigerated cabinets for the retail sale of packaged frozen foods. It provides for two climate classes, for use where the ambient temperature will not exceed 25°C (e.g. a naturally mild climate or a fully and continuously air-conditioned store) and for use where the ambient temperature may exceed 25°C but will not exceed 32°C.

Performance requirements and methods of test are specified, together with other requirements relating to construction, volume and area ratings, and markings. The Standard prescribes an electrical energy test methodology for refrigerated cabinets only, whether it has an integral condenser or a remote condenser.

This Standard was prepared by the Association's Committee on Frozen Food Retail Cabinets to supersede AS 1731—1975, which had itself superseded the original AS B220—1966. AS B220 had been published in response to a request by the Council of Australian Food Technology Associations, and had drawn largely upon BS 3053 and draft DIN 8954.

It is currently being re-drafted by Standards Australia/Standards New Zealand Committee ME/8, *Refrigerated Display Cabinets*. The Current Drafts are made up of a twelve-part series, based on British Standards BS EN 441. Public comment on these documents closed on 31 October 1999

It has been put forward to the International Standards Organisation (ISO) that they should similarly adopt this Standard.

Status: Current

Published: 7 March 1983

Pages: 16

APPENDIX B: BRITISH STANDARD, EU STANDARD & OTHER PROGRAMS

B.1 BS EN 441-9 Refrigerated display cabinets

EN441 (1995, updated in 1999) is a European standard in twelve parts. It has now been issued as a Europe-wide standard for the comprehensive testing of refrigerated display cabinets, and is very widely used throughout the industry.

This Standard specifies terminology, general mechanical and physical requirements, test conditions as well as installation, maintenance and users guide for refrigerated display cabinets for the sale and/or display of food products.

This Standard does not cover refrigerated vending machines or cabinets intended for use in catering or similar non-retail appliances.

Part 9 of EN 441 specifies the method of measuring the consumption of electrical energy for refrigerated display cabinets

This Standard and its associated series are currently being used as the bases for the draft to replace the current Australian Standard AS 1731—1975.

It is equivalent, or though not technically similar to the following ASHRAE standards in the USA:

- ANSI/ASHRAE Standard 72-1983 Method of testing open refrigerators for food stores;
- ANSI/ASHRAE Standard 117-1986 Method of testing self-service closed refrigerators for food stores.

These two standards were compared with EN441 at a meeting of the IIR Sub-commission D1 'Refrigerated Display Cabinets' on 31 March 1998. Amendments to EN441 are now being mooted.

The proposed SAVE energy labelling scheme (Elefson 1995) (see below) makes use of some of the results of testing done under EN441 to provide its basic technical data.

B.2 Energy Labelling & Other Programs

B.2.1 Labelling

A technical methodology to determine energy labels for integral and remote cabinets has been defined (Elefson 1995). The proposed methodology draws upon data generated by the existing operational EN441 testing standard and requires no additional testing, simply arithmetic on the results. EN441 is used throughout the European cabinet manufacturing industry.

The Dutch Government have an operational subsidy scheme for retail refrigeration called STIMECK, (see B.2.3) which gives subsidies towards cabinets achieving A or B ratings according to the Elefson assessment method, modified according to an amendment agreed with EUROVENT/CECOMAF.

The most often heard criticism of the EN441 testing is that it only involves study of the cabinet itself, whereas in the case of a remote cabinet the whole plant affects efficiency. The British Refrigeration Association and large retailers have developed the TEWI (Total Equivalent Warming Impact) factor for quantifying the impact of the whole plant. They advocate TEWI as a more appropriate framework, whilst recognising that it needs further developing. (See below).

The proposed scheme attempts to rank cabinets according to their inherent efficiency, as would be achieved by running them all with a 'standard' remote plant. However, it has been shown that for any given remote plant, the relative efficiency of cabinets will remain the same (ie E-rated cabinet is less efficient than a B-rated cabinet, no matter how good or bad the remote plant). The labels would therefore still perform a useful role in decision-making.

B.2.2 EUROVENT Certification

European Association of Air Handling and Refrigerating Equipment Manufacturers includes fifteen National Associations from the following eleven countries:

- Belgium: FABRIMETAL
- Finland: AFMAHE, FREA
- France: UNICLIMA
- Germany: FG ALT im VDMA
- Great Britain: FETA
- Italy: COAER, ANIMA
- Netherlands: NKI, VLA
- Norway: NVEF
- Spain: AFEC
- Sweden: KTG, SWEDVENT
- Turkey: ISKID

THE PURPOSE OF EUROVENT CERTIFICATION

The purpose of Eurovent Certification Programmes is to create a common set of criteria for rating products. Through specification of certified products, the engineer's tasks are made easier, since there is no need for carrying out detailed comparison and performance qualification testing.

Consultants, specifiers and users can select products with the assurance that the catalogue data is accurate.

COMMON REFERENCE IN EUROPE

The importance and reliability of the European Air Conditioning Industry are clearly demonstrated by the very existence of the voluntary certification programmes established and administered by Eurovent.

Comparison of product performances by third party testing based on well-defined procedures ensures healthy, solid competition within a market, which is open to all manufacturers.

BENEFITS OF CERTIFICATION

The Eurovent Certification provides clear benefits for selection of products and their performance. The end users may have confidence that equipment will operate in accordance with design specifications, the energy cost will be correctly predicted and therefore the supplied product will correspond to the initial investment.

For manufacturers, the Eurovent Certification programmes create a common platform for competition on equal terms based on comparable data.

Finally the image and integrity of the all industry is improved and a better confidence between manufacturers and specifiers is established.

CERTIFICATION PROCEDURES

Participants present performance and construction data for all products or for selected ranges within the scope of the programme. This data is evaluated by the Eurovent Certification Company and certain number of units are selected for testing. If results are satisfactory then products or ranges are listed in the Eurovent Directory. All products are subject to regular random testing to verify compliance with catalogue data.

INDEPENDENT LABORATORIES

Performance testing in the scope of Eurovent Certification is carried out by independent laboratories under contract with Eurovent.

WHAT HAPPENS WHEN THE PERFORMANCE CHARACTERISTICS OF THE TESTED PRODUCTS ARE FOUND OUTSIDE OF THE ALLOWED TOLERANCE?

If a product characteristics falls below value claimed in the catalogue by more than specified allowed tolerance, the participant will be required to rerate not only the tested model but all products in the same basic product range. Participants may otherwise decide to withdraw the product from the market.

HOW TO IDENTIFY EUROVENT CERTIFIED PRODUCT?

Certified products or ranges are listed in the Eurovent Directories, specification sheets, literature and, where appropriate, advertising display the Eurovent Certification Logo.

The Certification Logo guarantees that products have been submitted to independent checking and that they have been accurately rated.

SCOPE OF THE PROGRAMME

This programme concerns the Vertical Chilled Multi-deck (VC2) and Semi-vertical (VC1) Refrigerated Display Cabinets.

DEFINITIONS

Refrigerated Display Cabinets: Cabinet cooled by a refrigerating system which enables chilled and frozen foodstuff placed therein for display to be maintained within prescribed temperature limits.

Internal fitting type: HNLS : Horizontal Non Lighted Shelves & HLS : Horizontal Lighted Shelves ; TNLS : Tilted Non Lighted Shelves & TLS : Tilted Lighted Shelves ; MNLS : Mirror and tilted Non Lighted Shelves & MLS : Mirror and tilted Lighted Shelves (available for vertical only).

Number of shelves: The bottom shelf (well) and the mirror are not taken into account in this number.

M-package temperature class: Classification in test room climate class 3 : 3H2 (-1; +10), 3H1 (+1; +10), 3M2 or 3M1, according to EN441-6 : 1994 (where H class is substitute by H2 and H1 as above defined).

Average heat extraction rate 75% (W): According to EN441-12 : 1997 ; 4,1 NOTE 1, measurement based on 75 % of stabilised period between two defrosts, and mean running time figure to take into account day (12 h) and night (12 h) figures for a complete day if night covers are used.

For cycling running, the measurement frequency of 20' precised in note 2 of EN441-12 ; 4.1 must be respected.

At evaporating temperature (°C): According to EN441-12 : 1997 ; 4,1 NOTE 1, measurement based on 75 % of stabilised period between two defrosts.

REC (kWh/day): Refrigeration Electrical Energy Consumption according to Eurovent/Cecomaf Recommendation for energy consumption evaluation of remote refrigerated display cabinets REC 05 (December 1997).

DEC with 12 h lighting (kWh/day): Direct Electrical Energy Consumption according to EN441-9 : 1994 and Eurovent/Cecomaf Recommendation for energy consumption evaluation of remote refrigerated display cabinets REC 05 (December 1997).

TDA (m²): Total Display Area according to Eurovent/Cecomaf Recommendation for energy consumption evaluation of remote refrigerated display cabinets REC 05 (December 1997).

REFERENCES

Verification of performance characteristics are carried out in accordance with the European Standard EN 441.

EN 441-1 : 1994 and EN 441-1/A1 : 1995 - Terms and definitions

EN 441-3 : 1994 - Linear dimensions, areas and volumes

EN 441-4 : 1994 - General test conditions

EN 441-5 : 1996 - Temperature test

EN 441-6 : 1994 - Classification according to temperatures

EN 441-8 : 1994 - Water vapour condensation test

EN 441-9 : 1994 - Electrical energy consumption test

EN 441-12 : 1997 - Measurement of the heat extraction rate of the cabinets when the condensing unit is remote from the cabinet

Eurovent/Cecomaf Recommendation REC 04 : Standardisation of refrigerated display cabinets - Standard test report - June 1997

Eurovent/Cecomaf Recommendation REC 05 : Energy consumption evaluation of remote refrigerated display cabinets - December 1997

CEN/TC44 N 106 June 1999 General test conditions and test room definition

CERTIFIED CHARACTERISTICS

The following dimensional and performance characteristics are certified :

- M-package temperature class (H2 , H1 , M2 , M1)
- Refrigeration electrical energy consumption (REC)
- Direct electrical energy consumption (DEC)
- Total display area (TDA)

B.2.3 STIMECK: Dutch subsidy program for supermarket refrigeration [Tait 2000]

The Dutch subsidy scheme covers supermarket refrigeration, including the cooling plant and cabinets. The scheme was set up by three electricity distribution companies, together with NOVEM (the Dutch Energy Agency).

These parties have contracted TNO (a Dutch technological institute) and a small engineering firm to set up a scheme for subsidising energy conservation in supermarket refrigeration. The scheme stems from the targets set for the electricity distribution companies to save energy. They have funding for this aim, which originates from a special tax on electricity. There are guidelines which allow the distributors to subsidise energy saving by DFL 150 (A$ 207) per ton of CO_2 saved (one year basis), which amounts to about DFL 0.08 (A$ 0.11) per kWh.

TNO has implemented two frameworks which are both being used:

i) A subsidy on a range of technological measures that can be applied to save energy

ii) A subsidy on energy saved relative to a benchmark set for supermarkets

The subsidy under framework (i) is quite straightforward; if you buy night-covers, electronic expansion valves, strip curtains, evaporative condensers efficient cabinets etc. you can get a fixed amount of subsidy per kW of capacity to which the saving devices apply. 'Efficient cabinets' are defined as those earning energy label A or B according to the SAVE project methodology (Elefson 1995). TNO keeps a list of all options (and equipment models) that are eligible for subsidy.

The subsidy on option (ii) is more complicated. For a supermarket a reference consumption is set (depending on the refrigerated display areas). The energy consumption of the installation is calculated (not measured) by TNO, and the subsidy of DFL 0.08 / kWh saved is given for all savings relative to the reference.

The whole scheme is now regionally administered. Requests for subsidy must be made by supermarkets to the energy distribution companies. Each energy distribution company will select the ten best requests in their region (with the help of TNO), and subsidise these. Each distribution company has set aside a budget of about DFL 150.000 (A$ 206,850) for this pilot phase.

B.2.4 UK Enhanced Capital Allowance Scheme

The UK Government has recently announced an enhanced capital allowance scheme for introduction in 2001, for application to a range of energy efficiency improvements including commercial refrigeration. Under the scheme, companies investing in eligible energy efficiency technologies are able to claim 100% of expenditure against tax in the first year of investment. Eligible refrigeration technologies include:

- Evaporative condensers;
- Liquid pressure amplification systems;
- Automatic air purging systems;
- Refrigeration control systems with energy saving features, including electronic expansion valves, balanced port valves, defrost controls and pro-active controllers;
- Night blinds and strip curtains for retail display cabinets;
- Automated permanent refrigerant leak detection systems;
- Absorption cooling equipment driven by CHP heat.

B.3 Total Equivalent Warming Impact (TEWI)

This is a method of quantifying the total global warming effect of a refrigeration system. TEWI can be used to provide an indication of which of two or more options for refrigeration systems is the most environmentally-friendly in terms of global warming, for the same application. TEWI is not appropriate for comparing refrigeration systems for different applications.

To calculate a 'TEWI factor', the direct impact of any released refrigerant is added to the indirect effect from the energy consumed over the lifetime of the plant. A key point raised by TEWI analysis is thus that the energy consumption of a refrigeration system is usually as, if not more, significant than the effects of the refrigerant itself on the environment.

Since leakage reduces energy efficiency as well as releasing chemicals into the environment, control of leakage is very effective at improving the TEWI rating of a system. It is essential to control refrigerant leakage to minimise costs and environmental damage.

APPENDIX C: INTERNATIONAL ORGANISATION FOR STANDARDISATION

ISO 1992-6: Commercial refrigerated cabinets: methods of test: part VI: electrical energy consumption test

Applicable to commercial refrigerated cabinets intended for sale and/or display of food products. The electrical energy consumption test shall be made in accordance with part 2 of ISO 1992 and on ambient conditions corresponding to the climate class(es) for which the cabinet lighting shall be on continuously during test.

Published: 1974

International Relationships:

BS 6148 PART6- 1981, EQV* NS 4628-1979, NEQ * D74-010(1987/AFNOR)

APPENDIX D: CANADIAN STANDARDS

D.1 C657-95: Energy Performance Standard for Commercial Refrigerated Display Cabinets and Merchandisers

This standard applies to refrigerated display cabinets, both self-contained and with remote compressors. These are categorised in eight classes, as follows:

Class 1:	low temperature multideck, two or more air curtains, length of air curtain 1.0-1.3m
Class 2:	medium temperature multideck, single air curtain, length of air curtain 1.0-1.5m. Cabinet height 1.9-2.1m and depth 0.8-1.2m.
Class 3:	medium temperature multideck, single air curtain, length of air curtain 0.8-1.0m. Cabinet height 1.0-1.4m and depth 1.0-1.2m.
Class 4:	low or medium temperature closed multideck, single air curtain behind glass door. Cabinet height 2.0-2.1m and depth 1.0-1.2m.
Class 5:	low temperature, well type self service cabinet, open or closed, with horizontal air curtain, length of air curtain 0.75-0.85m or 1.0-1.2m. Product loading depth 0.3-0.45m
Class 6:	medium temperature single deck self service cabinet with single air curtain, length of air curtain 0.75-0.9m. Cabinet height 0.8-1.01m at the back and 0.7-0.9m at the front. Depth 1.0-1.2m.
Class 7:	medium temperature single deck wall or island type self service cabinet with a perforated product shelf. Class 7 cabinets are dividing into three subclasses on the basis of the width of the display area: a. narrow: 0.75-1.02m b. medium: 1.03-1.27m c. wide: 1.28-1.65m
Class 8:	low or medium temperature cabinet with a flat or curved front glass and a sliding door service access to the rear. Height 1.25-1.4m, depth 0.95-1.2m. Class 8 cabinets are dividing into two subclasses on the basis of their evaporator coil arrangements: a. fan coil. b. gravity coil.

The standard provides a test procedure, which draws heavily on ANSI/ASHRAI–72. Required minimum energy performance standards for each class are expressed in kWh/ft/day and are provided in the following table.

Table D1: Energy Performance Standard for Commercial Refrigerated Display Cabinets and Merchandisers

Class	Subclass	Evaporating Temp.(°C)	Standard Rating (kWh/ft/day)
1		-35	11.3
		-30	11.1
2		-10	6.4
		-5	5.5
3		-10	4.4
		-5	3.6
4		-30	6.6
		-5	5.0
5		-35	6.1
		-30	5.1
6		-10	3.3
		-5	2.6
7	Width: 0.77-1.02 m	-10	3.5
		-5	2.7
	Width: 1.03-1.27 m	-10	4.9
		-5	4.1
	Width: 1.28-1.55 m	-10	5.2
		-5	4.3
8	Fan	-25	5.1
		-5	1.7
	Gravity	-10	1.8
		-5	0.9

For remote equipment, C657-95 states that the minimum energy performance standard shall be the total power input to the cabinet plus an allowance for the remote condensing equipment (R_{EC}). Where:

- R_{EC} = Q/ERR x 24/1000
- Q = total refrigeration load per foot (W/ft)
- EER = average energy efficiency of condensing unit, W (See table below)

Table D2: Energy Efficiency Rate for Remote Condensing Equipment

EER Values for R-404a at constant condensing temp of 32.2 C	
Evaporating Temp (C)	EER Value, W
-40	5.2
-35	5.9
-30	6.7
-25	7.6
-20	8.9
-15	10.7
-10	12.4
-5	14.5
0	17.1

APPENDIX E: UNITED STATES STANDARDS

E.1 Standard Test Methodologies

Standards appropriate for remote technologies include:

- ANSI/ASHRI 72-1998: Method of Testing Open Refrigerators, and
- ANSI/ASHRI 117-1992: Method of Testing Closed Refrigerators

E.2 Energy Star Program

Energy Star is a voluntary program between the US EPA, DOE and product manufactures, aimed at achieving market transformation. It encourages the manufacture, promotion and use of efficient products, using the Energy Star to identify conforming products in the marketplace.

Energy Star criteria are currently under development for new product areas relating to commercial refrigeration. The initial focus is Reach in Refrigerators and Freezers which are generally self-contained and therefore not applicable here. There is an indication that remote technologies will be included in the Energy Star program in due course, however no firm timetable has been released.

APPENDIX F: SOUTH AFRICAN STANDARD

F.1 SABS 1406:1998 - Commercial refrigerated food display cabinets

Specifies requirements for three types and two climate classes of commercial refrigerated display cabinet for the storage, for sale, of frozen and fresh foods, and liquids in containers, and intended for operation on a three-phase 440 V power supply or on a single-phase power supply not exceeding 250 V phase to neutral.

The energy requirements of this standard are as follows:

F.1.1 Energy Consumption

When a cabinet is tested in accordance with 9.22, the power consumed shall not exceed 0.42 W.h/l of the gross capacity.

F.1.2 Test Conditions

Ensure that defrosting trays, shelves and other fittings are in their normal positions, and that all containers are empty.

Ensure that the voltage and frequency of the a.c. power supply does not differ by more than 1.0% from the specified voltage and frequency.

Use alternating current (where relevant) of nominal frequency 50Hz, and of substantially sine waveform.

Test a three-phase motor that is suitable for both single-phase or three-phase operation, under the most favourable conditions.

Shield the cabinet under test from any air current of velocity exceeding 0.25 m/s.

Operate the cabinet under test for 24 hour at an ambient temperature of 20 ^{o}C +/- 2 ^{o}C before starting any test.

Conduct the tests at a relative humidity in the range 45% to 75%.

F.1.3 Energy Consumption Test

If the temperature controller of the cabinet under test is manually adjustable, set it at its lowest temperature setting and disconnect the heating elements (if any) in accordance with the manufacturer's instructions.

Operate the cabinet until the stable operating conditions have been reached, and from the time of the first convenient cut-in of the temperature controller, measure, by means of a suitable kilowatt-hour meter, the energy consumed over 24 h.

Check for compliance with 8.12

Published: 1998

APPENDIX G: JAPANESE STANDARD

G.1 JRA 4032-1993: Commercial refrigerators, refrigerator-freezers and freezers

Published: 1993

Standards Australia advise that this is only available in Japanese.

APPENDIX H: MAILING LIST (INTERESTED PARTIES)

H.1 Organisations

Australia New Zealand Food Authority

Boeing House, 55 Blackall Street , BARTON ACT 2600

Ph: +61-2-6271 2222, Fax: +61-2-6271 2278

Postal Address: PO Box 7186, Canberra Mail Centre, ACT 2610 Australia.

email: info@anzfa.gov.au

Website: www.anzfa.gov.au

Australian Food and Grocery Council

Executive Director, Locked Bag 1, Kingston ACT 2604

Australian Greenhouse Office

John Gorton Building, GPO Box 621, Canberra ACT 2601

Telephone: +61 2 6274 1888, Facsimile: +61 2 6274 1795

Website: www.greenhouse.gov.au

Australian Industry Group

Nation Manager Trade Policy, GPO Box 817, Canberra ACT 2601

Australian Institute of Refrigeration Air Conditioning and Heating

The Director, James Harrison House, 52 Rosslyn Street, West Melbourne VIC 3003

Greenchill Technology Association Inc

PO Box 558, Katoomba, NSW 2780.

Ph: 02-4782-6639

Website: www.greenchill.org

Institute of Refrigeration Heating & AirConditioning Engineers of New Zealand

The Secretary, PO Box 11130, Ellerslie, Auckland NEW ZEALAND

Website: www.irhace.org.nz

Refrigeration & Air Conditioning Companies Association (New Zealand)

The Secretary, PO Box 12737, Auckland 1135 NEW ZEALAND

Refrigeration & Air Conditioning Contractors Association of Australia

The Secretary, 485 Princes Highway, St Peters NSW 2044

The Australian Institute of Refrigeration Air Conditioning and Refrigeration Inc.

Postal address: AIRAH National Office, James Harrison House, 52 Rosslyn Street, West Melbourne, Victoria 3003, Australia

Ph: +61 3 9328 2399, Fax: +61 3 9328 4116

Website: www.airah.org.au

Vehicle Air Conditioning Specialists of Australasia

President, 30-32 Lexton Road, Box Hill VIC 3128

H.2 Manufacturers

Commercial Refrigeration Manufacturers Association of Australia

The Secretary, PO Box 156, Wamberal NSW 2260

H.3 Individual Manufacturers

Frigrite Kingfisher Pty. Ltd.

P.O. Box 499, Braeside, Victoria 3195, Australia

Ph: 61-3-9584-2711, Fax: 61-3-9584-5624

Tyler Refrigeration Corporation

1329 Lake Street, Niles, MI 49120

Ph: (800) 992-3744, (616) 683-2000, Fax: (616) 684-9802

Email: tylercorp@tylerrefrigeration.com

ComCool Refrigeration PTY LTD

Unit A, 30-34 Hilly Street, Mortlake, N.S.W. 2137

Ph: +61 2 9743 1294, Fax: +61 2 9743 1404

Email: *comcool@comcool.com.au*

Website: www.comcool.com.au

Far North Air Conditioning & Refrigeration Services

Showroom: 135 Lyons St, CAIRNS Queensland, 4870

Ph: (07) 40312222, Fax: (07) 40312183

A/H: (0418) 773197

Pager: 132222 - pager 4014753

Email: fnac@c130.aone.net.au

Website: www.fnac.com.au

Stuart Ice Makers

23 Arkley St, Bankstown, NSW 2200

Tel: 02 9709 4077 Fax: 02 9796 2880

Orford Pty Ltd A.C.N. 009 790 265 trading as Orford Refrigeration

Head Office, 75 Vacy Street, Toowoomba Queensland AUSTRALIA 4350

P.O. Box 6085 Toowoomba West Queensland AUSTRALIA 4350

Ph: (07) 4639 9000, Fax (07) 4638 5326

Email: mail@orford.com.au

Website: www.orford.com.au

James N Kirby Pty Limited

Ph: +61 2 9774 7155

email webmaster@kirbyjn.com.au

Tri Tech Pty Ltd

Nevin Dr. Thomastown VIC 3074

Ph: 03 9465 0122, Fax 039464 1327

Whitechurch Refrig & Air Conditioning Pty Limited

31A McCoy St, Myaree WA 6154

Ph: 08 9330 1133, Fax 08 9330 2959

H.4 Regulators

NSW Ministry of Energy and Utilities

Tim Aldrich, PO Box 536, St Leonards NSW 2065

Ph: 02 9901 8837, Fax 02 9901 8403

Office of the Chief Electrical Inspector

Chairman, Electrical Approvals, 3/4 Riverside Quay, Southbank VIC 3006

PO Box 262, Collins Street West V 8007

Ph: 03 9203 9700, Fax: 03 9686 2197

Office of Chief Electrical Inspector

Michael Grubert, PO Box 262, Collins Street West VIC 8007

Ph: 03 9203 9741, Fax: 03 9686 2197

Department of Mines and Energy

Electrical Safety Branch, 61 Mary Street, Brisbane QLD 4000

PO Box 194, Brisbane QLD 4001

Ph: 07 3237 0239, Fax: 07 3237 0229

Department of Mines and Energy

Energy Division, Level 19, 30 Wakefield Adelaide SA 5000

Ph: 08 8226 5500, Fax: 08 8226 5523

Power and Water Authority

Chief Electrical Inspector, 4th Floor JAPE Building, 18-20 Cavenagh Street, Darwin NT 0800. GPO Box 1921, Darwin NT 0801

Ph: 08 8924 711, Fax: 08 8927 212

Office of Energy

Technical and Safety Division, 20 Southport Street, Leederville WA 6007

Ph: 08 9422 5200, Fax: 08 9422 5244

Hydro-Electric Commission

Chief Electrical Inspector, 4 Elizabeth Street, Hobart TAS 7000. GPO Box 355D, Hobart TAS 7001

Ph: 03 623 05855, Fax: 03 622 33279

Department of Urban Services

GPO Box 158, Canberra ACT 2601

Ph: 02 6207 5111, Fax: 02 6207 6229

H.5 Testing Interests

The most likely source of Testing Laboratory interest would be those typical of commercial refrigerators and through certification bodies such as.

QAS
Homebush - Head Office

1 The Crescent, Homebush, NSW 2150 Sydney Australia

Toll Free: 1300 360 314

Ph: (612) 97464900, Fax: (612) 9746 8460

Email: customerservice@qas.com.au

NATA

7 Leeds Street, Rhodes NSW 2138

Ph: +61 2 9736 8222, Fax: +61 9743 5311

H.6 Retailers

Australian Retailers Association

Executive Director, 132 Grenfell Street, Adelaide SA 5000

Individual retailer representation can be achieved through any of the major retailers throughout Australia. Some of these include:

- Woolworths
- Coles
- Franklins
- Jewel

H.7 Consumers

Australian Consumers Association

57 Carrington Road, Marrickville NSW 2204

Ph: 02 9577 3333, Fax 02 9577 3377

This Group would best be covered through consumer associations such as the ACA..

APPENDIX I: ADJUSTMENT OF OVERSEAS PERFORMANCE STANDARDS FOR AUSTRALIAN VOLTAGES

Calculations have been undertaken based on CAN/CSA – C827-98

In the following examples, a 1 cubic metre product has been used as the example.

Table I1: Calculations for Voltage Adjustment

	Refrigerators – Solid Doors		Refrigerators – Glass Doors		Freezers – Solid Doors		Freezers – Glass Doors	
Canadian Std	59V+1010		118V+2020		172 V + 930		334 V + 1860	
1cu m product (kWh/yr)	1069		2138		1102		2194	
At 115 volts								
Amps/yr	9.30		18.59		9.58		19.08	
Losses (I^2R)	86.41	x R1	345.64	x R1	91.83	x R1	363.98	x R1
At 240 volts								
Amps/yr	4.45		8.91		4.59		9.14	
Losses (I^2R)	19.84	x R2	79.36	x R2	21.08	x R2	83.57	x R2
R2/R1	1.73		1.73		1.73		1.73	
losses	34.32	x R1	137.29	x R1	36.47	x R1	144.58	x R1
Difference in losses	52.09		208.35		55.35		219.40	
% difference in losses	60.3%		60.3%		60.3%		60.3%	
Motor losses (@10%)	6.0%		6.0%		6.0%		6.0%	

APPENDIX J: EQUIVALENT ENERGY PERFORMANCE LEVELS TO THE CANADIAN STANDARD FOR REFRIGERATED DISPLAY CABINETS, C657-95, ACHIEVED UNDER AUSTRALIAN TEST CONDITIONS, AS SPECIFIED IN AS1761.

Preliminary Analysis:

The following tasks were performed:

- MEPS values converted to metric units for each unit category of equipment specified in the CAN standard;
- MEPS values adjusted for different climate class ambient temperatures specified under AS1761 test conditions.

The following are assumed to be the same in the Canadian and Australian tests:

- Evaporator temperatures (as specified in the CAN standard);
- Internal (storage) Temperatures (as specified in the CAN standard);
- Cabinet Types (as specified in the CAN standard);
- Temperature differential between the condenser and ambient air is 7^0C (different values can be modelled);
- Energy consumption by the compressor(s) account(s) for 60% of total energy consumed by the unit.

Methodology:

Ambient temperature adjustments for heat gain are based on the ratios between the internal to external temperature differentials, noting that internal temperatures are assumed to be the same for both countries. The heat gain loading is therefore:

(internal - ambient Can) / (internal - ambient Aus)

The coefficient of performance (COP) changes from Can to Aus are based on an idealised carnot engine, where the COP under a particular condition is defined as:

(Tevap) / (Tcond – Tevap) (all temperatures are in K)

Where: Tevap = Evaporator temperature

Tcond = Condenser temperature

Therefore, the change in COP expected for the change in ambient temperature is estimated to be:

(Tcond Aus – Tevap) / (Tcond Can – Tevap)

noting that Tevap is the same for both cases and that temperatures are in degrees K.

Since 60% of energy consumed is due to the operation of the compressor, the ratio of energy consumed =

(0.6 x heat gain differential) / ((COP change) + (1 - 0.6))

The results are shown in the following table.

Table J1: Canadian Standards for Refrigerated display cabinets under Australian test conditions

AS1761 Climate	Climate 1	Climate 2	Climate 3	Climate 4	Climate 5	Climate 6
	MEPS	MEPS	MEPS	MEPS	MEPS	MEPS
C657-95 Product Categories	kWh/m/d	kWh/m/d	kWh/m/d	kWh/m/d	kWh/m/d	kWh/m/d
AS1761 Ambient Temp (^{0}C)	16	22	25	30	40	27
Class 1:	26.8	34.4	38.6	46.1	63.0	41.6
Class 1:	26.0	33.8	38.0	45.6	62.9	41.0
Class 2:	10.8	18.3	22.6	30.8	50.8	25.8
Class 2:	9.0	15.6	19.5	27.0	45.4	22.4
Class 3:	7.4	12.6	15.6	21.2	34.9	17.7
Class 3:	5.9	10.2	12.8	17.7	29.7	14.6
Class 4:	15.5	20.1	22.6	27.1	37.4	24.4
Class 4:	8.2	14.2	17.8	24.5	41.2	20.3
Class 5:	14.4	18.6	20.9	24.9	34.0	22.4
Class 5:	11.9	15.5	17.5	21.0	28.9	18.8
Class 6:	5.6	9.4	11.7	15.9	26.2	13.3
Class 6:	4.3	7.4	9.2	12.8	21.4	10.6
Class 7: narrow	5.9	10.0	12.4	16.9	27.8	14.1
Class 7: narrow	4.4	7.7	9.6	13.3	22.3	11.0

Class 7: medium	8.3	14.0	17.3	23.6	38.9	19.7
Class 7: medium	6.7	11.6	14.6	20.1	33.8	16.7
Class 7: wide	8.8	14.9	18.4	25.1	41.3	21.0
Class 7: wide	7.0	12.2	15.3	21.1	35.5	17.5
Class 8: coil	11.8	15.5	17.5	21.1	29.5	18.9
Class 8: coil	2.8	4.8	6.0	8.3	14.0	6.9
Class 8: gravity	3.0	5.1	6.4	8.7	14.3	7.3
Class 8: gravity	1.5	2.6	3.2	4.4	7.4	3.7