1 Refrigeration System Controls

1.1 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.

1.2 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 ECA 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 ECA 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.

Investments in refrigeration controls can only qualify for Enhanced Capital Allowances if the product is named on the Energy Technology Product List. 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:

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.

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 52.1 to 52.6 below, for products that directly control by means of an analogue or digital signal connection:
a) Evaporators (see Table 1.1).
b) Condensers (see Table 1.2).
c) Compressors (see Table 1.3).
d) Evaporator fans (see Table 1.4).
e) Electronic expansion valves (see Table 1.5).
f) Door trim heaters (see Table 1.6).

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 EU Electromagnetic Compatibility (EMC) Directive 2014/30/EU, or be CE Marked. Products that allow wireless/remote functionality shall also conform to the requirements of the EU Radio Equipment Directive (RED) 2014/53/EU.

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 1.1 Requirements for control of evaporators

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<tr>
<th>Control of evaporators</th>
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<tbody>
<tr>
<td>All products that directly control evaporators shall:</td>
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<tr>
<td>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.</td>
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<td>2. Automatically terminate its defrost cycle when:</td>
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<td>a) The temperature of the evaporator or refrigerated space exceeds a pre-set value.</td>
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<td>b) A maximum defrost time consistent with sensor failure has been exceeded.</td>
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<td>3. Provide facilities that enable system managers to define separate temperature set points and alarm limits for each evaporator being controlled.</td>
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<td>4. Provide facilities that enable system managers to take the equipment out of service for cleaning or maintenance.</td>
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<tr>
<td>5. Generate an alarm signal when the temperature of the refrigerated space is in danger of straying outside, or has strayed outside, its pre-defined safe operating limits.</td>
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Table 1.2 Requirements for control of condensers

<table>
<thead>
<tr>
<th>Control of condensers</th>
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<tr>
<td>All products that directly control condensers shall:</td>
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<tr>
<td>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.</td>
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<tr>
<td>2. Allow the compressor discharge (head) pressure to “float” with ambient temperature down to the minimum safe level for the particular refrigeration system.</td>
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<tr>
<td>3. Provide facilities that enable system managers to define separate temperature set points and alarm limits for each condenser being controlled.</td>
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<tr>
<td>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.</td>
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<tr>
<td>5. Provide facilities that can enable modulating control of a condenser by controlling the speed of a variable speed condenser fan.</td>
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</table>
Table 1.3 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 1.4 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 1.5 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 1.6 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.

1.4 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 1.3.

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.

1.6 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.

1.7 Review

1.7.1 Indicative review date

This specification is scheduled to be reviewed during the 2022/23 review cycle.

1.7.2 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.