PUBLICLY AVAILABLE SPECIFICATION

PAS 57:2003

Cellar cooling equipment — Procedure for determining performance and calculating energy efficiency

ICS 27.200; 97.130.20

BSI British Standards

This Publicly Available Specification comes into effect on 20 March 2003

Amendments issued since publication

Amd. No.	Date	Comments

ISBN 0 580 41407 8

Contents

Foreword

This Publicly Available Specification, PAS 57, was sponsored by the DTI Construction Sector Unit and DEFRA's Market Transformation Programme and developed through the British Standards Institution.

Acknowledgement is given to the following organizations that were consulted in the development of this Publicly Available Specification.

Future Energy Solutions AEA Technology

BSI Product Services

Cool Concerns

Hubbard Refrigeration

Searle Manufacturing

Eaton-Williams

IMI Air Conditioning

Thermofrost Cryo

NRS-Wholesale

Federation of Environmental Trade Associations

Six Continents

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Summary of pages

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Introduction

This Publicly Available Specification was developed to provide manufacturers and suppliers of cellar cooling equipment with procedures and defined conditions for measuring the performance of their products and calculating the energy efficiency, expressed as a coefficient of performance.

It is expected that the use of coefficient of performance values for cellar cooling equipment will provide purchasers of such equipment with the means for comparing product energy efficiency information.

1 Scope

This Publicly Available Specification (PAS) specifies procedures for determining the performance and energy efficiency of cellar cooling equipment with a capacity between 2 kW and 12 kW, at a standard rating condition of 10 °C air onto the evaporator and 32 °C air onto the condenser, using air cooled condensers categorized as either:

a) a packaged system, comprising all components mounted on one base for "through the wall" installation; or

b) a split system, with the equipment supplied in two parts (evaporator and condensing unit) to be connected on site; or

c) a remote system, with equipment supplied in three parts (evaporator, compressor/receiver unit and condenser) to be connected on site.

This PAS is aimed at suitably qualified and experienced personnel in the refrigeration industry.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

BS EN 328*, Heat exchangers — Test procedures for establishing the performance of forced convection unit air coolers for refrigeration*.

3 Terms and Definitions

For the purposes of this Publicly Available Specification, the following terms and definitions apply.

3.1
cellar cooling equipment
refrigeration system designed to maintain an indoor environment at a condition suitable for the storage of chilled beverages, typically 10 °C to 12 °C

3.2
refrigerant
working fluid in a refrigerating system absorbing heat at low pressure/temperature by evaporation and rejecting it at a higher pressure/temperature by condensation

3.3
liquid
working fluid remaining liquid during the absorption of heat

3.4
cooling capacity
total heat (kW) removed by the cellar cooling equipment from test room B

3.5
evaporator pressure
absolute pressure of the refrigerant at the evaporator outlet

3.6
compressor discharge pressure
absolute pressure of the refrigerant at the compressor discharge port

3.7
expansion device
device used to control the flow of refrigerant in the evaporator and reduce the refrigerant pressure

3.8
system energy consumption
total electrical energy consumption of the cellar cooling equipment as measured during the system efficiency test

3.9
liquid receiver
pressure vessel permanently installed in the high pressure side of a refrigeration system to provide a reserve of liquid refrigerant and for the storage of the refrigerant charge during service

3.10
filter drier
device used to remove water or water vapour from refrigerant

3.11
compressor
mechanically operated component for compressing a refrigerant vapour

3.12
heat load
electrical heating appliance [resistance heater(s)], with adjustable output, used to balance the heat extraction rate of the cooling unit

3.13
thermal mass
pre-cooled liquid or solid mass used to dampen temperature changes in the test room

3.14
thermostat phial
temperature sensing part of the thermostat

4 Principle

The energy efficiency of cellar cooling equipment is evaluated by measuring its cooling capacity and energy consumption at specified conditions and expressing the results as a ratio.

5 Preparation

5.1 General

The cellar cooling system under evaluation shall be supplied complete.

All components supplied as part of the cellar cooling equipment system shall be included in the evaluation and used in accordance with the manufacturer's instructions.

The cellar cooling equipment shall be evaluated in the “as-sold” condition, i.e. installed and commissioned as recommended by the manufacturer.

5.2 Test rooms

5.2.1 *Test room A*

The condensing unit, consisting of the compressor, condenser, liquid receiver (where fitted), filter drier, or compressor/receiver set plus air cooled condenser or outdoor part of the packaged system shall be located in test room A.

The temperature and humidity is controlled in test room A, which shall have sufficient volume for unrestricted airflow through the condenser.

5.2.2 *Test room B (calorimeter room)*

The evaporator and expansion valve (where fitted to the evaporator) shall be located in test room B (the cellar).

Test room B shall be an insulated chamber with a heat load to simulate cellar conditions.

Test room B shall be of a size such that:

a) no obstacle is positioned within a distance of $1.5 \times \sqrt{A \times B}$ of the evaporator outlet;

b) no obstacle is positioned within a distance of $0.75 \times \sqrt{A \times B}$ parallel to the sides of the evaporator;

c) the volume in m^3 is between 1/30 and 1/600 of the air flow rate in m^3/h produced by the evaporator,

where A and B are the air inlet dimensions of the evaporator.

Test room B shall have a thermal mass such that during the system efficiency test, the room temperature increases at a rate less than 1 °C in 5 min when the cellar cooling equipment is turned off.

5.3 Cellar cooling equipment installation

5.3.1 *General*

The distance of the air on the face of the condenser from the test room wall shall be in accordance with the original equipment manufacturer's specifications for that condenser or condensing unit.

The distance of the air on the face of the evaporator from the test room wall shall be in accordance with the original equipment manufacturer's specification for that evaporator.

Following assembly of the split and remote equipment (see **5.3.2** and **5.3.3**), the system shall be evacuated to a vacuum of better than 2 mm Hg. Abs.

The system shall then be charged with the type and amount of refrigerant as specified by the manufacturer.

All controls shall be set as specified by the manufacturer.

5.3.2 *Split systems*

The following shall apply for split systems.

a) The liquid and suction pipes shall be at least 5 m long, with excess pipe looped and not bent.

b) Excess pipe shall be positioned within test room A.

c) The pipe size and insulation type, thickness and location shall be in accordance with the manufacturer's specifications.

5.3.3 *Remote systems*

The following shall apply to remote systems.

a) The pipe between the compressor and condenser shall be at least 5 m long.

b) The pipe between the condenser and receiver shall be at least 5 m long.

c) The pipe between the receiver and evaporator shall be at least 5 m long.

d) The pipe between the evaporator and compressor shall be at least 5 m long.

e) All excess pipe shall be looped and not bent.

f) Excess pipe shall be positioned within test room A.

g) The pipe size and insulation type, thickness and location shall be in accordance with the manufacturer's specifications.

h) The expansion device shall be positioned and adjusted in accordance with the manufacturer's specifications.

6 Measurement procedure

6.1 General

The following conditions shall be applied:

a) relative humidity of test room B shall be held at (80 ± 5) %;

b) single phase equipment shall be tested at (230 ± 5) V and (50 ± 0.5) Hz;

c) three phase equipment shall be tested at (400 ± 8) V and (50 ± 0.5) Hz.

6.2 Cooling capacity measurement

Measure the cooling capacity of the system (kW) at the following condition:

— air onto the condenser at (32 ± 0.5) °C;

— test room B temperature at (10 ± 0.5) °C; and

— cellar unit operating continuously (not cycling on thermostat).

Using the calorimeter room electrical heat balance method in accordance with BS EN 328, measure the cooling capacity at steady state conditions, which shall be achieved at least 30 min prior to the evaluation commencing, and maintained for 1 h.

Steady state conditions shall be considered to be when the air onto the evaporator and condenser is maintained at the specified condition.

The temperature in test room B for the cooling capacity test shall be (10 ± 0.5) °C, with the average temperature during the 1 h period being between 9.8 °C and 10.2 °C, controlled by the test room controller.

6.3 System energy consumption measurement

Measure the system energy consumption (kWh) at the following condition:

— cooling capacity as measured during **6.2**;

— air onto the condenser at (20 ± 0.5) °C;

— test room B temperature at (10 ± 0.5) °C; and

— cellar unit cycling on its thermostat.

Measure the system energy consumption at steady state conditions, which shall be achieved at least 30 min prior to the test commencing, and be maintained for the duration of the test, which shall be at least 2 h.

NOTE System energy consumption measured is in kWh, however, the system energy consumption should be calculated in kW.

Calculate the system energy consumption (kW) as follows:

$$\text{system energy consumption (kW)} = \frac{\text{system energy consumption measured (kWh)}}{\text{test duration (h)}}$$

Steady state conditions shall be considered to be when:

a) air onto the evaporator has reached 10 °C;

b) air onto the evaporator is maintained within the band 9.5 °C to 10.5 °C;

c) air onto the condenser is maintained within 19.5 °C and 20.5 °C.

The temperature in test room B for the system efficiency test shall be (10 ± 0.5) °C, with the average temperature during the test period being between 9.8 °C and 10.2 °C, controlled by the system controller.

6.4 Conditions to be recorded

During the procedures set out in **6.2** and **6.3**, the following conditions shall be recorded.

6.4.1 Temperature (°C), accuracy ±0.2 °C of the:

a) air onto the condenser at 4 locations across condenser air on the face;

b) air onto the evaporator at 4 locations across evaporator air on the face.

6.4.2 Temperature (°C), accuracy ±0.5 °C of the:

a) compressor suction (pipe surface as close to the compressor as possible);

b) compressor discharge (pipe surface as close to the compressor as possible);

c) condenser inlet (pipe surface);

d) condenser outlet (pipe surface);

e) receiver inlet (pipe surface);

f) receiver outlet (pipe surface);

g) filter drier outlet (pipe surface);

h) expansion device inlet (pipe surface);

i) expansion device outlet (pipe surface);

j) evaporator outlet (pipe surface as close to the thermostatic expansion valve (TEV) phial, where fitted, as possible);

k) test room B (adjacent to the thermostat phial, where fitted);

l) air off the evaporator at 4 locations across air off the face.

6.4.3 Pressure (bar abs), accuracy equivalent to ±0.5 °C of the:

a) evaporator pressure, after distributor, if fitted;

b) compressor discharge pressure.

6.4.4 Electrical energy (kW), accuracy ±1 % of the:

a) compressor(s);

b) evaporator fan(s);

c) defrost heater(s), if fitted;

d) condenser fan(s);

e) heat input to test room B.

6.4.5 Heat loss/gain through the structure of test room B (kW) in accordance with BS EN 328, accuracy within 1 % of measured capacity.

6.4.6 The voltage (V) of the electrical supply, accuracy ±2 %.

6.4.7 The frequency (Hz) of the electrical supply, ±1 %.

7 Calculation of coefficient of performance

The coefficient of performance (COP) shall be calculated using the formula:

$$\text{COP} = \frac{\text{system cooling capacity (kW), determined in accordance with } \mathbf{6.2}}{\text{system energy consumption (kW), determined in accordance with } \mathbf{6.3}}$$

8 Evaluation report

The following information shall be reported:

a) measurement procedure;

b) cellar cooling equipment manufacturer;

c) cellar cooling equipment category, i.e. packaged system, split system or remote system;

d) model designation;

e) refrigerant;

f) electrical supply voltage (V) and frequency (Hz);

g) cooling capacity (kW) derived during the capacity measurement;

h) cooling capacity (kW) derived during the system energy consumption measurement;

i) total energy consumption (kWh) of the compressor, evaporator and condenser fan motors and defrost heaters (where fitted) derived during the system energy consumption measurement;

j) duration of the system energy consumption measurement (h);

k) heat flow (loss or gain) (kW) to test room B;

l) coefficient of performance (COP) calculated in accordance with **7**.

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