MULTI-SPLIT SYSTEM AIR CONDITIONERS

THE CASE FOR MINIMUM ENERGY PERFORMANCE STANDARDS

Australian Government
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EQUIPMENT ENERGY EFFICIENCY

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1. INTRODUCTION

Australian and New Zealand energy efficiency regulators are proposing an extension to the scope of minimum energy performance standards (MEPS) for air conditioners to cover multi-split air conditioners. This fact sheet is the first stage in the public consultation process and is released for comment by the Equipment Energy Efficiency (E3) Committee.

2. HISTORY

Split-system air-conditioners were originally developed as a means of air conditioning where multiple indoor units were connected to a single outdoor unit controlled by a single thermostat and control, basically an alternative to ducted systems. These simple systems were designed mainly for commercial applications where the installation of ductwork was either too expensive, or aesthetically unacceptable. The small-bore refrigerant piping, which connected the indoor and outdoor units, was easier to install in many applications than metal ducting. Four indoor units could be connected to one outdoor unit in some models, but the most popular arrangement was a "two to one" combination (two indoor units and a single outdoor unit). All units utilised single-speed compressors. No inverters were offered. Common applications were small restaurants, bars etc. Since one thermostat/control station operated the whole system, individual control of the indoor units was not possible.

These systems were popular in Asia, particularly Japan, but failed to capture any significant market in Australia.

As these simple systems were controlled by a single thermostat, they were within the scope of AS/NZS 3823.1.1, AS/NZS 3823.1.2 and AS/NZ 3823.2, and have been required to comply with energy labelling and MEPS legislation since the clarification of the scope in 2002. *(Ref: AS/NZS 3823.1.1, Amendment 2, 15 August 2002)*

3. THE CURRENT SITUATION

The simultaneous development of inverters, sophisticated refrigerant control systems and electronics, enabled separate individual indoor units to be each controlled by their own thermostats, with some systems even able to heat and cool separate areas simultaneously. This type of system is referred to in the International (ISO) and Australian/New Zealand standards as a multi-split system (multiple indoor heads with separate controls for each head).

These systems were originally known in the air-conditioning industry as Variable Refrigerant Volume (VRV) or Variable Refrigerant Flow (VRF). It was considered that these types of systems were outside the scope of the ISO and AS/NZS test standards of the time. No international standards existed and sales were low. Developing a specific test method for multi-split systems in isolation from the international community made little sense. Delaying MEPS implementation for standard systems to include multi-split systems was not a logical option; therefore AZ/NZS 3823.2 included the clause:

> *"The following equipment is excluded from the scope of this Standard:*
>
> *...*
>
> *(b) Multi-split systems (i.e., those having more than one indoor unit with an independent control for each indoor unit) pending the development of a suitable test method. "*

Since then,

1. AS/NZS 3823.1.1 and AS/NZS 3823.1.2 standards have been clarified to clearly cover inverter systems.
2. A comprehensive ISO draft standard has been developed over the last 6 years specifically for multi-split systems. This standard was developed with the cooperation with all of the major overseas manufacturers and is now available in draft form.
3. Sales of multi-split systems, particularly the VRF, type have grown dramatically.

4. MARKET SHARE/GROWTH

CLASSIFICATION OF SYSTEMS

It is necessary to identify the two types of multi-split systems.

One is the Fixed Head type. These are small capacity systems output up to 10kW which are used almost exclusively for residential applications. They are commonly supplied as a twin head, three head or four head outdoor unit connected to the corresponding number of matching indoor units.

The second type of system is the VRF type. The capacity of the outdoor unit is up to 140 kW with possible connection of up to 48 indoor units.

Figure 1: Residential Fixed Head Multi-split system (two two-head systems shown)

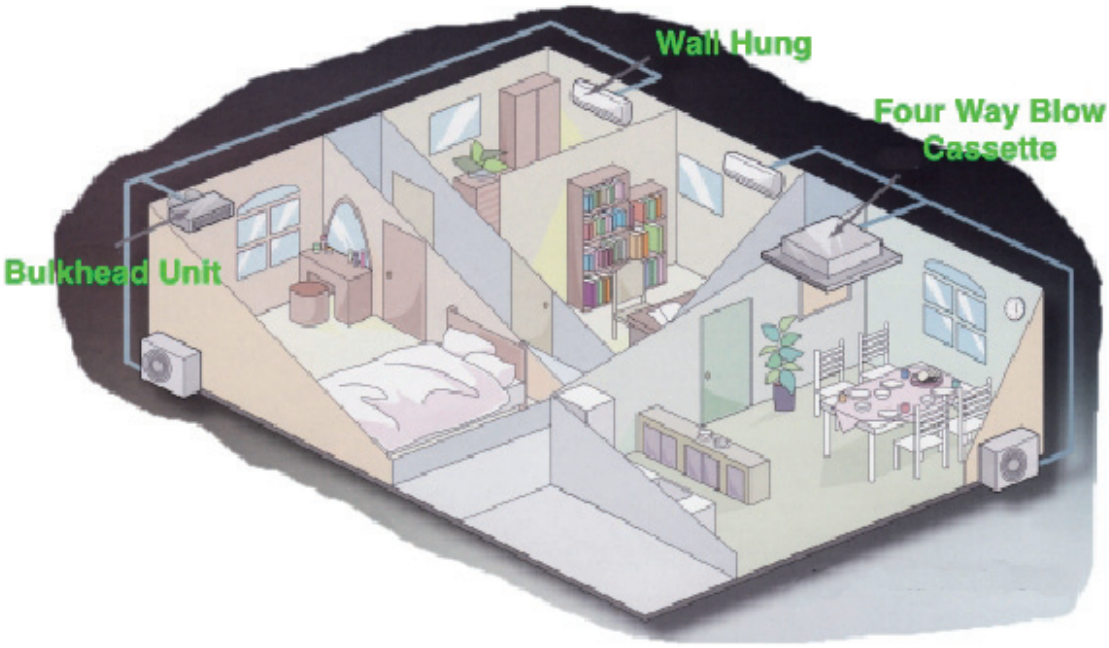
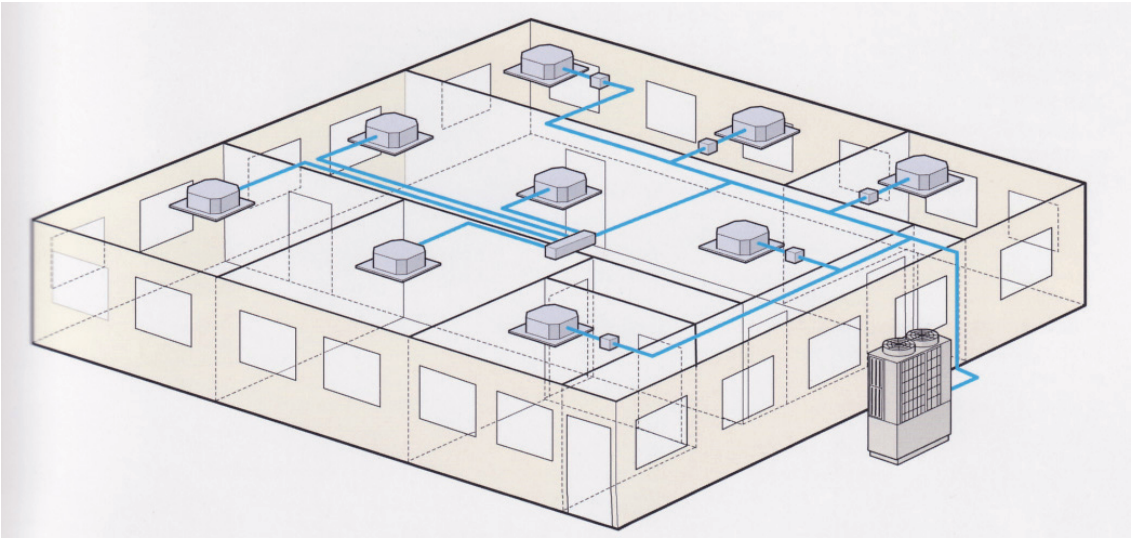


Figure 2: VRF Multi Split System (showing nine indoor units connected to one outdoor unit)



SALES OF FIXED-HEAD TYPE

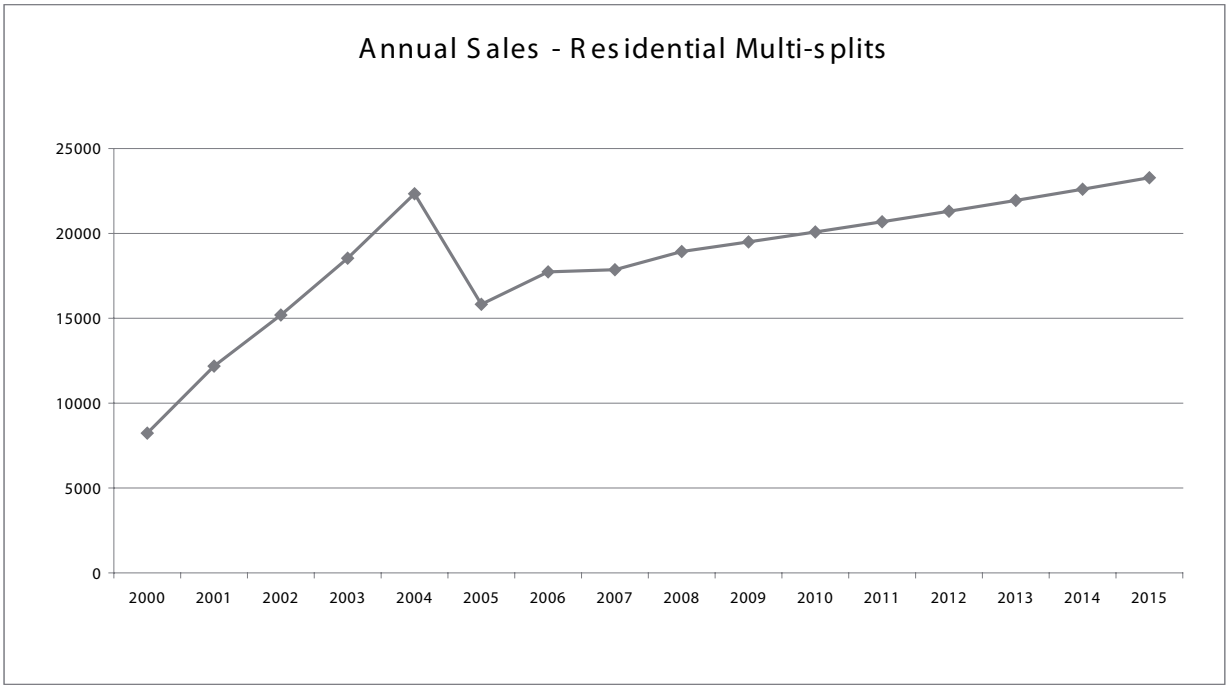
Most sales are to apartment buildings, with the outdoor unit on the balcony and commonly connected to three indoor units.

The growth of sales of multi-split systems in this market is not at the expense of single split systems, but water cooled ducted systems. Multi-split systems are less costly to install, maintenance is minimal and individual room control is possible. Thus sales for multi-split systems have grown very quickly since 2000 and now fluctuate relative to the construction of apartment buildings (which can vary considerably from year to year). Most small multi-split system sales are recorded by GFK (Informark) – see Figure 3.

The most common Fixed-Head multi-split system sold is the three head unit. A three-head unit is really the equivalent of three single split systems. Therefore 20,000 small multi-split systems are roughly equivalent to 60,000 single split systems.

Figure 3 below utilises data from GFK (Informark) reports to 2008 and projections to 2020 are based on current market trends.

Figure 3: Fixed Head Residential Multi Projected Sales



Note: Data source Informark to 2008, assume 3% pa growth from 2008

SALES OF VRF MULTI-SPLIT SYSTEMS

Sales of VRF multi-split systems have also grown at the expense of more traditional commercial systems. In particular sales of VRF units have displaced sales of water-cooled package units, large air cooled splits and roof top package units. The impact of this is graphically illustrated in the commercial energy consumption pie chart (See Figure 5 – Page 7).

Industry advice is that 90% of VRF sales are commercial and 10% are high value residential.

As GFK (Informark) does not report on VRF products and the only reliable source of information comes from The Department of Environment, Water, Heritage and The Arts, Ozone and Synthetic Gas Import Data. This data covers all multi-split systems including small residential. By subtracting the GFK data on small mutli-split systems from the total OSGT we are able to determine the VRF component. It is important to note that not all manufacturers contribute to GFK on small mutli-split systems. Therefore, a figure of 15% unreported has been used as a conservative guide to total small multi-split system sales.

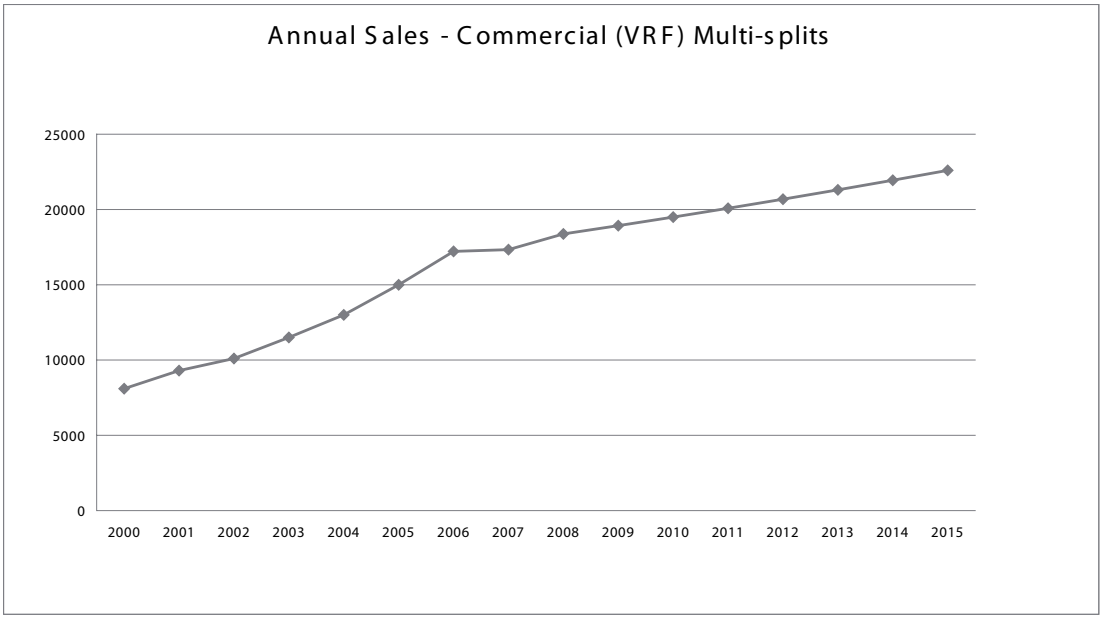
This calculation is based on 2006 because we have full year data from both OSGT and GFK.

Ozone and Synthetic Gas Data	Total number of Mutli-Split Systems Imported	= 37,608
GFK (Informark) Data	Small Fixed Head Systems	= 17,735
	Unreported Calculation	GFK x 1.15(15%) = 20,395
	Subtract from Total	37,608 – 20,395
	Therefore VRF Sales	= 17,215

With an average number of eight indoor units sold with each VRF outdoor this is the equivalent of 137,720 single-split systems.

The unit quantity for 2000 was derived from the Japan Refrigeration and Air-Conditioning Industry Association (JRAIA) export figures. Growth over this period to year 2006, has been at an average of 12% per annum. Projected The projected sales growth from 2008 is assumed to be 3% pa.

Figure 4: Projected Growth of Commerical VEF Units



Note: Source – author estimates and OSGI data to 2008, projected 3% pa growth from 2008

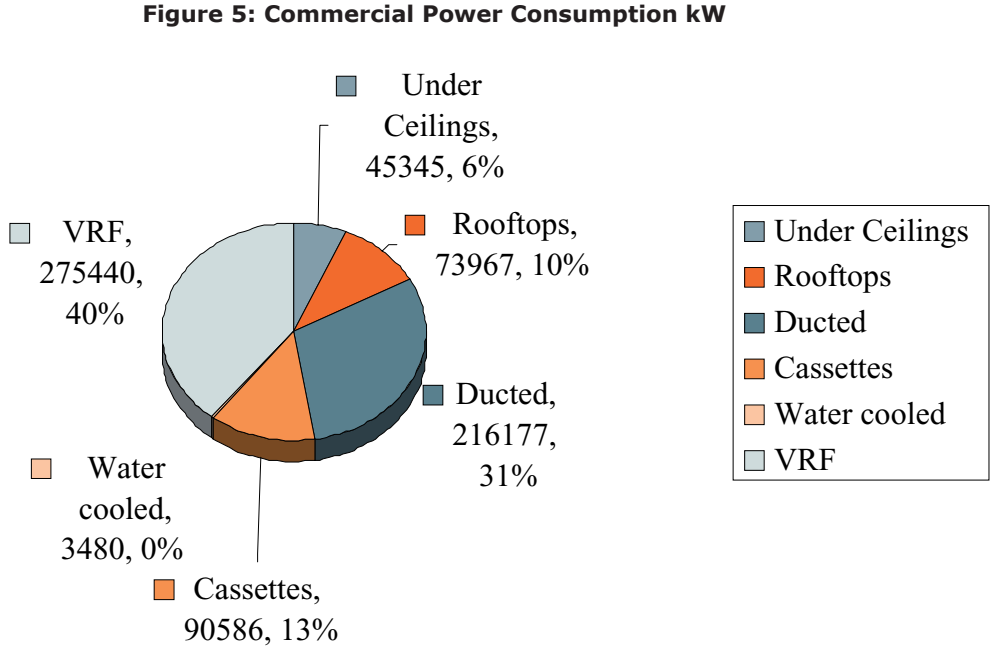
5. POWER CONSUMPTION YEAR 2006

COMMERCIAL POWER CONSUMPTION

The figures below are based on 2006 GFK data for Heat Pump products so as to compare with OSGT import data for 2006. The kW input for GFK units has been calculated based on 2004 MEPS by the number of units sold in each category. VRF data is based on 17,215 units as previously calculated and industry advice of average input kW of 16kW.

Members of the E3 Committee are concerned that VRF units, which appear to have the largest market share in the medium commercial category, are currently unregulated.

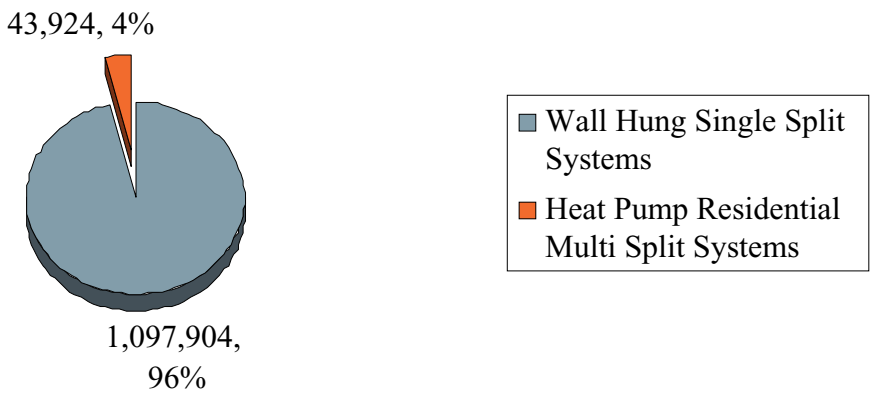
Figure 5: Commercial Power Consumption kW



RESIDENTIAL POWER CONSUMPTION

Graph data has been compiled from 2006 GFK for heat pump units only. There have been no adjustments for unreported sales. In 2006 GFK reported sales of heat pump single split systems sales of 569,585 versus multi-head heat pump sales of 14,873.

Figure 6: Residential Multi-split Power Consumption kW.



6. ENERGY SAVING POTENTIAL

As an initial estimate of potential energy savings, an average efficiency improvement of 16% has been assumed, which is comparable to the change in MEPS levels from 2004 MEPS to 2010. Based on preliminary data this will represent a savings in 2012 of:

Commercial (VRF) estimated kW	=	330 914 kW
VRF estimated kWh (based on 1200 h/yr)	=	397 096 339 kWh
Residential Multi-split system kW	=	52 770 kW
Residential kWh (based on 600 h/yr)	=	31 662 176 kWh
Total Energy Consumption (VRF + resid.)	=	428 758 515 kWh
Energy saving (16% reduction)	**=**	**68 601 362 kWh**

(The calculation showing estimated energy savings uses the total kW input of units reported to GFK in 2006, assuming all complied with 2004 MEPS, and then comparing that input (using the identical unit sales numbers) to the total input, if 2010 MEPS were applied, and an overall reduction of 16% was the result. Therefore 16% is used as the potential percentage of kWh saving).

MEPS should be applied to a product which enjoys, in the commercial sector at least, a large market share in its category. The growth of VRF into this market, here and overseas, would seriously undermine the viability of MEPS legislation if these products are not included. As commercial sector tariffs are generally expensive, the introduction of MEPS for these products should be highly cost effective. The prevalence of rental properties in the commercial sector mean that MEPS can help overcome split incentives which are often present in landlord-tenant relationships.

Because of the dominance of the commercial market by VRF that it would be unfair to apply anything other than MEPS levels that are of an equivalent stringency to both multi-split systems and competing products. Multi-split systems have inherent benefits for energy saving due to their ability to turn-down, and in technical terms should have no difficulty complying with MEPS levels that are in place for other types of air conditioners.

It is proposed that multi-split system MEPS levels would be implemented in 2012.

7. TEST AND MEASUREMENT STANDARD

If multi-split system air conditioners are to be regulated for energy efficiency (MEPS), it would be necessary to amend the scope of AS/NZS 3823.2 to include them and to set a MEPS level for the various types and sizes. AS/NZS 3823.2 would also need to specify a suitable test standard. Two possible options proposed.

Option 1. The scope of the existing standard (AS/NZS 3823.1.1 and 3823.1.2) used for determination of energy consumption and efficiency be expanded to incorporate multi-split systems.

To include multi-split systems in these Standards, it is necessary to add the condition that during the capacity test all indoor thermostat controls are over-ridden so that all units operate in the same mode, either full-load cooling or full-load heating. This would enable the Standard AS/NZS 3823.1.1 and AS/NZS 3823.1.2 to be used to determine compliance with any MEPS level introduced. Performance at full-load can be measured, and MEPS could be applied to these full load measured performance parameters in the same way as is currently done with single split air-conditioners.

Advantage

This is a very simple approach in the first instance; a simple modification to the descriptions of the test methods in the existing Standards is required.

Disadvantages

This approach would not enable a full range of tests for non-MEPS purposes to be carried out to Australian Standards on multi-split air-conditioners; to do this would require the development of a suitable test Standard, or the adoption of an International Standard. The only tests required for demonstration of MEPS compliance are full-load cooling and heating tests, together with the Maximum Cooling Performance Test. However, a complete range of tests on a multi-split air-conditioning system would include, in addition to the full-load cooling and heating tests, tests to measure the system's performance with only a proportion of the indoor units operating (on both cooling and heating) and, where provided for in the system, heat recovery performance. This is important as there is now a strong push towards a seasonal type energy efficiency rating which requires data at a number of load points for variable output systems. (Heat recovery in a multi-split system is operation with some indoor units in cooling mode and others in heating mode).

Once the new ISO Standards for non-ducted and ducted single-unit air-conditioners (ISO 5151, ISO 13253) are published and adopted for use as Australian Standards, these too would require similar modifications to include the test procedures for multi-split units, whereas with the alternative approach, described in below in Option 2, no such modifications would be necessary.

Option 2. To adopt ISO 15042 as an Australian Standard. Facilities currently available in Australia could test to this standard.

ISO 15042 "Multi-split system air-cooled air-conditioners and air-to-air heat pumps — Testing and rating for performance" was completed in draft form and sent to ISO Geneva Head Office for preparation as a Final Draft International Standard in late 2006. However, due to communication difficulties between the ISO TC 86 SC 6 Secretariat and the ISO head office, it still has not been issued for final ballot. At a meeting in Sydney of ISO TC 86 SC 6 WG 1, which developed the Standard, it was decided to fast-track any formatting and editorial changes necessary and prepare the Draft Standard for ballot early in 2009. It is not expected that any further technical changes will be made prior to final publishing.

Advantages

The test standard was developed with the cooperation of the Australian Standards Committee EL-015-16 and in consultation with the local technical community, and it is unlikely that it would require any changes if it were to be adopted in Australia for the purpose of MEPS.

This approach conforms to the general requirement that Australian Standards should, as far as possible, be based on or equivalent to international standards. This would ensure that the requirements for registration of the products in Australia would be compatible with Standards used in other countries, such as members of Asia Pacific Partnership on Clean Development and Climate, that adopt ISO Standards.

A significant advantage of the use of an International Standard, such as ISO 15042, is that it has been developed in cooperation with experts from countries in which many of these products are manufactured, so manufacturers will be already be aware of the requirements of the Standard. Consequently, it is expected that there should be no difficulties in their compliance with this Standard.

Disadvantages

At present, the draft ISO 15042 is still being prepared for public ballot, and is unlikely to be published as an International Standard until mid 2009, at the earliest. Once released as an FDIS, Australian Standards Committee EL 015 16 could begin the work of adopting this Standard as a new Australian Standard. An Australian Standard based on the FDIS (when released) could be prepared fairly quickly, even if only as an interim standard as the changes required will be similar to the existing cloned ISO standards for non-ducted and ducted air conditioners.

Of the two options, Option 2 appears to have the most potential to be a satisfactory response, in the long term. AS/NZS 3823.2 could then be modified to specify which clauses of the adopted ISO 15042 would be necessary to demonstrate compliance with the regulations. It is envisioned that, as with single-head systems, only full-load cooling and full-load heating tests would be required, together with the maximum cooling test. Additional points may be required if a seasonal rating system is developed for air conditioners.

8. THE AUSTRALIAN AND NEW ZEALAND REGULATORY PLAN

Multi-split systems were first investigated by the then Australian Greenhouse Office in November 2006. Further to that, the inverter test criteria were clarified to enable a progression onto multi-split system inverters. This fact sheet launches the consultation process for regulating multi-split systems in Australia and New Zealand and will be supported by a more detailed technical case and eventually a regulatory impact statement.

The Department of the Environment, Water, Heritage and the Arts on behalf of the Equipment Energy Efficiency (E3) Committee seeks feedback from stakeholders to this fact sheet.

9. CONTACT DETAILS FOR FURTHER INFORMATION OR TO MAKE SUBMISSIONS:

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Or via email to: energyrating@environment.gov.au

Website: www.energyrating.gov.au

10. REFERENCED STANDARDS:

AS/NZS 3823.1.1	Performance of electrical appliances—Airconditioners and heat pumps Part 1.1: Non-ducted airconditioners and heat pumps—Testing and rating for performance
AS/NZS 3823.1.2	Performance of electrical appliances— Airconditioners and heat pumps Part 1.1: Non-ducted airconditioners and heat pumps—Testing and rating for performance
AS/NZS 3823.2	Performance of electrical appliances—Airconditioners and heat pumps Part 2: Energy labelling and minimum energy performance standard (MEPS) requirements
ISO 5151	Non-ducted air-cooled air-conditioners and air-to-air heat pumps - — Testing and rating for performance
ISO 13253	Ducted air-cooled air-conditioners and air-to-air heat pumps – Testing and rating for performance
ISO 15042	(draft) Multi-split system air-cooled air-conditioners and air-to-air heat pumps — Testing and rating for performance