Department for
Business, Energy
& Industrial Strategy

Energy Technology Criteria List 2021

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Contents

Introduction

The Energy Technology List (ETL) is a UK Government backed energy-efficiency scheme that encourages private and public sector organisations to procure market leading energy-efficient plant and machinery.

The ETL is in two-parts; the Energy Technology Criteria List (ETCL) and the Energy Technology Product List (ETPL). The ETCL defines the specific high-performance criteria that a product must meet in order to be listed on the ETPL. Those criteria include functional specification, energy-efficiency and other performance measures. It aims to identify and promote the top 10-25% performing products in each of its product types. The ETPL is the list of products that have been assessed as being compliant with the ETCL criteria.

Both lists are reviewed by BEIS to ensure that the criteria and listed products fully reflect technological advancements in the marketplace, changing market trends/dynamics, and the development of products legislation and other regulations. **This document sets out the criteria that will apply with effect from 1 January 2021.**

Version Control

This REV 1 version of the ETCL 2021 was issued in June 2021 to amend the Pipework Insulation Category to allow the use of Representative Testing.

Copies of the earlier versions of the ETCL document are available on requestion from ETLMailbox@beis.gov.uk.

Automatic Monitoring & Targeting (aM&T)

1 Automatic Monitoring & Targeting (aM&T) Sub-metering Systems

Date published	2018
Date first launched	2003
Former name	Automatic Monitoring & Targeting Systems Component Based AMT Systems

1.1 Scope

Automatic Monitoring & Targeting (aM&T) sub-metering systems are products that are specifically designed to measure energy consumption, record and distribute metered energy data, and analyse and report on energy consumption.

1.2 Definitions

aM&T sub-metering systems help users to save energy by identifying energy wastage which they can then take steps to reduce. aM&T sub-metering systems generally comprise of three elements:

- Sub-metering & sensors
- Communication and data capture software, and;
- Monitoring software.

Fiscal metering and internet-based software are outside the scope of this category.

An aM&T sub-metering system captures energy consumption information automatically from which users can gain an understanding of their organisation's energy use. It consists of equipment components that measure, record, transmit, analyse, report and communicate the energy management information that an organisation needs to manage its energy use (i.e. through implementing an effective energy management system) and highlight any energy wastage.

A wide range of aM&T sub-metering systems are available. The Energy Technology List (ETL) aims to encourage the installation of sub-metering systems that can facilitate the proactive management of energy use in organisations.

Eligible aM&T sub-metering systems shall comply with the requirements as set out below. The individual equipment components or products used in the system do not need to be named on the ETL.

1.3 Requirements

1.3.1 Eligibility requirements

To be eligible, aM&T sub-metering systems shall

1. Include the following:
   a) One or more meters that measure energy use for metering purposes.
   b) Some means of automatically capturing, retrieving & storing energy metering data electronically.

c) Software that enables the analysis of energy metering data and the key factors that influence energy use by means of visualising energy performance data.

2. Be able to meter at least one of the following:

a) Electricity use

b) Gas use

c) Heat use

The following sub metering equipment and sensors are eligible but only as part of an aM&T sub-metering system that directly measures at least one of the parameters in section 2a-c (above):

- Oil fuel flow meters
- Compressed air mass flow meters
- Steam meters

3. Additionally, for electricity, gas and heat meters, the system shall be able to:

- Automatically capture data from meters or sensors at regular intervals in order to provide energy performance indicators. The collection intervals may be user definable or configured for particular meter types.
- Store and process meter readings made on a half hourly basis (as a minimum). The metering data may be transferred into the data store in real-time or at scheduled times.
- Automatically identify and report data collection failures, missing metering data and the failure of communications with meters, transducers and any other system components.
- Distribute data with no loss of accuracy, except for pulse outputs from meters, where the transmitted metered data shall be within +/- 0.5 % of the total variable measured.
- Present energy consumption data in graphical reporting formats (for example, histograms, line plots, etc.), and in user selectable time intervals / divisions / bases.
- Export the collected energy data in a standard format for use in other applications (for example, ASCII files or other formats commonly used by standard office applications).
- Retain a minimum of 2 complete years of metering data without loss of data resolution or accuracy, in a date/time stamped format, suitable for analysis of trends and patterns.

4. For electricity, gas and heat meters, the system shall provide facilities to enable the user to:

- Select datasets from individual meters and manipulate them by combining, comparing and calculating in order to analyse, identify and evaluate instances of energy waste.
- Undertake regression analysis using two variables in whatever frequency the dataset was obtained, and to display the results in graphical form with a correlation coefficient.

- Set up automatic exception reporting functions that are capable of basing exception reports on the raw data profile. The frequency capability of notifications should be kept at a minimum.
- Set up standard management reports that enable total energy consumption to be benchmarked against performance standards during a user selectable period. It may also be beneficial to compare energy consumption with the corresponding period in the previous year, including an analysis of energy use by meter, fuel type or energy accounting centre.

In addition, where new meters are being installed, they shall comply with the following requirements:

5. Electricity meters shall meet the accuracy requirements of one of the following:
   - BS EN62053-21:2003, “Electricity metering equipment (ac) – Particular requirements - Part 21: Static meters for active energy (classes 1 and 2)”.
   - BS 8431:2010, “Electrical static metering for secondary or sub-metering. Specification” (BSI, ISBN 0 580 451178). Classes 1 or 2.
6. Gas meters shall meet the accuracy requirements of one of the following standards:
   - BS EN12261:2002, Gas Meters - Turbine gas meters.
   - BS EN12480:2015, Gas Meters - Rotary displacement gas meters.
   - BS EN1359:1999, Gas Meters - Diaphragm gas meter.
7. Heat meters shall meet the requirements of:
   - BS EN 1434-1: 2015, Heat meters. General requirements.
   - BS EN 1434-4: 2015, Heat meters. Pattern approval tests
   - BS EN 1434-5: 2015, Heat meters. Initial verification tests
8. Oil fuel flow meters shall conform to the following requirements:
   - Be installed on the same aM&T submetering system as either an electricity, gas or heat meter.
   - The Measuring Instruments Regulations 2016 (Schedule 1, Section 7)[1].
   - Possess a minimum flow rate range of 4:1, where the flow rate range is defined as the range between the minimum flow rate (Qmin) and the maximum flow rate (Qmax).
   - The accuracy classification and Maximum Permissible Error (MPE) as defined within The Measuring Instruments Regulations 2016 (Schedule 1, Section 7) [2].
9. Compressed air mass flow meters shall conform to the following requirements:
   - Be installed on the same aM&T submetering system as either an electricity, gas or heat meter.
   - The Measuring Instruments Regulations 2016 (Schedule 1, Section 7)[3].
10. Steam meters shall conform to the following requirements:

[1] Annex I of the Measurement Instrument Directive (EC No. 2014/32/EU)

[2] Section 2 of Annex VII (MI-005) of the Measurement Instrument Directive (EC No. 2014/32/EU)

[3] Annex I of the Measurement Instrument Directive (EC No. 2014/32/EU)

- Be installed on the same aM&T submetering system as either an electricity, gas or heat meter.
- Be capable of displaying the measured steam pressure and temperature, and the current mass flow rate and cumulative mass of steam
- Shall have, as a minimum, the following components continuously measuring the steam properties and calculating the cumulative steam energy that has passed through the measuring system as shown on the system's schematic diagram:
- A flow meter – which determines how much fluid (steam) has passed through a pipe over a given time period
- A pressure sensor – to measure the pressure of steam flowing through the pipe
- A temperature sensor – to measure the temperature of steam flowing through the pipe
- A calculator/digital integrator – which uses the information provided by the flow meter, temperature and pressure sensors to calculate the cumulative heat energy transferred through the pipe.
- Conformity with the requirements of the appropriate BS EN ISO 5167 series of standards, if relevant for the steam meter

11. Instrument transformers used to measure energy use for metering purposes shall conform to the Class 1 accuracy requirements of one of the following:
    - BS EN 61869-2:2012, "Instrument transformers. Additional requirements for current transformers".
    - BS EN 61869-3:2011, "Instrument transformers. Additional requirements for inductive voltage transformers".

Meters offering equivalent or better levels of accuracy to those specified above will be accepted, provided they meet the accuracy requirements of applicable British Standards. Please note that this includes all electricity, gas and heat meters conforming to the specific accuracy requirements of The Measuring Instruments Regulations 2016.

1.4 Verification for ETL Listing

This sub-technology is "unlisted" therefore individual products do not need to be listed on the Energy Technology Product List.

1.5 Conformity testing

Products listed on the ETL may be subject to the scheme's conformity testing programme in order to ensure listed models continue to meet the ETL requirements.

2 Portable energy monitoring equipment

Date published	2020
Date first launched	2003
Former name	Portable AMT Equipment

2.1 Scope

Portable energy monitoring equipment covers products that are specifically designed to temporarily measure energy use in different locations, and to record, analyse and report on energy consumption.

Portable energy monitoring equipment helps to save energy by identifying energy wastage and ensuring the long-term effectiveness of other energy saving investment measures.

Portable energy monitoring equipment enables the temporary monitoring of energy use in different locations and can be used to record energy consumption data and to highlight unusual patterns of consumption. Some electricity monitoring equipment can also measure power quality. In total, these criteria cover four categories of equipment: energy monitors and loggers, power quality analysers, gas flow and heat flow monitoring equipment.

A wide range of portable energy monitoring equipment is available. The Energy Technology List (ETL) aims to encourage the purchase of products that can measure and analyse energy consumption and power quality data, and produce reports containing energy management information that enable businesses to manage their energy use.

To be eligible for inclusion on the ETL, products shall meet the definitions, eligibility and performance requirements as set out below.

2.2 Definitions

The ETL covers portable energy monitoring equipment that measures one or more of the following:

1. Electricity use
   Products which measure electricity use but not total harmonic distortion (THD).
2. Power quality
   Products which measure electricity use and total harmonic distortion (THD). They may also measure other optional power quality attributes such as voltage dips and swells, transients.
3. Gas flow

   Products which measure gas flow. For example, flow of industrial gases such as nitrogen and oxygen.
4. Heat flow

   Products which measure the flow of heat.

The portable energy monitoring equipment shall be clamped onto either a pipe or (a) cable(s) to measure consumption using transducers. These transducers should be easily moved and designed for temporary operation.

2.3 Requirements

2.3.1 Eligibility requirements

To be eligible, products shall:

- Be a portable measuring instrument package that includes:

a) An 'energy use' metering device and associated measurement transducers (or probes).

b) A means of electronically capturing and storing energy consumption data.

c) A means of transferring data to other computing devices or computer systems.

d) A software-based means of analysing and displaying energy consumption data, and of producing energy management reports, that can be used to identify the 'key factors' that influence energy consumption.

e) Technical support to facilitate competent operation of the product by the user

- Be able to meter one or more of the following:

a) Electricity use

b) Power quality

c) Gas flow (e.g. industrial gases)

d) Heat flow.

- Have an appropriate Conformity Assessment mark and conform to:

  - The Electromagnetic Compatibility Regulations 2016 The Electrical Equipment (Safety) Regulations 2016
    The Radio Equipment Regulations 2017 for products that communicate wirelessly.

2.3.2 Performance Requirements

Eligible products shall comply with the following. Note: portable energy monitoring equipment that measures more than one of electricity, power quality, gas or heat, shall comply with all the following performance requirements commensurate with its' scope.

2.3.2.1 Electricity Monitors and Loggers

Measurement accuracy of +/- 3% of meter reading across the product's entire operating temperature range for:

- Voltage
- Current
- Phase angle

Note: Products which measure electricity use (energy monitors and loggers), and also measure power quality attributes, at least total harmonic distortion (THD), shall be classified as power quality analysers for Energy Technology List purposes.

2.3.2.2 Power Quality Analysers

Comply with Class S or Class A as defined in IEC or BS EN 61000-4-30:2015. Existing listed products at Class B as defined in IEC or BS EN 61000-4-30:2015 remain eligible.

2.3.2.3 Heat flow monitoring equipment

Have a measurement accuracy of +/- 3% of meter reading across the product's entire operating temperature range for all measurement ranges relevant to the metering of heat flow.

2.3.2.4 Gas flow monitoring equipment

Have a measurement accuracy of +/- 3% of meter reading across the product's entire operating temperature range for all measurement ranges relevant to the metering of industrial gas flow.

2.4 Verification for ETL Listing

Manufacturers applying to list power quality analysers shall provide a certificate of conformity to verify the class (e.g. Class S) of the product according to IEC or BS EN 61000-4-30:2015.

Manufacturers of electricity monitors and loggers, heat flow, and gas flow monitoring equipment shall provide sales and technical brochures to evidence the conformity of their products against the requirements from section 2.3.

2.5 Conformity testing

Products listed on the ETL may be subject to the scheme's conformity testing programme in order to ensure listed models continue to meet the ETL requirements.

2.6 Review

2.6.1 Indicative review date

The next technical review is scheduled for 2023-24.

2.6.2 Illustrative future direction of the requirements

Future changes to the specification may include:

- Expansion of the software component to include carbon and price impacts

Boiler Equipment

3 Biomass Boilers

Date published	2016
Date first launched	2001/2003
Former name	Biomass Boilers and Room heaters

3.1 Scope

Biomass boilers are used to heat water for process or space heating.

Biomass boilers are available with a wide range of efficiencies. The Energy Technology List (ETL) Scheme aims to encourage the purchase of products with the highest thermal efficiency.

The fuels used in biomass boilers are renewable so their use will also reduce the amount of fossil fuel that might otherwise have been consumed.

To be eligible for inclusion on the ETL, products shall meet the requirements as set out below.

3.2 Definitions

Biomass boilers are products that are specifically designed to burn solid biomass fuels in order to heat water.

3.3 Requirements

3.3.1 Eligibility requirements

To be eligible, products must:

- Be designed to burn wood, cereal straw, or solid fuels derived from them.
- Heat water for process or space heating.
- Have an appropriate Conformity Assessment mark.
- Meet the following air quality emission limits:
  - Particulate matter (PM) emissions must not exceed 30 grams per gigajoule (g/GJ) net heat input
  - Oxides of nitrogen (NO_x) emissions must not exceed 150 grams per gigajoule (g/GJ) net heat input

Compliance with these emissions limits should be demonstrated by providing valid Renewable Heat Incentive (RHI) emissions certificates for the specific biomass boiler listed, or a certificate confirming that the boiler is part of range (as per the RHI emissions limits type testing rules) that meets these emission limits.

3.3.2 Performance Requirements and Test Procedure

Eligible products must exceed the minimum thermal efficiency set out in Table 3.1 and Table 3.2 based on based upon the maximum continuous rated output of the product covered.

Table 3.1 For use with biomass hot water boilers with a maximum continuous rated output up to and including 300kW

SECTION 1A –PERFORMANCE THRESHOLDS

To be eligible products must have, when tested at maximum continuous rated output:

- For boilers with a nominal rating of <=100kW, a thermal efficiency of at least 90.0 + log (Nominal Heat Output) based on the net calorific value of the fuel.
- For boilers with a nominal rating of >100kW and <=300kW, a thermal efficiency of at least 92.0 % based on the net calorific value of the fuel.

SECTION 1B –TEST PROCEDURES

All products <= 300kW must be tested in accordance with:

- EN 303-5:2012 “Heating boilers for solid fuels, hand and automatically fired, nominal heat output of up to 500 kW. Terminology, requirements, testing and marking”.

The tests must be done using a biomass test fuel (designated A, B1, B2, C & D) in accordance with Table 7 of EN 303-5:2012 that is appropriate to the advertised usage of the product.

Please note that performance data obtained in accordance with the procedures and standard rating conditions laid down in EN 303-5:1999 and using a biomass test fuel (designated A1, A2, B1, B2, C & D) in accordance with Table 8 will be accepted as an alternative to testing in accordance with EN303-5:2012 until further notice.

Table 3.2 For use with biomass hot water boilers with a maximum continuous rated output above 300kW

SECTION 2A –PERFORMANCE THRESHOLDS
To be eligible products must have, when tested at an output that is between 60% and 100% of Maximum Continuous Rating (MCR): ■ A thermal efficiency, of at least 90.0% based on the net calorific value of the test fuel.
SECTION 2B –TEST PROCEDURES
All products >300kW must be tested in accordance with: EITHER ■ BS 845-1:1987 “Methods for assessing thermal performance of boilers for steam, hot water and high temperature heat transfer fluids: Concise procedure”. OR (for shell boilers only) ■ BS EN 12953-11:2003 “Shell boilers — Part 11: Acceptance tests”. OR (for water tube boilers only) ■ BS EN 12952-15:2003 “Water-tube boilers and auxiliary installations. Acceptance tests”. OR ■ The testing procedures set out in EN 303-5:2012. The tests must be done using a biomass test fuel (designated A, B1, B2, C & D) in accordance with Table 7 of EN 303-5:2012 that is appropriate to the advertised usage of the product. Where BS 845-1:1987 is used, the standard test conditions are: ■ A maximum ambient air temperature of 25 degrees Centigrade. ■ An excess combustion air level certified as being representative of normal commercial operation. ■ The boiler must be operating at a rating of at least 60% of its maximum continuous rating (i.e. 60 – 100% MCR) during the tests. As an alternative to measurement of losses other than flue gas losses, a standard deduction of 2.0% x 100 %/% load may be used. Please note that performance data obtained in accordance with the procedures and standard rating conditions laid down in EN 303-5:1999 and using a biomass test fuel (designated A1, A2, B1, B2, C & D) in accordance with Table 8 will be accepted as an alternative to testing in accordance with EN303-5:2012 until further notice.

3.4 Measurement and Calculations

3.4.1 Test Requirements

All products must be tested in accordance with the procedures and test conditions set out in Table 3.1 or Table 3.2 based upon the maximum continuous rated output of the product covered.

For products up to and including 300kW all tests must be carried out by, or witnessed by, an accredited laboratory, where “accredited” means accredited by the United Kingdom Accreditation Scheme (UKAS), or the International Accreditation

Forum, or the International Laboratory Accreditation Co-operation (ILAC) agreements.

For products above 300kW, products can be either tested in an accredited laboratory OR performance may be determined from measurements made during field trials or acceptance tests, provided that the measurements have been made by, or witnessed by, an accredited laboratory or contractor that is accredited to make those measurements. The product's net thermal efficiency must be calculated by an independent body that is competent to verify the measurement data.

For the avoidance of doubt net thermal efficiency test data must be presented to one decimal place. As an example, a Biomass hot water boiler with a maximum continuous rated output above 300kW and a net thermal efficiency of 89.9% when tested at between 60% and 100% of its maximum continuous rating (MCR) (as specified in Table 3.2) would be deemed to be a fail.

The requirements for testing of PM and NO_x are:

- That testing is carried out in accordance with the provisions relevant to emissions of PM and NO_x specified in whichever of the following standards applies: EN 303-5:1999; or, EN 303- 5:2012.
- That testing is carried out in accordance with EN 14792:2005 for NO_x and EN 13284-1: 2002 or BS ISO 9096: 2003 for PM.

3.5 Verification for ETL Listing

Any of the following testing routes may be used to demonstrate the conformity of products against the requirements:

- Witnessed testing (test reports must be prepared by, or verified by, an independent accredited test laboratory)
- Independent testing (test reports must be prepared by, or verified by, an independent accredited test laboratory)
- Acceptance Tests or Field Trials (category 2&3 only; test reports must be prepared by, or verified by, an independent accredited test laboratory)
- Representative testing (see clause 3.5.1)

Further information regarding the first three routes can be found in Guidance Note 5 on the ETL product testing framework[4].

3.5.1 Representative testing

Where applications are being made for products of the same constructional design, which are less than or equal to 300kW, to be included on the ETL, the type testing procedures set out in Annex F of BS EN 303-3:1999 or section 5.1.4 of EN 303-5:2012 or Annex C.2.1 of BS EN 304:1992 (as amended) may be used to select representative models for testing and to reduce the overall number of performance tests that must be completed.

Where applications are being made for products of the same constructional design, which are greater than 300kW, to be included on the ETL, test data may be submitted for a single representative model provided that the maximum rated output of the products being applied for is not more than twice, or less than half, the

[4] https://www.gov.uk/government/publications/energy-technology-list-etl-product-testing-framework

maximum rated output of the product tested. Where the range of rated outputs exceeds these limits, products should be grouped into size ranges that comply with these rules, and test data submitted for one representative model for each group.

Where representative testing is used, details of the design calculations and data used to predict the performance of products that have not been tested must be submitted.

It should be noted that:

- If a manufacturer voluntarily removes a representative model from the ETL then other products linked with that representative model may or may not be permitted to remain on the ETL.
- If any product submitted under these representative model rules is later found not to meet the performance criteria when independently tested; then all products based on the same representative models will be removed from the ETL.

3.6 Conformity testing

Products listed on the ETL may be subject to the scheme's conformity testing programme in order to ensure listed models continue to meet the ETL requirements.

4 Gas-fired Condensing Water Heaters

Date published	2016
Date first launched	2004

4.1 Scope

Gas-fired condensing water heaters are used to provide hot water for domestic purposes or process heating, and offer an energy efficient method of generating hot water. They can be installed close to the point of use, or in a central plant room.

Gas-fired condensing water heaters are described as 'storage' type products if they generate hot water by heating water stored within the product itself. Other types of gas-fired condensing water heaters are described as 'non-storage' type products, and can be divided into continuous flow type products that are designed to instantaneously generate hot water directly from cold water, and those that heat water as it is circulated round a loop (which may also include buffer vessels).

Gas-fired condensing water heaters are available in a range of different efficiencies. The Energy Technology List (ETL) Scheme aims to encourage the purchase of higher efficiency products.

The ETL Scheme covers three categories of gas-fired condensing water heaters:

1. Storage type, gas-fired condensing water heaters not exceeding 150kW
2. Non- storage, instantaneous (or continuous flow) type, gas-fired condensing water heaters
3. Non-storage, circulator (or multi-pass) type, gas-fired condensing water heaters.

To be eligible for inclusion on the ETL, products shall meet the requirements as set out below.

4.2 Definitions

Gas-fired condensing water heaters are products that are specifically designed to continuously provide hot water either by the direct heating of water as it passes through the product, or the heating of water contained in an integral storage vessel.

4.3 Requirements

4.3.1 Eligibility requirements

To be eligible products, must:

- Be gas-fired.
- Comply with the requirements of the Water Supply (Water Fittings) Regulations 1999, the Water Byelaws 2000 Scotland and the Water Regulations in Northern Ireland (for example, by inclusion in the Water Regulations Advisory Scheme's Water Fittings and Materials Directory).
- Have an appropriate Conformity Assessment mark

In addition, non-storage – circulator type, gas-fired condensing water heaters must:

- Use fully premixed burners or an appropriately matched forced draught burner (or burners).
- Automatically respond to changes in hot water demand by modulating their output in a continuous manner across a minimum turndown ratio of 3.33:1, without initiating a purge cycle.
- Products with a thermal output in excess of 400kW must either use burners from the "burners with controls" part of the Energy Technology Product List or:
  - Incorporate a microprocessor based burner control system.
  - Use a variable speed motor controller (or Variable Speed Drive) to operate each forced draught fan incorporated into the product.
  - Where mechanical dampers are used to modulate the air flow to the burners, they must be operated by a precision servomotor. The servomotor must be controlled by a positional or flow based feedback mechanism that automatically adjusts its operation to correct for mechanical wear, valve stiction and hysteresis.
  - Where control valves are used to modulate the fuel flow to the burners, they must be operated by a precision servomotor. The servomotor must be controlled by a positional or flow based feedback mechanism that automatically adjusts its operation to correct for mechanical wear, valve stiction and hysteresis. (This requirement shall not apply to pneumatically operated modulating gas valves).

In addition, non-storage – instantaneous type, gas-fired condensing water heaters exceeding 70kW must be fitted with an integral, fully pre-mixed, modulating burner.

4.3.2 Performance requirements

Eligible products must meet or exceed the appropriate performance criteria:

- Products with a rated heat output <= 400kW, must meet or exceed the gross water heating energy efficiency η_{wh} thresholds shown in Table 4.1 at the declared load profile.

- Products with a rated heat output > 400kW, must meet or exceed the gross thermal efficiency thresholds shown in Table 4.2.

Table 4.1 Minimum gross water heating energy efficiency (η_{wh}) for gas-fired condensing water heaters with a rated heat output of 400kW or less (all product categories)

Declared load profile	3XS	XXS	XS	S	M	L	XL	XXL	3XL	4XL
Water Heating Energy Efficiency (*ηwh)*	>= 70.0%						>= 80.0%	>= 85.0%		

Where:

- Water Heating Energy Efficiency (η_{wh}) is the ratio between the useful energy in the water provided and the energy required for its generation, expressed as a percentage.
- Load profile is a given sequence of water draw-offs, as specified in in Annex III, Table 1 of Commission Regulation (EU) No 814/2013 “Ecodesign requirements for water heaters and hot water storage tanks”.

Table 4.2 Minimum gross thermal efficiency for gas-fired condensing water heaters with a rated heat output of over 400kW

Product category	Nominal heat input (kW)	Test conditions	Gross thermal efficiency %
Non storage – instantaneous type	> 400kW	At 100% load, flow/return temperatures of 80/60ºC	>= 85.6%
		At 30% load, return temperature of 30ºC	>= 93.7%
Non storage - circulator type	> 400kW	At 100% load, flow/return temperatures of 80/60ºC	>= 85.6%
		At 30% load, return temperature of 30ºC	>= 93.7%

“ >=” means “greater than or equal to”

For products with a rated heat output <= 400kW, the load profile used for the test must be declared by the manufacturer and shall be the maximum load profile or the load profile one below the maximum load profile for the product.

Products with a rated heat output > 400kW must meet or exceed the minimum gross thermal efficiencies at both full load and part load test conditions, as specified in Table 4.2.

4.4 Measurement and Calculations

4.4.1 Measurement standards

All products must be tested in accordance with the procedures set out in one of the test standards recognised by the ETL as set out below, or in accordance with equivalent procedures for assessing thermal efficiency within applicable British Standards

Tests to determine gross water heating energy efficiency (products <= 400kW) must be carried out at the conditions specified in BS EN 13203-2:2015.

Tests to determine gross thermal efficiency (products > 400kW) must be carried out at the test conditions specified in an appropriate test standard named in Table 4.3.

Table 4.3 ETL recognised test standards to determine gross thermal efficiency

Test standard	Applicable product categories		
	1	2	3
BS EN 89:2000 Gas-fired storage water heaters for the production of domestic hot water	☑		
BS EN 89:2015 Gas-fired storage water heaters for the production ofdomestic hot water	☑		
BS EN 303-3:1999 Heating boilers — Part 3: Gas-fired central heating boilers — Assembly comprising a boiler body and a forced draught burner‘.			☑
BS EN 303-7:2006 Heating boilers — Part 7: Gas-fired central heating boilers equipped with a forced draught burner of nominal heat output not exceeding 1,000kW‘.			☑
BS EN 15502-1:2012+A1:2015 Gas-fired heating boilers. General requirements and tests BS EN 15502-2-1:2012 Gas-fired central heating boilers. Specific standard for type C appliances and type B2, B3 and B5 appliances of a nominal heat input not exceeding 1 000 kW			☑
BS EN 483:1999+A4:2007 Gas-fired central heating boilers. Type C boilers of nominal heat input not exceeding 70kW‘			☑
BS EN 677:1998 Gas-fired central heating boilers. Specific requirements for condensing boilers with a nominal heat input not exceeding 70 kW			☑
BS EN 26:1998 Gas fired instantaneous water heaters for the production of domestic hot water, fitted with atmospheric burners		☑	☑
BS EN 26:2012 Gas-fired instantaneous water heaters for the production of domestic hot water		☑	☑
BS EN 26:2015 Gas-fired instantaneous water heaters for the production of domestic hot water		☑	☑

4.4.2 Rounding

For the avoidance of doubt, all efficiency test data should be presented to one decimal place. As an example, a 500kW non storage, instantaneous, gas fired condensing water heater with a gross thermal efficiency of 85.5% at the full load condition would be deemed to be a fail.

4.5 Verification for ETL Listing

Any of the following testing routes may be used to demonstrate the conformity of products against the requirements:

- In-house testing – Self-certified
- In-house testing – Self-tested and verified or cross-checked by an independent body
- Witnessed testing
- Independent testing
- Representative testing (see clause 4.5.1)

Further information regarding the first four routes can be found in Guidance Note 5 on the ETL product testing framework[5].

4.5.1 Representative testing

Where applications are being made for gas fired condensing water heaters that are variants of the same constructional design and rated outputs up to and including 400 kW to be included on the ETL, test data may be submitted for a representative selection of models. The representative models must be selected by dividing the range of products into groups of models with similar design characteristics, and testing a model in the lowest quartile of predicted performance in each group. The performance of each model in the group must be predicted using a validated mathematical model. As a minimum, at least one model must be tested in each range of products.

Where applications are being made for products of the same constructional design and rated outputs greater than 400 kW to be included on the ETL, test data may be submitted for a single representative model provided that the maximum rated output of the products being applied for is not more than twice, or less than half, the maximum rated output of the product tested. Where the range of rated outputs exceeds these limits, products should be grouped into size ranges that comply with these rules, and test data submitted for one representative model for each group.

It should be noted that:

- If a manufacturer voluntarily removes a representative model from the ETL then other products linked with that representative model may or may not be permitted to remain on the ETL.
- If any product submitted under these representative model rules is later found not to meet the performance criteria when independently tested, then all products based on the same representative models will be removed from the ETL.

4.6 Conformity testing

Products listed on the ETL may be subject to the scheme's conformity testing programme in order to ensure listed models continue to meet the ETL requirements.

[5] https://www.gov.uk/government/publications/energy-technology-list-etl-product-testing-framework

5 Hot Water Boilers

Date published	2018
Date first launched	2001

5.1 Scope

Hot water boilers are used to produce hot water for space heating, process heating and domestic uses. They are available in a wide range of different designs and efficiencies.

The Energy Technology List (ETL) scheme aims to encourage the purchase of the higher efficiency, modulating, gas and oil fired hot water boilers, including products that are designed to use liquid and gaseous biofuels.

The ETL Scheme covers four categories of products:

1. High temperature, high pressure, high efficiency hot water boilers with rated outputs greater than 400kW.
   Boilers designed to operate with a water pressure greater than 6 bar and/or outlet water temperature greater than 105°C, and that are not designed to recover latent heat from flue gases by condensing water vapour.
2. Low temperature, low pressure, high efficiency hot water boilers with rated outputs greater than 400kW.

   Boilers designed to operate with a water pressure up to and including 6 bar and/or an outlet water temperature up to and including 105°C that are not designed to recover latent heat from flue gases by condensing water vapour.
3. Condensing hot water boilers with rated outputs greater than 70kW:
   Boilers designed to recover latent heat from flue gas water vapour.
4. Condensing hot water boilers with rated outputs up to 70kW: Boilers designed to recover latent heat from flue gas water vapour.

To be eligible for inclusion on the ETL, products shall meet the requirements as set out below.

5.2 Definitions

Hot water boilers are products that are specifically designed to heat water by means of a heat exchanger that transfers heat from combustion into the water as it passes through the product.

5.3 Requirements

5.3.1 Eligibility requirements

To be eligible, products shall:

- Be gas and/or oil fired (where gas includes biogas and oil includes liquid biofuels).
- Automatically respond to changes in hot water demand by modulating their output in a continuous manner across a minimum specified turndown ratio, as set out in Table 5.1 in the performance criteria below, without initiating a purge cycle.

- Conform to the requirements of The Pressure Equipment (Safety) Regulations 2016 in respect of their design, manufacturer and testing procedures, or have an appropriate Conformity Assessment mark .

To be eligible, products with a thermal input greater than or equal to 1MW, and less than 50MW, shall comply with the minimum requirements as stated in Annex II of the Medium Combustion Plant Directive (EU) 2015/2193[6] as implemented in domestic law.

In addition, products with a rated output greater than 400kW shall either use burners from the "burners with controls" part of the Energy Technology Product List or:

- Incorporate a microprocessor based control system that continuously modulates burner output in response to measured boiler temperature or pressure values.
- Use fully pre-mixed burners, or forced draught burners. Where forced draft burners are used, automatic (electronic or pneumatic) air fuel ratio controls shall be fitted.
- Where mechanical dampers are used to modulate the air flow to the burners, they shall be operated by a precision servomotor. The servomotor shall be controlled by a positional or flow based feedback mechanism that automatically adjusts its operation to correct for mechanical wear, valve stiction and hysteresis.
- Where control valves are used to modulate the fuel flow to the burners, they shall be operated by a precision servomotor. The servomotor shall be controlled by a positional or flow based feedback mechanism that automatically adjusts its operation to correct for mechanical wear, valve stiction and hysteresis. (This requirement shall not apply to pneumatically operated modulating gas valves).
- Where the product is gas fired or dual fuelled, use a variable speed motor controller (or variable speed drive) to operate each fan incorporated into the product that controls air flow rate to the burner and, where relevant, the fuel-air pre-mixer.
- Provide product performance specification data in line with ETL Guidance Note 13.

Products with a rated output of up to 400kW shall be fitted with integrated burners.

For category 1 and 2 products, the respective thresholds as detailed in Table 5.1 may be achieved with or without an economiser designed to recover specific heat from the exhaust flue gas.

5.3.2 Performance requirements

Eligible products shall meet or exceed the minimum thermal efficiencies set out in Table 5.1 below at the specified part and full load test conditions, which vary according to product category and fuel type.

[6] The Environmental Permitting (England and Wales) (Amendment) Regulations 2018,
The Pollution Prevention and Control (Scotland) Amendment Regulations 2017,
The Pollution Prevention and Control (Industrial Emissions) (Amendment) Regulations (Northern Ireland) 2018.

Table 5.1 Performance requirements and test points for hot water boilers

	Product Category	Fuel Type	Turndown ratio	Test point (% of Maximum Nominal Output)	Gross thermal efficiency %	Seasonal Space Heating Energy Efficiency %[7]
1.	High temperature, high pressure, high efficiency hot water boilers	Gas, oil or dual fuelled	>= 3.33:1	30	>= 83.8%	
				100	>= 83.0%	
2.	Low temperature, low pressure, high efficiency hot water boilers	Gas, oil or dual fuelled	>= 3.33:1	30	>= 83.8%	
				100	>= 83.0%	
3.	Condensing hot water boilers >70kW	Gas fired or dual fuelled	>= 3.33:1	30	>= 97.3%	
				100	>= 87.4%	
		Oil fired		30	>= 94.6%	
				100	>= 89.0%	
4.	Condensing hot water boilers <=70kW	Gas, oil or dual fuelled	>= 3.33:1			>= 93%

">=" means "greater than or equal to"

"<=" means "less than or equal to"

5.4 Measurement and Calculations

5.4.1 Measurement Standards and Test Requirements

Product performance shall be demonstrated using Method A, Method B or Method C (as set out in 5.4.1.2, 5.4.1.3 and 5.4.1.4 below), which are subject to the following restrictions:

- Method A shall only be used, where all the burners incorporated in the product are listed on the “burners with controls” part of the Energy Technology Product List.
- Method B shall be used to demonstrate the performance of modular boilers, or where any of the burners incorporated in the product are not listed on the “burners with controls” part of the Energy Technology Product List. A modular boiler is defined as an assembly of two or more similar (but not necessarily identical) modules, each with their own heat exchanger, burner, and control and safety devices. The assembly has common water feed and return connections, but the water flow to, and flow from each module is independently controlled.
- Method C may only be used for category 1 and 2 boilers with rated outputs above 400kW and category 3 boilers with rated outputs above 900kW,

[7] As defined in EU Regulation No 813/2013

where it is not possible to measure product performance in a laboratory due to product size.

All performance measurements shall be carried out in accordance with the procedures set out in one, or more, of the test standards recognised by the ETL as set out in Table 5.2, or in accordance with equivalent procedures for assessing gross thermal efficiency within applicable British Standards. The selected test standard(s) shall be appropriate to the specific type of boiler tested.

Table 5.2 ETL recognised test standards

Test standard	Applicable product categories			
	1	2	3	4
BS EN 625:1996 'Gas-fired central heating boilers. Specific requirements for the domestic hot water operation of combination boilers of nominal heat input not exceeding 70kW'				☑
BS EN 483:1999+A4:2007 'Gas-fired central heating boilers. Type C boilers of nominal heat input not exceeding 70kW'				☑
BS EN 677:1998 'Gas-fired central heating boilers. Specific requirements for condensing boilers with a nominal heat input not exceeding 70kW'				☑
BS EN 13836:2006 'Gas fired central heating boilers. Type B boilers of nominal heat input exceeding 300kW, but not exceeding 1 000kW'			☑	
BS EN 15417:2006 'Gas-fired central heating boilers. Specific requirements for condensing boilers with a nominal heat input greater than 70kW but not exceeding 1000kW'			☑	
prEN 15420:2005 'EN 15420. Gas-fired central heating boilers. Type C boilers of nominal heat input exceeding 70kW, but not exceeding 1000kW' (CEN document code 06/30144913 DC)			☑	
BS 845-1:1987 'Methods for Assessing thermal performance of boilers for steam, hot water and high temperature heat transfer fluids — Part 1: Concise procedure'.	☑	☑	☑	☑
BS 7190:1989 'Method for assessing thermal performance of lowtemperature hot water boilers using a test rig'		☑	☑	☑
BS EN 303-3:1999 'Heating boilers — Part 3: Gas-fired central heating boilers — Assembly comprising a boiler body and a forced draught burner'.		☑	☑	☑
BS EN 303-7:2006 'Heating boilers — Part 7: Gas-fired central heating boilers equipped with a forced draught burner of nominal heat output not exceeding 1,000 kW'.		☑	☑	☑
BS EN 304:1992 'Heating boilers — Test code for heating boiler for atomising oil burners' (as amended).	☑	☑	☑	☑
BS EN 12953-11:2003 "Shell boilers — Part 11: Acceptance tests".	☑	☑	☑	☑
BS EN 12952-15:2003 "Water-tube boilers and auxiliary installations. Acceptance tests".	☑	☑	☑	☑

BS EN 14394:2005+A1:2008 “Heating boilers. Heating boilers with forced draught Burners. Nominal heat output not exceeding 10 MW and maximum operating temperature of 110°C”.	☑	☑		
BS EN 15502-1:2012+A1:2015 “Gas-fired heating boilers. Part 1: General requirements and tests”			☑	☑
BS EN 15502-2-1:2012 “Gas-fired central heating boilers. Specific standard for type C appliances and type B2, B3 and B5 appliances of a nominal heat input not exceeding 1000 kW”			☑	☑

Where BS 845- 1:1987 is used, the following standard test conditions shall be observed:

- A maximum ambient air temperature of 25ºC.
- An excess combustion air level of not less than 15%.

5.4.1.2 Method A - separate testing boilers and burners

Under this test method:

1. Boiler and burner performance are demonstrated separately.
2. Boiler performance can be assessed using any burner (or burners) that can provide the heat input and operational stability needed to complete the test.
3. The boiler’s gross thermal efficiency at full load (100%) shall be measured in accordance with the procedures set out in an ETL recognised standard (Table 5.2
4. The boiler’s gross thermal efficiency at part load (30%) is then inferred from burner performance data and design calculations of burner/boiler matching.

5.4.1.3 Method B – integrated testing at full and part loads

Under this test method, overall product performance shall be demonstrated by:

1. Measuring the gross thermal efficiency at the test points specified in Table 5.1, in accordance with the procedures set out in an ETL recognised standard (Table 5.2).

5.4.1.4 Method C – validated design calculations

Under this test method:

1. The product’s gross thermal efficiency at the full and part load conditions specified in Table 5.1 and the test conditions specified in one of the ETL recognised standards (Table 5.2) is determined from design calculations.
2. The accuracy of these design calculations shall be confirmed by using an indirect method (flue gas loss method) from one of the ETL recognised standards (Table 5.2) to measure the product’s actual gross thermal efficiency:
    a) At least one test point between 60 % and 100 % of product’s maximum rated input at the temperature conditions specified for the 100 % test point, and:
    b) At least one test point between 20% and 40 % of product’s maximum rated input at or near the temperature conditions specified for the 30 % test point.

3. To be eligible, the product's gross thermal efficiency shall exceed the performance thresholds specified in Table 5.1.

The test report shall include (or be accompanied by):

a) Details of the calculations used to determine product performance.

b) A copy of the published performance data for the product.

c) Manufacturer's design data for the product.

d) The following test data, which shall be obtained with the product operating under stable conditions at each selected test point:

I. Analysis of flue gas composition, including as a minimum levels or oxygen or carbon dioxide and carbon monoxide.

II. Ambient and flue gas temperatures.

III. Total conductive, convective and radiative loss rate.

IV. Gross thermal efficiency.

e) Details of the burners used during the test.

5.4.2 Rounding

For the avoidance of doubt gross thermal efficiency test data shall be presented to 1 decimal place. As an example, a gas fired condensing hot water boiler >70kW with a gross thermal efficiency of 87.3% at 100% of its maximum rated output would be deemed to be a fail.

5.5 Verification for ETL Listing

Any of the following testing routes may be used to demonstrate the conformity of products against the requirements:

- In-house testing – Self-certified
- In-house testing – Self-tested and verified or cross-checked by an independent body
- Witnessed testing
- Independent testing
- Acceptance Tests or Field Trials (Category 1 & 2 above 400kW and Category 3 above 900kW)
- Representative testing (see clause 5.5.1)

Further information regarding the first five routes can be found in Guidance Note 5 on the ETL product testing framework[8].

5.5.1 Representative testing

Where applications are being made for hot water boilers that are variants of the same constructional design and rated outputs up to and including 400kW to be included on the ETL, test data may be submitted for a representative selection of models. The representative models shall be selected by dividing the range of

[8] https://www.gov.uk/government/publications/energy-technology-list-etl-product-testing-framework

products into groups of models with similar design characteristics, and testing a model in the lowest quartile of predicted performance in each group. The performance of each model in the group shall be predicted using a validated mathematical model. As a minimum, at least one model shall be tested in each range of products.

Where applications are being made for products of the same constructional design and rated outputs greater than 400kW to be included on the ETL, test data may be submitted for a single representative model provided that the maximum rated output of the products being applied for is not more than twice, or less than half, the maximum rated output of the product tested. Where the range of rated outputs exceeds these limits, products should be grouped into size ranges that comply with these rules, and test data submitted for one representative model for each group.

It should be noted that:

- If a manufacturer voluntarily removes a representative model from the ETL then other products linked with that representative model may or may not be permitted to remain on the ETL.
- If any product submitted under these representative model rules is later found not to meet the performance criteria when independently tested, then all products based on the same representative models will be removed from the ETL.

5.6 Conformity testing

Products listed on the ETL may be subject to the scheme's conformity testing programme in order to ensure listed models continue to meet the ETL requirements.

6 Steam Boilers

Date published	2018
Date first launched	2001

6.1 Scope

Steam boilers are used to produce steam for process heating, space heating and water heating. They consist of a burner, a pressure vessel containing a heat exchanger, and associated burner control systems and boiler control equipment.

Steam boilers are available in a range of different designs and efficiencies. The Energy Technology List (ETL) Scheme aims to encourage the purchase of the higher efficiency gas and oil fired steam boilers, including products that are designed to use liquid and gaseous biofuels.

To be eligible for inclusion on the ETL, products shall meet the requirements as set out below.

6.2 Definitions

Steam boilers are products that are specifically designed to convert water into pressurised steam by means of a burner that converts fuel into heat and a heat exchanger that transfers the heat into the water as it passes through the product.

6.3 Requirements

6.3.1 Eligibility requirements

To be eligible, products shall:

- Be gas and/or oil fired.
- Use an appropriately matched forced draught burner (or burners).
- Automatically respond to changes in steam demand by modulating their output in a continuous manner across a minimum specified turndown ratio, as set out in the performance criteria below, without initiating a purge cycle.
- Conform to the requirements of The Pressure Equipment (Safety) Regulations 2016 in respect of their design, manufacturer and testing procedures, or have an appropriate Conformity Assessment mark.

To be eligible, products with a thermal input greater than or equal to 1MW, and less than 50MW, shall comply with the minimum requirements as stated in Annex II of the Medium Combustion Plant Directive (EU) 2015/2193[9] as implemented in domestic law.

In addition, products with a thermal output in excess of 400kW shall **either** use burners from the "burners with controls" part of the Energy Technology Product List **or**:

- Incorporate a microprocessor based control system that continuously modulates burner output in response to measured boiler temperature or pressure values.
- Use fully pre-mixed burners, or forced draught burners. Where forced draft burners are used, automatic (electronic or pneumatic) air fuel ratio controls shall be fitted.
- Where mechanical dampers are used to modulate the **air flow** to the burners, they shall be operated by a precision servomotor. The servomotor shall be controlled by a positional or flow based feedback mechanism that automatically adjusts its operation to correct for mechanical wear, valve stiction and hysteresis.
- Where control valves are used to modulate the **cc** to the burners, they shall be operated by a precision servomotor. The servomotor shall be controlled by a positional or flow based feedback mechanism that automatically adjusts its operation to correct for mechanical wear, valve stiction and hysteresis. (This requirement shall not apply to pneumatically operated modulating gas valves).
- Where the product is gas fired or dual fuelled, use a variable speed motor controller (or variable speed drive) to operate each fan incorporated into the product that controls air flow rate to the burner and, where relevant, the fuel-air pre-mixer.
- Provide product performance specification data in line with the ETL guidance note 13.

[9] The Environmental Permitting (England and Wales) (Amendment) Regulations 2018,
The Pollution Prevention and Control (Scotland) Amendment Regulations 2017
The Pollution Prevention and Control (Industrial Emissions) (Amendment) Regulations (Northern Ireland) 2018

6.3.2 Performance requirements

Products shall have a minimum net thermal efficiency of 92.0% at the full load and part load conditions set out in Table 6.1 below.

Table 6.1 Performance test points for steam boilers

Fuel Type	Turndown ratio	Test point % MCR	Net thermal efficiency %
Gas fired or dual fuelled	3.33:1	30	>= 92.0%
		100	>= 92.0%
Oil fired	2:1	50	>= 92.0%
		100	>= 92.0%

">=" means "greater than or equal to" Where MCR is the product's maximum continuous rating (MCR).

6.4 Measurement and Calculations

6.4.1 Measurement Standards and Test Requirements

The required minimum performance shall be demonstrated using Method A, Method B or Method C, (as set out in 6.5.1.1, 6.5.1.2 and 6.5.1.3 below), which are subject to the following restrictions:

- Method A shall only be used, where the all burners incorporated in the product are listed on the "burners with controls" part of the Energy Technology Product List.
- Method B shall be used to demonstrate the performance of modular boilers. A modular boiler is defined as an assembly of two or more similar (but not necessarily identical) modules, each with their own a heat exchanger, burner, and control and safety devices. The assembly has common water feed and steam output connections, but the water flow to, and steam flow from each module is independently controlled.
- Method C may only be used for products with rated outputs above 600kW, where it is not possible to measure product performance in a laboratory due to product size.

All performance measurements shall be carried out in accordance with the procedures set out in one of the following test standards:

- BS 845: Part 1:1987 'Methods for assessing thermal performance of boilers for steam, hot water and high temperature heat transfer fluids — Part 1: Concise procedure'.
- BS EN 12953-11:2003 'Shell boilers — Part 11: Acceptance tests'.

Where BS 845- 1:1987 is used, the following standard test conditions shall be observed:

- A maximum ambient air temperature of 25ºC.
- An excess combustion air level of not less than 15%.

6.4.2 Rounding

For the avoidance of doubt net thermal efficiency test data shall be presented to 1 decimal place. As an example, a product with a net thermal efficiency of 91.9% at 100% of its maximum continuous rating (MCR) would be deemed to be a fail.

6.5 Verification for ETL Listing

Any of the following testing routes may be used to demonstrate the conformity of products against the requirements:

- In-house testing – Self-certified
- In-house testing – Self-tested and verified or cross-checked by an independent body
- Witnessed testing
- Independent testing
- Representative testing (see clause 6.5.1)

Further information regarding the first four routes can be found in Guidance Note 5 on the ETL product testing framework[10].

6.5.1 Representative testing

Where applications are being made for products of the same constructional design to be included on the ETL, test data may be submitted for a single representative model provided that the maximum rated output of the products being applied for is not more than three times, or less than one third of, the maximum rated output of the product tested. Where the range of rated outputs exceeds these limits, products should be grouped into size ranges that comply with these rules, and test data submitted for one representative model for each group.

It should be noted that:

- If a manufacturer voluntarily removes a representative model from the ETL then other products linked with that representative model may or may not be permitted to remain on the ETL.
- If any product submitted under these representative model rules is later found not to meet the performance criteria when independently tested, then all products based on the same representative models will be removed from the ETL.

[10] https://www.gov.uk/government/publications/energy-technology-list-etl-product-testing-framework

6.5.1.1 Method A – separate testing of boilers and burners

Under this test method:

1. Boiler and burner performance are demonstrated separately.
2. Boiler performance can be assessed using any burner (or burners) that can provide the heat input and operational stability needed to complete the test.
3. The boiler's net thermal efficiency at 100% of product's maximum continuous rating (MCR) in accordance with the procedures in one of the specified standards.
4. The boiler's net thermal efficiency at part load (30%) is then inferred from burner performance data and design calculations of burner/boiler matching.

6.5.1.2 Method B - Integral testing at full and part loads

Under this test method, overall product performance shall be demonstrated by:

1. Measuring the net thermal efficiency at the test points specified in Table 6.1, in accordance with the procedures in one of the specified test standards.

6.5.1.3 Method C – validated design calculations

Under this test method:

1. The product's net thermal efficiency at the full and part load conditions specified in Table 6.1 is determined from design calculations.
2. The accuracy of these design calculations shall be confirmed by interpolation and extrapolation of measurements, obtained using the procedures in one of the specified test standards, of the product's net thermal efficiency:
    a) At least one test point between 60% and 100% MCR, and:
    b) At least one test point between 20% and 40% MCR.

The test report shall include (or be accompanied by):

a) Details of the calculations used to determine product performance.
b) A copy of the published performance data for the product.
c) Manufacturer's design data for the product.
d) The following test data, which shall be obtained with the product operating under stable conditions at each selected test point:
    I. Analysis of flue gas composition, including as a minimum levels or oxygen or carbon dioxide and carbon monoxide.
    II. Ambient and flue gas temperatures.
    III. Total conductive, convective and radiative loss rate.
    IV. Net thermal efficiency.
e) Details of the burners used during the test.

6.6 Conformity testing

Products listed on the ETL may be subject to the scheme's conformity testing programme in order to ensure listed models continue to meet the ETL requirements.

Boiler Retrofit Equipment

7 Burners with Controls

Date published	2018
Date first launched	2001

7.1 Scope

Burners with controls are used to provide heat for hot water, steam and thermal oil boilers, heaters and processes. They are widely used in industry and commerce.

A wide range of burners is available, and these are fitted with combustion controls that offer different levels of precision and repeatability of control. A selected range of burner systems designed to recover combustion exhaust gas heat are also available. The Energy Technology List (ETL) Scheme aims to encourage the purchase of products that are able to accurately control combustion and maintain their efficiency over a specified turn down range.

7.2 Definitions

Burners with Controls covers products that are specifically designed to create and burn air and fuel mixtures in a safe, efficient and controlled manner, and to direct the heat released through combustion into a pressurised vessel (or other combustion chamber).

Eight different categories of burners with controls are covered:

1. Gas fired and dual fuel burners rated up to, and including, 400kW.
2. Gas fired and dual fuel burners rated between 401kW and 1,200kW.
3. Gas fired and dual fuel burners rated in excess of 1,200kW.
4. Oil fired burners rated up to, and including, 400kW.
5. Oil fired burners rated between 401 kW and 1,200kW.
6. Oil fired burners rated in excess of 1,200kW.
7. Gas fired burners designed to operate with external or built-in thermal storage material that recovers exhaust gas heat (of all rated outputs).
8. Gas fired burners designed to operate with external or built-in exhaust gas recovery heat exchanger (of all rated outputs).

Products that are designed to use liquid or gaseous biofuels are also covered by these categories.

To be eligible for inclusion on the ETL, products shall meet the requirements as set out below.

7.3 Requirements

7.3.1 Eligibility requirements

To be eligible, products shall:

- Be gas and/or oil fired.

- Be a forced draught burner.
- Be fitted with air dampers that fully close on burner shutdown.
- Automatically respond to changes in heat demand by modulating their output in a continuous manner (or alternatively for oil-fired burners rated up to and including 400kW only, in a step-wise manner across at least three stages of output).
- Conform to the requirements of The Pressure Equipment (Safety) Regulations 2016 in respect of their design, manufacture and testing procedures, or have an appropriate Conformity Assessment mark.
- Not use any form of mechanical linkage between the product's modulating fuel valve, and its air damper or air control valve, to adjust the product's air to fuel ratio.
- Be fitted with a burner heat input control system which is amplitude-modulating or frequency-modulating (pulse firing).

To be eligible, products with a thermal input greater than or equal to 1MW, and less than 50MW, shall comply with the minimum requirements as stated in Annex II of the Medium Combustion Plant Directive (EU) 2015/2193[11] as implemented in domestic law.

In addition, products with a thermal output in excess of 400kW shall:

- Incorporate a microprocessor based burner control system.
- Where mechanical dampers are used to modulate the air flow to the burners, they shall be operated by a precision servomotor. The servomotor shall be controlled by a positional or flow based feedback mechanism that automatically adjusts its operation to correct for mechanical wear, valve stiction and hysteresis.
- Where control valves are used to modulate the fuel flow to the burners, they shall be operated by a precision servomotor. The servomotor shall be controlled by a positional or flow based feedback mechanism that automatically adjusts its operation to correct for mechanical wear, valve stiction and hysteresis. (This requirement shall not apply to pneumatically operated modulating gas valves).
- Where the product is gas fired or dual fuelled, use a variable speed motor controller (or variable speed drive) to operate its forced draught fan.

7.3.2 Performance requirements

For product categories 1 to 6, the product shall meet the following criteria:

- Automatically respond to changes in heat demand by modulating the output whilst adjusting the ratio of air and fuel fed to the product's burner in a manner that maintains combustion efficiency across the required turndown range and complies with the maximum permitted levels of oxygen and carbon monoxide in the product's exhaust gases, as set out in Table 7.1.

[11] The Environmental Permitting (England and Wales) (Amendment) Regulations 2018
The Pollution Prevention and Control (Scotland) Amendment Regulations 2017
The Pollution Prevention and Control (Industrial Emissions) (Amendment) Regulations (Northern Ireland) 2018

- Products shall not exceed the maximum permitted levels of oxygen (O_2) and carbon monoxide (CO) in their exhaust gas at each of test points specified in Table 7.1.

Table 7.1 Minimum performance requirements for burners with controls.

	Product category	Minimum turndown ratio	Maximum O_2 level at test point			Maximum CO level
			High	Mid	Low	All test points
1.	Gas fired and dual fuel burners rated up to, and including, 400	3.33:1	3.0%	4.0%	4.8%	20 ppmv
2.	Gas fired and dual fuel burners rated between 401 kW and 1,200	4:1	3.0%	4.0%	5.0%	20 ppmv
3.	Gas fired and dual fuel burners rated in excess of 1,200 kW	4:1	3.0%	4.0%	5.0%	20 ppmv
4.	Oil fired burners rated up to, and including, 400 kW	3.33:1	3.0%	4.0%	4.8%	20 ppmv
5.	Oil fired burners rated between 401 kW and 1,200 kW	3.33:1	3.0%	4.0%	4.8%	20 ppmv
6.	Oil fired burners rated in excess of 1,200 kW	4:1	3.0%	4.0%	5.0%	20 ppmv

Where the required test points are:

- High: the burner is operating at 100% of its maximum continuous rating.
- Mid: the burner is operating at 50% of its maximum continuous rating.
- Low: the burner is operating at a level corresponding to the specified minimum turndown, which is 25% of maximum continuous rating for 4:1 and 30% for 3.33:1.

And:

- Dual fuel means that the product can separately burn both gas and oil.

In addition, gas fired and dual fuelled burners with a thermal output up to, and including, 400kW shall incorporate pneumatic or electronic air fuel ratio controls that permit the oxygen levels in the exhaust gases to be adjusted at each of the test points specified in Table 7.1.

For product categories 7 and 8, the product shall meet the following criteria:

- Automatically respond to changes in heat demand by modulating the output whilst adjusting the ratio of air and fuel fed to the product's burner in a manner that maintains combustion air inlet temperature as set out in Table 7.2, while operating at 100% of its maximum continuous rating.
- Products shall not exceed the maximum permitted levels of nitrogen oxide (NO_x) in their exhaust gas specified in Table 7.2, while operating at 100% of its maximum continuous rating.

Table 7.2 Minimum performance requirements for burners designed to recover exhaust gas heat

	Product category	Minimum air temperature entering the burner for combustion at 100% of maximum continuous rating	Maximum NO_x level at 100% of maximum continuous rating
7.	Gas fired burners designed to operate with external or built-in thermal storage material that recovers exhaust gas heat (of all rated outputs).	75.0% of designed combustion chamber operating temperature	105 ppmv (Maximum O_2 level: 3.0%)
8.	Gas fired burners designed to operate with external or built-in exhaust gas recovery heat exchanger (of all rated outputs).	37.5% of designed combustion chamber operating temperature	75 ppmv (Maximum O_2 level: 3.0%)

7.4 Measurement and Calculations

7.4.1 Measurement standards

Product performance shall be determined in accordance with the procedures and test conditions in the following standards (or equivalent procedures within applicable British Standards:

- BS EN 676:2003 (as amended), “Automatic forced draught burners for gaseous fuels”.
- BS EN 267:2009 (as amended), “Automatic forced draught burners for liquid fuels”.
- ISO 13579-1:2013 (as amended), “Industrial furnaces and associated processing equipment. Method of measuring energy balance and calculating efficiency. General methodology”

7.4.2 Calculation Requirements

Where the product’s turndown ratio is greater than the minimum required, performance at the low and mid test points may be calculated by linear interpolation of the test results. Where operation at the product’s maximum continuous rated output is not possible, performance at the high test point may be determined by extrapolation of test data at two additional test points (e.g. 70% and 90%).

For the avoidance of doubt oxygen levels in the product’s exhaust and combustion air inlet reference percentage shall be presented to one decimal place. Carbon monoxide and nitrogen oxide levels to zero decimal places. For example,

- a gas fired burner rated in excess of 1,200kW and whose exhaust gases contain oxygen levels of 3.1%, and/or carbon monoxide levels of 21ppmv, at 100% of its maximum continuous rating, would be deemed a fail.
- a gas fired burner (designed to operate with an external thermal storage material that recovers exhaust gas heat) with combustion air inlet

temperature of 74.9% of designed combustion chamber operating temperature would be deemed a fail.

- a gas fired burner (designed to operate with external or built-in exhaust gas recovery heat exchanger) with a nitrogen oxide level of 76ppmv (with oxygen levels measured at 3.0%), or a nitrogen oxide level of 75ppmv (with oxygen levels measured at 3.1%), at 100% of its maximum continuous rating, would be deemed a fail.

7.5 Verification for ETL Listing

Any of the following testing routes may be used to demonstrate the conformity of products against the requirements:

- In-house testing – Self-certified
- In-house testing – Self-tested and verified or cross-checked by an independent body
- Witnessed testing
- Independent testing
- Representative testing (see clause 7.5.1)

Further information regarding the first four routes can be found in Guidance Note 5 on the ETL product testing framework[12].

7.5.1 Representative testing

Where applications are being made for two or more products that are variants of the same basic design, test data may be submitted for a representative selection of models, provided that all variants:

- Are designed to burn the same fuel(s) as the representative models.
- Have the same basic constructional design as the representative models.
- Use the same burner control system / mechanisms as the representative models.
- Have the same or better energy efficiency as the representative models. It should be noted that:
  - If a manufacturer voluntarily removes the representative model from the ETL then other products linked with that representative model may or may not be permitted to remain on the ETL.
  - If any product submitted under these representative model rules is later found not to meet the performance criteria when independently tested, then all products based on the same representative model will be removed from the ETL.

7.6 Conformity testing

Products listed on the ETL may be subject to the scheme's conformity testing programme in order to ensure listed models continue to meet the ETL requirements.

[12] https://www.gov.uk/government/publications/energy-technology-list-etl-product-testing-framework

8 Condensing Economisers

Date published	2020
Date first launched	2001

8.1 Scope

Condensing economisers are a type of heat exchanger that enables some of the sensible heat and latent heat from boiler flue gases to be recovered. This heat is normally used to preheat the boiler's feedwater and to supply low grade heating requirements. Typically, a condensing economiser will improve boiler net thermal efficiency (expressed in percentage terms) by at least 9 percentage points (i.e. a boiler with efficiency of 84.0% is improved to at least 93.0%). The Energy Technology List (ETL) aims to encourage the purchase of higher efficiency condensing economisers.

To be eligible for inclusion on the ETL, products shall meet the requirements as set out below.

8.2 Definitions

Condensing Economisers are products specifically designed to improve boiler net thermal efficiency by recovering both sensible and latent heat from boiler flue gases.

8.3 Requirements

8.3.1 Performance requirements

The product shall increase the net thermal efficiency of the boiler system to which it is designed to be fitted by at least 9.0%p., when the boiler system is operating at the test points set out in Table 8.1.

Table 8.1 Performance test points for condensing economisers

Test point % MCR	Increase in net thermal efficiency of boiler system.
30	>= 9.0%p.
50	>= 9.0%p.
100	>= 9.0%p.

">=" means "greater than or equal to"
"%p." means "percentage point"

Where MCR is the maximum continuous rating (MCR) of the boiler system for which the product is designed.

8.4 Measurement and Calculations

8.4.1 Measurement Standards and Test Requirements

The required minimum performance shall be demonstrated using Methods A, B or C, as set out in 8.4.1.1, 8.4.1.2 and 8.4.1.3 below:

8.4.1.1 Method A – Indirect measurement

Under this test method, product performance shall be demonstrated by measuring the improvement in net thermal efficiency of a test boiler resulting from the addition of the condensing economiser. Net thermal efficiency shall be measured at test points that are equivalent to 30%, 50% and 100% of the maximum continuous rating (MCR) of the boiler system for which the product is designed.

Boiler net thermal efficiency shall be measured in accordance with the procedures set out in BS 845-1:1987, BS EN 303-3:1999 or BS EN 304:2017.

Where BS 845-1:1987 is used, the standard test conditions are: a maximum ambient air temperature of 25 degrees Centigrade and an excess combustion air level of not less than 15%.

8.4.1.2 Method B – Direct measurement

Under this test method, product performance shall be demonstrated by calculating the improvement in boiler net thermal efficiency that will occur at 30 %, 50 % and 100 % of the maximum continuous rating (MCR) of the boiler system for which the product is designed. This calculation shall be based on an assessment of the transfer of heat power that will occur at each of these test points.

The assessment of transfer of heat power shall be done in accordance with the procedures set out in BS EN 305:1997, BS EN 306:1997 and/or BS EN 308:1997.

8.4.1.3 Method C – validated design calculations

Under this test method:

9. The product's performance is determined from design calculations. The calculations should assess the improvement in the net thermal efficiency of a boiler system that the product will deliver at the full and part load conditions specified in Table 8.1 when tested in accordance with the procedures and test conditions specified in Method A.
10. The accuracy of these design calculations shall be confirmed by interpolation and extrapolation of measurements of the improvement in net thermal efficiency actually realised by the product. The measurements shall be obtained using an indirect method (flue gas loss method) from one of the test standards specified in Method A:
    a) At least one test point between 60% and 100% MCR, and:
    b) At least one test point between 20% and 40% MCR.
11. To be eligible, the improvement in the net thermal efficiency of the boiler system at the full and part load conditions realised by fitting the product to the boiler system shall exceed the performance thresholds specified in Table 8.1.

The test report shall include (or be accompanied by):

a) Details of the calculations used to determine product performance.
b) A copy of the published performance data for the product.
c) Manufacturer's design data for the product.
d) The following test data, which shall be obtained with the product operating under stable conditions at each selected test point before and after fitting the product:

I. Analysis of flue gas composition, including as a minimum, the levels of oxygen (or carbon dioxide) and carbon monoxide in the flue gas.

II. Ambient and flue gas temperatures.

III. Net thermal efficiency of the boiler system.

e) Details of the boiler system used during the test.

8.4.2 Rounding

For the avoidance of doubt the increase in net thermal efficiency of the boiler system shall be presented to one decimal place. As an example, a condensing economiser that delivers an increase in net thermal efficiency of 8.94% at 100% of the maximum continuous rating (MCR) of the boiler system for which the product is designed would be deemed to be a fail.

8.5 Verification for ETL Listing

Any of the following testing routes may be used to demonstrate the conformity of products against the requirements:

- In-house testing – Self-certified
- In-house testing – Self-tested and verified or cross-checked by an independent body
- Witnessed testing
- Independent testing
- Representative testing (see clause 8.5.1)

Further information regarding the first four routes can be found in Guidance Note 5 on the ETL product testing framework[13].

8.5.1 Representative testing

Where applications are being made for condensing economiser products of the same constructional design to be included on the ETL, test data may be submitted for a single representative model provided that the maximum rated output of the products being applied for is not more than twice, or less than half, the maximum rated output of the product tested. Where the range of rated outputs exceeds these limits, products should be grouped into size ranges that comply with these rules, and test data submitted for one representative model for each group.

It should be noted that:

- If a manufacturer voluntarily removes a representative model from the ETL then other products linked with that representative model may or may not be permitted to remain on the ETL.
- If any product submitted under these representative model rules is later found not to meet the performance criteria when independently tested, then all products based on the same representative models will be removed from the ETL.

[13] https://www.gov.uk/government/publications/energy-technology-list-etl-product-testing-framework

8.6 Conformity testing

Products listed on the ETL may be subject to the scheme's conformity testing programme in order to ensure listed models continue to meet the ETL requirements.

8.7 Review

8.7.1 Indicative review date

The next technical review is scheduled for 2023-24.

8.7.2 Illustrative future direction of the requirements

Future changes to the Specification may include:

- Absolute value of boiler system efficiency
- Requirements regarding condensate

9 Non-condensing Economisers

Date published	2020
Date first launched	2001
Former name	Flue gas economisers

9.1 Scope

Non-condensing economisers are a type of heat exchanger that enables some of the sensible heat in boiler flue gases to be recovered. This heat is normally used to preheat the boiler's feedwater. Typically, a non-condensing economiser will increase boiler net thermal efficiency (expressed in percentage terms) by at least 3 percentage points (i.e. a boiler with efficiency of 89.0% is improved to at least 92.0%). The Energy Technology List (ETL) aims to encourage the purchase of higher efficiency non-condensing economisers.

To be eligible for inclusion on the ETL, products shall meet the requirements as set out below.

9.2 Definitions

Non-condensing Economisers are products that are specifically designed to improve boiler net thermal efficiency by recovering sensible heat from boiler flue gases.

9.3 Requirements

9.3.1 Performance requirements

The product shall increase the net thermal efficiency of the boiler system to which it is designed to be fitted by at least 4.5%, when the boiler system is operating at the test points set out in Table 9.1.

Table 9.1 Performance test points for non-condensing economisers

Test point	Increase in net thermalefficiency of boiler system.
30	>= 4.5%p.
50	>= 4.5%p.
100	>= 4.5%p.

">=" means "greater than or equal to"

"%p." means "percentage point"

Where MCR is the maximum continuous rating (MCR) of the boiler system for which the product is designed.

9.4 Measurement and Calculations

9.4.1 Measurement Standards and Test Requirements

The required minimum performance shall be demonstrated using Methods A, B or C, as set out in 9.4.1.1, 9.4.1.2 and 9.4.1.3 below.

9.4.1.1 Method A – indirect measurement

Under this test method, product performance shall be demonstrated by measuring the improvement in net thermal efficiency of a test boiler resulting from the addition of the flue gas economiser. Net thermal efficiency shall be measured at test points that are equivalent to 30%, 50% and 100% of the maximum continuous rating (MCR) of the boiler system for which the product is designed.

Boiler net thermal efficiency shall be measured in accordance with the procedures set out in BS 845-1:1987, BS EN 303-3:1999 or BS EN 304:2017.

Where BS 845-1:1987 is used, the standard test conditions are: a maximum ambient air temperature of 25 degrees Centigrade and an excess combustion air level of not less than 15%.

9.4.1.2 Method B – direct measurement

Under this test method, product performance shall be demonstrated by calculating the improvement in boiler net thermal efficiency that will occur at 30%, 50% and 100% of the maximum continuous rating (MCR) of the boiler system for which the product is designed. This calculation shall be based on an assessment of the transfer of heat power that will occur at each of these test points.

The assessment of transfer of heat power shall be done in accordance with the procedures set out in BS EN 305:1997, BS EN 306:1997 and/or BS EN 308:1997.

9.4.1.3 Method C – validated design calculations

Under this test method:

1. The product's performance is determined from design calculations. The calculations should assess the improvement in the net thermal efficiency of a boiler system that the product will deliver at the full and part load conditions specified in Table 9.1 when tested in accordance with the procedures and test conditions specified in Method A.

2. The accuracy of these design calculations shall be confirmed by interpolation and extrapolation of measurements of the improvement in net thermal efficiency actually realised by the product. The measurements shall be obtained using an indirect method (flue gas loss method) from one of the test standards specified in Method A:
    a) At least one test point between 60% and 100% MCR, and:
    b) At least one test point between 20% and 40% MCR.
3. To be eligible, the improvement in the net thermal efficiency of boiler system at the full and part load conditions realised by fitting the product to the boiler system must exceed the performance thresholds specified in Table 9.1.

The test report shall include (or be accompanied by):

a) Details of the calculations used to determine product performance.
b) A copy of the published performance data for the product.
c) Manufacturer's design data for the product.
d) The following test data, which shall be obtained with the product operating under stable conditions at each selected test point before and after fitting the product:
    I. Analysis of flue gas composition, including as a minimum, the levels of oxygen (or carbon dioxide) and carbon monoxide in the flue gas.
    II. Ambient and flue gas temperatures.
    III. Net thermal efficiency of the boiler system.
e) Details of the boiler system used during the test.

9.4.2 Rounding

For the avoidance of doubt the increase in net thermal efficiency of the boiler system shall be presented to one decimal place. As an example, a non-condensing economiser that delivers an increase in net thermal efficiency of 4.44% at 100% of the maximum continuous rating (MCR) of the boiler system for which the product is designed would be deemed to be a fail.

9.5 Verification for ETL Listing

Any of the following testing routes may be used to demonstrate the conformity of products against the requirements:

- In-house testing – Self-certified
- In-house testing – Self-tested and verified or cross-checked by an independent body
- Witnessed testing
- Independent testing
- Representative testing (see clause 9.5.1)

Further information regarding the first four routes can be found in Guidance Note 5 on the ETL product testing framework[14].

9.5.1 Representative testing

Where applications are being made for flue gas economiser products of the same constructional design to be included on the ETL, test data may be submitted for a single representative model provided that the maximum rated output of the products being applied for is not more than twice, or less than half, the maximum rated output of the product tested. Where the range of rated outputs exceeds these limits, products should be grouped into size ranges that comply with these rules, and test data submitted for one representative model for each group.

It should be noted that:

- If a manufacturer voluntarily removes a representative model from the ETL then other products linked with that representative model may or may not be permitted to remain on the ETL.
- If any product submitted under these representative model rules is later found not to meet the performance criteria when independently tested, then all products based on the same representative models will be removed from the ETL.

9.6 Conformity testing

Products listed on the ETL may be subject to the scheme's conformity testing programme in order to ensure listed models continue to meet the ETL requirements.

9.7 Review

9.7.1 Indicative review date

The next technical review is scheduled for 2023-24.

9.7.2 Illustrative future direction of the requirements

Future changes to the Specification may include:

- Absolute value of boiler system efficiency
- Requirements regarding condensate

[14] https://www.gov.uk/government/publications/energy-technology-list-etl-product-testing-framework

10 Heat Recovery from Flash Steam and Boiler Blowdown Condensate

Date published	2020
Date first launched	2001
Former name	Heat Recovery from Condensate and Boiler Blowdown

10.1 Scope

Significant amounts of heat can be recovered from boiler blowdown water condensate and from flash steam. This category is relevant for steam condensate collection and boiler blowdown systems, not process heat recovery. Boiler blowdown water can contain significant levels of contaminants that reduce the efficiency of the heat recovery process.

The Energy Technology List (ETL) encourages the purchase of heat recovery equipment that is specifically designed to recover heat from flash steam and/or water from boiler blowdown.

10.2 Definitions

Boiler blowdown is a necessary process undertaken in steam boilers to control the level of total dissolved solids (TDS) within the boiler. The number of times a boiler is blown down depends on how dirty the boiler feedwater is. The product is discharged into a flash vessel which reduces the pressure of the liquid, and results in flash steam and boiler blowdown water. Heat recovery then may take place, both on the flash steam and boiler blowdown water, by means of heat exchangers.

Flash steam is also the by-product when steam condensate is released from high pressure to low pressure, typically in a vented collection tank. Heat recovery may take place upon this flash steam by means of heat exchangers. Steam condensate is then returned to the boiler feed tank, deaerator or can be used within process.

10.2.1 Categories

The ETL Scheme covers three categories of product:

1. Flash steam recovery vessels or packages with associated control and safety devices
2. Heat exchanger units or packages with associated control and safety devices
3. Flash steam vessel with heat exchanger packages with associated control and safety devices

Where packages may include the following components necessary for operation of the equipment: pressure gauges, vacuum breakers, vent heads, valves and steam traps.

To be eligible for inclusion on the ETL, products shall meet the requirements as set out below.

10.3 Requirements

10.3.1 Eligibility requirements

To be eligible products, shall:

- Be specifically designed to recover heat from flash steam and / or water from boiler blowdown, by means of heat exchangers and/or flash steam recovery vessels used within boiler systems.
- Conform to the requirements of The Pressure Equipment (Safety) Regulations 2016 in respect of their design, manufacture and testing procedures.

10.4 Verification for ETL Listing

There are no testing requirements, however manufacturers shall provide sales and technical brochures to evidence the conformity of their products against the requirements from section 10.3.

10.5 Conformity testing

Products listed on the ETL may be subject to the scheme's conformity testing programme in order to ensure listed models continue to meet the ETL requirements.

10.6 Review

10.6.1 Indicative review date

This specification will be reviewed during the 2023/24 ETL review cycle.

10.6.2 Illustrative future direction of the requirements

If uptake increases, consideration can be given to differentiating models based on the amount of energy saved.

11 Retrofit Burner Control Systems

Date published	2020
Date first launched	2001

11.1 Scope

Burners are used to provide heat for hot water, steam and thermal oil boilers, heaters and processes. They are widely used in industry and commerce. Traditionally adjustable cams and mechanical linkages have been used to control the fuel valves and air dampers that modulate burner heat output. These mechanisms are susceptible to mechanical wear and hysteresis, and are progressively being replaced by more accurate burner control systems.

A range of retrofit burner control systems is available, and these offer different levels of precision and repeatability of control. The Energy Technology List (ETL) aims to encourage the purchase of microprocessor- based products that are able to accurately control combustion and maintain burner efficiency over a specified turn down range.

As installers assemble retrofit burner control systems on site from standard components from different manufacturers, which reflect the specific requirements of the installation, only the retrofit burner control units are listed on the ETL.

To be eligible for inclusion on the ETL, products shall meet the requirements as set out below.

11.2 Definitions

Retrofit burner control systems are products that are specifically designed to automatically control in an energy efficient manner, the operation of industrial and commercial burners, and the matching of burner heat production with heat demand.

11.3 Requirements

11.3.1 Eligibility requirements

To be eligible, products shall:

- Incorporate a microprocessor based control system.
- Be designed to:

a) Control one or more forced draught, gas and/or oil fired burners.

b) Use a precision servomotor to adjust any mechanical airflow dampers and/or modulating gas valves that control the air-fuel ratio of the burners controlled. Each precision servomotor shall be controlled by a positional or flow based feedback mechanism that automatically adjusts its operation to correct for mechanical wear, valve stiction and hysteresis.

c) Where the burners being controlled are gas fired or dual fuelled, use a variable speed motor drive or controller to operate the burners' forced draught fans.

d) Fully close the air dampers of the burners on shutdown.

- Automatically respond to changes in heat demand by modulating burner output:

a) In a continuous manner across a minimum specified turndown ratio of 4:1
b) Whilst adjusting the ratio of air and fuel fed to the burner in a manner that maintains combustion efficiency across the required turndown range and complies with the maximum permitted levels of oxygen and carbon monoxide in the burner's exhaust gases, as set out in Table 11.1.

- Have an appropriate Conformity Assessment mark, or conform with The Electromagnetic Compatibility Regulations 2016 in respect of their design, manufacturer and testing procedures.

11.3.2 Performance requirements

Products shall be able to control all categories of burners for which they are designed in a manner that does not exceed the maximum permitted levels of oxygen (O_2) and carbon monoxide (CO) in the burners' exhaust gas at each of test points specified in Table 11.1.

Table 11.1 Minimum performance requirements for retrofit burner control systems

Maximum O_2 level at test point			Maximum CO level
100% MCR	50% MCR	25% MCR	All test points

Maximum O_2 level at test point			Maximum CO level
3%	4%	5%	20ppmv

Where MCR is the product's maximum continuous rating.

11.4 Measurement and Calculations

11.4.1 Measurement standards

Product performance at the three required test points specified in Table 11.1 (above) shall be determined by fitting the product to an appropriate burner and testing in accordance with the procedures and test conditions in one of the following standards:

- BS EN 676:2003+A2:2008 "Automatic forced draught burners for gaseous fuels"
- BS EN 267:2009+A1:2011 "Automatic forced draught burners for liquid fuels"

11.4.2 Calculation Requirements

Where the product's turndown ratio is greater than the minimum required, performance at the 25% and 50% test points may be calculated by linear interpolation of the test results. Where operation at the burner's maximum continuous rated output is not possible, performance at the 100% test point may be determined by extrapolation of test data at two additional test points (e.g. 70% and 90%).

11.4.3 Rounding

For the avoidance of doubt, the oxygen levels in the test burner's exhaust should be presented to 1 decimal place, and carbon monoxide levels to zero decimal places. As an example, where the test burner's exhaust gases contain oxygen levels of 3.1% at 100% of the test burner's maximum continuous rating, or carbon monoxide levels of 21ppmv at any test point, the product application would be deemed to be a fail.

11.5 Verification for ETL Listing

Any of the following testing routes may be used to demonstrate the conformity of products against the requirements:

- In-house testing – Self-certified
- In-house testing – Self-tested and verified or cross-checked by an independent body
- Witnessed testing
- Independent testing
- Acceptance Tests or Field Trials

Further information regarding the routes can be found in Guidance Note 5 on the ETL product testing framework[15].

11.6 Conformity testing

Products listed on the ETL may be subject to the scheme's conformity testing programme in order to ensure listed models continue to meet the ETL requirements.

11.7 Review

11.7.1 Indicative review date

The next technical review is scheduled for 2023-24.

11.7.2 Illustrative future direction of the requirements

Future changes to the Specification may include:

- To consider re-introducing exhaust gas analysers at the time of the next criteria review
- Absolute value of boiler system efficiency
- Requirements regarding multi-fuel capabilities (i.e. hydrogen)
- Introduction of advanced feedback loop category that would incorporate live measurements in control algorithms.

[15] https://www.gov.uk/government/publications/energy-technology-list-etl-product-testing-framework

Combined Heat and Power

12 Combined Heat and Power

Combined Heat and Power is the simultaneous generation of heat and power (usually electricity) in a single process. CHP Schemes are by their nature bespoke and approval of a given CHP manufacturer or product would not provide sufficient assurance of environmental benefit. With CHP, case by case Certification is needed to ensure support is provided for 'good quality' CHP. Certification is achieved using the CHP Quality Assurance programme (CHPQA). Because a certificate is used, no specific products appear on the Energy Technology List.

Further information about CHP eligibility criteria and the CHPQA programme can be found at https://www.gov.uk/guidance/combined-heat-power-quality-assurance-programme

Questions on CHP eligibility should be directed to the CHPQA Helpline – 01235 75 3004 or chpqainfo@chpqa.com

Compressed Air Equipment

13 Desiccant Air Dryers with Energy Saving Controls

Date published	2014
Date first launched	2014

13.1 Scope

Desiccant air dryers are commonly fitted to compressed air systems to prevent moisture from condensing within pipe work and equipment. They are typically utilised where compressed air is needed at higher quality or with a lower dew point than can be achieved by a refrigerated air dryer.

They contain a desiccant material which absorbs the moisture and is then regenerated, for example, by blowing air through the dryer.

The direct energy usage of a desiccant air dryer typically increases the energy used in compressed air generation by between 10% and 25% depending on the product design and how it is controlled. Indirect energy usage, in the form of the pressure drop across the dryer and the compressed air used for purging can increase the overall energy usage in compressed air generation by between 20% and 50%. The aim of the Energy Technology List (ETL) Scheme is to encourage the purchase of higher efficiency models, which have low pressure drops across them. The aim of the ETL Scheme is to encourage the purchase of models which use energy efficient methods of desiccant regeneration, have low pressure drops across them and include energy savings controls.

To be eligible for inclusion on the ETL, products shall meet the requirements as set out below.

13.2 Definitions

Desiccant air dryers are products that are specifically designed to extract water vapour from industrial compressed air systems by absorbing moisture using a desiccant material which is then, for example, regenerated by blowing air through the dryer.

13.3 Requirements

13.3.1 Eligibility requirements

To be eligible, products must:

- Have a dew point rating of -40ºC i.e. Class 2 specifications for moisture removal in BS ISO 8573-1:2010.
- Utilise a regeneration method which is either heatless or internally/externally electrically heated or utilises a blower or vacuum system. Desiccant dryers that utilise steam, heat of compression or are heated in any way other than electrically are not eligible.
- Incorporate dew point sensing controls that automatically control the regeneration cycle to optimise the time between regenerations depending

on the dew point of the exit air in a manner that reduces the energy consumption of the product.

- **Not** exceed the limits set out in the performance criteria below for the composite specific energy consumption (SEC) at 100% load (i.e. rated air flow), corrected for the pressure drop across the dryer and any compressed air used by the dryer for regeneration, purging and/or cooling.
- Conform with the requirements of The Pressure Equipment (Safety) Regulations 2016 in respect of their design, manufacture and testing procedures, or have an appropriate Conformity Assessment mark.

13.3.2 Performance requirements

Products must not exceed the values for composite specific energy consumption (SEC), corrected for the pressure drop across the dryer and any compressed air used by the dryer, set out in the Table 13.1 below at 100% load (i.e. rated air flow).

Table 13.1 Maximum Allowable Composite SEC in kW/m^3/min

Percentage of full load (i.e. rated air flow)	Maximum allowable Composite SEC (kW/m^3/min)
100%	<= 1.07

The composite SEC should be calculated as follows:

$$SEC = \frac{P + (1.67 \times \Delta p \times Q) + (5 \times C)}{Q - C}$$

Where:

P = Total electrical power consumed by air dryer, inclusive of any external heaters, blowers, vacuum pumps or other associated equipment, kW

Δp = Pressure drop across air dryer, bar

Q = Flow rate of air, m^3/min

C = Total compressed air loss of air dryer for regeneration, purging, cooling or any other purpose, m^3/min

13.4 Measurement and Calculations

13.4.1 Measurement Standards and Test Requirements

All products must be tested in accordance with the procedures and test conditions laid down in BS ISO 7183:2007, which specifies how to measure the electrical power consumed by the product at full load, the pressure drop across the dryer, compressed air loss and the flow rate of air through the product. The test results should be presented in the format laid down in Annex B of BS ISO 7183-2:2007.

Products must also meet the Class 2 specifications for moisture removal in BS ISO 8573-1:2010, “Table 2 Compressed air purity classes for humidity and liquid water”

13.4.2 Rounding

For the avoidance of doubt composite SEC data must be presented to 2 decimal places. As an example, a product with a composite SEC of 1.08 at 100% of full load would be deemed to be a fail.

13.5 Verification for ETL Listing

Any of the following testing routes may be used to demonstrate the conformity of products against the requirements:

- In-house testing – Self-certified
- In-house testing – Self-tested and verified or cross-checked by an independent body
- Witnessed testing
- Independent testing

Further information regarding the routes can be found in Guidance Note 5 on the ETL product testing framework[16].

13.6 Conformity testing

Products listed on the ETL may be subject to the scheme's conformity testing programme in order to ensure listed models continue to meet the ETL requirements.

14 Master Controllers

Date published	2019
Date first launched	2008

14.1 Scope

Master controllers are microprocessor-based controllers that can be used to improve the control of compressed air systems with two or more compressors. They realise energy savings by reducing the pressure fluctuations that are normally present in compressed air systems when simple cascade or sequence controls are used to maintain system pressure, and by allowing users to schedule compressor operations that reflect working patterns.

To be eligible for inclusion on the Energy Technology List (ETL), products shall meet the requirements as set out below.

14.2 Definitions

Master controllers are products that are specifically designed to control the operation of multiple air compressors in a manner that maintains the operating pressure of the compressed air system within a narrow band, thereby minimising energy consumption.

[16] https://www.gov.uk/government/publications/energy-technology-list-etl-product-testing-framework

14.3 Requirements

14.3.1 Eligibility requirements

To be eligible, products shall:

- Be able to automatically control the operation of:

1. At least two air compressors.
2. Both fixed speed and variable speed compressors.
3. Any positive displacement compressor that is capable of accepting a remote load/unload control signal via a volt-free switching circuit or electromechanical pressure switch, or in the case of variable speed drives capable of accepting a speed control signal or a remote pressure set point adjustment**.**

- Incorporate a microprocessor based controller that is pre-programmed to provide facilities for users to:

1. Detect/determine efficiency to load level curve for Variable speed compressors.
2. Prioritise the use of more efficient compressors over less efficient ones, whilst making optimal use of any variable speed compressors being controlled (including optimal efficiency of variable speed compressors).
3. Schedule the times of the week (in intervals of five minutes or less) when the compressed air system should be switched on and off and be operated at a reduced pressure.
4. Schedule at least two different operating pressures for the compressed air system (to enable for example operation at lower pressure at off peak times).
5. Define the minimum and maximum limits for the operating pressure (or pressure band) that the controller must maintain the compressed air system within.

- Incorporate an anti-tampering mechanism that prevents automatic control from being disabled, except during commissioning, maintenance or testing.
- The Master controller shall be capable of controlling any air compressor, regardless of compressor manufacturer.
- Incorporate a pressure transducer that has a measurement accuracy of at least (i.e. <=) +/- 0.5% of full scale across its rated operating pressure range and across a rated temperature range of –25 to 80 degrees Centigrade.
- Incorporate automatic control algorithms that monitor rate of change in system air pressure/flow and prevent compressors from being brought on load or unloaded in response to small fluctuations in demand.
- Be capable of automatically regulating the operating pressure of the compressed air system (where all compressors in the system are situated at a single location), based on the output of a single pressure transducer, to within +/-0.1 bar of the operating pressure set-point, as air demand varies in 60 seconds between 10% and 100% of the maximum combined, continuous, rated output of air compressors being controlled.
- Conform with the requirements of The Electromagnetic Compatibility Regulations 2016, and have an appropriate Conformity Assessment mark.

Where products provide facilities for operators to override automatic control, they must be pre-programmed to return to automatic control at the next scheduled time for system switch off / on, and to automatically reset the override within 24 hours.

Where products are also designed to control desiccant air dryers, they must also satisfy the eligibility criteria for ‘energy saving controls for desiccant air dryers.

Automatic control may be implemented either directly by means of an analogue or digital signal connection, or indirectly by means of another control device or network. Where products are designed to indirectly control variable speed compressors, they must be capable of monitoring the operating speed of the variable speed compressors, and of remotely adjusting the speed or pressure set points (or pressure or speed range limits) within the variable speed compressor’s control device.

Products that cannot directly control the speed (or speed range) of a variable speed compressor, or indirectly control their speed of operation by adjusting their pressure set points, are not eligible.

14.4 Verification for ETL Listing

There are no testing requirements, however manufacturers shall provide sales and technical brochures to evidence the conformity of their products against the requirements from section 14.3.

14.5 Conformity testing

Products listed on the ETL may be subject to the scheme’s conformity testing programme in order to ensure listed models continue to meet the ETL requirements.

14.6 Review

14.6.1 Indicative review date

This technology specification will be reviewed in 2022-23

14.6.2 Illustrative future direction of the requirements

Future changes in Technology Specification may include:

- Master controllers shall enable a much tighter running of compressors to match demand. Software upgrades could be upgraded to detect if there is excess demand due to a leak in the system.
- Master controllers shall monitor and report the energy savings achieved by the end user as a result from its installation. Through this monitoring, the device would be capable of making recommendations to the user for better system performance.

15 Refrigerated Air Dryers with Energy Saving Controls

Date published	2014
Date first launched	2003

15.1 Scope

Refrigerated air dryers are commonly fitted to compressed air systems to prevent moisture from condensing within pipe work and equipment. They work by cooling the air to a desired dew point temperature, thus forcing moisture to condense out of the air. This resulting condensate is then drained from the compressed air system.

A refrigerated air dryer typically increases the energy used in compressed air generation by between 2% and 5% depending on the type of product selected and how it is controlled. The pressure drop across the refrigerated air dryer is also a key factor in the amount of additional energy consumed as a result of the use of refrigerated air dryers. The aim of the Energy Technology List (ETL) Scheme is to encourage the purchase of higher efficiency models, which have low pressure drops across them.

To be eligible for inclusion on the ETL, products shall meet the requirements as set out below.

15.2 Definitions

Refrigerated air dryers are products that are specifically designed to extract water vapour from industrial compressed air systems by means of cooling with a refrigeration cycle.

15.3 Requirements

15.3.1 Eligibility requirements

To be eligible, products must:

- Incorporate energy saving controls that automatically reduce the cooling output of the refrigerated air dryer as the average flow rate and temperature of the inlet air decreases in a manner that reduces the energy consumption of the product.
- Automatically control their output between 20% and 100% in response to changes in the flow rate and/or temperature of the inlet air and/or outlet air.
- Not exceed the limits set out in the performance criteria below for pressure drop corrected composite specific energy consumption (SEC) at 50%, 75% and 100% load (i.e. rated air flow).
- Conform with the requirements of The Pressure Equipment (Safety) Regulations 2016 in respect of their design, manufacture and testing procedures, or have an appropriate Conformity Assessment mark

15.3.2 Performance requirements

Products must not exceed the values for pressure drop corrected composite specific energy consumption (SEC) set out in the Table 15.1 below at the specified percentage of full load.

Table 15.1 Maximum Allowable Composite SEC in kW/m^3/min

Percentage of full load (i.e. rated air flow)	Maximum allowable Composite SEC (kW/m^3/min)
50%	<= 0.30
75%	<= 0.40
100%	<= 0.50

The pressure drop-corrected composite SEC should be calculated as follows:

$$SEC = \frac{P + (1.67 \times \Delta p \times Q)}{Q}$$

Where:

P = Total electrical power consumed by air dryer, kW

Δp = Pressure drop across air dryer, bar

Q = Flow rate of air, m^3/min

15.4 Measurement and Calculations

15.4.1 Measurement Standards and Test Requirements

All products must be tested in accordance with the procedures and test conditions laid down in BS ISO 7183:2007, which specifies how to measure the electrical power consumed by the product at full load, the pressure drop across the dryer and the flow rate of air through the product. The test results should be presented in the format laid down in Annex B of BS ISO 7183-2:2007.

Products must also meet the Class 4 specifications for moisture removal in BS ISO 8573-1:2010, “Table 2 Compressed air purity classes for humidity and liquid water”

In addition, manufacturers should use the above procedures to evaluate the pressure drop corrected composite SEC of their products at two part load conditions (50% and 75%).

Please note that performance data obtained in accordance with the procedures in ISO 7183: 1986 will be accepted as an alternative to testing in accordance with ISO 7183:2007 until further notice.

15.4.2 Rounding

For the avoidance of doubt composite SEC data must be presented to 2 decimal places. As an example, a product with a composite SEC of 0.49 at 75% of full load) would be deemed to be a fail.

15.5 Verification for ETL Listing

Any of the following testing routes may be used to demonstrate the conformity of products against the requirements:

- In-house testing – Self-certified
- In-house testing – Self-tested and verified or cross-checked by an independent body
- Witnessed testing
- Independent testing

Further information regarding the routes can be found in Guidance Note 5 on the ETL product testing framework[17].

15.6 Conformity testing

Products listed on the ETL may be subject to the scheme's conformity testing programme in order to ensure listed models continue to meet the ETL requirements.

[17] https://www.gov.uk/government/publications/energy-technology-list-etl-product-testing-framework

Heat pumps

16 Air to Air Heat Pumps, Split, Multi-split and VRF

Date published	2019
Date first launched	2002
Former name	Air Source: Split and Multi-Split (including VRF) Heat Pumps

16.1 Scope

Air to air heat pumps are products that are specifically designed to transfer heat from the air in one space to the air within another space by means of a refrigeration cycle.

'Split' type heat pumps have separate heat collection and rejection units for each space known as 'outdoor' and 'indoor' units. The 'outdoor' and 'indoor' units are specifically designed to be connected together during installation by refrigerant pipework to form a single functional system.

Variable Refrigerant Flow (VRF) heat pumps are systems specifically designed to automatically adjust the flow of refrigerant to each 'indoor' unit so that the heat delivered is matched to its demand. In particular, one of the 'indoor' units of a VRF system could be an air curtain.

16.2 Definitions

Air to Air Heat Pumps, Split, Multi-Split and VRF use an electrically operated refrigeration system to transfer heat from air outside a building to the air inside it. They can be used to provide space heating in a wide range of buildings, and some products also are able to provide cooling by reversing the refrigeration flows around the product (these products are also known as reversible 'air-cooled' air conditioning units).

Split, multi-split and VRF heat pumps are available with a wide range of efficiencies. The Energy Technology List (ETL) Scheme aims to encourage the purchase of higher efficiency products.

The ETL Scheme covers three categories of products:

1. Single split (non-VRF) heat pumps that consist of one 'outdoor' unit and one 'indoor' unit.
2. Multi-split (non-VRF) heat pumps that consist of one 'outdoor' unit connected to two or more 'indoor' units using either individual refrigerant circuits (with the indoor units individually controlled) or using a common refrigerant circuit with the indoor units controlled as one.
3. VRF heat pumps that consist of one 'outdoor' unit connected to one or more 'indoor' units using a common refrigerant circuit with the indoor units individually controlled.

A heat pump driven air curtain unit for VRF heat pumps may replace one or more 'indoor' heat pump units within an ETL eligible VRF heat pump.

Systems with cascade refrigerant/other-medium (e.g. water) heat distribution shall be tested using same methodology as other VRF systems, taking into account all additional energy used in supplementary medium loops, such as circulation pumps' consumption.

16.3 Requirements

16.3.1 Eligibility requirements

Eligible air to air heat pumps, split, multi-split and VRF shall comply with the requirements as set out below. The individual products do not need to be named on the ETL.

To be eligible, products shall:

- Consist of an 'outdoor' unit and one or more 'indoor' units that are:
  - Factory–built sub-assemblies.
  - Supplied as a matched set of units.
  - Designed to be connected together during installation.
- Incorporate an electrically driven refrigeration system.
- Be designed for, and include fittings for, permanent installation.
- Have an appropriate Conformity Assessment mark

To be eligible, heat pump driven air curtain 'indoor' units for multi-split heat pump products shall also:

- Be specifically designed to be fitted above a doorway or similar opening.
- Be designed to use electrical air heaters (where fitted) only during defrosting or heat pump failure.

16.3.2 Performance requirements

Eligible products must meet the performance criteria set out in Table 16.1 for:

- Seasonal Space Heating Energy Efficiency as defined by Ecodesign Commission Regulation (EU) 2016/2281.
- Seasonal Space Cooling Energy Efficiency as defined by Ecodesign Commission Regulation (EU) 2016/2281.

Products with a rated cooling capacity less than, or equal to, (≤) 12kW shall meet the performance criteria set out in Table 16.1 for:

- Seasonal Coefficient of Performance (SCOP) across the range of connected capacities.
- Seasonal Energy Efficiency Ratio (SEER) across the range of connected capacities.

Table 16.1 Performance requirements for air to air heat pumps, split, multi-split and VRF

	Rated Cooling Capacity	>12 kW		≤12 kW	
	Product Category	**Heating mode ($\eta_{s,h}$)**	**Cooling mode ($\eta_{s,c}$)**	**Heating mode (SCOP)**	**Cooling mode (SEER)**
1.	Single split (non-VRF) heat pumps	≥165%	≥250%	≥4.20	≥6.40
2.	Multi-split (non-VRF) heat pumps	≥160%	≥240%	≥4.10	≥6.30
3.	VRF heat pumps	≥170%	≥260%	≥4.30	≥6.50

"≥" means "greater than or equal to"

In addition, eligible heat pump driven air curtain 'indoor' units for multi-split heat pump products shall have an outlet air velocity uniformity (u_{ACU}), as defined in Section 5.4.4 of BS ISO 27327-1: 2009, greater than or equal to 70% over the range of doorway/opening heights that they are designed to be fitted above.

16.4 Measurement and Calculations

16.4.1 Energy efficiency metrics

Seasonal Space Heating Energy Efficiency ($\eta_{s,h}$) – ratio between the space heating demand for reference heating season, supplied by a space heater and the annual primary energy consumption required to meet this demand, as defined by Ecodesign Commission Regulation (EU) 2016/2281.

Seasonal Space Cooling Energy Efficiency ($\eta_{s,c}$) – ratio between the space cooling demand for reference cooling season supplied and annual primary energy consumption required to meet that demand, as defined by Ecodesign Commission Regulation (EU) 2016/2281.

Seasonal Coefficient Of Performance (**SCOP)** – overall coefficient of performance of a heat pump using electricity, representative of the heating season, calculated as the reference annual heating demand divided by annual energy consumption for heating as defined by Commission Regulation (EU) No 206/2012.

Seasonal Energy Efficiency Ratio (**SEER)** – ratio of the total cooling capacity to the effective power input of the unit Commission Regulation (EU) No 206/2012.

Primary energy consumption for electricity usage is obtained using **Conversion Coefficient** (CC), known also as Primary Energy Factor, equal to 2.5, as defined by Ecodesign Commission Regulation (EU) 2016/2281, Annex I.

Reference heating season, also called **climate** - set of operating conditions describing per bin the combination of outdoor temperatures and the number of hours these temperatures occur for heating for which the unit is declared fit for purpose. There are three reference heating seasons: "A" average, "C" colder and "W" warmer. UK is located in two reference zones: A and W, but for the ETL purposes "**A" for average** is to be used.

Correction factor (F1) is a correction that accounts for a negative contribution to the seasonal space heating energy efficiency of heaters due to adjusted contributions of temperature controls, equal to 3 % (BS EN 14825:2016).

In case of any changes regarding the value of CC in relevant regulations or test reporting procedures, performance indicators will be calculated using following equations:

$$(1)\ \eta_{s,h} = SCOP/CC - F1$$

$$(2)\ \eta_{s,c} = SEER/CC - F1$$

16.4.2 Test Requirements

No additional testing requirements beyond the measurement standard below.

16.4.3 Measurement standards

Testing for non-VRF products with a cooling capacity greater than 12kW and all VRF products shall be carried out in accordance with the procedures in Ecodesign

Commission Regulation (EU) 2016/2281. The standard rating conditions are set out in the Table 16.2 below.

Table 16.2 Test conditions for air to air split, multi-split and VRF heat pumps >12kW

	Product Category	Heating mode ($\eta_{s,h}$)	Cooling mode ($\eta_{s,c}$)
1.	Single split (non VRF) heat pumps	Commission Regulation (EU) No 2281/2016 Annex III, tables 16, 21, 26, average rating conditions	Commission Regulation (EU) No 2281/2016 Annex III, tables 16, 27, average rating conditions,
2.	Multi-split (non VRF) heat pumps	Commission Regulation (EU) No 2281/2016 Annex III, tables 16, 21, 26, average rating conditions	Commission Regulation (EU) No 2281/2016 Annex III, tables 16, 27, average rating conditions
3	VRF heat pumps	Commission Regulation (EU) No 2281/2016 Annex III, tables 16, 21, 26, average rating conditions	Commission Regulation (EU) No 2281/2016 Annex III, tables 16, 27, average rating conditions

Testing products should be carried out in accordance with the procedures in BS EN 14825: 2016 under the test conditions set out in the Table 16.3 below.

Performance data for units with cooling capacity greater than 12 kW should be obtained in accordance with requirements of Commission Regulation (EU) No 2281/2016 Annex III.

Performance data for non-VRF products with a cooling capacity less than or equal to 12kW should be determined following the requirements of Commission Regulation (EU) No 206/2012 Annex II.

Table 16.3 Test conditions for air to air heat pumps split, multi-split and VRF <12kW

	Product Category	Heating mode (SCOP)	Cooling mode (SEER)
1.	Single, Multi-Split and VRF heat pumps	Commission Regulation (EU) No 206/2012 Annex II, table 1, average rating conditions	Commission Regulation (EU) No 206/2012 Annex II, table 1

Please note that performance data obtained in accordance with the corresponding procedures and standard rating conditions laid down in BS EN 14825: 2013 will be accepted as an alternative to testing in accordance with BS EN 14825: 2016 until further notice.

16.4.3.2 Calculated results

Where results are determined by calculation then this should be on the basis of design and/or extrapolation from other combinations of indoor and outdoor units. In this case, details of such calculations and/or extrapolations, and of tests to verify the accuracy of the calculations undertaken (including details of the mathematical model for calculating performance of such combinations, and of measurements taken to verify this model) shall be made available. Tests undertaken to verify the accuracy of the calculations must be carried out in accordance with the test procedures described above.

16.4.4 Rounding

For the avoidance of doubt test data should be presented to 0 decimal places for percentage points in η_{sh} and η_{sc} values and to 2 decimal places for SEER and SCOP indicators. As an example, a 20kW air source, single split (non-VRF) heat pump product with a heating mode η_{sh} of 164.4% would be deemed to be a fail.

16.5 Verification for ETL Listing

This sub-technology is “unlisted” therefore individual products do not need to be listed on the Energy Technology Product List.

16.6 Conformity testing

Products listed on the ETL may be subject to the scheme’s conformity testing programme in order to ensure listed models continue to meet the ETL requirements.

16.7 Review

16.7.1 Indicative review date

The next technical review is scheduled for 2022-23.

16.7.2 Illustrative future direction of the requirements

Future changes to the Specification may include:

- Increasing performance thresholds for $\eta_{sh,}$ η_{ch} and/or SCOP, SEER.
- Introduction of refrigerant’s GWP requirements

17 Air to Domestic Hot Water Heat Pumps

Date published	2019
Date first launched	2013
Former name	Heat Pumps for Domestic Hot Water Heating CO2 Heat pumps for domestic hot water heating

17.1 Scope

Air to Domestic Hot Water Heat Pumps are products that are specifically designed to transfer heat from the outdoor environment into a domestic hot water tank by means of a refrigeration cycle.

17.2 Definitions

Air to Domestic Hot Water Heat Pumps use an electrically operated refrigeration system to transfer heat from the ambient source into a domestic hot water system. They can be used to provide sanitary hot water in a wide range of buildings, including commercial and leisure.

Air to Domestic Hot Water heat pumps are available in a range of efficiencies. The Energy Technology List (ETL) Scheme aims to encourage purchase of higher efficiency products. Air to Domestic Hot Water Heat pumps can realise substantial

reductions in carbon emissions when used instead of fossil fuel based, or resistive electric, water heating.

The ETL Scheme covers various types of products, including:

1. Air Source CO_2 heat pumps for domestic hot water heating
2. Air Source non-CO_2 heat pumps for domestic hot water heating

17.3 Requirements

17.3.1 Eligibility requirements

To be eligible for inclusion on the ETL, products shall meet the requirements as set out below.

To be eligible, products shall:

- Consist either of a single factory built unit or of an 'outdoor' unit and one or more 'indoor' units that are:
  - Factory-built sub-assemblies.
  - Supplied as a matched set of units.
  - Designed to be connected together during installation.
- Incorporate an electrically driven refrigeration system that uses refrigerant which has a Global Warming Potential (GWP) of below 1,800.
- Be designed for, and include fittings for, permanent installation.
- Be designed primarily to provide domestic hot water heating
- Have an appropriate Conformity Assessment mark.

GWP values will be those set out in Annex I to Regulation (EC) No 842/2006. For refrigerants not included in this reference, the IPCC UNEP 2010 report on Refrigeration, Air Conditioning and Heat Pumps should be used as the reference.

17.3.2 Performance requirements

Eligible products shall meet the performance criteria set out in Table 17.1 below for:

- Water Heating Energy Efficiency (η_{wh}) at the declared load profile.

Table 17.1 Performance thresholds for air to domestic hot water heat pumps (all product categories)

Declared load profile	L	XL	XXL	3XL	4XL
Water Heating Energy Efficiency (η_{wh})	≥110%	≥115%	≥120%	≥125%	≥130%

"≥" means "greater than" or equal to"

Where:

- Water Heating Energy Efficiency' (η_{wh}) is the ratio between the useful energy in the water provided and the energy required for its generation, expressed as a percentage.
- Load profile is a given sequence of water draw-offs, as specified in in Annex III, Table 1 of Commission Regulation (EU) No 814/2013 "Ecodesign requirements for water heaters and hot water storage tanks".

17.4 Measurement and Calculations

17.4.1 Energy efficiency metrics

Water Heating Energy Efficiency (η_{wh}) – means the ratio between the useful energy provided by a water heater and the energy required for its generation, expressed in %.

Reference Energy (Q_{ref}) means the sum of the useful energy content of water draw-offs, expressed in kWh, in a particular load profile.

Smart Control Factor (**SCF**) means the water heating energy efficiency gain due to smart control under the conditions.

17.4.2 Test Requirements

No additional testing requirements beyond the measurement standard below.

17.4.3 Measurement standards

The product's performance data shall be determined in accordance with the procedures detailed in BS EN 16147:2011 "Heat pumps with electrically driven compressors - Testing and requirements for marking of domestic hot water units" and the water heating energy efficiency calculation, following the requirements of Commission Regulation (EU) No 814:2013 or Commission Regulation (EU) No 812:2013".

The load profile used for the test shall be declared by the manufacturer and shall be the maximum load profile or the load profile one below the maximum load profile for the product.

17.4.4 Rounding

For the avoidance of doubt test data should be presented to zero decimal places. As an example, an Air to Domestic Hot Water Heat Pump product with a declared load profile of XL and a water heating energy efficiency of 114.4% would be deemed to be a fail.

17.5 Verification for ETL Listing

There are five main ways that applicants can demonstrate their product's performance:

- In-house testing – Self-certified
- In-house testing – Self-tested and verified or cross-checked by an independent body
- Witnessed testing
- Independent testing
- Representative testing (see clause 17.5.1)

Further information regarding the first four routes can be found in Guidance Note 5 on the ETL product testing framework[18].

17.5.1 Representative Testing

Where applications are being made for a range of products that are variants of the same basic design, test data may be submitted for a representative model, provided that all variants, i.e. models, share the following characteristic features:

- Use the same refrigerant
- Have the same compressor type (i.e. manufacturer, line of models), which should imply:
  - same method of compression (e.g. reciprocating or scroll) and
  - same type of enclosure (e.g. hermetic or semi-hermetic)
- Use the same defrosting method (e.g. hot gas defrost)
- Fit within the same product category (i.e. are all low-temperature air to water heat pumps, or are all non-low-temperature air to water heat pumps.

The representative models may be selected by dividing the range of products into groups of models with similar design characteristics. The performance of each model shall be predicted using a validated mathematical model. At least one model in each group shall be tested for validation purposes. A report documenting performed model calculations, showing all significant calculation steps, shall be submitted with the application.

It should be noted that:

- If a manufacturer voluntarily removes the representative model from the ETL then other products linked with that representative model may or may not be permitted to remain on the ETL.
- If any product submitted under these representative model rules is later found not to meet the performance criteria when independently tested, then all products based on the same representative model will be removed from the ETL.

17.6 Conformity testing

Products listed on the ETL may be subject to the scheme's conformity testing programme in order to ensure listed models continue to meet the ETL requirements.

17.7 Review

17.7.1 Indicative review date

The next technical review is scheduled for 2022-23.

17.7.2 Illustrative future direction of the requirements

Future changes to the Specification may include:

- Increasing performance thresholds for Water Heating Energy Efficiency (η_{wh}),
- Decreasing the maximum allowed GWP for refrigerant used,

[18] https://www.gov.uk/government/publications/energy-technology-list-etl-product-testing-framework

- Adding a sub-category for exhaust air heat pumps.

18 Air Source: Gas Engine Driven Split and Multi-Split (including VRF) Heat Pumps

Date published	2018
Date first launched	2004

18.1 Scope

Air-source gas engine driven (GED) split and multi-split heat pumps use a gas-fired internal combustion engine driven refrigeration system to transfer heat from air outside a building to the air inside it. They can be used to provide space heating in a wide range of buildings, and some products also are able to provide cooling by reversing the refrigeration flows around the product. (These products are known as reversible gas engine driven 'air-cooled' air conditioning units).

Air source gas engine driven split and multi-split heat pumps are available with a wide range of efficiencies. The Energy Technology List (ETL) Scheme aims to encourage the purchase of higher efficiency products.

The ETL Scheme covers four categories of products:

1. Air source: GED single split (non-VRF) heat pumps that consist of one 'outdoor' unit and one 'indoor' unit.
2. Air source: GED dual split (non-VRF) heat pumps that consist of one 'outdoor' unit and two 'indoor' units.
3. Air source: GED multi-split (non-VRF) heat pumps that consist of one 'outdoor' unit connected to two or more 'indoor' units using either individual refrigerant circuits (with the indoor units individually controlled) or using a common refrigerant circuit with the indoor units controlled as one.
4. Air source: GED split or multi-split variable refrigerant flow (VRF) heat pumps that consist of one 'outdoor' unit connected to one or more 'indoor' units using a common refrigerant circuit with the indoor units individually controlled.

To be eligible for inclusion on the ETL, products shall meet the requirements as set out below.

18.2 Definitions

Air-source, gas engine driven (GED), heat pumps covers products that are specifically designed to transfer heat from the air in one space to the air in another space by means of a refrigeration cycle that is driven by a gas-fired internal combustion engine.

'Split' type heat pumps have separate heat collection and rejection units for each space known as 'indoor' and 'outdoor' units. The 'indoor' and 'outdoor' units are specifically designed to be connected together during installation by refrigerant pipework to form a single functional unit.

Variable refrigerant flow (VRF) heat pumps are specifically designed to automatically adjust the flow of refrigerant to each indoor unit so that the heat delivered is matched to the demand.

18.3 Requirements

18.3.1 Eligibility requirements

To be eligible, products shall:

- Consist of an ‘outdoor’ unit and one or more ‘indoor’ units that are:

  a) Factory–built sub-assemblies.

  b) Supplied as a matched set of units.

  c) Designed to be connected together during installation.

- Incorporate a refrigeration system that is driven by a gas-fired internal combustion engine.
- Be designed for, and include fittings for, permanent installation.
- Have an appropriate Conformity Assessment mark.

18.3.2 Performance requirements

Eligible products shall meet the performance criteria set out in Table 18.1 below for:

- Seasonal Primary Energy Ratio in heating mode (SPERh) across the range of connected capacities and including 100% (full) load in heating mode.
- Seasonal Primary Energy Ratio in cooling mode (SPERc) across the range of connected capacities and including 100% (full) load in cooling mode, where the product is designed to provide cooling.

Table 18.1 Performance requirements for air source: (GED) split and multi-split heat pumps

	Product Category	Heating mode ($SPER_h$)	Cooling mode ($SPER_c$)
1.	Air source: GED single split (non VRF) heat pumps.	>=1.30	>=1.72
2.	Air source: GED dual split (non VRF) heat pumps.	>=1.30	>=1.72
3.	Air source: GED multi-split (non VRF) heat pumps.	>=1.30	>=1.72
4.	Air source: GED split and multi-splitvariable refrigerant flow (VRF) heat pumps.	>=1.30	>=1.72

">=" means "greater than or equal to"

The performance requirements in Table 18.1 shall include all relevant energy inputs to the indoor unit(s) for the matched indoor and outdoor model assembly.

18.4 Measurement and Calculations

18.4.1 Measurement standards

All products shall be tested in accordance with the procedures laid down in the following standards:

- BS EN 16905-3:2017, “Gas-fired endothermic engine driven heat pumps – Part 3: Test conditions”;
- BS EN 16905-4:2017, “Gas-fired endothermic engine driven heat pumps – Part 4: Test methods”;
- BS EN 16905-5:2017, “Gas-fired endothermic engine driven heat pumps – Part 5: Calculation of seasonal performances in heating and cooling mode”.

18.4.2 Test Requirements

The standard rating conditions are set out in the Table 18.2 below.

Table 18.2 Test conditions for air source: gas engine driven (GED) split and multi-split heat pumps

	Product Category	Heating mode ($SPER_h$)	Cooling mode ($SPER_c$)
1.	Air source: GED single split (non-VRF) heat pumps.	BS EN 16905-3:2017 Table 3	BS EN 16905-3:2017 Table 4
2.	Air source: GED dual split (non-VRF) heat pumps.	BS EN 16905-3:2017 Table 3	BS EN 16905-3:2017 Table 4
3.	Air source: GED multi-split (non-VRF) heat pumps.	BS EN 16905-3:2017 Table 3	BS EN 16905-3:2017 Table 4
4.	Air source: GED split and multi-split variable refrigerant flow (VRF) heat pumps.	BS EN 16905-3:2017 Table 3	BS EN 16905-3:2017 Table 4

Notes

The heating standard test requires an entering air temperature on the indoor side of 20°C (Dry-bulb), and an entering air temperature on the outdoor side of 7°C (Dry-bulb) and 6°C (Wet-bulb).

The cooling standard test requires an entering air temperature on the indoor side of 27°C (Dry-bulb) and 19°C (Wet-bulb), and an entering air temperature on the outdoor side of 35°C (Dry-bulb).

18.4.3 Rounding

For the avoidance of doubt test data should be presented to 2 decimal places. As an example, an air source gas engine driven single split (non-VRF) heat pump product with a heating mode $SPER_h$ of 1.29 would be deemed to be a fail.

18.5 Verification for ETL Listing

There are five main ways that applicants can demonstrate their product's performance:

- In-house testing – Self-certified
- In-house testing – Self-tested and verified or cross-checked by an independent body
- Witnessed testing
- Independent testing
- Representative Testing (see clause 18.5.1)

Further information regarding the first four routes can be found in Guidance Note 5 on the ETL product testing framework[19].

18.5.1 Representative testing

Where applications are being made for a range of two or more products that are variants of the same basic design, test data may be submitted for a representative selection of models, provided that all variants:

- Use the same gas engine constructional design.
- Use the same refrigerant as the representative model.
- Have the same compressor type (i.e. manufacturer, method of compression (e.g. reciprocating or scroll) and type of enclosure (e.g. hermetic or semi-hermetic) as the representative model.
- Use the same defrosting method (e.g. hot gas defrost).
- Fit within the same product category (i.e. are all low temperature air to water heat pumps, or are all air to water heat pumps (except low temperature heat pumps).
- Use multiple indoor units with the same outdoor unit.

The representative models shall be selected by dividing the range of products into groups of models with similar design characteristics, and testing a model in each group.

As a minimum, at least one complete matched outdoor and indoor unit(s) model assembly shall be tested (as per the required test procedures listed above) in each range of products. Where other variants of indoor unit(s) are applied, the performance of each representative model assembly in the group may be calculated using a validated mathematical model.

It should be noted that:

- If a manufacturer voluntarily removes the representative model from the ETL then other products linked with that representative model may or may not be permitted to remain on the ETL.
- If any product submitted under these representative model rules is later found not to meet the performance criteria when independently tested,

[19] https://www.gov.uk/government/publications/energy-technology-list-etl-product-testing-framework

then all products based on the same representative model will be removed from the ETL.

18.6 Conformity testing

Products listed on the ETL may be subject to the scheme's conformity testing programme in order to ensure listed models continue to meet the ETL requirements.

19 Air to Water Heat Pumps

Date published	2019
Date first launched	2009
Former name	Air Source: Air to Water Heat Pumps

19.1 Scope

Air to water heat pumps are products that are specifically designed to transfer heat from ambient air outside a building to a water-based heating system, by means of a refrigeration cycle.

This specification covers reversible and irreversible models below 45kW and irreversible heat pumps above 45kW. Reversible products above 45kW may be considered within the Packaged Chillers sub-technology.

19.2 Definitions

An air to water heat pump uses an electrically driven refrigeration system to transfer heat from outside air into a water-based heating system. It is primarily used to provide space heating in a wide range of buildings. Additional functionality which may be available includes:

- Provision of heat to domestic hot water
- Space cooling using a water loop by reversing the product's refrigeration cycle.

Air to water heat pumps are available with a wide range of efficiencies and the Energy Technology List (ETL) Scheme aims to encourage the purchase of higher efficiency products.

The ETL Scheme distinguishes between three categories of Air to Water Heat Pumps:

1. Low-temperature heat pumps - specifically designed for low-temperature applications, that cannot deliver heating water with an outlet temperature of 52 °C at an inlet dry (wet) bulb temperature of -7°C (-8°C) in the reference conditions for average climate, with rated output not greater than 45kW.
2. Medium and high temperature heat pumps – that are capable of delivering water with an outlet temperature of 52°C or greater at an inlet dry (wet) bulb temperature of – 7°C (– 8°C) in the reference conditions for average climate, with rated output not greater than 45kW.
3. Large irreversible heat pumps with rated output greater than 45kW.

19.3 Requirements

19.3.1 Eligibility requirements

To be eligible for inclusion on the ETL, products shall meet the requirements as set out below.

To be eligible, products shall:

- Incorporate an electrically driven refrigeration system.
- Be designed for, and include fittings for, permanent installation.
- Have an appropriate Conformity Assessment mark.
- Be designed primarily to provide space heating and:
  - space heating only, i.e. “space heater” as defined by Commission Regulation (EU) No 813/2013, or
  - providing heat to deliver domestic hot water, i.e. “combination heater” as defined by Commission Regulation (EU) No 813/2013.

In addition, single split products shall consist of an ‘outdoor’ unit and an ‘indoor’ unit that are:

- Factory–built sub-assemblies.
- Supplied as a matched set of units.
- Designed to be connected together during installation.

19.3.2 Performance requirements

Eligible products shall meet the performance criteria set out in Table 19.1 below for:

- Seasonal Space Heating Energy Efficiency ($\eta_{s,h}$), as defined by Commission Regulation (EU) No 813/2013.
- Seasonal Energy Efficiency Ratio (SEER) for average climate conditions, where the product is designed to provide cooling.

Table 19.1 Performance thresholds for air to water heat pumps

	Product Category	Heating mode ($\eta_{s,h}$)	Cooling mode (SEER)
1.	Low temperature heat pumps	≥155%	≥4.50
2.	Medium and high temperature heat pumps	≥130%	≥4.50
3.	Large irreversible heat pumps	≥125%	n/a

"≥" means "greater than or equal to"

19.4 Measurement and Calculations

19.4.1 Energy efficiency metrics

Seasonal Space Heating Energy Efficiency **(η_{sh})** – ratio between the space heating demand for reference heating season, supplied by a space heater and the annual primary energy consumption required to meet this demand (BS EN 14825:2016).

Seasonal Coefficient Of Performance **(SCOP)** – overall coefficient of performance of a heat pump using electricity, representative of the heating season, calculated as

the reference annual heating demand divided by annual energy consumption for heating (BS EN 14825:2016).

Seasonal Energy Efficiency Ratio (**SEER)** – ratio of the total cooling capacity to the effective power input of the unit (BS EN 14825:2016)

Primary energy consumption for electricity usage is obtained using **Conversion Coefficient** (CC), known also as Primary Energy Factor, equal to 2.5, as defined by Ecodesign Commission Regulation (EU) 813/2013.

Reference heating season, also called **climate** – a set of operating conditions describing per bin the combination of outdoor temperatures and the number of hours these temperatures occur for heating for which the unit is declared fit for purpose There are three reference heating seasons: “A” average, “C” colder and “W” warmer. UK is located in two reference zones: A and W, but for the ETL purposes **A” for average** is to be used.

Correction factor (**F1**) is a correction that accounts for a negative contribution to the seasonal space heating energy efficiency of heaters due to adjusted contributions of temperature controls, equal to 3% (BS EN 14825:2016).

Equation for calculating η_{sh} corresponding to section 7.1 of BS EN 14825:2016:

$$(1)\ \eta_{s,h} = SCOP/CC - F1$$

19.4.2 Test Requirements

No additional testing requirements beyond the measurement standard below.

19.4.3 Measurement standards

Performance data shall be determined and the η_{sh} calculated, following the requirements of Commission Regulation (EU) No 813/2013.

The product’s capacity and SEER (where the product is designed to provide cooling), must be determined at the conditions shown in Table 19.2 and in accordance with the procedures detailed in BS EN 14825:2016 “Air conditioners, liquid chilling packages and heat pumps, with electrically driven compressors, for space heating and cooling - Testing and rating at part load conditions and calculation of seasonal performance.”

Table 19.2 Part load conditions for air to water heat pumps

	Product category	Heating mode	Cooling mode
1.	Low temperature heat pumps	Commission Regulation (EU) No 813/2013, Annex III, Tables 4 and 5 and Table 3 for outdoor air and low-temperature heat pumps	BS EN 14825:2016 Table 4, Part load condition A, cooling floor application
2.	Medium and high temperature heat pumps	Commission Regulation (EU) No 813/2013, Annex III Tables 4 and 5 and Table 3 for outdoor air and heat pump space heaters other than low-temperature heat pumps	BS EN 14825:2016 Table 4, Part load condition A, cooling floor application
3.	Large irreversible heat pumps	Commission Regulation (EU) No 813/2013, Annex III Tables 4 and 5 and Table 3	N/A

	Product category	Heating mode	Cooling mode
		for outdoor air and heat pump space heaters other than low-temperature heat pumps	

The $\eta_{s,h}$ shall be calculated in accordance with the requirements of Commission regulation (EU) No 813/2013 Annex III, by dividing the SCOP by the factor 2.5 (to allow for generation efficiency), corrected by contributions accounting for temperature controls.

Where results are determined by calculation then this should be on the basis of design and/or extrapolation. In this case, details of such calculations and/or extrapolations, and of tests to verify the accuracy of the calculations undertaken (including details of the mathematical model for calculating performance of such combinations, and of measurements taken to verify this model) shall be made available.

19.4.4 Rounding

For the avoidance of doubt test data should be presented to three significant figures. As an example, a low temperature heat pump with a cooling mode SEER of 4.444 or a heating mode $\eta_{s,h}$ of 154.4% would be deemed to be a fail.

19.5 Verification for ETL Listing

There are five main ways that applicants can demonstrate their product's performance:

- In-house testing – Self-certified
- In-house testing – Self-tested and verified or cross-checked by an independent body
- Witnessed testing
- Independent testing
- Representative testing (see clause 19.5.1)

Further information regarding the first four routes can be found within Guidance Note 5 on the ETL product testing framework[20].

19.5.1 Representative Testing

Where applications are being made for a range of products that are variants of the same basic design, test data may be submitted for a representative model, provided that all variants, i.e. models, share following characteristic features:

- Use the same refrigerant
- Have the same compressor type (i.e. manufacturer, line of models), which should imply:
  - same method of compression (e.g. reciprocating or scroll) and
  - same type of enclosure (e.g. hermetic or semi-hermetic)

[20] https://www.gov.uk/government/publications/energy-technology-list-etl-product-testing-framework

- Use the same defrosting method (e.g. hot gas defrost)
- Fit within the same product category (i.e. are all low-temperature air to water heat pumps, or are all non-low-temperature air to water heat pumps.

The representative models may be selected by dividing the range of products into groups of models with similar design characteristics. The performance of each model shall be predicted using a validated mathematical model. At least one model in each group shall be tested for validation purposes. A report documenting performed model calculations, showing all significant calculation steps, shall be submitted with the application.

It should be noted that:

- If a manufacturer voluntarily removes the representative model from the ETL then other products linked with that representative model may or may not be permitted to remain on the ETL.
- If any product submitted under these representative model rules is later found not to meet the performance criteria when independently tested, then all products based on the same representative model will be removed from the ETL.

19.6 Conformity testing

Products listed on the ETL may be subject to the scheme's conformity testing programme in order to ensure listed models continue to meet the ETL requirements.

19.7 Review

19.7.1 Indicative review date

The next technical review is scheduled for 2022-23.

19.7.2 Illustrative future direction of the requirements

Future changes to the Specification may include:

- Increasing performance thresholds for $\eta_{s,h}$ and/or SEER,
- Introduction of refrigerant's GWP requirements.

20 Heat Pump Dehumidifiers

Date published	2016
Date first launched	2008

20.1 Scope

Heat pump dehumidifiers are widely used to improve personal comfort, to protect building fabric and stored goods or materials, and to dry industrial products. They work by circulating the moist air over the evaporator of the refrigeration system. This reduces the temperature of the air, which causes the water vapour to condense. The resulting condensate can be then drained away.

Heat pump dehumidifiers are available in a range of different designs and efficiencies. The Energy Technology List (ETL) Scheme aims to encourage the purchase of the higher efficiency products that recover both sensible and latent heat

released during dehumidification, and use it to heat the air as it leaves the product or for other useful purposes, such as water heating.

To be eligible for inclusion on the ETL, products shall meet the requirements as set out below.

20.2 Definitions

Heat pump dehumidifiers are products that are specifically designed to remove water vapour from moist air using an electrically driven refrigeration cycle.

20.3 Requirements

20.3.1 Eligibility requirements

To be eligible, products must:

- **Either** be a single packaged unit or consist of two or more factory built sub-assemblies that are designed to be connected together during installation.
- Incorporate an electrically driven refrigeration system that is designed to remove water vapour from the surrounding atmosphere, as the air is recirculated through the product.
- Recover both sensible and latent heat released during dehumidification, and use it to heat the air as it leaves the product and/or for other useful purposes (such as water heating).
- Incorporate a control system that monitors the relative humidity of the surrounding atmosphere, and automatically switches off dehumidification, or modulates the rate of dehumidification, when the relative humidity falls below a pre-set value.
- Be designed for, and include fittings for, permanent installation within a building.
- Have a dehumidification capacity that is greater than or equal to (>=) 0.625 litres per hour.
- **Not** be designed to be connected to compressed air systems.
- Have an appropriate Conformity Assessment mark.

20.3.2 Performance requirements

Products must have a dehumidification efficiency ratio (DER) equal to or greater than the thresholds set out in Table 20.1 below, which depend on the dehumidification capacity (C) of the product.

Table 20.1 Performance test points for heat pump dehumidifiers

Dehumidification capacity(C) (Litres/hour)	Dehumidification efficiencyratio (DER) (Litres/kWh)
>= 0.625 and < 1.5	>= 1.40
>= 1.5 and < 2.3	>= 1.80

Dehumidification capacity(C) (Litres/hour)	Dehumidification efficiencyratio (DER) (Litres/kWh)
>= 2.3	>= 2.30

">=" means "greater than or equal to"

Where the product's dehumidification capacity and dehumidification efficiency ratio are defined in sections 3.5 and 3.6 (respectively) of BS EN 810:1997 "Dehumidifiers with electrically driven compressors. Rating tests, marking, operational requirements and technical data sheet".

20.4 Measurement and Calculations

20.4.1 Measurement standards

All products must be tested in accordance with the procedures laid down in BS EN 810:1997.

20.4.2 Test Requirements

The dehumidification capacity must be determined at the appropriate rating test conditions for the type of product (or intended application) as set out in Tables 2, 3 and 4 of BS EN 810:1997.

The dehumidification efficiency ratio must be determined at an air inlet temperature of 27 degrees Centigrade (dry bulb) and 21 degrees Centigrade (wet bulb) and, where applicable, include the corrections for the power input of fans and water pumps specified in section 4.1 of BS EN 810:1997.

Test results may be submitted in summary form provided that:

- Sufficient data is included to confirm that the dehumidification capacity (kW), COP and DER of each product was determined in accordance with the test procedures in BS EN 810:1997 and at the appropriate rating test conditions as described above.
- At least two detailed test reports are submitted for each range of products. The data must be recorded in a detailed test report as defined in Section 5 of BS EN 810:1997. The test report must include details of the data recording period and duration of the performance measurement.

20.4.3 Rounding

For the avoidance of doubt, test data should be presented to 2 decimal places. As an example, a DER of 1.39 litres/kWh for a heat pump dehumidifier with a dehumidification capacity of 1.2 litres per hour would be deemed to be a fail.

20.5 Verification for ETL Listing

There are five main ways that applicants can demonstrate their product's performance:

- In-house testing – Self-certified

- In-house testing – Self-tested and verified or cross-checked by an independent body
- Witnessed testing
- Independent testing
- Representative testing (see clause 20.5.1)

Further information regarding the first four routes can be found in Guidance Note 5 on the ETL product testing framework[21].

20.5.1 Representative testing

Where applications are being made for a range of two or more products that are variants of the same basic design, test data may be submitted for a representative selection of models, provided that all variants:

- Use the same refrigerant as the representative model.
- Have the same compressor type (i.e. manufacturer, method of compression (e.g. reciprocating or scroll) and type of enclosure (e.g. hermetic or semi-hermetic)) as the representative model.
- Use the same defrosting method (e.g. hot gas defrost).
- Consist of the same number of units (e.g. are all single packaged units).

The representative models must be selected by dividing the range of products into groups of models with similar design characteristics, and testing a model in each group. The performance of each model in the group must be predicted using a validated mathematical model. As a minimum, at least two models must be tested in each range of products.

It should be noted that:

- If a manufacturer voluntarily removes the representative model from the ETL then other products linked with that representative model may or may not be permitted to remain on the ETL.
- If any product submitted under these representative model rules is later found not to meet the performance criteria when independently tested, then all products based on the same representative model will be removed from the ETL.

20.6 Conformity testing

Products listed on the ETL may be subject to the scheme's conformity testing programme in order to ensure listed models continue to meet the ETL requirements.

[21] https://www.gov.uk/government/publications/energy-technology-list-etl-product-testing-framework

21 Heat Pump Driven Air Curtains

Date published	2019
Date first launched	2012
Former name	Heat Pump Driven Air Curtains

21.1 Scope

Heat Pump Driven Air Curtains are products fitted above a doorway or similar opening that are specifically designed to reduce the infiltration of air from one space to another, and that is heated and/or cooled by a heat pump that transfers heat by means of a refrigeration cycle.

21.2 Definitions

Air curtains are used to reduce losses by disrupting the natural convection between two adjacent spaces that are at differing temperatures, thereby reducing the amount of heating or cooling needed to maintain the temperature of a space. They are typically used in commercial premises for situations where an open door is required to allow uninterrupted access or where traffic through the doorway is so high that the door is open for extended periods.

Heat pump driven air curtains use a heat pump to heat or cool the air expelled by the product. This heat substitutes the need to heat the air with resistive electric heaters or fuel combustion.

The Energy Technology List (ETL) Scheme aims to encourage the purchase of higher efficiency split type heat pump driven air curtains, which have separate heat collection and rejection units for each space known as ‘indoor’ and ‘outdoor’ units. The ‘indoor’ and ‘outdoor’ units are specifically designed to be connected together during installation by refrigerant pipework to form a single functional unit.

The sub-technology described within this Specification covers:

1. Single-split Heat Pump Driven Air Curtains, that consist of one ‘outdoor’ heat pump unit and one air curtain unit.

Heat pump driven air curtain units for multi-split and VRF heat pumps, that consist of one air curtain unit that is specifically designed to replace one or more ‘indoor’ heat pump units are covered by the Air to Air Heat Pumps, Split, Multi-Split and VRF sub-technology.

21.3 Requirements

21.3.1 Eligibility requirements

To be eligible for inclusion on the ETL, products shall meet the requirements as set out below.

To be eligible, products shall:

- Include an air curtain unit or package that:
  - Is specifically designed to be fitted above a doorway or similar opening.

- Is specifically designed to use a heat pump to heat and/or cool the air curtain expelled by it, and to use electrical air heaters (where fitted) only during defrosting or heat pump failure.
- Has been rated in terms of air curtain airflow rate, outlet air velocity uniformity and air curtain velocity projection in accordance with the procedures in BS ISO 27327-1:2009.

- Be able to automatically modulate in response to changes in air inlet temperature and/or space temperature(s), the amount of heating and/or cooling applied to the air curtain between 40% and 100% of its nominal rated heating/cooling capacity output.
- Be designed for, and include fittings for, permanent installation.
- Have an appropriate Conformity Assessment mark.

In addition, single split heat pump driven air curtain products shall:

- Consist of one air curtain unit (or package) and one outdoor heat pump unit that are:
  - Factory–built sub-assemblies.
  - Supplied as a matched set of units.
  - Designed to be connected together during installation.
- Incorporate an electrically driven refrigeration system.

21.3.2 Performance requirements

Eligible products shall meet the performance criteria set out in Table 21.1 below for:

- Coefficient of Performance (COP), across the range of connected capacities, including at 100% (full) load, in heating mode, where the product is designed to heat the expelled air.
- Energy Efficiency Ratio (EER) across the range of connected capacities, including at 100% (full) load in cooling mode, where the product is designed to cool the expelled air.
- Outlet air velocity uniformity (u_{ACU}), as defined in Section 5.4.4 of BS ISO 27327-1: 2009, over the range of doorway/opening heights that they are designed to be fitted above.

Table 21.1 Performance requirements for heat pump driven air curtains

	Product Category	Heating mode (COP)	Cooling mode (EER)	Outlet air velocity uniformity (u_{ACU})
1.	Single-split heat pump driven air curtains	≥3.00	≥3.00	≥ 70%

"≥" means "greater than or equal to"

21.4 Measurement and Calculations

21.4.1 Energy efficiency metrics

Coefficient of Performance (**COP**) - ratio of the heating capacity to the effective power input of the unit (as defined by BS EN 14511:2018).

Energy Efficiency Ratio (**EER**) - ratio of the total cooling capacity to the effective power input of the unit (as defined by BS EN 14511:2018).

Outlet air velocity uniformity ($\mathbf{u_{ACU}}$) - a percentage calculated from the average air curtain core velocity and velocity's standard deviation, as defined by BS EN 27327-1:2009

21.4.2 Test Requirements

No additional testing requirements beyond the measurement standard below.

21.4.3 Measurement standards

All products shall be tested in accordance with the procedures in BS EN 14511:2018 using the standard rating conditions as set out in the Table 21.2 below.

Table 21.2 Test conditions for heat pump driven air curtains

	Product Category		Heating mode (COP)	Cooling mode (EER)
1.	Single-split heat pump driven air curtains	Air source	BS EN 14511:2018 Table 3 Standard rating conditions, Outdoor air/recycled air.	BS EN 14511:2018 Table 4 Standard rating conditions: Comfort (outdoor air/recycled air)

Please note that performance data obtained in accordance with the corresponding procedures and standard rating conditions laid down in BS EN 14511: 2011 and BS EN 14511: 2013 will be accepted as an alternative to testing in accordance with BS EN 14511: 2018 until further notice. Outlet air velocity uniformity shall be tested in accordance with BS EN 27327-1: 2009.

21.4.4 Rounding

For the avoidance of doubt test data for COP and EER should be presented to 2 decimal places. As an example, a single split heat pump driven air curtain with a heating mode COP of 2.994 would be deemed to be a fail.

21.5 Verification for ETL Listing

There are five main ways that applicants can demonstrate their product's performance:

- In-house testing – Self-certified
- In-house testing – Self-tested and verified or cross-checked by an independent body
- Witnessed testing
- Independent testing
- Representative testing (see clause 21.5.1)

Further information on the first four routes can be found within Guidance Note 5, ETL product testing framework[22].

21.5.1 Representative Testing

Where applications are being made for two or more products that are variants of the same basic design, test data may be submitted for a single 'representative model', provided that all products:

- Use the same model of outdoor unit.
- Use the same refrigerant as the representative model.
- Provide the same air curtain core velocity range allowing for same installation height.

The representative model may be selected by dividing the range of products into groups of models with similar design characteristics. The performance of each model shall be predicted using a validated mathematical model. At least one model in each group shall be tested for validation purposes. A report documenting the performed model calculations, showing all significant calculation steps, shall be submitted with the application.

It should be noted that:

- If a manufacturer voluntarily removes the representative model from the ETL then other products linked with that representative model may or may not be permitted to remain on the ETL.
- If any product submitted under these representative model rules is later found not to meet the performance criteria when independently tested, then all products based on the same representative model will be removed from the ETL.

21.6 Conformity testing

Products listed on the ETL may be subject to the scheme's conformity testing programme in order to ensure listed models continue to meet the ETL requirements.

21.7 Review

21.7.1 Indicative review date

The next technical review is scheduled for 2022-23.

21.7.2 Illustrative future direction of the requirements

Future changes to the Specification may include:

- Increasing the performance thresholds for COP and EER
- Introduction of refrigerant GWP requirements.

[22] https://www.gov.uk/government/publications/energy-technology-list-etl-product-testing-framework

22 Packaged Air to Air Heat Pumps (rooftop)

Date published	2019
Date first launched	2002
Former name	Air Source: Packaged Heat Pumps

22.1 Scope

'Packaged' type heat pumps are single[23] factory assembled units that incorporate all the elements of the refrigeration system and air distribution mechanisms for space heating, often referred to as 'rooftop' due to the most common placement of the product.

Air to air heat pumps are products that are specifically designed to transfer heat from the air in one space into the air within another space by means of a refrigeration cycle.

22.2 Definitions

Packaged Air to Air heat pumps use an electrically operated refrigeration system to transfer heat from air outside a building to the air inside it. They can be used to provide space heating in a wide range of buildings, and some products also are able to provide cooling by reversing the refrigeration cycle (these products are known as reversible 'air-cooled' air conditioning units).

Packaged Air to Air heat pumps are available with a wide range of efficiencies. The Energy Technology List (ETL) Scheme aims to encourage the purchase of higher efficiency products.

22.3 Requirements

22.3.1 Eligibility requirements

To be eligible for inclusion on the ETL, products shall meet the requirements as set out below.

To be eligible, products shall:

- Consist of a single[23] factory–built unit.
- Incorporate an electrically driven refrigeration system.
- Incorporate all the elements of the air distribution mechanisms for space heating.
- Be designed for, and include fittings for, permanent installation.
- Have an appropriate Conformity Assessment mark.

Products shall be designed to primarily supply heating by means of the built-in heat pump and must not incorporate a gas-fired burner, hot water heating coil or steam heating coil.

[23] As per Ecodesign guidelines single package should be interpreted as "a unique functional unit that is provided by one manufacturer with one single commercial reference. However, this assembly can be provided on one or two separate frames".

22.3.2 Performance requirements

Eligible products shall meet the performance criteria set out in Table 22.1 below for:

- Seasonal Space Heating Energy Efficiency ($\eta_{s,h}$) as defined by Ecodesign Commission Regulation (EU) 2016/2281.
- Seasonal Space Cooling Energy Efficiency as defined by Ecodesign Commission Regulation (EU) 2016/2281.

Table 22.1 Performance requirements for Packaged Air to Air heat pumps

Product Category	Heating mode ($\eta_{s,h}$)	Cooling mode ($\eta_{s,h}$)
Air source: packaged heat pumps	≥135%	≥145%

"≥" means "greater than"

22.4 Measurement and Calculations

22.4.1 Energy efficiency metrics

Seasonal Space Heating Energy Efficiency ($\boldsymbol{\eta_{s,h}}$) – ratio between the space heating demand for reference heating season, supplied by a space heater and the annual primary energy consumption required to meet this demand, as defined by Ecodesign Commission Regulation (EU) 2016/2281.

Seasonal Space Cooling Energy Efficiency ($\boldsymbol{\eta_{s,c}}$) – ratio between the space cooling demand for reference cooling season supplied and annual primary energy consumption required to meet that demand, as defined by Ecodesign Commission Regulation (EU) 2016/2281.

Seasonal Coefficient Of Performance (**SCOP**) - overall coefficient of performance of a heat pump using electricity, representative of the heating season, calculated as the reference annual heating demand divided by annual energy consumption for heating, as defined by Ecodesign Commission Regulation (EU) 2016/2281.

Seasonal Energy Efficiency Ratio (**SEER**) – overall energy efficiency ratio of a heat pump working in reverse mode for a representative cooling season, calculated as the reference annual cooling demand divided by the annual energy consumption for cooling, as defined by Ecodesign Commission Regulation (EU) 2016/2281.

Primary energy consumption for electricity usage is obtained using the **Conversion Coefficient** (CC), known also as the Primary Energy Factor, equal to 2.5, as defined by Ecodesign Commission Regulation (EU) 2016/2281.

Reference heating season, also called **climate** - set of operating conditions describing per bin the combination of outdoor temperatures and the number of hours these temperatures occur for heating for which the unit is declared fit for purpose. There are three reference heating seasons: “A” average, “C” colder and “W” warmer. The UK is located in two reference zones: A and W, but for the ETL purposes **“A” for average** is to be used.

Correction factor (**F1**) is the correction that accounts for a negative contribution to the seasonal space heating energy efficiency of heaters due to adjusted contributions of temperature controls, equal to 3% (BS EN 14825:2016)

In case of any changes regarding the value of CC in relevant regulations or test reporting procedures, the performance indicators will be calculated using the following equations:

(3) $\eta_{s,h}$= SCOP/CC -F1

(4) $\eta_{s,c}$= SEER/CC -F1

22.4.2 Test Requirements

No additional testing requirements beyond the measurement standard below.

22.4.3 Measurement standards

Performance data shall be determined and the $\eta_{s,h}$, $\eta_{s,c}$ calculated, following the requirements of Commission Regulation (EU) No 2281/2016 The standard rating conditions are set out in Table 22.2 below.

Table 22.2 Test conditions for Packaged Air to Air heat pumps

Product Category	Heating mode ($\eta_{s,h}$)	Cooling mode ($\eta_{s,c}$)
Packaged Air to Air Heat Pumps	Commission Regulation (EU) No 2281/2016 Annex III, tables 16, 21, 26, average rating conditions	Commission Regulation (EU) No 2281/2016 Annex III, tables 16, 27, average rating conditions,

Please note that performance data obtained in accordance with the corresponding procedures and standard rating conditions laid down in BS EN 14825:2013 and BS EN 14825: 2016 will be accepted as an alternative to testing in accordance with Commission Regulation (EU) No 2281/2016 until further notice.

22.4.4 Rounding

For the avoidance of doubt test data should be presented to 0 decimal places for percentage points. As an example, a product with a heating mode $\eta_{s,h}$ of 134.4% would be deemed to be a fail.

22.5 Verification for ETL Listing

There are five main ways that applicants can demonstrate their product's performance:

- In-house testing – Self-certified
- In-house testing – Self-tested and verified or cross-checked by an independent body
- Witnessed testing
- Independent testing
- Representative testing (see clause 22.5.1)

Further information regarding the first four routes can be found within Guidance Note 5, the ETL product testing framework[24].

[24] https://www.gov.uk/government/publications/energy-technology-list-etl-product-testing-framework

22.5.1 Representative Testing

Where applications are being made for a range of products that are variants of the same basic design, test data may be submitted for a representative model, provided that all variants, i.e. models, share following characteristic features:

- Use the same refrigerant,
- Have the same compressor type (i.e. manufacturer, line of models), which should imply:
  - same method of compression (e.g. reciprocating or scroll) and
  - same type of enclosure (e.g. hermetic or semi-hermetic),
- Use the same defrosting method (e.g. hot gas defrost),
- Are powered using same configuration of inverters.

The representative models may be selected by dividing the range of products into groups of models with similar design characteristics. The performance of each model shall be predicted using a validated mathematical model. At least one model in each group shall be tested for validation purposes. A report documenting performed model calculations, showing all significant calculation steps, shall be submitted with the application.

It should be noted that:

- If a manufacturer voluntarily removes the representative model from the ETL then other products linked with that representative model may or may not be permitted to remain on the ETL.
- If any product submitted under these representative model rules is later found not to meet the performance criteria when independently tested, then all products based on the same representative model will be removed from the ETL.

22.6 Conformity testing

Products listed on the ETL may be subject to the scheme's conformity testing programme in order to ensure listed models continue to meet the ETL requirements.

22.7 Review

22.7.1 Indicative review date

The next technical review is scheduled for 2022-23.

22.7.2 Illustrative future direction of the requirements

Future changes to the Specification may include:

- Increasing performance thresholds for $\eta_{s,h}$ and $\eta_{s,c}$
- Introduction of refrigerant GWP requirements.

23 Water to Air Heat Pumps, Split, Multi-split and VRF

Date published	2019
Date first launched	2002
Former name	Water Source: Split and Multi-Split (including VRF) Heat Pumps

23.1 Scope

Water to Air Heat Pumps, Split, Multi-Split and VRF, are products that are specifically designed to transfer heat from water (in a building's internal water loop) into the air within the space to be heated by means of a refrigeration cycle.

'Split' type heat pumps have separate heat collection and rejection units for each space known as 'outdoor' and 'indoor' units. The 'outdoor' and 'indoor' units are specifically designed to be connected together during installation by refrigerant pipework to form a single functional unit.

Variable refrigerant flow (VRF) heat pumps are specifically designed to automatically adjust the flow of refrigerant to each indoor unit so that the heat delivered is matched to the demand.

23.2 Definitions

Water to Air Heat Pumps, Split, Multi-Split and VRF, use an electrically operated refrigeration system to transfer heat from an internal water loop into the air within the space to be heated. They can be used to provide space heating in a wide range of buildings and some products also are able to provide cooling by reversing the refrigeration cycle within the product (these products are known as reversible 'water cooled' air conditioning units).

Water to Air Heat Pumps, Split, Multi-Split and VRF are available with a range of efficiencies. The Energy Technology List (ETL) Scheme aims to encourage the purchase of higher efficiency products.

The ETL Scheme covers two categories of products:

1. Single split (non-VRF) heat pumps that consist of one 'outdoor' unit and one 'indoor' unit
2. Multi-split VRF heat pumps that consist of one 'outdoor' unit connected to one or more 'indoor' units using a common refrigerant circuit with the indoor units individually controlled.

23.3 Requirements

23.3.1 Eligibility requirements

To be eligible for inclusion on the ETL, products shall meet the requirements as set out below.

To be eligible, products shall:

- Consist of an 'outdoor' unit and one or more 'indoor' units that are:
  - Factory–built sub-assemblies.
  - Supplied as a matched set of units.

- Designed to be connected together during installation.

- Incorporate an electrically driven refrigeration system.
- Be designed for, and include fittings for, permanent installation.
- Have an appropriate Conformity Assessment mark.

23.3.2 Performance requirements

Eligible products shall meet the performance criteria set out in Table 23.1 below for:

- Seasonal Space Heating Energy Efficiency for water heat source, as defined by Ecodesign Commission Regulation (EU) 2016/2281
- Seasonal Space Cooling Energy Efficiency for ground coupled heat sink, as defined by Ecodesign Commission Regulation (EU) 2016/2281

Table 23.1 Performance thresholds for water to air heat pumps, split, multi-split & VRF

	Product Category	Heating mode ($\eta_{s,h}$)	Cooling mode ($\eta_{s,c}$)
1.	Single split (non-VRF) heat pumps	≥165%	≥270%
2.	Multi-split VRF heat pumps	≥170%	≥280%

"≥" means "greater than"

23.4 Measurement and Calculations

23.4.1 Energy efficiency metrics

Seasonal Space Heating Efficiency **($\eta_{s,h}$)** – ratio between the space heating demand for reference heating season, supplied by a space heater and the annual primary energy consumption required to meet this demand (as defined by Ecodesign Commission Regulation (EU) 2016/2281).

Seasonal Space Cooling Energy Efficiency **($\eta_{s,c}$)** – ratio between the space cooling demand for reference cooling season supplied and annual primary energy consumption required to meet that demand

Seasonal Coefficient Of Performance **(SCOP)** – overall coefficient of performance of a heat pump using electricity, representative of the heating season, calculated as the reference annual heating demand divided by annual energy consumption for heating (as defined by Ecodesign Commission Regulation (EU) 2016/2281).

Seasonal Energy Efficiency Ratio **(SEER)** – overall energy efficiency ratio of a heat pump working in reverse mode for a representative cooling season, calculated as the reference annual cooling demand divided by the annual energy consumption for cooling (as defined by Ecodesign Commission Regulation (EU) 2016/2281).

Primary energy consumption for electricity usage is obtained using **Conversion Coefficient** (CC), known also as Primary Energy Factor, equal to 2.5, as defined by Ecodesign Commission Regulation (EU) 2016/2281.

Reference heating season, called also **climate** - set of operating conditions describing per bin the combination of outdoor temperatures and the number of hours these temperatures occur for heating for which the unit is declared fit for purpose There are three reference heating seasons: “A” average, “C” colder and “W”

warmer. UK is located in two reference zones: A and W, but for the ETL purposes **"A" for average** is to be used.

Correction factor (**F1**) is correction that accounts for a negative contribution to the seasonal space heating energy efficiency of heaters due to adjusted contributions of temperature controls, equal to 3% (BS EN 14825:2016)

In case of any changes regarding the value of CC in relevant regulations or test reporting procedures, performance indicators will be calculated using following equations:

(5) $\eta_{s,h}$= SCOP/CC -F1

(6) $\eta_{s,c}$= SEER/CC -F1

23.4.2 Test Requirements

No additional testing requirements beyond the measurement standard below

23.4.3 Measurement standards

All products shall be tested in accordance with the procedures in Commission Regulation (EU) No 2281/2016, consistent with BS EN 14825:2016. The standard rating conditions are set out in the Table 23.2 below.

Table 23.2 Test conditions for water to air heat pumps, split, multi-split and VRF

	Product Category	Heating mode ($\eta_{s,h}$)	Cooling mode ($\eta_{s,c}$)
1.	Single split (non-VRF) heat pumps	Commission Regulation (EU) No 2281/2016 Annex III, tables 19, 21, 26, water rating conditions	Commission Regulation (EU) No 2281/2016 Annex III, tables 19, 27, ground coupled rating conditions,
2.	Multi-split VRF heat pumps	Commission Regulation (EU) No 2281/2016 Annex III, tables 19, 21, 26, water rating conditions	Commission Regulation (EU) No 2281/2016 Annex III, tables 19, 27, ground coupled rating conditions,

Please note that performance data obtained in accordance with the corresponding procedures and standard rating conditions laid down in BS EN 14825: 2013 will be accepted as an alternative to testing in accordance with BS EN 14825: 2016 until further notice.

23.4.4 Rounding

For the avoidance of doubt test data should be presented to three significant figures. As an example, a multi-split VRF heat pump with a heating mode $\eta_{s,h}$ of 169.4% would be deemed to be a fail.

23.5 Verification for ETL Listing

There are five main ways that applicants can demonstrate their product's performance:

- In-house testing – Self-certified

- In-house testing – Self-tested and verified or cross-checked by an independent body
- Witnessed testing
- Independent testing
- Representative testing (see clause 23.5.1)

Further information regarding the first four routes can be found in Guidance Note 5 on the ETL product testing framework[25].

23.5.1 Representative Testing

Where applications are being made for a range of products that are variants of the same basic design, test data may be submitted for a representative model, provided that all variants, i.e. models, share following characteristic features:

- Use the same refrigerant
- Have the same compressor type (i.e. manufacturer, line of models), which should imply:
  - same method of compression (e.g. reciprocating or scroll) and
  - same type of enclosure (e.g. hermetic or semi-hermetic)
- Use the same defrosting method (e.g. hot gas defrost)
- Fit within the same product category (i.e. are all low-temperature air to water heat pumps, or are all non-low-temperature air to water heat pumps.
- The representative models may be selected by dividing the range of products into groups of models with similar design characteristics. The performance of each model shall be predicted using a validated mathematical model. At least one model in each group shall be tested for validation purposes. A report documenting performed model calculations, showing all significant calculation steps, shall be submitted with the application.

It should be noted that:

- If a manufacturer voluntarily removes the representative model from the ETL then other products linked with that representative model may or may not be permitted to remain on the ETL.
- If any product submitted under these representative model rules is later found not to meet the performance criteria when independently tested, then all products based on the same representative model will be removed from the ETL.

23.6 Conformity testing

Products listed on the ETL may be subject to the scheme's conformity testing programme in order to ensure listed models continue to meet the ETL requirements.

[25] https://www.gov.uk/government/publications/energy-technology-list-etl-product-testing-framework

23.7 Review

23.7.1 Indicative review date

The next technical review is scheduled for 2022-23.

23.7.2 Illustrative future direction of the requirements

Future changes to the Specification may include:

- Increasing performance thresholds for $\eta_{s,h}$ and $\eta_{s,h}$
- Introduction of refrigerant GWP requirements.

24 Water or Brine to Water Heat Pumps

Date published	2019
Date first launched	2004
Former name	Ground Source and Surface Water Source Heat Pumps Ground Source: Brine to Water Heat Pumps

24.1 Scope

Water or Brine to Water Heat Pump systems are specifically designed to transfer heat from the ground or surface water to a water-based heating system by means of a refrigeration cycle.

The liquid heat transferring medium for the heat pump may be brine or water.

In a brine to water heat pump, the heat is collected from the ground or surface water by circulating a solution of water and anti-freeze (known as ‘brine’) through a buried or submerged, closed-loop, ground heat exchanger.

In a water to water heat pump, the heat is collected from ground water (aquifer) or surface water by circulating the water through a direct, open-loop heat exchanger.

24.2 Definitions

Water or Brine to Water Heat Pumps use an electrically operated refrigeration system to transfer heat from the ground or surface water into a water-based heating system. They can be used to provide space heating in a wide range of buildings, and some products may be also able to provide cooling by reversing the refrigeration cycle within the product.

Products which are designed to be used for a water heat source without the use of an intermediate circuit, i.e. direct open-loop system, are classified as **water to water** heat pumps. All others are classified as **brine to water** heat pumps. The Energy Technology List (ETL) Scheme aims to encourage the purchase of higher efficiency water or brine to water heat pumps, which can be used to realise substantial reductions in carbon emissions.

24.3 Requirements

To be eligible for inclusion on the ETL, products shall meet the requirements as set out below.

24.3.1 Eligibility requirements

To be eligible, products shall:

- Consist of a single factory-built unit.
- Incorporate an electrically driven refrigeration system.
- Be designed to use an indirect, closed-loop ground heat exchanger, indirect, closed-loop surface water heat exchanger or a direct, open-loop ground or surface water heat source.
- Be designed for, and include fittings for, permanent installation.
- Have an appropriate Conformity Assessment mark.

24.3.2 Performance requirements

Eligible products shall meet the relevant performance criteria set out in Table 24.1 below for:

- Seasonal Space Heating Energy Efficiency ($\eta_{s,h}$) as defined by Commission Regulation (EU) No 813/2013.
- Seasonal Energy Efficiency Ratio (SEER) for average climate conditions, where the product is designed to provide cooling.

Table 24.1 Performance thresholds for water or brine to water heat pumps

	Product Category	Heating mode ($\eta_{s,h}$)	Cooling mode (SEER)
1.	Brine to water heat pumps	≥175%	≥5.00
2.	Water to water heat pumps	≥185%	≥5.00

"≥" means "greater than or equal to"

24.4 Measurement and Calculations

24.4.1 Energy efficiency metrics

Seasonal Space Heating Efficiency ($\eta_{s,h}$) – ratio between the space heating demand for reference heating season, supplied by a space heater and the annual primary energy consumption required to meet this demand (as defined by Commission Regulation (EU) No 813/2013).

Seasonal Coefficient Of Performance (**SCOP**) – overall coefficient of performance of a heat pump using electricity, representative of the heating season, calculated as the reference annual heating demand divided by the annual energy consumption for heating (as defined by Commission Regulation (EU) No 813/2013).

Seasonal Energy Efficiency Ratio (**SEER**) – ratio of the total cooling capacity to the effective power input of the unit (BS EN 14825:2016).

Primary energy consumption for electricity usage is obtained using **Conversion Coefficient** (CC), known also as Primary Energy Factor, equal to 2.5, as defined by Ecodesign Commission regulation (EU) 813/2013.

Reference heating season, called also **climate** – a set of operating conditions describing per bin the combination of outdoor temperatures and the number of hours these temperatures occur for heating for which the unit is declared fit for purpose There are three reference heating seasons: “A” average, “C” colder and “W”

warmer. UK is located in two reference zones: A and W, but for the ETL purposes "**A" for average** is to be used.

Correction factor (**F1**) is correction that accounts for a negative contribution to the seasonal space heating energy efficiency of heaters due to adjusted contributions of temperature controls, equal to 3% (BS EN 14825:2016).

Correction factor (**F2**) is correction that accounts for a negative contribution to the seasonal space heating energy efficiency of heaters due to electricity consumption of brine and water pumps, equal to 5% (BS EN 14825:2016).

Equation corresponding to section 7.1 of BS EB 14825:2016:

$$(1)\ \eta_{s,h} = SCOP/CC - F1 - F2$$

24.4.2 Test Requirements

No additional testing requirements beyond the measurement standard below.

24.4.3 Measurement standards

Performance data shall be determined and the SSHEE calculated, following the requirements of Commission Regulation (EU) No 813/2013, Annex III.

The product's capacity and performance indicators, shall be determined at the conditions shown in Table 24.2 and in accordance with the procedures detailed in BS EN 14825:2016 "Air conditioners, liquid chilling packages and heat pumps, with electrically driven compressors, for space heating and cooling - Testing and rating at part load conditions and calculation of seasonal performance."

Table 24.2 Part load conditions for water or brine to water heat pumps

	Product Category	Heating mode ($\eta_{s,h}$)	Cooling mode (SEER)
1.	Brine to water heat pumps	Commission Regulation (EU) No 813/2013, Annex III, table 3 for brine	BS EN 14825:2016 Table 5, Part load condition A, cooling tower application and cooling floor application
2.	Water to water heat pumps	Commission Regulation (EU) No 813/2013, Annex III, table 3 for water	BS EN 14825:2016 Table 5, Part load condition A, cooling tower application

The seasonal coefficient of performance (SCOP) shall be determined according to the calculation methods in BS EN 14825:2016.

Where results are determined by calculation then this should be on the basis of design and/or extrapolation. In this case, details of such calculations and/or extrapolations, and of tests to verify the accuracy of the calculations undertaken (including details of the mathematical model for calculating performance of such combinations, and of measurements taken to verify this model) shall be made available. Tests undertaken to verify the accuracy of the calculations shall be carried out in accordance with the test procedures described above.

Please note that the performance data for heating mode COP can only be obtained in accordance with the corresponding procedures laid down in BS EN 14825:2016 and standard rating conditions laid down in Table 12, BS EN 14825:2013 will be accepted as an alternative to testing in accordance with Table 24, BS EN 14825:2016 until further notice.

24.4.4 Rounding

For the avoidance of doubt data should be presented to three significant figures. As an example, a brine to water heat pump with a heating mode performance $\eta_{s,h}$ of 174.4% would be deemed to be a fail.

24.5 Verification for ETL Listing

There are five main ways that applicants can demonstrate their product's performance:

- In-house testing – Self-certified
- In-house testing – Self-tested and verified or cross-checked by an independent body
- Witnessed testing
- Independent testing
- Representative testing (see clause 24.5.1)

Further information regarding the first four routes can be found in Guidance Note 5 on the ETL product testing framework[26].

24.5.1 Representative Testing

Where applications are being made for a range of products that are variants of the same basic design, test data may be submitted for a representative model, provided that all variants, i.e. models, share following characteristic features:

- Use the same refrigerant
- Have the same compressor type (i.e. manufacturer, line of models), which should imply:
  - same method of compression (e.g. reciprocating or scroll) and
  - same type of enclosure (e.g. hermetic or semi-hermetic)
- Are powered using same configuration of inverters.

The representative models may be selected by dividing the range of products into groups of models with similar design characteristics. The performance of each model shall be predicted using a validated mathematical model. At least one model in each group shall be tested for validation purposes. A report documenting performed model calculations, showing all significant calculation steps, shall be submitted with the application.

It should be noted that:

- If a manufacturer voluntarily removes the representative model from the ETL then other products linked with that representative model may or may not be permitted to remain on the ETL.
- If any product submitted under these representative model rules is later found not to meet the performance criteria when independently tested, then all products based on the same representative model will be removed from the ETL.

[26] https://www.gov.uk/government/publications/energy-technology-list-etl-product-testing-framework

24.6 Conformity testing

Products listed on the ETL may be subject to the scheme's conformity testing programme in order to ensure listed models continue to meet the ETL requirements.

24.7 Review

24.7.1 Indicative review date

The next technical review is scheduled for 2022-23.

24.7.2 Illustrative future direction of the requirements

Future changes to the Specification may include:

- An increase of the performance thresholds for $\eta_{s,h}$
- Introduction of refrigerant GWP limits.

Heat Recovery Ventilation Units

25 Heat Recovery Ventilation Units

Date published	2020
Date first launched	2004
Former name	Air-to-air energy recovery devices

25.1 Scope

Heat Recovery Ventilation Units are products designed to replace utilised air with outdoor air that provides an option to recover (or salvage) waste heat from the exhaust air stream from a building ventilation system and use it to heat the incoming air stream to the same building ventilation system.

25.2 Definitions

Heat Recovery Ventilation Units use heat exchanger technologies to recover heat from the exhaust air of building ventilation systems that would otherwise be lost to atmosphere. Some products may also be used to reduce the energy used by air conditioning systems by removing heat from the incoming air.

A wide range of heat recovery ventilation units is available. The Energy Technology List (ETL) Scheme aims to encourage the purchase of products with higher levels of effectiveness in heat recovery.

The ETL Scheme covers two categories of product:

- Ventilation Units with plate heat exchangers.
- Ventilation Units with rotating heat exchangers (including thermal and desiccant heat wheels).

To be eligible for inclusion on the ETL, products shall meet the requirements as set out below.

25.3 Requirements

25.3.1 Eligibility requirements

To be eligible, in addition to a heat exchanger, products shall be equipped with:

- Fans for supplied and extracted air,
- Filters for supplied and extracted air,
- Sensors with an embedded control system or an interface to an external control unit,
- Housing encompassing the above.

25.3.2 Performance requirements

Products shall have:

- A dry heat recovery efficiency at the product's 100% nominal air flow balanced flow condition that is greater than or equal to the values set out in Table 1.1 below.

- A pressure drop across each side of the heat exchanger(s) within the product at the product's 100% nominal air flow that is less than or equal to the values set out in Table 25.1 below.

Table 25.1 Performance requirements for Heat Recovery Ventilation Units.

	Product category	Dry heat recovery efficiency (%)	Pressure drop (in pascals)
1.	Units with plate heat exchangers	>= 78 %	<= 250 Pa across each side.
2.	Units with rotating heat exchangers	>= 78 %	<= 200 Pa across each side.

">=" means "greater than or equal to"

"<=" means "less than or equal to"

Where:

- The 100% nominal air flow is the flow rate specified by the manufacturer according to the product's design. If no nominal air flow is specified, air flow resulting from the full fan speed (at standard air conditions 20 °C and 101 325 Pa) may be used.

25.4 Measurement and Calculations

25.4.1 Measurement standards

All products shall be tested in accordance with the relevant procedures and test conditions in one of the following standards:

- BS EN 308:1997 "Heat Exchanger: Test procedures for establishing performance of air to air and flue gases heat recovery devices".
- ANSI / AHRI 1060 / 1061:2018 "Performance rating of air-to-air heat exchangers for energy recovery ventilation", Air-conditioning, Heating & Refrigeration Institute. ANSI / AHRI 1060 /1061:2014 and 2005 will be accepted until further notice.
- JIS B 8628: 2017, "Air to air heat exchanger". JIS B 8628:2003 will be accepted until further notice.
- Other equivalent test standards where the resulting performance data can be scientifically proven, using the methodologies in ANSI/ASHRAE Standard 84-2008 "Method of Testing Air-to- Air Heat/Energy Exchangers", to be equivalent to that obtained under BS EN 308:1997.
- In particular, submitting results of tests performed to obtain Heat Recovery System's thermal efficiency for a Non-Residential Ventilation Unit as defined by Commission Regulation (EU) No 1253/2014, is encouraged.

25.4.2 Test Requirements

The dry heat recovery efficiency shall be calculated using the formula for thermal efficiency in Annex IX of Commission Regulation (EU) No 1253/2014 and test data collected when rating the product's performance in heating mode at the test conditions specified in the selected standard for the type of product.

Where products are too large to be tested at their 100% nominal air flow under the standard test conditions specified in AHRI 1060 / 1061: 2018, BS EN 308: 1997 or JIS B 8628: 2017, then performance data obtained at other test conditions may be extrapolated using validated models.

25.4.3 Rounding

For the avoidance of doubt test data should be presented to zero decimal places. As an example, a plate heat exchanger with a minimum dry heat recovery efficiency of 77.4%, or a pressure drop of 250.5 pascals, would be deemed to be a fail.

25.5 Verification for ETL Listing

Any of the following testing routes may be used to demonstrate the conformity of products against the requirements:

- In-house testing – Self-certified
- In-house testing – Self-tested and verified or cross-checked by an independent body
- Witnessed testing
- Independent testing
- Representative testing (see clause 25.5.1)

Further information regarding the first four routes can be found in Guidance Note 5 on the ETL product testing framework[27].

25.5.1 Representative testing

Where applications are being made for two or more products that are variants of the same basic design, test data may be submitted for a representative selection of models, provided that all variants:

- Use the same heat transfer mechanisms as the representative models.
- Are constructed from materials with same heat transfer characteristics.
- The 100% nominal rated output of the products being applied for is not more than five times, or less than one-fifth, the 100% nominal rated output of the product tested

It should be noted that:

- If a manufacturer voluntarily removes the representative model from the ETL then other products linked with that representative model may or may not be permitted to remain on the ETL.
- If any product submitted under these representative model rules is later found not to meet the performance criteria when independently tested, then all products based on the same representative model will be removed from the ETL.

[27] https://www.gov.uk/government/publications/energy-technology-list-etl-product-testing-framework

25.6 Conformity testing

Products listed on the ETL may be subject to the scheme's conformity testing programme in order to ensure listed models continue to meet the ETL requirements.

25.7 Review

25.7.1 Indicative review date

The next technical review is scheduled for 2023-24.

25.7.2 Illustrative future direction of the requirements

Future changes to the Specification may include:

- Further uplift of thresholds

Heating, Ventilation and Air Conditioning (HVAC) Equipment

26 Active Chilled Beams

Date published	2019
Date first launched	2014

26.1 Scope

Active chilled beams incorporate an integral (primary) air supply and cooling coil(s) to provide cooled air into occupied spaces without the use of an integral fan, in order to achieve comfortable working conditions. The primary air supply enhances and controls the induction of air from the occupied space through the cooling coil.

Active chilled beams may provide space cooling only or both space heating and cooling. Where beams provide space heating, they will also incorporate a heating coil to provide warm air to occupied spaces.

26.2 Definitions

Active chilled beams are terminal units attached to heating, ventilation and air conditioning (HVAC) systems that are specifically designed to provide chilled air (and warm air for heating and cooling products) into a treated environment.

Cooling only active chilled beams are convectors with an integrated (primary) air supply and cooling coil(s) through which chilled water passes to provide the cooling effect. Heating and cooling active chilled beams also have an integrated heating coil to provide space heating. Primary ventilation air produces an inductive effect to increase the convection of room air. The induced air flow passes through the cooling or heating coil, and then mixes with the primary air before being discharged into the space through integral air distributors.

Active chilled beams do not incorporate fans for air distribution. They are designed to use dry (sensible) cooling to prevent condensation thus negating the need for condensate collection and disposal. Dehumidification of the primary supply air is important to prevent the risk of condensation as well as any internal latent gains.

Active chilled beams can be linear or modular in format:

- Linear active chilled beams are produced in various widths and lengths with either one or two directional air throw patterns (1 or 2-way throws). One or more linear active chilled beams can be installed as a continuous linear beam to make up desired length.
- Modular or cassette format active chilled beams are characterized by modular sized units, typically 0.6m x 0.6m and 0.6m x 1.2m with 4 directional outlets (4-way throws).
- Bulkhead active chilled beams are designed to fit into restricted spaces with low ceilings such as bulkheads. They deliver treated air in a horizontal direction.

Multi-service chilled beams (MSCBs) combine chilled beams with additional building services such as lighting, controls & control sensors, sprinklers, cables or public-address speakers.

The Energy Technology List (ETL) scheme aims to encourage the purchase of active chilled beams which are energy efficient due to their use of relatively high chilled water temperatures and the use of outdoor ventilation air, resulting in increased efficiency of chiller operation and the opportunity to maximise free-cooling.

To be eligible for inclusion on the ETL, products shall meet the requirements as set out below.

26.3 Requirements

26.3.1 Eligibility requirements

To be eligible, products shall:

- Be an active chilled beam designed to introduce primary ventilation air into the treated space through the beam.
- Be designed to operate above the dew point. Any condensate tray fitted should be included as a precautionary measure only, and should have no facility to connect to drainage.
- Not include any electrical heating elements.
- Not include an integral fan

Multi-service chilled beams that contain lighting equipment are eligible as long as the lighting equipment also meets the relevant ETL criteria for high efficiency lighting units, white light emitting diode lighting units, or lighting controls, as appropriate.

26.3.2 Performance requirements

Products shall have a “Specific Waterside Cooling Capacity” that is greater than or equal to the values set out in Table 26.1 for “Linear Active Chilled Beams” and Table 26.2 for “Modular Active Chilled Beams” and Table 26.3 for “Bulkhead Active Chilled Beams” at the operating conditions specified below.

Table 26.1 Linear active chilled beam performance requirements

Nominal Active Chilled Beam Width	≤ 300mm		> 300mm and ≤ 600mm	
Air Throw	1-Way	2-Way	1-Way	2-Way
Induction (nozzle) pressure (P_A)	≤ 100 Pa	≤ 100 Pa	≤ 100 Pa	≤ 100 Pa
Cooling coil pressure drop (P_W)	≤ 20 kPa	≤ 20 kPa	≤ 20 kPa	≤ 20 kPa
Specific waterside cooling capacity	≥ 15.0 W/mK	≥ 25.0 W/mK	≥ 20.0 W/mK	≥ 45.0 W/mK

Table 26.2 Modular active chilled beam performance requirements

Nominal Active Chilled Beam Size (Active width x Active length)	600mm x 600mm	600mm x 1200mm
Air Throw	4-Way	4-Way
Induction (nozzle) pressure (P_A)	≤ 100 Pa	≤ 100 Pa
Cooling coil pressure drop (P_W)	≤ 20 kPa	≤ 20 kPa

Nominal Active Chilled Beam Size (Active width x Active length)	600mm x 600mm	600mm x 1200mm
Air Throw	4-Way	4-Way
Specific waterside cooling capacity	≥ 45.0 W/K	≥ 40.0 W/K

Table 26.3 Bulkhead active chilled beam performance requirements

Nominal Active Chilled Beam Size (Active length)	Bulkhead unit up to 1500mm
Induction (nozzle) pressure (P_A)	≤ 100 Pa
Cooling coil pressure drop (P_W)	≤ 20 kPa
Specific waterside cooling capacity	≥ 40.0 W/mK

Where:

- Specific waterside cooling capacity in W/mK is the waterside cooling capacity per unit length of beam and per unit temperature difference between the reference room air temperature and the mean chilled water temperature. For modular active chilled beams, the specific waterside cooling capacity is measured for the modular unit in W/K.
- Nominal active chilled beam width/dimensions is the size of the active cooling element excluding architectural components that do not affect product cooling performance
- All other terms are as defined in BS EN 15116:2008
- "≤" means "less than or equal to", "≥" means "greater than or equal to"

26.4 Measurement and Calculations

26.4.1 Measurement standards

Product performance specified in Table 26.1, Table 26.2 and Table 26.3 (above) shall be determined in accordance with the procedures and test conditions laid out in the following standard:

- BS EN 15116:2008 "Ventilation in buildings. Chilled beams. Testing and rating of active chilled beams"

26.4.2 Performance metric

The specific waterside cooling capacity for the product shall be calculated using the equation below:

$$Specific\ Waterside\ Cooling\ Capacity = \frac{P_w}{L\Delta\theta}$$

Where:

- P_w = Waterside cooling capacity [Watts]
- L = Cooling length [metres], the active length of cooling section
- $\Delta\theta$ = Temperature difference between reference air temperature (θ_r) and mean cooling water temperature (θ_w) i.e. $\Delta\theta = (\theta_r - \theta_w)$ [Kelvin]

For modular active chilled beams, where the product is a fixed size, the specific waterside cooling capacity is simply the ratio between the waterside cooling capacity

in Watts to the temperature difference between reference air temperature and mean cooling water temperature in Kelvin, as described above.

26.4.3 Test Requirements

All products shall be tested in accordance with the procedure set out in BS EN 15116:2008. A test report shall be submitted in accordance with the format specified in Section 6 of BS EN 15116:2008.

26.4.4 Rounding

For the avoidance of doubt test data should be presented to one decimal place. As an example, a Specific Waterside Cooling Capacity of 14.9 Watts/mK for a 1 Way throw linear active chilled beam with Nominal Active Width of ≤ 300 mm would be deemed to not meet the performance requirements.

26.4.5 Uncertainties of measurement

The total calculated uncertainty when calculating the specific waterside cooling capacity of a product shall be less than ±6% at nominal flow and $\Delta\theta$ = 8K, in accordance with Section 5 of BS EN 15116:2008.

26.5 Verification for ETL Listing

Any of the following testing routes may be used to demonstrate the conformity of products against the requirements:

- In-house testing – Self-tested and verified or cross-checked by an independent body
- Witnessed testing
- Independent testing
- Representative testing (see clause 26.5.1)

Further information regarding the first three routes can be found within Guidance Note 5, ETL product testing framework[28].

26.5.1 Representative testing

Where applications are being made for a range of two or more products that are variants of the same basic design, test data may be submitted for a representative selection of models, provided that it can be demonstrated that all variants have:

- the same cooling coil width
- the same cooling coil height
- fins that are made from the same material, with the same surface and spacing between adjacent fins
- pipes that are the same shape (e.g. internally smooth or rifled), and of the same material and pattern.
- the same plenum and diffuser geometry

[28] https://www.gov.uk/government/publications/energy-technology-list-etl-product-testing-framework

- the same discharge (e.g. are all one way, two ways, three ways or four ways)

As a minimum, at least one representative model shall be tested in each range of products. The performance of each model in the representative group shall be predicted using a validated mathematical model.

It should be noted that:

- If a manufacturer voluntarily removes the representative model from the ETL then other products linked with that representative model may or may not be permitted to remain on the ETL.
- If any product submitted under these representative model rules is later found not to meet the performance criteria when independently tested, then all products based on the same representative model will be removed from the ETL.

26.6 Conformity Testing

Products listed on the ETL may be subject to the scheme's conformity testing programme in order to ensure listed models continue to meet the ETL requirements.

26.7 Review

26.7.1 Indicative review date

This specification is scheduled for review during the 2022/23 ETL review cycle.

26.7.2 Illustrative future direction of the requirements

In future, the ETL technology specification for active chilled beams sub-categories will be reviewed for a potential scope expansion to include other product types not currently covered under the scope of this specification.

27 HVAC Building Controls

Date published	2020
Date first launched	2004
Former name	Building Environment Zone Controls (Incorporating) Heating Management Controllers (for Wet Heating Systems) Heating, Ventilation and Air Conditioning (HVAC) Zone Controls

27.1 Scope

Heating, Ventilation and Air conditioning (HVAC) Building controls are used to control the environmental conditions (i.e. temperature, ventilation rate and/or air quality) in individual zones (i.e. rooms or areas) within a building. They can be programmed to maintain these environmental conditions within pre-set limits in a manner that reflects occupation schedules, occupation status and/or level of activity in the zone, whilst also taking account of environmental conditions, and the specific operating requirements of the zone. These criteria are designed in order for controllers to be capable of functioning in an EN 15232 class A system.

A wide range of HVAC Building controls is available. The Energy Technology List (ETL) Scheme aims to encourage the purchase of products that automatically

minimise the energy consumption of building heating, cooling, ventilation, or air conditioning equipment, and associated distribution systems.

Some products are also able to control lighting, electrical appliances and window shading equipment in a zone in line with its occupation schedule/status. For these applications, the respective criteria to be met are described in Table 27.8.

The Scheme covers three categories of products:

1. 'Add-on' control modules that are not self-contained units but are designed to incorporate zone control facilities into HVAC control units or equipment.
2. Control units not enabled to communicate with 3rd party devices
3. Control units enabled to communicate with 3rd party devices

To be eligible for inclusion on the ETL, products shall meet the definitions and eligibility requirements as set out below.

27.2 Definitions

HVAC Building controls are products that are designed and programmed to automatically control in an energy efficient manner, the amount of heating, cooling, ventilation or air conditioning that is applied to individual rooms or defined areas within a building, known as "zones".

"HVAC" is the collective term used to refer to the combination of heating, cooling, ventilation, or air conditioning that is specifically employed within a particular building.

27.3 Requirements

27.3.1 Eligibility requirements

27.3.1.1 General

To be eligible, products shall:

1. Incorporate a microprocessor-based controller that is programmed (as factory produced, tailored to customer building or reprogrammed during an installation upgrade) to automatically control the individual environmental conditions in one or more zones within a building, in an energy efficient manner that reflects the occupation status or the level of activity in each zone.
   Controllers operating under zone occupation schedules are authorised, under the provision that they are also capable of control under occupation status or activity level.
2. Be able to automatically control the operation of the equipment:
   a) Heating and/or cooling the zones being controlled; and/or:
   b) Ventilating and/or air quality the zones being controlled.
3. Be designed to have at least two of the following zone operating modes:
   a) A "normal/comfort" operating mode where zone environmental conditions are maintained within predefined levels consistent with zone occupation or a high level of activity in the zone.
   b) An "economy/standby" mode where zone environmental conditions are maintained at reduced levels to reflect, for example, the fact that the zone is unoccupied, or a reduced level of activity in the zone or

c) A “off” mode where the zone heating, cooling, ventilation and air-conditioning is switched off or operated solely for fabric, frost and equipment protection.

4. Incorporate an anti-tampering mechanism that prevents the product’s control strategy and configuration settings from being modified, and automatic control from being disabled, except during commissioning, maintenance or testing.
5. Conform with the requirements of The Electromagnetic Compatibility Regulations 2016, or have an appropriate Conformity Assessment mark.
6. Make any feature allowing for building users to adjust temperature and/or ventilation settings in their zone to be only on a temporary basis. Products shall automatically reset user adjustments, either after a pre-defined time interval (which may be fixed or defined by the building manager) or at the next scheduled switching time.
7. Adhere to requirements detailed in Table 1.8 when controlling other types of equipment. If the product is not detailed in Table 1.8, then the control shall be based on status or levels of activity.

■ For control valves, actuators and dampers with integrated controls (i.e. factory assembled), these products shall be eligible under the HVAC Building Controls criteria.

For motors, pumps, fans and variable speed drives, controllers which are integrated (i.e. factory assembled) into these products shall also meet the relevant ETL criteria for the associated product. Where ETL criteria for the associated product does not exist, the integrated controller shall not be eligible for the ETL. This criterion does not apply for fans and pumps incorporated solely for the purpose of cooling the controller.

27.3.1.2 Specific

1. Comply with the relevant requirements for particular type of zone control and type of HVAC plant controlled, as set out in Table 27.1 to Table 27.6 below, for products that:
   a) Control zone temperature (see Table 27.1).
   b) Control zone ventilation rate or air condition (see Table 27.2).
   c) Control based on zone occupation status or level of activity (see Table 27.3).
   d) Control based on zone occupation schedules (see Table 27.4).
   e) Control centralised HVAC plant (see Table 27.5).
   f) Control wet heating systems (see Table 27.6).
   g) Controls for workstation ventilation (see Table 27.7).

Table 27.1 Requirements for control zone temperature

Control of zone temperature
All products that are designed to control zone temperature shall: 1. Be designed to directly measure zone temperature by means of a temperature sensor, and automatically adjust heat flow into, or out of, the zone to maintain temperature within the predefined temperature limits for the operating mode. 2. Provide facilities that enable building managers to define the temperature set-points for each operating mode in each zone to +/- 1 degree centigrade. 3. Conform with the requirements of BS EN 15500-1:2017, with control accuracy and control setpoint deviation are defined, such that they respect: a. Control Accuracy for Heating is smaller than 2 degrees Celsius b. Control Setpoint Deviation for heating is smaller than 2 degrees Celsius c. Control accuracy for cooling is smaller than 2 degrees Celsius d. Control setpoint deviation for cooling is smaller than 2 degrees Celsius 4. Monitor internal temperatures and automatically switch zone heating circuits on or cooling circuits off, to stop condensation occurring and to protect building fabric. In addition, products that are designed to control both zone heating and cooling shall: 5. Provide facilities that enable building managers to define separate temperature set-points for zone heating and zone cooling in each zone. 6. Incorporate a mechanism(s) that prevent simultaneous zone heating and cooling, and frequent cycling of heating and cooling equipment on and off. In addition, products that are designed to control window shading equipment shall: 7. If the product is capable of controlling window blinds or orientation of louvres, be designed to monitor the position of the sun, and automatically adjust the position of window blinds or orientation of louvres in a manner that minimises the entry of solar radiation, when the zone is in cooling mode, without excessive reduction in natural light.
Notes
8. Products that solely rely on an external, to the building, thermostatic device (for example, a digital thermostat) to determine when additional heating or cooling is required within a zone, are not eligible.

Table 27.2 Requirements for control zone ventilation rates or air quality

Control of zone ventilation rates or air quality
All products that are designed to control zone ventilation rate or air quality shall: 9. Be designed to monitor zone ventilation rate or air quality by means of a presence detector, activity or air quality sensor (see Table 1.3, note 8), and automatically adjust the airflow into, or out of, the zone to maintain zone ventilation rates or air quality within the predefined limits for the operating mode. 10. Incorporate a mechanism that automatically minimises ventilation rates in unoccupied zones, and in zones operating in economy or standby modes.
Notes
11. Products that solely rely on an electronic or mechanical ‘timing out’ mechanism (for example, a spring-loaded button) to determine when a zone is unoccupied are not eligible. 12. Products that have a “night cooling mode” that is designed to make use of natural ventilation to remove excess heat and cool the building fabric when the zone is unoccupied are eligible.

Table 27.3 Requirements for control based on zone occupation status or level of activity

Control based on zone occupation status or level of activity
All products that are designed to control zones based on occupation status shall: 1. Be able to monitor zone occupation status by means of presence detector or activity sensor, and automatically adjust zone-operating mode to maintain environmental conditions within the predefined limits for the zone occupation status. 2. Provide facilities that enable building managers or users to manually switch the zone into economy or standby mode, without disabling automatic zone controls. All products that are designed to control zones based on level of activity shall: 3. Be able to monitor the level of activity in the zone by means of presence detector or activity or air quality sensor, and automatically modulate the amount of heating, cooling, ventilation and/or air-conditioning applied in a manner that reflects the level of activity in the zone. 4. Provide facilities that enable building managers or users to manually switch the zone into economy or standby mode, without disabling automatic zone controls.
Notes
5. The product may monitor zone occupation status by means of one or more presence detectors, or activity sensors, which may include for example, CO_2 level monitors, heat or motion detectors, moisture sensors etc. However, manually operated devices (for example, electrical switches, electronic touch buttons or entry detection devices) are not considered to be presence detectors unless they automatically reset to a “no presence detected state” after a pre-set period of time. 6. A key card activated master control switch may be used as an alternative to a presence detector, provided that: a. when the key card is removed from it, it is designed to switch the zone controller into economy or standby mode and to switch off all lighting and electrical appliances being controlled. b. the system returns to economy/standby mode if the card is left in the controller for more than 24h. 7. Products that are designed to monitor the usage of lighting and electrical appliances by measuring energy use are eligible, provided that they are also designed to use a presence detector or activity sensor to detect that the zone is unoccupied, and then to automatically switch such equipment off. 8. Products that are designed to monitor the operation of plant and machinery within a zone and raise an alarm when a fault or fire is detected, or when unauthorised occupation is detected, are eligible. In this context, a fault may include the local override of control settings or automatic control. 9. Products that are designed to share the use of presence detectors and activity sensors with other types of management and control systems (e.g. building management systems) are eligible.

Table 27.4 Requirements for control based on zone occupation schedules

Control based on zone occupation schedules
All products that include a control zones based on occupation schedules shall:
1. Automatically switch zones between operating modes, in accordance with the predefined and individual weekly occupation schedule for each zone controlled.
2. Provide facilities that enable building managers to define the normal occupation times in each zone (in intervals of five minutes or less), for each day of the week, including at least two periods of occupation per day (i.e. at least 14 different occupation periods a week).
3. Provide facilities that enable building managers to define future dates (e.g. holidays) when zone heating, cooling, ventilation and air-conditioning should be in standby, economy, completely switched off, or operated at frost, fabric or equipment protection levels.
In addition, products that also control zone heating and cooling shall:
4. Incorporate a zone “optimum start” mechanism that monitors external and/or internal temperatures and calculates when heating or cooling needs to begin in the zone in order to reach the pre-set temperature by the start of the next occupancy period.
5. Provide facilities that enable building managers to define different temperature set-points for each scheduled period of normal occupation throughout the day and week.
Notes
6. Products that control domestic hot water (DHW) systems shall provide facilities that enable building managers to define a separate operating schedule for the operation of DHW systems.

Table 27.5 Requirements for control of centralised HVAC plant

Control of centralised HVAC plant
Where products control the operation of centralised HVAC plant, they shall:
1. Incorporate a mechanism that enables the building’s HVAC systems to be easily switched into economy or standby mode, for example, when a scheduled activity finishes early.
In addition, products that control central heating or cooling systems shall:
2. Provide facilities to control the operation of the centralised heating or cooling systems, and zone environmental conditions based on zone sensor feedback (as defined in Table 1.4).
3. Monitor internal temperatures and automatically switch zone heating circuits on or cooling circuits off, to stop condensation occurring and to protect building fabric.
4. Incorporate an overall “optimum start” mechanism that monitors external or internal temperatures, and calculates when the heating or cooling system needs to be switched on in order to reach pre-set temperatures by the start of the next occupancy period, after taking account of the requirements of each zone.
Notes
5. Products that control centralised HVAC plant shall be designed to control at least two zones.

Table 27.6 Requirements for control of wet heating systems

Control of wet heating systems
Where products control the overall operation of wet heating systems, they shall: 1. Incorporate a “weather compensation” mechanism that automatically saves energy during milder weather conditions, by reducing the temperature set-point of the boiler water circuit as the external temperature rises, and also the temperature of, or the heat flow through, the individual heating circuits for each zone controlled. 2. Incorporate a “frost protection” mechanism that monitors external and/or internal temperatures (or pipework temperatures), and switches on boilers and heating circuits as required to prevent equipment and pipework from “freezing up”. 3. Provide facilities for building managers to “temporarily override” or manually adjust the degree (or amount) of weather compensation applied to each zone controlled. 4. A mechanism that prevents the boilers supplying the heating system from “dry cycling” (i.e. switching on and off), when there is no change in heat demand. 5. When managing multiple heat/chilled water generators, the controller shall be capable of managing generators according to a dynamic priority list based on load, efficiency and capacity of generators.
Notes
6. The requirements in Table 1.5 also apply to products that control wet heating systems.

Table 27.7 Requirements for workstation ventilation controls

Controls of workstation ventilation
Where workstations are defined as delineated containable working surfaces, such as a kitchen or laboratory fume extractor. They shall: 1. Adhere to the ventilation requirements detailed in Table 1.2 2. Adhere to the control requirements detailed in Table 1.3 3. Be designed to monitor the level of fumes and to automatically reduce the rate of extraction to the minimum necessary to maintain air quality within predefined limits.
Notes
4. Specific to this technology group, a zone is defined as the extractors above a workstation.

Table 27.8 Additional requirements when other types of equipment are controlled

Type of equipment controlled	Relevant ETL eligibility criteria
Electrical lighting equipment	Lighting controls
Automatic monitoring and targeting equipment	Automatic Monitoring & Targeting (aM&T) Sub-metering Systems
Commercial refrigeration equipment	Refrigeration system controls
Two or more air compressors	Master controllers

27.4 Verification for ETL Listing

There are no testing requirements, however manufacturers shall provide sales and technical brochures to evidence the conformity of their products against the requirements from section 27.3. Manufacturers shall also provide evidence of conformity with the EN 15500 criteria, detailing control accuracy and control setpoint deviation values.

27.5 Conformity testing

Products listed on the ETL may be subject to the scheme's conformity testing programme in order to ensure listed models continue to meet the ETL requirements.

27.6 Review

27.6.1 Indicative review date

The next technical review is scheduled for 2023-24.

27.6.2 Illustrative future direction of the requirements

Future changes to the specification may include:

a) For controller units to be capable of remote internet access (potentially through a local central secured hub), allowing for remote operation and maintenance.

b) For controller units to be compatible to function with any 3rd party HVAC system, sensor or control device.

- ETL scoping studies are underway on Building Energy Management Systems, Product systems and Smart products which may recommend future revisions to the HVAC Building Controls criteria.
- ETL scoping studies are underway for pumps and fans. These studies may result in criteria for the inclusion onto the ETL.

28 Close Control Air Conditioning Equipment

Date published	2016
Date first launched	2009

28.1 Scope

Close control air conditioning equipment is used to control temperature (and optionally humidity) in rooms and enclosures containing heat generating equipment, such as servers, computers or telecommunications devices, and in some types of manufacturing process (e.g. clean rooms). The equipment typically operates continuously and has a much higher unit floor area cooling load requirement than conventional air conditioning.

Close control air conditioning equipment is available with a wide variety of efficiencies. The Energy Technology List (ETL) Scheme aims to encourage the purchase of higher efficiency products.

The ETL Scheme covers seven categories of product:

1. DX air cooled close control air conditioning equipment (without free cooling coil).
2. DX air cooled close control air conditioning equipment with integral chilled water free cooling coil(s).
3. DX water cooled close control air conditioning equipment (without free cooling coil).
4. DX water cooled close control air conditioning equipment with integral chilled water free cooling coil(s).
5. Chilled water (CHW) cooled close control air conditioning equipment.
6. Dual mode: DX air cooled and chilled water (CHW) cooled close control air conditioning equipment (without free cooling).
7. Dual mode: DX water cooled and chilled water (CHW) cooled close control air conditioning equipment (without free cooling).

Where DX stands for 'direct expansion' and refers to products that effect cooling, or partial cooling, of the air by evaporating a refrigerant in their indoor heat exchangers.

The ETL Scheme covers products that are designed to provide close control air conditioning to the room containing the heat generating equipment (room air conditioning, or room AC, products) and those that are designed to provide close control air conditioning to the local area surrounding the heat generating equipment or the heat generating equipment itself (close coupled cooling, or CCC, products).

To be eligible for inclusion on the ETL, products shall meet the requirements as set out below.

28.2 Definitions

Close control air conditioning equipment covers products that are specifically designed to provide the cooling needed to maintain the air temperature, and optionally the relative humidity, in rooms that contain equipment or processes with high sensible heat loads.

28.3 Requirements

28.3.1 Eligibility requirements

To be eligible, products must:

- **Either** be a single packaged unit or consist of two or more factory built sub-assemblies that are designed to be connected together during installation.
- **Either** incorporate an electrically powered compressor (or compressors) and / or incorporate a chilled water cooling coil with fittings for connection to an external chilled water circuit.
- Have a ratio of sensible cooling capacity to the total cooling capacity (i.e. sensible heat ratio) that is greater than or equal to (>=) 0.9 at the relevant rating conditions specified in Table 28.2 and Table 28.3 below.
- Have an appropriate Conformity Assessment mark.

28.3.2 Performance requirements

Products must have an energy efficiency ratio (EER), and a free cooling capacity (where applicable) that is greater than or equal to the values set out in Table 28.1 below.

Table 28.1 Performance thresholds for close control air conditioning equipment

	Product category		EER	Free cooling capacity
1.	DX air cooled (without free cooling).		>= 3.20	
2.	DX air cooled with integral chilled water free cooling coil(s).		>= 3.00	Free cooling coil cooling capacity >= 90% of cooling capacity in DX operating mode where both cooling capacities are measured at the rating conditions given in Table 28.2 for room AC products and Table 28.3 for CCC products.
3.	DX water cooled (without free cooling).		>= 3.90	
4.	DX water cooled with integral chilled water free cooling coil(s).		>= 3.60	Free cooling coil cooling >= 90% of cooling capacity in DX operating mode where both cooling capacities are measured at the rating conditions given in Table 28.2 for room AC products and Table 28.3 for CCC products.
5.	Chilled water (CHW) cooled (only).		>= 18.00	
6.		DX mode	>= 3.20	

'>=' means 'greater than or equal to'.

Where EER is the ratio of total gross cooling capacity (Watts) to the electric power absorbed by the product (Pelec). In the case of DX and dual mode products, the electric power absorbed by the product should include that of both the indoor and outdoor heat exchangers.

28.4 Measurement and Calculations

28.4.1 Measurement Standards and Test Requirements

All room AC products must be tested in accordance with the test standards, procedures and conditions specified in Table 28.2. All CCC products must be tested in accordance with the test standards, procedures and conditions specified in Table 28.3.

Table 28.2 Required test procedures for room AC close control air conditioning equipment

Product category	Standard	Rating condition

1.	DX air cooled (without free cooling).		BS EN 14511:2013	Outdoor heat exchanger, inlet dry bulb temperature 35°C Indoor heat exchanger, inlet dry bulb temperature 23.9°C and inlet wet bulb temperature 16.2°C
2.	DX air cooled with integral chilled water free cooling coil(s).	DX refrigeration part	BS EN 14511:2013	Outdoor heat exchanger, inlet dry bulb temperature 35°C Indoor heat exchanger, inlet dry bulb temperature 23.9°C and inlet wet bulb temperature 16.2°C
		Free cooling coil	BS 4856-3:1975 (if ducted) BS 4856-2:1975 (if not ducted) or BS EN 1397: 2015	Liquid side conditions, inlet temperature 10°C and outlet 16.7°C Indoor heat exchanger, inlet dry bulb temperature 23.9°C and inlet wet bulb temperature 16.2°C
3.	DX water cooled (without free cooling).		BS EN 14511:2013	Outdoor heat exchanger, inlet temperature 28.3°C and outlet temperature 35°C Indoor heat exchanger, inlet dry bulb temperature 23.9°C and inlet wet bulb temperature 16.2°C
4.	DX water cooled with integral chilled water free cooling coil(s).	DX refrigeration part	BS EN 14511:2013	Outdoor heat exchanger, inlet temperature 28.3°C and outlet temperature 35°C Indoor heat exchanger, inlet dry bulb temperature 23.9°C and inlet wet bulb temperature 16.2°C
		Free cooling coil	BS 4856-3:1975 (if ducted) BS 4856-2:1975 (if not ducted) or BS EN 1397:2015	Liquid side conditions, inlet temperature 10˚C and outlet 16.7˚C Indoor heat exchanger, inlet dry bulb temperature 23.9˚C and inlet wet bulb temperature 16.2˚C
5.	Chilled water (CHW) cooled (only).		BS 4856-3:1975 (if ducted) BS 4856-2:1975 (if not ducted) or BS EN 1397:2015	Liquid side conditions, inlet temperature 10°C and outlet 16.7°C Indoor heat exchanger, inlet dry bulb temperature 23.9°C and inlet wet bulb temperature 16.2°C
6.	Dual mode: DX air cooled and chilled water cooling	DX mode	BS EN 14511:2013	Outdoor heat exchanger, inlet dry bulb temperature 35°C Indoor heat exchanger, inlet dry bulb temperature 23.9°C and inlet wet bulb temperature 16.2°C

	(without free cooling).	CHW mode	BS 4856-3:1975 (if ducted) BS 4856-2:1975 (if not ducted) or BS EN 1397:2015	Liquid side conditions, inlet temperature 10°C and outlet 16.7°C Indoor heat exchanger, inlet dry bulb temperature 23.9°C and inlet wet bulb temperature 16.2°C
7.	Dual mode: DX water cooled and chilled water cooling (without free cooling).	DX mode	BS EN 14511:2013	Outdoor heat exchanger, inlet temperature 28.3°C and outlet temperature 35°C Indoor heat exchanger, inlet dry bulb temperature 23.9°C and inlet wet bulb temperature 16.2°C
		CHW mode	BS 4856-3:1975 (if ducted) BS 4856-2:1975 (if not ducted) or BS EN 1397:2015	Liquid side conditions, inlet temperature 10°C and outlet 16.7°C Indoor heat exchanger, inlet dry bulb temperature 23.9°C and inlet wet bulb temperature 16.2°C

Table 28.3 Required test procedures for CCC close control air conditioning equipment

	Product category		Standard	Rating condition
1.	DX air cooled (without free cooling).		BS EN 14511:2013	Outdoor heat exchanger, inlet dry bulb temperature 35°C Indoor heat exchanger, inlet dry bulb temperature 35.0°C and inlet wet bulb temperature 19.9°C
2.	DX air cooled with integral chilled water free cooling coil(s).	DX refrigeration part	BS EN 14511:2013	Outdoor heat exchanger, inlet dry bulb temperature 35°C Indoor heat exchanger, inlet dry bulb temperature 35.0°C and inlet wet bulb temperature 19.9°C
		Free cooling coil	BS 4856-3:1975 (if ducted) BS 4856-2:1975 (if not ducted) or BS EN 1397:2015	Liquid side conditions, inlet temperature 10°C and outlet 16.7°C Indoor heat exchanger, inlet dry bulb temperature 35.0°C and inlet wet bulb temperature 19.9°C
3.	DX water cooled (without free cooling).		BS EN 14511:2013	Outdoor heat exchanger, inlet temperature 28.3°C and outlet temperature 35°C Indoor heat exchanger, inlet dry bulb temperature 35.0°C and inlet wet bulb temperature 19.9°C
4.	DX water cooled with integral chilled water free cooling coil(s).	DX refrigeration part	BS EN 14511:2013	Outdoor heat exchanger, inlet temperature 28.3°C and outlet temperature 35°C Indoor heat exchanger, inlet dry bulb temperature 35.0°C and inlet wet bulb temperature 19.9°C

		Free cooling coil	BS 4856-3:1975 (if ducted) BS 4856-2:1975 (if not ducted) or BS EN 1397:2015	Liquid side conditions, inlet temperature 10°C and outlet 16.7°C Indoor heat exchanger, inlet dry bulb temperature 35.0°C and inlet wet bulb temperature 19.9°C
5.	Chilled water (CHW) cooled (only).		BS 4856-3:1975 (if ducted) BS 4856-2:1975 (if not ducted) or BS EN 1397:2015	Liquid side conditions, inlet temperature 10°C and outlet 16.7°C Indoor heat exchanger, inlet dry bulb temperature 35.0°C and inlet wet bulb temperature 19.9°C
6.	Dual mode: DX air cooled and chilled water cooling (without free cooling).	DX mode	BS EN 14511:2013	Outdoor heat exchanger, inlet dry bulb temperature 35°C Indoor heat exchanger, inlet dry bulb temperature 35.0°C and inlet wet bulb temperature 19.9°C
		CHW mode	BS 4856-3:1975 (if ducted) BS 4856-2:1975 (if not ducted) or BS EN 1397:2015	Liquid side conditions, inlet temperature 10°C and outlet 16.7°C Indoor heat exchanger, inlet dry bulb temperature 35.0°C and inlet wet bulb temperature 19.9°C
7.	Dual mode: DX water cooled and chilled water cooling(without free cooling).	DX mode	BS EN 14511:2013	Outdoor heat exchanger, inlet temperature 28.3°C and outlet temperature 35°C Indoor heat exchanger, inlet dry bulb temperature 35.0°C and inlet wet bulb temperature 19.9°C
		CHW mode	BS 4856-3:1975 (if ducted) BS 4856-2:1975 (if not ducted) or BS EN 1397:2015	Liquid side conditions, inlet temperature 10°C and outlet 16.7°C Indoor heat exchanger, inlet dry bulb temperature 35.0°C and inlet wet bulb temperature 19.9°C

An external static pressure of at least (>=) 20 Pascals must be used for testing downflow units with ducted outlets.

Please note that performance data obtained in accordance with the corresponding procedures and the standard rating conditions for Close Control laid down in BS EN 14511:2007 or BS EN 14511:2011 will be accepted as an alternative to testing in accordance with BS EN 14511:2013 and the rating conditions given in Table 28.2 and Table 28.3 until further notice.

Please note that performance data obtained in accordance with the corresponding procedures laid down in BS EN 1397:1999 will be accepted as an alternative to testing in accordance with BS EN 1397:2015 until further notice.

28.4.2 Rounding

For the avoidance of doubt test data should be presented to 2 decimal places. As an example an EER of 3.19 for a DX air cooled product would be deemed a fail.

28.5 Verification for ETL Listing

Any of the following testing routes may be used to demonstrate the conformity of products against the requirements:

- In-house testing – Self-certified
- In-house testing – Self-tested and verified or cross-checked by an independent body
- Witnessed testing
- Independent testing
- Representative testing (see clause 28.5.1)

Further information regarding the first four routes can be found in Guidance Note 5 on the ETL product testing framework[29].

28.5.1 Representative testing

Where applications are being made for a range of two or more products that are variants of the same basic design, test data may be submitted for a representative selection of models, provided that all variants:

- Use the same refrigerant as the representative model.
- Have the same compressor type (i.e. manufacturer, method of compression (e.g. reciprocating or scroll) and type of enclosure (e.g. hermetic or semi-hermetic)) as the representative model.
- Fit within the same product category (e.g. are all DX air cooled without free cooling).
- Use the same indoor heat exchanger configuration (e.g. 4-row and fan blow through).

The representative models must be selected by dividing the range of products into groups of models with similar design characteristics, and testing a model in the lowest quartile of predicted performance in each group. The performance of each model in the group must be predicted using a validated mathematical model. As a minimum, at least two models must be tested in each range of products.

It should be noted that:

- If a manufacturer voluntarily removes the representative model from the ETL then other products linked with that representative model may or may not be permitted to remain on the ETL.
- If any product submitted under these representative model rules is later found not to meet the performance criteria when independently tested, then all products based on the same representative model will be removed from the ETL.

[29] https://www.gov.uk/government/publications/energy-technology-list-etl-product-testing-framework

28.6 Conformity testing

Products listed on the ETL may be subject to the scheme's conformity testing programme in order to ensure listed models continue to meet the ETL requirements.

29 Evaporative Air Coolers

Date published	2018
Date first launched	2018

29.1 Scope

Evaporative air coolers can be direct or indirect. With direct evaporative air cooling, outside air is blown through a water-saturated medium and cooled by evaporation. The cooled air is circulated by a fan. With indirect evaporative air cooling, a secondary air stream is cooled by water. The cooled secondary air stream passes through a heat exchanger, where it cools the primary air stream. The cooled primary air stream is circulated by a fan.

Evaporative air coolers are available with a wide variety of efficiencies. The Energy Technology List (ETL) Scheme aims to encourage the purchase of direct evaporative air coolers and higher efficiency indirect evaporative air coolers.

The ETL Scheme covers two categories of product:

1. Direct evaporative air coolers
2. Indirect evaporative air coolers

To be eligible for inclusion on the ETL, products shall meet the requirements as set out below.

29.2 Definitions

An evaporative air cooler is a device that cools air through the evaporation of water.

29.3 Requirements

29.3.1 Eligibility requirements

General functional criteria for evaporative air coolers

Direct and Indirect evaporative air coolers shall conform to the following functional criteria:

- Incorporate one or more electrically powered fans
- Incorporate an electrically powered pump to circulate water to a water-saturated medium through which an air stream passes or to spray nozzles in an air stream.
- Minimise scale build up with optimised water bleed rates
- Maintains conditions compliant with ACoPl8 legionella code of practice and guidance.
- **Not** use air to cool a water stream.

Direct and indirect evaporative air coolers shall have an appropriate Conformity Assessment mark.

In addition to the general functional criteria above, evaporative air coolers shall also conform to specific functional criteria for either direct or indirect evaporative air coolers.

Functional criteria for direct evaporative air coolers

In order for the product to be classified as a direct evaporative air cooler, all of the following criteria shall be met:

- The product cools an air stream by moving air through a water-saturated medium which is cooled by evaporation. Moisture must be added to the air stream until it is close to the point of saturation (i.e., the wet bulb depression is close to zero).
- The product dry bulb temperature should reduce while the wet bulb temperature remains constant.

Functional criteria for indirect evaporative air coolers

The product will be classified as an indirect evaporative air cooler should any one of the following criteria be met:

- The product incorporates a secondary air stream that is cooled by means of evaporation of water.
- The product incorporates a secondary air stream that passes through a heat exchanger in order to provide further cooling to a primary air stream.
- The product incorporates a primary airstream with no change in absolute moisture content.

29.3.2 Performance requirements

Eligible indirect evaporative air coolers shall meet the following criteria:

1. Energy Efficiency Ratio (EER). The EER is the ratio of cooling capacity (kW) to electrical power input (kW).

$$EER = \frac{Cooling\ capacity\ (kW)}{electrical\ power\ input\ (kW)}$$

$$Cooling\ capacity, q = 1.21 Q_p (t_{d1} - t_{d2})$$

t_{d1} and t_{d2} are the primary air inlet and outlet dry-bulb temperatures, respectively.

Q_p is the primary standard airflow rate (m^3/s).

The total $electric\ power\ input$ is the sum of pump, air-moving device, and any other electric power input due to appurtenances required to produce cooling.

Table 29.1 EER performance threshold for indirect evaporative air coolers

Product Category	EER
Indirect	>= 7.0

">=" means "greater than or equal to"

2. Cooling Effectiveness (ε), which is the primary air dry-bulb temperature reduction divided by the primary air entering dry-bulb temperature less the entering secondary air wet-bulb temperature.

$$\varepsilon = \frac{t_{d1} - t_{d2}}{t_{d1} - t_{w3}}$$

Where, t_{w3} is the secondary air inlet wet bulb temperature.

Table 29.2 Cooling effectiveness performance threshold for indirect evaporative air coolers

Product Category	Cooling effectiveness (%)
Indirect	>= 95.0

">=" means "greater than or equal to"

3. Water consumption. For information purposes only, provide details on the amount of water consumed by the indirect evaporative cooling unit (m^3/hr).

29.4 Measurement and Calculations

29.4.1 Measurement standards

All indirect evaporative air coolers shall be tested in accordance with the procedures and test conditions laid down in:

ANSI/ASHRAE Standard 143-2015: Method of Test for Rating Indirect Evaporative Coolers.

29.4.2 Calculation Requirements

The EER and cooling effectiveness of the evaporative air cooler will be calculated when operated at an inlet psychometric condition of 35°C dry bulb temperature, and a 24°C wet bulb temperature. Furthermore, the following external resistance (system static pressure) will be applied:

- Units up to 4 m^3/s = 80 Pa resistance
- Units greater than 4 m^3/s = 120 Pa resistance

29.4.3 Rounding

For the avoidance of doubt test data should be presented to 1 decimal place. As an example, a Cooling Effectiveness of 94.9 % for an indirect unit would be deemed to be a fail.

29.5 Verification for ETL Listing

Any of the following testing routes may be used to demonstrate the conformity of products against the requirements:

- Witnessed testing
- Independent testing
- Representative testing (see clause 29.5.1)

Further information regarding the first two routes can be found in Guidance Note 5 on the ETL product testing framework[30].

29.5.1 Representative testing

Where applications are being made for a range of two or more products that are variants of the same basic design, test data may be submitted for a representative selection of models, provided that it can be demonstrated that all variants:

- Utilise the same core technology as the tested model;
- Utilise the same key components as the tested model.

The representative models must be selected by dividing the range of products into groups of models with similar design characteristics, and testing a model in the lowest quartile of predicted performance in each group. The performance of each model in the group must be predicted using a validated mathematical model. As a minimum, at least one model must be tested in each range of products.

It should be noted that:

- If a manufacturer voluntarily removes the representative model from the ETL then other products linked with that representative model may or may not be permitted to remain on the ETL.
- If any product submitted under these representative model rules is later found not to meet the performance criteria when independently tested, then all products based on the same representative model will be removed from the ETL.

29.6 Conformity testing

Products listed on the ETL may be subject to the scheme's conformity testing programme in order to ensure listed models continue to meet the ETL requirements.

[30] https://www.gov.uk/government/publications/energy-technology-list-etl-product-testing-framework

High Speed Hand Air Dryers

30 High Speed Hand Air Dryers

Date published	2014
Date first launched	2011

30.1 Scope

Hand air dryers are widely used in washrooms to dry hands after washing, as an alternative to paper or linen hand towels. They use an electric blower to produce one or more jets of air that are used to dry hands placed under, or into, the hand air dryer unit. Some models heat the air jets prior to use with electrical heating elements or by passing it over the electric motor that drives the blower.

Hand air dryers are available with a wide range of efficiencies. The Energy Technology List (ETL) Scheme aims to encourage the purchase of high speed hand air dryer products with the highest efficiency.

To be eligible for inclusion on the ETL, products shall meet the requirements as set out below.

30.2 Definitions

High speed hand air dryers are products that are specifically designed to dry human hands by moving air past the hands in a manner that removes water from the hands by physical displacement and/or evaporation.

30.3 Requirements

30.3.1 Eligibility requirements

To be eligible, products must:

- Incorporate an electrically driven blower that produces one or more jets of high speed air that can be used to dry human hands that are placed beneath, or into, the product.
- Automatically switch off power to the blower and air heater (where fitted) when hands are removed from the product's drying zone.
- **Not** incorporate facilities to wash or apply soap to hands, or to dispense towels.
- Have an appropriate Conformity Assessment mark.

30.3.2 Performance requirements

Eligible products must:

- Use not more than (<=) 5.5kWh of electricity per 1,000 standard drying cycles in its normal mode of operation.
- Have a standard drying time that is less than, or equal to, 15 (+/- 0.5) seconds

For the avoidance of doubt, test data should be presented to one decimal place. As an example, a product that uses 5.6kWh per 1,000 standard drying cycles would be deemed to be a fail.

30.4 Measurement and Calculations

30.4.1 Measurement standards

The product's standard drying time and electricity consumed per standard drying cycle must be determined in accordance with the method and test conditions set out in:

- ETL Method for Testing of High Speed Hand Dryers[31].

30.5 Verification for ETL Listing

Any of the following testing routes may be used to demonstrate the conformity of products against the requirements:

- In-house testing – Self-certified
- In-house testing – Self-tested and verified or cross-checked by an independent body
- Witnessed testing
- Independent testing

Further information regarding the routes can be found in Guidance Note 5 on the ETL product testing framework[32].

30.6 Conformity testing

Products listed on the ETL may be subject to the scheme's conformity testing programme in order to ensure listed models continue to meet the ETL requirements.

[31] https://www.gov.uk/government/publications/energy-technology-list-etl-method-for-the-testing-of-high-speed-hand-air-dryers

[32] https://www.gov.uk/government/publications/energy-technology-list-etl-product-testing-framework

Lighting equipment

31 Efficient White Lighting Units

Date published	2018
Date first launched	2001
Former name	White Light Emitting Diode Lighting Units High Efficiency Lighting Units

31.1 Scope

Efficient White Lighting Units are a combination of a light fitting (or luminaire), one or more light sources, and associated control gear that have been assembled either into a single packaged unit or a luminaire with remote control gear. Neither light fitting, light sources nor control gear alone can be said to 'comply with the ETL'. Efficient White Lighting Units may also incorporate lighting control devices such as dimming and 'presence' controls. The luminaire could also include an optical system that reflects and/or focuses the product's light output onto the item(s) being illuminated. An Efficient White Lighting Unit may be equipped with any high efficiency light source, such that it meets the eligibility criteria set down in this document.

Efficient White Lighting Units have been included on the Energy Technology List (ETL) because they offer substantial energy and carbon savings. A wide variety of products are available with a range of performance levels. The ETL scheme aims to encourage the purchase of higher efficiency products that meet certain minimum quality, design and performance standards.

The ETL Scheme covers four categories of products:

1. Amenity, accent and display lighting units
2. General interior lighting units
3. Exterior area lighting units
4. Exterior floodlighting units

Where:

- **Amenity lighting** is decorative lighting intended to enhance the appearance of a building or outdoor area in order to promote the activities of a business. It can include 'mood' lighting of hotels, bars and restaurants and other leisure activities; and decorative lighting for public areas of buildings and parts of buildings or the surrounding grounds (where such lighting is necessary to the enhancement of the business function). It does not include lighting to provide general illumination or circulation, or building lighting that would be present regardless of the type of business being carried out.
- **Display lighting** comprises lighting intended to highlight displays of exhibits, merchandise and other associated uses. It includes for instance spot or projector lighting in shops, theatres, galleries and studios.
- **Accent lighting** comprises lighting that is intended to provide additional light over a specific small area in order to carry out or promote the activities of a business. This may include lighting required for a particular task (e.g. medical or dental examination, supplementary lighting for fine machining work or critical inspection work). It does not cover general lighting for an entire room or a large part of a room.

- **General interior lighting** covers all other interior lighting.
- **Exterior area lighting** covers all exterior lighting which is intended to provide downward light onto horizontal or near horizontal surfaces, including roadways, car parks, paths, stairs, ramps, gardens and other open spaces. This includes illuminated bollards and post-top lanterns.
- **Exterior floodlighting** covers exterior lighting that is intended to light vertical or near vertical surfaces, including floodlighting of buildings, monuments and statues.

Eligible Efficient White Lighting Units shall comply with the requirements as set out below. The individual products do not need to be named on the ETL.

31.2 Definitions

Efficient White Lighting Units are products that are specifically designed to provide efficient, high quality, illumination. These criteria shall only apply to the complete lighting unit.

31.3 Requirements

31.3.1 Eligibility requirements

To be eligible, products shall:

- Include one or more light sources, a luminaire and associated control gear.
- Not be luminaires designed to incorporate or be supplied with light sources that retrofit to existing light fittings.
- Not be exclusively for emergency lighting. However combined emergency/general lighting is acceptable[33].

In addition:

- The luminaire, lamps and control gear shall have an appropriate Conformity Assessment mark.
- Where products incorporate fluorescent or compact fluorescent lamps, they shall be controlled by non-dimmable 'warm start' or 'dimmable' (regulating) type, high frequency (HF) electronic control gear.
- Where products incorporate compact fluorescent lamps, they shall be of the non-integral type (i.e. those types that do not incorporate the control gear in the lamp cap).
- Where products incorporate high intensity discharge lamps rated below 200W, they shall use electronic control gear.
- Where products incorporate LEDs, they shall use electronic control gear, and be capable of producing white light. White light is defined in Annex 2, paragraph 3b of EC Regulation 245/2009 “Implementing Directive 2005/32/EC of the European Parliament and of the Council with regard to Ecodesign requirements for fluorescent lamps without integrated ballast,

[33] A luminaire containing two or more light sources, at least one of which is energised from the emergency supply and the remainder from the normal supply.

for high intensity discharge lamps, and for ballasts and luminaires able to operate such lamps”

- Only include components that are compliant with the Ecodesign requirements and energy labelling regulations in force, where applicable. At the finalisation of this ETL criteria, the relevant regulations were:
  - Commission Regulation (EU) No 1194/2012 of 12 December 2012 under the Directive 2009/125/EC of the European Parliament and of the Council with regard to Ecodesign requirements for directional lamps, light emitting diode lamps and related equipment.
  - Commission Regulation (EC) No 244/2009 of 18 March 2009 implementing Directive 2005/32/EC of the European Parliament and of the Council with regard to Ecodesign requirements for non-directional household lamps
  - Commission Regulation (EC) No 245/2009 of 18 March 2009 implementing Directive 2005/32/EC of the European Parliament and of the Council with regard to Ecodesign requirements for fluorescent lamps without integrated ballast, for high intensity discharge lamps, and for ballasts and luminaires able to operate such lamps, and repealing Directive 2000/55/EC of the European Parliament and of the Council
  - Commission Delegated Regulation (EU) No 874/2012 of 12 July 2012 supplementing Directive 2010/30/EU of the European Parliament and of the Council with regard to energy labelling of electrical lamps and luminaires

In addition, lamps and control gear shall comply with the following performance standards (where relevant):

- Compact fluorescent lamps shall comply with BS EN 60901:1996 +A5:2012, “Specification for single-capped fluorescent lamps. Performance specifications”.
- Linear fluorescent lamps shall comply with BS EN 60081:1998+A5:2013, “Double-capped fluorescent lamps. Performance specifications”.
- "Warm start" high-frequency control gear (where fitted) for fluorescent lamps shall comply with BS EN 60929:2011+A1:2016, “A.C. supplied electronic ballasts for tubular fluorescent lamps. Performance requirements”.
- BS EN 61347-2-13:2014, “Lamp control gear. Particular requirements for d.c. or a.c. supplied electronic control gear for LED modules”.
- BS EN 62384:2006+A1:2009, “D.C. or A.C. supplied electronic control for LED modules. Performance requirements”.
- BS EN 62717:2017, “LED modules for general lighting. Performance requirements”
- BS EN 61167:2016, “Metal halide lamps. Performance specification”
- BS EN 62639:2012, “Fluorescent induction lamps. Performance specification”
- BS EN 60923:2005, “Auxiliaries for lamps. Ballasts for discharge lamps (excluding tubular fluorescent lamps). Performance requirements”.
- BS EN 60598-2-22:2014: Luminaires. Particular requirements. Luminaires for emergency lighting

31.3.2 Performance requirements

Eligible efficient white lighting units shall:

- Have a luminaire efficacy (i.e. lighting efficiency) that is greater than, or equal to, the thresholds set out in Table 31.1 below, when tested after 100 hours of continuous operation.
- Have a power factor that is greater than, or equal to, 0.9 at its highest light output level.
- Be able to provide a light output (in lumens) after 6000 hours of continuous operation that is not less than 90% of their initial light output (in lumens).

In addition:

- General lighting units installed indoors shall comply with the glare and angular exclusion zone recommendations in paragraph 94 of HSG 38 (1997), “Lighting at work” (ISBN: 9780717612321).
- With the exception of combined emergency lighting, individual control gear shall have a standby power not exceeding 0.5 Watts when the lighting unit incorporates an electronically addressed dimming or switching circuit. If the product is not fitted with an automatic switching or dimming circuit, the product shall not consume power when it is switched off.
- White LED, Fluorescent and compact fluorescent lamps in all categories, and all light sources used in amenity, accent and display lighting fittings shall have a colour rendering index that is at least Ra 80. All other light sources shall have a colour rendering index of at least Ra 40.
- If the product incorporates dimming control it shall be tested at its highest light output level.
- Amenity, accent and display lighting units to be installed indoors shall have a minimum light output of at least 100 lumens after 100 hours of continuous operation. All other fittings shall have a minimum light output of at least 200 lumens after 100 hours of continuous operation.

Table 31.1 Minimum luminaire efficacies for efficient white lighting units

Category	Minimum luminaire efficacy (in luminaire lumens per circuit watt)
Amenity, accent and display lighting units	≥ 95
General interior lighting, using downlighting units (DLOR/LOR>=0.9)	≥ 105
General interior lighting using uplighting units (DLOR/LOR<0.1)	≥ 125
General interior lighting using combined up and down lighting units (DLOR/LOR>=0.1 and <0.9)	≥ 125– (20 x DLOR/LOR)
Exterior area lighting units	≥ 105
Exterior floodlighting units	≥ 105

Where:

- “≥” means "greater than or equal to".
- Downward Light Output Ratio (DLOR) is the ratio of the light emitted by the unit in a downward direction to that emitted by the bare lamp(s) in any direction.
- Light Output Ratio (LOR) is the ratio of the total light emitted by the unit to that emitted by the bare lamp(s).
- Luminaire efficacy is defined in terms of lumens of light output emitted by the luminaire per circuit watt of electrical power consumed.
- The electrical power consumed (in circuit watts) is defined as the total power consumed by the whole lighting unit from main circuit connection point to the light source, including losses in the control gear (ballast or driver).
- The product shall perform at the minimum required efficacy at each drive current for which the product is designed to operate, when tested after 100 hours of continuous operation. If the product incorporates dimming control it shall be tested at its highest light output level.
- For amenity, accent and display lighting units, general interior lighting, and exterior floodlighting units, light output is defined as the total light output in all directions (TLO), which is the sum of:

a) Light output in a downward direction (DLO) i.e. below the horizontal as installed, and
b) Light output in an upward direction (ULO) i.e. above the horizontal as installed.

Note: In luminaires containing replaceable lamps the TLO may also be expressed as the result of the following calculation:

Initial (100 hour) lamp lumen output x LOR

- For exterior area lighting units **only**, light output is defined as total light output in a downward direction (DLO) only i.e. below the horizontal as installed (i.e. light output in an upward direction is not included in the calculation of product light output or luminaire efficacy). Note: As above the DLO may also be expressed by the calculation:

Initial (100 hour) lamp lumen output x DLOR

31.4 Measurement and Calculations

31.4.1 Test Requirements

All products shall be tested in accordance with the procedures laid down in one of the following:

- BS EN 13032-1:2004 +A1:2012, "Light and lighting. Measurement and presentation of photometric data of lamps and luminaires. Measurement and file format".
- IESNA LM-79-08, "Electrical and Photometric Measurements of Solid-State Lighting Products".
- BS EN 62722-2-1:2016, "Luminaire performance Part 2-1: Particular requirements for LED luminaires".

If a white LED based product is sold solely[34] for use in refrigerators or freezers with a declared application temperature of 5ºC or below, its efficacy and luminous flux may be measured at a temperature of between 0º and 5ºC on its external casing.

31.4.2 Rounding

For the avoidance of doubt, test data should be presented to zero decimal places by rounding down. As an example, an efficacy of 94.9 luminaire lumens per circuit Watt for a display lighting unit would be expressed as 94llm/W and deemed to be a fail.

31.5 Verification for ETL Listing

This sub-technology is "unlisted" therefore individual products do not need to be listed on the Energy Technology Product List.

31.6 Conformity testing

Products listed on the ETL may be subject to the scheme's conformity testing programme in order to ensure listed models continue to meet the ETL requirements.

[34] If luminaires are used in other applications, this is not required.

32 Lighting Controls

Date published	2016
Date first launched	2001

32.1 Scope

Lighting controls manage electric lighting levels within specific areas, as and when required to match changes in daylight or occupancy, or individual activities.

A wide variety of lighting control products are available, and these range from simple manual switches to fully automatic control systems that adjust electric lighting levels to reflect planned operating hours, activities, occupation levels and the availability of daylight in specific areas.

The Energy Technology List (ETL) scheme aims to encourage the purchase of lighting controls that realise energy savings by automatically switching or dimming lighting in these ways.

Five different categories of lighting controls are covered by the ETL scheme:

1. Time controllers that automatically switch off lighting, or dim it down, at predetermined times.
2. Presence detectors with associated controllers that monitor occupancy or movement of personnel, and automatically switch off lighting, or dim it down, when the area is unoccupied.
3. Daylight detectors with associated switching controllers that monitor daylight availability, and automatically switch off lighting when daylight is sufficient to illuminate the area.
4. Daylight detectors with associated dimming controllers that monitor daylight availability, and automatically dim lighting, by reducing its power consumption, to the level needed to sufficiently illuminate the area.
5. Central area and network control units that provide the facility to manage the overall operation of electric lighting installations that include some or all of the categories of lighting controls above.

The above categories of controls may be installed either individually, or in combination.

Eligible lighting controls shall comply with the requirements as set out below. The individual products do not need to be named on the ETL.

32.2 Definitions

Lighting controls are products that are specifically designed to switch electric lighting on or off, and/or to dim its output.

32.3 Requirements

32.3.1 Eligibility requirements

To be eligible, products must:

- Incorporate one or more of the categories of lighting controls set out in Table 32.1, Table 32.2, Table 32.3, Table 32.4 and Table 32.5 below, and comply with the specific eligibility criteria in the relevant table(s).

- Have an appropriate Conformity Assessment mark.

Products may also incorporate the facility that permits the automatic switching of lights to be temporarily overridden on a central basis for maintenance or security purposes, or to ensure the safety of occupants during particular events or activities.

Table 32.1 Time Controllers

SECTION 1A –ELIGIBILITY CRITERIA

To be eligible under this category of Lighting Controls:

- The product must automatically switch the lighting off, or dim it down, at predetermined times of the day or week, or after a predefined interval.

Where automatic dimming controls are used, they must be capable of reducing the power consumption of the controlled lamps by at least 75%.

Where fluorescent lighting is being dimmed, it must incorporate high frequency dimmable ballast and electronic control gear. Other forms of lighting may incorporate either mains frequency or high frequency dimmable ballasts and associated controls.

SECTION 1B –Notes

1. The product may also be set to automatically switch on the lighting at predetermined times.
2. Products may incorporate the facility for local users to manually switch on and off lighting in a local area and thus to override the predetermined lighting levels at that particular time. However products that allow local users to locally override subsequent predetermined times for the lighting to be automatically switched off, or dimmed down, are not eligible.
3. If the product used is designed to control any form of heating, ventilation or air conditioning (HVAC) equipment, then it must be listed under the HVAC Zone Controls part of the ETL.

Table 32.2 Presence detectors with associated controllers

SECTION 2A –ELIGIBILITY CRITERIA

To be eligible under this category of Lighting Controls:

- The product must automatically switch off the lighting, or dim it down, after the area has become unoccupied.

Where automatic dimming controls are used, they must be capable of reducing the power consumption of the controlled lamps by at least 75 %.

Where fluorescent lighting is being dimmed, it must incorporate high frequency dimmable ballast and electronic control gear. Other forms of lighting may incorporate either mains frequency or high frequency dimmable ballasts and associated controls.

SECTION 2B –Notes

1. The product may also automatically switch on the lighting when the space becomes occupied. Alternatively local users may manually switch on the lighting at the start of occupancy.
2. Products may incorporate the facility for local users to manually override the presence detector/controller and to switch the lighting off at any particular instance. However products that allow local users to override the ability of the presence detector/controller to automatically switch off, or dim the lighting, are not eligible.
3. Products must not consume more than 0.5 Watts in parasitic power, when the associated lights are turned off.

Table 32.3 Daylight detectors with associated switching controllers

SECTION 3A –ELIGIBILITY CRITERIA

To be eligible under this category of Lighting Controls:

- The product must monitor the availability of daylight and automatically switch the lighting off when sufficient daylight is available to illuminate the area.

SECTION 3B –Notes

1. The product may also automatically switch on the lighting when daylight has fallen below the required level. Alternatively local users could be allowed to switch on the lighting manually, when daylight has fallen below the required level.
2. Products may incorporate the facility for local users to manually override daylight detector/controller and switch the lights off at any particular instance. However products that allow local users to override the ability of the daylight detector/controller to automatically switch off the lighting are not eligible.
3. Products must not consume more than 0.5 Watts in parasitic power, when the associated lights are turned off.

Table 32.4 Daylight detectors with associated dimming controllers

SECTION 4A –ELIGIBILITY CRITERIA

To be eligible under this category of Lighting Controls:

- The product must monitor the availability of daylight and automatically dim the electric lighting to the level just needed to sufficiently illuminate the area, and switch it off when there is enough daylight.
- The product must be able to reduce the power consumption of the lamps being controlled by at least 75% through dimming.

Where fluorescent lighting is being dimmed, it must incorporate high frequency dimmable ballasts and electronic control gear. Other forms of lighting may incorporate either mains frequency or high frequency dimmable ballasts and associated controls.

SECTION 4B –Notes

1. The product may also automatically switch on the lighting when daylight has fallen below the required level. Alternatively local users could be required to switch on the lighting manually, as and when needed.
2. Products may incorporate the facility for local users to manually override the dimming controller at any particular instance and to set the lighting to a lower level than it would be under automatic control, or switch it off. However products that allow local users to override the ability of the daylight detector/controller to automatically dim the lighting are not eligible.
3. Products must not consume more than 0.5 Watts in parasitic power, when the associated lights are turned off.

Table 32.5 Central area and network control units (lighting control systems)

SECTION 5A –ELIGIBILITY CRITERIA
To be eligible under this category of Lighting Controls: ■ The product must be able to manage the overall operation of the electric lighting installation that includes some or all of the categories of lighting controls set out in Table 32.1 to Table 32.4 above.
SECTION 5B –Notes
1. The product may make use of pre-programmed “scenes” that configure the lighting levels in different areas for a particular activity or daylight level or occupancy status in the most energy efficient manner. However products that are only capable of manual scene setting are not eligible. 2. Products may also incorporate the facility to monitor lighting energy consumption. 3. If the product is designed to control any form of heating, ventilation or air conditioning (HVAC) equipment then, it must be listed under the HVAC Zone Controls part of the ETL.

32.4 Verification for ETL Listing

This sub-technology is “unlisted” therefore individual products do not need to be listed on the Energy Technology Product List.

32.5 Conformity testing

Products listed on the ETL may be subject to the scheme’s conformity testing programme in order to ensure listed models continue to meet the ETL requirements.

33 White LED Lighting Modules for Backlit Illuminated Signs

Date published	2018
Date first launched	2018

33.1 Scope

The internally illuminated box signage and built up letters that, for example, spell out company names, logos or other messages and pictures, have been included in the Energy Technology List (ETL) scheme because they offer substantial energy and carbon savings, considering their usual long hours of operation. These products are designed to provide a more efficient solution to back-lit Illuminated signs, which have traditionally been using fluorescent batten fixtures or cold cathode systems.

These products are a form of Display Lighting, i.e. lighting used to highlight displays of exhibits, signs associated with the business function, merchandise, and display case lighting used predominantly in the services and the retail industries either indoors (e.g. shop vitrines) or outdoors (e.g. hotels and restaurant facades).

The ETL criteria are only applicable for situations where the white LED lighting modules are integrated with the electronic control gear. Neither the individual white LED lighting module or electronic control gear alone can be said to ‘comply with the ETL’.

The internally illuminated signs with white LEDs may also incorporate lighting control devices such as dimming and presence controls.

To be eligible for inclusion on the ETL products shall meet the requirements as set out below.

33.2 Definitions

White light emitting diode (LED) lighting modules for backlit illuminated signs are products which provide white light by means of solid state lighting to illuminate signage.

The technology is used to internally illuminated box signs and built up letters using white LEDs and modules, in combination with appropriate control gear, in both internal and external applications.

33.3 Requirements

33.3.1 Eligibility requirements

To be eligible, white LED lighting modules for backlit illuminated signs shall:

- Be used exclusively to back light illuminated signage;
- Not be used as road traffic signs, safety signs or fire safety signs, trackside railway signs or airside airport signs.
- Include one or more LEDs, driven by suitable electronic control gear;
- **Not** be designed to incorporate or be supplied with LED based ‘lamps’ that retrofit to traditional light sources;
- Include only appropriately Conformity Assessment marked components;
- Be capable of producing white light. White light is defined in Annex 2, paragraph 3b of EC Regulation 245/2009 “Implementing Directive 2005/32/EC of the European Parliament and of the Council with regard to Ecodesign requirements for fluorescent lamps without integrated ballast, for high intensity discharge lamps, and for ballasts and luminaires able to operate such lamps”;
- Only include components that are compliant with the Ecodesign requirements and energy labelling regulations in force, where applicable. At the finalisation of this ETL criteria, the relevant regulations were:
  - Commission Regulation (EU) No 1194/2012 of 12 December 2012 under the Directive 2009/125/EC of the European Parliament and of the Council with regard to Ecodesign requirements for directional lamps, light emitting diode lamps and related equipment.
  - Commission Delegated Regulation (EU) No 874/2012 of 12 July 2012 supplementing Directive 2010/30/EU of the European Parliament and of the Council with regard to energy labelling of electrical lamps and luminaires

In addition, lamps and control gear shall comply with the following British standards:

- BS EN 50107-3. Product standard covering luminous signs with discharge lamps and/or LED (light emitting diodes) and/or EL (electroluminescent)

light sources with a nominal voltage not exceeding 1000 V, with the exclusion of general lighting, traffic- or emergency purposes

- BS EN 61347-2-13:2014, “Lamp control gear. Particular requirements for d.c. or a.c. supplied electronic control gear for LED modules”.

33.3.2 Performance requirements

Eligible white LED lighting modules for backlit illuminated signs shall:

- Have a lighting efficacy that is greater than, or equal to, 93 lumens per circuit watt[35], when tested after 100 hours of continuous operation. If the product incorporates dimming control it shall be tested at its highest light output level.
- Have a power factor that is greater than, or equal to, 0.9 at ≥75% of designed driver load at highest light output level.
- Be able to provide a light output (in lumens) after 6000 hours of continuous operation that is not less than 90% of their initial light output (in lumens).

In addition:

- The electrical power consumed (in circuit watts) is defined as the total power consumed by the whole unit from main circuit connection point to the LED light source, including losses in the control gear.
- Individual control gear shall have a standby power not exceeding 0.5 Watts when the lighting unit incorporates an electronically addressed dimming or switching circuit. If the product is not fitted with an automatic switching or dimming circuit, the product shall not consume power when it is switched off.

33.4 Measurement and Calculations

33.4.1 Measurement standards

All products shall be tested in accordance with the procedures laid down in one of the following standards:

- BS EN 13032-1:2004 +A1:2012, “Light and lighting. Measurement and presentation of photometric data of lamps and luminaires. Measurement and file format”.
- IESNA LM-79-08, “Electrical and Photometric Measurements of Solid-State Lighting Products”.
- BS EN 62722-2-1:2016, “Luminaire performance Part 2-1: Particular requirements for LED luminaires”.

33.4.2 Rounding

For the avoidance of doubt test data should be presented to zero decimal places by rounding down. As an example, an efficacy of 99.9 lumens per circuit Watt for backlit illuminated signs would be expressed as 99 lm/W and deemed to be a fail.

[35] Lumens of light output emitted by the module per circuit watt of electrical power consumed.

33.5 Verification for ETL Listing

Any of the following testing routes may be used to demonstrate the conformity of products against the requirements:

- Independent testing
- Representative testing (see clause 33.5.1)

Further information regarding the first route can be found in Guidance Note 5 on the ETL product testing framework[36].

33.5.1 Representative testing

Where applications are being made for a range of two or more products that are variants of the same basic design, test data may be submitted for a representative selection of models, provided that all variants conform to the following condition:

1. Parameters such as size, shape, power rating and constructional design do not reduce product energy efficiency performance or basic functionality.

The representative models shall be selected by dividing the range of products into groups of models with similar design characteristics, and testing a model in the lowest quartile of predicted performance in each group. The performance of each model in the group shall be predicted using a validated mathematical model.

It should be noted that:

- If a manufacturer voluntarily removes the representative model from the ETL then other products linked with that representative model may or may not be permitted to remain on the ETL.
- If any product submitted under these representative model rules is later found not to meet the performance criteria when independently tested, then all products based on the same representative model will be removed from the ETL.

33.6 Conformity testing

Products listed on the ETL may be subject to the scheme's conformity testing programme in order to ensure listed models continue to meet the ETL requirements.

[36] https://www.gov.uk/government/publications/energy-technology-list-etl-product-testing-framework

Motors and Drives

34 Converter-Fed Motors

Date published	2020
Date first launched	2010
Former name	Permanent Magnet Synchronous Motors

34.1 Scope

Converter-fed motors are applied throughout industry and commerce in a wide range of 'general purpose' and specialist applications.

A converter-fed motor is designed to be operated from a non-sinusoidal multi-phase electrical power supply and may comprise permanent magnet, synchronous reluctance or other design.

A converter-fed motor drive is a combination of a motor and an electronic variable speed drive (VSD). The VSD can either be physically mounted on the motor to form a single factory assembled, integrated unit, or the VSD and motor can be supplied as a package of two units that are designed to be connected together during installation.

Converter-fed motors are available in a wide range of designs and efficiencies. The Energy Technology List (ETL) aims to support the purchase of higher efficiency products with rated power outputs ranging between 0.12 kW and 1,000 kW.

The ETL covers three categories of converter-fed motors:

1. Converter-fed ac motors (sold without VSD).
2. Integrated converter-fed motor drive units.
3. Matched converter-fed motor drive packages.

Integrated converter-fed motor drive units include electrically commutated motors which comprise a brushless dc multi-phase motor and an integral electronic control device. The ac power supply is commutated to dc by the control device and the power output is used to rotate the motor.

To be eligible for inclusion on the ETL, products shall meet the requirements as set out below.

34.2 Definitions

Converter-fed motors are products that are specifically designed to convert electrical power into mechanical power, and to rotate a drive shaft at a speed that is directly related to the non- sinusoidal multi-phase electrical power supplied to the motor.

Converter-fed ac motor drives consist of a motor, and a matched, electronic, VSD that is specifically designed to provide the multi-phase electrical power input needed to operate the motor, and to vary its speed in a controlled manner in response to an external signal.

34.3 Requirements

34.3.1 Eligibility requirements

Eligible products shall:

- Be designed to include or operate with an electronic VSD
- Incorporate a converter-fed motor that:

a) Has a rated operating voltage between 200 and 700 Volts

b) Has an appropriate Conformity Assessment mark.

- **Not** incorporate any type of mechanical apparatus that derives its motive force from the product's motor, except for fans or pumps incorporated solely for the purpose of product cooling or lubrication, integrated torque couplings, and position encoding mechanisms.
- **Not** include a mechanically commutated dc motor

Category 1 (converter-fed ac motor) products shall be designed to operate with an electronic VSD providing a non-sinusoidal multi-phase ac electrical power supply to the motor.

Category 2 and 3 (converter-fed motor drive unit and package) products shall be configured for direct connection to the UK public electricity supply system, or a private alternating current supply of nominally fixed frequency and voltage. The electronic VSD should provide a non-sinusoidal multi-phase electrical power supply to the motor.

In addition, for all products (except for electronically commutated motors) that include an electronic VSD, the VSD shall also comply with the separate ETL criteria for Variable Speed Drives.

34.3.2 Performance requirements

Products shall have an efficiency at 100% of their maximum continuous speed rating that is greater than or equal to the values shown in Table 34.1 below, which vary with power rating and maximum continuous speed rating. If the product's specific power rating is not shown in Table 34.1, then the performance threshold for the next highest power rating should be used to determine eligibility.

Table 34.1 Performance thresholds for converter-fed motors and motor drive units

Rated Power of motor, P_N (kW)	Efficiency at full load of motor and VSD combined (%)			
	2 Pole	4 Pole	6 Pole	8 Pole
0.12	>= 60.8	>= 64.8	>= 57.7	>= 50.7
0.18	>= 65.9	>= 69.9	>= 63.9	>= 58.7
0.2	>= 67.2	>= 71.1	>= 65.4	>= 60.6
0.25	>= 69.7	>= 73.5	>= 68.6	>= 64.1
0.37	>= 73.8	>= 77.3	>= 73.5	>= 69.3
0.40	>= 74.6	>= 78.0	>= 74.4	>= 70.1
0.55	>= 77.8	>= 80.8	>= 77.2	>= 73.0
0.75	>=75.0	>= 78.9	>= 82.5	>= 80.7
1.1	>=77.7	>= 81.0	>= 84.1	>= 82.7
1.5	>=79.7	>= 82.5	>= 85.3	>= 84.2
2.2	>=81.9	>= 84.3	>= 86.7	>= 85.9
3.0	>=83.5	>= 85.6	>= 87.7	>= 87.1
4.0	>=84.8	>= 86.8	>= 88.6	>= 88.1
5.5	>=86.2	>= 88.0	>= 89.6	>= 89.2
7.5	>=87.7	>=90.0	>=91.5	>=90.5
11.0	>=89.0	>=91.1	>=92.3	>=91.5
15.0	>=89.9	>=91.8	>=93.0	>=92.3
18.5	>=90.5	>=92.4	>=93.3	>=92.8
22.0	>=90.9	>=92.8	>=93.7	>=93.1
30.0	>=91.6	>=93.3	>=94.1	>=93.7
37.0	>=92.1	>=93.7	>=94.5	>=94.0
45.0	>=92.4	>=94.0	>=94.7	>=94.3
55.0	>=92.8	>=94.4	>=95.1	>=94.6
75.0	>=93.3	>=94.7	>=95.4	>=94.9
90.0	>=93.6	>=94.9	>=95.5	>=95.2
110.0	>=93.9	>=95.2	>=95.7	>=95.4
132.0	>=94.1	>=95.4	>=95.9	>=95.6
160.0	>=94.4	>=95.6	>=96.1	>=95.7
200	>=94.7	>=95.7	>=96.2	>=96.0
250	>=94.7	>=96.0	>=96.2	>=96.0
315 up to 1,000	>=94.7	>=96.0	>=96.2	>=96.0

">=" means "greater than or equal to"

"<=" means "less than or equal to"

Where the rated power (P_N) is that of the motor, for 'Duty type S1 – Continuous running duty' as defined in Section 4.2.1 of BS EN 60034-1: 2010 "Rotating

electrical machines – Part 1: Rating and performance", and is determined with the product operating at 100 % of its maximum continuous speed rating.

The efficiency at full load refers to the overall efficiency of the motor and VSD combined.

34.4 Measurement and Calculations

34.4.1 Measurement Standards and Test Requirements

Product efficiency at 100% of maximum continuous speed rating shall be determined using either option a) or b) below:

a) Type tests according clause 7.3 of BS EN 61800-9-2:2017 "Adjustable speed electrical power drive systems. Ecodesign for power drive systems, motor starters, power electronics and their driven applications. Energy efficiency indicators for power drive systems and motor starters."

   Note: until further notice, results of tests according to BS EN 50598-2:2014+A1:2016 will also be accepted

b) Method 2-1-2A according to Table 4 in Section 7 of BS EN 60034-2-1:2014 "Rotating electrical machines – Part 2-1: Standard methods for determining losses and efficiency from tests (excluding machines for traction vehicles)". Where the input power P 1, shall be measured at the main input terminals to the electronic VSD.

Until further notice, products listed before September 2020 will be accepted with testing performed according to BS EN 60034-2-1:2007.

Products shall be operated from a standard 230, 400 or 690 Volt ac, 50Hz electrical power supply during testing, and any filters that are required by the product in order to comply with The Electromagnetic Compatibility Regulations 2016 shall be fitted.

Where the product does not include a VSD, it may be tested using any appropriately matched VSD. If a single product is submitted for assessment, one detailed test report should be submitted.

For a product range, test results may be submitted in summary form provided:

- Sufficient data is included to confirm that product performance was determined in accordance with the procedures and test conditions laid down in the relevant standards.

34.4.2 Rounding

For the avoidance of doubt test data should be presented to 1 decimal place. As an example, a 4 pole, converter-fed motor with rated power output of 45.0kW and an efficiency at full load of 95.3% would be deemed to be a fail.

34.5 Verification for ETL Listing

Any of the following testing routes may be used to demonstrate the conformity of products against the requirements:

- In-house testing – Self-certified

- In-house testing – Self-tested and verified or cross-checked by an independent body
- Witnessed testing
- Independent testing
- Representative testing (see clause 34.5.1)

Further information regarding the first four routes can be found in Guidance Note 5 on the ETL product testing framework[37].

34.5.1 Representative testing

Where applications are being made for two or more products that are variants of the same basic design, test data may be submitted for a representative selection of models, provided that:

- All variants are of the same product range as the representative models and the primary variations between models are rated power and physical dimensions.
- All variants are constructed from the same materials.
- At least one detailed representative test report is provided for each product range.
- Clear descriptions of the formulae or mathematical model used for calculating performance of the variants, and details of measurements taken to verify this model are provided. Tests undertaken to verify the accuracy of the model shall be carried out in accordance with the test procedures described above.

It should be noted that:

- The efficiency value stated on the ETL for tested products should be taken from the test data provided, and not from the calculated or modelled values.
- If a manufacturer voluntarily removes the representative model from the ETL then other products linked with that representative model may or may not be permitted to remain on the ETL.
- If any product submitted under these representative model rules is later found not to meet the performance criteria when independently tested, then all products based on the same representative model will be removed from the ETL.

34.6 Conformity testing

Products listed on the ETL may be subject to the scheme's conformity testing programme in order to ensure listed models continue to meet the ETL requirements.

[37] https://www.gov.uk/government/publications/energy-technology-list-etl-product-testing-framework

34.7 Review

34.7.1 Indicative review date

The next technical review is scheduled for 2023-24.

34.7.2 Illustrative future direction of the requirements

Future changes to the specification may include:

A revision of the converter losses allowed for in the efficiency thresholds, to align with the findings from the Global Round Robin test programme for converter losses, which will inform IEC 61800-9-2. This is being performed from 2017-2021 by the EMSA and IEC SC 22G WG18.

35 Line Operated AC Motors

Date published	2020
Date first launched	2001
Former name	Single Speed AC Induction Motors

35.1 Scope

Line operated AC motors are used to drive plant and machinery throughout industry and commerce, and a wide range of 'general purpose' products are available in internationally agreed, standard designs with different rated power outputs, frame sizes, fixed operating speeds, and energy efficiency ratings.

The Energy Technology List (ETL) aims to encourage the purchase of higher efficiency three-phase line operated AC motors ranging between 0.12 kW and 1,000 kW, and single phase line operated AC motors ranging from 0.12 kW upwards.

To be eligible for inclusion on the ETL, products shall meet the requirements as set out below.

35.2 Definitions

Line operated ac motors covers products that are specifically designed to convert standard single and three phase electrical power into mechanical power, and to rotate a drive shaft at a fixed speed that is directly related to the frequency of the electrical power supply.

- Single-phase motors: rotating electrical machines driven by a single phase alternating current, in which all the supplied voltage changes simultaneously.
- Three-phase motors: rotating electrical machine driven by three single-phase alternating currents of equal frequency and amplitude, with a 120-degree phase difference.
- Ex-eb increased safety motors: motors providing a higher level of protection required under The Equipment and Protective Systems Intended for use in Potentially Explosive Atmospheres Regulations 2016. These motors ensure reliable prevention of abnormally high temperatures, sparks or electrical arcs, of the motor's electrical equipment.

35.3 Requirements

35.3.1 Eligibility requirements

To be eligible both single and three-phase motors shall:

- Be a totally enclosed AC motor that has:

a) A maximum rated operating voltage above 50 V up to 1,000 V
b) 2, 4, 6 or 8 poles.
c) A built-in method of cooling that is classified according to BS EN 60034-6:1994, “Rotating electrical machines. Methods of cooling (IC Code) as:
- IC 410: (frame surface cooled – free convection),
- IC 411: (frame surface cooled – self circulation)
- IC 418: (frame surface cooled circulation by relative displacement.)
d) Dimensions and a power rating that conform with the requirements of IEC 60072-1: 1991-02 (sixth edition), “Dimensions and output series for rotating electrical machines – Part 1: Frame numbers 56 to 400 and flange numbers 55 to 1080”.

- Be capable of direct connection to the UK public electricity supply system, or a private alternating current supply of nominally fixed frequency and voltage
- Be rated at 50 Hz in accordance BS EN 60034-1:2010 (or IEC 60034-1: 2010) “Rotating electrical machines - Part 1: Rating and performance”.
- Have a ‘Duty type S1 – Continuous running duty’ rated power output that is greater than or equal to 0.12 kW and, in the case of three-phase line operated AC motors, less than or equal to 1000 kW as defined in Section 4.2.1 of BS EN 60034-1: 2010.
- Have an appropriate Conformity Assessment mark.

35.3.2 Performance requirements

35.3.2.1 Tier 1 – From September 2020

Products shall have an efficiency when tested in accordance with BS EN 60034-2-1: 2014 at full load (i.e. 100% of their maximum continuous rated power output) that is greater than or equal to the values shown in Table 35.1 below, which vary with the rated power output, safety classification and the number of poles.

If the product’s specific rated power output is not shown in Table 35.1, then the performance threshold is determined by interpolation in accordance with the method set out in Section 5.4.5 of BS EN 60034-30-1: 2014.

Until further notice results of tests according to BS EN 60034-2-1:2007 for products listed before September 2020 will also be accepted.

Efficiencies at full load for Ex-eb increased safety motors can be found in red in Table 35.1, which vary with the rated power and the number of poles.

Table 35.1 Performance thresholds for three-phase line operated AC motors from 0.12 kW to 1000 kW (including Ex-eb increased safety motors in red).

Rated Power Output (kW)	Efficiency at full load (%)							
	2 Pole		4 Pole		6 Pole		8 Pole	
0.12	>= 60.8	>= 53.6	>= 64.8	>= 59.1	>= 57.7	>= 59.1	>= 50.7	>= 39.8
0.18	>= 65.9	>= 60.4	>= 69.9	>= 64.7	>= 63.9	>= 64.7	>= 58.7	>= 45.9
0.2	>= 67.2	>= 61.9	>= 71.1	>= 65.9	>= 65.4	>= 65.9	>= 60.6	>= 47.4
0.25	>= 69.7	>= 64.8	>= 73.5	>= 68.5	>= 68.6	>= 68.5	>= 64.1	>= 50.6
0.37	>= 73.8	>= 69.5	>= 77.3	>= 72.7	>= 73.5	>= 72.7	>= 69.3	>= 56.1
0.4	>= 74.6	>= 70.4	>= 78.0	>= 73.5	>= 74.4	>= 73.5	>= 70.1	>= 57.2
0.55	>= 77.8	>= 74.1	>= 80.8	>= 77.1	>= 77.2	>= 77.1	>= 73.0	>= 61.7
0.75	>= 83.5	>= 77.4	>= 85.7	>= 79.6	>= 82.7	>= 78.9	>=78.4	>= 66.2
1.1	>= 85.2	>= 79.6	>= 87.2	>= 81.4	>= 84.5	>= 81.0	>=80.8	>= 70.8
1.5	>= 86.5	>= 81.3	>= 88.2	>= 82.8	>= 85.9	>= 82.5	>=82.6	>= 74.1
2.2	>= 88.0	>= 83.2	>= 89.5	>= 84.3	>= 87.4	>= 84.3	>=84.5	>= 77.6
3	>= 89.1	>= 84.6	>= 90.4	>= 85.5	>= 88.6	>= 85.5	>=85.9	>= 80.0
4	>= 90.0	>= 85.8	>= 91.1	>= 86.6	>= 89.5	>= 86.6	>=87.1	>= 81.9
5.5	>= 90.9	>= 87.0	>= 91.9	>= 87.7	>= 90.5	>= 87.7	>=88.3	>= 83.8
7.5	>=91.7	>= 88.1	>=92.6	>= 88.7	>=91.3	>= 88.7	>=89.3	>= 85.3
11	>=92.6	>= 89.4	>=93.3	>= 89.8	>=92.3	>= 89.8	>=90.4	>= 86.9
15	>=93.3	>= 90.3	>=93.9	>= 90.6	>=92.9	>= 90.6	>=91.2	>= 88.0
18.5	>=93.7	>= 90.9	>=94.2	>= 91.2	>=93.4	>= 91.2	>=91.7	>= 88.6
22	>=94.0	>= 91.3	>=94.5	>= 91.6	>=93.7	>= 91.6	>=92.1	>= 89.1
30	>=94.5	>= 92.0	>=94.9	>= 92.3	>=94.2	>= 92.3	>=92.7	>= 89.8
37	>=94.8	>= 92.5	>=95.2	>= 92.7	>=94.5	>= 92.7	>=93.1	>= 90.3
45	>=95.0	>= 92.9	>=95.4	>= 93.1	>=94.8	>= 93.1	>=93.4	>= 90.7
55	>=95.3	>= 93.2	>=95.7	>= 93.5	>=95.1	>= 93.5	>=93.7	>= 91.0
75	>=95.6	>= 93.8	>=96.0	>= 94.0	>=95.4	>= 94.0	>=94.2	>= 91.6
90	>=95.8	>= 94.1	>=96.1	>= 94.2	>=95.6	>= 94.2	>=94.4	>= 91.9
110	>=96.0	>= 94.3	>=96.3	>= 94.5	>=95.8	>= 94.5	>=94.7	>= 92.3
132	>=96.2	>= 94.6	>=96.4	>= 94.7	>=96.0	>= 94.7	>=94.9	>= 92.6
160	>=96.3	>= 94.8	>=96.6	>= 94.9	>=96.2	>= 94.9	>=95.1	>= 93.0
200	>=96.5	>= 95.0	>=96.7	>= 95.1	>=96.3	>= 95.1	>=95.4	>= 93.5
250 up to 1000	>=96.5	>= 95.0	>=96.7	>= 95.1	>=96.5	>= 95.1	>=95.4	>= 93.5

">=" means "greater than or equal to"

35.3.2.2 Tier 2 – From April 2023

Products shall have an efficiency, when tested in accordance with BS EN 60034-2-1: 2014 at full load (i.e. 100% of their maximum continuous rated power output), that is greater than or equal to the values shown in tables below, which vary with the rated power output, safety classification and the number of poles. If the product's specific rated power output is not shown in these tables, then the performance threshold is determined by interpolation in accordance with the method set out in Section 5.4.5 of BS EN 60034-30-1: 2014.

Until further notice results of tests according to BS EN 60034-2-1:2007 for products listed before September 2020 will also be accepted.

The requirements under Tier 1 will remain the same from April 2023 apart from under the following circumstances:

- Efficiency thresholds for Ex-eb increased safety motors will be increased as indicated in Table 35.2.
- Efficiency thresholds for power sizes equal to or greater than 75 kW and equal to or lower than 200 kW will be increased as indicated in Table 35.3.
- Single phase motors ≥0.12 kW will be in scope, with a minimum efficiency at full load that is greater than or equal to the values shown in Table 35.4.

Table 35.2 Tier 2 performance thresholds for Ex-eb increased safety motors.

Rated Power Output (kW)	Efficiency at full load (%)			
	2 Pole	4 Pole	6 Pole	8 Pole
0.12	>= 60.8	>= 64.8	>= 57.7	>= 50.7
0.18	>= 65.9	>= 69.9	>= 63.9	>= 58.7
0.2	>= 67.2	>= 71.1	>= 65.4	>= 60.6
0.25	>= 69.7	>= 73.5	>= 68.6	>= 64.1
0.37	>= 73.8	>= 77.3	>= 73.5	>= 69.3
0.4	>= 74.6	>= 78.0	>= 74.4	>= 70.1
0.55	>= 77.8	>= 80.8	>= 77.2	>= 73.0
0.75	>= 80.7	>= 82.5	>= 79.6	>= 75.0
1.1	>= 82.7	>= 84.1	>= 81.4	>= 77.7
1.5	>= 84.2	>= 85.3	>= 82.8	>= 79.7
2.2	>= 85.9	>= 86.7	>= 84.3	>= 81.9
3	>= 87.1	>= 87.7	>= 85.6	>= 83.5
4	>= 88.1	>= 88.6	>= 86.8	>= 84.8
5.5	>= 89.2	>= 89.6	>= 88.0	>= 86.2
7.5	>= 90.1	>= 90.4	>= 89.1	>= 87.3
11	>= 91.2	>= 91.4	>= 90.3	>= 88.6
15	>= 91.9	>= 92.1	>= 91.2	>= 89.6
18.5	>= 92.4	>= 92.6	>= 91.7	>= 90.1
22	>= 92.7	>= 93.0	>= 92.2	>= 90.6
30	>= 93.3	>= 93.6	>= 92.9	>= 91.3
37	>= 93.7	>= 93.9	>= 93.3	>= 91.8
45	>= 94.0	>= 94.2	>= 93.7	>= 92.2
55	>= 94.3	>= 94.6	>= 94.1	>= 92.5
75	>= 94.7	>= 95.0	>= 94.6	>= 93.1
90	>= 95.0	>= 95.2	>= 94.9	>= 93.4
110	>= 95.2	>= 95.4	>= 95.1	>= 93.7
132	>= 95.4	>= 95.6	>= 95.4	>= 94.0
160	>= 95.6	>= 95.8	>= 95.6	>= 94.3
200	>= 95.8	>= 96.0	>= 95.8	>= 94.6
250 up to 1000	>= 95.8	>= 96.0	>= 95.8	>= 94.6

">=" means "greater than or equal to"

Table 35.3 Tier 2 Performance thresholds for three-phase line operated AC motors equal to or greater than 75 kW and equal to or lower than 200 kW.

Rated Power Output (kW)	Efficiency at full load (%)			
	2 Pole	4 Pole	6 Pole	8 Pole
75	>=96.3	>=96.8	>=96.3	>=95.4
90	>=96.4	>=96.9	>=96.5	>=95.5
110	>=96.6	>=97.0	>=96.6	>=95.8
132	>=96.7	>=97.1	>=96.8	>=95.9
160	>=96.9	>=97.3	>=97.0	>=96.1
200	>=97.1	>=97.4	>=97.0	>=96.3

">=" means "greater than or equal to"

Table 35.4 Tier 2 Performance thresholds for single-phase line operated AC motors

Rated Power Output (kW)	Efficiency at full load (%)			
	2 Pole	4 Pole	6 Pole	8 Pole
0.12	>= 60.8	>= 64.8	>= 57.7	>= 50.7
0.18	>= 65.9	>= 69.9	>= 63.9	>= 58.7
0.2	>= 67.2	>= 71.1	>= 65.4	>= 60.6
0.25	>= 69.7	>= 73.5	>= 68.6	>= 64.1
0.37	>= 73.8	>= 77.3	>= 73.5	>= 69.3
0.4	>= 74.6	>= 78.0	>= 74.4	>= 70.1
0.55	>= 77.8	>= 80.8	>= 77.2	>= 73.0
0.75	>= 83.5	>= 85.7	>= 82.7	>=78.4
1.1	>= 85.2	>= 87.2	>= 84.5	>=80.8
1.5	>= 86.5	>= 88.2	>= 85.9	>=82.6
2.2	>= 88.0	>= 89.5	>= 87.4	>=84.5
3	>= 89.1	>= 90.4	>= 88.6	>=85.9
4	>= 90.0	>= 91.1	>= 89.5	>=87.1
5.5	>= 90.9	>= 91.9	>= 90.5	>=88.3
7.5	>=91.7	>=92.6	>=91.3	>=89.3
11	>=92.6	>=93.3	>=92.3	>=90.4
15	>=93.3	>=93.9	>=92.9	>=91.2
18.5	>=93.7	>=94.2	>=93.4	>=91.7
>=22	>=94.0	>=94.5	>=93.7	>=92.1

">=" means "greater than or equal to"

35.4 Measurement and Calculations

35.4.1 Measurement Standards and Test Requirements

Product efficiency at full load (100% of maximum continuous rated power output) shall be determined in accordance with:

- Method 2-1-1B according to Table 2 (Induction Machines - preferred testing methods) of BS EN 60034-2-1:2014 “Rotating electrical machines – Part 2-1: Standard methods for determining losses and efficiency from tests (excluding machines for traction vehicles)”

Products shall be operated from a 400 V AC, 3 phase, 50 Hz electrical power supply during testing. (If the product is not designed to operate at this voltage, then product testing should be undertaken using a 230 V AC or 690 V AC electrical power supply, or alternatively at all rated operating voltages).

Until further notice, products listed before September 2020 will be accepted with testing performed according to BS EN 60034-2-1:2007.

If a single product is submitted for assessment, one detailed test report should be submitted. For a product range, test results may be submitted in summary form provided:

- Sufficient data is included to confirm that product performance was determined in accordance with the procedures and test conditions laid down in the relevant standards.
- Detailed test reports have been prepared for each product tested and are available on request for inspection, where not submitted with the application.

35.4.2 Rounding

For the avoidance of doubt test data should be presented to 1 decimal place. As an example, a 4 pole, three-phase line operated AC motor with a rated power output of 90.0 kW and an efficiency at full load of 96.8% would be deemed to fail.

35.5 Verification for ETL Listing

Any of the following testing routes may be used to demonstrate the conformity of products against the requirements:

- In-house testing – Self-certified
- In-house testing – Self-tested and verified or cross-checked by an independent body
- Witnessed testing
- Independent testing
- Representative testing (see clause 35.5.1)

Further information regarding the first four routes can be found in Guidance Note 5 on the ETL product testing framework[38].

[38] https://www.gov.uk/government/publications/energy-technology-list-etl-product-testing-framework

35.5.1 Representative testing

Where applications are being made for two or more products that are variants of the same basic design, test data may be submitted for a representative selection of models, provided that:

- All variants are of the same product range as the representative models and the primary variations between models are rated power and physical dimensions.
- All variants are constructed from the same materials.
- A detailed test report is provided for at least one representative product in each range.
- The representative model is in the bottom quartile of predicted performance within each range.
- Clear descriptions and formulae describing the relationship between the representative model(s) and the variants are provided.

It should be noted that:

- If a manufacturer voluntarily removes the representative model from the ETL then other products linked with that representative model may or may not be permitted to remain on the ETL.
- If any product submitted under these representative model rules is later found not to meet the performance criteria when independently tested, then all products based on the same representative model will be removed from the ETL.

35.6 Conformity testing

Products listed on the ETL may be subject to the scheme's conformity testing programme in order to ensure listed models continue to meet the ETL requirements.

35.7 Effective Date

These criteria will take effect from September 2020. Tier 2 requirements will automatically take effect from April 2023.

35.8 Review

35.8.1 Indicative review date

The next technical review is scheduled for 2024-25.

35.8.2 Illustrative future direction of requirements

Future changes to the specification may include:

- Updates to efficiency thresholds to precede the implementation of stricter Ecodesign requirements for electric motors.

36 Variable Speed Drives

Date published	2018
Date first launched	2001

36.1 Scope

A variable speed drive is essentially an electronic power converter that generates a multi-phase, variable frequency output that can be used to drive a standard line operated ac motor, or permanent magnet synchronous or other converter-fed motor, and to modulate and control the motor's speed, torque and mechanical power output.

Variable speed drives may be purchased either as a stand-alone product or purchased as part of another item of plant or machinery. They are included on the Energy Technology Product List because they can realise substantial energy savings when used to control the speed of machinery.

The Energy Technology List (ETL) Scheme covers two categories of products:

1. Variable Speed Drives for line operated ac motors (as defined within the ETL category line operated ac motors)
2. Variable Speed Drives for converter-fed motors (as defined within the ETL category converter-fed motors)

Products which are able to control both line operated ac motors and converter-fed motors are also covered, as long as all of the eligibility criteria are met for both forms of control.

To be eligible for inclusion on the ETL, products shall meet the requirements as set out below.

36.2 Definitions

A variable speed drive is specifically designed to drive a motor in a manner that rotates the motor's drive shaft at a variable speed dictated by an external signal.

36.3 Requirements

36.3.1 Eligibility requirements

Eligible products shall:

- Incorporate an electronic VSD that generates a controlled variable frequency, variable voltage, 3 phase power output (with each phase displaced by approximately 120 degrees) that is suitable for operating a 3 phase motor.
- Provide an adjustable variable-voltage, variable-frequency output that can be matched to the torque-speed characteristic of the load (being driven by the motor), including both loads with a quadratic torque-speed and linear torque-speed characteristics. The relationship between the voltage and frequency of the product's output shall either be:

a) Predefined prior to sale to match a number of specific motor loads, which can be selected during commissioning; OR

b) Programmed into the product during installation using a multi-point approximation or parametric motor model as part of a clearly defined commissioning procedure; OR

c) Determined during commissioning by a self-tuning or automatic model identification algorithm that automatically minimises the energy consumption of the drive; OR

d) Automatically adjusted during operation as part of a control algorithm in a manner that ensures the product's output matches the characteristics of the motor and its load and minimises energy consumption of the drive; OR

e) Any combination of (a) to (d) above.

- Be able to automatically vary, in response to an external control signal, the frequency of its output between 5% (or less) and 100% (or greater) of the frequency of its alternating current supply.
- Be configured for direct connection to the UK public electricity supply system, or a private alternating current supply of nominally fixed frequency and voltage.
- Be designed to make smooth controlled transitions between speed changes by the use of predefined, programmable, or automatically adjusted, acceleration and deceleration ramps.
- Have an appropriate Conformity Assessment mark, or otherwise demonstrate conformity with the requirements of The Electromagnetic Compatibility Regulations 2016
- The Electromagnetic Compatibility Regulations 2016.
- Not incorporate any type of mechanical apparatus that derives its motive force from the product’s variable frequency output, including any form of electric motor or fluid movement mechanism, except for fans or pumps incorporated solely for the purpose of product cooling.

Where the relationship between the voltage and frequency of the product's output is determined by a multi-point approximation, then flux optimisation shall be adjustable at a minimum of five points.

The criteria stated above shall be clearly presented in the product brochure, leaflet, technical specification sheet. It may also be supported by the relevant operation instruction document demonstrating the product’s functionality in accordance with the criteria listed above.

36.4 Verification for ETL Listing

There are no testing requirements, however manufacturers shall provide sales and technical brochures to evidence the conformity of their products against the requirements from section 36.3.

36.5 Conformity testing

Products listed on the ETL may be subject to the scheme’s conformity testing programme in order to ensure listed models continue to meet the ETL requirements.

Pipework Insulation

37 Pipework Insulation

Date published	2021
Date first launched	2001

37.1 Scope

Pipework insulation is used to reduce the amount of heat lost from pipework containing hot fluids, and the amount of heat gained by pipework containing cold and chilled fluids, thus reducing the amount of energy wasted on maintaining the temperature of the fluids.

The pipework insulation category includes insulation for both lengths of pipe and pipe fittings e.g. flanged joints, valves tees, bends.

The Energy Technology List (ETL) scheme covers six categories of pipework and pipework fittings insulation:

1. Refrigeration pipework and fittings
2. Chilled water pipework and fittings
3. Process pipework and fittings
4. 'Domestic' space heating & hot water services and fittings (excluding insulation within individual dwellings)
5. Non-domestic hot water services and fittings
6. Non-domestic space heating services and fittings

To be eligible for inclusion on the ETL, products shall meet the requirements as set out below.

37.2 Definitions

Pipework insulation covers products that are specifically designed to be applied to the outer circumference of a pipe and/or pipe fittings with the primary objective of reducing thermal flow into or out of the pipe. Pipe fittings cover flanged joints, valves, tees and bends.

37.3 Requirements

37.3.1 Performance requirements

To be eligible, installations of pipework insulation and fittings shall:

1. Have an appropriate Conformity Assessment mark.
2. For categories 1 and 2:
    a. comply with clause 28.4 of BS 5970:2012 (applicable to cold pipework fittings)
    b. comply with the relevant clauses, tables and annexes of BS 5422: 2009 as set out in Table 1.1 below.
3. For category 3:
    a. comply with clause 28.4 (applicable to cold pipework fittings) or clause 8.4 of BS 5970:2012 (applicable to hot pipework fittings)

b. comply with the relevant clauses, tables and annexes of BS 5422:2009 as set out in Table 37.1 below.

Table 37.1 Relevant clause, table(s) and annex(es) of BS 5422 (2009) used to determine the minimum required thickness for each category of pipework insulation covered by the ETL

	Category	Relevant Clause	Relevant Table(s)	Relevant Annex
1.	Refrigeration pipework.	6	None	F
2.	Chilled water pipework.	7	10 & 11	A
3.	Process pipework.	10	21	A

4. For categories 4, 5 and 6:
   a. comply with clause 29.2.10 BS 5970:2012 (applicable to hot pipework fittings)
   b. comply with the maximum permissible heat loss criteria found within Table 37.2, Table 37.3 & Table 37.4 below, which duly form the basis for determining the minimum required thickness of pipework insulation for each category for an eligible installation.

Table 37.2 Maximum Permissible Heat Losses for Domestic Space Heating & Hot Water

Domestic Space Heating & Hot Water	
Temperature 60°C	
Outside pipe diameter (mm)	Permitted Heat loss (W/m)
8	<= 5.82
10	<= 6.20
12	<= 6.52
15	<= 7.03
22	<= 8.02
28	<= 8.87
35	<= 9.63
42	<= 10.58
54	<= 11.83

Table reproduced with kind permission from the 'ECA Enhanced' tables of NES Y-50 (2011).

Table 37.3 Maximum Permissible Heat Losses for Non-Domestic Hot Water Supply

Non-Domestic Hot Water Supply **Temperature 60°C**	
Outside pipe diameter (mm)	Permitted Heat loss (W/m)
17.2	<= 6.04
21.3	<= 6.45

Non-Domestic Hot Water Supply Temperature 60ºC	
26.9	<= 7.00
33.7	<= 7.71
42.4	<= 8.46
48.3	<= 9.01
60.3	<= 9.94
76.1	<= 11.25
88.9	<= 12.17
114.3	<= 14.29
139.7	<= 16.09
168.3	<= 18.24
219.1	<= 22.06
273 and above	<= 25.95

Table reproduced with kind permission from the 'ECA Enhanced' tables of NES Y-50 (2011).

Table 37.4 Maximum Permissible Heat Losses for Non-Domestic Heating Supplies

Non-Domestic Heating Installations Maximum permitted heat loss (W/m)			
Temperature	**Low**	**Medium**	**High**
	<=95ºC	96-120ºC	121-150ºC
Outside pipe diameter (mm)	**Permitted Heat loss (W/m)**	**Permitted Heat loss (W/m)**	**Permitted Heat loss (W/m)**
17.2	<= 7.78	<= 10.57	<= 13.27
21.3	<= 8.42	<= 11.25	<= 14.06
26.9	<= 9.05	<= 12.06	<= 15.02
33.7	<= 9.86	<= 13.04	<= 16.07
42.4	<= 10.83	<= 14.12	<= 17.34
48.3	<= 11.42	<= 14.80	<= 18.09
60.3	<= 12.61	<= 16.22	<= 19.62
76.1	<= 14.12	<= 17.88	<= 21.41
88.9	<= 15.28	<= 19.20	<= 22.87
114.3	<= 17.51	<= 21.66	<= 25.53
139.7	<= 19.72	<= 23.99	<= 27.98
168.3	<= 22.34	<= 26.63	<= 30.69
219.1	<= 26.61	<= 31.15	<= 35.25
273 and above	<= 30.91	<= 35.83	<= 40.05

Table reproduced with kind permission from the 'ECA Enhanced' tables of NES Y-50 (2011).

Where:

- Where "<=" means "less than or equal to"
- If the pipe diameter differs from the parameters used to generate these tables, then linear interpolation methods may be used to calculate the maximum permissible heat flows and, in combination with information on the thermal conductivity of the chosen product at the relevant mean temperature, the minimum required thickness of insulation.
- If the parameters of the specific installation are outside the scope of these tables (e.g. different ambient air temperature, or linear interpolation is not possible) then the minimum required thickness of insulation shall be calculated using BS EN ISO 12241:2008.
- BS EN ISO 12241:2008 shall be used to calculate the pipework heat gains for refrigeration pipework insulation needed to comply with clause 6.3.2 of BS 5422:2009.

37.4 Measurement and Calculations

37.4.1 Measurement standards

The following standards, where applicable, shall be used for measuring and calculating product performance:

- BS 5422:2009 Method for specifying thermal insulating materials for pipes, tanks, vessels, ductwork and equipment operating within the temperature range -40°C to +700°C
- BS EN ISO 12241:2008 Thermal insulation for building equipment and industrial Installations. Calculation rules
- BS 5970:2012 Thermal insulation of pipework, ductwork, associated equipment and other industrial installations in the temperature range of -100°C to +870°C. Code of practice
- NES Y-50 (2011)

37.4.2 Performance metrics

Minimum pipework insulation thickness must be specified to meet the heat loss/gain metrics listed and/or referenced in the tables above, according to the product's thermal conductivity.

37.4.3 Test requirements

Manufacturers shall provide a Declaration of Performance (DoP) to declare the thermal conductivity used to calculate pipework thickness. Standardised assumptions used to calculate the heat loss according to EN ISO 12241:2008 are to be submitted for categories 4, 5 & 6. This shall include ambient air temperature, surface emissivity, operating temperature and orientation.

37.4.4 Rounding

For the avoidance of doubt, thermal conductivity test data should be presented to 3 decimal places.

37.5 Verification for ETL Listing

Any of the following testing routes may be used to demonstrate the conformity of products against the requirements:

- In-house testing – Self-certified
- In-house testing – Self-tested and verified or cross-checked by an independent body
- Witnessed testing
- Independent testing
- Representative testing for categories 4, 5 and 6 only (see clause 37.5.1)

Further information regarding the five routes can be found in Guidance Note 5 on the ETL product testing framework[39].

37.5.1 Representative Testing

Representative testing may be used for pipework insulation products that fall under the following categories:

- 'Domestic' space heating & hot water services (excluding insulation within individual dwellings)
- Non-domestic hot water services
- Non-domestic space heating services

Where applications are being made for two or more pipework insulation products that are made from the same insulating material, with the same thermal conductivity, representative testing may be used. Test data for the pipework insulation material may be used to determine product performance for all pipework insulation products in the representative range.

Under this method, product performance shall be demonstrated by calculating the permitted heat loss (W/m) for the relevant outside pipe diameter. Manufacturers shall submit supporting information regarding the calculation method, in order to determine its suitability and effectiveness. Thermal conductivity (W/m.K) i.e. the lambda value, shall be determined for the pipework insulation material through product testing.

It should be noted that:

- If any product submitted under these representative testing rules is later found not to meet the performance criteria when independently tested, then all products based on the same representative model will be removed from the ETL.

37.6 Conformity testing

Products listed on the ETL may be subject to the scheme's conformity testing programme in order to ensure listed models continue to meet the ETL requirements.

[39] https://www.gov.uk/government/publications/energy-technology-list-etl-product-testing-framework

37.7 Review

37.7.1 Indicative review date

This specification is scheduled to be reviewed during the 2023/24 review cycle.

Radiant and Warm Air Heaters

38 Radiant Heating Equipment

Date published	2019
Date first launched	2002

38.1 Scope

Radiant heating equipment covers products that are specifically designed to heat people or objects in the space below them by infrared radiation without heating the surrounding air directly, and optimising controllers that ensure radiant heating systems operate in an efficient manner.

38.2 Definitions

Radiant heaters are widely used to provide space heating for warehouses, retail sheds, sports centres, factories, and other buildings containing similarly large spaces. Radiant heaters contain a gas or oil-fired burner that is used to heat a tube, cone or plaque that emits infrared radiation when hot. This infrared radiation is focussed and directed downwards by reflectors within the product.

Radiant heaters are available in a range of different types and efficiencies. The Energy Technology List (ETL) Scheme encourages the purchase of higher efficiency radiant heaters. It also encourages the purchase of optimising controllers that ensure that radiant heating products and systems operate in an energy efficient manner that reflects weather conditions, occupation schedules and user requirements.

The ETL Scheme covers five categories of product:

1. Unitary radiant tube heater units and packages.
2. Multi burner radiant tube heater units and packages.
3. Continuous radiant tube heater units and packages.
4. Radiant plaque and cone heater units and packages.
5. Optimising controllers for radiant heating systems. (including both standalone unit and add-on module type products).

Where packages consist of a combination of radiant heater units, and an optimising controller.

To be eligible for inclusion on the ETL, products shall meet the requirements as set out below.

38.3 Requirements

38.3.1 Eligibility requirements

To be eligible, all products shall comply with the relevant requirements set out below:

1. All products incorporating radiant heaters shall:
   - Be gas or oil-fired.
   - Be designed to be permanently mounted above head height.

- Have an appropriate Conformity Assessment mark.

2. All products incorporating radiant tube type heaters shall incorporate a reflector (with end caps) that directs the radiated heat downwards.
3. All products that incorporate optimising controllers shall:
   - Incorporate a microprocessor based controller that is pre-programmed to:
     a) Automatically control the temperature in one or more zones within a building in an energy efficient manner that reflects predefined zone occupation schedules.
     b) Automatically switch radiant heating equipment on and off in accordance with the predefined occupation schedule for each of the zones being controlled.
   - Incorporate the following automatic control mechanisms:
     c) A frost protection mechanism that monitors internal air temperature, and switches on the radiant heaters to prevent equipment and/or pipework from freezing up.
     d) A building fabric protection mechanism that monitors external or internal temperatures and switches heating on to prevent condensation from occurring.
     e) An anti-tampering mechanism that prevents the product's control strategy from being modified, and the specified automatic control mechanisms from being disabled, except during commissioning, maintenance or testing.
   - Provide facilities that enable building managers to:
     f) Define the normal occupation times for the building and for each zone controlled (in intervals of five minutes or less), for each day of the week, including at least two periods of occupation per day (i.e. at least 14 different occupation periods per week).
     g) Define the temperature set-points for each zone to ±1°C.
   - Provide facilities that enable building users to "temporarily override" the pre-set times when the radiant heating is scheduled to be switched off within an individual zone.
   - Incorporate, or be packaged with, a black bulb sensor.
   - Conform with the requirements of The Electromagnetic Compatibility Regulations 2016 or have an appropriate Conformity Assessment mark.

Where:

- A mechanism is defined as "any sequence of pre-defined actions that performs a given function, where an action can be defined in hardware and/or software terms".
- Products that incorporate control strategies that are specifically designed to control other types of equipment (other than warm air or radiant heaters) are not eligible.

38.3.2 Performance requirements

All products that incorporate radiant heaters shall have a seasonal space heating energy efficiency (η_S) that is greater than or equal to the values set out in Table 38.1 below.

Table 38.1 Performance requirements for radiant heating equipment.

	Product category	Seasonal space heating energy efficiency (η_S) %
1.	Unitary radiant tube heater units and packages.	≥ 80.0%
2.	Multi burner radiant tube heater units and packages.	≥ 80.0%
3.	Continuous radiant tube heater units and packages.	≥ 90.0%
4.	Radiant plaque and cone heater units and packages.	≥ 88.0%

"≥" means "greater than or equal to"

38.4 Measurement and Calculations

38.4.1 Measurement standards

The seasonal space heating energy efficiency of the product shall be determined in accordance with the procedure and test conditions set out in:

- Commission Regulation (EU) 2015/1188 implementing Directive 2009/125/EC of the European Parliament and of the Council with regard to Ecodesign requirements for local space heaters.

The emission efficiency associated with the radiant heating component of continuous radiant heating systems shall be determined in accordance with the relevant procedures and test conditions in the following standard:

- prEN 17175: 2017, “Gas-fired overhead radiant strip heaters and multi-burner continuous radiant tube heater systems for non-domestic use - Safety and energy efficiency”.

38.4.2 Performance metric

The seasonal space heating energy efficiency for the product shall be calculated using the equation below:

$$\eta_S = \eta_{S,on} - F(1) - F(4) - F(5)$$

Where:

- $\eta_{S,on}$ is the seasonal space heating energy efficiency in active mode, expressed in %.

$$\eta_{S,on} = \eta_{S,th} \cdot \eta_{S,RF}$$

- $\eta_{S,th}$ is the weighted thermal efficiency and $\eta_{S,RF}$ is the emission efficiency, both of which shall be determined in accordance with Annex III, point 5(b) of Commission Regulation (EU) 2015/1188 for commercial local space heaters.
- F(1) is a correction factor accounting for a negative contribution to seasonal space heating efficiency for commercial local space heaters due

to adjusted contributions for options for the heat output, expressed in %. The value for this shall be determined in accordance with Table 6 of Commission Regulation (EU) 2015/1188.

- F(4) is a correction factor accounting for a negative contribution to the seasonal space heating energy efficiency by auxiliary electricity consumption, expressed in %. The value for this shall be determined in accordance with Annex III, point 5(f) of Commission Regulation (EU) 2015/1188 for commercial local space heaters.
- F(5) is a correction factor accounting for a negative contribution to the seasonal space heating energy efficiency by energy consumption of a permanent pilot flame, expressed in %. The value for this shall be determined in accordance with Annex III, point 5(g) of Commission Regulation (EU) 2015/1188 for commercial local space heaters.

38.4.3 Test requirements

The product shall be tested with the minimum possible length of flue that is consistent with the product's design specification. Where the product is supplied in several parts that are to be connected together during installation, the product shall be tested with the minimum possible interconnecting pipework.

38.4.4 Rounding

For the avoidance of doubt, efficiency test data shall be presented to 1 decimal place. As an example, a unitary radiant tube heater with a seasonal space heating energy efficiency of 79.9% would be deemed to not meet the performance requirements.

38.5 Verification for ETL Listing

Any of the following testing routes may be used to demonstrate the conformity of products against the requirements:

- In-house testing – Self-certified
- In-house testing – Self-tested and verified or cross-checked by an independent body
- Witnessed testing
- Independent testing
- Representative testing (see clause 38.5.1)

Further information regarding the first four routes can be found in Guidance Note 5 on the ETL product testing framework[40].

38.5.1 Representative testing

Where applications are being made for a range of two or more products that are variants of the same basic design, test data may be submitted for a representative selection of models, provided that all variants:

- Use the same fuel (e.g. oil or gas) as the representative model.

[40] https://www.gov.uk/government/publications/energy-technology-list-etl-product-testing-framework

- Fit within the same product category (e.g. are all unitary radiant tube heater units) as the representative model.

The representative models shall be selected by dividing the range of products into groups of models with similar characteristics, as above, and testing a model in each group. The performance of each model in the group shall be predicted by extrapolation or interpolation or by using a validated mathematical model. As a minimum, a full test report shall be provided for at least one model tested in each range of products. Details of the calculation method used in determining the performance of models that have not been tested shall also be provided.

It should be noted that:

- If a manufacturer voluntarily removes the representative model from the ETL then other products linked with that representative model may or may not be permitted to remain on the ETL.
- If any product submitted under these representative model rules is later found not to meet the performance criteria when independently tested, then all products based on the same representative model will be removed from the ETL.

38.6 Conformity testing

Products listed on the ETL may be subject to the scheme's conformity testing programme in order to ensure listed models continue to meet the ETL requirements.

38.7 Review

38.7.1 Indicative review date

This specification is scheduled for review during the 2022/23 ETL review period.

38.7.2 Illustrative future direction of the requirements

A suite of provisional test standards has been introduced to enable performance measurement for the Ecodesign regulation for local space heaters. With the exception of the test standard for continuous radiant heating systems which previously did not exist, these provisional standards are not included in this specification. Future requirements will reference the finalised versions of the test standards when they come into force.

39 Warm Air Heating Equipment

Date published	2019
Date first launched	2003

39.1 Scope

Warm air heating equipment covers products that are specifically designed to provide space heating by using the heat generated by a burner to raise the air temperature in the space(s) being heated, and optimising controllers that ensure warm air heating systems operate in an efficient manner.

39.2 Definitions

Warm air heaters are widely used to provide space heating for warehouses, retail sheds, sports centres, factories, and other buildings containing similarly large spaces. Warm air heaters contain a gas or oil-fired burner that is used to heat the air in the space directly, or indirectly by means of a heat exchanger. A fan is used to distribute the warm air throughout the space(s) being heated.

Warm air heaters are available in a range of different types and efficiencies. The Energy Technology List (ETL) Scheme encourages the purchase of higher efficiency warm air heaters. It also encourages the purchase of optimising controllers that ensure that warm air heating products and systems operate in an energy efficient manner that reflects weather conditions, occupation schedules and user requirements.

The ETL Scheme covers three categories of product:

1. Indirect fired condensing packaged warm air heater units including on/off, high/low and fully-modulating type products.
2. Indirect fired condensing packaged air heater modules including on/off, high/low and fully-modulating type products.
3. Optimising controllers for warm air heating systems including both standalone unit and add-on module type products.

To be eligible for inclusion on the ETL, products shall meet the requirements as set out below.

39.3 Requirements

39.3.1 Eligibility requirements

To be eligible, all products shall comply with the relevant requirements set out below:

1. All products incorporating warm air heaters shall:
   - Be gas or oil-fired (where gas includes biogas and oil includes liquid biofuels).
   - Be designed to be permanently installed in one of the following ways:
     a) As a suspended, wall mounted or floor-standing unit.
     b) As a heating module within an air handling unit.
   - Incorporate a fan to distribute warm air within the heated space, unless they are warm air heating modules that are specifically designed to be installed in an air handling unit.
   - Have an appropriate Conformity Assessment mark.
2. All products that incorporate optimising controllers shall:
   - Incorporate a microprocessor based controller that is pre-programmed to:
     a) Automatically control the air temperature in one or more zones within a building in an energy efficient manner that reflects predefined zone occupation schedules.
     b) Automatically switch warm air heating equipment on and off in accordance with the predefined occupation schedule for each of the zones being controlled.

- Incorporate the following automatic control mechanisms:
  a) An optimum start mechanism that monitors external and/or internal temperatures, and calculates when the warm air heating equipment need to be switched on in order to just reach pre-set temperatures by the start of the next occupancy period.
  b) A “self-learning” algorithm that automatically monitors the accuracy of the optimum start mechanism and periodically updates the heating curve that the mechanism uses, to reflect changes in building characteristics.
  c) A frost protection mechanism that monitors internal air temperature, and switches on the warm air heaters to prevent equipment and/or pipework from freezing up.
  d) A building fabric protection mechanism that monitors external or internal temperatures and switches heating on to prevent condensation from occurring.
  e) An anti-tampering mechanism that prevents the product’s control strategy from being modified, and the specified automatic control mechanisms from being disabled, except during commissioning, maintenance or testing.
- Provide facilities that enable building managers to:
  a) Define the normal occupation times for the building and for each zone controlled (in intervals of five minutes or less), for each day of the week, including at least two periods of occupation per day (i.e. at least 14 different occupation periods per week). b) Define the temperature set-points for each zone to ±1°C.
  b) Define future dates (e.g. holidays) when the warm air heating equipment should be completely switched off, or operated at frost, fabric or equipment protection levels.
- Provide facilities that enable building users to “temporarily override” the pre-set times when the warm air heating is scheduled to be switched off within an individual zone.
- Conform to the requirements of The Electromagnetic Compatibility Regulations 2016 or have an appropriate Conformity Assessment mark.

Where:

- A mechanism is defined as “any sequence of pre-defined actions that performs a given function, where an action can be defined in hardware and/or software terms”.
- Products that incorporate control strategies that are specifically designed to control other types of equipment (other than warm air or radiant heaters) are not eligible.

39.3.2 Performance requirements

All products shall have a seasonal space heating energy efficiency that is greater than or equal to 80.0%.

39.4 Measurement and Calculations

39.4.1 Performance metric and Measurement standard

The product's seasonal space heating energy efficiency shall be determined in accordance with the method set out in:

- Commission Regulation (EU) No 2016/2281 implementing Directive 2009/125/EC of the European Parliament and of the Council establishing a framework for the setting of Ecodesign requirements for energy-related products, with regard to Ecodesign requirements for air heating products, cooling products, high temperature process chillers and fan coil units.

39.4.2 Rounding

For the avoidance of doubt seasonal space heating energy efficiency test data shall be presented to 1 decimal place. As an example, a warm air heater unit with a seasonal space heating energy efficiency of 79.9% would be deemed to not meet the performance requirements.

39.5 Verification for ETL Listing

Any of the following testing routes may be used to demonstrate the conformity of products against the requirements:

- In-house testing – Self-certified
- In-house testing – Self-tested and verified or cross-checked by an independent body
- Witnessed testing
- Independent testing
- Representative testing (see clause 39.5.1)

Further information regarding the first four routes can be found in Guidance Note 5 on the ETL product testing framework[41].

39.5.1 Representative testing

Where applications are being made for a range of two or more products that are variants of the same basic design, test data may be submitted for a representative selection of models, provided that all variants:

- Use the same fuel (e.g. oil or gas) as the representative model.
- Fit within the same product category (e.g. are all indirect fired condensing packaged warm air heater units) as the representative model.
- Have the same control mechanism (e.g. are all fully-modulating warm air heater units) as the representative model.

The representative models shall be selected by dividing the range of products into groups of models with similar characteristics, as above, and testing a model in each group. The performance of each model in the group shall be predicted by extrapolation or interpolation or by using a validated mathematical model. As a

[41] https://www.gov.uk/government/publications/energy-technology-list-etl-product-testing-framework

minimum, a full test report shall be provided for at least one model tested in each range of products. Details of the calculation method used in determining the performance of models that have not been tested shall also be provided.

It should be noted that:

- If a manufacturer voluntarily removes the representative model from the ETL then other products linked with that representative model may or may not be permitted to remain on the ETL.
- If any product submitted under these representative model rules is later found not to meet the performance criteria when independently tested, then all products based on the same representative model will be removed from the ETL.

39.6 Conformity testing

Products listed on the ETL may be subject to the scheme's conformity testing programme in order to ensure listed models continue to meet the ETL requirements.

39.7 Review

39.7.1 Indicative review date

This specification will be reviewed during the 2022/23 ETL review period.

39.7.2 Illustrative future direction of the requirements

The eco-design Tier 2 Minimum Energy Performance Standards for this category of products is due to come into force on 1 January 2021. At this time, there may be some scope to increase performance thresholds; however, the technology is close to its energy efficiency limits. Future requirements may look to encourage the use of 'green' gases with lower carbon emissions than oil and natural gas.

A new test standard has also been introduced to enable performance measurement for the Ecodesign regulation for warm air heaters. This is currently under provisional status and is therefore not included in this specification. Future requirements will reference the finalised version of the new test standard when it comes into force.

Refrigeration Equipment

40 Absorption & Other Heat Driven Cooling & Heating Equipment

This category only covers products installed as part of a CHP scheme that has been awarded a certificate from the CHP Quality Assurance (CHPQA) programme. The absorption chiller's useful chilling effect must be driven by heat derived from the CHP plant. The absorption plant is assessed with the CHP plant under CHPQA programme - for further information go to https://www.gov.uk/guidance/combined-heat-power-quality-assurance-programme.

41 Air Blast Coolers

Date published	2018
Date first launched	2003
Former name	Forced Air Pre-Coolers

41.1 Scope

Air blast coolers (including 'ambient air pre-coolers' and 'dry adiabatic coolers', and commonly known as 'free coolers' and 'hybrid coolers', and previously referred to as 'forced air pre-coolers') normally consist of a finned tube heat exchanger and a cooling fan(s). The cooling fan is used to force air over the heat exchanger and to cool water and other process liquids as they passed through the heat exchanger. Some products also make use of adiabatic cooling for limited periods.

Air blast coolers can be used to reduce the load on refrigeration systems by cooling water and other process liquids, prior to their transfer into the refrigeration system.

Air blast coolers can be broadly categorised as packaged air blast free coolers and general air blast coolers. Packaged air blast free coolers include the valves and control systems required for use as a pre-cooler to a refrigeration chiller with full, partial or no free cooling depending on the ambient conditions. The free cooler is bypassed when ambient conditions are not suitable for free cooling. General air blast coolers (also known as dry coolers) are sold ready to connect to any suitable closed circuit cooling system.

The Energy Technology List (ETL) Scheme encourages the purchase of free standing air blast coolers that either turn off the cooling fan when the ambient air temperature is high, and/or feature variable speed fan(s) with appropriate controller to modulate the cooling fan speed according to cooling demand.

Air blast coolers that are sold as an integrated part of a mechanical chiller are not included in this category, but are covered by the 'Packaged Chillers' sub-technology of the ETL.

To be eligible for inclusion on the ETL, products shall meet the requirements as set out below.

41.2 Definitions

Air blast coolers are products that are specifically designed to cool water or process liquid by means of a heat exchanger, over which air is forced by a fan(s), prior to transfer to a refrigeration system.

41.3 Requirements

41.3.1 Eligibility requirements

To be eligible, products shall:

- Incorporate a heat exchanger designed to cool water or other process liquids.
- Incorporate a fan(s) which forces air over the heat exchanger.
- Conform with the requirements of The Pressure Equipment (Safety) Regulations 2016 in respect of its design, manufacture and testing procedures, or have an appropriate Conformity Assessment mark.

In addition air blast coolers shall incorporate:

Either:

- a series of control valves (or “by-pass mechanism”) that re-direct the water or other process liquid around the pre-cooler in response to a control signal, and a controller that operates the by-pass mechanism and turns off the cooling fan at times when the ambient air temperature is higher than the water/process liquid inlet temperature.

And/Or:

- a variable speed fan(s) with appropriate controller which reduces the duty of the cooling fan as the cooling demand decreases, or as the ambient air temperature decreases

41.3.2 Performance requirements

Eligible general air blast coolers shall have:

- A minimum energy efficiency rating (EER) that, at a 5K liquid temperature difference (i.e., difference between **inlet** and outlet **liquid temperatures**) and a 15K approach temperature difference (i.e. difference between inlet air and outlet leaving water temperature) and when operating at maximum cooling capacity (as stated on the datasheet), is greater than or equal to (>=) 100.0.

All packaged air blast free coolers are eligible, and do not need to meet a minimum EER performance threshold.

41.4 Measurement and Calculations

41.4.1 Performance metrics

Where EER = net cooling capacity (kW) / effective power input (kW).

41.4.2 Measurement Standards and Test Requirements

The required minimum performance shall be demonstrated using Method A or B, as set out in 41.4.2.1 and 41.4.2.2 below.

For both methods A and B, the liquid for the test shall be water. Effective measured power input is the electricity required to run the fan(s) at full speed plus any control equipment. Water pump power shall not be included. The measurement of air flow

will not be required as part of the test. Hybrid coolers shall be run dry i.e. without adiabatic cooling.

41.4.2.1 Method A - Direct Measurement

Product performance shall be demonstrated by measuring the cooling capacity and power input in accordance with the test procedure in BS EN 1048:2014 at a 5K liquid temperature difference and at 3 test points corresponding to a 10K, 15K and 20K difference in approach temperature. The EER should be determined for each test point. The approach temperature is the difference in temperature between the outlet water leaving the product and the inlet air temperature onto the product (i.e. the ambient temperature condition of the inlet air).

41.4.2.2 Method B - Indirect Measurement

Product performance shall be demonstrated by two separate tests conducted on the same product model and in accordance with BS EN 1048:2014, using a different set of operating conditions for each test. The product performance and EER at a 5K liquid temperature difference and 15K inlet temperature difference shall then be determined by extrapolation from the test results.

41.4.3 Rounding

For the avoidance of doubt test data should be presented to 1 decimal place. As an example, an EER of 99.9 would be deemed to be a fail.

41.5 Verification for ETL Listing

Any of the following testing routes may be used to demonstrate the conformity of products against the requirements:

- In-house testing – Self-certified
- In-house testing – Self-tested and verified or cross-checked by an independent body
- Witnessed testing
- Independent testing
- Representative testing (see clause 41.5.1)

Further information regarding the first four routes can be found in Guidance Note 5 on the ETL product testing framework[42].

41.5.1 Representative testing

Where applications are being made for two or more products that are variants of the same basic design, heat exchanger test data or predictions using a validated mathematical model may be submitted for a single representative model, provided that all variants:

- Use air to liquid heat exchangers of the same constructional design.
- Have the same general arrangement of fans and heat exchangers.

[42] https://www.gov.uk/government/publications/energy-technology-list-etl-product-testing-framework

- Are constructed from materials with same heat transfer characteristics.
- Have the same (+/- 5%) or better energy efficiency as the representative models.

Since model numbers are dependent on configuration, dimensions, number and type of fans, heat exchanger coil number and fin type, wild cards can be used for representative models as long as the criteria listed above are met. For example, LF-PA2**T2*-080N06D, where the wild card is applied to number of fans per row, and orientation (horizontal or vertical).

Evidence supporting representative models, including a description of the fan and heat exchanger configuration, fan area to coil area ratios, dimensions and orientation shall be provided (e.g., technical brochure).

It should be noted that:

- If a manufacturer voluntarily removes the representative model from the ETL then other products linked with that representative model may or may not be permitted to remain on the ETL.
- If any product submitted under these representative model rules is later found not to meet the performance criteria when independently tested, then all products based on the same representative model will be removed from the ETL.

41.6 Conformity testing

Products listed on the ETL may be subject to the scheme's conformity testing programme in order to ensure listed models continue to meet the ETL requirements.

42 Air-Cooled Condensing Units

Date published	2019
Date first launched	2004

42.1 Scope

Air-cooled condensing units covers products that are specifically designed to provide cooling to other equipment and systems that incorporate evaporators (and associated expansion valve control systems). Air-cooled condensing units are factory-assembled units that consist of an air-cooled condenser, one or more compressors, and interconnecting pipe work. They may include liquid receivers, filter driers, oil separators, shut off valves and related controls, and a weatherproof housing.

42.2 Definitions

An air-cooled condensing unit is a factory-assembled, packaged unit that consists of a refrigeration compressor, an air-cooled condenser and various ancillary components. This packaged unit does not contain a complete refrigeration system, but is designed to provide a convenient method for cooling a cold room or other equipment fitted with an evaporator that is controlled by an expansion valve.

Air-cooled condensing units are used in a variety of commercial and industrial cooling applications, including cold rooms, refrigerated display cabinets, back-bar

equipment, temperature controlled food preparation areas, and for air conditioning systems.

Air-cooled condensing units are available in a range of different designs and efficiencies. The Energy Technology List (ETL) Scheme aims to encourage the purchase of the higher efficiency products.

The ETL Scheme covers products in three temperature categories:

- High temperature units.
- Medium temperature units.
- Low temperature units.

These categories are defined in terms of the product performance at a particular temperature rating point. Products may be submitted under more than one category.

To be eligible for inclusion on the ETL, products shall meet the requirements as set out below.

42.3 Requirements

42.3.1 Eligibility requirements

To be eligible, products shall:

- Be designed to operate with one or more clearly identified standard refrigerants.
- Be a factory assembled unit that incorporates at least the following components:
  a) Air-cooled refrigerant condenser.
  b) One or more electrically driven refrigeration compressors.
  c) A control system that controls the product's compressor(s) and cooling fan(s).
- Conform to the requirements of The Pressure Equipment (Safety) Regulations 2016 in respect of their design, manufacture and testing procedures.

42.3.2 Performance requirements

Products shall have a coefficient of performance (COP) or Seasonal Energy Performance Ratio (SEPR) that is greater than or equal to the values shown in Table 42.1, according to the rated cooling capacity of the product.

Table 42.1 Performance thresholds for air-cooled condensing units

		Evaporating temperature (Dew point)	Rated cooling capacity, P_A (kW)	Performance parameter	Threshold
Operating temperature	HT	+5°C	n/a	COP	≥ 3.4
	MT	-10°C	$0 < P_A \leq 5$	COP	≥ 2.0
			$5 < P_A \leq 20$	SEPR	≥ 3.30
			$20 < P_A \leq 50$	SEPR	≥ 3.30
			$P_A > 50$	COP	≥ 2.0

		Evaporating temperature (Dew point)	Rated cooling capacity, P_A (kW)	Performance parameter	Threshold
	LT	-35°C	$0 < P_A \leq 2$	COP	≥ 1.1
			$2 < P_A \leq 8$	SEPR	≥ 1.70
			$8 < P_A \leq 20$	SEPR	≥ 1.80
			$P_A > 20$	COP	≥ 1.1

“≥" means "greater than or equal to"

"≤ " means "less than or equal to"

The COP, where applicable, should be measured at the specified standard rating points shown in Table 42.2.

Table 42.2 Testing conditions for COP of air-cooled condensing units at the standard rating points

Temperature category	Evaporating temperature (Dew point)	Ambient (Condenser air-on) temperature	Compressor suction gas temperature
High temperature units	+5°C	32°C	20°C
Medium temperature units	-10°C	32°C	20°C
Low temperature units	-35°C	32°C	20°C

Where:

- COP = refrigerating capacity divided by the power absorbed.
- SEPR = reference annual cooling demand divided by the annual electricity consumption of the product
- Refrigerating capacity, power absorbed and reference annual cooling demand are as defined in BS EN13215:2016 “Condensing units for refrigeration – Rating conditions, tolerances and presentation of manufacturer’s performance data”.
- Any condenser sub-cooling factored into the refrigerating capacity shall be clearly declared, noting that when a liquid receiver is incorporated into the product with no subsequent sub-cooler, the liquid temperature at the unit outlet should be used to determine capacity.

42.4 Measurement and Calculations

42.4.1 Measurement standards

The following standards, where applicable, shall be used for measuring and calculating product performance:

- BS EN 13215:2016 “Condensing units for refrigeration – Rating conditions, tolerances and presentation of manufacturer’s performance data”
- BS EN 13771-2:2017 “Compressor and condensing units for refrigeration. Performance testing and test methods. Part 2: Condensing units”
- BS EN 12900:2013 “Refrigerant compressors. Rating conditions, tolerances and presentation of manufacturer’s performance data”

Please note that performance data obtained in accordance with the test procedures set out in BS EN 13771-2:2007 will be accepted as an alternative to testing in accordance with BS EN 13771-2:2017 until further notice.

For product categories where a COP threshold is specified, performance data obtained in accordance with BS EN 13215:2000 will be accepted as an alternative to BS EN 13215:2016 until further notice.

42.4.2 Test Requirements

Product performance can either be determined using Method A or Method B to determine COP, or Method C to determine SEPR, subject to the following reporting requirements:

1. For COP measurement, a detailed test report shall be provided and include a statement of achieved performance at the required standard rating point.
2. For SEPR measurement, a detailed test report shall be provided for test point condition A or condition B according to the rating conditions defined in BS EN 13215:2016 “Condensing units for refrigeration – Rating conditions, tolerances and presentation of manufacturer’s performance data”.
   In addition, a statement of performance at load conditions A, B, C and D, shall be provided. Where results are determined by calculation then this should be on the basis of design and/or extrapolation. In this case, details of such calculations and/or extrapolations, and of tests to verify the accuracy of the calculations undertaken shall be made available.
3. The refrigerant properties used in the analysis of product / compressor performance shall be obtained from one of the following sources:
   - The US National Institute of Standards & Technology (NIST) Standard Reference Database 23 Thermodynamic and Transport Properties of Refrigerants and Refrigerant Mixtures Database: Version 6.0 or later. See http://fluidproperties.nist.gov/ or http://www.nist.gov/.
   - The ASERCOM properties database as defined in the ASERCOM Compressor Certification scheme, which is based closely on the NIST database (see http://www.asercom.org/).
4. For the high temperature category only, data for a suction gas temperature of 20°C may be obtained by the thermodynamic translation of data physically tested at 10K superheat.
5. To enable calculations to be checked, the report shall include (or be accompanied by) the manufacturer’s design data for the product and its key components, including the type of refrigerant used, condenser fan motor power, and compressor make and model number.

42.4.3 Performance metrics

42.4.3.1 Method A to determine COP

Under method A:

- The product’s coefficient of performance (COP) at relevant standard rating point (as specified in Table 42.2) shall be calculated with the method used to generate its published performance over the standard range of air temperature and evaporating temperature conditions.
- The accuracy of these calculations shall be confirmed in the following manner:

a) Actual product performance should be determined at two test conditions close to the relevant standard rating point specified in Table 42.2 that comply with the following limits:

   i. Evaporation temperature shall be within ±1°C of the standard rating point.

   ii. Ambient temperature shall be within ±5°C of the standard rating point, and one point shall be above the standard rating condition, and one below it.

   iii. Suction Temperature shall be within ±1°C of the standard rating point.

   The following measurements shall be made at each test condition with the level of measurement uncertainty specified in Table 3 of BS EN 13771-2: 2017, whilst the product operating under stable conditions at full load:

   i. Condensing and evaporating pressures and dew point temperatures at the compressor inlet and outlet.
   ii. Superheat and sub-cooling at the compressor's inlet and the product's outlet.
   iii. Condenser air inlet temperature.

b) The condenser's UA value is determined at each test condition using the verified compressor performance data to establish the heat rejection rate.

c) The arithmetic mean of the UA values at the two test conditions is used to determine the condensing temperature, and the product's performance at the standard rating point.

- The test report shall include (or be accompanied by):

  a) Details of the calculation used to determine product performance.

  b) The following information on the product's compressor:

     i. Refrigerating capacity and COP at the appropriate standard rating point specified in BS EN 12900: 2013, and at the relevant standard rating point specified in the eligibility criteria for 'refrigeration compressors'.
     ii. Evidence that the product's compressor is listed on the Energy Technology Product List, or that its performance has been independently verified
     iii. A copy of the manufacturer's published performance data (or a print out of its key performance data from the manufacturer's design/selection software).

42.4.3.2 Method B to determine COP

Under method B, product performance shall be demonstrated by testing the product in accordance with BS EN 13771-2: 2017 "Compressor and condensing units for refrigeration. Performance testing and test methods. Part 2: Condensing units".

42.4.3.3 Method C to determine SEPR

Under method C, product performance shall be demonstrated by testing the product in accordance with the procedures in BS EN 13771-2: 2017 “Compressor and condensing units for refrigeration. Performance testing and test methods. Part 2: Condensing units”. The test conditions to be used, and the SEPR calculation method, should be those described in BS EN 13215:2016 “Condensing units for refrigeration – Rating conditions, tolerances and presentation of manufacturer’s performance data”.

42.4.4 Rounding

For the avoidance of doubt COP test data should be presented to 1 decimal place. SEPR test data should be provided to 2 decimal places. As an example, a product in the high temperature category with a COP of 3.3 would be deemed to not meet the performance requirements.

42.5 Verification for ETL Listing

Any of the following testing routes may be used to demonstrate the conformity of products against the requirements:

- In-house testing – Self-tested and self-certified
- In-house testing – Self-tested and verified or cross-checked by an independent body
- Witnessed testing
- Independent testing
- Representative testing (see clause 42.5.1)

Further information regarding the first four routes can be found in Guidance Note 5 on the ETL product testing framework[43].

42.5.1 Representative Testing

Where applications are being made for a range of two or more products that are variants of the same basic design, test data may be submitted for a representative selection of models, provided that all variants:

- Use the same refrigerant as the representative model.
- Have the same compressor type (i.e. manufacturer, method of compression (e.g. reciprocating or scroll) and type of enclosure (e.g. hermetic or semi-hermetic)) as the representative model.
- Have the same sub cooling arrangement as the representative model.
- Fit within the same product category (e.g. are all high temperature units).

The representative models shall be selected by dividing the range of products into groups of models with similar design characteristics, and testing a model in each group. The performance of each model in the group shall be predicted using a validated mathematical model. As a minimum, at least one model shall be tested in each range of products.

[43] https://www.gov.uk/government/publications/energy-technology-list-etl-product-testing-framework

It should be noted that:

- If a manufacturer voluntarily removes the representative model from the ETL then other products linked with that representative model may or may not be permitted to remain on the ETL.
- If any product submitted under these representative model rules is later found not to meet the performance criteria when independently tested, then all products based on the same representative model will be removed from the ETL.

42.6 Conformity testing

Products listed on the ETL may be subject to the scheme's conformity testing programme in order to ensure listed models continue to meet the ETL requirements.

42.7 Review

42.7.1 Indicative review date

This specification is scheduled for review during the 2021/22 ETL review cycle.

42.7.2 Illustrative future direction of the requirements

As the use of new low Global Warming Potential (GWP) refrigerants becomes more widespread in the air cooled condensing units market, eligibility and performance requirements may be reviewed, to account for the range of new lower GWP refrigerants that will become more widespread due to the EU F-gas regulations. The performance parameters may also be reviewed; products could potentially be assessed on their overall environmental impact accounting for seasonal efficiency, refrigerant GWP and refrigerant leakage.

43 Automated Permanent Refrigerant Leak Detection Systems

Date published	2019
Date first launched	2001

43.1 Scope

Automated permanent refrigerant leak detection systems are products that are specifically designed to continuously monitor the atmosphere in the vicinity of refrigeration equipment and, in the event of detection of refrigerant, give an alarm.

43.2 Definitions

An automated permanent refrigerant leak detection system continuously monitors the atmosphere in the vicinity of refrigeration equipment, and other components or pipework that contain refrigerant. The detection system shall be permanently fixed in place at the site of the refrigeration equipment.

Detection systems may be standalone/fixed point or aspirated systems. Where standalone/fixed point systems have a sensor for each space, aspirated systems

have a single master control panel which senses refrigerant concentration levels from multiple spaces by extracting air samples from each space through tubing.

The Energy Technology List (ETL) Scheme aims to encourage the purchase of products that give an early warning of refrigerant leaks, to allow their early repair, and thus improve the energy efficiency of the refrigeration system and reduce carbon emissions.

To be eligible for inclusion on the ETL, products shall meet the requirements as set out below.

43.3 Requirements

43.3.1 Eligibility requirements

To be eligible, products shall:

- Continuously monitor the refrigeration system for refrigerant leakage.
- Detect the presence of one or more refrigerants (which shall be clearly named in the information supporting the application) and raise an audible alarm when a pre-set level of refrigerant is reached.
- Have fittings to allow permanent fixing to the wall or floor.
- Standalone systems shall be able to operate in conditions of between --25 to 50°C and relative humidity levels of up to 90%.
- Aspirated systems shall be capable of extracting air samples in conditions of between -25 to 50°C and relative humidity levels of up to 90%. The control panels of these systems shall be able to operate in conditions of between 0 to 50°C and relative humidity levels of up to 90%.
- Have an appropriate Conformity Assessment mark.

Automated permanent refrigerant leak detectors shall be calibrated for each refrigerant named in the application. The product shall be capable of detecting at least one of the following types of refrigerant: HCFC, HFC, HC, HFO, Carbon Dioxide (CO_2) or Ammonia (NH_3).

Automated permanent leak detection systems dedicated to ammonia detection for concentration levels at which ammonia is flammable, are not eligible.

43.3.2 Performance requirements

To be eligible, products shall:

- Meet the relevant alarm signal threshold set out in Table 43.1 below, which varies with refrigerant type.
- Generate an alarm signal when the level of refrigerant in the atmosphere exceeds the alarm signal threshold, which may be equal to or lower than the refrigerant-specific thresholds set out in Table 43.1 below.
- Have a measurement accuracy and measurement sensitivity according to the refrigerant type, equal to or better than the levels set out in Table 43.1 at refrigerant concentrations up to the relevant alarm threshold in Table 43.1.

Table 43.1 Performance thresholds for automated permanent refrigerant leak detection systems

Refrigerant	Alarm signal threshold (parts per million, ppm)	Measurement accuracy (ppm)	Measurement sensitivity (ppm)
HCFC, HFC, HFO or HC	≤100	±20	10
CO_2	≤5,000	±500	100
NH_3	≤100	±20	10

"≤" means "less than or equal to" where products that can generate an alarm signal at lower refrigerant concentration levels than stated in the above Table 43.1, exceed the performance requirements.

Where:

- Measurement accuracy refers to the allowed variation between the measured and actual refrigerant level in the atmosphere.
- Measurement sensitivity refers to the change in the refrigerant concentration level that a product is able to detect. This is not the minimum refrigerant concentration level that the product is able to detect.

43.4 Measurement and Calculations

43.4.1 Measurement standards

The test procedures set out in the following test standards can be used to demonstrate product performance:

- BS EN 14624:2005 “Performances of mobile leak detectors and of room controllers of halogenated refrigerants”. (Section 11.2 – Efficiency tests of room controller).
- BS EN 14624:2012 “Performance of portable leak detectors and of room monitors for halogenated refrigerants”.
- Gas Detector Selection and Calibration Guide, SIRA, 2005, ISBN 10: 1856092976 ISBN 13: 9781856092975.

43.4.2 Test Requirements

The performance of the equipment shall be tested at the concentrations stated in the performance criteria using calibration gases produced using methods that are traceable to British standards.

A calibration report shall be supplied that demonstrates the product’s sensitivity, accuracy and alarm setting using test gases.

43.5 Verification for ETL Listing

Any of the following testing routes may be used to demonstrate the conformity of products against the requirements:

- In-house testing – Self-certified

- In-house testing – Self-tested and verified or cross-checked by an independent body
- Witnessed testing
- Independent testing
- Representative testing (see clause 43.5.1)

Further information regarding the first four routes can be found in Guidance Note 5 on the ETL product testing framework[44].

43.5.1 Representative testing

Where applications are being made for two or more products that are constructed using a common set of sensors and electronic modules, then test data may be submitted for a representative selection of models that clearly demonstrate the performance of each type of sensor with each refrigerant, and impact on performance of using different electronic modules.

It should be noted that:

- If a manufacturer voluntarily removes the representative model from the ETL then other products linked with that representative model may or may not be permitted to remain on the ETL.
- If any product submitted under these representative model rules is later found not to meet the performance criteria when independently tested, then all products based on the same representative model will be removed from the ETL.

43.6 Conformity testing

Products listed on the ETL may be subject to the scheme's conformity testing programme in order to ensure listed models continue to meet the ETL requirements.

43.7 Review

43.7.1 Indicative review date

This specification is scheduled for review during the 2022/23 review cycle.

43.7.2 Illustrative future direction of the requirements

A provisional update to the standard for measuring refrigerant concentration levels, prEN 14624:2018 for portable leak detectors has been released. It is currently under review and has not been referenced in this specification; however, future requirements will reference it. There is also a provisional standard prEN 50676 for electrical equipment used for refrigerant and SF6 detection and concentration measurement, which will be referenced in future requirements.

[44] https://www.gov.uk/government/publications/energy-technology-list-etl-product-testing-framework

44 Cellar Cooling Equipment

Date published	2020
Date first launched	2003

44.1 Scope

Cellar cooling equipment covers refrigeration products that are specifically designed to maintain, by means of a refrigeration system, an indoor environment at a condition suitable for the storage of chilled beverages below 12°C, and free cooling units that ensure free cooling is utilised when the outside ambient temperature is sufficiently low.

44.2 Definitions

Cellar cooling refrigeration equipment is permanently installed and uses the standard refrigeration cycle of evaporation, compression and condensation to cool a cellar or other storage space.

Cellar cooling refrigeration equipment is available in a range of different designs and efficiencies. The Energy Technology List (ETL) Scheme aims to encourage the purchase of higher efficiency products. It also encourages the purchase of free cooling units that utilise free cooling in order to reduce the energy consumption of the cellar cooling refrigeration equipment when weather conditions are suitable.

44.2.1 Sub-categories

The ETL Scheme covers three categories of cellar cooling equipment:

- Single split systems with the equipment supplied in two parts (evaporator and condensing unit) to be connected on installation.
- Dual split systems with the equipment supplied in three parts (two evaporators and one condensing unit) to be connected on installation.
- Free cooling units for cellar cooling.

To be eligible for inclusion on the ETL, products shall meet the requirements as set out below.

44.3 Requirements

44.3.1 Eligibility requirements

To be eligible, cellar cooling refrigeration equipment products shall:

- Have a cooling capacity of between 2 kW and 12 kW at the standard rating conditions for ambient air temperature of 32°C and a cellar air temperature of 10°C.
- Consist of two or three factory-built sub-assemblies that are designed to be connected during installation.
- Conform with the requirements of The Pressure Equipment (Safety) Regulations 2016.

To be eligible, free cooling unit products shall:

- Utilise a fan to draw in ambient air from outdoors to provide free cooling when the ambient temperature is sufficiently below the required indoor temperature.
- Incorporate a fan which meets the minimum energy efficiency requirements for fans driven by motors with an electric input power between 125 W and 10 kW as given in eco-design regulation (EU) No 327/2011.
- Include a damper which is designed to close when the free cooling unit is not in operation in order to prevent air leakage from outdoors into the cooled space.
- Incorporate an automatic control system which controls both the free cooling unit and cellar cooling equipment as follows:
  - The free cooling unit is in operating mode when the outside ambient temperature is below a set temperature.
  - Air is circulated within the cooled space by using one or two fans of the cellar cooling unit evaporator when the free cooling unit is in operating mode, the remaining one or more evaporator fans being switched off.
  - The free cooling unit fan starts and draws ambient air into the cooled space when the temperature rises to a given setpoint and the outside ambient temperature is below the set temperature.
  - When the temperature of the cooled space reduces to the setpoint temperature minus the set temperature differential, the free cooling unit fan switches off.
  - If the outside temperature rises above the set temperature, the free air cooling system goes into standby mode and the cellar cooling equipment resumes normal operation.
- Have an appropriate Conformity Assessment mark.

44.3.2 Performance requirements

Cellar cooling refrigeration products (currently listed on the ETL[45]) shall have a Coefficient of Performance (COP) equal to or greater than the figures shown in Table 44.1 below.

For new applicants, a Seasonal Energy Performance Ratio (SEPR) shall be declared using the ETL calculation tool derived from BS EN 14825:2018.

Table 44.1 Coefficient of Performance thresholds for cellar cooling equipment

Product category	COP
Single split systems	≥ 3.30
Dual split systems	≥ 3.30

"≥" means "greater than or equal to"

The refrigerant used in the testing and resulting declaration of the equipment's COP/SEPR shall be stated on application.

[45] August 2020

44.4 Measurement and Calculations

44.4.1 Measurement standards

Either of the following standards shall be used to determine product performance:

For ETL listed products (through August 2020): BSI Publicly Available Specification PAS 57:2003 “Cellar cooling equipment – Procedure for determining performance and calculating energy efficiency”

After August 2020: BS EN 14825:2018 Air conditioners, liquid chilling packages and heat pumps, with electrically driven compressors, for space heating and cooling. Testing and rating at part load conditions and calculation of seasonal performance.

- To be used in conjunction with the ETL Cellar Cooling Equipment SEPR calculation tool (see below).

44.4.2 Performance metrics

The Coefficient of Performance (COP) at full load shall be calculated using the following equation, in accordance with BSI PAS 57:2003.

$$COP = \frac{system\ cooling\ capacity\ (kW)}{system\ energy\ consumption\ (kW)}$$

The Seasonal Energy Performance Ratio (SEPR), shall be calculated using the ETL Cellar Cooling Equipment SEPR Calculation Tool in conjunction with BS EN 14825:2018, which is based upon four rating point measurements of COP (32, 25, 15 and 5°C ambient temperatures).

44.4.3 Test Requirements

Testing (after August 2020) shall use the calorimeter test method defined in Annex A of BS EN 14511-3:2018.

44.4.4 Rounding

For the avoidance of doubt test data should be presented to 2 decimal places. As an example, a COP of 3.29 would be deemed to not meet the performance requirements.

44.5 Verification for ETL Listing

Any of the following testing routes may be used to demonstrate the conformity of products against the requirements:

- In-house testing – Self-tested and verified or cross-checked by an independent body
- Witnessed testing
- Independent testing
- Representative testing (see clause 44.5.1 below)

Further information regarding the first four routes can be found in Guidance Note 5 on the ETL product testing framework[46].

44.5.1 Representative testing

Where applications are being made for a range of two or more products that are variants of the same basic design, test data may be submitted for a representative selection of models, provided that all variants:

- Use the same refrigerant as the representative model.
- Have the same compressor type (i.e. manufacturer, method of compression (e.g. reciprocating or scroll) and type of enclosure (e.g. hermetic or semi-hermetic)) as the representative model.
- Have the same sub cooling arrangement as the representative model.
- Have the same number of evaporators.
- Fit within the same product category (e.g. are all split systems).

The representative models shall be selected by dividing the range of products into groups of models with similar design characteristics, and testing a model in the lowest quartile of predicted performance in each group. The performance of each model in the group shall be predicted using a validated mathematical model. As a minimum, at least two models shall be tested in each range of products and in each laboratory used for product testing.

It should be noted that:

- If a manufacturer voluntarily removes the representative model from the Energy Technology List (ETL) then other products linked with that representative model may or may not be permitted to remain on the ETL.
- If any product submitted under these representative model rules is later found not to meet the performance criteria when independently tested, then all products based on the same representative model will be removed from the ETL.

44.6 Conformity testing

Products listed on the ETL may be subject to the scheme's conformity testing programme in order to ensure listed models continue to meet the ETL requirements.

44.7 Review

44.7.1 Indicative review date

This specification will be reviewed during the 2022/23 ETL review cycle.

44.7.2 Illustrative future direction of the requirements

Future changes to the Specification may include:

[46] https://www.gov.uk/government/publications/energy-technology-list-etl-product-testing-framework

- Transition to SEPR as the basis for performance thresholds, using BS EN 14825:2018.
- Removal of BSI PAS 57:2003 as a measurement standard, testing requirement, and associated COP thresholds.
- Define an SEPR performance threshold and reassess all listed products against this requirement, ensuring only models with an SEPR are listed on the ETL from April 2023.

45 Curtains, Blinds, Doors and Covers for Refrigerated Display Cabinets

Date published	2015
Date first launched	2001

45.1 Scope

Curtains, blinds, doors and covers are barriers that can be used to reduce the infiltration of ambient air (and heat flow) into refrigerated display cabinets, thereby reducing the energy consumption of the cabinet.

The Energy Technology List (ETL) Scheme covers six categories of products:

1. Strip curtains that consist of transparent, flexible strips hung adjacent to each other, and fastened at both ends to neighbouring strips, in a manner that allows temporary openings to be made in the curtain for the purpose of removing items from the cabinet.
2. Blinds that consist of a flexible fabric mounted on a roller mechanism that enables the blind to be deployed across the display window of the cabinet when the retail outlet is closed or during trading. The blind may also incorporate a motorised control system.
3. Transparent chest freezer covers (or ‘bubble lids’) that consist of a rigid transparent material that fits across the display window of the cabinet, and incorporates access holes that enable items to be removed from the cabinet without removing the cover.
4. Transparent sliding doors that consist of doors with a heat reflective coating, mounted in a mechanism (that is designed to be installed in the window of the cabinet) that enables the doors to be opened when items need to be removed from the cabinet.
5. Transparent hinged doors that consist of doors with a heat reflective coating, mounted in a mechanism (that is designed to be installed in the window of the cabinet) that enables the doors to be opened when items need to be removed from the cabinet.
6. Enhanced air flow management equipment designed to enhance the descending air curtain at the front of an open refrigerated display cabinet in order to reduce the infiltration of ambient air. This equipment comprises modifications or attachments to the shelves of the cabinet.

To be eligible for inclusion on the ETL, products must meet the requirements as set out below.

45.2 Definitions

Curtains, blinds, doors and covers (for refrigerated display cabinets) are products that are specifically designed to reduce the infiltration of ambient air into a refrigerated display cabinet.

45.3 Requirements

45.3.1 Eligibility requirements

To be eligible, products must:

- Be of fixed design and dimensions with a unique product code.

In addition, products in categories 1, 2, 3, 4 and 5 must:

- Provide a flexible or rigid barrier that can be used to reduce the infiltration of ambient air (and heat flow) through the open display window of a refrigerated display cabinet.
- Be designed to fit one or more specific types or models of refrigerated display cabinet in a manner that ensures that when fitted there is no air gap around the edges of the product's rigid barriers, and an air gap of less than 20mm around the edges of the product's flexible barriers.

Products in category 6 must:

- Be a physical device designed to modify or be permanently attached to the shelving of one or more specific types or models of refrigerated display cabinet.
- Be designed to guide the air flow(s) more closely down the entire front of a refrigerated display cabinet in order to reduce the infiltration of ambient air.

Equipment that contains integrated lighting equipment is eligible as long as the lighting equipment also meets the relevant ETL criteria for high efficiency lighting units or white light emitting diode lighting units as appropriate.

45.4 Verification for ETL Listing

There are no testing requirements, however manufacturers shall provide sales and technical brochures to evidence the conformity of their products against the requirements from section 45.3.

45.5 Conformity testing

Products listed on the ETL may be subject to the scheme's conformity testing programme in order to ensure listed models continue to meet the ETL requirements.

46 Evaporative Condensers

Date published	2018
Date first launched	2001

46.1 Scope

Evaporative condensers allow refrigeration systems to operate with lower head pressures and higher efficiencies than can be achieved using air-cooled condensers or water-cooled condensers. They use evaporative cooling to remove heat from the refrigerant vapour.

Evaporative condensers are generally used in larger refrigeration systems and the Energy Technology List (ETL) Scheme aims to encourage their purchase as an alternative to lower efficiency solutions.

To be eligible for inclusion on the ETL, products shall meet the requirements as set out below.

46.2 Definitions

Evaporative Condensers are specifically designed to cool and condense high-pressure refrigerant vapour by means of a heat exchanger that has a wetted external surface across which air is blown by a fan.

46.3 Requirements

46.3.1 Eligibility requirements

To be eligible, products shall:

- Incorporate:
  - a) A heat exchanger that is designed to cool and condense refrigerant vapour.
  - b) An axial fan that blows air over the heat exchanger.
  - c) A blow down facility for the water storage tank to enable total dissolved solids content of the water in the storage tank to be controlled.
  - d) And either:
    - A mechanism that wets the external surface of the heat exchanger that includes a water pump and a water storage tank; or
    - A hybrid mechanism that wets the external surface of the heat exchanger at high ambient temperatures (evaporative cooling) and switches to dry operation when a user defined dry switch-point is reached at lower temperatures (dry cooling). The hybrid mechanism will also include includes a water pump and a water storage tank.
- Conform with the requirements of The Pressure Equipment (Safety) Regulations 2016 in respect of its design, manufacture and testing procedures, or have an appropriate Conformity Assessment mark.

- In addition, where products incorporate an automatic blow down control system, they shall also incorporate a means of measuring total dissolved solids content of the water in the storage tank.

46.4 Verification for ETL Listing

There are no testing requirements, however manufacturers shall provide sales and technical brochures to evidence the conformity of their products against the requirements from section 46.3.

46.5 Conformity testing

Products listed on the ETL may be subject to the scheme's conformity testing programme in order to ensure listed models continue to meet the ETL requirements.

47 Packaged Chillers

Date published	2019
Date first launched	2014
Former name	Packaged Chillers (tested for seasonal performance to ESEER)

47.1 Scope

Packaged chillers cover products that are specifically designed to cool liquids by means of a refrigeration system that is packaged within a single factory assembled unit. Optionally products also may be designed to heat liquids

47.2 Definitions

Packaged chillers generate chilled water that can be used to provide space cooling in summer in large air-conditioned buildings; these are comfort chillers. They can also be used as process chillers to generate chilled water or other fluids for industrial process cooling.

Reverse cycle packaged chillers are able to heat fluids and can be used to provide space heating in winter, or for industrial process heating. Simultaneous heating and cooling packaged chillers are able to provide space heating and cooling simultaneously to meet different space conditioning needs within a building. Some air cooled packaged chillers also incorporate free cooling mechanisms that can be used to reduce the amount of electricity needed by the product to provide cooling at lower ambient temperatures.

Under the Energy Technology List (ETL) scheme, comfort chillers are defined as products which are designed to deliver a chilled water flow temperature of greater than or equal to 2°C. High temperature process chillers are defined as products that are designed to meet a process cooling load with a chilled water flow temperature of between 2°C and 12°C, inclusive.

Packaged chillers are available in a wide range of different designs and efficiencies. The ETL Scheme aims to encourage the purchase of the higher efficiency products.

47.2.1 Sub-categories

The ETL Scheme covers seven categories of products:

1. Air-cooled comfort chillers that provide cooling only and have a cooling capacity that is less than or equal to 1,500kW.
2. Air-cooled, reverse cycle, comfort chillers that provide both heating and cooling and have a cooling capacity that is less than or equal to 1,500kW.
3. Water-cooled comfort chillers that provide cooling only and have a cooling capacity that is less than or equal to 2,000kW.
4. Water-cooled, reverse cycle, comfort chillers that provide both heating and cooling and have a cooling capacity that is less than or equal to 2,000kW.
5. Air-cooled simultaneous heating and cooling comfort chillers that are able to provide both heating and cooling simultaneously and have a cooling capacity that is less than or equal to 1,500kW.
6. Air-cooled high temperature process chillers that have a refrigeration capacity that is less than or equal to 1,500kW.
7. Water-cooled high temperature process chillers that have a refrigeration capacity that is less than or equal to 2,000kW.

To be eligible for inclusion on the ETL, products shall meet the requirements as set out below.

47.3 Requirements

47.3.1 Eligibility requirements

To be eligible, products shall:

- Incorporate the following items of equipment:
  a) One or more electrically powered compressors.
  b) One or more air-cooled or water-cooled condensers.
  c) One or more evaporators.
  d) A control system that ensures the safe, reliable and efficient operation of the product.
- Have an appropriate Conformity Assessment mark.

Where the product incorporates an integral free-cooling mechanism, it shall be:

- Fully integrated into the packaged chiller unit during product manufacturing.
- Directly controlled by the product's control system in a manner that maximises the use of free cooling for outside air, dry bulb temperatures between 2.0 and 15.0°C, where the inlet and outlet water temperatures may differ from the standard rating condition specified in Table 47.2 to enable free cooling to occur at these ambient conditions.
- Able to provide a cooling capacity at an outside air, dry bulb temperature of 2.0°C and an outlet water temperature of 7.0°C that is at least (≥) 50% of the cooling capacity obtained at the standard rating condition specified in Table 47.2.

47.3.2 Performance requirements

Products shall have a Seasonal Space Cooling Energy Efficiency ($\eta_{S,C}$) or Seasonal Energy Performance Ratio (SEPR) that is greater than or equal to the values set out in Table 47.1, according to the rated cooling/refrigeration capacity of the product and the product category. Products that can be used for comfort cooling and process cooling applications can be listed under both categories, provided that the applicable performance requirements for both comfort and process chillers, as set out in Table 47.1, are met.

In addition, reverse cycle products shall have a Seasonal Space Heating Energy Efficiency ($\eta_{S,H}$) greater than or equal to the values set out in Table 47.1. Simultaneous heating and cooling products shall have a cooling Energy Efficiency Ratio (EER) and heating Coefficient of Performance (COP) greater than or equal to the values set out in Table 47.1.

Table 47.1 Performance thresholds for packaged chillers at standard rating conditions

	Product category		Rated cooling capacity (kW)	Performance thresholds	
				Cooling $\eta_{S,C}$ (%)	Heating $\eta_{S,H}$ (%)
1.	Air-cooled comfort chillers that provide cooling only	**without** integral free cooling mechanism	< 400 kW	≥ 175.0%	
			≥ 400 kW and ≤ 1500 kW	≥ 190.0%	
		with integral free cooling mechanism	< 400 kW	≥ 168.0%	
			≥ 400 kW and ≤ 1500 kW	≥ 185.0%	
2.	Air-cooled, reverse cycle, comfort chillers that provide heating and cooling		< 400 kW	≥ 168.0%	≥ 143.0%
			≥ 400 kW and ≤ 1500 kW	≥ 185.0%	≥ 143.0%
3.	Water-cooled comfort chillers that provide cooling only		< 400 kW	≥ 230.0%	
			≥ 400 kW and < 1500 kW	≥ 310.0%	
			≥ 1500 kW and ≤ 2000 kW	≥ 320.0%	
4.	Water-cooled, reverse cycle, comfort chillers that provide heating and cooling		< 400 kW	≥ 220.0%	≥ 212.0%
			≥ 400 kW and < 1500 kW	≥ 270.0%	≥ 284.0%
			≥ 1500 kW and ≤ 2000 kW	≥ 284.0%	≥ 290.0%

	Product category	Rated cooling capacity (kW)	Performance thresholds	
			Cooling EER	Heating COP
5.	Air-cooled, simultaneous heating and cooling comfort chillers that provide heating and cooling	up to 1500kW	≥ 3.30	≥ 3.70

	Product category	Rated refrigeration capacity (kW)	Cooling SEPR performance thresholds
6.	Air-cooled, high temperature process chillers	< 400 kW	≥ 6.50
		≥ 400 kW and ≤ 1500 kW	≥ 7.00
7.	Water-cooled, high temperature process chillers	< 400 kW	≥ 8.00
		≥ 400 kW and < 1500 kW	≥ 9.00
		≥ 1500 kW and ≤ 2000 kW	≥ 9.10

“≥" means "greater than or equal to"

“≤” means “less than or equal to”

“<” means “less than”

Where:

- The seasonal space cooling energy efficiency ($\eta_{S,C}$) is defined as the ratio between the reference annual cooling demand pertaining to the cooling season for a product and the annual energy consumption for cooling, corrected by contributions accounting for temperature control and the electricity consumption of ground water pumps, where applicable.

- The seasonal space heating energy efficiency ($\eta_{S,H}$) is defined as the ratio between the reference annual heating demand pertaining to the heating season for a product and the annual energy consumption for heating, corrected by contributions accounting for temperature control and the electricity consumption of ground water pumps, where applicable.
- The seasonal energy performance ratio (SEPR) is the efficiency ratio of a high temperature process chiller at standard rating conditions, representative of the variations in load and ambient temperature throughout the year, and calculated as the ratio between the annual refrigeration demand and the annual electricity consumption.
- The cooling energy efficiency ratio (EER) is the ratio of the net cooling capacity to the effective power input when the product is cooling at full load.
- The heating coefficient of performance (COP) is the ratio of the net heating capacity to the effective power input when the product is heating at full load.

47.4 Measurement and Calculations

47.4.1 Measurement standards

The following standards, where applicable, shall be used to determine product performance:

- BS EN 14511:2018 “Air conditioners, liquid chilling packages and heat pumps, with electrically driven compressors, for space heating and cooling”
- BS EN 14825:2018 “Air conditioners, liquid chilling packages and heat pumps, with electrically driven compressors, for space heating and cooling – Testing and rating at part load conditions and calculation of seasonal performance”

Please note that performance data for comfort chillers obtained in accordance with the procedures and standard rating conditions laid down in BS EN 14511:2013 will be accepted as an alternative to testing in accordance with BS EN 14511:2018 until further notice. Performance data for comfort chillers obtained in accordance with the procedures and standard rating conditions laid down in BS EN 14825:2016 will also be accepted as an alternative to testing in accordance with BS EN 14825:2018.

47.4.2 Performance metrics

47.4.2.1 Calculation of $\eta_{S,C}$

The seasonal space cooling energy efficiency ($\eta_{S,C}$) shall be calculated using the equation below:

$$\eta_{S,C} = \frac{1}{CC} \times SEER - \sum F(i)$$

Where:

- The Seasonal Energy Efficiency Ratio (SEER) is defined as the overall energy efficiency ratio of the product, representative for the cooling season and shall be calculated in accordance with the methods described in BS EN 14825:2018.

- The value of the Conversion coefficient (CC), which accounts for the estimated 40% average EU generation efficiency, shall be 2.5.
- ΣF(i) is the sum of the space cooling correction factors, of which there are two:
  - F(1), the temperature controls correction factor, shall be 3%
  - F(2), the brine and water pumps correction factor, which is only applicable for water-cooled cooling only and reverse-cycle comfort chillers, shall be 5%.

The seasonal space cooling energy efficiency shall be calculated based on the part load Energy Efficiency Ratios (EER) at the 24 outdoor temperature conditions of the reference cooling season, as defined in BS EN 14825:2018. Each part load EER shall be weighted by the number of hours in a year during which each outdoor temperature condition occurs, as defined by the reference cooling season.

The part-load EER values shall be measured at four of the 24 part-load conditions; A, B, C and D, which are defined in BS EN 14825:2018 – see Table 47.3. The remainder of the EER values shall be determined via interpolation of the EER values at part-load conditions A, B, C and D. For ambient temperatures above the part load A ambient temperature, the same EER value as for part load condition A shall be used. For ambient temperatures below the part load D ambient temperature, the EER value for part load condition D shall be used.

The methods for calculating the $\eta_{S,C}$ and SEER are described in full in Clause 5 of BS EN 14825:2018, with a worked example in Annex G of the same test standard.

47.4.2.2 Calculation of $\eta_{S,H}$

The seasonal space heating energy efficiency ($\eta_{S,H}$) shall be calculated using the equation below, in accordance with the methods described in BS EN 14825:2018.

$$\eta_{S,H} = \frac{1}{CC} \times SCOP - \sum F(i)$$

Where:

- The Seasonal Coefficient of Performance (SCOP) is defined as the overall energy efficiency ratio of the product, representative for the heating season.
- The value of the Conversion coefficient (CC), which accounts for the estimated 40% average EU generation efficiency, shall be 2.5.
- ΣF(i) is the sum of the space heating correction factors, of which there are two:
  - F(1), the temperature controls correction factor, shall be 3%
  - F(2), the brine and water pumps correction factor, which is only applicable for water-cooled reverse-cycle comfort chillers, shall be 5%.

The seasonal space heating energy efficiency shall be calculated for a low temperature application with a water supply temperature of 35°C. $\eta_{S,H}$ shall be based on the part load Coefficient of Performance (COP) at the 46 outdoor temperature conditions of the reference heating season, as defined in BS EN 14825:2018. Each part load COP shall be weighted by the number of hours in a year during which each outdoor temperature condition occurs, as defined by the reference heating season.

The part-load COP values shall be measured at four of the 46 part-load conditions; A, B, C and D, which are defined in BS EN 14825:2018 – see Table 47.3. The remainder of the COP values shall be determined via interpolation/extrapolation of the COP values at part-load conditions A, B, C and D. For ambient temperatures above the part load D ambient temperature, the COP and capacity shall be extrapolated from the values for part load conditions C and D.

The methods for calculating the $\eta_{S,H}$ and SCOP are described in full in Clause 8 of BS EN 14825:2018, with a worked example in Annex H of the same test standard.

47.4.2.3 Calculation of SEPR

The SEPR shall be determined in accordance with the test conditions and calculation method described in Clause 10 of BS EN 14825:2018.

47.4.2.4 Calculation of EER

The cooling Energy Efficiency Ratio (EER) at full load shall be calculated using the following equation:

$$EER = \frac{net\ cooling\ capacity\ (kW)}{effective\ power\ input\ (kW)\ when\ cooling}$$

47.4.2.5 Calculation of COP

The heating Coefficient of Performance (COP) at full load shall be calculated using the following equation:

$$COP = \frac{net\ heating\ capacity\ (kW)}{effective\ power\ input\ (kW)\ when\ heating}$$

47.4.3 Test Requirements

All products shall be tested to determine product performance under laboratory conditions in accordance with the procedures set out in BS EN 14511:2018.

The product's cooling/refrigeration capacity (kW), EER (at full load) and COP shall be determined at the standard rating conditions set out in Table 47.2 below, which vary by product category.

Table 47.2 Standard rating conditions for Packaged Chillers

	Product category	Cooling EER and Cooling/refrigeration capacity (kW)	Heating COP
1.	Air-cooled comfort chillers that provide cooling only	BS EN 14511-2:2018 Table 16, Standard rating conditions, Water (for intermediate temperature heating application and comfort chillers)	
2.	Air-cooled, reverse cycle, comfort chillers that provide heating and cooling	BS EN 14511-2:2018 Table 16, Standard rating conditions, Water (for intermediate temperature heating application and comfort chillers)	BS EN 14511-2:2018 Table 12, Standard rating conditions, Outdoor air
3.	Water-cooled comfort chillers that provide cooling only	BS EN 14511-2:2018 Table 11, Standard rating conditions, Water-to-water (for intermediate temperature heating applications) from cooling tower and comfort chillers	
4.	Water-cooled, reverse cycle, comfort chillers that provide heating and cooling	BS EN 14511-2:2018 Table 11, Standard rating conditions, Water-to-water (for intermediate temperature heating applications) from cooling tower and comfort chillers	BS EN 14511-2:2018 Table 7, Standard rating conditions, Water
5.	Air-cooled, high temperature, process chillers	BS EN 14511-2:2018 Table 25, Cooling capacity conditions for air-cooled, water-cooled process chillers	
6.	Water-cooled, high temperature, process chillers	BS EN 14511-2:2018 Table 25, Cooling capacity conditions for air-cooled, water-cooled process chillers	

The product's cooling/refrigerating capacity (kW) and EER at part load; and heating capacity (kW) and COP at part load, shall be determined at the part load conditions shown in Table 47.3 below and in accordance with the procedures detailed in BS EN 14825:2018 for comfort and process chillers.

For comfort chillers, where cooling capacity (kW) and EER test data is available at four part load conditions other than those stated in Table 47.3, these can be used to calculate the cooling capacity and EER at part load ratios A, B, C and D as below. In this scenario, test data in accordance with BS EN 14825:2013 will also be accepted as an alternative to testing in accordance with BS EN 14825:2018 until further notice.

Table 47.3 Part Load Conditions for Packaged Chillers

Product category	Cooling EER and cooling/refrigerating capacity (kW) at part load	Heating COP and heating capacity (kW) at part load
Air-cooled comfort chillers	BS EN 14825:2018 Table 4, Part load ratios A, B, C and D, fan coil application, fixed or variable outlet	BS EN 14825:2018 Table 8, Part load ratios A, B, C and D low temperature application, average reference heating season, fixed or variable outlet
Water-cooled comfort chillers	BS EN 14825:2018 Table 5, Part load ratios A, B, C and D, cooling tower application, fan coil application, fixed or variable outlet	BS EN 14825:2018 Table 12, Part load ratios A, B, C and D low temperature application, average reference heating season, ground water, fixed or variable outlet
Air-cooled high temperature process chillers	BS EN 14825:2018 Table 16, Part load ratios A, B, C and D, high temperature application	
Water-cooled high temperature process chillers	BS EN 14825:2018 Table 17, Part load ratios A, B, C and D, high temperature application	

Test results may be submitted in summary form provided that:

- Sufficient data is included to confirm that the cooling/refrigerating capacity (kW), EER, COP and SEPR, as applicable for each product was determined in accordance with the test procedures in BS EN 14511: 2018 and determined at, or corrected to, the standard rating conditions outlined in Table 47.2 and the part load conditions outlined in Table 47.3.
- At least one detailed test report is submitted for each range of products and for each laboratory used. The data to be recorded in a detailed test report for the test at standard rating conditions is defined in Table 6 of BS EN 14511-3: 2018. The test report shall include details of the data recording period and duration of performance measurement.
- Detailed test reports have been prepared for each product tested and are available on request for inspection, where not submitted with the application.

Where the same product can be used for comfort and process cooling applications, a single test report demonstrating that the $\eta_{S,C}$ performance threshold for comfort chillers is achieved may be provided. For these products, evidence that the SEPR performance threshold for process chillers is achieved may be provided by calculation using a validated mathematical model.

47.4.4 Rounding

For the avoidance of doubt test data should be presented to one decimal place. As an example, a water-cooled, reverse cycle, comfort chiller with a cooling capacity of 100kW, and a seasonal space cooling energy efficiency of 219.9, or a seasonal space heating energy efficiency of 211.9, would be deemed to not meet the performance requirements.

47.4.5 Uncertainties of measurement

All measurements used for the calculation of the SEER shall have a maximum level of uncertainty as stated in BS EN 14825:2018.

47.5 Verification for ETL Listing

Any of the following testing routes may be used to demonstrate the conformity of products against the requirements:

- In-house testing – Self-certified
- In-house testing – Self-tested and verified or cross-checked by an independent body
- Witnessed testing
- Independent testing
- Representative testing (see clause 47.5.1 below)

Further information regarding the first four routes can be found in Guidance Note 5 on the ETL product testing framework[47].

47.5.1 Representative Testing

Where applications are being made for a range of two or more products that are variants of the same basic design, test data may be submitted for a representative selection of models, provided that all variants:

- Use the same refrigerant as the representative model.
- Have the same compressor type (i.e. manufacturer, method of compression (e.g. reciprocating or scroll) and type of enclosure (e.g. hermetic or semi-hermetic)) as the representative model.
- Fit within the same product category (e.g. are all water-cooled comfort chillers).

The representative models shall be selected by dividing the range of products into groups of models with similar design characteristics, and testing a model in each group. The performance of each model in the group shall be predicted using a validated mathematical model. As a minimum, at least one model shall be tested in each range of products.

For air-cooled comfort chillers that provide cooling only, test data for representative models that incorporate free cooling can only be used to represent variants of similar design that incorporate free cooling. Test data for representative models that do not incorporate free cooling can only be used to represent variants of similar design that do not incorporate free cooling.

It should be noted that:

- If a manufacturer voluntarily removes the representative model from the ETL then other products linked with that representative model may or may not be permitted to remain on the ETL.
- If any product submitted under these representative model rules is later found not to meet the performance criteria when independently tested, then all products based on the same representative model will be removed from the ETL.

[47] https://www.gov.uk/government/publications/energy-technology-list-etl-product-testing-framework

47.6 Conformity Testing

Products listed on the ETL may be subject to the scheme's conformity testing programme in order to ensure listed models continue to meet the ETL requirements.

47.7 Review

47.7.1 Indicative review date

This specification will be reviewed during the 2021/22 ETL review cycle.

47.7.2 Illustrative future direction of the requirements

When the Tier 2 minimum energy performance standards of Commission Regulation (EU) 2016/2281 come into force for packaged chillers on 1 January 2021, the market average product performance will rise. Future requirements will therefore see a tightening of thresholds to reflect the top 25% of products with regards to energy efficiency.

Also, as the use of new low Global Warming Potential (GWP) refrigerants becomes more widespread in the packaged chillers market, the requirements will be reviewed to assess their impact on product performance.

48 Professional Refrigerated Storage Cabinets

Date published	2019
Date first launched	2003
Former name	Commercial Service Cabinets

48.1 Scope

Professional refrigerated storage cabinets are products that are specifically designed to store, but not to display, chilled and frozen foodstuffs.

48.2 Definitions

Professional refrigerated storage cabinets are widely used in the catering industry to store frozen or chilled foodstuffs (including super-chilled or partly-frozen foodstuffs), but a door, lid or drawer shall be opened to view or access the contents of the cabinet.

Professional refrigerated storage cabinets are available in a range of different designs and efficiencies. The Energy Technology List (ETL) Scheme aims to encourage the purchase of higher efficiency products.

The ETL Scheme covers three categories of product:

- Single door (vertical) professional refrigerated storage cabinets with one solid door or drawer accessing the same compartment.
- Double door (vertical) professional refrigerated storage cabinets with two solid doors or drawers accessing the same compartment.
- Under counter and counter (counter type) professional refrigerated storage cabinets with one or more solid doors or drawers accessing the same compartment.

To be eligible for inclusion on the ETL, products shall meet the requirements as set out below.

48.3 Requirements

48.3.1 Eligibility requirements

To be eligible, products shall:

- Be designed to store chilled or frozen foodstuffs, whilst maintaining them within prescribed temperature limits.
- Be fitted with solid-faced lids, drawers or doors that:
  - Are normally kept closed, but can be opened to access the contents of a single compartment.
  - Obscure the contents of the cabinet from view when closed.
  - Enable users to access the contents of any part of the interior without stepping into the refrigerated space.
- Be a ‘plug in’ type cabinet with an integral refrigeration system (i.e. incorporating a compressor and condensing unit).
- Have a gross internal volume between 68 and 1,495 litres; where the gross internal volume is as defined as the volume within the inside walls of the cabinet or of a compartment without internal fittings, with any doors being closed.
- Have an appropriate Conformity Assessment mark.

48.3.2 Performance requirements

Products shall have an Energy Efficiency Index (EEI) that is less than, or equal to, the thresholds set out in Table 48.1 below, which depend on the type of cabinet, number of doors/drawers, cabinet overall external height and temperature classification.

Table 48.1 Performance thresholds for professional refrigerated storage cabinets

		EEI (ratio) performance threshold	
Type	Overall external height (mm)	Chilled (M1)	Frozen (L1)
Single door professional refrigerated storage cabinets (vertical)	≥ 1,050	≤ 50.0	≤ 60.0
Double door professional refrigerated storage cabinets (vertical)	≥ 1,050	≤ 60.0	≤ 65.0
Under counter and counter professional refrigerated storage cabinets (counter)	< 1,050	≤ 30.0	≤ 55.0

"≤" means "less than or equal to"

“<” means “less than”

“≥” means “greater than or equal to”

Where:

- The Energy Efficiency Index (EEI) is defined as the ratio between AEC (Annual Energy Consumption of the cabinet in kWh/year) and SAEC (Standard Annual Energy Consumption of the cabinet in kWh/year).
- The overall external height shall be based on the 'as-installed' product height.

48.4 Measurement and Calculations

48.4.1 Measurement standards

The following standard shall be used for measuring and calculating product performance:

- BS EN 16825:2016 "Refrigerated storage cabinets and counters for professional use. Classification, requirements and test conditions."

Equivalent test standards will be accepted as an alternative to testing in accordance with BS EN 16825:2016 where the resulting performance data can be shown to be equivalent to that obtained under BS EN 16825:2016.

48.4.2 Performance metrics

The Energy Efficiency Index (EEI) of a product shall be calculated using the equation below:

$$\mathrm{EEI} = \left(\frac{\mathrm{AEC}}{\mathrm{SAEC}}\right) \times 100 = \left(\frac{(\mathrm{E24h} \times 365)}{(\mathrm{M} \times \mathrm{Vn} + \mathrm{N})}\right) \times 100$$

Where:

- E24h = the energy consumption of the cabinet over 24 hours, as defined in BS EN 16825:2016 (measured in kWh)
- Vn= net volume of the appliance, which is the sum of net volumes of all compartments of the cabinets (measured in litres). Net volume is as defined in Section 6.1 of BS EN 16825:2016. The net volume shall be calculated as follows: the usable shelf area that food can be loaded onto, multiplied by the usable height into which food can be loaded minus an allowance for the height of the shelves, minus any other protrusions into the usable space.
- M and N are scaling coefficients with values defined in Table 48.2 below.

Table 48.2 M and N scaling coefficients

Climate class 4 (30°C 55%RH)	Value for M	Value for N
Vertical chilled (single or double door)	1.643	609
Vertical frozen (single or double door)	4.928	1,472
Counter chilled	2.555	1,790
Counter frozen	5.840	2,380

48.4.3 Test Requirements

Cabinets shall be able to conform to the temperature classifications set out in Table 48.3 below, when tested to BS EN 16825:2016 in climate class 4 (30°C, 55% RH).

Table 48.3 Product classification according to temperature

Temperature classification	The highest temperature Φαη of the warmest M-package equal to or lower than °C	The lowest temperature Φβ of the coldest M-package equal to or higher than °C	The lowest temperature Φαλ of the warmest M-package equal to or lower than °C
Chilled cabinets (M1)	+5	-1	-
Frozen cabinets (L1)	-15	-	-18

Cabinets shall be tested in a test room conforming to BS EN 16825:2016.

Cabinets shall be tested according to the requirements for “Commercial Service Refrigerated Cabinets and Counters intended for use in commercial kitchens” in BS EN 16825:2016 with the following test conditions:

- **Loading:** as described in BS EN 16825:2016. For cabinets with shelves, the minimum number of shelves to be used is calculated by dividing by 300mm the vertical distance from the surface of the lowest shelf or loadable surface to the load limit line. The number of shelves resulting shall be rounded to the nearest lowest integer, with a minimum of one shelf to be used. The lowest height shelf should be located at the lowest available height fitting.
- **Temperature test:** as described in BS EN 16825:2016, specifically section 5.3.4
- **The energy consumption of the cabinet over 24 hours (E24h)** of cabinets fitted with integral condensing units shall be measured in accordance with sections 5 and 6 of BS EN 16825:2016, and to the accuracy specified in section 5.3.2.7 of BS EN 16825:2016.

48.4.4 Rounding

For the avoidance of doubt test data should be presented to 1 decimal place. As an example, a frozen, single door vertical professional refrigerated storage cabinet with an EEI of 60.1 would be deemed to not meet the performance requirements.

48.5 Verification for ETL Listing

Any of the following testing routes may be used to demonstrate the conformity of products against the requirements:

- In-house testing – Self-tested and verified or cross-checked by an independent body
- Witnessed testing
- Independent testing
- Representative testing (see clause 48.5.1)

Further information regarding the first three routes can be found in Guidance Note 5 on the ETL product testing framework[48].

[48] https://www.gov.uk/government/publications/energy-technology-list-etl-product-testing-framework

48.5.1 Representative Testing

Where applications are being made for two or more cabinet models that are variants of the same basic design, test data may be submitted for a single 'representative model'. The rules in Table 48.4 shall be used to select the representative model that should be performance tested.

Table 48.4 Rules for selecting the representative model for performance testing

Variation between models	Selection rule
Cosmetic differences to the exterior	Any model may be selected to be the representative model.
Heaters (door, trim etc.), fans, defrosts, lighting and other accessories	The model with the greatest energy consumption shall be the representative model.
Cabinets with the same refrigeration system components but different refrigerants	The model with the greatest energy consumption shall be the representative model.
Two or more of the above variations	The rules set out above shall be combined when selecting the representative model.

It should be noted that:

- If a manufacturer voluntarily removes the representative model from the ETL then other products linked with that representative model may or may not be permitted to remain on the ETL.
- If any product submitted under these representative model rules is later found not to meet the performance criteria when independently tested, then all products based on the same representative model will be removed from the ETL.

48.6 Conformity testing

Products listed on the ETL may be subject to the scheme's conformity testing programme in order to ensure listed models continue to meet the ETL requirements.

48.7 Review

48.7.1 Indicative review date

This specification is scheduled for review during the 2022/23 review cycle.

48.7.2 Illustrative future direction of the requirements

The Energy Technology List aims to capture the upper quartile of products with regards to energy efficiency. As professional refrigerated storage cabinet technology improves, future requirements will be revised to cover this portion of the market.

49 Refrigerated Display Cabinets

Date published	2019
Date first launched	2004

49.1 Scope

Refrigerated display cabinets are products that are specifically designed to store and display chilled and/or frozen foodstuffs.

49.2 Definitions

Refrigerated display cabinets are used to maintain foodstuffs and drinks at chilled and frozen temperatures. There are many different designs of refrigerated display cabinets, but all enable the customer to view the foodstuff stored in the cabinet, either through an opening in the cabinet, or through a transparent door or lid. Refrigerated display cabinets also include commercial beverage coolers, which are specifically designed to chill and store pre-packaged, non-perishable beverage products for sale to customers.

Refrigerated display cabinets are available in a range of different designs and efficiencies. The Energy Technology List (ETL) Scheme aims to encourage the purchase of higher efficiency products.

The ETL Scheme covers four categories of products:

- ‘Plug in’/ integral refrigerated display cabinets with integral refrigeration systems (i.e. incorporating a compressor and condensing unit).
- ‘Remote’ refrigerated display cabinets that are designed to work with a non-integral refrigeration system (i.e. where the compressor and condenser, or all or parts of the refrigeration system are located at a different location from the cabinet).
- ‘Water loop’ refrigerated display cabinets that are designed to work with integral refrigeration systems where the condenser is partially or fully cooled by a closed water circuit, from which heat may be recovered for space heating or for pre-heating hot water systems. The closed water circuit may also be cooled by a water chiller.
- ‘Chilled air’ refrigerated display cabinets that are designed to work with a ducted air system served by a remote refrigeration system where the compressor, condenser, evaporator and all parts of the refrigeration system are located at a different location from the cabinet.

To be eligible for inclusion on the ETL, products shall meet the requirements as set out below.

49.3 Requirements

49.3.1 Eligibility requirements

To be eligible, products shall:

- Be designed to display chilled and/or frozen foodstuffs, whilst maintaining them within prescribed temperature limits.

- Conform to one of the temperature classifications in Table 49.1 when tested to BS EN ISO 23953-2:2015 in climate class III (25°C, 60% RH). Commercial beverage coolers shall conform to one of the temperature classifications in Table 49.2 when tested to BS EN 16902:2016 in climate class III (25°C, 60% RH).
- Be classified in accordance with the precise 5-digit classification system set out in Annex A of BS EN ISO 23953-1:2015. Commercial beverage coolers shall be classified in accordance with the precise classification system set out in Annex A of BS EN 16902:2016.
    - Have an appropriate Conformity Assessment mark.

Water loop refrigerated display cabinets designed for use with a dry air cooler with variable chilled water flow temperatures, are not eligible.

Table 49.1 Classification according to temperature

Class	Highest temperature θ_{ah} of the warmest M-package colder than or equal to (°C)	Lowest temperature θ_b of the coldest M-package warmer than or equal to (°C)	Lowest temperature θ_{al} of the warmest M-package colder than or equal to (°C)
L1	-15	-	-18
L2	-12	-	-18
L3	-12	-	-15
M0	+4	-1	-
M1	+5	-1	-
M2	+7	-1	-
H1	+10	+1	-
H2	+10	-1	-

Table 49.2 Classification according to temperature for commercial beverage coolers

Class	Highest temperature θ_{ah} of the warmest M-can colder than or equal to (°C)	Lowest temperature θ_b of the coldest M-can warmer than or equal to (°C)	Average temperature colder than or equal to (°C)
K_1	+7.0	0.0	+3.5
K_2	+6.0	-1.0	+2.5
K_3	+1.0	-3.5	-1.0
K_4	+9.0	+1.0	+5.0

All commercial beverage cooler classes are as described in BS EN 16902:2016, where the M-can temperature classes shall be measured with an accuracy of ±0.8°C.

49.3.2 Performance requirements

Products shall have an Energy Efficiency Index (EEI) that is less than, or equal to, the threshold shown in Table 49.3 for the relevant temperature class and type of cabinet.

Table 49.3 Performance thresholds for refrigerated display cabinets

		EEI performance thresholds (kWh/day/m²)	
		Geometry/configuration	
		Horizontal	Vertical
Temperature Class	L1	≤ 10.00	≤ 11.50
	L2	≤ 8.50	≤ 11.00
	L3	≤ 8.00	≤ 11.00
	M0	≤ 6.00	≤ 7.50
	M1	≤ 5.00	≤ 6.00
	M2	≤ 4.50	≤ 5.50
	H1	≤ 4.00	≤ 5.00
	H2	≤ 4.00	≤ 5.00
	K_1	≤ 4.00	≤ 5.00
	K_2	≤ 4.50	≤ 5.50
	K_3	≤ 5.50	≤ 6.00
	K_4	≤ 3.50	≤ 4.50

"≤" means "less than or equal to"

Where the Energy Efficiency Index (EEI) is defined as the ratio of the product's Total Energy Consumption (TEC) to Total Display Area (TDA)

And where the geometry/configuration of the cabinet refers to the designation under the classification system in BS EN ISO 23953-1:2015 Annex A and BS EN 16902:2016 Annex A for commercial beverage coolers, as follows:

- Vertical (V) cabinets comprise:
  - VC1 to VC4, VF1, VF2 and VF4, YC1 to YC4, YF1 to YF4, and YM5 to YM8 units.
  - BCSO, BCST, BCSS, BCVO, BCVT, BCVS, BCCO, BCCOT, BCCOS, BCCTO, BCCSO, BCCTT, BCCTS and BCCST commercial beverage cooler units.
- Horizontal (H) cabinets comprise:
  - HC1 to HC8, HF1 and HF3 to HF7 units.
  - BCHO, BCHT and BCHS commercial beverage cooler units.

49.4 Measurement and Calculations

49.4.1 Measurement standards

The following standards shall be used to determine product performance:

- BS EN ISO 23953-2:2015 'Refrigerated display cabinets – Part 2: Classification, requirements and test conditions'
- BS EN 16902:2016 'Commercial beverage coolers. Classification, requirements and test conditions'

Please note that performance data obtained in accordance with the procedures and standard rating conditions laid down in BS EN ISO 23953-2:2005+A1:2012 will be

accepted as an alternative to testing in accordance with BS EN ISO 23953-2:2015 until further notice. For products with glass that have been tested in accordance with BS EN ISO 23953-2:2005+A1:2012, performance data will only be accepted if the Total Display Area (TDA) is recalculated in accordance with BS EN ISO 23953-2:2015.

For products listed on the Energy Technology prior to 1 January 2019, performance data obtained in accordance with BS EN ISO 23953-2:2005 will also be accepted as an alternative to testing in accordance with BS EN ISO 23953-2:2015. Similarly, if these products contain glass, the TDA shall be recalculated in accordance with BS EN ISO 23953-2:2015.

49.4.2 Performance metrics

The Energy Efficiency Index (EEI) shall be calculated using the equation below:

$$EEI = \frac{Total\ energy\ consumption\ (TEC)}{Total\ display\ area\ (TDA)}$$

Where:

- TEC is the daily energy consumption of the product in kWh/day calculated according to BS EN ISO 23953-2:2015 section 5.3.6.3.4 and BS EN 16902:2016 section 6.3.13.3 for commercial beverage coolers.
- TDA is the total display area of the product in m^2 calculated according to BS EN ISO 23953-2:2015 Annex A and BS EN 16902:2016 Annex D for commercial beverage coolers.

For water loop cabinets, the TEC shall be the sum of the direct cabinet consumption (DEC) including compressor energy consumption, the pumping daily energy consumption (CPEC) for the water circuit and the refrigeration energy consumption (REC_{RI}) for a remote indirect refrigerating system. The REC_{RI} is used to approximate the energy consumption associated with cooling the chilled water circuit when free cooling or heat recovery for space or hot water heating is not feasible. The DEC, CPEC and REC_{RI} for water loop cabinets shall be calculated in accordance with BS EN ISO 23953-2:2015 Section 5.3.5.3 and Section 5.3.6.3.3.

For chilled air cabinets, the TEC shall be calculated in accordance with the calculation methodology described in the air-cooled cases testing procedure and calculation method document available from: https://www.rdandt.co.uk/news/aircooled.

49.4.3 Test Requirements

All cabinets shall be tested in a test room conforming to BS EN ISO 23953-2:2015 and BS EN 16902:2016 for commercial beverage coolers.

During testing, the cabinet shall comply with the conditions defined in BS EN ISO 239532:2015 with the following specifications:

- Section 5.3.2.7.1 – Lighting – section (b).
- Section 5.3.2.7.2 – Night covers – Test data shall not include results from testing with night blinds.
- Section 5.3.6 - Heat extraction rate measurement when condensing unit is remote from cabinet shall be calculated according to section 5.3.6.3.1 and 5.3.6.3.2 method Ø24-deft.

Water loop cabinets shall be tested in accordance with the method described in BS EN ISO 23953-2:2015 for remote indirect refrigerating systems. In addition to the specifications listed above, the inlet chilled water flow temperature shall be set at 20°C. A tolerance of ±1°C shall be allowed for the inlet chilled water flow temperature.

Chilled air cabinets shall be tested in accordance with the methodology set out in the air-cooled cases testing procedure and calculation method document available from: https://www.rdandt.co.uk/news/aircooled.

During testing of commercial beverage coolers, the cabinet shall comply with the conditions defined in BS EN 16902:2016 with the following specifications:

- Section 6.3.8 – Lighting and night covers – follow the procedure described in Figure 24 for commercial beverage coolers with lighting and night covers. Test data shall not include results from testing with night blinds.

Products that use refrigerant blends consisting of a mixture of two or more component refrigerants may exhibit temperature glide, where the refrigerant evaporates and condenses over a temperature range at constant pressure. For these products, the evaporating temperature shall be the mid-point temperature of the evaporating temperature range.

Hybrid water loop cabinets which are also able to operate as air-cooled integral cabinets shall be tested in both air-cooled and water-cooled modes. The TEC for hybrid water loop cabinets shall be calculated as the average of the TEC in air-cooled mode and the TEC in water-cooled mode.

The test report shall be prepared in accordance with the specification set out in BS EN ISO 23953-2:2015 and in BS EN 16902:2016 for commercial beverage coolers.

49.4.4 Rounding

For the avoidance of doubt, M-package temperatures should be rounded to the nearest integer value (where 0.5 should be rounded up). M-can temperatures for commercial beverage coolers should be rounded to one decimal place. Other test data should be presented to two decimal places. As an example, a vertical M0 cabinet with an EEI performance threshold of 7.51 would be deemed to not meet the performance requirements.

49.5 Verification for ETL Listing

Any of the following testing routes may be used to demonstrate the conformity of products against the requirements:

- In-house testing – Self-tested and verified or cross-checked by an independent body (for all categories except for water loop refrigerated display cabinets)
- Witnessed testing
- Independent testing
- Representative testing (see clause 49.5.1 below)

Further information regarding the first three routes can be found in Guidance Note 5 on the ETL product testing framework[49].

[49] https://www.gov.uk/government/publications/energy-technology-list-etl-product-testing-framework

49.5.1 Representative testing

Where applications are being made for two or more cabinet models that are variants of the same basic design, test data may be submitted for a single 'representative model' provided that all variants have the same precise 5-digit classification according to Annex A of BS EN ISO 23953-1:2015. For commercial beverage coolers, all variants shall have the same precise classification according to Annex A of BS EN 16902:2016. The rules in Table 49.4 shall be used to select the representative model that should be performance tested.

Table 49.4 Rules for selecting the representative model for performance testing

Variation between models	Selection rule
Cosmetic differences to the exterior	Any model may be selected to be the representative model.
Heaters (door, trim etc.), fans, defrosts, lighting and other accessories	The model with the greatest direct electrical energy consumption (DEC) shall be the representative model.
Temperature level	The model with the lowest temperature setting shall be the representative model.
Length	Any model may be selected to be the representative model. All variants shall have a length that is within ±50% of the representative model length.
Type of doors	Where some variants have sliding doors and some have hinged doors, the representative model should be equipped with hinged doors.
Cabinet depth	The model with the greatest cabinet depth shall be the representative model.
Shelves	The model with the lowest number of shelves shall be the representative model.
Front-opening height (throat):	The model with the largest front-opening height (throat) shall be the representative model.
Two or more of the above variations	The rules set out above shall be combined when selecting the representative model

It should be noted that:

- If a manufacturer voluntarily removes the representative model from the ETL then other products linked with that representative model may or may not be permitted to remain on the ETL.
- If any product submitted under these representative model rules is later found not to meet the performance criteria when independently tested, then all products based on the same representative model will be removed from the ETL.

49.6 Conformity testing

Products listed on the ETL may be subject to the scheme's conformity testing programme in order to ensure listed models continue to meet the ETL requirements.

49.7 Review

49.7.1 Indicative review date

This specification is scheduled to be reviewed during the 2022/23 review cycle.

49.7.2 Illustrative future direction of the requirements

Future requirements will see the alignment of the Energy Efficiency Index definition for refrigerated display cabinets with the proposed eco-design regulation for refrigerating appliances with a direct sales function. The requirements for small ice cream freezers will be separated out from the horizontal refrigerated display cabinet segment. Performance thresholds will also be reviewed to ensure that the ETL specification captures the upper quartile of products on the market.

50 Refrigeration Compressors

Date published	2019
Date first launched	2002

50.1 Scope

Refrigeration compressors are products that are specifically designed to raise the pressure, temperature and energy level of a refrigerant vapour by mechanical means as part of a "vapour-compression, economised vapour compression or transcritical CO_2 refrigeration cycle.

Economiser packages consist of a refrigeration compressor, an expansion device, and an economiser that is capable of increasing refrigerant sub-cooling and refrigeration cycle efficiency.

50.2 Definitions

Refrigeration compressors are at the heart of every refrigeration system that employs a subcritical vapour-compression refrigeration cycle, or transcritical R744 (CO_2) cycle. They range in size from those used in refrigerated display cabinets used in shops and supermarkets, to those used in large industrial refrigeration systems in breweries.

Refrigeration compressors are available in a range of different designs and efficiencies, and can be manufactured as fully hermetic, semi-hermetic or open products. The Energy Technology List (ETL) Scheme aims to encourage the purchase of the higher efficiency products.

The categories of refrigeration compressor and economiser package covered are:

1. High temperature with HFC or HC refrigerant.
2. Medium temperature with HFC or HC refrigerant.
3. Low temperature with HFC or HC refrigerant.
4. Medium temperature transcritical/subcritical with R744 refrigerant.
5. Low temperature transcritical/subcritical with R744 refrigerant
6. Low temperature subcritical cascade with R744 refrigerant.

Where:

- These categories are defined in terms of the specific refrigerant type and the product performance at a particular temperature rating point.
- 'Subcritical cascade' refers to the first stage of a two-stage process using two vapour compression cycles, the first stage with R744 and the second stage with an HFC or other refrigerant.
- 'Transcritical/subcritical' refers to single stage products that normally operate in a subcritical mode, but can also operate in transcritical mode as and when conditions demand.
- Products may be submitted under more than one category.

To be eligible for inclusion on the ETL, products shall meet the requirements as set out below.

50.3 Requirements

50.3.1 Eligibility requirements

To be eligible, products shall:

- Use the refrigerant specified by the product category.
- Be either a refrigeration compressor or an economiser package.
- Incorporate a positive displacement type, hermetic or semi hermetic compressor (with integral electric motor).
- Be subject to quality assurance procedures that ensure consistency of performance between one production item and any other.

In addition, all low temperature transcritical/subcritical R744 products shall include an appropriately matched gas intercooler that is capable of reducing the intermediate gas temperature to the level required for second stage compression.

Products that depend on an external motor for compressor operation (i.e. 'open' type compressors) are not eligible.

50.3.2 Performance requirements

Products shall have a coefficient of performance (COP) that is greater than the values shown in Table 50.1 below at the specified standard rating points. The rated refrigerating capacity for the product shall be specified and for products that use HFC or HC refrigerants, the specific refrigerant with which the stated COP has been achieved shall be named.

Table 50.1 Performance thresholds for refrigeration compressors at the standard rating points

Category	Evaporating temperature (Dew Point)	Condensing temperature (Dew Point)	Compressor suction gas temperature	Liquid sub-cooling	COP threshold
High temperature with HFC or HC refrigerant	+5°C	50°C	20°C	0K	≥ 3.20
Medium Temperature with HFC or HC refrigerant	-10°C	45°C	20°C	0K	≥ 2.40

Category	Evaporating temperature (Dew Point)	Condensing temperature (Dew Point)	Compressor suction gas temperature	Liquid sub-cooling	COP threshold
Low Temperature with HFC or HC refrigerant	-35°C	40°C	20°C	0K	≥ 1.45
Medium temperature transcritical/subcritical with R744 refrigerant	-10°C	15°C	0°C	0K	≥ 4.70
Low temperature transcritical/subcritical with R744 refrigerant	-35°C	15°C	-25°C	0K	≥ 1.80
Low temperature subcritical with R744	-35°C	-5°C	-25°C	0K	≥ 3.70

"≥" means "greater than or equal to"

Where:

- COP is the ratio of the refrigerating capacity to the power absorbed.
- For economiser packages, zero sub-cooling refers to the liquid condition at the condenser exit.

50.4 Measurement and Calculations

50.4.1 Measurement standards

The following standards, where applicable, shall be used for measuring and calculating product performance:

- BS EN12900:2013 “Refrigerant compressors. Rating conditions, tolerances and presentation of manufacturer’s performance data”.
- BS EN13771-1:2016 “Compressor and condensing units for refrigeration. Performance testing and test methods. Part 1: Refrigerant compressors”.
- ANSI/ASHRAE Standard 23-2005 “Methods of Testing for Rating Positive Displacement Refrigerant Compressors and Condensing Units”.

Please note that tests carried out in accordance with the procedures set out in BS EN 13771-1:2003 shall be accepted as an alternative to those set out in BS EN 13771-1:2016 until further notice.

50.4.2 Performance metrics

The Coefficient of Performance (COP) of a product shall be calculated using the equation below:

$$COP = \frac{Refrigerating\ capacity}{Power\ absorbed}$$

The product’s COP shall be calculated at the standard rating point in the manner set out in BS EN12900:2013 “Refrigerant compressors. Rating conditions, tolerances and presentation of manufacturer’s performance data”.

50.4.3 Test requirements

Product performance may be calculated by interpolation of performance data obtained in accordance with the specified test standards at a minimum of three rating points commonly used to independently verify compressor performance characteristics within the industry. The calculated performance shall be adjusted to take account for uncertainties in the measurements and interpolation method in line with industry best practice.

A test report shall be submitted in accordance with the formats specified in BS EN13771-1:2016. This shall include a statement of measured or calculated performance at the standard rating point.

The refrigerant properties used in the analysis of compressor performance shall be obtained from one of the following sources:

- The US National Institute of Standards & Technology (NIST) Standard Reference Database 23 Thermodynamic and Transport Properties of Refrigerants and Refrigerant Mixtures Database: Version 6.0 or later. See http://fluidproperties.nist.gov/or http://www.nist.gov/.
- The ASERCOM properties database as defined in the ASERCOM Compressor Certification scheme, which is based closely on the NIST database (see http://www.asercom.org/).

Where necessary some liquid sub-cooling may be used during testing to ensure the correct operation of the test apparatus, provided the results are corrected back to a liquid sub-cooling of 0K.

50.4.4 Rounding

For the avoidance of doubt, test data should be presented to 2 decimal places. As an example, a product in the high temperature category with a COP of 3.19 would be deemed to not meet the performance requirements.

50.5 Verification for ETL Listing

Any of the following testing routes may be used to demonstrate the conformity of products against the requirements:

- In-house testing – Self-tested and self-certified
- In-house testing – Self-tested and verified or cross-checked by an independent body
- Witnessed testing
- Independent testing
- Representative testing (see clause 50.5.1)

Further information regarding the first four routes can be found in Guidance Note 5 on the ETL product testing framework[50].

[50] https://www.gov.uk/government/publications/energy-technology-list-etl-product-testing-framework

50.5.1 Representative testing

Where applications are being made for a range of two or more products that are variants of the same basic design, test data may be submitted for a representative selection of models, provided that all variants:

- are the same compressor type i.e. method of compression (e.g. reciprocating or scroll) and type of enclosure (e.g. hermetic or semi-hermetic) as the representative model.
- fit within the same product category (e.g. are all high temperature HFC or HC units).

The representative models shall be selected by dividing the range of products into groups of models with similar design characteristics using the same refrigerant, and testing a model in each group. The performance of each model in the group shall be predicted using a validated mathematical model or validated simulation software. Evidence should be provided for both the method and the type of validation used. As a minimum, a test report for at least one model in each range of products shall be provided.

It should be noted that:

- If a manufacturer voluntarily removes the representative model from the ETL then other products linked with that representative model may or may not be permitted to remain on the ETL.
- If any product submitted under these representative model rules is later found not to meet the performance criteria when independently tested, then all products based on the same representative model will be removed from the ETL.

50.6 Conformity testing

Products listed on the ETL may be subject to the scheme's conformity testing programme in order to ensure listed models continue to meet the ETL requirements.

50.7 Review

50.7.1 Indicative review date

This specification is scheduled for review during the 2022/23 review cycle.

50.7.2 Illustrative future direction of the requirements

As the refrigeration compressor market evolves to meet the requirements of the EU F-gas regulations, the use of new lower Global Warming Potential (GWP) refrigerants will become more widespread. The performance parameters may also be reviewed in light of the potential impact of the new refrigerants on product performance. Furthermore, future compressor performance thresholds may be categorised by compressor rated refrigerating capacity.

51 Refrigeration System Controls

Date published	2019
Date first launched	2001

51.1 Scope

Refrigeration system controls are products that are specifically designed to automatically optimise the operating temperatures, fan speeds and/or pressures within a distributed commercial refrigeration system in a manner that minimises the system's energy consumption, whilst maintaining the spaces or equipment being refrigerated within predefined temperature limits.

51.2 Definitions

Refrigeration system controls are used to control the temperatures, pressures and fan speeds within a distributed, commercial refrigeration system, and to automatically adjust the refrigeration system operation to reflect changes in load, weather conditions, and operating requirements.

A wide range of refrigeration system control products is available. The Energy Technology List (ETL) Scheme aims to encourage the purchase of products that automatically optimise the operation of a distributed, commercial refrigeration system and minimise its energy consumption.

The ETL Scheme covers two categories of products:

- System management units or packages consisting of one or more control units or modules that are designed to optimise an entire refrigeration system, including the operation of refrigeration compressor(s), evaporator(s), electronic expansion valve(s) and condenser(s).
- 'Add-on' controllers that are designed to be used in conjunction with a specific system management unit or package, and enable the operation of additional refrigeration compressors, evaporators, electronic expansion valves and condensers to be optimised.

To be eligible for inclusion on the ETL, products shall meet the requirements as set out below.

51.3 Requirements

51.3.1 Eligibility requirements

To be eligible, products shall:

1. Incorporate a microprocessor based controller that is pre-programmed to automatically control the rate of flow of refrigerant through, and/or operating temperature of, and/or the fan speed of, at least one of the following components of refrigerating systems:
   a) Evaporators.
   b) Condensers.
   c) Compressors.
   d) Electronic expansion valves.

e) Door trim heaters.

2. Be one of the following:
   a) A system management unit or package that:
      - Automatically adjusts system operating set points in a manner that minimises the refrigeration system's energy consumption under different operating loads, weather conditions and surrounding air temperatures.
      - Is pre-programmed to undertake one or more of the following:
        - Monitor temperatures and/or pressures around the refrigeration system, and automatically initiate defrost cycles, or inhibit (or delay) scheduled defrost cycles, within individual parts of the refrigeration system, as required, to optimise the overall performance of the refrigeration system.
        - Monitor refrigeration system energy input (kWh) and generate a visual or audible alarm when system power consumption exceeds a pre-defined limit, or when system efficiency degradation is preventing automatic adjustment.
        - Automatically in accordance with a pre-defined weekly time schedule, turn off, or turn down, ancillary power loads around the refrigeration system (such as lighting in display cabinets, trim heaters or fans), or activate night blinds, in order to reduce system energy consumption.
      - Provides facilities that enable system managers to define the default set points, and alarm limits, for each item of refrigeration equipment controlled.

   b) An add-on controller that:
      - Automatically accepts instructions from the system manager to change its operating set points or alarm limits, or to initiate or inhibit a defrost cycle.
      - Automatically transmits data on operating temperatures, pressures, or flow rates to the system manager at intervals not exceeding 1 minute.

        OR:

      - For products which solely control the evaporator fan speed, automatically transmit data on the evaporator fan speed to the system manager at intervals not exceeding 10 minutes.

3. Comply with the relevant requirements, as set out in Tables 51.1 to 51.6 below, for products that directly control by means of an analogue or digital signal connection:
   a) Evaporators (see Table 51.1).
   b) Condensers (see Table 51.2).
   c) Compressors (see Table 51.3).
   d) Evaporator fans (see Table 51.4).
   e) Electronic expansion valves (see Table 51.5).
   f) Door trim heaters (see Table 51.6).
4. Incorporate an anti-tampering mechanism that prevents the product's control strategy and configuration settings from being modified, and automatic control from being disabled, except during commissioning, maintenance or testing.

5. Conform to the requirements of The Electromagnetic Compatibility Regulations 2016, or have an appropriate Conformity Assessment mark. Products that allow wireless/remote functionality shall also conform to the requirements of The Radio Equipment Regulations 2017.
6. Not incorporate any form of variable speed drive (with the exception of evaporator fan speed controllers), fan, pump, heat exchanger or valve, except where incorporated solely for the purposes of cooling electronic circuitry.

Table 51.1 Requirements for control of evaporators

Control of evaporators
All products that directly control evaporators shall: 1. Be designed to directly measure evaporator pressure or temperature by means of a sensor, and automatically adjust the flow of refrigerant through the evaporator to maintain the refrigerated space within pre-defined operating limits. 2. Automatically terminate its defrost cycle when: a) The temperature of the evaporator or refrigerated space exceeds a pre-set value. b) A maximum defrost time consistent with sensor failure has been exceeded. 3. Provide facilities that enable system managers to define separate temperature set points and alarm limits for each evaporator being controlled. 4. Provide facilities that enable system managers to take the equipment out of service for cleaning or maintenance. 5. Generate an alarm signal when the temperature of the refrigerated space is in danger of straying outside, or has strayed outside, it's pre-defined safe operating limits.

Table 51.2 Requirements for control of condensers

Control of condensers
All products that directly control condensers shall: 1. Be designed to directly measure condenser pressure or temperature by means of a sensor, and automatically adjust the airflow across the condenser(s) in a manner that maintains condensation at the rate required to maintain the thermal balance of the refrigeration system under different operating loads and weather conditions. 2. Allow the compressor discharge (head) pressure to "float" with ambient temperature down to the minimum safe level for the particular refrigeration system. 3. Provide facilities that enable system managers to define separate temperature set points and alarm limits for each condenser being controlled. 4. Generate an alarm signal when the condensing pressure or temperature is in danger of straying outside, or has strayed outside, the predefined safe limits. 5. Provide facilities that can enable modulating control of a condenser by controlling the speed of a variable speed condenser fan.

Table 51.3 Requirements for control of compressors

Control of compressors
All products that are designed to directly control compressors shall: 1. Be able to control the operation of at least two refrigeration compressors. 2. Be able to provide modulating control of a single variable speed compressor within a multi-compressor pack consisting of other fixed speed compressors. 3. Incorporate automatic control algorithms that monitor rate of change in system suction pressure or refrigerant temperature to prevent compressors from unnecessarily being controlled to load or unload in response to small fluctuations in cooling demand. For multi-compressor packs containing a single variable speed compressor, the product shall be able to optimise the operation of the variable speed compressor using the monitored changes to the suction pressure or refrigerant temperature to minimise the energy consumption of the refrigeration system. 4. Be able to provide crankcase heater control using ambient and superheat temperature conditions to restrict crankcase heater operation to only when required, thereby reducing the energy consumption of the compressor pack. 5. Be able to use operational data from the refrigerated display cabinets/cases (transmitted via the system management unit) to float the suction pressure of the compressor pack. Floating the suction pressure during low load conditions will help to reduce the operational energy consumption of the refrigeration system.

Table 51.4 Requirements for evaporator fan speed controllers

Evaporator fan speed controllers
All products that are designed to directly optimise the speed of evaporator fans shall: 1. Be able to optimise the speed of at least two evaporator fans. 2. Incorporate automatic control algorithms that reduce the speed of the evaporator fans in response to signals from the master controller, for example that *the set point has been reached/exceeded, a doorway within the refrigerated space has been opened or a defrost cycle is underway*. 3. Not affect the ability of the refrigeration system to achieve the set point and maintain any temperature legally required to refrigerate products contained in the space. 4. Be compatible with ETL compliant system management unit or package type refrigeration system controls.

Table 51.5 Requirements for control of electronic expansion valves

Control of electronic expansion valves
All products that are designed to directly control electronic expansion valves shall: 1. Be able to control the operation of at least two electronic expansion valves. 2. Enable the modulating control of electronic expansion valves by monitoring refrigerant temperature and pressure.

Table 51.6 Requirements for control of door trim heaters

Control of door trim heaters
All products that are designed to directly control door trim heaters on refrigerated display cabinets/cases with doors shall: 1. Be able to control the operation of at least two refrigerated display cabinet/case door trim heaters by pulsing the trim heaters on and off to reduce their energy consumption. 2. Be able to monitor ambient relative humidity levels to turn the trim heaters off for longer periods if ambient humidity levels are low, thereby reducing the door trim heater energy consumption.

Where:

- Automatic control may be implemented either directly by means of an analogue or digital signal connection, or indirectly by means of another control device or network.
- A mechanism is defined as “any sequence of pre-defined actions that performs a given function, where an action can be defined in hardware and/or software”.
- An algorithm is defined as “a mechanism that is defined in software”.
- The product’s control strategy is the combination of automatic control functions, mechanisms and facilities specified for the particular equipment controlled. In this context, products may be pre-programmed in one of the following ways:
  - One or more fixed control strategies that are designed to control a specific set of equipment that can be selected during commissioning.
  - One or more flexible control strategies that can be configured to control different equipment, as part of a clearly defined commissioning procedure.
- Products that incorporate control strategies that are designed to control any type of equipment that is not directly related to refrigeration systems are not eligible.

51.4 Verification for ETL Listing

There are no testing requirements, however manufacturers shall provide sales and technical brochures to evidence the conformity of their products against the requirements from section 51.3.

51.5 Conformity testing

Products listed on the ETL may be subject to the scheme’s conformity testing programme in order to ensure listed models continue to meet the ETL requirements.

51.6 Review

51.6.1 Indicative review date

This specification is scheduled to be reviewed during the 2022/23 review cycle.

51.6.2 Illustrative future direction of the requirements

The ETL aims to keep up to date with innovations in the refrigeration system controls industry and future requirements will incorporate such innovations that help to reduce the energy consumption of refrigeration systems.

Solar Thermal Collectors

52 Solar Thermal Collectors

Date published	2020
Date first launched	2002
Former name	Solar Thermal Systems and Collectors Solar Thermal Systems

52.1 Scope

Solar thermal collectors are energy saving products that reduce the amount of energy consumed by conventional water or space heating equipment. They are built around a solar absorbers that uses radiation to increase the temperature of heating fluid flowing through the collector. This heat is then transferred to a storage vessel by means of a circulating fluid, or in some instances, the solar collector could be directly connected into the heating circuit.

To be eligible for inclusion on the Energy Technology List (ETL), products shall meet the requirements as set out below.

52.2 Definitions

Solar thermal collectors are products that are specifically designed to capture solar energy and convert it, with a broader solar system, to useful heat for water or space heating applications.

52.3 Requirements

52.3.1 Eligibility requirements

To be eligible, products shall be collectors that comply with the requirements of BS ISO 9806:2017 “Solar energy. Solar thermal collectors. Test methods”.

For models introduced to the market before 2017, compliance with BS EN 12975-2:2006 will be accepted.

52.3.2 Performance requirements

The solar collector within the product shall pass the reliability tests detailed in the standards specified in Table 52.1 below:

Table 52.1 Requirements for reliability tests

Year of Market Entry	Applicable Standard
Solar collectors introduced to the market in 2017 or later	BS EN ISO 9806:2017 “Solar energy. Solar thermal collectors. Test methods”.
Solar collectors introduced to the market before 2017	BS EN 12975-2:2006 “Solar energy. Solar thermal collectors. Test methods”.

Upon application, the supplier shall declare the following collector parameters:

- Active Area (m^2)
- Zero-loss Efficiency (-)
- First-order Efficiency Coefficient (W/m^2K)
- Second-order Efficiency Coefficient (W/m^2K^2)

52.4 Measurement and Calculations

52.4.1 Test Requirements

All products shall be tested in accordance with the procedures and test conditions laid down in the standards specified in the performance criteria above.

52.5 Verification for ETL Listing

Any of the following testing routes may be used to demonstrate the conformity of products against the requirements:

- In-house testing – Self-certified
- In-house testing – Self-tested and verified or cross-checked by an independent body
- Witnessed testing
- Independent testing

Further information regarding the routes can be found in Guidance Note 5 on the ETL product testing framework[51].

52.6 Conformity testing

Products listed on the ETL may be subject to the scheme's conformity testing programme in order to ensure listed models continue to meet the ETL requirements.

52.7 Review

52.7.1 Indicative review date

The next technical review is scheduled for 2023-24.

52.7.2 Illustrative future direction of the requirements

Future changes to the Specification may include:

- Switching to new international standard metric
- Re-introducing solar thermal systems
- Creating a separate category for collectors designed specifically to act as heat sources for heat pumps

[51] https://www.gov.uk/government/publications/energy-technology-list-etl-product-testing-framework

Uninterruptible Power Supplies

53 Uninterruptible Power Supplies

Date published	2018
Date first launched	2009

53.1 Scope

Uninterruptible power supplies are used to allow electrical equipment to continue operating when the mains power supply is interrupted for a period, or the quality of the power supply deteriorates. They are widely used throughout industry and commerce to maintain the safety critical and business critical systems located in process control stations, computer rooms, data centres and server areas.

Uninterruptible power supplies are available with a wide range of different efficiencies. The Energy Technology List (ETL) Scheme aims to encourage the purchase of products with the highest efficiency.

The ETL Scheme covers two categories of products:

1. Static (installed) uninterruptible power supply units or packages, with a power range greater than or equal to 10kVA, that use one or more electronic power converters, switches and energy storage devices (such as batteries) to generate their output voltage when operating without mains input power.
2. Rotary uninterruptible power supply units or packages, with a power range greater than or equal to 200 kVA that use one or more rotating electrical machines (i.e. AC generators) to generate their output voltage when operating without mains input power.

To be eligible for inclusion on the ETL, products shall meet the requirements as set out below.

53.2 Definitions

Uninterruptible power supplies are products that are specifically designed to maintain the continuity and quality of a power supply to electrical appliances or electrically driven equipment in the case of input power failure. When the mains electricity supply is operating, they charge up an energy storage device, which can be used to provide electrical power for a defined period when the mains electricity supply is interrupted

53.3 Requirements

53.3.1 Eligibility requirements

To be eligible, products shall:

- Be one of the following categories of product:

a) A static uninterruptible power supply as defined in BS EN 62040-3:2011 (or IEC 62040- 3: 2011).

b) A rotary uninterruptible power supply as defined in BS EN 88528-11:2004 (or IEC 88528- 11: 2004).

- Include the following components (within the unit or package):
  a) An electronic control system that controls the operation of the product.
  b) Voltage inverter and rectifier devices (required for static uninterruptible power supplies, optional for rotary uninterruptible power supplies).
  c) One or more energy storage devices (for example: batteries, flywheels, etc.) specified for use with the UPS.
  d) One or more power supply filters.
  e) A bypass switch (where required)
  f) A motor generator set or alternator (for rotary uninterruptible power supplies only).
- Be designed to be connected to, and to provide electrical power backup to, a three-phase electricity supply of nominally fixed frequency and voltage.
- Have an appropriate Conformity Assessment mark.

Functionality criteria

To be eligible:

a) Static UPS with more than one operating mode shall incorporate a high efficiency operating mode and include controls to switch between modes quickly and automatically when the utility supply falls below acceptable tolerances.
b) Modular products shall incorporate controls to operate automatically at higher load per module, provided this demonstrably improves efficiency.

53.3.2 Performance requirements

Eligible products shall:

a) Meet or exceed the minimum efficiencies at full and part load conditions set out in Table 53.1 below, which depends on the product category.
b) Have an input power factor that is greater than or equal to (i.e. >=) 0.93 at 25%, 50%, 75% and 100% of rated maximum power output at nominal input voltage.
c) Have an input total harmonic distortion (THD) that is less than or equal to (i.e. <=) 5% at 100% of rated maximum power output.

Table 53.1 Performance thresholds for uninterruptible power supplies

Product Category	Power range (kVA)	% of rated maximum power (i.e. % full load)			
		25%	50%	75%	100%
Static uninterruptible power supply units or packages	>=10	>=94.0	>=95.5	>=95.5	>=95.5
Rotary uninterruptible power supply units or packages	>=200	>=91.0	>=95.0	>=95.5	>=96.0

"<=" means "less than or equal to"

">" means "greater than"

">=" means "greater than or equal to"

53.4 Measurement and Calculations

53.4.1 Measurement standards

Product performance shall be tested in accordance with the procedures and standard rating conditions laid down in the following standard:

- Section 6.4.1.6 and Annex J of BS EN 62040-3:2011 (or IEC 62040-3:2011): “Uninterruptible power systems (UPS) – Part 3: Method of specifying the performance and test requirements”.

53.4.2 Test Requirements

With the following amendments:

- Products shall be operated in their least efficient normal operating mode from a standard 230/400 Volt AC (+/-10%), 50Hz electrical power supply.
- The package tested shall exclude additional isolation transformers that are not physically incorporated into the uninterruptible power supply unit or package, switchgear, low voltage switchboards, and generation sets.
- Any static bypass switches fitted shall be in the ‘open’ position.

53.4.3 Rounding

For the avoidance of doubt, test data should be presented to one decimal place. As an example, a rotary uninterruptible power supply product with an efficiency of 94.9 % when operating at 50% of its rated maximum power output would be deemed to be a fail.

53.5 Verification for ETL Listing

Any of the following testing routes may be used to demonstrate the conformity of products against the requirements:

- In-house testing – Self-certified
- In-house testing – Self-tested and verified or cross-checked by an independent body

- Witnessed testing
- Independent testing
- Representative testing (see clause 53.5.1)

Further information regarding the first four routes can be found in Guidance Note 5 on the ETL product testing framework[52].

53.5.1 Representative testing

Where applications are being made for two or more products that are constructed out of a number of identical power supply modules, test data may be submitted for a single 'representative model'.

53.6 Conformity testing

Products listed on the ETL may be subject to the scheme's conformity testing programme in order to ensure listed models continue to meet the ETL requirements.

[52] https://www.gov.uk/government/publications/energy-technology-list-etl-product-testing-framework

Waste Heat to Electricity Conversion Equipment

54 Organic Rankine Cycle Heat Recovery Equipment

Date published	2018
Date first launched	2015

54.1 Scope

Organic Rankine Cycle (ORC) Heat Recovery Equipment typically captures waste heat from exhaust stacks in manufacturing plants, or other waste heat from industrial processes, and uses it to generate electricity that is used on site.

The Energy Technology List (ETL) scheme covers products that can capture low to medium grade waste heat through an Organic Rankine Cycle. In ORC units, the captured waste heat is used to heat a working fluid. Vapour is produced, which is used to mechanically drive an electricity generator by means of an expander (e.g. turbine or screw). The low pressure vapour is then condensed (rejecting its heat to a lower temperature heat sink) and pumped back to the higher pressure, to complete the cycle.

The waste heat may be captured directly, by means of an internal or external heat exchanger, or indirectly, by means of a secondary heat recovery system.

Heat rejection to the lower temperature ambient heat sink may be directly to the air using a heat exchanger, or via a secondary cooling medium (e.g. cooling water).

The ETL scheme covers three categories of product:

1. Remote, secondary-cooling type

These products include a complete, closed circuit for the working fluid, contained within the unit. The condensing heat-exchanger is supplied with open connections for a secondary cooling circuit (e.g. cooling water), for connection on site.

2. Integral cooling type

These products include a complete, closed circuit for the working fluid, contained within the unit. The condenser rejects its heat directly or indirectly to the air, via a heat exchanger (contained within the unit). The heat exchanger may use dry air cooling, evaporative or adiabatic cooling.

3. Split-circuit type

‘Split’ type products have separate heat collection and rejection units specifically designed to be connected together during installation by pipework to create the closed circuit for the working fluid, forming a single functional unit. The main assembly includes the heat capture heat-exchanger, expander and power generator. The second unit includes the condensing heat- exchanger, for rejection of heat to the air, using dry air cooling, evaporative or adiabatic cooling.

ORC Heat Recovery Equipment is available in a range of efficiencies. The ETL Scheme aims to encourage purchase of higher efficiency products, which can realise substantial reductions in carbon emissions when used to reduce the use of electricity from the mains supply.

To be eligible for inclusion on the ETL, products shall meet the requirements as set out below.

54.2 Definitions

Organic Rankine Cycle (ORC) Heat Recovery Equipment covers products that are specifically designed to convert waste heat to electrical power by means of a closed thermodynamic power cycle that does not involve the internal combustion of fuel.

54.3 Requirements

54.3.1 Eligibility requirements

To be eligible, products shall:

- Consist of a factory-built packaged unit or split system (comprising a main assembly and a matched heat-rejection unit, designed for connection together on site).
- Be designed to generate electricity or produce mechanical power in the ORC shaft from waste heat with a temperature of less than or equal to (<=) 350 °C.
- Be designed to provide three-phase electricity at 230/400 Volt a.c. at 50Hz.
- Be rated for continuous operation with an electrical power output not exceeding 1.5 MWe.
- Not incorporate any form of combustion equipment, including boost burners.
- Not use water, ammonia or any water based solution as a working fluid.
- Be designed for, and include fittings for, permanent installation.
- Have an appropriate Conformity Assessment mark.

54.3.2 Performance requirements

Eligible products shall meet or exceed the minimum adjusted net efficiency set out in Table 54.1, according to the maximum temperature of waste heat that the product is designed to capture:

Table 54.1 Adjusted net efficiency thresholds for ORC Heat Recovery Equipment

	Maximum design waste heat temperature (°C)	<= 125°C	> 125°C and <= 250°C	> 250°C and <= 350°C
	Product Category	**Minimum adjusted net efficiency, $\bar{\eta}$**		
1.	Remote, secondary-cooling type	>= 7.0%	>= 12.5%	>= 17.5%
2.	Integral cooling type	>= 4.6%	>= 7.4%	>= 15.6%
3.	Split-circuit type	>= 4.6%	>= 7.4%	>= 15.6%

"<=" means "less than or equal to"

">=" means "greater than or equal to"

“>” means “greater than”

Where:

$$Net\ Efficiency, \eta = \frac{Electrical\ output\ (kW) - Electrical\ input\ (kW)}{Thermal\ Input\ (kW)}$$

And adjusted net efficiency $\bar{\eta}$ is defined in 54.4.1.1 below.

The electrical input applies to 100 % of the electrical consumption of the product, including any pumps and fans contained within it. However, for remote, secondary-cooling type (category 1) products, the energy use of pumps and fans associated with the secondary cooling circuit should not be included as electrical input, and are not included in the net efficiency calculation.

54.4 Measurement and Calculations

54.4.1 Measurement Standards and Test Requirements

The required minimum performance shall be determined using Methods A or B, as set out in 54.4.1.1. and 54.4.1.2 below.

Products can either be tested in an accredited laboratory, or performance may be determined from measurements made during field trials or acceptance tests, provided that the measurements have been made by, or witnessed by, an accredited laboratory or contractor that is accredited to make those measurements. The product's adjusted net efficiency shall be calculated by an independent body that is competent to verify the measurement data.

54.4.1.1 Method A – Direct Measurement

Under this test method, product performance shall be demonstrated by calculating the net efficiency (as defined above), from measurements of thermal input, electrical output and electrical input, in the application and at the rated capacity, for which it is designed.

The reference test conditions, which depend on the maximum temperature of waste heat that the product is designed to capture, are set out in Table 54.2 below.

Table 54.2 Reference test conditions

Maximum design waste heat temperature (°C)		<= 125°C	> 125°C and <= 250°C	> 250°C and <= 350°C
		Reference test conditions		
T1 – inlet temperature of the captured waste heat source		125°C	250°C	350°C
T2 – inlet temperature of the heat rejection sink	Remote, secondary cooling type products (inlet temperature of the secondary coolant)	30°C	30°C	30°C
	Integral cooling type products (air on temperature, dry bulb)	20°C	20°C	20°C
	Split-circuit type products (air on temperature, dry bulb)	20°C	20°C	20°C

At the reference conditions, the adjusted net efficiency, $\bar{\eta}$, is equal to the net efficiency η, as defined above.

Where the application does not make it feasible for tests to be carried out at the conditions above, then alternative inlet temperatures T1 and T2 can be used. In such cases, the adjusted net efficiency, $\bar{\eta}$, should be calculated as defined in Table 54.3 below.

Table 54.3 Adjusted net efficiency for alternative inlet temperatures

Maximum design waste heat temperature (°C)	<= 125°C	> 125°C and <= 250°C	> 250°C and <= 350°C
T1 (allowable range)	<= 125°C	> 125°C and <= 250°C	> 250°C and <= 350°C
Remote, secondary-cooling type products Adjusted net efficiency, $\bar{\eta}$=	$\eta\left(\frac{125-30}{T_1-T_2}\right)\left(\frac{273.15+T_1}{273.15+125)}\right)$	$\eta\left(\frac{250-30}{T_1-T_2}\right)\left(\frac{273.15+T_1}{273.15+250)}\right)$	$\eta\left(\frac{350-30}{T_1-T_2}\right)\left(\frac{273.15+T_1}{273.15+350)}\right)$
Integral cooling and split circuit type products Adjusted net efficiency, $\bar{\eta}$=	$\eta\left(\frac{125-20}{T_1-T_2}\right)\left(\frac{273.15+T_1}{273.15+125}\right)$	$\eta\left(\frac{250-20}{T_1-T_2}\right)\left(\frac{273.15+T_1}{273.15+250)}\right)$	$\eta\left(\frac{350-20}{T_1-T_2}\right)\left(\frac{273.15+T_1}{273.15+350)}\right)$

Note: T1 and T2 above are defined in Table 54.2 and expressed in degrees Celsius.

The adjusted efficiency, $\bar{\eta}$, shall meet or exceed the associated minimum adjusted net efficiency threshold defined in Table 54.1.

For example, a category 1 ORC product designed for a maximum waste heat temperature of 200ºC, with a net efficiency of 10.8% (T1 = 200ºC and T2 =30ºC), will have an adjusted net efficiency of 12.6%, and therefore deemed eligible.

The assessment of thermal input shall be done in accordance with the procedures set out in:

- EN 305:1997 — "Heat exchangers – Definitions of performance of heat exchangers and the general test procedure for establishing performance of all heat exchangers"; or
- EN 306:1997 — "Heat exchangers – Methods of measuring the parameters necessary for establishing the performance"; or
- EN 308:1997 — "Heat exchangers – Test procedures for establishing the performance of air to air and flue gas heat recovery devices".

The assessment of electrical output and electrical input shall be done in accordance with the relevant procedures set out in:

■ BS ISO 8528-6:2005	"Reciprocating internal combustion engine driven alternating current generating sets – Test methods".

54.4.1.2 Method B - Validated Design Calculations

Under this test method, product performance shall be demonstrated by calculating net efficiency (as defined above), from design calculations.

The accuracy of these calculations shall be confirmed by interpolation and extrapolation of measurements obtained from tests (carried out according to Method A above) of at least two units of the same basic design as the product, i.e.:

- Use the same working fluid as the product
- Use the same thermodynamic cycle
- Have the same expander type – i.e. manufacturer, method of expansion (e.g. reciprocating, turbine, or screw)
- Use the same heat exchanger types – for both waste heat capture and heat rejection to the ambient heat sink; and any other recuperative heat exchangers
- Use the same method of rejecting heat to the ambient heat sink – i.e. water-cooled; or dry or evaporative air-cooled.

The product shall have a rated maximum electrical output of no more than 20% greater or smaller than one of the tested products.

The test report shall include (or be accompanied by):

a) Details of the methodology and calculations used to determine product performance

b) A copy of the published performance data for the product

c) Manufacturer's design data for the product

d) The following data for the tests carried out according to Method A and for the design conditions of the product:

   i. Details of the composition, specific heat capacity, inlet and outlet temperatures, and flow-rates of:

      - The captured waste heat source
      - The low-temperature heat sink

   ii. Electricity output and input

   iii. Calculated net efficiency and adjusted net efficiency

e) Details of main components of the tested units and (where these are not identical to the product) calculations demonstrating that their performance can be used to validate that of the product, including:

   i. Heat exchangers

   ii. Expander

   iii. Alternator

54.4.2 Rounding

For the avoidance of doubt, test data should be presented to one decimal place. As an example, a remote, secondary-cooling type product designed to capture waste heat with a temperature of 125°C, with an adjusted net efficiency of 6.9%, would be deemed to be a fail.

54.5 Verification for ETL Listing

Any of the following testing routes may be used to demonstrate the conformity of products against the requirements:

- Witnessed testing
- Independent testing
- Acceptance tests or Field Trials (must be witnessed by an independent body)
- Representative testing (see Method B – 54.4.1.2)

Further information regarding the first three routes can be found in Guidance Note 5 on the ETL product testing framework[53].

54.6 Conformity testing

Products listed on the ETL may be subject to the scheme's conformity testing programme in order to ensure listed models continue to meet the ETL requirements.

55 Saturated Steam to Electricity Conversion Equipment

Date published	2018
Date first launched	2018

55.1 Scope

Saturated steam to electricity conversion equipment covers products that are specifically designed to generate electrical power from waste or excess wet or saturated steam by reducing the steam pressure. The categories of product covered under the Energy Technology List (ETL) scheme include:

1. Screw expanders – as wet steam passes through the product, it turns a screw rotor, which is connected to a generator. Energy is removed from the steam as the pressure reduces, which is converted into rotational shaft energy and then electricity.
2. Non-condensing or back pressure turbines – equipment which features rotary turbines where high pressure input steam is allowed to expand as it passes through the turbine. This releases energy and lowers the pressure of the steam at the outlet, without increasing the temperature.

Products should be sold as packaged units that can be fitted to industrial processes. Products that incorporate any form of combustion equipment, including boost burners, shall be excluded.

[53] https://www.gov.uk/government/publications/energy-technology-list-etl-product-testing-framework

55.2 Definitions

Saturated steam to electricity conversion equipment is specifically designed to convert waste or excess saturated steam, from a specific process, into electrical power by means of a closed thermodynamic power cycle that does not involve the internal combustion of fuel.

55.3 Requirements

55.3.1 Eligibility requirements

To be eligible, products shall:

- Utilise waste or excess steam source from a process (i.e. steam is not produced for the primary purpose of power generation).
- Use wet or saturated steam at the inlet (i.e. not superheated steam).
- Be designed to use water or steam as the thermal working fluid (i.e. product shall not use any thermal working fluid applicable to Organic Rankine Cycle).
- Not be part of a Good Quality CHP scheme, under CHPQA.
- Not exceed 700kWe power output at standard conditions.
- Be designed to provide three-phase electricity output.
- Not incorporate any form of combustion equipment, including boost burners.
- Be designed and include fittings for permanent installation.
- Have an appropriate Conformity Assessment mark.

55.3.2 Performance requirements

Eligible products shall meet or exceed minimum overall efficiencies as set out in Table 55.1. Minimum efficiencies shall be achieved across the specified range of inlet and outlet pressures. Eligible products shall also achieve a net electrical efficiency of at least 4.5%.

Table 55.1 Overall efficiency thresholds for saturated steam to electricity conversion equipment

Standard conditions for the measurement of overall efficiencies			**Inlet Pressure Test Point (barA)**		
			8	**11**	**15**
No.	Product Category	Outlet Pressure Test Point (barA)	Minimum Overall Efficiency%		
1.	Screw Expanders	2	>= 84.0	>= 88.0	>= 90.0
		5	N/A	>= 80.0	>= 87.0
2.	Non-condensing or back pressure turbines	2	>= 72.0	>= 76.0	>= 78.0
		5	N/A	>= 68.0	>= 70.0

55.4 Measurement and Calculations

55.4.1 Performance metrics

The Overall Efficiency is defined as:

$$Overall\ Efficiency\ (\%) = \frac{Net\ Electrical\ Output\ (kWe)}{Actual\ Enthalpy\ Drop\ (kJ/kg) * Inlet\ Mass\ Flow\ Rate\ (kg/s)}$$

The Net Electrical Efficiency shall meet or exceed 4.5% and is defined as follows:

$$Net\ Electrical\ Efficiency\ (\%) = \frac{Net\ Electrical\ Output\ (kWe)}{Inlet\ Enthalpy\ (kJ/kg) * Inlet\ Mass\ Flow\ Rate\ (kg/s)}$$

Net electrical output is defined as the electrical output minus any electrical input into the product. Actual enthalpy drop is defined as the change in the inlet enthalpy of the steam entering the product minus the outlet enthalpy of the steam. The inlet mass flow rate is the flowrate of the steam as it enters the product.

55.4.2 Measurement Standards and Test Requirements

The required minimum performance shall be determined using Methods A or B, as set in 55.4.2.1 and 55.4.2.2 below.

55.4.2.1 Method A - Direct measurement

Under this test method, product performance shall be demonstrated by calculating the overall efficiency from measurements of net electrical output, actual enthalpy drop and inlet mass flow rate. Overall efficiencies shall meet or exceed the threshold minimum efficiencies as set out in Table 55.1.

Products can either be tested in an accredited laboratory, or performance may be determined from measurements made during field trials or acceptance tests, provided that the measurements have been made by, or witnessed by, an accredited laboratory or contractor that is accredited to make those measurements. The product's overall efficiency shall be calculated by an independent body that is competent to verify the measurement data.

The assessment shall be done in accordance with the procedures set out in:

- EN 306:1997 — "Heat exchangers – Methods of measuring the parameters necessary for establishing the performance"; or
- BS EN 60953-2:1996 — "Rules for steam turbine thermal acceptance tests, Part 2: Method B: Wide range of accuracy for various types and sizes of turbines"

The assessment of electrical output and electrical input shall be done in accordance with the relevant procedures set out in:

■ BS ISO 8528-6:2005	"Reciprocating internal combustion engine driven alternating current generating sets – Test methods".

55.4.2.2 Method B - Validated design calculations

Under this test method, product performance shall be demonstrated by calculating overall efficiency and net electrical efficiency from design calculations. The accuracy of these calculations shall be verified by an independent accredited laboratory.

The product shall not exceed the threshold electrical power output of 700kWe at standard conditions.

The test report shall include (or be accompanied by):

a) Manufacturer's design data for the product

b) Details of the methodology (including any standards used) and calculations verified by the independent accredited laboratory, used to determine product performance

c) A copy of the published performance data for the product

55.5 Verification for ETL Listing

Any of the following testing routes may be used to demonstrate the conformity of products against the requirements:

- In-house testing – Self-tested and verified or cross-checked by an independent body
- Witnessed testing
- Independent testing
- Acceptance Tests or Field Trials (must be witnessed by an independent body)

Further information regarding the routes can be found in Guidance Note 5 on the ETL product testing framework[54].

55.6 Conformity testing

Products listed on the ETL may be subject to the scheme's conformity testing programme in order to ensure listed models continue to meet the ETL requirements.

[54] https://www.gov.uk/government/publications/energy-technology-list-etl-product-testing-framework

Wastewater Heat Recovery Systems

56 Wastewater Heat Recovery Systems (Instantaneous)

Date published	**2020**
Date first launched	2020

56.1 Scope

Wastewater heat recovery systems cover heat recovery technology that is specifically designed to use residual heat from drained wastewater via an instantaneous heat exchange to pre-heat incoming mains water. These systems save energy by reducing the energy consumption of hot water heating equipment, such as boilers.

They can be used to recover waste heat from wastewater streams where there is a simultaneous demand for hot water, such as showers, dishwashers, industrial processes etc.

56.2 Definitions

Wastewater heat recovery systems normally consist of a long copper pipe, where the warm water runs alongside the colder mains water to allow the heat exchange to occur. These devices typically have no electrical components, pumps or controllers, requiring very little maintenance.

Wastewater heat recovery systems are available in a range of different designs and efficiencies, where product suitability is determined by the specific requirements of the application. The Energy Technology List (ETL) Scheme aims to encourage heat recovery from wastewater streams and the purchase of higher efficiency products suitable for a given application.

56.2.1 Sub-categories

The ETL Scheme covers three categories of wastewater heat recovery systems:

- Standalone horizontal systems: consisting of a single instantaneous heat exchanger installed horizontally underneath the wastewater stream.
- Standalone vertical systems: consisting of a single instantaneous heat exchanger installed vertically, connected to one or more wastewater streams.
- Plant room systems: consisting of a single instantaneous heat exchanger, normally located in a plant room connected to multiple wastewater streams.

To be eligible for inclusion on the ETL, products shall meet minimum eligibility criteria as set out below.

56.3 Requirements

56.3.1 Eligibility requirements

To be eligible, wastewater heat recovery systems shall:

- Be specifically designed to recover heat from shower and bath drains, by means of an instantaneous heat exchanger for simultaneous hot water pre-heating.
- For standalone systems, the pre-heat run – pipework run between the heat exchanger and the farthest point of use – shall be designed to be no greater than 3 metres, and this shall be stated in the installation requirements.
- Maintain conditions that comply with ACOP L8: 2013 “Approved Code of Practice and guidance – Legionnaire’s disease. The control of legionella bacteria in water systems”.
- Comply with the requirements of the Water Supply (Water Fittings) Regulations 1999, the Water Byelaws 2000 Scotland and the Water Regulations in Northern Ireland (for example, by inclusion in the Water Regulations Advisory Scheme’s Water Fittings and Materials Directory or by manufacturer/supplier declaration).
- Be designed to prevent backflow through the use of twin wall construction and venting – this can be demonstrated by compliance with BS EN 1717:2000 “Protection against pollution of potable water in water installations and general requirements of devices to prevent pollution by backflow”.
- For wastewater heat recovery systems made from copper, these shall be designed and manufactured in compliance with one of the following or other equivalent international standards:
  - BS EN 1057:2006+A1:2010 “Copper and copper alloys. Seamless, round copper tubes for water and gas in sanitary and heating applications (for copper tubes and fittings)”;
  - ASTM B88 - 16 “Standard Specification for Seamless Copper Water Tube” and ASTM B306 - 13 “Standard Specification for Copper Drainage Tube (DWV)”.

56.3.2 Performance requirements

Wastewater heat recovery products shall have a Heat Recovery Score greater than or equal to the figures shown in Table 56.1 below.

Table 56.1 Performance thresholds for wastewater heat recovery systems

Product category	Heat Recovery Score
Standalone horizontal systems	≥ 0.25
Standalone vertical systems	≥ 0.35
Plant room systems	≥ 0.40

“≥” means “greater than or equal to”

56.4 Measurement and Calculations

56.4.1 Measurement standards

The following guidance and standards shall be used to determine product performance:

- NTA 8800:2019-06 nl “Energieprestatie van gebouwen – Bepalingsmethode” (Energy performance of buildings - Determination method)
  - Tests and performance measurements carried out in accordance with NEN 7120:2011/C2:2011 nl “Energieprestatie van gebouwen – Bepalingsmethode”

(Energy performance of buildings - Determination method) will be accepted in place of NTA 880:2019-06 nl.

- CSTB Protocole RECADO 2015
  - Tests and performance measurements carried out in accordance with CSTB Protocole RECADO 2012 will be accepted in place of RECADO 2015.
- CSA B55. 1-15 “Test method for measuring efficiency and pressure loss of drain water heat recovery units.”
  - for standalone vertical and plant room systems only
- IAPMO IGC 347-2017 “Test method for measuring the performance of drain water heat recovery units.”
  - for standalone vertical and plant room systems only
- The UK Government’s Standard Assessment Procedure for Energy Rating of Dwellings, 2012 edition (SAP 2012)

56.4.2 Performance metrics

The Heat Recovery Score is a performance parameter based on the heat recovery efficiency and the utilisation factor of the product, calculated using the equation below:

$$Heat\ Recovery\ Score = Heat\ recovery\ efficiency\ (\%) \times Utilisation\ factor$$

Where:

- The Heat Recovery Efficiency in % is the heat recovered by the wastewater heat recovery system as a proportion of the heat available in the wastewater stream. It shall be calculated in accordance with heat transfer principles, following the prescribed method in the test standard being used (from Section 1.4.3). In general, the heat recovery efficiency is described by:

$$Heat\ Recovery\ Efficiency = \frac{Heat\ recovered\ by\ the\ product}{Heat\ available\ in\ the\ wastewater\ stream}$$

- The Utilisation Factor (UF) is a factor between 0 and 1, which accounts for energy losses not included in the laboratory data but are likely to occur in an installation. These losses include energy lost from the water in the heat exchanger and from the water in the connecting pipes.

  The product’s UF shall be calculated using the following equation in accordance with the SAP 2012 guidance for a balanced system where the incoming cold and wastewater stream flow rates are equal:

$$UF = 1 - \frac{2000 l \pi r^2 \rho C_p \eta + 0.5(\rho C_p V_{hx} + M_{hx} C_{hx})}{V \rho C_p \eta}$$

  Where:

  l is the installed pipe run length (preheated water output from heat exchanger to unit from which waste heat is being recovered). 3 metres is taken as typical for standalone systems. For standalone horizontal systems fitted directly into the unit from which waste heat is being recovered e.g. fitted in a shower tray, an installed pipe run length of 1.5 metres should be used.

  r is the inside radius of the connecting pre-heated water outlet pipe from the wastewater heat exchanger in metres

  ρ is the density of water (use 1 kg/litre)

  C_p is the specific heat capacity of water (use 4.19 kJ/kg.K)

  η is the heat recovery efficiency, as determined above

V_{hx} is the volume of water in the heat exchanger in litres

M_{hx} is the mass of the dry wastewater heat exchanger in kg

C_{hx} is the specific heat capacity of the heat exchanger in kJ/kg.K

V is the volume of water in the unit from which waste heat is being recovered in litres. This should be assumed to be 66 litres for the UF calculation for standalone horizontal and vertical systems.

The 2000 multiplication factor consists of two factors:

- ×1000 is to convert the pipe volume from m^3 to litres
- ×2 assumes the wasted drainage water volume is the same as the wasted pre-heated outlet water volume. For horizontal systems fitted directly into the unit e.g. fitted in a shower tray, only the wasted water in the pre-heated heat exchanger outlet pipe needs to be accounted for. Halving the installed pipe run length to 1.5 metres for these product types, as stated above, is a simple approximation to account for this.

All parameters used in calculating the utilisation factor should be presented in the test report.

56.4.3 Test Requirements

Testing and performance measurement shall be carried out in accordance with any of the following test standards:

- NTA 8800:2019-06 nl “Energieprestatie van gebouwen – Bepalingsmethode” (Energy performance of buildings - Determination method)
- CSTB Protocole RECADO 2015
- CSA B55. 1-15 “Test method for measuring efficiency and pressure loss of drain water heat recovery units.”
- IAPMO IGC 347-2017 “Test method for measuring the performance of drain water heat recovery units.”

Performance data shall be based on testing carried out for conditions that fall within the limits below, adhering to the tolerances prescribed in the test standard:

- an average flow rate volume of between 8 and 11 litres per minute
- a room temperature of 20°C
- an incoming mains cold water temperature of between 10 and 13°C
- a drain water temperature of between 37 and 40°C

The specific test conditions under which the performance is measured shall be presented in the test report. Where performance has been measured at multiple test conditions, these shall also be presented in the test report.

The test apparatus shall be set up such that the pre-heated water from the wastewater heat recovery system flows into both the cold water feed for the water heater and into the cold water feed for the unit from which wastewater heat is being recovered. For example, where heat is being recovered from a shower supplied with hot water from a boiler, the pre-heated water shall flow into the boiler cold water feed and into the shower mixer cold water feed.

56.4.4 Rounding

For the avoidance of doubt the Heat Recovery Score should be presented to 2 decimal places. As an example, a standalone vertical waste water heat recovery

system with a Heat Recovery Score of 0.34 would be deemed to not meet the performance requirements.

56.5 Verification for ETL Listing

Any of the following testing routes may be used to demonstrate the conformity of products against the requirements:

- In-house testing – Self-tested and verified or cross-checked by an independent body
- Witnessed testing
- Independent testing

Further information regarding these routes can be found in Guidance Note 5 on the ETL product testing framework[55].

56.6 Conformity testing

Products listed on the ETL may be subject to the scheme's conformity testing programme in order to ensure listed models continue to meet the ETL requirements.

56.7 Review

56.7.1 Indicative review date

This specification will be reviewed during the 2023/24 ETL review cycle.

56.7.2 Illustrative future direction of the requirements

With the recent introduction of wastewater heat recovery systems to Building Regulations Part L calculation software for non-domestic buildings, commercial applications for these systems will continue to evolve in the coming years. Future eligibility and performance requirements will be reviewed to account for this.

[55] https://www.gov.uk/government/publications/energy-technology-list-etl-product-testing-framework