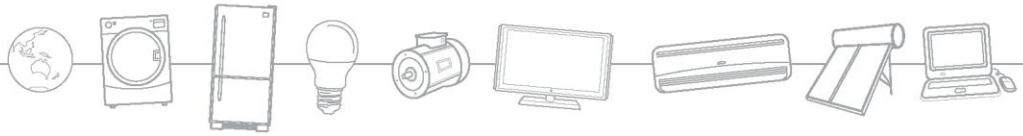
E3
Equipment Energy Efficiency

Chillers: Updated policy positions

Supplementary consultation document

18 June 2018



A joint initiative of Australian, State and Territory and New Zealand Governments.

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Background

Chillers produce chilled water that is used by space cooling equipment in buildings and in many industrial processes. Heat is removed by a circulating cold water loop and discharged to the outside air. This occurs through a cooling tower (in the case of water cooled chillers) or through an air cooled condenser (in the case of air cooled chillers).

Minimum Energy Performance Standards (MEPS) for chillers greater than 350kW capacity were introduced in 2009 under the Equipment Energy Efficiency (E3) program. Chillers within the scope of MEPS are generally used to cool the air in large buildings, such as office blocks and commercial premises.

The E3 committee published a consultation Regulation Impact Statement (RIS) and a supplementary consultation paper in 2016 with proposals to update the regulations for air conditioners and chillers. Feedback on these papers demonstrated a need for additional consideration to be given to the chiller policy options. The proposals in this paper take account of:

- feedback on the consultation RIS and supplementary paper,
- one on one discussions with companies in Sydney, Melbourne, Canberra and New Zealand in 2017 and 2018,
- discussions at the 2018 Air conditioning, Refrigeration Building Services Exhibition (ARBS),
- discussions with officers from the Australian Buildings Code Board and international developments since the review of the regulations started, including discussions with the Air Conditioning, Heating and Refrigeration Institute (AHRI) in the United States and Eurovent in Europe.

The aim of the proposed changes is to provide cost effective energy savings, while making the regulations more effective, easier to comply with and easier to administer. The Energy Efficiency Advisory Team (EEAT) considers the best way to meet all these objectives is by aligning with the regulations and certification schemes operating in the US and in Europe.

Feedback on this document will inform a decision Regulation Impact Statement (RIS). The decision RIS will be provided to the Council of Australian Governments' Energy Council and the New Zealand Government for decision on whether to adopt any of the policy proposals. If the proposals in the decision RIS are accepted, the *Greenhouse and Energy Minimum Standards (Liquid-chilling Packages Using the Vapour Compression Cycle) Determination 2012* in Australia and the *Energy Efficiency (Energy Using Products) Regulations 2002* in New Zealand would need to be revised.

E3 would appreciate any feedback you have. The closing date for written submissions is **COB Friday 27 July, 2018**. Submissions should include the subject 'Chillers' and be sent via email to acrac@environment.gov.au for Australia or to regs@eeca.govt.nz for New Zealand. Submissions will be published, unless otherwise requested.

Broad questions stakeholders may wish to consider in providing feedback include:

- What are the barriers to the implementation of the proposals contained in this consultation paper?
- What effects would these proposals have in Australia and New Zealand, beyond the effects identified in this consultation paper?
- How accurate are the data and assumptions on which the proposals are based?
- Will the proposals have any adverse effects that have not been considered?
- What will be the costs of any required upgrades to meet these proposed changes?
- If the proposals contained in this document are approved by the COAG Energy Council by the end of 2018, would you support the new regulations aligning with the EU changes and becoming mandatory in 2021?

1. Remove AS/NZS 4776 and align with AHRI and Eurovent certification

The current regulations offer three pathways for registrants to demonstrate compliance with MEPS. Registrants can provide:

- a physical test report to the local test standard AS/NZS 4776:2008; or
- a certificate from the AHRI in the US, which certifies performance equivalent to AHRI 550/590:2015; or
- a certificate from Eurovent in Europe.

Over time, these pathways have diverged and are now incompatible.

Australia/New Zealand specific testing and rating standard

The local test standard, AS/NZS 4776:2008, was based on a now-abandoned draft International Organisation for Standardisation (ISO) standard and incorporates elements (such as rating conditions) of AHRI 550/590:2003. It no longer covers all technology types and features of the chillers market, which creates difficulties both in administering the regulations and for the two percent of applicants using this compliance pathway. For example, AS/NZS 4776 has no means of interpolating energy efficiency ratings for products that cannot be measured at the standard load points. Nor does it have a way to test or rate the heating cycle of chillers that can heat (these products are currently excluded from the regulations). It has become necessary to either update or replace AS/NZS 4776.

Suppliers need to obtain AS/NZS 4776 to use the AHRI and Eurovent compliance pathways. AS/NZS 4776 gives a set of standard rating conditions that mean products using the different overseas ratings need to be re-rated to these specific parameters to normalise the results.

Performing compliance check testing to a unique Australia/New Zealand chiller test standard is not practical. Independent, third party, large chiller testing is not available in Australia or New Zealand.[1] Overseas certification programs have their own compliance

[1] One Australian chiller manufacturer owns and operates an AHRI accredited, water-cooled test rig, but this facility is not available for wider use by other chiller suppliers.

regimes, so linking to them offers a level of compliance that cannot be achieved by using a local test standard.

US based test standard AHRI 550/590 and AHRI certification

AHRI 550/590 was one of the early major test standards to test chiller performance and has been adopted by many countries around the world. The US, Canada, Japan, China and Chinese Taipei all use some version of it. The 2003 version of AHRI 550/590 used to help establish AS/NZS 4776:2008 has changed markedly. It underwent major revisions in 2011 and 2015, and a metric version (AHRI 551/591) was published in 2011.

AHRI certification certifies that a chiller's selection software can produce results equivalent to a physical test. However, the actual certificates contain no specific model performance. One certificate typically covers tens of nominal models. Performance is demonstrated by a printout of the selection software or other catalogued data. Previously, this performance was certified equivalent to the test standard. As of 2018, however, it can also certify cooling performance to the European test standards. Fifty-eight per cent of chillers registered under the E3 program rely on AHRI certification.

Unlike the European regulatory standards, AHRI has no part load metric for heating and only rates the full load performance at an air temperature of 8 ˚C, for air-cooled products, or a water temperature of 12 ˚C, for water-cooled products. All AHRI based ratings include a 'fouling' factor to simulate the loss of performance from an installed unit, because water impurities inhibit the heat transfer process and therefore the efficiency of the chiller over time. Because AHRI treats a chiller as a standalone product, AHRI certification excludes the power used by internal water pumps to pump the chilled water through the building. American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) 90.1 (an energy efficiency building performance standard) sets separate MEPS levels for the components of a cooling system.

Eurovent and European chiller requirements

European regulations have changed markedly, since the E3 program decided to accept Eurovent certification in 2008. In the EU, at that time, chiller test standards and requirements used a voluntary disclosure system based on the European test standard EN 14511:2007 and a modified AHRI IPLV seasonal metric (the ESEER).[2] In September 2015, heating cycle MEPS were introduced based on a new seasonal metric, the Seasonal Coefficient of Performance (SCOP), derived from a new seasonal test standard: EN 14825. The heating MEPS were increased in September 2017.

Since 2011, and in contrast to the AHRI standard, EN 14511 includes the power used by water pumps and fans, lowering the apparent efficiency rating of products.

[2] See EU Directive 2009/125/EC of 21 October 2009.

EN 14511-3:2013 also applies a pump power penalty for chillers that do not come with an integrated pump. The standard, however, does not include a fouling factor correction, unlike AHRI. The part load efficiency metrics of EN 14825 also include standby power measurements, while AHRI's IPLV does not.

The EU's requirements changed again on 1 January 2018 with the introduction of a cooling cycle MEPS based on a new seasonal cooling metric, the Seasonal Energy Efficiency Ratio (SEER). The SEER is fundamentally different to AHRI's IPLV and the old ESEER. The SEER tests are performed at different temperatures and the weightings bear no resemblance to those used by AHRI. These changes will go further in January 2021, when the more stringent Tier 2 MEPS are introduced.

The EU MEPS metrics are not exclusively based on SEER/SCOP values, but incorporate a constant conversion coefficient to represent the EU's average electricity generation efficiency, and a correction factor for the electricity used by temperature controls and cooling tower water pumps. This is to allow the use of a primary energy metric that can be compared across all fuels and technology types. However, the SEER and SCOP values can be isolated from these metrics and the SEER values are detailed in Appendix A.

Eurovent certificates now reflect these changes with a transition that will see the old ESEER metric disappear in 2019. As such, Eurovent will have nothing in common with the Australian/New Zealand standard or AHRI requirements. The Eurovent scheme issues individual certificates for each nominal model from the certified range. As the whole range becomes certified, this is effectively certifying the selection software as well, because the certification process only requires a percentage of the range to be physically tested, while the remaining products rely on selection software values.

Proposal

E3 considers that compelling all applicants to re-rate chillers to a unique Australian/New Zealand standard places an onerous regulatory burden on all suppliers. E3 also considers that adopting only one of the world's two major certification schemes would force an unreasonable regulatory burden on those companies that do not use whichever scheme is chosen. The proposed approach, therefore, is to accept both AHRI and Eurovent certification; but this is not without its difficulties. As outlined above, the underlying test standards used for both schemes are fundamentally different. This raises the issue of equivalence: what EU value is equivalent to a given AHRI value? There is no straightforward conversion factor that can be applied, because the individual characteristics of every unit mean that the differences will vary over a range. The RIS will, therefore, propose abandoning the obsolete local test standard, AS/NZS 4776, and will investigate a dual compliance pathway, with the aim of allowing the use of both AHRI and Eurovent certification.

It is E3's preferred position that only chillers with AHRI or Eurovent Certification[3] be accepted for registration. Both AHRI and Eurovent have comprehensive certification and ongoing compliance regimes that cover over 80 chiller companies between them (with some companies using both schemes). This would allow E3 to categorise all registered chillers as low risk product with a reduced need for physical check testing. The need to factor in the costs of buying and physically check testing a chiller adds significantly to the registration fees. Accepting only certified chillers would lead to a review of registration fees and a lowering of the registration fee.[4]

2. Registration

Product registration is required for products in Australia subject to MEPS, labelling, and other GEMS requirements under the *Greenhouse and Energy Minimum Standards Act 2012* (the Act), where products are "supplied, offered for supply, or used commercially". New Zealand registrations are required by the *Energy Efficiency (Energy Using Products) Regulations 2002*. Suppliers submit product registrations on the Energy Rating Website.

The current approach to registration is not suited to the bespoke nature of chiller sales. The capacity (cooling power output) of a single large chiller can be varied according to the application for which it is being sold. For instance, two physically identical chillers could be rated at 1,200 kW and 1,400 kW, or anything in between.

These have been treated under the Act as separate models requiring separate registrations, because they have different energy performance characteristics, despite being identical equipment. This is because the Act sets out the circumstances in which two or more products are considered the same model. These circumstances are when the products have the same:

- technical specifications, as they relate to compliance with the Act;
- brand or trademark used in supplying or offering to supply the products; and
- unique model identifier.

Some suppliers are getting around this problem by grouping multiple products into a single registration; sometimes as a 'family' registration, even though they technically do not fall within the family definition set out in the determination. Others are using a single registration with 'wildcards' in the model number.

The current determination does not make it clear whether registrations should be based on nominal performance or the performance of each chiller as supplied. Furthermore, there is

[3] The current practice of including products in a certified range that are not certified due to being outside of the certification scope due to capacity or power supply frequency will be maintained.

[4] Chiller registrations cost $780 each. All GEMS registration fees are being reviewed.

confusion as to whether a catalogue of nominal models constitutes an offer to supply, which would trigger the requirement to register all products in a catalogue.

In addition, the exact model numbers and capacities of large chillers are often not fixed until a customised product is ordered. For instance, the rated capacity (in kilowatts) may form part of the model number string. The exact capacity, however, is specified by the buyer, based on their building's requirements.

A review of chillers registered under the current determination has shown some approved applications cover physically different models under one registration (e.g. they cover different compressors), which shows that even the assessors are not sure of the registration requirements for chillers.

Some stakeholders have raised concerns that some chillers are being registered with a rated capacity that meets MEPS to achieve compliance, but sold later at a higher rated capacity, at which point the chiller does not meet MEPS. Submissions have suggested that disclosing a maximum MEPS compliant capacity would solve this issue, although some have suggested that there should be a tolerance on this maximum capacity.

Eurovent Certificates are issued per model on a 'Basic Model Group' basis. While Eurovent's definition of a 'Basic Model Group' isn't precise, it does define units that include capacities with no more than 10 percent difference that are otherwise 'essentially the same' or 'comparable'. While this might work for smaller chillers, it may not be appropriate for a larger chiller.

AHRI Certificates certify a company's selection software as being accurate. They are also based on a "Basic Model Group" (BMG) that is defined as:

> *"a family of chillers using the same compressor model family or combination of same compressors from the same compressor model family. A participant may choose to further subdivide its products into additional BMGs."*

In practice, a single AHRI Certificate can cover a family of chillers ranging from 300 kW to 3000 kW of capacity. A single E3 registration based on one AHRI BMG would not provide enough information on the energy efficiency performance of the chillers sold in Australia and New Zealand. Nor would it offer assurance that all products within such a large and diverse range actually met the requirements, because certification doesn't automatically mean conformance to MEPS.

Component based model definition

E3 proposes that a chiller model be defined by the primary components that constitute the unit's energy use characteristics and each model would have the same nominal model number that reflects this combination of components. On this basis, two or more chillers would be considered to have the same technical specifications for the purposes of the Act, and therefore be the same model, where they have:

1. The same compressor or combination of compressors, including the same motor or motors.
2. The same evaporators and condensers.
3. Fans with the same energy use characteristics.

Under this approach, the capacity and power input of a component based model would be irrelevant. The nominal values for capacity, power input and efficiency, however, would still need to be registered. This approach reflects a process that many companies are using to register their chillers.

Other information would also be required:

- A maximum MEPS compliant capacity would need to be stipulated, noting that for standard (i.e. non-customisable) products, this value would be the same as the registered value.
    - Customisable models would not be able to be sold above their maximum MEPS compliant capacity.
- For modular chillers,[5] the maximum combined number of modules that are MEPS compliant would need to be stipulated.
    - Only the base unit of systems comprising multiple modules would need to be registered.
- Model designations and descriptions of the compressors and motors, heat exchangers and fans.

3. Offer to supply

As outlined above, registration is required for products offered for supply in Australia subject to MEPS level, mandatory labelling and other requirements under the Act. In New Zealand, the rules for regulated products made "available for sale" are set out in the Energy Efficiency (Energy Using Products) Regulations 2002. While the terminology differs between Australia and New Zealand, the concept is the same: registration of regulated products is required where they are offered to be supplied in Australia or made available for sale in New Zealand.

As discussed above, chillers are often bespoke products with many customisable features. Furthermore, annual sales of chillers are low, when compared with other products subject to GEMS regulations, such as whitegoods. Nevertheless, there are dozens of overseas manufacturers and suppliers that offer a wide range of products. This means that some

[5] A modular chiller is marketed in discrete modules that are designed to be piped and wired together, so that a single system can be built up of the separate modules.

suppliers offer large product ranges, where only a small proportion may ever be sold in Australia or New Zealand.

What is 'offer to supply' of a chiller?

Offer to supply includes advertising products as available for sale, display of products for sale in retail or wholesale outlets, listing of products as available for sale on websites or in catalogues, and installation of products in premises offered for sale. Registration is required before an offer to supply may be made.

In cases where a supplier offers a service to custom make a chiller, either to the customer's specifications or to specifications developed in consultation with the customer (and the specific product design does not exist before this interaction), the concept of 'offer to supply' would be triggered when the supplier and the customer agree on the final specifications to be used. At this point the product must be registered (including the certified selection software or catalogue performance data to demonstrate compliance), prior to an order being made.

The act of referencing a third party overseas catalogue by a supplier to the Australian market is not, in itself, an offer to supply, provided the stock is not held in Australia and the Australian supplier website or catalogue indicates that the availability of these products for the Australian market needs to be confirmed, before the sale of the product.

Direct supply by overseas suppliers: To be clear, a direct offer of available products by an overseas supplier to an Australian customer, including via online or catalogue order forms, is considered an offer to supply and registration is required.

How does this differ in New Zealand?

In New Zealand, similar to Australia, where a product is advertised as available for sale, displayed for sale in retail or wholesale outlets, listed as available for sale on websites or in catalogues, or similar, the product should be registered.

4. Scope

Many issues of scope were raised through the consultation RIS and subsequent consultation. This section outlines the issues and proposed policies in each case. They are framed with the intent that only AHRI or Eurovent certified chillers would be accepted.

4.1 Chillers under 350 kW capacity

Chillers below 350 kW are not covered by a GEMS determination. The National Construction Code (NCC), however, covers the installation of chillers up to 350 kW. Buildings can meet this requirement in one of two ways:

- The deemed-to-satisfy provisions include prescriptive examples of materials, products and design factors that are deemed to comply. Minimum COPs and IPLVs for chillers are contained in these provisions.

- The performance approach models the energy efficiency performance of the heating and cooling system as a whole or the energy efficiency performance of the entire building. For example, a performance solution may allow for a reduction in the energy efficiency of the building's services, below the minimum specified in the deemed-to-satisfy provisions, by increasing the performance of the building fabric. This provides flexibility in achieving the overarching mandatory requirements for building energy performance.

A combination of the deemed to satisfy and performance solutions may also achieve compliance.

The NCC applies to all new work. The replacement of a chiller could be deemed 'maintenance', in which case it would not be subject to any energy efficiency requirements. The department estimates that replacement chillers are around 50 per cent of the market. In addition, chillers below 350 kW are not subject to any efficiency requirements in New Zealand.

The consultation RIS proposed that, if the MEPS regulations are extended to chillers under 350 kW in capacity, the NCC deemed to satisfy requirements could be removed. However, progress has been slow in developing the proposed MEPS for smaller chillers. Meanwhile, the Australian Building Codes Board (ABCB) has begun its review of the NCC and is considering options to increase the stringency of the deemed-to-satisfy provisions. The February 2018 draft NCC consultation documents are proposing to cover all chillers, regardless of capacity, with COP and IPLV values mirroring either Path A or Path B ASHRAE 90.1 values (excluding the separate values for centrifugal chillers) for the deemed-to-satisfy option.

In the longer term, the MEPS and the NCC requirements for chillers should be harmonised. Unfortunately, this cannot be achieved in the current review cycle of the NCC, but this is the longer term objective for both E3 and the ABCB. E3 and ABCB officials agree that chiller MEPS and the deemed to satisfy requirements in the NCC should be harmonised with international requirements by 2022.

As a first step, MEPS could be established to cover chillers under 350 kW. AHRI and Eurovent certification is available for chillers in this size range and, by mirroring the requirements in Europe and North America, Australian requirements could be harmonised with the main international standards.

Including chillers under 350 kW in GEMS would bring in smaller liquid chilling packages that are used in the hydronic heating/cooling (often domestic) section of the market. E3 sees this as reasonable, because these types of chillers are competing with air-to-air air conditioners and heat pumps, which are subject to MEPS.

4.2 Adiabatic chillers

An adiabatic chiller uses evaporative pads or netting to evaporate water and pre-cool air before that air reaches the air-cooled condenser. No water is evaporated on the condenser

itself. Adiabatic chillers are covered by the existing regulations, but it is not clear whether this was intentional or inadvertent.

The GEMS Regulator published a guidance note in August 2017 that clarified that adiabatic chillers are in the scope of the regulations. Feedback on drafts of this guidance note showed that some companies considered that adiabatic chillers should be treated like an air-cooled chiller. However, other companies were equally firm that, due to some of the inherent design features of an adiabatic chiller, such as corrosion inhibitor on the condenser surface and the larger fans required to draw air through the pads, they should not be considered an air-cooled chiller.

There is no test standard or certification system that covers adiabatic chillers. Given this, E3 proposes that dedicated purpose-built adiabatic chillers be excluded from the updated regulations. Air-cooled chillers with aftermarket evaporative pads or spray kits would continue to be treated as an air-cooled chiller. E3 will review this decision, if a test standard is created and adiabatic chillers are covered by a certification scheme.

4.3 Free cooling chillers

The term, 'free cooling chiller', can describe a range of technologies that are designed to take advantage of cool ambient conditions to maintain cooling capacity, without the need for mechanical compression. Most free cooling chillers are covered by the current determination, but at least one type, which uses an additional 'free cooling' water loop through the heat exchanger, is excluded.

The efficacy and efficiency of any of the free cooling technologies are not tested by the AHRI test standard. Eurovent also excludes the performance of free cooling features. There is no reason, however, why such chillers cannot be certified with the free cooling function inactive. Furthermore, European and ASHRAE 90.1 energy efficiency regulations assume that efficiency levels are met without the use of any of the free cooling technologies.

E3 proposes that all free cooling chillers be included in the scope of energy efficiency regulation and that they meet the performance requirements with their free cooling function inactive.

4.4 Reverse cycle and heat pump chillers

The consultation RIS asked whether the regulations should cover reverse cycle chillers, which provide both heating and cooling. The supplementary paper sought further feedback, because some suppliers claimed that the reverse cycle exemption is being used as a way to avoid complying with MEPS, which only applies to cooling efficiency.

Most feedback supported including reverse cycle chillers, with differing views on how this should be done. It was suggested there is little point in covering products under 350 kW, if the regulations are not also extended to cover reverse cycle chillers, because reverse cycle chillers are the main product type in this size of chiller, notably in New Zealand. More

recent consultation has also raised the issue of '4-pipe' units that can cool, heat, or cool and heat simultaneously.

Eurovent certification covers the heating cycle of reverse cycle units and dedicated heat pumps can also be certified. Furthermore, the EU moved to their second Tier for heating chiller MEPS in September 2017, giving both the means and the levels for a potential MEPS on these products.

E3 proposes that regulations for chillers capable of heating would replicate the EU requirements, but offer flexibility for products using AHRI certification. A reverse cycle chiller would need to meet MEPS for either the cooling or the heating cycle:

- Heating MEPS would match the EU SCOPs for products less than 400 kW in heating capacity, noting that applicants can choose to demonstrate compliance to the cooling MEPS instead, if they prefer.
- Reverse cycle products 400 kW or above would be required to meet the applicable cooling MEPS, mirroring EU requirements.
- Heating MEPS would apply to heating only units less than 400 kW in capacity, mirroring EU requirements.
- 'Polyvalent' or '4 pipe' units would need to meet either the cooling or heating MEPS applicable in the EU.
- Chillers capable of both heating and cooling would have the option of demonstrating that they meet both cooling and heating MEPS, if a company considers this advantageous and has the certification to support it.

The European heating requirements give two MEPS levels: one for outlet temperatures of 45 °C and one at an outlet temperature of 35 °C for low temperature heat pumps.[6] The applicable MEPS levels would be:

- Intermediate temperature applications (45 °C outlet temperature)
  - Air-to-water – SCOP of 2.825
  - Water-to-water – SCOP of 2.95
- Low temperature applications (35 °C outlet temperature)
  - Air-to-water – SCOP of 3.2
  - Water-to-water – SCOP of 3.325.

[6] Low temperature heat pumps are defined as those air-cooled products not cable of producing heating water with an outlet temperature of 52 °C at an inlet dry (wet) bulb air temperature of -7 °C (-8 °C) in the reference design conditions of the 'average' EU climate. See www.eup-network.de/fileadmin/user_upload/Heaters_Ecodesign_Reg_813_2013.pdf for further details.

4.5 Heat recovery chillers

Heat recovery chillers are excluded from GEMS chiller regulations. This type of chiller is designed to capture the heat that would normally be rejected to the air during cooling. Typically, the heat is used to heat potable water. This feature can be either integrated with the chiller or fitted later. The heat recovery performance can be tested by AHRI 551/591, but certification of this data is voluntary. Both AHRI and Eurovent certify chiller cooling performance with any heat recovery features inactive.

EU and ASHRAE 90.1 stipulate that heat recovery chillers must meet the relevant MEPS levels, for heating or cooling, with the heat recovery feature inactive. AHRI and Eurovent certificates reflect this. E3, therefore, proposes heat recovery chillers would be included in the scope of GEMS regulation and would need to meet the applicable MEPS level for heating or cooling with the heat recovery device inactive.

4.6 Chillers with remote condensers

Under the current determination, chillers with remote condensers are excluded from MEPS. The EU includes these chillers in their cooling and heating energy efficiency requirements and this is supported by the European test standards and Eurovent certification (for cooling only). ASHRAE 90.1 also specifies cooling energy efficiency requirements for chillers with remote condensers and AHRI 551/591 can be used to test them. They are excluded, however, from AHRI certification.

It is E3's preference to only accept certified chillers. While the European segment of the market would be able to comply, those companies using only AHRI would be at a distinct disadvantage. E3, therefore, proposes to continue to exclude chillers with remote condensers.

4.7 Chillers with centrifugal fans

Under the current determination, chillers with centrifugal fans are excluded from MEPS. Centrifugal fans are generally used with air-cooled chillers, where the fans are working against high static pressure, generally because the chiller has been installed within a building, as opposed to outside of it. These types of fans use more electricity than an axial (or propeller) fan, making it harder for chillers incorporating them to meet MEPS.

Neither ASHRAE 90.1 nor the EU regulations set different MEPS for chillers with centrifugal fans. Nor do they appear to exclude them from MEPS. Eurovent certification, however, acknowledges that 'ducted' chiller efficiency is harder than non-ducted chiller efficiency and this is reflected in a different set of efficiency classes (an A to G rating system).

Given that neither the EU nor ASHRAE 90.1 excludes chillers with centrifugal fans and that both Eurovent and AHRI certification covers them, the current exclusion is no longer warranted. E3 proposes to include chiller with centrifugal fans in GEMS regulation.

Products with a genuine need to use a large, inefficient, centrifugal fan would be able to apply for an exemption from meeting MEPS.

4.8 Temperature and application scope

Chillers that use 'liquids other than water' are excluded from the chiller determination. This is because such chillers are used in specialised industrial applications or are designed to deliver liquid at temperatures below 4 °C, which was considered outside of the range for air conditioning for human comfort.

European regulations cover 'comfort' chillers (i.e. ones that are used in comfort air conditioning applications) that produce a leaving water temperature of greater than 2 °C. The inclusion of glycol or brine does not, of itself, exclude a chiller from the regulations. Process chillers (i.e. not for comfort air conditioning, but still rated at a leaving temperature of 7 °C) are classified, rated and regulated separately. They are excluded if they produce leaving water of less than 2 °C or more than 12 °C.

ASHRAE 90.1 covers a larger range of leaving temperatures, from 0 °C to 46 °C, which fall well outside 'comfort air conditioning' applications. Chillers, however, are still rated at a leaving temperature of 7 °C with water as the fluid.

Many chillers can operate at a range of temperatures. Their outlet temperatures can be raised to above 15 °C, for a data centre application, or they can be lowered to below 4 °C for food processing, with the addition of glycol and some other, minor modifications.

The intention of the original regulations was to cover leaving temperatures of 4 °C to 9 °C and rate chillers at the standard outlet temperature of 7 °C, from an entering temperature of 12 °C. This means that a single chiller can either be in or out of scope, depending on the end use of the product.

E3 would like to extend MEPS to all liquid chilling packages producing leaving liquid temperatures of 2 °C or above, which are capable of producing leaving water at 7 °C (from 12 °C).[7] This would include chillers using water or glycol, but continue to exclude chillers using other liquids. E3 considers that a product that meets MEPS at 7 °C will be more efficient at 2 °C, than one that cannot meet MEPS at 7 °C. Re-rating these units using certified selection software to standard rating conditions (assuming the use of water) should also be viable, given E3's proposal to rely on AHRI and Eurovent certification. This would make compliance and market surveillance simpler, because all general purpose chillers would need to be registered. It would also help establish a comprehensive level playing field covering chillers used for most cooling applications.

[7] E3 is proposing to maintain temperature based adjustment formulae for water-cooled centrifugal chillers for non-standard rating conditions. Appendix E of AS/NZS 4776.2:2008 gives this conversion method, but a new determination would mirror clause 6.4.1.2 of ASHRAE 90.1:2016.

Feedback to date indicates that chillers used for temperatures of 2 °C or less tend to be highly specialised. E3 is seeking more comment on whether there are physical attributes of chillers designed for these specialised temperatures that can be used to exclude them. As explained above, simply relying on application outlet temperatures can make the scope difficult to apply. Exclusions (and the justification) being considered include:

- Titanium heat exchangers – used for pool heating.
- Stainless steel heat exchangers – used in specialised food processing.
- Cooling potable water – specialised, high ambient applications.

Are there other physical features of specialised chillers that could be used to exclude them from the scope of a future determination?

5. MEPS levels

The consultation RIS and supplementary consultation paper proposed increasing MEPS levels to a modified version of the US ASHRAE 90.1 levels. These proposals and the feedback E3 received reflected the market at the time and did not appear to take account of the changes to the regulations occurring in the EU between 2018 and 2021. Subsequent consultation has received support for international harmonisation, so E3 proposes that Australia and New Zealand harmonise with ASHRAE 90.1 and EU MEPS levels to the extent possible, recognising that there are significant differences between the two.

5.1 Heating MEPS

As detailed in Section 4.4, E3 proposes that heating MEPS would mirror the EU SCOP levels. Reverse cycle chillers less than 400 kW in rated heating capacity would have the choice of meeting the heating MEPS or the applicable cooling MEPS relevant to their rated cooling capacity. Heating only chillers less than 400 kW rated heating capacity would be required to meet the heating MEPS.

5.2 Cooling MEPS

There are several issues in trying to align with both ASHRAE 90.1 and EU requirements. The different underpinning test methods are explained in Section 1 and lead to issues of equivalence. The other issues that E3 sees are:

- Different size categories between the EU and ASHRAE 90.1.
- No specific full load MEPS requirements (COP or EER) for the EU.
- ASHRAE 90.1 offers two pathways: Path A for higher full load performance and Path B for higher part load performance.
- ASHRAE 90.1 includes different levels for chillers with centrifugal compressors.

E3 proposes that Australia and New Zealand use ASHRAE 90.1 as the framework for the cooling MEPS, while using the EU framework for heating MEPS. ASHRAE 90.1 levels

would be converted to an EU equivalent value, so that Eurovent Certification could be accepted, without the need to re-rate products (although re-rating to different test standards would be acceptable for those who can). This approach would include both full load metrics (COP and EER), to ensure minimum energy efficiency during peak load conditions; something that a part load metric does not guarantee.

This approach would use the different levels and size categories of ASHRAE 90.1 for chillers with centrifugal compressors. It would also mirror the provision of Path A and B options. Path A values would apply to fixed speed products and Path B values would apply to variable speed products. This approach focuses on the strength of each technology in a way the current hybrid MEPS approach cannot. (See Appendix B for current MEPS categories and levels.) It is not intended to apply a MEPS that favours one technology over another.

The conversion of the IPLV to SEER values and COP to EER values[8] would be based on data from an International Energy Agency (IEA) Energy Efficient End-use Equipment (4E) study[9] and other information supplied by companies during 2017. As the IEA report makes clear, this cannot be an exact conversion factor and there are a range of observed conversions for different models, size categories and chiller types. This proposal uses average conversion factors in an attempt to come up with a combined pathway. The categories and converted values are detailed in Appendix C.

6. Other issues

6.1 Cost-benefit analysis

As a result of feedback on the consultation RIS, future cost-benefit modelling will assume an operating profile in line with AHRI's IPLV loading. This equates to one per cent of operating hours at full load, 42 per cent at three-quarter load, 45 per cent at half load and 12 per cent at quarter load.

For the recent changes to EU regulations, a study was done of the manufacturing cost of upgrades to improve the efficiency of chillers (air-cooled and water-cooled). This analysis found that, to meet the new MEPS levels, the price efficiency (PE) ratio was below 1:1 in most cases.[10]

[8] The ASHRAE 90.1 levels are based on AHRI 551/591's Integrated Part Load Value (IPLV) and Coefficient of Performance (COP) as the full load metric. The EU levels are based on EN 14825's Seasonal Energy Efficiency Ratio (SEER) and EN 14511's Energy Efficiency Ratio (EER) as the full load metric.

[9] *Policy benchmarking for Packaged Liquid Chillers and evaluating the lack of comparability between economies*, IEA 4E, 4 August 2015.

[10] *www.eup-network.de/fileadmin/user_upload/Produktgruppen/Lots/Working_Documents/Task_6_Lot_6_Air_Conditioning_Final_report_July_2012.pdf*

E3 is seeking your input on using a PE ratio of 1:1 to cost the upgrades required to meet the proposed new efficiency levels. Any information you can provide about the actual cost of upgrading products to meet the efficiency standards in the EU and US based on your experience would assist E3 in preparing these proposals for consideration by the COAG Energy Council.

6.2 Data reporting

Sales data is not collected under the GEMS Act in Australia[11]. Data on chiller sales is scarce and E3 has requested data on a voluntary ad hoc basis with limited success. AREMA has previously expressed support for companies to report sales data (mainly in relation to air conditioners), if it is collected as part of the mandatory reporting required under the Ozone Protection and Synthetic Greenhouse Gas Management (OPSGGM) Act. For chiller data to be useful, it would need to provide sales by nominal model to provide EER and COP data.

Your feedback is sought on whether chiller sales by model could be provided or deduced as part of OPSGGM Act reporting. For example, do some companies import refrigerant in bulk, making it difficult to easily link refrigerant import reporting to sales of specific models of chillers? Furthermore, does the increasing use of non-reportable refrigerants (e.g. HFOs, ammonia etc.) risk undermining the usefulness of this data?

6.3 Start date and transition arrangements

If the proposals in this policy paper are approved by the COAG Energy Council, E3 would consider whether to create a new determination to replace the Part 2 standard, AS/NZS 4776.2, or to initiate a process to update the standard, which would then be called up by a new determination. Stakeholders would have the opportunity to comment on exposure drafts of any new determination, before it is finalised by E3 and sent to the minister for signature. The new determination would then be incorporated into New Zealand energy efficiency regulations.

E3 proposes that the new determination would take effect on 1 January 2021. Products that are currently out of scope (e.g. reverse cycle chillers, chillers less than 350 kW, etc.) that are imported into, or manufactured in Australia before 1 January 2021, would be treated in one of two ways:

a) If they meet the new MEPS levels, they would need to be registered, before being offered for sale.

b) If they don't meet the new MEPS levels, all remaining stock could be offered for sale, but no new non-compliant equipment could be manufactured or imported.

[11] Sales data reporting is required for New Zealand registrations.

Voluntary registrations to the new determination would be allowed as soon as the determination has been signed. The five year registration period for the new determination would commence on 1 January 2021, for products registered prior to this date.

The existing determination would remain in place until 31 December 2020, for applicants who wish to register under this determination. After this date, the current determination would no longer be available for new registrations. From 1 January 2021, equipment registered under the superseded determination that meets the new MEPS levels would be allowed to see out the remainder of their five year registration period. Equipment registered under the superseded determination that does not meet the new MEPS would not be allowed to be manufactured or imported from 1 January 2021, but existing stock could still be offered for sale.

Appendix A – EU chiller cooling MEPS

Table 1 European Union chiller cooling MEPS

Chiller configuration	Tier 1 SEER, from 1 January 2018	Tier 2 SEER, from 1 January 2021
Air cooled <400 kW	3.8	4.1
Air cooled ≥400 kW	4.1	4.55
Water cooled <400 kW	5.1	5.2
Water cooled 400 – 1500 kW	5.875	6.5
Water cooled ≥1500 kW	6.325	7

Appendix B – Current chiller MEPS

Table 2 Current Australian and New Zealand chiller cooling MEPS

Chiller type	Size (kW)	Current COP	Current IPLV
Air cooled	350-499	2.70	3.70
	500-699	2.70	3.70
	700-999	2.70	4.10
	1000-1499	2.70	4.10
	>1500	2.70	4.10
Water cooled	350-499	5.00	5.50
	500-699	5.10	6.00
	700-999	5.50	6.20
	1000-1499	5.80	6.50
	>1500	6.00	6.50

Appendix C – Proposed MEPS levels

Table 3 Proposed cooling MEPS levels

Chiller type	Size (kW)	Eurovent pathway				AHRI pathway				Conversion factor SEER = IPLV/factor
		Fixed speed compressor		Variable speed compressor		Fixed speed compressor		Variable speed compressor		
		EER	SEER	EER	SEER	COP	IPLV	COP	IPLV	
Air-cooled	<528	2.931	3.387	2.814	3.907	2.985	4.048	2.866	4.669	1.195
	≥528	2.931	3.462	2.814	3.982	2.985	4.137	2.866	4.758	1.195
Water cooled, positive displacement	<264	4.591	4.411	4.414	5.294	4.694	5.867	4.513	7.041	1.33
	≥264 to <528	4.781	4.726	4.591	5.402	4.889	6.286	4.694	7.184	1.33
	≥528 to <1055	5.217	5.034	5.063	6.178	5.334	6.519	5.177	8.001	1.295
	≥1055 to <2110	5.644	5.228	5.509	6.630	5.771	6.770	5.633	8.586	1.295
	≥2110	6.148	5.437	5.886	7.154	6.286	7.041	6.018	9.264	1.295
Water cooled, centrifugal	<528	5.644	4.813	4.954	6.016	5.771	6.401	5.065	8.001	1.33
	≥528 to <1055	5.644	4.943	5.422	6.178	5.771	6.401	5.544	8.001	1.295
	≥1055 to <1407	6.148	5.228	5.787	6.971	6.286	6.770	5.917	9.027	1.295
	≥1407 to <2110	6.148	5.437	5.886	7.154	6.286	7.041	6.018	9.264	1.295
	≥2110	6.148	5.437	5.886	7.154	6.286	7.041	6.018	9.264	1.295

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