1. **Refrigeration Compressors**

<table>
<thead>
<tr>
<th>Date published</th>
<th>2019</th>
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<tbody>
<tr>
<td>Date previously reviewed</td>
<td>2016</td>
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<tr>
<td>Date first launched</td>
<td>2002</td>
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1.1 **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 $\text{CO}_2$ 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.

1.2 **Definitions**

Refrigeration compressors are at the heart of every refrigeration system that employs a subcritical vapour-compression refrigeration cycle, or transcritical R744 ($\text{CO}_2$) 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 ECA 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.

Investments in refrigeration compressors can only qualify for Enhanced Capital Allowances if the specific product is named on the Energy Technology Product List. Claims shall be made for listed products with a named refrigerant and specified rated refrigerating capacity. To be eligible for inclusion on the Energy Technology Product List, products shall meet the eligibility requirements as set out below.
1.3 Requirements

1.3.1 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.

1.3.2 Performance requirements

Products shall have a coefficient of performance (COP) that is greater than the values shown in Table 1.1 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 1.1 Performance thresholds for refrigeration compressors at the standard rating points

<table>
<thead>
<tr>
<th>Category</th>
<th>Evaporating temperature (Dew Point)</th>
<th>Condensing temperature (Dew Point)</th>
<th>Compressor suction gas temperature</th>
<th>Liquid sub-cooling</th>
<th>COP threshold</th>
</tr>
</thead>
<tbody>
<tr>
<td>High temperature with HFC or HC refrigerant</td>
<td>+5°C</td>
<td>50°C</td>
<td>20°C</td>
<td>0K</td>
<td>≥ 3.20</td>
</tr>
<tr>
<td>Medium Temperature with HFC or HC refrigerant</td>
<td>-10°C</td>
<td>45°C</td>
<td>20°C</td>
<td>0K</td>
<td>≥ 2.40</td>
</tr>
<tr>
<td>Low Temperature with HFC or HC refrigerant</td>
<td>-35°C</td>
<td>40°C</td>
<td>20°C</td>
<td>0K</td>
<td>≥ 1.45</td>
</tr>
<tr>
<td>Medium temperature transcritical/subcritical with R744 refrigerant</td>
<td>-10°C</td>
<td>15°C</td>
<td>0°C</td>
<td>0K</td>
<td>≥ 4.70</td>
</tr>
<tr>
<td>Low temperature transcritical/subcritical with R744 refrigerant</td>
<td>-35°C</td>
<td>15°C</td>
<td>-25°C</td>
<td>0K</td>
<td>≥ 1.80</td>
</tr>
<tr>
<td>Low temperature subcritical with R744</td>
<td>-35°C</td>
<td>-5°C</td>
<td>-25°C</td>
<td>0K</td>
<td>≥ 3.70</td>
</tr>
</tbody>
</table>

"≥" 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.
1.4 Measurement and Calculations

1.4.1 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”.

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.

1.4.2 Performance metrics

The Coefficient of Performance (COP) of a product shall be calculated using the equation below:

\[
COP = \frac{\text{Refrigerating capacity}}{\text{Power absorbed}}
\]

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”.

1.4.3 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 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.
1.4.4 **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.

1.5 **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 1.5.1)

Further information regarding the first four routes can be found in Guidance Note 5 on the ETL product testing framework\(^1\).

1.5.1 **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 Energy Technology Product List (ETPL) then other products linked with that representative model may or may not be permitted to remain on the ETPL.
- 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 ETPL.

\(^1\) http://www.gov.uk/government/publications/energy-technology-list-etl-product-testing-framework
1.6 **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.

1.7 **Scope of Claim**

Expenditure on the provision of plant and machinery can include not only the actual costs of buying the equipment, but other direct costs such as the transport of the equipment to site, and some of the direct costs of installation. Clarity on the eligibility of direct costs is available from HMRC.

1.8 **Review**

1.8.1 **Indicative review date**

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

1.8.2 **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.