International Review of Minimum Energy Performance Standards for Air Conditioners

Report V1

Prepared for

AUSTRALIAN GREENHOUSE OFFICE

By

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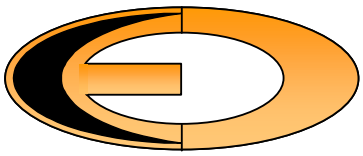

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INTRODUCTION

Background

The Australian Greenhouse Office (AGO) is the lead Commonwealth agency on greenhouse matters, responsible for both the coordination of domestic climate change policy and for managing the delivery of major new and existing Commonwealth greenhouse programs.

The National Appliance and Equipment Energy Efficiency Committee (NAEEEC) comprises officials from the Commonwealth, State and Territory government agencies, together with representatives from New Zealand is responsible for implementing product energy efficiency initiatives in those jurisdictions. NAEEEC's role is to coordinate the National Appliance and Equipment Energy Efficiency Program (NAEEEP). Through this program, the various Governments work together to develop and introduce measures that improve the energy efficiency of appliances and equipment used by households and business.

MEPS for Packaged Air Conditioning (PAC) equipment of up to 65 kW cooling capacity was implemented from the 1 October 2001. The minimum Energy Efficiency Ratios (EER) is specified in Australian New Zealand Standard AS/NZS 3823 for all air conditioners taking a three-phase electricity supply and with a cooling capacity up to 65kW. As part of the NAEEEC approach for MEPS, products are reviewed regularly and sufficient notice should be given to industry if changes are suggested to the MEPS levels. To meet world best practice for MEPS, a review of the international MEPS levels is proposed.

There are currently no specific MEPS for single-phase air conditioners. *The Scope for Application of Minimum Energy Performance Standards to Additional Household Appliances* (G Wilkenfield & Associates, December 2001) for NAEEEC has recommended that MEPS for these units be introduced.

Objectives of this Study

The AGO asked EnergyConsult Pty Ltd to identify and report on the international MEPS levels for airconditioners and propose the international MEPS levels that would be appropriate for Australia to consider for the various airconditioners product categories. In addition, the preliminary greenhouse impacts of the MEPS are estimated.

It should be noted that this report is a preliminary discussion paper for the purpose of obtaining feedback on the proposed MEPS levels and is not the final recommended MEPS program. The objective of this report is to inform the reader of the range of international MEPS and our assessment of which are the most appropriate, based on the research conducted. Of course, the report does not represent the views of the Australian Greenhouse Office nor any particular stakeholder.

Methodology

The research focused on obtaining information on international MEPS programs for air conditioners and what MEPS regimes would be applicable to Australia. The overall tasks associated with this project are:

- Review the international MEPS levels currently in force and compare them to the Australian situation.
- Analyse these different MEPS levels in terms of the AS/NZS test procedure (as far as is possible) and make recommendations to the AGO on the likely Australian levels and timing for consideration.
- Estimate the likely greenhouse abatement from the introduction of the suggested MEPS levels and the implications for these levels with the current models on the market.
- Work with Professor Leonardi on the proposed changes that would be required for the current Australian Standards.
- Support the AGO with technical advice for stakeholder consultation, including modelling alternative MEPS levels as required, and assistance with the preparation of the Regulatory Impact Statement (RIS).

SUMMARY

This document examined the testing standards and MEPS for airconditioners for countries relevant to Australia. Those relevant to Australia were countries that have MEPS for single and three-phase airconditioners and were major trading partners. The countries examined were:

- Japan
- USA
- China
- Korea
- Taiwan (Chinese Taipei)
- Singapore
- Philippines

The country's MEPS levels were compared to the efficiency of current Australian models registered for MEPS and/or labelling where appropriate to the product category. The Singapore and Philippines MEPS were assess as being lower than the other countries and were not graphically examined in this analysis.

Packaged Air-conditioners – Three Phase

The only county with MEPS levels for medium to large PAC is the USA. The USA proposed MEPS levels in 2004 are the most stringent and are international best practice.

It is proposed to adopt the proposed USA MEPS levels of 2004 for Australia in 2006.

Room or Window/Wall Units (Unitary)- Single Phase

From the analysis of international standards, the MEPS levels of Taiwan and the "Top-Runner" program in Japan represent the international best practice for MEPS. As the MEPS level for Taiwan is already in force and approximately 10 to 13% of Australian models would currently exceed the Taiwan MEPS, it would be appropriate to use this MEPS as the international best practice.

It is proposed to adopt the current Taiwanese MEPS levels in Australia for 2006 and further consideration could be given to the Japanese "Top-Runner" targets during the cost-benefit analysis to be undertaken in the Regulatory Impact Statement.

Split Systems - Single Phase

From the analysis of international standards, the MEPS levels of Taiwan are currently the most stringent MEPS levels. The USA MEPS levels proposed for 2006 and the "Top-Runner" program in Japan (proposed for 2007) represent the international best practice for MEPS. As the MEPS level for Taiwan is already in force and approximately 16% to 30% of Australian

models would currently exceed the Taiwan MEPS, it would be appropriate to use this MEPS as the international best practice.

It is proposed to adopt the current Taiwanese MEPS levels in Australia for 2006 and further consideration could be given to the Japanese "Top-Runner" targets and the USA MEPS levels during the cost-benefit analysis to be undertaken in the RIS.

Estimated GHG Impact

The estimated greenhouse reduction from these proposed MEPS in Australia by product category are shown in Table 1.

Table 1 Product Type Estimated Greenhouse and Energy Reductions

Product Type		Energy Savings (MWh/pa)	GHG reduction (Tonnes pa)
Split	Cooling only	2 437	2 186
	Reverse Cycle	10 066	9 029
Window/Wall	Cooling only	2 687	2 411
	Reverse Cycle	2 119	1 901
Sub total		**17 309**	**15 526**
PAC	All	42 440	38 069
Total		**59 749**	**53 595**

The total cumulative energy and greenhouse savings for single phase airconditioners is 2,077 GWh and 1.86 Mt CO_2-e over 15 years; for packaged airconditioners the estimated energy and greenhouse savings are 5,092 GWh and 4.56 Mt CO_2-e over 15 years.

INTERNATIONAL TEST PROCEDURES & MEPS

Summary

MEPS for air conditioners were first introduced in the 1980's. Currently 13 countries including Australia have mandatory MEPS, one has voluntary MEPS and one operates a target program. Table 2 details the introduction of air-conditioning MEPS around the world.

Table 2 Countries with MEPS for air conditioners

Country	Central AC	Room (Window-wall and split)	Large Heat Pump & condensing units	Packaged terminal & Heat Pump	Single-packaged central & Heat Pump	Split-system central & Heat Pump
Australia	M 2001		M 2001	M 2001	M 2001	M 2001
Canada	M 1998	M 1995	M 1998	M 1998	M 1998	M 1998
China		M 1998				
Costa Rica		M 1996				
India		V 1999				
Israel		M 1985				
Japan		T 1979				
Korea		M 1993				
Mexico	M 1998	M 1995				M 1998
Philippines		M 1993				M 2002
Russia		M 1986				
Saudi Arabia		M 2001				
Singapore		M 1998				
Taiwan		M 1991				
USA	M 1992	M 1990	M 1992	M 1992	M 1992	M 1992

Test standards and procedures vary from country to country. The following section of the report presents detailed descriptions of each countries air conditioner standards program including test procedures and MEPS levels .

Japan

Japan does not apply minimum energy performance standards as such instead opting for a target program known as "Top Runner". The top runner program sets targets using the most efficient models in each appliance category as the benchmark. The COP from the most efficient models becomes the target level for the future. However, this level does not have to be met by all appliances rather the weighted average of units shipped in the fiscal year for each manufacturer and importer is expected to be at or above the target. While not strictly a mandatory program penalties can be evoked for poor performance.

Japanese standards apply to all air conditioners with cooling capacities less than 28kW. The exceptions being those for chilled water coolers, those without electric compression, and those used in transportation. In the fiscal year 1997 the penetration of residential air conditioners was 1.8 units per household, with the trend showing penetration continuing to increase for heat pump air conditioners (Murakosh *et al.* 1999). The regulations cover 98% of all units shipped which in the FY1997 equalled 7.701 million air conditioners (Murakosh *et al.* 1999).

Test Procedures

Japan has two categories of air conditioners for test procedure purposes. They are room air conditioners and unitary units.

Room air conditioners use the test standard JIS 9612:1999. A room air conditioner must have a rated voltage less than 300V, a rated frequency of either 50 Hz, or 60 Hz and be of a packaged-type. This category covers cooling-only, reverse-cycle, single-phase, three-phase, air-cooled, water-cooled and ducted units. Room air conditioners are defined as the *integral* type (one cabinet) or *separate* type (two cabinets). This broad definition sees most air conditioners being classified as a room air conditioner.

The JIS 9612:1999 test procedures require the following variables to be measured:

- Product classification according to its function
- Rated cooling capacity (kW)
- Standard heating capacity (kW)
- Heating capacity at low temperature (kW)
- Classification according to the condenser cooling system
- Rated voltage, phase and frequency
- Cooling power consumption (kW)
- Rated standard heating power consumption and heating power consumption at low temperature
- Cooling performance factor (the EER)
- Heating performance factor (the COP)

The test conditions for determining the cooling capacity and electrical power demand in the cooling-mode are almost identical to ISO 5151-94. The requirements are:

Temperature of air entering indoor side (°C)	dry bulb:	27±1(0.3)[1]
	wet bulb:	19±0.5(0.2)
Temperature of air entering outdoor side (°C)	dry bulb:	35±1(0.3)
	wet bulb[2]:	24±0.5(0.2)
Condenser water temperature[3] (°C)	inlet:	30±0.3
	outlet:	35±0.3

The heating capacity test conditions have overload and defrosting tests that differ from ISO 5151-94. However all other aspects are identical.

Cooling and heating capacities are calculated from the measurements in the same way as specified in ISO 5151-94(E). Equilibrium test conditions have to be maintained for a minimum of 1 hour before capacity data can begin to be recorded. The capacity tests last for 35 minutes with readings taken every 5 minutes. (Energy Efficient Strategies *et al.* 1999). Units are always measured at full load however, the standard sets out a procedure that can be used to examine part load performance. The standard also sets a maximum refrigerant piping length of 5m for split-system units.

Unitary units use the test standard JIS B 8616:1999. The Japanese standard classifies packaged air conditioners (in one assembly or are designed to be used in one assembly) as unitary units. They can be single-packaged or split packaged, ducted or non-ducted.

The regulations require that the following variables be measured:

- Product classification according to its function
- Rated cooling capacity (W)
- Standard heating capacity (W)
- Classification according to the condenser cooling system
- Rated voltage, phase and frequency
- Cooling power consumption (kW)
- Rated standard heating power consumption
- Energy Efficiency Ratio, EER, (W/W)

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1 Tolerances are first indicated as the maximum permissible variation of individual readings from the specified value followed by the permitted variation of the arithmetical mean value from the specified value, indicated in parentheses

2 The wet-bulb temperature is not required when testing air-cooled condensers which do not evaporate the condensate.

3 Representative of equipment working with cooling towers. For equipment designed for other uses, the manufacturer shall designate the condenser water inlet and outlet temperatures or the water flow rates and the inlet temperature in the ratings

MEPS Levels

The last time Air Conditioners were required to meet targets was in 1998. At this time new targets were set according to the results achieved by the best models on the market. Additionally the new round of targets has included regulations for multi-split systems (a single outside unit with the compressor and condenser connected to several inside units in different rooms). The categories for efficiency standards are chosen according to basic function, type, and cooling capacity. The standard is shown as the COP value for cooling only air conditioners and the average of the cooling and heating COPs for heat pump air conditioners. The new targets for heat pump air conditioners need to be achieved by 2004 and will result in a 63% improvement from the 1992 program baseline efficiency. These targets are presented in Table 3. Cooling only air conditioners have until 2007 to achieve the new standard. These targets presented in Table 4 will improve the market by 14% when compared to the 1992 baseline.

Table 3 Top Runner 2004 Targets for Heat Pump Air Conditioners

Type of Air Conditioner	Cooling Capacity Category (kW)	Target Level (COP)
Window Wall	All	2.85
Wall mounted	2.5	5.27
	3.2	4.9
	4.0	3.65
	7.1	3.17
	28.0	3.10
Direct Blow Others	2.5	3.96
	3.2	3.96
	4.0	3.2
	7.1	3.12
	28.0	3.06
Duct Type	All	3.02
Multi Type	Up to 4.0	4.12
	7.1	3.23
	28	3.07

Source: Murakosh et al 1999

Table 4 Top Runner 2007 Targets for Cooling Only Air Conditioners

Type of Air Conditioner	Cooling Capacity Category (kW)	Target Level (COP)
Window Wall	All	2.67
Wall mounted	2.5	3.64
	3.2	3.64
	4.0	3.08
	7.1	2.91
	28.0	2.81
Direct Blow Others	Up to 4.0	2.88
	7.1	2.85
	28.0	2.85
Duct Type	Up to 4.0	2.72
	7.1	2.71
	28.0	2.71
Multi Type	Up to 7.1	3.23
	28.0	2.47

Source: Murakosh et al 1999

USA

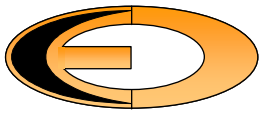
The USA introduced MEPS for Air Conditioners in the early 1990's. The program covers room air conditioners, central air conditioners and heat pumps, and commercial heating and air conditioning equipment. All the standards for air conditioners have been reviewed and upgraded since the initial implementation of the program. While some of the USA standards rely on EER and COP measurements, others include seasonal energy efficiency ratio (SEER) and heating season performance factor (HSPF). The SEER is defined as the total cooling output (in Btu-British thermal units) provided by the unit during its normal annual usage period divided by its total energy input (in Watt-hours) during the same period. The HSPF tells you the ratio of the seasonal heating output in Btu's divided by the seasonal power consumption in Watt-hours (USA Department of Energy, 2002).

Test Procedures

Room Air Conditioners use the test procedure set out in CFR 430 Subpart B, Appendix F. The procedure requires that tests are conducted under the conditions specified in ANSI/AHAM RAC-1-1982, using the method presented in ASHRAE-16-69. The regulations apply to single-phase window/wall room air conditioners but exclude split-packaged air conditioners, and packaged-terminal air conditioners. Cooling-only and reversible units are included as are air and water cooled units. Part-load conditions are not tested.

The test procedures require the following measurements:

- Total cooling and heating capacities (sensible, latent and total, rounded to the nearest 0.01 kW) expressed in Btu/h
- Cooling-mode EER (Btu/Wh expressed in multiples of 0.1)



- Cooling-mode electrical power consumption (W)

The required test conditions are similar to ISO 5151-94. The exceptions being the temperatures are based on values rounded to the nearest whole degree Fahrenheit. Additionally the condenser water inlet temperature for water cooled units is significantly cooler than the ISO 5151 value. The requirements are:

Temperature of air entering indoor side (°C)	dry bulb:	26.7±0.56(0.28)
	wet bulb:	19.4±0.34(0.17)
Temperature of air entering outdoor side (°C)	dry bulb:	35±0.56(0.28)
	wet bulb:	23.9±0.34(0.17)
Condenser water temperature (°C)	inlet:	23.9±0.22(0.11)
	outlet:	35±0.22(0.11)

Stable test conditions have to be maintained for a series of eight readings taken at 15 minute intervals with a maximum temperature variation of 0.56°C before capacity data can begin to be recorded. The capacity tests last for not less than 1 hour with readings taken every 10 minutes for a total of 7 readings. In addition, equilibrium conditions shall be maintained for not less than 1 hour before capacity test starts

Residential Central Air Conditioners are covered by the US test procedure contained in CFR 430 Appendix M. The procedure refers to ARI 210/240-89 & ASHRAE 37 for test conditions and methodology. A central air conditioner or heat pump is defined as a 'product other than a packaged terminal air conditioner, which is powered by single phase electrical current, air cooled and rated below 65000 Btu/h (19.05 kW). It is not contained within the same cabinet as a furnace, the rated capacity of which is above 225000 Btu/h and is a heat pump or cooling only unit'. This definition includes split-packaged room air conditioners (mini splits).

Measurements required for regulatory purposes are:

- Total cooling capacities (sensible, latent and total) expressed in Btu/h or W
- SEER (Btu/Wh expressed in multiples of 0.1)
- Cooling-mode electrical power consumption

As seasonal energy efficiency ratio (SEER) measurements are required for central air conditioners there 4 different temperature rating points in the test conditions. These are called "A" to "D". Point "A" is essentially ISO 5151 T1 condition with minor differences. Test conditions required for A-D are set out in Table 5.

Table 5: Test conditions for Central Air Conditioners, USA

	Standard test conditions			
	A	B	C	D
Temperature of air entering indoor side (°C)				
dry-bulb	27±0.56(0.28)	27±0.56(0.28)	27±0.56(0.28)	27±0.56(0.28)
wet-bulb	19±0.34(0.17)	19±0.34(0.17)	14±0.34(0.17)	14±0.34(0.17)
Temperature of air entering outdoor side (°C)				
dry-bulb	35±0.56(0.28)	28±0.56(0.28)	28±0.56(0.28)	28±0.56(0.28)
wet-bulb				

Source: Energy Efficient Strategies et al 1999.

Packaged Terminal Air Conditioners use the test procedure set out in ASHRAE 90-1. This standard references ARI-310/380, ASHRAE-16 and ASHRAE-37 when setting out the test conditions and methodology.

Regulation require the following quantities to be measured:

- Total cooling capacities (sensible, latent and total, rounded to the nearest 0.03 kW) expressed in W or Btu/h
- EER (Btu/Wh expressed in multiples of 0.1)
- Cooling-mode electrical power consumption

The USA packaged terminal air conditioner cooling rating conditions are similar to the ISO 5151 standard. Differences occur due to values being rounded to the nearest whole degree Fahrenheit. Additionally there are slight differences in the tolerances. The conditions for the cooling tests are:

Temperature of air entering indoor side (°C)	dry bulb:	26.7±0.56(0.28)
	wet bulb:	19.4±0.34(0.17)
Temperature of air entering outdoor side (°C)	dry bulb:	35±0.56(0.28)
	wet bulb:	23.9±0.34(0.17)

The test conditions for the heating components differ from ISO 5151 by up to 1.4 °C. They are:

Temperature of air entering indoor side (°C)	dry bulb:	21.1±0.56(0.28)
Temperature of air entering outdoor side (°C)		
High Temperature Test	dry bulb:	8.3±0.56(0.28)
	wet bulb:	6.1±0.34(0.17)
Low Temperature Test	dry bulb:	-8.3±0.56(0.28)
	wet bulb:	–9.4±0.34(0.17)

Stable test conditions have to be maintained, for a series of eight readings taken at 15 minute intervals with a maximum temperature variation of 1°F (0.56°C) before capacity data can begin to be recorded.

Commercial Air Conditioners are classified as either small or large. Both categories use test procedure ASHRAE 90.1 and the methodology set out in ASHRAE-37. The test procedure for Small commercial air conditioners also refers to ARI 210/240 while the large commercial air conditioners also refers to ARI 360 and ARI 340. A small commercial air conditioner or heat pump is defined as a unit rated at below 135000 Btu per hour (≈40 kW) while a large commercial air conditioner or heat pump is rated at above 135000 Btu per hour (≈40 kW) and below 240 000 Btu/h (≈70 kW). Air-cooled, water-cooled, evaporative cooled, water source electrically operated, unitary central air conditioners and central air conditioning heat pumps for commercial application are all included.

The regulations require the following measurements:

- Total cooling and heating capacities (sensible, latent and total, rounded to the nearest 0.01 kW) expressed in kW or Btu/h
- EER (Btu/Wh expressed in multiples of 0.05 up to 40 kW and 0.1 above)
- COP (Btu/Wh expressed in multiples of 0.02 up to 40 kW and 0.1 above)
- The above at standard and part-load ratings.

The required test conditions vary dependent upon the type of cooling technology being used and whether full or part load is being measured. The test temperatures are listed in Table 6.

Table 6: Test conditions for Commercial Air Conditioners, USA

	Indoor unit		Outdoor unit					
			Air entering and surrounding					
	Air entering		Air-cooled		Evaporative		Water	
	Dry Bulb	Wet Bulb	Dry Bulb	Wet Bulb	Dry Bulb	Wet Bulb	In	Out
Cooling								
Standard rating	26.7	19.4	35.0	23.9	35.0	23.9	29.4	35.0
Part-load rating	26.7	19.4	26.7	19.4	26.7	19.4	23.9	
Heating								
High-temp rating	21.0	15.0	8.3	6.1				
Low-temp rating	21.0	15.0	-8.3	-9.4				

Source Energy Efficient Strategies et al, 1999

MEPS Levels

The MEPS level for room air conditioners in the USA were reviewed in 1997 with the new standards becoming effective October 2000. These current levels are presented in Table 7.

Table 7 Room Air Conditioner MEPS for USA

Type of Air Conditioner	Cooling Capacity Category (Btu/h)	MEPS Level (SEER) (Btu/Wh)
Cooling Only		
Louvered Sides	< 20 000	9.7
	≥ 20 000	8.5
No Louvered Sides	< 8 000	9
	≥ 8 000	8.5
Cooling and Heating		
Louvered Sides	< 20 000	9
	≥ 20 000	8.5
No Louvered Sides	< 14 000	8.5
	≥ 14 000	8
Casement Only	All	8.7
Casement Slider	All	9.5

Source: USA Department of Energy 1997

Residential Central Air conditioner standards have been in place since 1992, although it should be noted that these type of airconditioners are not the same as Australian types. The MEPS levels are presented in Table 8. This standard has broad reaching effects with most new homes built in the USA installing a central air conditioning system. In January 2001 a 30% increase in the standard was approved, and was to become operational in the year 2006. However, a change of government in the USA occurred shortly after the registration of the final rule and the enactment of it has been postponed. In its place the new administration has proposed a lower standard be approved, which requires a 20% improvement. The issue is currently up for debate in the senate. Source: USA Department of Energy 2002

Table 9 presents the MEPS levels required by both proposals.

Table 8 Current Residential Central Air Conditioner MEPS for USA

Type of Air Conditioner	Cooling Capacity Category (kJ/h)	MEPS Level (SEER)	MEPS Level (HSPF)
Cooling Only			
Split System	All	10	-
Single Packaged	All	9.7	-
Cooling and Heating			
Split System	All	10	6.8
Single Packaged	All	9.7	6.6

Source: USA Department of Energy 2002

Table 9 Residential Central Air Conditioner USA MEPS Proposed for 2006

Type of Air Conditioner	Cooling Capacity Category (kj/h)	MEPS Level (SEER)	MEPS Level (HSPF)
*** Final Rule January 2001*			
Cooling Only			
Split System	All	13	-
Single Packaged	All	13	-
Cooling and Heating			
Split System	All	13	7.7
Single Packaged	All	13	7.7
*** Proposed Rule July 2001*			
Cooling Only			
Split System	All	12	-
Single Packaged	All	12	-
Cooling and Heating			
Split System	All	12	7.4
Single Packaged	All	12	7.4
Through the Wall Split System	All	10.9	7.1
Through the Wall Single Packaged	All	10.6	7.0

Source: USA Department of Energy 2001a, 2001b

MEPS for Commercial air conditioners and Packaged terminal units became effective in 1994. The standards were issued separately and issued different MEPS levels according to the cooling method employed. The current levels are presented in Table 10. In January 2001 new levels were approved and the standard was simplified. The new standard will apply from October 2003 for small commercial units and from October 2004 for Large commercial units. These new standards are presented in Table 11.

Table 10 Current Commercial Air Conditioner MEPS for USA

Type of Air Conditioner	Cooling Capacity Category (Btu/h)	MEPS Levels			
		SEER	EER	COP	HSPF
Air Cooled Split System	< 65 000	10			6.8
Air Cooled Packaged System		9.7			6.6
Air Cooled	65 000 ≤ CC <135 000		8.9	3.0	
	135 000 ≤ CC < 240 000		8.5	2.9	
Water Cooled Evaporative	< 65 000		9.3		
	65 000 ≤ CC <135 000		10.5		
	135 000 ≤ CC < 240 000		9.6		
Water Source Heat Pump	< 65 000		9.3	3.8	
	65 000 ≤ CC <135 000		10.5	3.8	
	135 000 ≤ CC < 240 000		9.6		
Packaged Terminal Air Conditioners & Heat Pumps	All		10[a]		1.3[b]

(a) 10 – (0.16 x capacity)/1000 (b) 1.3 + (0.16 x min EER)
Source: USA Department of Energy 2001c, 2002

Table 11 Commercial Air Conditioner MEPS for USA Effective 2003/2004

Type of Air Conditioner	Cooling Capacity Category (Btu/h)	MEPS Levels			
		SEER	EER	COP	HSPF
Air Cooled Split System	< 65 000	10			6.8
Air Cooled Packaged System		9.7			6.6
Air Cooled	65 000 ≤ CC <135 000		10.3	3.2	
	135 000 ≤ CC < 240 000		9.3	3.1	
Water Cooled Evaporative	< 65 000		12.1		
	65 000 ≤ CC <135 000		11.5		
	135 000 ≤ CC < 240 000		11.0		
Water Source Heat Pump	< 65 000		12.0	4.2	
	65 000 ≤ CC <135 000		12.0	4.2	
	135 000 ≤ CC < 240 000		11.0		
Packaged Terminal Air Conditioners & Heat Pumps	All		10[a]		1.3[b]

(a) 10 – (0.16 x capacity)/1000 (b) 1.3 + (0.16 x min EER)
Source: USA Department of Energy 2001c, 2002

China

Air Conditioners were among the first appliances to be subject to MEPS when China introduced standards in 1989. The MEPS cover cooling only and reverse cycle room air conditioners. The standard was last updated in 2000. There are plans to extend this program to cover central Air conditioners by the year 2003. Also under consideration is a change to the test method that would allow partial loads to be measured.

Test Procedures

Room air conditioners in China are subject to the national standard GB12021.3. The test method is not available in English however it appears that it is equivalent to ISO 5151. Cooling capacity is measured using the ISO 5151 T1 test conditions.

ISO 5151 requires the following variables to be measured:

- Climate classification types
- Total cooling capacities (sensible, latent and total, rounded to the nearest 0.1 kW)
- EER (expressed in multiples of 0.05)
- Heating capacity (as appropriate, rounded to the nearest 0.1 kW)
- COP (only applicable to reversible units operating in the heating-mode and expressed in multiples of 0.05)
- Rated voltages and frequencies
- Cooling power consumption
- Refrigerant designation and refrigerant mass charge

MEPS Levels

In 2000 new MEPS levels were established for room air conditioners. These are presented in Table 12.

Table 12 Room Air Conditioner 2000 MEPS for China

Type of Air Conditioner	Cooling Capacity Category (kW)	Target Level (COP)
Cooling only		
Single Package	≤ 4.5	2.2
Split System	≤ 2.5	2.5
	2.5 < CC ≤ 4.5	2.45
	>4.5 CC ≤ 7.1	2.4
	>7.1	2.3
Cooling and Heating		
Single Package	≤ 4.5	2.15
Split System	≤ 2.5	2.4
	2.5 < CC ≤ 4.5	2.35
	>4.5 CC ≤ 7.1	2.3
	>7.1	2.25

Source: *The Limited Values of Energy Efficiency and Evaluating Values of Energy Conservation for Room Air Conditioners in China* 2000

Korea

MEPS were introduced in Korea in 1992. The standard sets out a two tier system which includes a MEPS level and a more stringent target level know as TEPS. While the aim of the MEPS is to eliminate the most inefficient models from the market, TEPS are in place to

encourage manufacturers to increase the efficiency of their products. Typically Korea updates the standards every 3 to 5 years and it is common that the TEPS becomes the new MEPS level. The most recent standard came into effect in 2000.

Test Procedures

Room air conditioners in are subject to the Korean Standard KSC 9306-1999. It covers both cooling only and reverse cycle air conditioners.

The Standard stipulates the following variables be reported:

- Product classification according to its function
- Rated cooling capacity (kcal/h or W)
- Standard heating capacity (kcal/h or W)
- Rated voltage, phase and frequency
- Cooling power consumption (kW)
- Rated standard heating power and heating power at low temperature (kW)

The test conditions for determining the cooling capacity and electrical power demand in the cooling-mode are almost identical to ISO 5151-94. The requirements are:

Temperature of air entering indoor side (°C)	dry bulb:	27±1
	wet bulb:	19±0.5
Temperature of air entering outdoor side (°C)	dry bulb:	35±1
	wet bulb:	24±0.5
Condenser water temperature (°C)	inlet:	30±0.5
	outlet:	35±0.5

MEPS Levels

Table 13 presents the latest MEPS and TEPS levels required for air conditioners in Korea.

Table 13 Room Air Conditioner MEPS & TEPS for Korea

Type of Air Conditioner	Cooling Capacity Category (kW)	MEPS Level (COP)	Target Level (COP)
Single Package	All	2.37	3.05
Split System	< 4	2.86	3.54
	4 < CC ≤ 10	2.46	3.14
	>10 CC ≤ 17.5	2.25	2.93

Source: *KEMCO 2000*

Taiwan (Chinese Taipei)

Taiwan introduced mandatory MEPS for Air Conditioners in 1991 and recently updated in 2001. There are two standards, one for room air conditioners and one for unitary models. Room air conditioners cover all packaged models that have power consumption less than 3kW. Unitary air conditioners are classified as those models that have power consumption more than 3kW. This category does not include multi split units.

Test Procedures

Room Air Conditioners use the test procedure CNS3615. The standard covers both cooling only and reverse cycle units however there are no efficiency requirements on the heating components. The test conditions are always at full-load. The standard requires the following measurements be taken:

- Product classification according to its function
- Rated cooling capacity (kcal/h)
- Standard heating capacity (kcal/h)
- Rated voltage, phase and frequency
- Cooling power consumption (kW)
- Rated standard heating power consumption (kW)
- EER (kcal/Wh)

The test conditions for determining the cooling capacity and electrical power demand in the cooling-mode are almost identical to ISO 5151-94. The requirements are:

Temperature of air entering indoor side (°C)	dry bulb:	27±1
	wet bulb:	19.5±1
Temperature of air entering outdoor side (°C)	dry bulb:	35±1
	wet bulb:	24±1
Condenser water temperature (°C)	inlet:	30±0.5
	outlet:	35±0.5

Unitary air conditioners are subject to the standard CNS 2725. The requirements and test conditions are essentially identical to the room air conditioner tests listed above.

MEPS Levels

Table 14 presents the MEPS standards that are applicable to air conditioners in Chinese Taipei. These levels became effective 1 January 2002.

Table 14 Air Conditioner MEPS for Taiwan

Type of Air Conditioner	Cooling Capacity Category (kW)	MEPS Level (EER)
Room Air Conditioners		
Single Package	< 2.3	2.71
	2.3< CC ≤ 4.1	2.77
	> 4.1	2.6
Split System	≤ 4.1 Normal Type	2.97
	≤ 4.1 Inverter Type	2.77
	> 4.1Both Types	2.73
Unitary Air Conditioners		
Air Cooling Type (input >3kW)	All	2.84
Water Cooling Type	All	3.69

Source: Chwan-Shing Huang, Manager, Energy Division, Research Department, Taiwan Electric Research & Testing Centre, confirmed this by email on 30 April 2002.

Philippines

The Philippines first developed a MEPS program in the early 1990's. The department of energy and the Bureau of Product Standards jointly runs the program. The regulations specifically for Window wall room air conditioners were introduced in 1992 however the requirement for split systems to meet the standard was established in 2000.

Test Procedures

PNS 240-1989: *Method of Testing and Rating Room Air-conditioners* is the standard used to set out the test procedure. The standard excludes any heating tests but does not exclude heat pumps and water-cooled units operating in the cooling-mode. The test conditions are always at full-load, at the rated frequency and voltage, and with a single set of stable environmental conditions.
Variables required to be measured include:

- Phase
- Climate type
- Total cooling capacity
- EER (kJ/Wh)
- Cooling-mode electrical power consumption

The test conditions for determining the cooling capacity and electrical power demand in the cooling-mode are designed to reflect typical Philippines conditions and as such have significant differences from the ISO 5151-94, but only for water cooled and wet condenser coils. The requirements are:

Temperature of air entering indoor side (°C)	dry bulb:	27±0.5
	wet bulb:	19±0.3
Temperature of air entering outdoor side (°C)	dry bulb:	35±0.5
	wet bulb:	27±0.3
Condenser water temperature (°C)	inlet:	31±0.2
	outlet:	37±0.2

MEPS Levels

MEPS levels are prescribed in a different standard to the test procedure. The standard is PNS 396-1:1995 -*Household Appliances Standard for Energy Efficiency Ratio and Labeling Requirement-Part I Room Air-conditioners*. The standard was tightened in 1997 to allow the minimum EER to be increased by 5% every three years. Table 15 presents the current MEPS levels required.

Table 15 Room Air Conditioner MEPS for Philippines

Type of Air Conditioner	Cooling Capacity Category (kj/h)	MEPS Level (EER) (kJ/Wh)
Single Package	< 12 000	9.1
	≥ 12 000	8.6
Split System	< 12 000	9.1
	≥ 12 000	8.6

Source: *Egan & du Pont 1998.*

Singapore

Air Conditioners are the only appliance in Singapore to be covered by MEPS. The program began in 1998 and applies to Window type Air conditioners only. The Productivity and Standards Board (PSB) is responsible for this program.

Test Procedures

Room Air Conditioners in Singapore are subject to the test procedure SS CP24.

MEPS Levels

Table 16 presents the MEPS standards that are applicable to air conditioners in Singapore.

Table 16 Room Air Conditioner MEPS for Singapore

Type of Air Conditioner	Cooling Capacity Category (kW)	MEPS Level (EER) (kJ/Wh)
Single Package	≥ 2.6	8

Source: *Pacudan & Gooneratne 2001.*

Additional Standards

Costa Rica, India, Israel, Russia and Saudi Arabia also have MEPS for room air conditioners. However, given that they have little trade relevance to Australia, that none of the standards are in English and that only very small amounts of information are available about these programs further details were not pursued. Additionally, Mexico has MEPS for room, central and split system central and heat pump air conditioning. The report did not provide details on these as they have been aligned so as to replicate those of the USA. From July 2002 MEPS levels for the majority of Canadian Air conditioners will also be identical to those of the USA. Therefore this report does not cover Canada's program.

COMPARISON WITH OVERSEAS MEPS LEVELS

Approach

General

The international MEPS levels for three phase packaged airconditioners and single phase window/wall and spilt airconditioners were compared to the current models and (for PAC) MEPS levels in Australia. In general, the test conditions used by the countries chosen for comparison were based on, or close to, the ISO 5151-94 (T1 conditions), therefore it is possible to make relatively direct comparisons with the MEPS levels of these countries and Australia.

The countries selected for comparison were:

- USA – PAC, Window/Wall, Split
- Taiwan – Window/Wall, Split
- Japanese – Window/Wall, Split
- Korea – Window/Wall, Split
- China – Window/Wall, Split

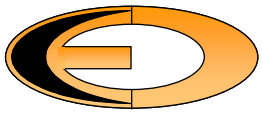
The USA and Japan have different MEPS levels for cooling only and reverse cycle window/wall airconditioners, while the other countries do not differentiate between the cooling only and reverse cycle units (they do specify a cooling based MEPS). In Japan, the MEPS levels for split units are also different for cooling only or reverse cycle, and the MEPS level specified is based on an equal average of the cooling and heating EER

The two major issues to be addressed in this analysis for the conversion of international MEPS levels are:

- Conversion of MEPS levels in the USA from Seasonal Energy Efficiency Ration (SEER) to EER.
- Conversion of the Japanese "Top-Runner" combined cooling and heating target EER to an equivalent cooling EER for reverse cycle units.

SEER to EER Conversion

The SEER is defined as the total cooling output (in Btu-British thermal units) provided by the unit during its normal annual usage period divided by its total energy input (in Watt-hours) during the same period.



The formulae for calculating SEER is shown below:

SEER = $EER_{Test\ B}$ x Part Load Factor (May use default PLF = 0.875)

Part Load Factor = 1 - 0.5 x Degradation Factor*Test A = indoor(27°CDB/19.5°CWB),

$$DegradationFactor = \left(1 - \frac{EER_{Test\,D}}{EER_{Test\,C}}\right) \div \left(1 - \frac{Capacity_{Test\,D}}{0.5xCapacity_{Test\,C}}\right)$$

outdoor(35°CDB)

*Test B = indoor(27°CDB/19.5°CWB), outdoor(28°CDB)

Test C = indoor(27°CDB/14°CWB), outdoor(28°CDB)

Test D = indoor(27°CDB/14°CWB), outdoor(28°CDB) - cyclic

Source: UNSW, E. Leonardi, personal communication

The EER rating is a steady state rating, and does not account for the time the unit operates before reaching peak efficiency, however the EER rating is used by international standards, including those adopted by Australia. To address the issue that the USA uses SEER for MEPS for packaged and spilt system airconditioners under 19 kW output, an average ratio of SEER to EER was determined from the models sold in the USA, and applied to the SEER MEPS levels. This average ratio is a very good approximation of the EER for a given SEER, as the USA DOE have suggested a MEPS based on an EER that is derived from the median EER for models meeting the proposed SEER MEPS in the USA market. The USA DOE proposed EER MEPS is very close to the one derived by our analysis of average SEER to EER ratio. In the Final Rule by the USA DOE, they have not adopted an additional EER based MEPS as they consider that *"Most benefits accruing from an EER standard will likely accrue from the SEER standards alone"*, hence the close correlation between SEER and EER.

The specific ratios and numbers of units used to calculate the ratio are discussed in the sections below

Japanese Combined Cooling and Heating Target EER Conversion

As the Japanese target is determined by an average of both cooling and heating EER. For this analysis the cooling target has been estimated by taking the average difference between heating and cooling EER for Australian units and subtracting this from the Japanese target. This is an approximate estimate, and assumes that all units are close to this average. Due to the nature of the conversion; if the EER heating to cooling difference were much larger, the converted target cooling EER would be lower.

As the Japanese "Top-Runner" scheme is a target for the sales weighted average EER of the units on the market, as compared to the MEPS, which specifies the minimum EER that a unit must exceed to be sold in the market, therefore a direct comparison is not easily undertaken. An approximate guide to an equivalent MEPS level could be determined by examining the current

distribution of models and targets under the 'Top Runner" program. By determining the percentage of models below and above the target level and applying this same distribution to the proposed levels in 2007, approximate MEPS could be determined. This would require the analysis of actual sales data from the Japanese market and is not currently being considered in this analysis.

International Comparison

Summary

Countries were selected for comparison on the basis of (1) they were a major source of air conditioners imported to Australia and (2) there was a MEPS in place or being proposed. For medium to large packaged airconditioners, the only country with MEPS levels is the USA, while for single phase airconditioners there were several countries with MEPS levels in place and all these countries were major sources of units for the Australian market.

The categories of units compared to the Australian market were:

- Packaged Air-Conditioners – three phase, with no distinction between cooling or reverse cycle
- Single phase unitary room or window/wall units
  - Cooling only
  - Heat pump (reverse cycle)
- Single phase split systems
  - Cooling only
  - Heat pump (reverse cycle)

The international MEPS levels were chosen to represent these categories although many countries did not distinguish between cooling only or heat pump type airconditioners.

Packaged Air-conditioners – Three Phase

The only county with MEPS levels for medium to large PAC is the USA. Figure 1 shows the comparison of the Australian MEPS levels, registered Australian units (as of March 2002) and the USA levels currently in force and those proposed in 2004. The step change at 19 kW cooling output is due to the USA rule defining an EER MEPS level for units above 19 kW output and a SEER for units below 19 kW cooling capacity. The conversion of SEER to an EER is based on the ratio of SEER to EER of 3200 models on the USA market for small packaged units of less then 19 kW cooling capacity; the ratio is EER = 1.126 SEER.

Figure 1: Packaged AC - Comparison of International MEPS Levels

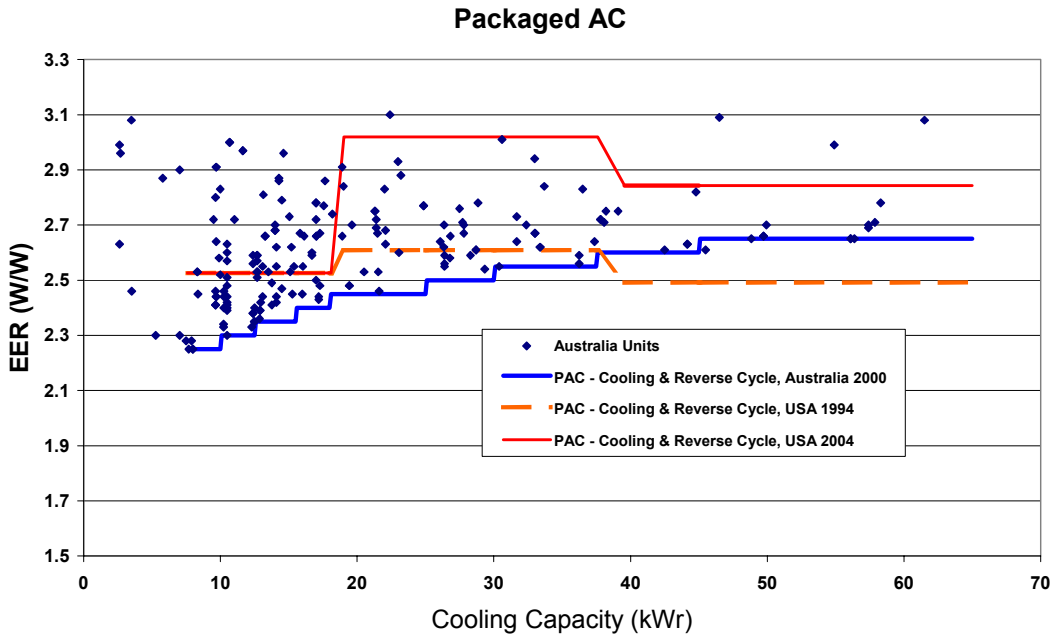


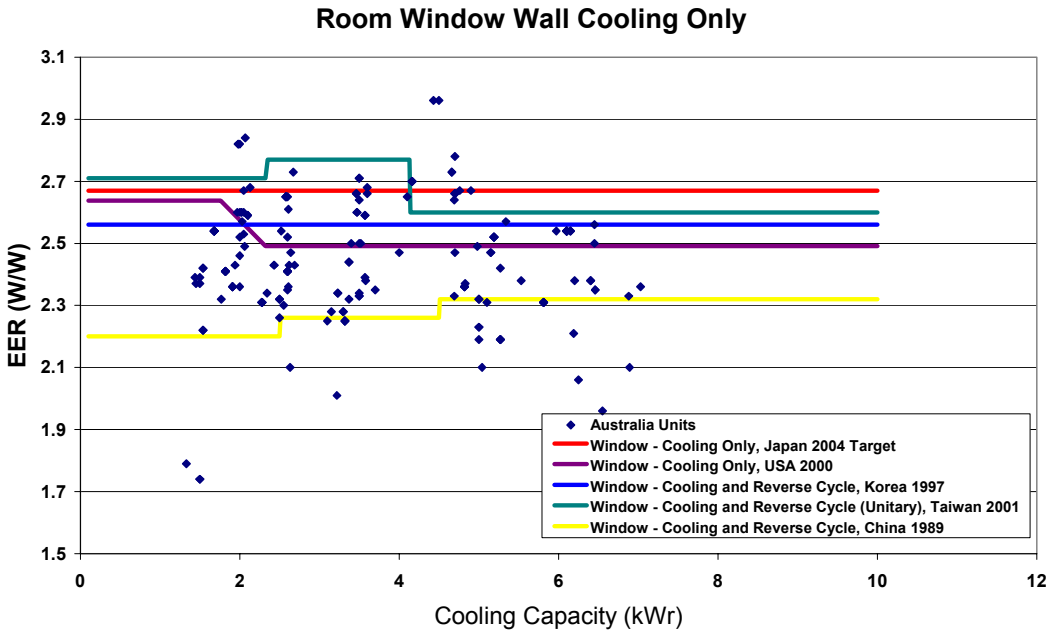
Figure 1 shows that approximately 65% of the Australian models in 2002 would not meet the proposed USA MEPS levels for 2004 if these levels were implemented now. However, for units with output of 19 kW and above, only 4 would exceed the proposed USA MEPS levels for 2004.

The USA DOE is encouraging ASHRAE to give further consideration to the MEPS for units below 19 kW output capacity, as they did not revise the MEPS level when updating ASHRAE standard 90.1 1999. Hence the current MEPS of 9.7 SEER, according to the USA DOE, is likely to be increased. This factor is clearly illustrated in Figure 1 as the MEPS level for units greater than 19 kW is 20% higher than the MEPS level for models below 19 kW.

Room or Window/Wall Units (Unitary)- Single Phase

Several countries have MEPS that are applicable to room and window wall airconditioners. Figure 2 shows the comparison of the registered Australian units (as of March 2002) and the international levels currently in force and those proposed for cooling only.

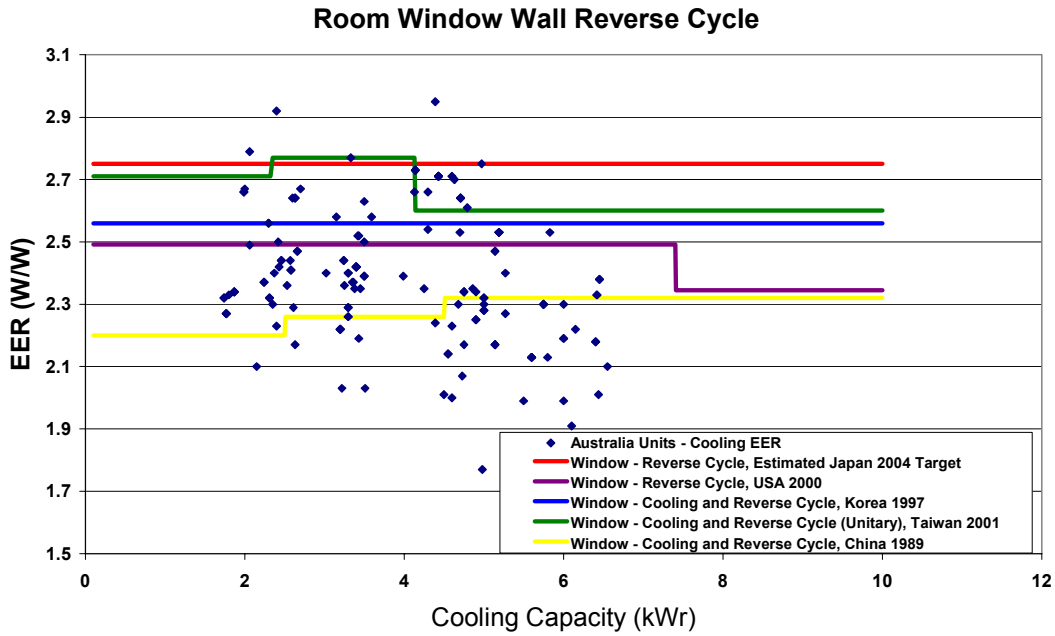
Figure 2: Room AC Cooling Only - Comparison of International MEPS Levels



The most stringent MEPS levels currently in force are those of Taiwan. The Japanese "Top-Runner" target comes into force in 2004. Figure 2 shows that approximately 10% of the Australian models in 2002 would meet the Taiwan 2001 MEPS levels if these levels were implemented now.

Figure 3 shows the comparison of the Australian MEPS levels, registered Australian units (as of March 2002) and the international levels currently in force and those proposed for reverse cycle.

Figure 3: Room AC Reverse Cycle - Comparison of International MEPS Levels

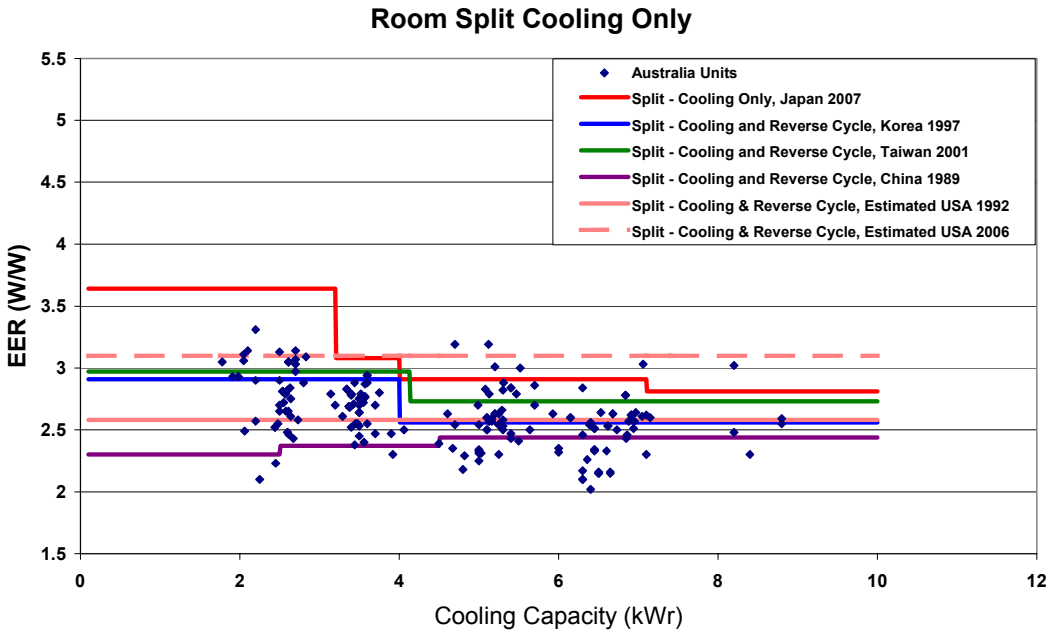


As was the case for cooling only units, the most stringent MEPS levels currently in force are those of Taiwan. The Japanese "Top-Runner" target comes into force in 2004. As the Japanese target is determined by an average of both cooling and heating EER, in this analysis the cooling target has been estimated by taking the average difference between cooling and heating EER for Australian units (found to be an EER of 0.1) and subtracting this from the Japanese target. This is an approximate estimate, however if the difference were much larger, the target cooling EER would be lower. Figure 3 shows that approximately 13% of the Australian models in 2002 would meet the Taiwan 2001 MEPS levels if these levels were implemented now.

Split Systems - Single Phase

Most of the countries that are the source of imported air conditioners in Australia have MEPS that apply to split system airconditioners. Figure 4 shows the comparison of the registered Australian units (as of March 2002) and the international levels currently in force and those proposed for cooling only units.

Figure 4: Split System: Cooling Only - Comparison of International MEPS Levels



The most stringent MEPS levels currently in force are those of Taiwan. The Japanese "Top-Runner" target comes into force in 2007 while the proposed USA MEPS level is scheduled to be implemented in 2006. Figure 4 shows that approximately 16% of the Australian models in 2002 would meet the Taiwan 2001 MEPS levels if these levels were implemented now. If the more stringent Japanese MEPS levels were chosen for comparison, only 6 models would exceed the proposed target MEPS and 7 models currently exceed the proposed USA MEPS levels. The issues considered in the conversion of the USA and Japanese MEPS levels for this analysis are:

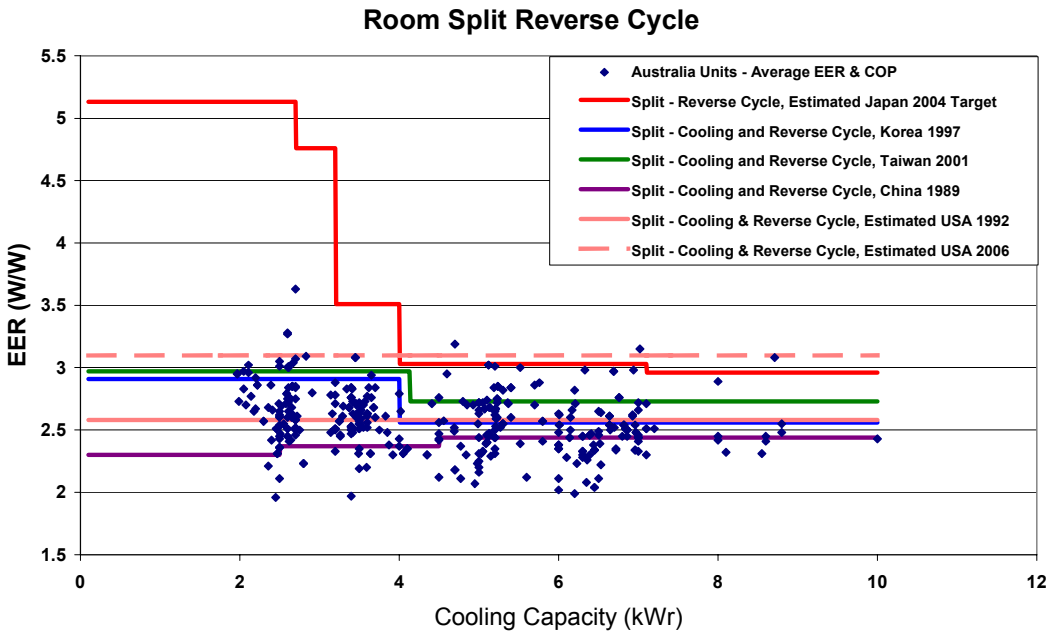
- The Japanese "Top Runner" program is a target sales weighted average of models sold in the market from 2007. It is therefore not directly comparable to a MEPS level in the Australian regulatory environment, as some models would have EERs that are on the market but below the target level. An approximate guide to an equivalent MEPS level could be determined by examining the current distribution of models and targets under the 'Top Runner" program. By determining the percentage of models below and above the target level and applying this same distribution to the proposed levels in 2007, approximate MEPS could be determined. Further examination of this approach could be warranted if the Japanese program is chosen as the international regulatory best practice MEPS to be applied to Australia.

- The USA MEPS levels for split systems are based on SEER. This SEER level has been converted to an EER by taking the average of the ratio of SEER to EER for current models on the market. This produces a good approximation to the EER that would be equivalent to the SEER MEPS in 2006. The USA DOE have also examined the possibility of an addition EER based MEPS for these units, under there 10 CFR Part 430, proposed rule 5 October 2000, but did not adopt this under the final rule, as they found a high

correlation of SEER to EER. In the proposed rule, the DOE proposed a minimum EER for the proposed minimum SEER by examining the median EER of units at the proposed SEER MEPS. They concluded that at the proposed 13 SEER MEPS, an 11.9 EER MEPS should apply. From our analysis, taking the average SEER to EER ratio of approximately 1900 models, the 13 SEER MEPS would be equivalent to an 11.45 EER. Hence, our conversion of the USA SEER is slightly conservative for split system airconditioners. The latest proposed rule (July 2001) is for a SEER MEPS of 12.

Figure 5 shows the comparison of the registered Australian units (as of March 2002) and the international levels currently in force and those proposed for reverse cycle units.

Figure 5: Split System: Reverse Cycle - Comparison of International MEPS Levels



The most stringent MEPS levels currently in force are those of Taiwan. The Japanese "Top-Runner" target comes into force in 2004 while the proposed USA MEPS level is scheduled to be implemented in 2006. As the Japanese target is determined by an average of both cooling and heating EER, in this analysis the cooling target has been estimated by taking the average difference between cooling and heating EER for Australian units (found to be an EER of 0.14) and subtracting this from the Japanese target.

Figure 5 shows that approximately 31% of the Australian models in 2002 would meet the Taiwan 2001 MEPS levels if these levels were implemented now. If the more stringent Japanese MEPS levels were chosen for comparison, only 3 models would exceed the proposed target MEPS and 4 models currently exceeds the proposed USA MEPS levels. The issues considered in the conversion of the USA and Japanese were discussed earlier.

POLICY OPTIONS

The options available to the government for introduction of MEPS for single-phase airconditioners and the determination of the new MEPS level for three phase units are described below.

The basic premise for the policy options is that Australia matches the international best practice MEPS levels (if cost effective) within a few years of their enforcement in that country. A Regulatory Impact Statement (RIS) will need to be completed to determine the cost effectiveness of the MEPS levels chosen for Australia.

Packaged Air-conditioners – Three Phase

From the analysis of international standards, the USA proposed MEPS levels in 2004 are the most stringent and are international best practice. The major issues with this MEPS level are the uncertainty of the MEPS level for units under 19kW output capacity. The USA is likely to report on the suitability of new MEPS levels soon for this category of airconditioners; hence we may be able to update the analysis. In addition to this change to the proposed USA MEPS level for units under 19 kW, it would be an opportunity to align the same size three–phase airconditioners MEPS levels with those proposed for single phase units. It is proposed to adopt the proposed USA MEPS levels of 2004 for Australia in 2006.

Room or Window/Wall Units (Unitary)- Single Phase

From the analysis of international standards, the MEPS levels of Taiwan and the "Top-Runner" program in Japan represent the international best practice for MEPS. As the MEPS level for Taiwan is already in force and approximately 10 to 30% of Australian models would currently exceed the Taiwan MEPS, it would be appropriate to use this MEPS as the international best practice. Further consideration could be given to the Japanese "Top-Runner" targets during the cost-benefit analysis to be undertaken in the RIS.

The difficulty with adopting the Japanese targets as a MEPS level is that they are not directly comparable. However, assumptions about the distribution of the models in the Japanese market could be used to determine an approximate equivalent MEPS level. By examining the earlier figures for window/wall airconditioners, the Taiwan MEPS levels are very close, or exceed, the Japanese target levels.

It is proposed to adopt the current Taiwanese MEPS levels in Australia for 2006 and further consideration could be given to the Japanese "Top-Runner" targets during the cost-benefit analysis to be undertaken in the RIS.

Split Systems - Single Phase

From the analysis of international standards, the MEPS levels of Taiwan are currently the most stringent MEPS levels. The USA MEPS levels proposed for 2006 and the "Top-Runner"

program in Japan (proposed for 2007) represent the international best practice for MEPS. As the MEPS level for Taiwan is already in force and approximately 16 to 30% of Australian models would currently exceed the Taiwan MEPS, it would be appropriate to use this MEPS as the international best practice.

The major differences between the Taiwan, USA and Japanese MEPS are:

- The USA levels are about 13% higher than the Taiwanese level for units greater than 4 kW output capacity, while very similar for less than 4 kW output capacity
- The Japanese target is significantly higher than the Taiwan and USA MEPS levels for sizes less than 4 kW output capacity.

It is proposed to adopt the current Taiwanese MEPS levels in Australia for 2006 and further consideration could be given to the Japanese "Top-Runner" targets and the USA MEPS levels during the cost-benefit analysis to be undertaken in the RIS.

ESTIMATED GHG IMPACT

The greenhouse gas impacts has been estimated on the basis that a MEPS would be implemented as follows:

- PAC – Adopt the USA MEPS levels for 2004 in 2006
- Room or Window/Wall Units (Unitary) – Adopt the Taiwan MEPS levels in 2006
- Split Systems - Adopt the Taiwan MEPS levels in 2006

The estimated greenhouse and energy reductions are modelled on the basis of model average efficiency changes., as sales by units are not available for this analysis. The estimated is based on the following approach:

- Model average changes due to MEPS are determined, using the following assumptions and data.
  - Model average EER is determined by product type for 2002
  - Business as Usual (BAU) efficiency improvement is estimated as 1.2% pa (Regulatory Impact Statement on MEPS for Packaged Air Conditioners, 2000)
  - The average proposed MEPS level is determined from the international MEPS level selected above
  - The model average EER is estimated to be 10% above the MEPS level
- Average energy and greenhouse reductions are determined, using the following assumptions and data
  - Average hours of operation is estimated (based on the figures used in the "Energy Smart Guide: Air Conditioners" for single phase units and estimated as 800 hrs of cooling for packaged units (based on average commercial operation)
  - Model average capacity (in kW) is also determined for each product type
  - The model average EER difference in 2006 is determined from the above and applied to sales of airconditioners by product type
  - Energy savings (per unit pa) = (Model Avg Capacity /EER BAU – Model Avg Capacity / EER 2006) x hrs of operation.
  - Total sales are estimated to be constant at 60,000 PAC pa and 370,000 room and split units pa. (RIS on MEPS for PAC, 2000)
  - Average CO_2 Emission Factor (0.897 kg/kWh)
  - Annual and cumulative reductions are estimated over a 15 year period and assumed to be constant for each year.

The result of the assumptions and calculations are shown in Table 17

Table 17 Product Type Estimated Greenhouse and Energy Reductions

Product Type		Model Average, 2002 (EER)	Model Average, BAU 2006 (EER)	Average Proposed MEPS (EER)	Model Average with MEPS 2006 (EER)	% Share of Total Sales	Estimated Cooling Hours	Model Average Cooling Capacity (kW)
Split	Cooling only	2.63	2.75	2.85	3.14	13%	250	4.61
	Reverse Cycle	2.57	2.70	2.85	3.14	46%	250	4.56
Window/Wall	Cooling only	2.45	2.56	2.69	2.96	25%	150	3.62
	Reverse Cycle	2.39	2.50	2.69	2.96	15%	150	3.97
PAC	All	2.61	2.74	2.80	3.08	100%	800	22.07

Product Type		Energy Savings (kWh/pa)	Total Sales (pa)	Energy Savings (MWh)	GHG reduction (Tonnes pa)
Split	Cooling only	50.77	370 000	2 437	2 186
	Reverse Cycle	58.87	370 000	10 066	9 029
Window/Wall	Cooling only	28.59	370 000	2 687	2 411
	Reverse Cycle	37.17	370 000	2 119	1 901
Sub total				*17 309*	*15 526*
PAC	All	707.33	60 000	42 440	38 069
Total				59 749	53 595

The total cumulative energy and greenhouse savings for single phase airconditioners is 2,077 GWh and 1.86 Mt CO_2-e over 15 years; for packaged airconditioners the estimated energy and greenhouse savings are 5,092 GWh and 4.56 Mt CO_2-e over 15 years.

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