

# **Appliance Energy Labelling Review Committee Support Documentation**

prepared by Energy Efficient Strategies, 20 March 1998  
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Note that this version is paginated for A4 paper

## **Introduction to this Version**

This document has been made public to illustrate the process that has been used in the revision of the appliance energy label in Australia through 1998. The Energy Labelling Review Committee is made up of selected members of government, manufacturers, importers and consumer groups. The committee was formed in early 1998 and has a mandate to consider all aspects of the energy labelling program. EES is contracted as a consultant to the state and federal governments to support the process. Ultimately the committee's role is to make recommendations to government on changes to the energy labelling program which the government can consider prior to implementation. It should also be noted that there are strong links between the Energy Labelling Review Committee and the relevant product Standards Australia committee through common membership, but the roles are quite different. Standards committees in Australia have representatives from all major stakeholders (including a strong government presence). Their prime role is to develop and maintain product test procedures and they operate on a consensus basis. Standards Australia also publish, on behalf of government, the requirements for energy labelling for each product as a separate (but related) Australian Standard (although this is prepared by the same standards committee). The document "Revised System of Energy Labelling in Australia" gives more background regarding the relationship between Standards Australia and government with respect to energy labelling.

## **Background to this Document**

At the Energy Labelling Review Committee meeting of 5 February 1998, issues raised in the consultant reports (Brown 1998 and Patterson 1998) and by the committee members were identified. It was agreed that additional background data sources should be compiled (where relevant) for consideration by committee during their deliberations on possible changes to the appliance energy label. This has turned out to be a significant exercise, but a necessary step for sound decision making.

This paper attempts to compile available data sources for review by the Committee and provides a brief commentary on the relevance or use of the data to assist in the current project. Issues raised by Brown (1998), Patterson (1998) and the Committee itself are grouped into appliance types. Other issues which are not appliance specific are listed afterwards.

This is an information document to support the decision making processes of the Appliance Energy Labelling Review Committee. The opinions offered within this document are those of EES and are not intended to bind the committee to any particular course of action.

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## **1. Refrigerators and Freezers**

### **1.1. Correction of Size Bias**

**Issue:** Current Energy Efficiency Rating (EER or decimal value of the star rating) for refrigerators and freezers is based on a volumetric efficiency - kWh per litre of adjusted volume. However, energy consumption is probably more influenced by surface area (and other factors) rather than volume.

**Discussion on the Issue:** Under the current star rating system, larger refrigerators appear more efficient than smaller refrigerators, even when these are of “equivalent technology” (ie similar compressor efficiency, gasket design and insulation thickness) as the surface area to volume ratio decreases with increasing size. Also, the current system sets the kWh difference between stars to be equal, which means that more stars are increasingly harder to achieve as the star rating increases.

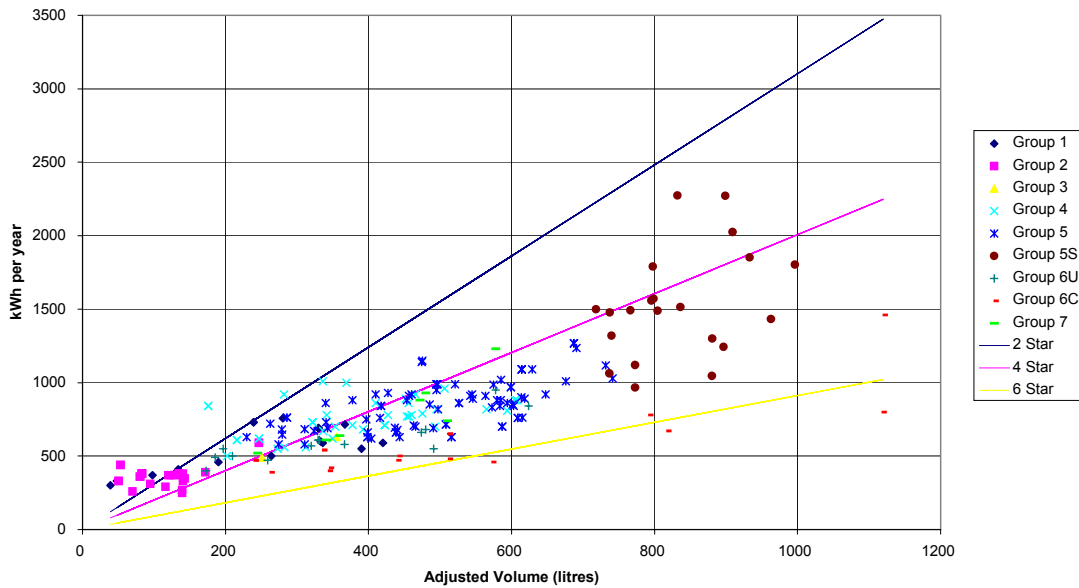
The size bias issue has been on the table since the energy labelling program was first developed in 1986 and has been identified by numerous parties, including the recent reports by consultants Brown and Patterson. Ideally, a rating system which takes into account the volume-energy relationship needs to be developed, so that “technically equivalent” cabinets of different sizes achieve a similar rating. Care is required because different Groups (broad refrigerator and freezer types defined in AS/NZS4474) can exhibit very different volume-energy relationships. Consideration needs to be given to ensuring that there is a degree of comparability for different Groups that provide a similar energy service.

Some decisions need to be made regarding which refrigerators Groups (if any) are to be amalgamated for rating purposes, together with some technical assessment of the current market efficiency and how this is likely to change in the next 5 years. The issue of a linear versus a geometric progression also needs to be considered, as well as the models on the market which are likely to be eliminated through MEPS.

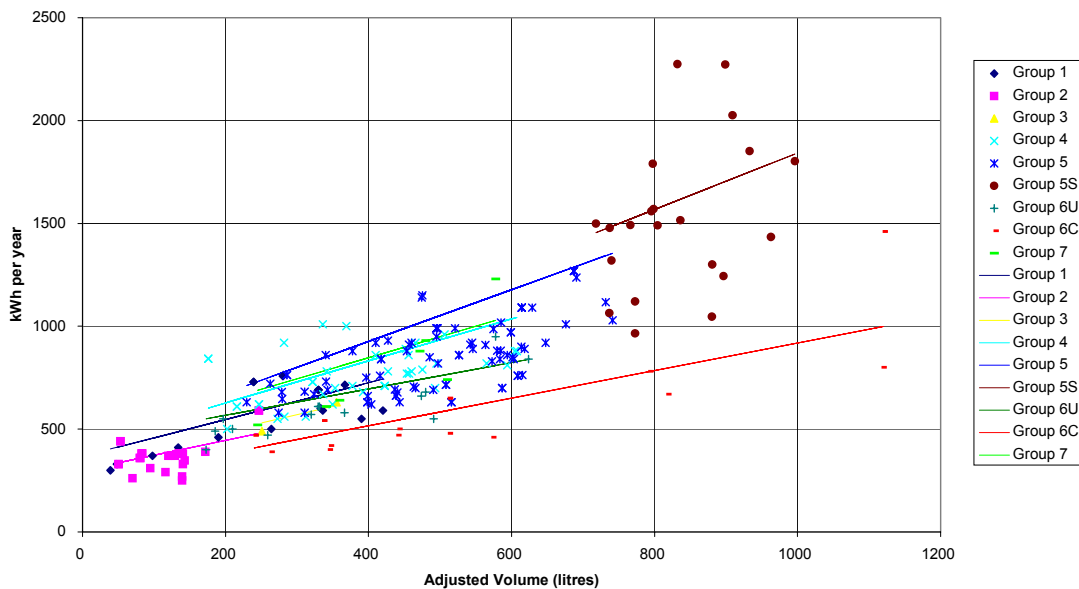
**Data Sources:** The main data source is the energy and volume characteristics on the market at present, which is available from the energy labelling register. These are shown in the energy labelling brochures (copy attached). An electronic copy is of course available for further analysis. A summary of this data is shown in Figure 1 which clearly illustrates the current size bias in the star rating system.

Figure 2 shows current models in 1997 compared with the 1999 MEPS levels for refrigerators and freezers. Clearly, the MEPS levels (lines) have been constructed in a way that takes into account the size bias in energy consumption for each Group.

**Figure 1: Australian Refrigerator and Freezer Models - 1997**



**Figure 2: 1999 MEPS Levels with 1997 Models for Refrigerators & Freezers**



Note: MEPS levels for each Group are shown as lines.

The other key source is the Brown consultant report. He has provided a number of good initial proposals for consideration. These are documented in Section 6.3 on page 14 to 17 of the report. In summary, the 4 options canvassed are as follows:

*Option A* provides a separate rating scale for each refrigerator Group. The MEPS cut-off for each group is set at 1 star and to obtain each additional star the energy consumption has to be reduced by 15% (ie a geometric progression).

*Option B* separately rates refrigerators (Groups 1 to 5S) and freezers (Groups 6C, 6U and 7). The 1 star line was chosen empirically to lie close to the MEPS lines for these Groups and there is a 20% energy reduction for each additional star.

*Option C* is as per *Option A* except that the MEPS cut-off is equal to 2 stars.

*Option D* is as per *Option B*, except that chest freezers and vertical freezers are separated for the analysis.

Brown notes that under *Option B* that the chest freezer MEPS line would be at about 3 stars, as the energy intensity of chest freezers is much lower than vertical freezers. Options A to D are tabulated and graphed on pages 18 to 38 of the report.

Options A and C would mean that efficiency grades are not comparable between products that provide similar energy service e.g. Group 5 models will have much higher star ratings c.f. similar Group 4 models with the same energy and volume, as the MEPS levels for Group 5 are quite weak. This is in fact how the European labelling system works and the resulting non-comparability between groups has caused problems over there. Brown himself suggests that *Option B* is the most promising. Another variation on *Option B* that could be considered is having three groupings for star ratings (not just two) viz, refrigerators (Groups 1 to 3), refrigerator-freezers (Groups 4, 5 & 5S) and Freezers (Groups 6U, 6C and 7) as these provide quite different energy service functions and most consumer selections are likely to be within one of these grouping. It is unclear what projection of efficiency change has been used to set the current upper star ratings under any of the Brown options. The issue of 5 stars vs 6 stars vs more stars obviously needs to be resolved before further analysis is undertaken.

Brown states that an additional volume adjustment factor of 1.2 has been used for frost free models in the rating schemes under Options B & D and states that this factor is also used in Europe. European energy labelling and MEPS requirements *do* provide for an additional volume adjustment factor of 1.2 for those compartments which are cooled by forced air (ie no frost). This is noted as a “provisional” value in the European directive and that in practice the Europeans have virtually no experience with frost free appliances. Currently, less than 1% of European sales are frost free appliances. Inclusion of such a factor will mean that star ratings between Group 4, 5 & 5S or 6U and 7 will not be comparable any more, as is currently the case. This issue needs to be considered carefully before a decision is made.

## **1.2. Allowance for Post MEPS market**

**Issue:** Once MEPS for refrigerators comes into force in October 1999, a number of models will be eliminated from the market. This may result in the elimination of some star ratings within some groups, meaning that the models remaining on the market will be from a more restricted range of star ratings, which will limit the market impact of the scheme.

**Discussion on the Issue:** The post MEPS market for refrigerators was used in the data analysis by Brown when he developed the various proposals. It is important that the post MEPS market as well as likely future changes in technology be considered as further options are analysed.

**Data Sources:** MEPS cut-off lines for refrigerators and freezers are documented in AS/NZS 4474.2-1997.

### **1.3. Ambient Test Temperature 25°C vs 32°C**

**Issue:** AS/NZS4474.1 currently specifies an ambient temperature of 32°C without door openings for the determination of energy consumption. The ISO standards specifies an ambient of 25°C without door openings.

**Discussion on the Issue:** There is currently a large degree of “disharmony” with respect to refrigerator test procedures around the world, where ISO specify 25°C ambient, USA and AS/NZS specify 32°C ambient and various Asian countries specify 30°C ambient (eg Korea and China). The JIS Standard previously specified energy measurements at 30°C and 16°C with door openings, but this standard has now been discontinued in favour of ISO (although the ISO version has recently been disbanded and a dual temperature door opening standard has again been introduced). There are also differing internal temperature requirements for various standards. The nub of the problem is that a refrigerator is a dynamic appliance and has to operate under a range of ambient temperatures during normal use. A static test at a single temperature without door openings (which is the basis for most current refrigerator tests) will not provide accurate data on how a refrigerator is likely to perform under a range of normal ambient conditions. The slope of the energy-ambient temperature profile for each refrigerator model will differ and it is not possible to estimate this function from a single static test point (see Figure 12 and Figure 13 for a summary of data from Europe). In this respect, all existing refrigerator test procedures are inadequate, so continuing with the current requirements of AS/NZS4474.1 is a reasonable proposition in the short term until a more sophisticated approach is developed, proven and implemented (this in itself is a substantial task). However, there is a range of data that should be considered by the committee.

**Data Sources:** Brown (1998) briefly discusses the issue in Section 6.2 (page 14). There are few examples where in-use measurement of energy consumption has been compared with the measured value on the energy label, particularly in Australia. One firm local data source is a project undertaken by ACA (which was commissioned by the NSW Department of Energy) where 25 refrigerators were laboratory tested and then installed in households for 2 years. The units were tested in the laboratory again after one year and then again after 2 years (ACA 1990). In-use energy consumption was metered quarterly for 9 of the models. The general findings were that for refrigerators in NSW, the energy label test (ie 32°C ambient test) over-estimates the in-use energy consumption by about 10% to 20%. Summary of the models tested are shown in Table 1.

**Table 1: Tested versus In-Use Energy Consumption - NSW**

<b>Model</b>	<b>Group</b>	<b>Tested Energy</b>	<b>Measured Year 1</b>	<b>Measured Year 2</b>	<b>Average kWh/day</b>	<b>Ratio test/in-use</b>
NE1	2	1.493		0.900	0.900	60%
KE3	4	2.783	2.630	2.360	2.495	90%
PH2	4	2.577	1.650		1.650	64%
KE6	5	3.243	2.540	2.810	2.675	82%
M11	5	2.220	1.790	2.120	1.955	88%
PA2	5	3.940		3.490	3.490	89%
PH4	5	2.613	2.490	2.400	2.445	94%
SI2	5	4.693	4.050	3.590	3.820	81%
WE1	6	1.123	0.730	0.790	0.760	68%

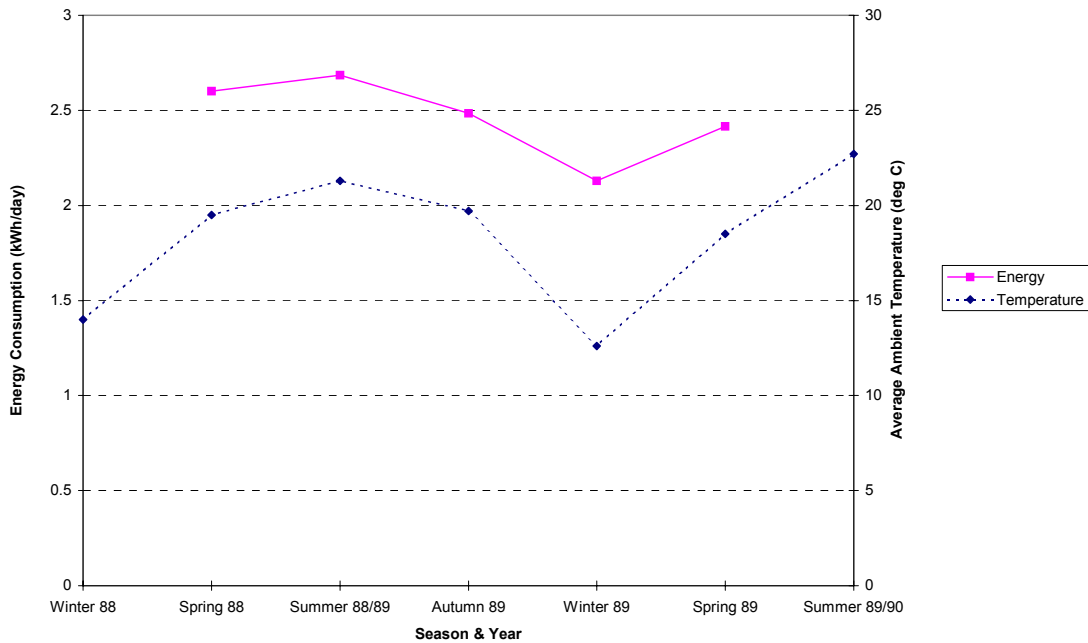
Source: ACA (1990). Measurements were taken over the period 1988 to 1990. Standard test conditions were at 32°C ambient temperature.

Some data is missing due to faulty meters. Interestingly, the energy consumption results for the laboratory tests were highly repeatable over the 3 year period, with a standard deviation of the 3 measurements being less than 2% of energy for all but one unit (which recorded 5% standard deviation due to an increase in energy consumption over the two years from 1.42 kWh/day to 1.56 kWh/day). This tends to confirm the view that in most cases there is no obvious degradation in energy performance of refrigerators, at least in the short term.

It would appear that the in-use energy consumption of freezers is much lower than determined under standard conditions (32°C). The data for model PH2 was not listed by season, so this annual figure may be suspect. The overall seasonal impact of energy consumption on refrigerators is shown in

Figure 3 (although the energy curve is based on a small sample in some cases, so care is required).

**Figure 3: Seasonal Variation of Energy and Temperature - NSW**

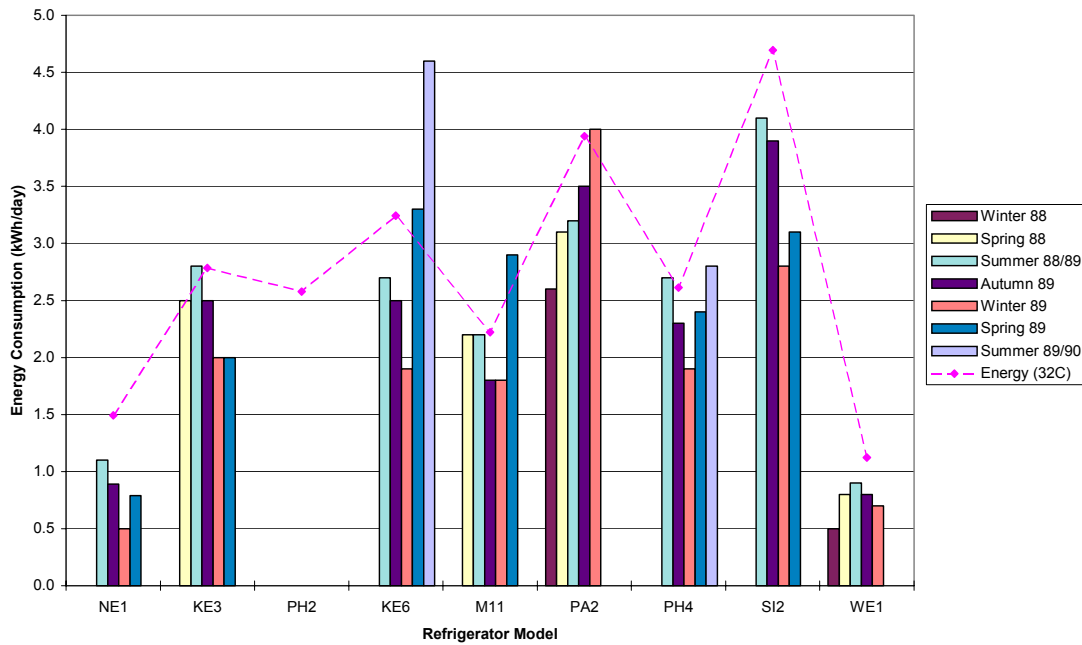


Source: ACA (1990) and author analysis

ACA data also shows that seasonal energy consumption of refrigerators varies considerably. Seasonal data by model, together with the energy determined under standard conditions is shown in Figure 4. It would appear that the energy consumption under standard conditions is similar to the peak summer consumption in many cases, but the average ambient temperature in summer is considerably lower than the test conditions of 32°C, indicating that food loads and door openings have a significant impact on energy.

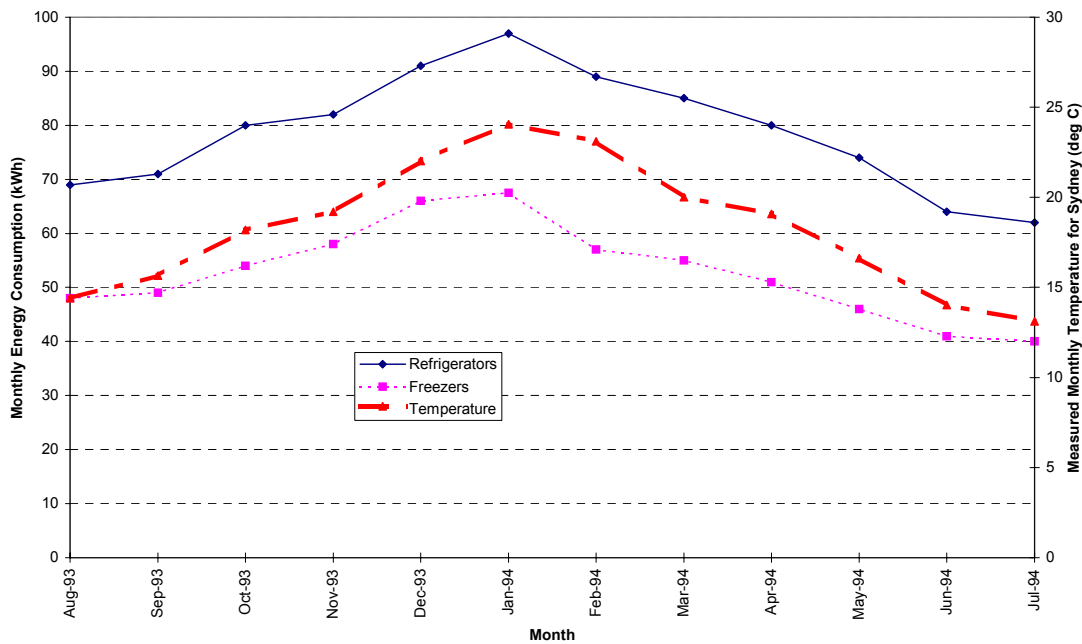
Another key source may be the Pacific Power Residential End-Use Study (Pacific Power 1996). The raw data contains actual in-use information for some 327 refrigerators and freezers for a period of about 18 months from early 1993 to mid 1994. However, the raw data is not yet available (the data has been agreed to be released and expected to be analysed through early 1999) and it is still unclear whether any energy labelling data for the units measured will be available.

**Figure 4: Seasonal and Tested Energy Consumption by Model - NSW**



Source: ACA (1990) and author analysis

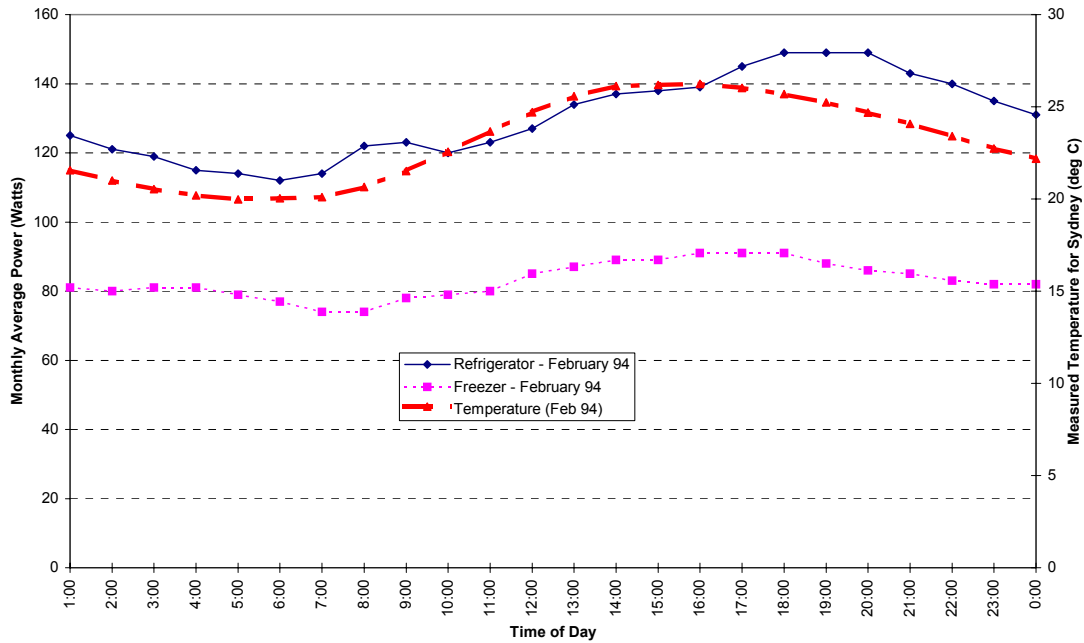
**Figure 5: Monthly Variation of Energy Consumption - NSW**



Source: Pacific Power (1996) and EES (1998)

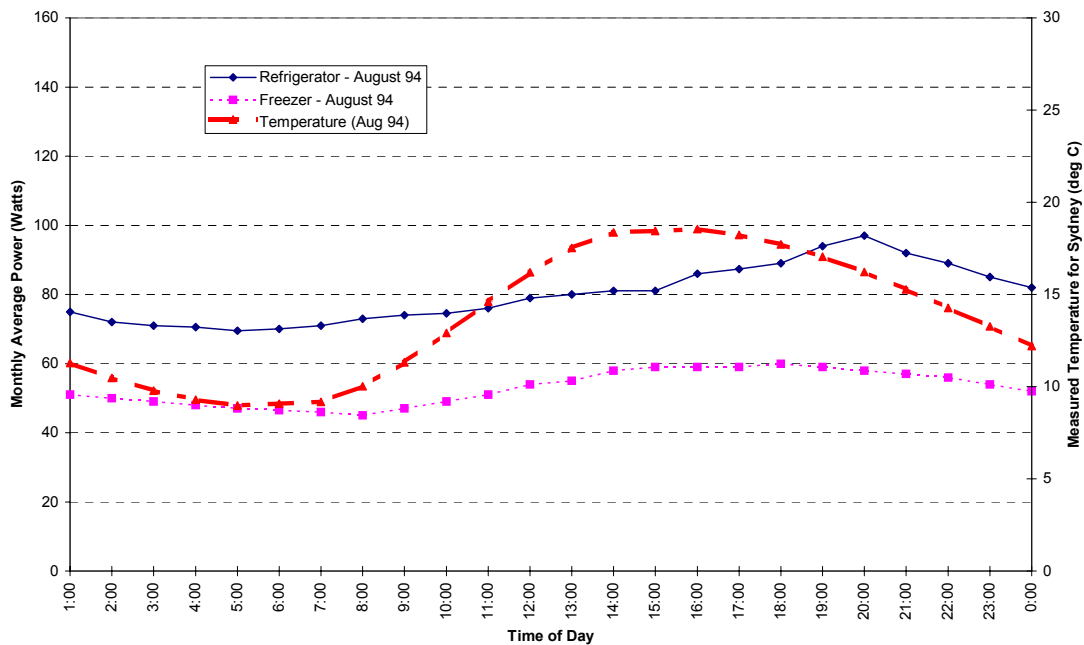
Data from the main report (Pacific Power 1996) shows seasonal variation of energy consumption for refrigerators and freezers (see Figure 5). Note that the temperature data is actual average monthly figures for Sydney based on hourly estimates from the Bureau of Meteorology for the same period. However, some of the sample were outside of the Sydney area. The sample size for refrigerators was 219 and for freezers it was 108.

**Figure 6: Daily Variation of Energy Consumption (February 1994) - NSW**



Source: Pacific Power (1996) and EES (1998)

**Figure 7: Daily Variation of Energy Consumption (August 1994) - NSW**



Source: Pacific Power (1996) and EES (1998)

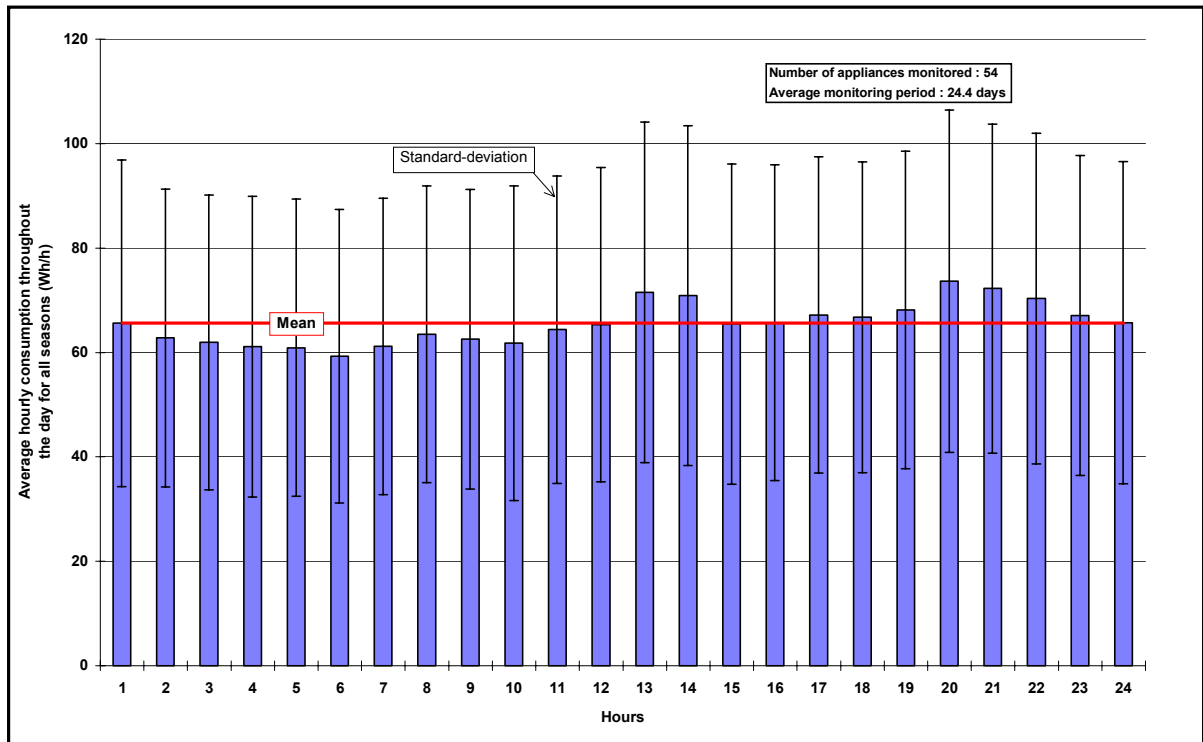
Data on the time of use of refrigerators and freezers for February 1994 and August 1994 are shown in Figure 6 and Figure 7. Clearly energy consumption is highly correlated to outdoor temperature for both months, although the diurnal variation in energy during August is lower than February as the external temperature is closer to

the internal refrigerator temperature which means dramatically reduced heat gain. However, there will be some space heating in August, in the evenings in particular. Note also that inside temperatures are likely to lag outdoor temperatures and that indoor temperature variations will be less than outdoor (as a result of building shell thermal mass and insulation).

The peak demand for both refrigerators and freezers occurs in the evening for both months during the period of peak use of the appliance (ie 18:00 to 21:00 hours), indicating that door openings are having some impact on energy consumption patterns.

There have been some extensive end use monitoring programs in Europe, one of which was undertaken in France (Sidler 1997). While some 130 refrigerators and freezers were monitored under this program, most of these are for a period of less than 1 month (25 days average), so that seasonal data cannot be estimated directly. Unfortunately, there was also little data available on the claimed energy rating of refrigerators monitored, as the measurements were undertaken substantially before energy labelling was introduced in Europe. However, the report concludes for refrigerators (single door) and freezers, that the in-use energy consumption is somewhat less than that declared on the energy label which is measured under ISO (25°C ambient). No conclusions for refrigerator-freezers were possible due to lack of data. An excerpt on refrigerators from Sidler (1997) is attached. This shows the daily variation of energy consumption for refrigerators and freezers monitored. Refrigerators and refrigerator-freezers show significant hourly variation, while freezers show little variation. This confirms that freezers are both less affected by variations in ambient temperature and are subject to few door openings. This data is broadly consistent with Pacific Power (1996).

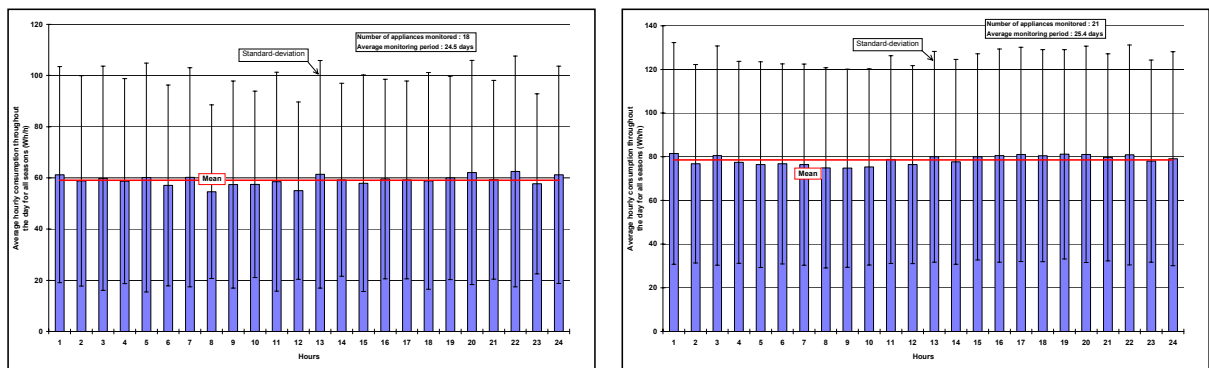
**Figure 8: Daily Variation of Refrigerator-Freezer Energy Consumption (France)**



Source: Sidler (1997)

Note: Large standard deviation is a result of seasonal variations - most appliances are monitored for only one month. Hourly variation is a result of temperature variations and door openings/food loads.

**Figure 9: Daily Variation of Freezer Energy Consumption (France)**

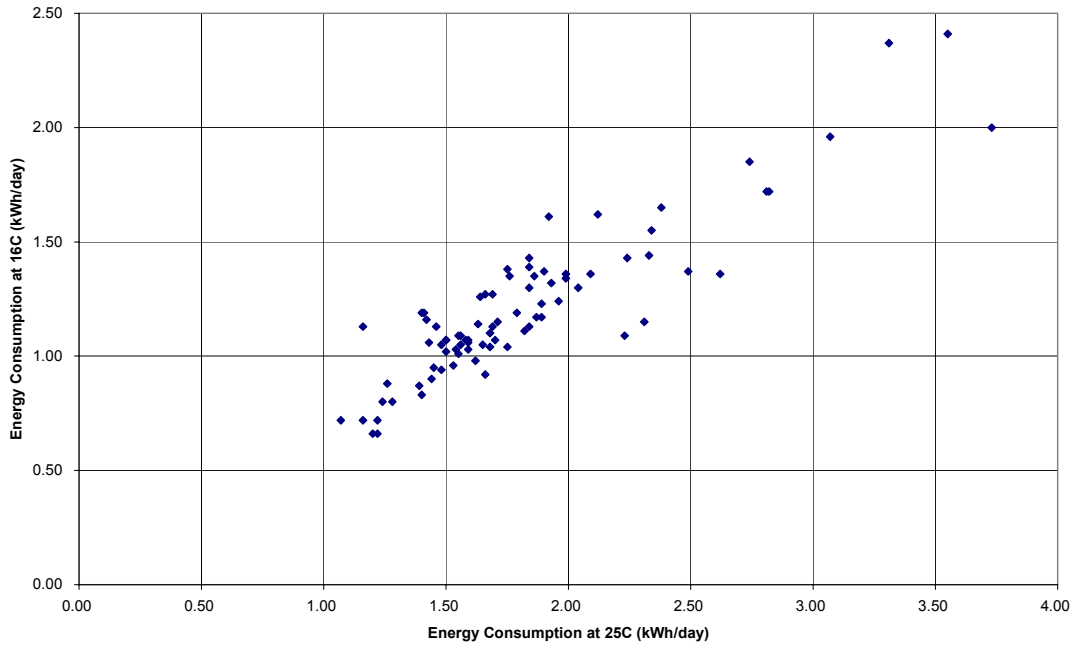


Source: Sidler (1997)

Note: Large standard deviation is a result of seasonal variations - most appliances are monitored for only one month. Chest freezers are on the left and vertical freezers on the right.

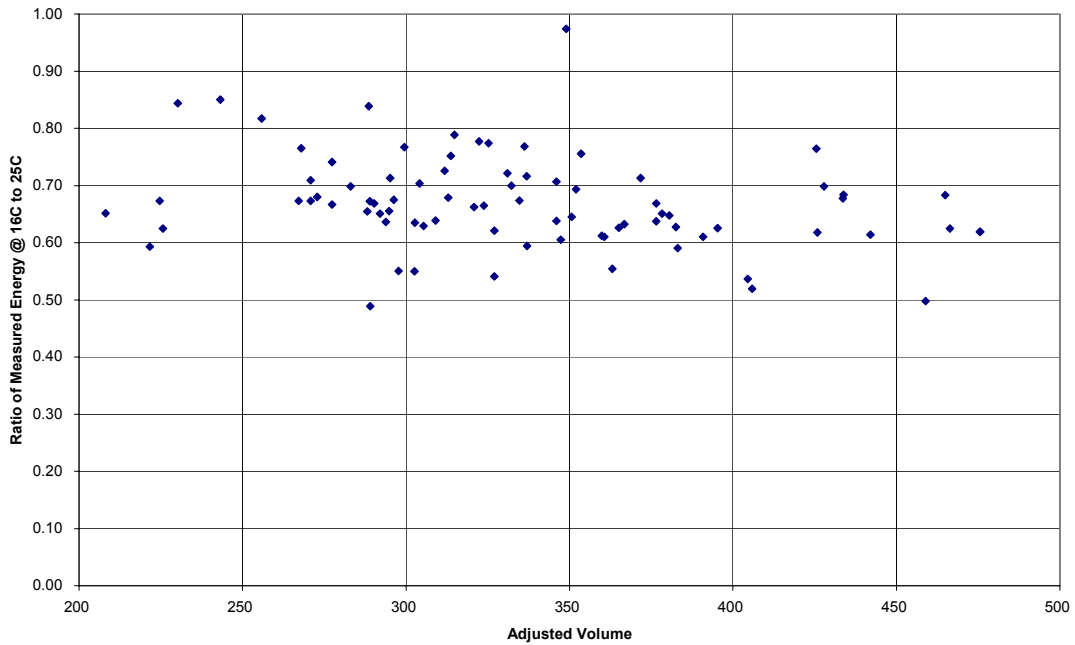
Another useful source is a database of energy consumption of refrigerators in Europe for both 16°C and 25°C which was recorded in 1992 by the Consumers Association of the UK during their appliance testing programs (Waide 1992). Data for some 100 freezers and 90 refrigerator-freezers (2 door) was made available for analysis. The results are shown in Figure 10 to Figure 13).

**Figure 10: European Refrigerator-Freezers: Energy at 25°C versus 16°C**



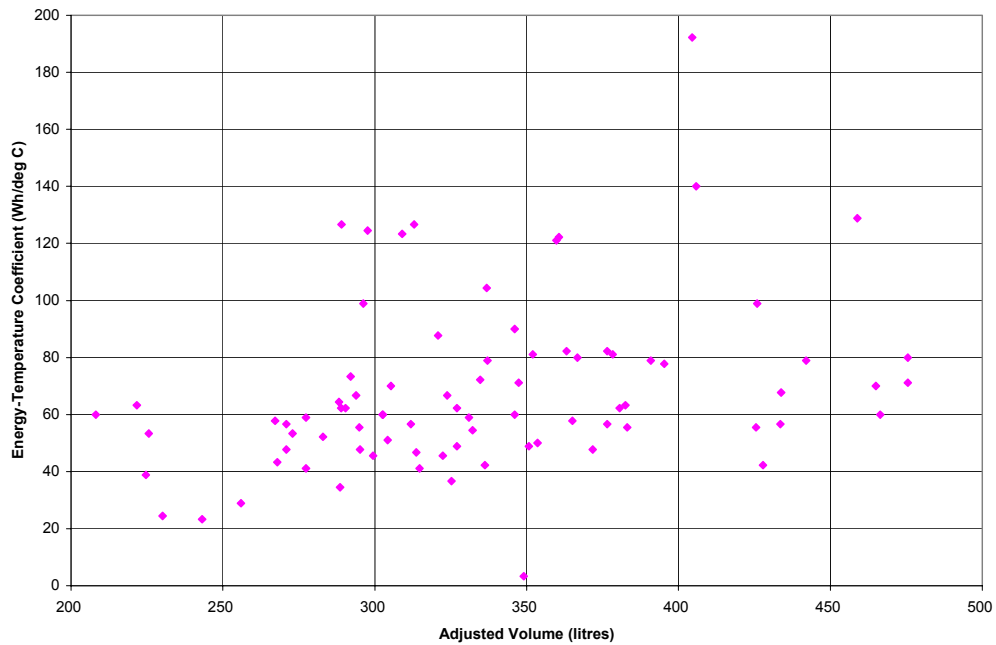
Source: Author analysis basis on data in Waide (1992)

**Figure 11: European Refrigerator-Freezers: Energy Ratio versus Adjusted Volume**



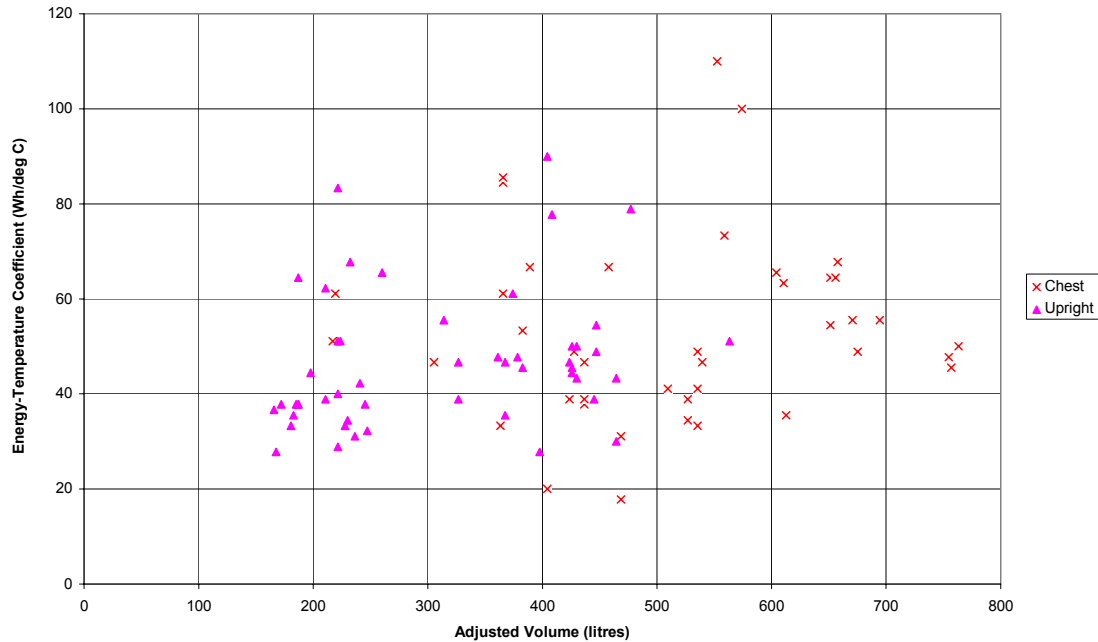
Source: Author analysis basis on data in Waide (1992). Note FAF = 2.15 for Europe.

**Figure 12: European Refrigerator-Freezers: Energy-Temperature Coefficients**



Source: Author analysis basis on data in Waide (1992). Note FAF = 2.15 for Europe.

**Figure 13: European Freezers: Energy-Temperature Coefficients**



Source: Author analysis basis on data in Waide (1992). Note FAF = 2.15 for Europe.

This data shows that the energy-temperature coefficient for refrigerator-freezers and separate freezers varies enormously between models, so that accurate in-use energy consumption would be impossible to estimate from energy consumption measurements at a single temperature (even where indoor temperature profiles are known). Note that measurement of energy consumption at a single ambient

temperature is the method currently used by all national and international test procedures (except Japan).

#### **1.4. Correlation with Actual Use**

**Issue:** As refrigerators and freezers operate continuously, they are less affected by patterns of consumer use in comparison with other appliances. It is therefore important to closely correlate measured energy consumption with in-use consumption.

**Discussion on the Issue:** As discussed above, the major factor which affects refrigerator and freezer energy consumption is ambient temperature, so a simple correlation between measured and in-use energy consumption is not possible. Section 1.3 above (test standards and in-use measurements) adequately covers this issue within its scope.

**Data Sources:** There are no additional data sources for this issue.

#### **1.5. Multi-compartment Refrigerators**

**Issue:** As markets become more open, more unusual configurations are appearing on the market. It is important to ensure that both the test standard and the energy labelling requirements are able to cope with these products.

**Discussion on the Issue:** AS/NZS4474.1 was revised in 1997 and was expanded somewhat to cover unusual configurations including multi-compartment/multi-door models, multi-function compartments and new features like adaptive defrost. Part 2 of the standard (which specifies energy labelling requirements) is more restrictive in its scope than Part 1 and at this stage only includes mains powered vapour compression models. However, the scope and content of both standards is adequate for the moment.

**Data Sources:** AS/NZS4474 Parts 1 & 2

#### **1.6. Impact of Door Openings**

**Issue:** Current test procedures are conducted at a single ambient temperature (32°C in AS/NZS) without door openings, which is not reflective of actual use.

**Discussion on the Issue:** Most test procedures in the world for refrigerators do not include door openings. The only major national standard with door opening has been JIS9607 (Japan). Door openings are both technically difficult to test, (frequency and duration of door openings need to be specified plus opening speed, as well as tight controls on ambient humidity) and the results also have a much lower level of repeatability.

To compensate for heat gain during door openings, most refrigerator test standards test at a higher ambient temperature in an attempt to increase the heat load into the refrigerator or freezer. Anecdotal data in the past has indicated that heat load from door openings is relatively small in comparison with total heat loads for a refrigerator (note that the thermal mass of air is low). However, as insulation levels for refrigerators increase, the heat load from both door openings and warm food will become increasingly important factors.

There is little concrete data on the impact of door openings on energy consumption. Figure 6 to Figure 9 show that ambient temperature is still the main factor to influence energy but that door openings have some impact. The problem is that differences between energy consumption measured under standard conditions and in-use measurements will be the result of three factors: ambient temperature, door openings and food loads and there is no easy method to apportion the impact of each without very sophisticated monitoring systems.

An improved energy test standard which characterised the refrigerator's response to both ambient temperature changes and to internal heat loads would provide a sound basis for further development work in this area. However, this is likely to be a medium term project and will not directly affect the current label revision. This issue is covered to some degree in Section 1.3 above (Ambient Test Temperature 25oC vs 32oC).

**Data Sources:** There are no additional data sources for this issue.

### **1.7. Use of Net Volume for Energy Labelling**

**Issue:** The current energy labelling algorithms in Australia use gross volume to determine volumetric efficiency, whereas most other energy labelling programs use net (useable) volume.

**Discussion on the Issue:** Brown (1998) outlines a number of the issues in Section 6.1 (page 14). The AS/NZS specifies the measurement of both gross volume and net (useable) volume. In many ways, the net volume is the value which is most relevant to the consumer. It is unclear how gross volumes came to be used in the energy labelling program in Australia in the first place. The use of gross volume has created some problems for energy labelling as it has been necessary to define the gross volume for internal sub-compartments such as iceboxes, which has meant that new rules for this type of assessment had to be developed. ISO only define total gross volume: gross volume at the compartment or sub-compartment level is not defined. This results in a divergence between ISO and AS/NZS for volume measurements, which is undesirable. Note that other major labelling programs such as the USA and Europe use net volume for energy labelling purposes (or equivalent).

It is recommended that net volume be used when new energy labelling algorithms are developed for refrigerators and freezers. It should be possible to make adjustments to the algorithms and for MEPS to provide equivalent results for either gross or net

volumes as required. However, there will be a transition period required as net volume is not currently reported for energy labelling purposes.

**Data Sources:** There are no additional data sources for this issue.

### **1.8. Show Volume on the Energy Label**

**Issue:** Volume is a key characteristic of refrigerators and freezers. Although an approximate measure of the volume can be obtained through inspection, it is not always possible to accurately assess differences visually, especially where sub-compartments or unusually shaped liners are present.

**Discussion on the Issue:** Volume of each compartment is a key piece of data for consumers and this is not always available on the appliance or in the product literature. All major energy labelling programs overseas show volume for refrigerators and freezers on the label.

Consideration should be given to the inclusion of volume on the energy label. If recommended, this should be tested on consumers.

**Data Sources:** The international review of energy labelling provides examples of refrigerator labels for consideration.

## **2. Air Conditioners**

### **2.1. New Test Procedure**

**Issue:** A new air conditioner standard based on ISO5151 has been published (AS/NZS 3823-1998).

**Discussion on the Issue:** The new AS/NZS standard is a “clone” of the ISO standard, with a number of minor amendments for clarification. Most of these changes are being incorporated into the next version of the ISO standard in any case.

There are a number of differences between the new ISO clone and AS1861.1 (old test procedure for energy labelling in Australia), mainly with respect to definition of tolerances and test duration which are of minor consequence. For cooling, the new test procedure is essentially identical with the old AS1861.1. For heating, there are some differences with respect to dealing with frosting conditions (ie where the outdoor unit either enters a defrost mode or where ice accumulates). The ISO clone requires indoor temperatures to be maintained at 20°C under all conditions, even where frost or defrost action occurs. AS1861.1 requires the indoor temperature be 21°C under non-frosting conditions. Where defrost action or frost occurs, the indoor temperature is raised until this stops (as per old ISO859). For some models the difference in capacity and energy may be significant, but this has not yet been quantified. The ISO test condition is more reflective of consumer behaviour, so is

preferred for energy labelling purposes. The committee should not have to consider this issue in any detail.

**Data Sources:** A pre-publication draft of the new AS/NZS standard Parts 1 & 2 should be available shortly. See Brown (1998) Section 7.1 (page 39) for a brief overview.

## **2.2. Scope of Energy Labelling for Air Conditioners**

**Issue:** Current regulations nominally apply to all air conditioners under 7.5 kW cooling capacity. It is proposed to clarify the scope of energy labelling to eliminate certain types of units.

**Discussion on the Issue:** The new AS/NZS test procedure (ISO clone) only applies to non-ducted air conditioners with a single refrigeration circuit. This means that it will not be possible to test multi-split or ducted models when the standards are republished. The scope of Part 2 (energy labelling requirements) has been modified to exclude these types for the time being. Few ducted systems under 7.5 kW cooling capacity are on the market in any case. Multi-split systems can be included once ISO publish a multi-split test procedure which we can clone as AS/NZS. A committee draft for multi-splits (ISO CD 15042-1) has been circulated and should proceed once the current revisions of ISO5151 (non-ducted) and ISO13253 (ducted) are complete.

It should be noted that there is government interest in energy labelling for all air conditioners up to 20 kW under the commercial and industrial equipment efficiency program. Any changes to the energy label should also bear in mind requirements for this sector. An ISO clone for ducted models could be prepared in a short time frame if necessary for use within this program. Note that ISO are currently considering an Australian request that ISO5151 and ISO13253 be merged into a single standard.

**Data Sources:** AS/NZS 3823 Parts 1 & 2. See Brown (1998) Sections 7.2 and 7.3 (page 39) for a brief overview. Copies of the various ISO standards are available on request.

## **2.3. Improved Repeatability of Test Method**

**Issue:** A round robin of air conditioner test laboratories showed some significant differences in measured capacity and energy consumption. The test procedure needs to be highly reproducible if energy labelling requirements are to be enforceable.

**Discussion on the Issue:** This issue is being treated as a high priority by NAEEEEC and a major comparative test program between UNSW and Uni of SA is currently under way. There is ongoing liaison with EL15/16 (air conditioners) as necessary.

**Data Sources:** There are no additional data sources for this issue.

## 2.4. Provision of Latent and Sensible Cooling Data

**Issue:** The cooling effect of an air conditioner is the result of both lower air temperatures (sensible cooling) and reduced humidity (latent cooling). In dryer climates, there is likely to be little benefit from latent cooling. In more humid areas, the requirements are less clear.

**Discussion on the Issue:** The energy label currently shows total cooling capacity (in kW), which is the sum of both sensible and latent cooling capacities. In dry climates where humidity is low, there is likely to be little benefit from the latent component (moisture removal). In humid climates, moisture removal can increase comfort levels and can result in a higher dry bulb temperature being acceptable when the inside humidity is low. However, feedback from Queensland (hot and humid climate) has indicated that the most important factor is probably still sensible capacity, which results in reduced temperature of the air. Many houses in Queensland have high ceilings and it appears that a large airflow (which maximises sensible cooling) is an important factor. While some latent cooling capacity is required, indoor humidity is generally not a problem and almost all units will exceed the minimum latent cooling requirements to control humidity (in a sealed room with limited humidity sources).

Data on latent and sensible cooling is available both through test reports and via product literature. However, latent cooling data in product literature is generally provided in terms of moisture removal per hour (generally in kg or litres per hour). Moisture removal can be converted to latent cooling capacity by multiplying by 683 to get Watts cooling, but this is not generally known by consumers. In any case, the raw data is of little direct benefit for consumers.

If sensible capacity is the most critical value for households in both dry and humid climates (as initial data suggests), there may be a case for revising the energy label star rating to be based on sensible capacity or placing some limits on the latent capacity that can be included in the calculation of the star rating.

A related question is whether better advice can be provided for purchasers of air conditioners. It seems fairly clear that such advice is not suitable for inclusion on the energy label. However, consideration could be given to other mechanisms for delivery of such information. Possible options may include brochures and information on the energy labelling web site. Types of guidelines that could be considered are:

- for dry climates: size systems primarily on the basis of sensible cooling capacity as there may little latent cooling capacity available under dry indoor conditions;
- for humid climates: ensure that the sensible cooling capacity is sufficient for your requirements (as a guide - sensible heat ratio >80%);
- for humid climates: the moisture removal effect is increased when the fan speed is set at on slower speed.

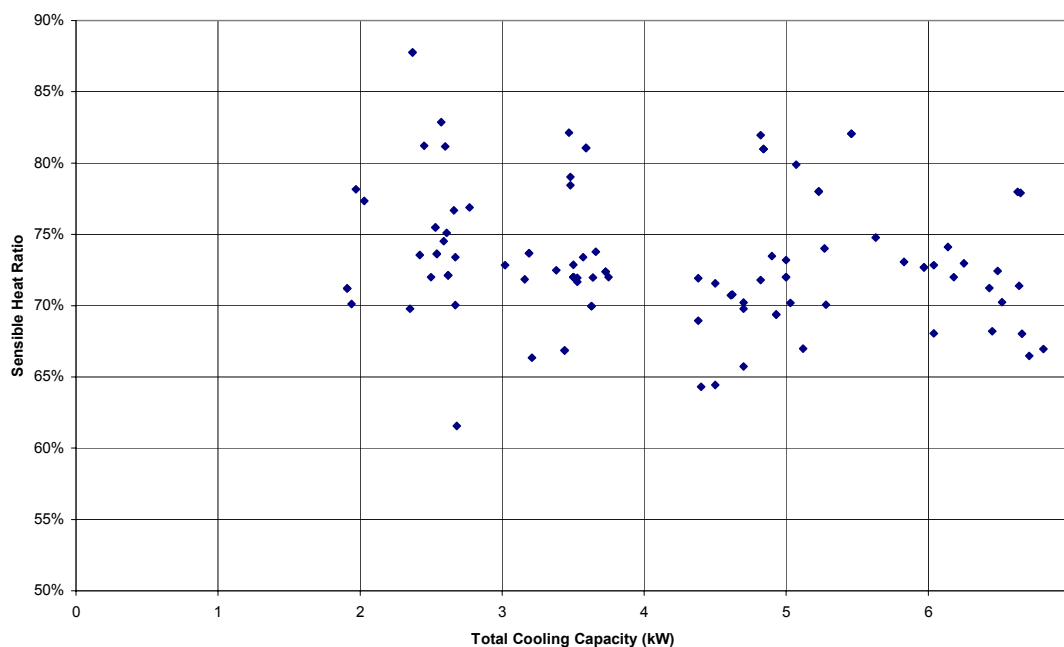
Such brochures or advice can be tailored for local climatic requirements.

If sensible and latent data is to be presented, this should be based on rated values, as the rated total cooling capacity is the value that is shown on the energy label.

**Data Sources:** Brown (1998) discusses the issue in Section 7.4 (page 40). Brown suggests that total capacity continue to be used for energy labelling and that sensible cooling not be added to the label. However, the action to be taken in response to this issue should be reviewed by the committee.

Sensible heat ratio is defined as the ratio of sensible cooling to total cooling. A lower sensible heat ratio implies a higher proportion of dehumidifying performance. Data from 100 energy labelling registrations (circa 1993) have been analysed to show the range of sensible heat ratios on the market. These are shown in Figure 14. As can be seen, there is considerable variation for all cooling capacities. The Queensland argument is that units with a sensible heat ratio of lower than about 80% will have a sensible capacity which is inadequate if total capacity is used to size the units.

**Figure 14: Sensible Heat Ratio for 100 Air Conditioner Registrations**



Source: NSW air conditioner register.

Consumers and advisers in Queensland and manufacturers should be further consulted regarding suitable advice for humid climates.

## **2.5. Determination of Air Conditioner CEC**

**Issue:** The Comparative Energy Consumption (CEC) for air conditioners is based on 500 hours for heating and 500 hours for cooling. The actual use of air conditioners varies considerably in different climate regions. One thing is clear - actual use is almost never 500 hours.

**Discussion on the Issue:** The use of air conditioners is dependent on a range of factors including climate, daily temperature profiles and building shell performance. Given the huge variation in climates around Australia, it would seem impossible to

put onto an energy label a figure which is representative of annual energy consumption for air conditioners.

It is unclear how the 500 hours currently in use was derived. However, changing the label energy to input power during operation (kW or Watts) has a number of supporters. If this was to be undertaken, it would be important to provide guidance to consumers regarding the expected range of use in different regions. The best delivery mechanism for this data may be through local state based brochures.

A related issue is that air conditioners in normal use tend to operate at rated capacity for only part of their total operating time (see 2.7 Part Load Operation)

**Data Sources:** Brown (1998) discusses the issue in some detail in Section 7.5 (pages 40 to 43). Pacific Power (1996) provides directly metered energy consumption for both heating and cooling air conditioners for one year in 1993/94. It is expected that hours of operation will be available from the raw data, but it is unclear whether additional data on each appliance monitored will be available as well. Note that the Pacific Power data is for NSW households only.

ABS 8218.0 (1988) collected diary data from 19,331 households over the period from 17 June 1995 until July 1996. A new group of about 750 households collected one week's diary data commencing at the start of each fortnight over the period, so that usage patterns for the whole year were covered. A summary of the data is shown in Table 2 to Table 4.

**Table 2: Air Conditioner Penetration by State**

State	Households '000	Own AC '000	Penetration
NSW	1744.5	538.2	30.9%
Victoria	1300.2	524.7	40.4%
Queensland	811.1	141.7	17.5%
SA	475.1	295.5	62.2%
WA	462.6	179.2	38.7%
Tasmania	145.1	0.7	0.5%
NT	26.7	15.5	58.1%
ACT	78.8	23.8	30.2%
<b>Australia</b>	<b>5044.1</b>	<b>1719.3</b>	<b>34.1%</b>

Source: ABS8218.0-1988, see also EES (1998) for more recent data and ownership estimates.

**Table 3: Proportion of all air conditioners used on at least one day in seven**

State	Spring	Summer	Autumn
NSW	5.1%	54.3%	20.2%
Victoria	9.6%	40.3%	15.0%
Queensland	26.6%	63.0%	29.2%
SA	10.2%	45.9%	18.5%
WA	14.2%	55.5%	9.8%
Tasmania	0.0%	50.0%	0.0%
NT	90.4%	91.7%	58.3%
ACT	6.0%	32.1%	3.3%
Australia	10.9%	49.7%	18.0%

Source: Table 17, ABS8218.0-1988. Winter use was recorded as essentially zero.

**Table 4: Annual air conditioner use by state during 1985/86**

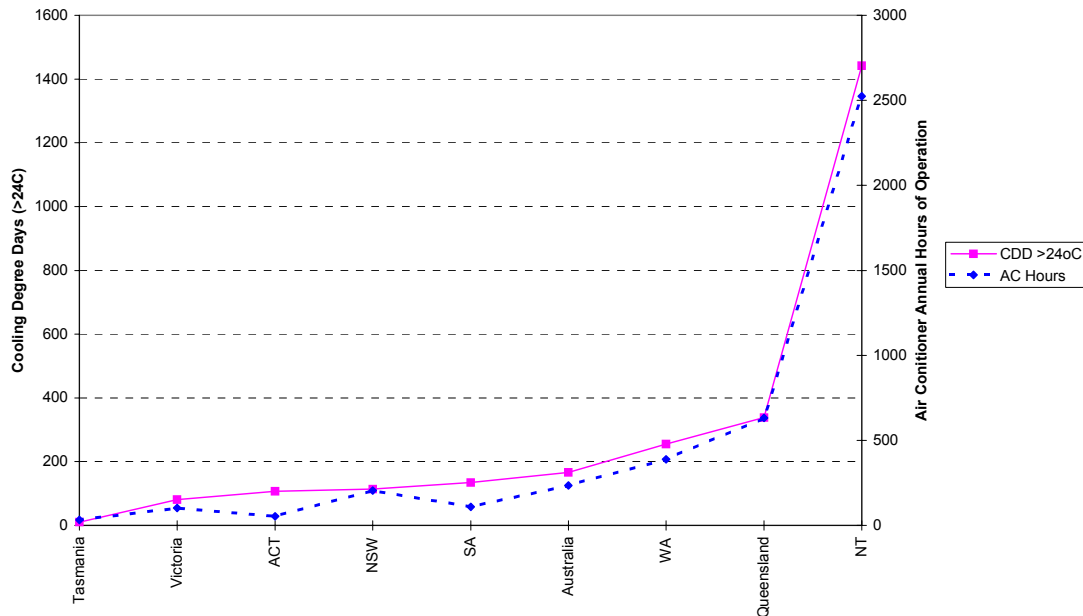
State	Annual Average Use (Hours)
NSW	206
Victoria	102
Queensland	632
SA	108
WA	389
Tasmania **	33
NT	2525
ACT **	53
Australia	235

Source: Table 17, ABS8218.0-1988. Assumes 13 weeks per season.

Note\*\*: Values for Tasmania and ACT are estimates only due to small sample size.

Actual hours of air conditioner operation by state and cooling degree days (based on degree hours over 24°C in capital cities only) are shown in Figure 15. On a weighted basis, it would appear that use of air conditioners are on average 1.4 hours per cooling degree day (based on a threshold of 24°C), with a range typically from 0.8 in South Australia (dry) to 1.9 in Queensland and Northern Territory (humid). Data for Tasmania and ACT are suspect due to the small sample size in the ABS survey. There is no data on the load level during these hours of operation (ie full or part load).

**Figure 15: Hours of AC Operation and Cooling Degree Days by State for 1985/86**



Source: Table 17, ABS8218.0-1988 and EES (1998).  
 Note: CDD based on capital cities only, hours are for the whole state.

Long term heating and cooling degree data by capital city (EES 1998) for 27 years from 1970 to 1996 is shown in Table 5. Other values are available in CSIRO (1980).

**Table 5: Heating and Cooling Degree Days for Australian Capital Cities (1970 to 1996)**

City	HDD <18°C	HDD <15°C	HDD <12°C	CDD >24°C
Brisbane	445	199	72	279
Sydney	641	273	84	102
Canberra	2272	1522	930	118
Melbourne	1283	658	255	114
Hobart	1867	1092	519	25
Adelaide	1153	585	230	177
Perth	819	391	147	308
Darwin	3	0	0	1371

Source: EES 1998

## 2.6. Bunching of Star Ratings

**Issue:** Star ratings are starting to bunch around 5 and 6 under the current algorithms.

**Discussion on the Issue:** The co-efficient of performance is used to determine star ratings for air conditioners. It would be a straight forward task to revise the air conditioner algorithm to provide a greater spread of the models on the market. Consideration should also be given to introduction of a geometric progression instead of a linear progression.

**Data Sources:** The main data source is the energy and capacity characteristics on the market at present, which is available from the energy labelling register. These are shown in the energy labelling brochures (copy attached). An electronic copy is of course available for further analysis.

## **2.7. Part Load Operation**

**Issue:** Air conditioners are rated under full load conditions. Air conditioners typically only spend a small proportion of their normal operating hours at rated capacity. For those units with a single speed compressor, the nominal efficiency at part load will be similar to full load as the compressor cycles on and off with the thermostat. However, for multi-speed compressors or those which use a variable speed drive (eg inverter systems), the apparent efficiency will increase substantially under part load conditions.

**Discussion on the Issue:** This issue is really only a serious concern for models with multi-speed compressors, variable output compressors or those with variable speed drives (most commonly inverter based systems). Inverter systems now dominate the market in Japan and they are now appearing on the Australian market as well.

For a standard single speed compressor, the overall efficiency remains fairly stable at part load (typically a slight decline in efficiency) because the thermostat is essentially making the compressor run for short periods at rated capacity. For variable speed compressors, as the cooling load declines, the compressor output also declines to the level required (the unit does not cycle like a single speed compressor) and the efficiency of the unit starts to climb, because although the condenser and evaporator size remains constant, the relatively smaller compressor output increases the overall system efficiency (air conditioner efficiency is broadly proportional to the ratio of the evaporator/condenser area to the compressor output).

Although this is a real issue for multi-speed compressors, there are two serious problems at the moment. Firstly there is no adequate test procedure which defines the performance at part load (apart from multiple direct measurements) and secondly there is virtually no data on how air conditioners are used in real households, so even where there was a method to determine performance under part load conditions, it is unclear how this could be implemented through an energy label.

A step forward will be to develop a test procedure which can characterise the air conditioner under a wide range of conditions (a simulation model which can be calibrated with a few physical tests). The issue of part load testing has been raised with ISO, but a clear direction is yet to emerge. Note the Japan and USA have part load testing procedures, but these are extremely involved and prescriptive and are not recommended for use in Australia at this stage. A number of computer models are currently available which could be used to form the basis of a new test procedure, but there is still a good deal of development work to be done.

**Data Sources:** Brown (1998) discusses the issue in some detail in Section 7.7 (page 45). Pacific Power (1996) provides directly metered energy consumption for both

heating and cooling air conditioners for one year in 1993/94. It is expected that hours of operation and the power used during operation will be available from the raw data, but it is unclear whether data on each appliance monitored will be available as well. Note that the Pacific Power data is for NSW households only.

## **2.8. Highlighting Capacity on the Energy Label**

**Issue:** Heating and cooling capacity are key variables of concern to consumers. Although the capacities are currently shown on the label, they are in small print.

**Discussion on the Issue:** Consideration should be given to highlighting capacity on the energy label. If recommended, this should be tested on consumers.

**Data Sources:** The international review of energy labelling provides examples of air conditioner labels for consideration.

## **3. Clothes Dryers**

### **3.1. Determination of Clothes Dryer CEC**

**Issue:** The current algorithm assumes some 150 uses of a clothes dryer per year. Preliminary data from an end use metering project suggests that this is too high by a factor of 3 to 5.

**Discussion on the Issue:** Sales weighted average CEC (comparative energy consumption shown on the energy label) for clothes dryers sold in 1996 was 643 kWh (EES 1997). Data from Pacific Power (1996) shows that metered in-use energy consumption of some 135 clothes dryers over a one year period was 123 kWh. This suggests that actual frequency of use is of the order of 30 to 50 times per year compared with 150 times assumed in the energy labelling algorithm. Raw data collected by Pacific Power will provide statistics on frequency and duration of use, particularly the spread of use across households. Although the average use across all households is low, there are likely to be some households with high levels of use (eg where there is no clothes line eg flats). This data should be considered when making changes to the energy label.

**Data Sources:** Brown (1998) discusses the issue in Section 8.1 (page 48). Pacific Power (1996) provides directly metered energy consumption for 135 clothes dryers for one year in 1993/94. It is expected that frequency of operation by household will be available from analysis of the raw data, but it is unclear whether data on each appliance monitored will be available as well. Note that the Pacific Power data is for NSW households only.

Data collected in Queensland (Report 2, Table 32, QEC 1993) suggests that average use is about 3.5 times per month (around 40 times per year) which broadly corroborates data collected by Pacific Power.

ABS 8218.0 (1988) collected diary data from 19,331 households over the period from 17 June 1995 until July 1996. A new group of about 750 households collected one week's diary data commencing at the start of each fortnight, so that usage patterns for the whole year were covered. A summary of the data is shown Table 6 to Table 8. Table 7 clearly shows the seasonal pattern of use by state, with peak use in winter and minimum use in summer, as expected. Annual use by state in 1985/86 was derived from ABS8218.0 (1988) and is shown in Table 8. The indicative frequency distribution of use was also derived from ABS8218.0 and is shown in Figure 16. Note that only days that the appliance was used over a one week period were used to derive this figure, so that the number of cycles shown in this distribution does not include those cases where the appliance was used more than once per day (underestimates total use).

**Table 6: Clothes Dryer Penetration by State - 1985/86**

State	Households '000	Own CD '000	Penetration
NSW	1744.5	850.2	48.7%
Victoria	1300.2	667.6	51.3%
Queensland	811.1	362.1	44.6%
SA	475.1	221.2	46.6%
WA	462.6	154.7	33.4%
Tasmania	145.1	83.3	57.4%
NT	26.7	8.4	31.5%
ACT	78.8	42.4	53.8%
<b>Australia</b>	<b>5044.1</b>	<b>2389.9</b>	<b>47.4%</b>

Source: ABS8218.0-1988, see also EES (1998) for more recent data and ownership estimates.

**Table 7: Proportion of all clothes dyers used on at least one day in seven**

State	Winter	Spring	Summer	Autumn
NSW	62.4%	61.9%	43.1%	48.5%
Victoria	76.5%	60.7%	43.6%	59.3%
Queensland	52.9%	47.0%	42.1%	48.1%
SA	73.7%	45.9%	37.1%	54.3%
WA	78.3%	47.8%	24.1%	57.3%
Tasmania	67.0%	48.4%	45.7%	55.2%
NT	61.1%	17.4%	57.1%	35.9%
ACT	75.2%	63.2%	24.5%	64.1%
<b>Australia</b>	<b>67.6%</b>	<b>56.3%</b>	<b>41.1%</b>	<b>52.9%</b>

Source: Table 15, ABS8218.0-1988.

**Table 8: Annual clothes dryer use by state during 1985/86**

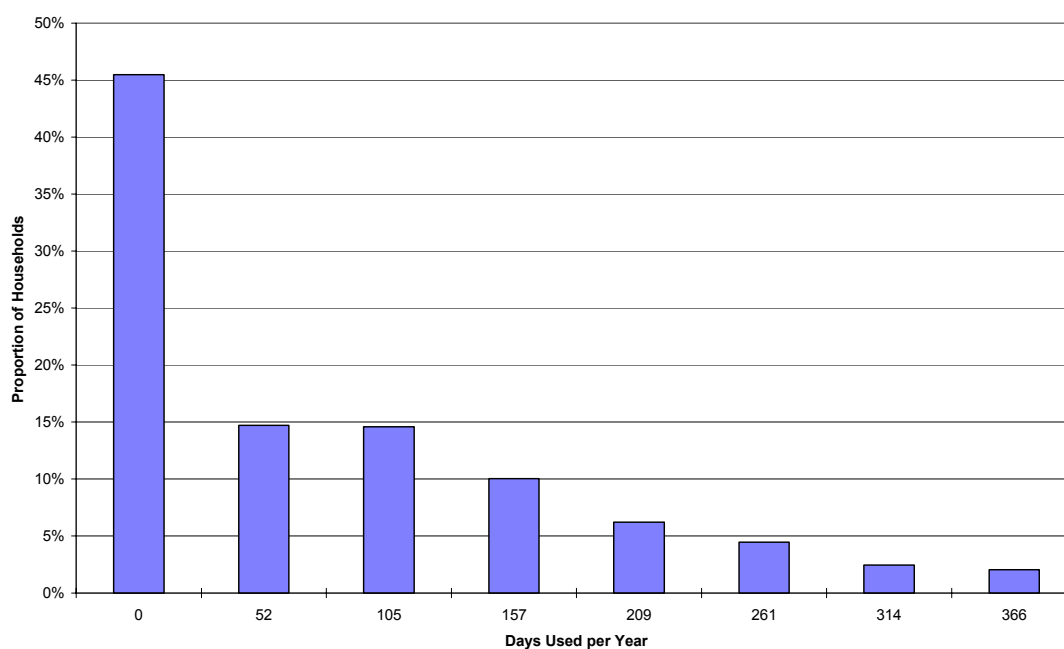
State	Annual Average Use (Hours)	Cycles per Year
NSW	86	37
Victoria	123	54
Queensland	70	30
SA	91	39
WA	98	43
Tasmania	109	47
NT **	37	16
ACT	84	37
<b>Australia</b>	<b>96</b>	<b>42</b>

Source: Table 15, ABS8218.0-1988, Assumes 13 weeks per season.

Cycles per year based on cycle time of 2.3 hours from EES (1997).

Note\*\*: Values for NT are estimates only due to small sample size.

**Figure 16: Frequency Distribution of Dryer Use, 1995/96**



Source: Table 15, ABS8218.0-1988 & author analysis. Likely to be >1 use per day in some cases.

In Europe, dryer use is much higher than in Australia, which is to be expected given the climate and housing types. Sidler (1997) indicates that average use is 5.2 times per week based on end use metering results. The diary data for the same households that were monitored showed that consumers underestimated their actual use by about 25%, so care needs to be taken when using consumer diary or recall data. Interestingly, diary data for dishwashers overestimated the actual use by about 30% (Sidler 1997). The author warns of the danger of relying on consumer reports of appliance use.

### **3.2. Bunching of Star Ratings**

**Issue:** Star rating for clothes dryers are bunched around 2 and 3 stars, with only a few models at 4 stars.

**Discussion on the Issue:** Most clothes dryers sold in Australia at the moment are low cost units which are all based on similar technology. The reason for bunching is that the technical efficiency is similar for most models within a size range. The best models on the market at the moment (generally European designs, which tend to be expensive) can just achieve 4 stars.

In 1997 AEG in Germany released clothes dryers which are based on heat pumps (AEG 1997). The purchase costs are still high (of the order of US\$1,500), but the efficiency is dramatically increased (claimed 50% energy reduction in comparison with a conventional dryer - around 1.75 kWh to dry a 5 kg load to IEC61121, cf 3.5 kWh for conventional dryers). While this type of unit is unlikely to have a large market impact in Australia (given the high cost and low average dryer use here), it shows that technically advanced units are possible. This is the first model to achieve an "A" energy efficiency rating under the European energy labelling program. This unit would achieve a rating of about 7 stars under the current Australian system (assuming about 0.6 kWh per kg moisture removed to AS/NZS2442.1).

The USA has been undertaking some research into microwave clothes dryers with a view to reducing energy consumption (EPRI 1992), but there have been some technical problems (eg microwave action on metal items). Gas dryers are also available in Australia, Europe and the USA but these are not within the scope of the electrical energy labelling program in Australia.

**Data Sources:** Brown (1998) discusses the issue in Section 8.2 (page 48). The main data source is the energy and capacity characteristics on the market at present, which is available from the energy labelling register. These are shown in the energy labelling brochures (copy attached). An electronic copy is available for further analysis. AEG (1997) and EPRI (1992) also provide additional information.

### **3.3. Size Bias in Algorithm**

**Issue:** The current star rating system is based on kWh per kg of moisture removed. There is currently a slight size bias in this rating system which makes small units appear less efficient.

**Discussion on the Issue:** Most clothes dryers sold in Australia at the moment are low cost units which are all based on similar technology. Currently most 3.5 kg models rate only 2 stars while most 5 kg models rate 3 stars. Consideration should be given to removing this size bias if and when the labelling algorithm is revised.

**Data Sources:** Brown (1998) discusses the issue in Section 8.2 (page 48). The main data source is the energy and capacity characteristics on the market at present, which is available from the energy labelling register. These are shown in the energy labelling brochures (copy attached). An electronic copy is available for further analysis.

### **3.4. Star Rating for Clothes Dryers Should be Removed**

**Issue:** Clothes dryers are only used infrequently so the total energy consumption is small. In addition, most units sold are low cost units which are based on similar technology, so there is very little difference in efficiency.

**Discussion on the Issue:** This issue was raised by Patterson, who suggests that labelling for clothes dryers is unnecessary, given the low frequency of use and narrow efficiency range of current models (ie choice of model will not significantly influence energy consumption).

The issues that need to be considered are as follows:

- the technical range is now large, with energy consumption varying by a factor of 2 with the advent of heat pump units in Europe - however these are unlikely to achieve much penetration in Australia, at least in the short term
- average consumers appear to only use dryers infrequently, but there is likely to be a core of higher frequency users - should labelling be retained to target these consumers?

**Data Sources:** Patterson (1998) mentions the issue in Section 5.4 but has little supporting documentation (page 16). It may be necessary to carry out a cost benefit evaluation of the elimination of labelling for clothes dryers. Data on the distribution of use patterns is essential. This will be obtained from analysis of the Pacific Power data.

### **3.5. Frequency Distribution of Use for Clothes Dryers**

**Issue:** Use of clothes dryers is likely to be bi-modal with most households having low use but with some households having high use.

**Discussion on the Issue:** This issue is covered under Section 3.1, Determination of Clothes Dryer CEC). See also Figure 16 for an indicative frequency distribution of dryer use.

### **3.6. Field Use Factor (Timer Penalty) in Current Algorithm**

**Issue:** The current algorithm for clothes dryers allocates a penalty (field use factor) of 10% energy for timer controlled dryers (1.10), with no penalty for auto-sensing dryers (1.00).

**Discussion on the Issue:** The field use factor is based on the assumption that an auto sensing dryer will consume the same energy in the field as is shown on the energy label (assuming same initial moisture content), because the program will terminate on each occasion when the clothes are at the same level of dryness. For a timer dryer, it is assumed that consumers will, on average, tend to over dry clothes, hence the 10% energy penalty, which applies to the CEC and subsequent calculations of EER.

It is believed that the Australian figure for field use factor was based on data from the USA. Okalahoma Gas and Electric Company undertook a study on dryer use in 60 households for a period of about a year in the 1970's (?) (some 33,000 loads were dried with an average energy consumption of 2.5 kWh per load). The study must have found some differences between timer dryers and autosensing (or automatic termination) dryers. The US Code of Federal Regulations appears to have enshrined these findings in the test procedure for dryers (CFR430 Subpart B, Appendix D - test method for clothes dryers) and assigns a field use factor of 1.04 for autosensing dryers and 1.18 for timer dryers (see Clause 4.1) giving the difference between the two control types of about 13%. However, the original report or data has never been sighted (see GWA 1991 for more details - page 138 of main report and page 82 of the Appendices).

**Data Sources:** Manufacturers have indicated that they may be able to provide the results of some in-house research on this topic.

### **3.7. Inclusion of Program Time on the Brochure**

**Issue:** Clothes dryer program time is currently included on the energy labelling brochure, as this is a variable of interest to consumers. However, the program time determined from the test does not include the cool down period.

**Discussion on the Issue:** Information included in energy labelling brochures should be accurate as far as is possible. Program time is a variable that is of interest to

consumers but there is currently no standardised way of reporting this in product literature. Values in current brochure are taken from the test report which does not include the cool down period. Values should be based on manufacturer rated values as far as possible. Approaches to this issue should be discussed by the committee including the measurement and reporting of cooldown time in the test report.

**Data Sources:** There are no specific data sources for this issue.

### **3.8. Highlighting Capacity on the Energy Label**

**Issue:** Clothes dryer capacity is a key variable of concern to consumers. Although the capacity is currently shown on the label, it is in small print.

**Discussion on the Issue:** Consideration should be given to highlighting capacity on the energy label. If recommended, this should be tested on consumers.

**Data Sources:** The international review of energy labelling provides examples of clothes dryer labels for consideration.

## **4. Clothes Washers**

### **4.1. Manufacturers Overstating Rated Capacity**

**Issue:** There has been a distinct increase in claimed capacities for larger top loading clothes washers in recent years, even when the physical dimensions have remained constant. This is now starting to occur in the front loader market.

**Discussion on the Issue:** Claimed (rated) capacity levels have been pushed to a level where there has been a distinct and noticeable decline in performance of clothes washers. Manufacturers are doing this as a means of increasing their star ratings or possibly for marketing advantages. Although there has been some regulatory action to date, this has been partly hampered by the fact that there has been some variation in the washability of various soil swatch batches. These variations make determination of performance failure less certain in some cases.

The new standard for clothes washers has been published and this contains a process for swatch normalisation, which should make the performance limits in the standard much more enforceable. This will result in the elimination of overstated capacities.

**Data Sources:** Brown (1998) discusses the issue in Section 9.1 (page 53). This issue is being considered by EL15/4 and it should not be necessary for the Committee to consider this further.

## **4.2. Wear and Tear Performance (cold washing)**

**Issue:** The current wear and tear limits in AS2040 are moderate. Cold water washing, with increased wash times to meet performance requirements may increase wear and tear on the clothes load to unacceptable levels.

**Discussion on the Issue:** The current limit for wear and tear is mild (severity of washing index of 0.5 for 3 runs - this is being reduced to 0.35 for a single run in AS/NZS2040-1998). The actual wear and tear on clothes could be increased if performance requirements are included for cold water washing (eg longer wash times). However, such requirements for cold water washing, if any, are unclear at this stage. The issue of wear and tear and the washing performance requirements are an issue for the committee to consider when cold water covered.

**Data Sources:** Brown (1998) raises the issue in Section 9.1 (page 53) and in section 9.2 (page 55). The issue is being adequately managed by the Standards Committee.

## **4.3. Washes per Year for the CEC**

**Issue:** The CEC on the label assumes 365 loads per year, whereas some sources suggest that this is an over-estimate.

**Discussion on the Issue:** The number of washer per year has a direct impact on the CEC. Clearly there will be a wide distribution of washes per year for different household types and there is some debate whether the mean or median is a more appropriate measure of the frequency of use. A number of data sources are available for consideration.

**Data Sources:** Brown (1998) raises the issue in Section 9.2 (page 54) and suggests the current number of washes per year is too high. The data he cites is Test Research (1995, Q69 page 41) which suggests an average number of “washing sessions” of about 3.7 per week (although the data was collected in a poor manner). Brown seemed to overlook the fact that this reference also suggests that each session consisted of around 2.34 loads of washing (Q70), giving the total washes per week as 8.7, which means that the current CEC understates the frequency, if anything. QEC 1993 also shows a Queensland average for 1992 at about 3.7 washes per week, but there is some uncertainty as to whether this is “loads” or “sessions”.

Some data is available in ABS8218.0 (1988) based on diary records in 1985/86, but this is based on hours of use rather than loads and is difficult to use directly (program times vary considerably between machines).

Another key source will be the Pacific Power Residential End-Use Study (Pacific Power 1996). The raw data contains actual in-use information for some 151 clothes washers for a period of about 18 months from early 1993 to mid 1994. While the raw data is to be analysed in the near future, it is still unclear whether any energy labelling data for the units measured will be available (it appears unlikely). The reported

energy consumption is 55 kWh per year (Pacific Power 1996), which is consistent with 365 loads per year at 0.15 kWh per load (almost all units in Australia will use external hot water).

Some data on frequency of use may be available from manufacturers, as this data is sometimes recorded within the machines for service purposes.

#### **4.4. Program Nominated for Energy Labelling**

**Issue:** Program nominated for energy labelling should be the one recommended by the manufacturer for a normally soiled cotton load.

**Discussion on the Issue:** This requirement is now included in AS/NZS2040 Part 2. The performance requirements in Part 1 also relate specifically to the program recommended for a normally soiled cotton load.

**Data Sources:** Brown (1998) raises the issue in Section 9.2 (page 54). It should not be necessary for the Committee to consider this further.

#### **4.5. Cold Water Washing**

**Issue:** There is a long term towards increased use of cold water washing in Australia. This trend should be reflected in the energy label to show consumers the energy benefits of cold water washing.

**Discussion on the Issue:** This is a well documented problem with the current energy labelling system for clothes washers. From a labelling perspective, cold water washing will have the biggest impact where the consumer can compare the energy savings of cold water washing with warm water washing, so it may be desirable to show both on the label. However, selection of a warm wash or a cold wash temperature is a behavioural aspect of energy use and the energy label is not likely to be very effective at reinforcing these trends once the machine is purchased and the label removed. Trends in wash temperatures in Australia are as follows:

<b>Wash Temperature Mostly Used</b>	<b>Cold</b>	<b>Warm</b>	<b>Hot</b>
1988	31%	53%	16%
1992	44%	49%	7%
1995 **	54%	41%	4%

Source: Chapter 5, GWA (1993), Test Research (1995)

Note \*\*: 1995 figure was for last wash load, not mostly used, but should be equivalent

The main issues to be addressed are washing performance requirements and capacity for cold water washing: should performance requirements be specified for machines which are labelled for cold water washing and can a machine have a different rated capacity for cold washing and warm washing? This is potentially a very complicated issue.

Obviously, the star rating algorithm will need to be revisited in the light of inclusion of cold water washing into the program. It will probably need revision in any case, even if cold water washing is not included. Revision will also allow the removal of the small size bias from the current algorithm if this is thought to be necessary. Note that even with cold water washing (ie very low energy consumption), it is not possible to achieve 6 stars under the current algorithm.

**Data Sources:** Brown (1998) raises the issues of cold water washing in Section 9.2 (pages 54-55) and revised algorithms in Section 9.3 (page 56) where a number of options are canvassed.

#### **4.6. Spin Credit in Star Rating**

**Issue:** The spin performance of a clothes washer is partly reflected in the clothes washer star rating on the basis that some consumers will place the load directly into a clothes dryer. However, the influence of spin performance on star rating should be reviewed based on the latest data.

**Discussion on the Issue:** The impact on spin index should be reviewed if the energy labelling algorithm is revised on the basis of average clothes dryer characteristics, data on frequency of use and ownership of clothes dryers in Australia. It has been suggested that the spin performance should also be partly included in the CEC, but this would be double counting the energy, as all dryer energy is shown on the dryer label. When the labelling algorithm is examined in detail, various options will be considered with and without spin performance included in the star rating equation.

**Data Sources:** Brown (1998) raises the issue in Section 9.2 (pages 55-56). Data on frequency of use of clothes dryers will be covered under Section 3.1, Determination of Clothes Dryer CEC). Data on trends in ownership are available by state and nationally in EES (1998). Information on average characteristics of new clothes washers and clothes dryers are available in EES (1997).

#### **4.7. Inclusion of Water Consumption on the Energy Label**

**Issue:** There is a case for inclusion of water consumption on the energy label.

**Discussion on the Issue:** Information on water consumption is already included in energy labelling brochures. Should this also be included on energy labels? There is the question of jurisdiction - whether there is power to require water consumption to be supplied and whether false claims can be addressed under the current heads of power. Values in current brochures are taken from the test report. However, values should be based on manufacturer rated values as far as possible so that the potential for conflict between claimed values and values on the energy label are minimised. Approaches to this issue should be discussed by the committee.

**Data Sources:** There are no specific data sources in addition to energy labelling brochures for this issue. See also results of recent focus groups where inclusion of water consumption tested very positively.

#### **4.8. Inclusion of a Rinse Performance Requirement**

**Issue:** The current and proposed clothes washer standards do not include a minimum rinse performance requirement. With the declaration of water performance and water efficiency labelling, there is pressure to reduce water consumption through reduced rinsing, hence a minimum performance requirement is needed.

**Discussion on the Issue:** Standards committee EL15/4 is highly conscious that this performance requirement is missing from the clothes washer standard. The fundamental problem is that there have been difficulties developing a repeatable and reproducible test procedure. Without a test procedure, it is not possible to specify a minimum performance requirement. Further development work on the IEC procedure is proposed by EL15/4 in 1998.

**Data Sources:** There are no specific data sources for this issue. It should not be necessary for the Committee to consider this further as this is being adequately handled through the standards process.

#### **4.9. Suds Saver**

**Issue:** Should the suds saver feature get some sort of credit under the energy labelling program?

**Discussion on the Issue:** Suds saver is a water conservation issue and is not related to energy consumption (it is equivalent to a cold water wash). It is recommended that this feature be not shown on the label. The committee should consider whether it is possible or worthwhile to show the feature on energy labelling brochures.

**Data Sources:** There are no specific data sources for this issue.

#### **4.10. Declaration of Spin Performance**

**Issue:** Should spin performance be shown on the label or in the energy labelling brochures?

**Discussion on the Issue:** It has been agreed with industry that spin performance is a performance variable that generates a good deal of public interest as it is also currently required to calculate the EER. While spin performance is probably not suitable for inclusion on the energy label, the data could be shown in the energy labelling brochures and on the Internet site.

**Data Sources:** There are no specific data sources in addition to energy labelling registers which have data on spin performance.

#### **4.11. Highlighting Capacity on the Energy Label**

**Issue:** Clothes washer capacity is a key variable of concern to consumers. Although the capacity is currently shown on the label, it is in small print.

**Discussion on the Issue:** Consideration should be given to highlighting capacity on the energy label. If recommended, this should be tested on consumers.

**Data Sources:** The international review of energy labelling provides examples of clothes washer labels for consideration.

### **5. Dishwashers**

#### **5.1. Definition of Capacity**

**Issue:** Historically, there appeared to be excessive capacity claims for dishwashers.

**Discussion on the Issue:** Claimed capacity levels for dishwashers were high in the early 1990's, but capacity definitions have been carefully revised and included in the new version of AS/NZS2007-1998. Claimed capacities have also been dropping in recent years (EES 1997) in the expectation of the new standard. The use of a reference machine in the new standard will also mean that minimum performance requirements are more enforceable. This issue is unlikely to be a problem in the future.

**Data Sources:** Brown (1998) discusses the issue in Section 10.1 (page 64). It should not be necessary for the Committee to consider this further.

#### **5.2. Washes per Year for the CEC**

**Issue:** The CEC on the label assumes 365 loads per year, whereas some sources suggest that this is an over-estimate.

**Discussion on the Issue:** The number of washer per year has a direct impact on the CEC. Clearly there will be some distribution of washes per year for different household types and there is some debate whether the mean or median is a more appropriate measure of the frequency of use. A number of data sources are available for consideration.

**Data Sources:** Brown (1998) raises the issue in Section 10.2 (page 64) and suggests the current number of washer per year is too high. The data he cites is Test Research (1995, Q48 page 32) which suggests an average number of uses of about 4.0 per week

(210 times per year) (although the data was collected in a poor manner). QEC 1993 did not collect data on the frequency of use of dishwashers.

Some data is available in ABS8218.0 (1988) based on diary records in 1985/86, but this is based on hours of use rather than loads and is difficult to use directly (program times vary considerably between machines).

Another key source may be the Pacific Power Residential End-Use Study (Pacific Power 1996). The raw data contains actual in-use information for some 65 dishwashers for a period of about 18 months from early 1993 to mid 1994. The raw data will soon be available for analysis but it is still unclear whether any energy labelling data for the units measured will be available.

In Europe, dishwasher use is likely to be similar to Australia. Sidler (1997) indicates that average use is 3.6 times per week based on end use metering results. The diary data for the same households that were monitored showed that consumers overestimated their actual use by about 30%, so care needs to be taken when using consumer diary or recall data (Sidler 1997). The author warns of the danger of relying on consumer reports of appliance use.

Some data on frequency of use may be available from manufacturers, as this data is sometimes recorded within the machines for service purposes.

### **5.3. Program Nominated for Energy Labelling**

**Issue:** Program nominated for energy labelling should be the one recommended by the manufacturer for energy labelling.

**Discussion on the Issue:** The requirement in AS/NZS2007-1998 is a little ambiguous as it possibly allows the manufacturer to specify a program for energy labelling purposes that is different to the one recommended for normally soiled dishware. In addition, the dishwasher must meet the minimum washing and drying performance requirements on the program nominated for energy labelling.

The only serious issue for consideration is where a manufacturer recommends an obscure program for energy labelling purposes and a different program for normal use. There should be much stronger links between manufacturer recommendations, product literature and the program used for labelling. Recommendations by the committee should be implemented through the standard.

**Data Sources:** Brown (1998) raises the issue in Section 10.2 (page 64-65).

### **5.4. Bunching of Star Ratings**

**Issue:** Star ratings for dishwashers are bunched around 4 and 5 stars, with only a few models at 3 stars or lower.

**Discussion on the Issue:** There is a case for the downward revision of the dishwasher algorithm, as there is bunching at 4 and 5 stars and there are a number of models at 6 stars. However, many of the models on the market are based on similar technology, so care is needed to ensure that artificial differences are not created during re-grading.

**Data Sources:** Brown (1998) discusses the issue in Section 10.3 (page 65). The main data source is the energy and capacity characteristics on the market at present, which is available from the energy labelling register. These are shown in the energy labelling brochures (copy attached). An electronic copy is available for further analysis.

### **5.5. Size Bias in Algorithm**

**Issue:** The current star rating system is based on kWh per place setting. There is currently a size bias in this rating system which makes small units appear less efficient.

**Discussion on the Issue:** Most dishwashers sold in Australia at the moment are standard sized (600mm wide). Small dishwashers only have a very small market share. Small dishwashers are in fact somewhat less efficient than standard sized units, but consideration could be given to removing the size bias if and when the labelling algorithm is revised, but this is not likely to be a high priority.

**Data Sources:** Brown (1998) mentions the issue in Section 10.3 (bottom of page 65). The main data source is the energy and capacity characteristics on the market at present, which is available from the energy labelling register. These are shown in the energy labelling brochures (copy attached). An electronic copy is available for further analysis.

### **5.6. Highlighting Capacity on the Energy Label**

**Issue:** Dishwasher capacity is a key variable of concern to consumers. Although the capacity is currently shown on the label, it is in small print.

**Discussion on the Issue:** Consideration should be given to highlighting capacity on the energy label. If recommended, this should be tested on consumers.

**Data Sources:** The international review of energy labelling provides examples of dishwasher labels for consideration.

### **5.7. Inclusion of Water Consumption on the Energy Label**

**Issue:** There is a case for inclusion of water consumption on the energy label.

**Discussion on the Issue:** Information on water consumption is already included in energy labelling brochures. Should this also be included on energy labels? There is the question of jurisdiction - whether there is power to require water consumption to be supplied and whether false claims can be addressed under the current heads of power. Values in current brochures are taken from the test report. However, values should be based on manufacturer rated values as far as possible. Approaches to this issue should be discussed by the committee.

**Data Sources:** There are no specific data sources in addition to energy labelling brochures for this issue. See also results of recent focus groups.

### **5.8. Claimed Capacity versus Actual Use**

**Issue:** Dishwashers in actual use are likely to be used at a lower capacity than that defined in the standard.

**Discussion on the Issue:** This issue was raised by Patterson (1998). The definition of capacity in the standard provides a repeatable and reproducible test method for comparison of dishwashers. Every consumer is likely to use a dishwasher in a different way (even vary their use from day to day in terms of load items and soils), so there is no possibility of developing a test procedure which accurately reflects the range of consumer behaviour. The standard test is rigorous and requires good performance for both cleaning performance (removal of soil) and filtration (redeposition) under heavy soil loads.

**Data Sources:** AS/NZS2007.1-1998 defines the test procedure for dishwashers. The committee should be aware that there is a new IEC international dishwasher standard under development. It should not be necessary for the Committee to consider this further.

### **5.9. Minimum Wash Performance Requirement**

**Issue:** Some have argued that the minimum wash performance requirement in AS/NZS2007 is too stringent and this impacts on energy.

**Discussion on the Issue:** This issue was raised by Patterson (1998). The minimum wash performance has been modified in the new version of AS/NZS2007-1998 so that the test machine performance is compared against a specified program on the reference machine. The intention was to ensure that the wash performance requirement is broadly equivalent to the old method under AS2007-1988. The degree of equivalence is still being assessed by manufacturers. Historically, the wash performance requirement in AS2007 has been regarded as satisfactory from a consumer perspective. There is no compelling evidence that this needs to either be strengthened or weakened. In any case, this is an issue for Standards Committee EL15/4 and is currently under consideration by a working group.

**Data Sources:** AS/NZS2007.1-1998 defines the performance requirements for dishwashers. It should not be necessary for the Committee to consider this further.

### **5.10. Performance and Energy for Half Loads**

**Issue:** Should consideration be given to a half load test for energy and performance?

**Discussion on the Issue:** Most dishwashers are designed to operate fully loaded (even though there are usually 2 baskets, there is effectively only a single compartment). A few models have an option to conserve water and energy for part loads through some minor adjustments to water volumes and temperatures, but these tend to be incremental in nature. This issue arose primarily due to the appearance of the new Fisher & Paykel dishwasher which has separate drawers which can be operated separately or together. This feature significantly reduces energy and water consumption for a half load. While the committee may wish to consider this issue, it is unclear if or how such data should be shown on the energy label. It may be more appropriate to show this in brochures. One option would be to request EL15/4 to develop an approach for testing such a dishwasher at half load (eg it could carry a label for both half load and full load operation).

**Data Sources:** Fisher & Paykel product and performance literature.

## **6. Other Issues Raised by Patterson**

### **6.1. Putting Energy Cost on the Label**

**Issue:** Consumers find the issue of kWh difficult to grasp and generally relate better to the cost of operation.

**Discussion on the Issue:** This is a vexed question and one that is central to the whole energy label labelling program in terms of continuity across all product types. On the pro side, \$ on the label make it more consumer friendly - consumers consistently prefer \$ to kWh on energy labels. However, on the con side, some consumers become confused with \$ on labels (is it the cost of energy, or the energy savings or is it related to the cost of the appliance?), there is a wide range of tariffs in the residential sector making an average national figure less relevant (and especially for NZ, given they use the same label but have a different currency) and \$ values require constant updating of labels. A range of data sources need to be considered in detail before a decision is made.

**Data Sources:** Artcraft report on the energy label focus groups provides valuable base line data on consumer understanding and desires (Artcraft 1998). The international review of energy label evaluations (EES) provides a summary of international experience. Internationally, there is a general tendency not to put costs on energy labels but to supply this in supplementary information (eg brochures or Internet).

### **6.2. 6th Star is Invisible**

**Issue:** The energy label has a possible 6th star, few consumers are aware of this.

**Discussion on the Issue:** With the current design, the 6th star is not labelled or marked in any way, so that few consumers are aware of its existence. This probably needs to be redressed if the label is redesigned. One option is to regrade to 5 stars, and/or show all stars in some form of outline mode. Showing fractional stars in some form is another option. Any proposals need to be tested on consumers.

**Data Sources:** Artcraft report on the energy label focus groups provides valuable base line data on consumer understanding (Artcraft 1998).

### **6.3. How can consumers know that they have found the best?**

**Issue:** The current system of star ratings is absolute in nature and does not directly provide a rating in comparison with similar products on the market.

**Discussion on the Issue:** This is a fundamental issue regarding the label design. An absolute rating scale (eg used in most labelling programs other than USA/Canada) provides a subjective measure of absolute efficiency (ie good to bad). Where the

technical efficiency is low, the efficiency rating is low, even where this may be the most efficient product available in that particular category. In this respect, a consumer may get frustrated because they may continue to look for a better product where none exists.

A relative rating system (eg USA/Canada) shows the energy consumption of a product of interest relative to similar models. While such a label gives good comparative information for one product, it does not facilitate comparison of models. The problem with this system is that comparative information (shown in terms of kWh values or \$ operating cost) is much more difficult for a consumer to remember data for many models and there is generally very poor recall once a number of products are examined. The other major problem is that relative rating scale needs to be updated on a regular basis (annually or biennially), which means that the rating system is a moving target from a manufacturer perspective - there are no clear efficiency goals to achieve. “Star engineering” (making incremental efficiency improvements to achieve the next star rating) is a well understood engineering concept for local manufacturers.

To some degree, problems of relative model performance within an absolute rating system can be addressed through the improved provision of market data via brochures at point of sale, for example, where all models are listed in order of descending efficiency. Another program option which could also assist is the use of an endorsement program to indicate “best in class” models in conjunction with the energy label. Endorsement labels in this context are complementary to comparison labels.

**Data Sources:** Artcraft report on the energy label focus groups provides valuable base line data on consumer understanding (Artcraft 1998). The international review of energy label evaluations (EES) provides a summary of international experience.

## **7. Other Issues Raised by the Committee**

### **7.1. Other products to be covered by energy labelling?**

**Issue:** Should other product groups be the subject of energy labelling?

**Discussion on the Issue:** While this is probably within the scope of the Committee, it is generally agreed that short term efforts should be concentrated on those products which already carry a label, where there is a strong case for revision.

**Data Sources:** A summary of residential end use energy consumption by GWA (1998) provides an indication of key energy consumption areas and possible candidates for future energy labelling programs. This issue is being further considered by NAEEEC.

### **7.2. Checktesting Program**

**Issue:** Information on government checktesting activities should be higher profile. Industry needs to have confidence that regulations are being enforced so that their investments in higher efficiency products are protected from non-complying competitors.

**Discussion on the Issue:** A national checktesting program has been under way for 6 years, but the public profile to date has been very low key. A range of issues are currently under consideration by NAEEEC, particularly raising the profile of the program to increase its deterrence value and to encourage 3rd party participation. This is particularly important into the lead up to the introduction of MEPS for refrigerators and electric water heaters in late 1999. NAEEEC is also considering the issue of policing.

**Data Sources:** NAEEEC will communicate proposals to the Committee in due course.

### **7.3. Managing the Standards Process**

**Issue:** With re-publication of all of the appliance standards used for energy labelling, a coordinated program of conversion to these standards needs to be implemented. Any new changes recommended by the committee also need to have an implementation timetable.

**Discussion on the Issue:** By mid 1998 all of the Australian Standards used for energy labelling were re-published in the new 2 part format. NAEEEC and industry need to develop an implementation timetable for these new standards to become operational.

In addition to this, part of the recommendations of the Appliance Energy Labelling Review Committee will be the development of an implementation timetable for any new labelling requirements, including transition arrangements to the new system. Transition arrangements also need to be considered for future energy label revisions, which may be recommended on a regular cycle.

**Data Sources:** There are no specific data sources for this issue.

#### **7.4. Highlighting kWh Units for CEC**

**Issue:** The CEC is highly visible on the energy label, but the units are unclear.

**Discussion on the Issue:** The units of “kWh per year” for the CEC are in very small print on the next line, so the units may be unclear to consumers. Any proposals need to be tested on consumers.

**Data Sources:** Artcraft report on the energy label focus groups provides valuable base line data on consumer understanding (Artcraft 1998).

#### **7.5. Standby Consumption of Labelled Appliances**

**Issue:** Test procedures in Australian Standards include only the energy consumed during the test. Some appliances with electronic controls now consume significant energy when not in use, which needs to be included on the energy label.

**Discussion on the Issue:** Standby power consumption for models with electronic controls is becoming significant in some cases - standby losses can be as high as 20 watts in some cases, which equates to 175 kWh per year. This is of a similar order to the total CEC for some appliances. The relevant standards committees should be requested to modify all relevant standards to measure standby energy consumption (ie when the unit is off), so that this value can be included in the CEC value in future. This applies to all labelled appliances other than refrigerators and freezers (as “off” time energy consumption is included within the energy test procedure). Determination of standby losses for electric storage water heaters is also not relevant.

The standard will need to define various “states” of energy consumption (standby, delayed start, off mode etc) in the Part 1 standard. For clothes washers, clothes dryers and dishwashers, the Part 2 standard can then sum data on assumed uses per year and energy per cycle (as is currently specified) with standby losses (if any) for non-use periods - these will total to give the CEC for the year. Standby losses (power) are likely to be eventually be shown in brochures and the Internet.

Standby losses for air conditioners may be more difficult to incorporate directly into the CEC (eg if hours of use per year are removed and units show only power consumption). It may be necessary to declare standby power consumption separately.

**Data Sources:** There are no specific data sources for this issue.

## **7.6. Relation between Algorithm and Actual Use**

**Issue:** The algorithm is intended to reflect average use, but this is not always the case.

**Discussion on the Issue:** There are two elements to this issue. The first is that the test procedure should, as far as is possible, reflect real consumer use of the product. This is not always the possible (eg under-loading dishwashers and clothes washers, running air conditioners at less than rated capacity, refrigerators running in an ambient of less than 32°C but with door openings and food loads), but generally the test procedure tries to reflect actual use within the bounds of having a repeatable and reproducible test method. Standards committees are generally well aware of these issues and are generally try to improve test methods to reflect consumer behaviour as far as is possible. It should not be necessary for the Committee to consider this further. However, if there are any improvements to make the test procedures more relevant, these should be suggested to the relevant standard's committee.

The second element is how data from the test procedure is used within the energy label algorithm. Historically, data on frequency and duration of use has been used to develop the algorithms, but there are now a number of known cases where large discrepancies exist (eg clothes dryers, air conditioners). The job of the committee is to improve and minimise these discrepancies as far as is possible, based on the available data.

One of the issues raised within the appliance groups above is mean frequency of use versus the median value, which may be more reflective for the population. Unfortunately, little data on frequency distributions of use are generally available. Other issues include climatic variations around Australia (eg air conditioners, and to a lesser degree, refrigerators), policy implications of intentional overstating of energy (eg makes efficiency appear more cost effective to the consumer) and cases where bi-modal distributions may exist (eg clothes dryers - some high users and mostly low users).

**Data Sources:** Data sources are already included above.

## **7.7. Use of Galaxy Award as an Endorsement Label**

**Issue:** The Galaxy Award could be used as a clear indicator of “best in class” but the national profile of the Awards needs to be raised.

**Discussion on the Issue:** The Galaxy Awards may present an opportunity to implement an endorsement label which can work in conjunction with the normal energy label which applies to all appliances. If implemented, this would help consumers to easily identify “the best” in category appliances. There are other options for endorsement labels for appliance, such as US EPA's energy star. However, before

this could be used, Australia would need to get permission to be able to set local criteria for major appliances.

***Data Sources:*** The international review of energy label evaluations (EES) provides a summary of international experience.

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