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Information technology — Data centres key performance indicators —

Part 7: Cooling efficiency ratio (CER)

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives or www.iec.ch/members_experts/refdocs).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html. In the IEC, see www.iec.ch/understanding-standards.

This document was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 39, *Sustainability, IT and data centres*.

A list of all parts in the ISO/IEC 30134 series can be found on the ISO and IEC websites.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html and www.iec.ch/national-committees.

Introduction

The global economy is today reliant on information and communication technologies and the associated generation, transmission, dissemination, computation and storage of digital data. All markets have experienced exponential growth in that data, for social, educational and business sectors and, while the internet backbone carries the traffic, there are a wide variety of data centres at nodes and hubs within both private enterprise and shared/collocation facilities.

The historical data generation growth rate exceeds the capacity growth rate of information and communications technology hardware and, with less than half (in 2014) of the world's population having access to an internet connection, that growth in data can only accelerate. In addition, with many governments having "digital agendas" to provide both citizens and businesses with ever-faster broadband access, the very increase in network speed and capacity will, by itself, generate ever more usage (Jevons Paradox). Data generation and the consequential increase in data processing and storage are directly linked to increasing power consumption.

With this background, data centre growth, and power consumption in particular, is an inevitable consequence; this growth will demand increasing power consumption despite the most stringent energy efficiency strategies. This makes the need for key performance indicators (KPIs) that cover the effective use of resources (including but not limited to energy) and the reduction of CO_2 emissions essential.

Within the ISO/IEC 30134 series, the term "resource usage effectiveness" is more generally used for KPIs in preference to "resource usage efficiency", which is restricted to situations where the input and output parameters used to define the KPI have the same units.

The cooling efficiency ratio (CER) allows data centre operators to quickly determine the efficiency of their data centre cooling system, compare the results, and determine if energy efficiency improvements need to be made. The impact of operational cooling efficiency is proving to be extremely important in the design, location and operation of current and future data centres.

In order to determine the overall resource efficiency of a data centre, a holistic suite of metrics is required. This document is one of a series of International Standards for such KPIs and has been produced in accordance with ISO/IEC 30134-1, which defines common requirements for a holistic suite of KPIs for data centre resource efficiency. This document does not specify limits or targets for the KPI and does not describe or imply, unless specifically stated, any form of aggregation of this KPI into a combination with other KPIs for data centre resource efficiency. This document presents specific rules on CER's use, along with its theoretical and mathematical development. This document concludes with several examples of site concepts that could employ the CER metric.

Information technology — Data centres key performance indicators —

Part 7: Cooling efficiency ratio (CER)

1 Scope

This document specifies the cooling efficiency ratio (CER) as a key performance indicator (KPI) for quantifying the efficient use of energy to control the temperature of spaces within a data centre (DC).

This document:

a) defines the CER of a DC;

b) describes the relationship of this KPI to a DC's infrastructure, information technology equipment and information technology operations;

c) defines the measurement, the calculation and the reporting of the parameter; and

d) provides information on the correct interpretation of the CER.

Annex A describes the correlation of the CER and other KPIs.

Annex B provides examples of the usage of the CER.

Annex C introduces the parameters that affect the CER.

Annex D describes requirements and recommendations for derivatives of KPIs associated with the CER.

This document is not applicable to cooling systems that are not powered by electricity (e.g. heat-driven absorption chillers).

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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.

ISO/IEC 30134-1, *Information technology — Data centres — Key performance indicators — Part 1: Overview and general requirements*

3 Terms, definitions and abbreviations

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/IEC 30134-1 and the following apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1.1
cooling efficiency ratio
CER
ratio of total heat removed and electrical energy used by a cooling system

Note 1 to entry: The value of "total heat annual removed" from the DC is measured in kWh.

3.1.2
cooling performance ratio
CPR
ratio of actual heat load and electrical power used by a cooling system

Note 1 to entry: The actual heat load is measured in kW.

3.1.3
energy loss
dissipation of energy caused by electric utilities

Note 1 to entry: The energy loss turned into heat are measured in kWh.

Note 2 to entry: Energy loss is caused, for example. by transformers, uninterruptible power supply (UPS), fans of computer room air handling units (CRAH), pumps, lighting, power cables.

3.2 Abbreviated terms

For the purposes of this document, the terms and definitions given in ISO/IEC 30134-1 and the following apply.

CEF	cooling efficiency factor
CER	cooling efficiency ratio
COP	coefficient of performance
CPR	cooling performance ratio
DC	data centre
EER	energy efficiency ratio
HVAC	heating, ventilation, air conditioning
iCER	interim cooling efficiency ratio
NSenCOP	net sensible coefficient of performance
PUE	power usage effectiveness
pCEF	partial cooling efficiency factor
pPUE	partial power usage effectiveness
$pPUE_{HVAC}$	partial power usage effectiveness for heating, ventilation and air conditioning systems
SEER	seasonal energy efficiency ratio
UPS	uninterruptible power supply

3.3 Symbols

For the purposes of this document, the following symbols apply.

$E_{cooling}$	cooling system energy consumption (annual) in kWh
$E_{cooling,DC}$	part of $E_{cooling}$ that is attributed to the DC in kWh
$E_{cooling,other}$	part of $E_{cooling}$ that is not attributed to the DC in kWh
$E_{cooling,room}$	part of $E_{cooling}$ that is allocated to one room of the DC in kWh
$E_{cooling,subsystem}$	electrical energy use of the sub-system in kWh
E_{heat}	electrical energy transferred to heat in kWh
$E_{heat,room}$	electrical energy allocated to one room transferred to heat in kWh
$E_{heat,DC}$	electrical energy of the DC that is transferred to heat (annual) in kWh
E_{IT}	IT equipment energy consumption (annual) in kWh
$E_{IT,room}$	IT equipment energy consumption (annual) allocated to one room in kWh
E_{losses}	electrical energy losses (annual) in kWh
$E_{losses,room}$	electrical energy losses (annual) allocated to one room in kWh
$E_{total,room}$	total energy consumption allocated to one room (annual) in kWh
E_{DC}	total DC energy consumption (annual) in kWh
F_{EC}	cooling efficiency factor
$F_{EC,p}$	partial cooling efficiency factor
$P_{cooling}$	actual electrical power of the cooling system in kW
P_{heat}	actual heat load in kW
R_{CE}	cooling efficiency ratio
R_{CP}	cooling performance ratio
$\eta_{U,P,p}$	power usage effectiveness, PUE
$\eta_{U,P}$	partial power usage effectiveness, pPUE

4 Applicable area of the data centre

The CER as specified in this document:

— is associated with the DC infrastructure within its boundaries only;

— describes the efficiency of a cooling system with respect to its electrical energy use.

Derivatives of the CER which are useful in certain circumstances are described in Annex D.

5 Definition of the CER

The CER, R_{CE}, is defined according to Formula (1):

$$R_{CE} = \frac{E_{heat}}{E_{cooling}} \quad (1)$$

Both E_{heat} and $E_{cooling}$ shall be measured in kWh and for the same time period.

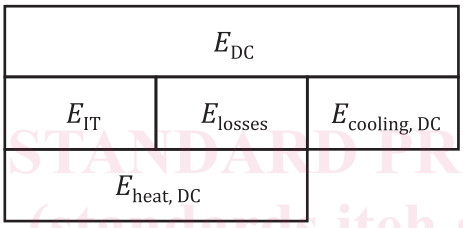
NOTE Within ISO/IEC TS 22237-7:2018, Formula (1) is designated as the energy efficiency ratio (EER). This will be corrected with the revision of ISO/IEC TS 22237-7.

The following applies to dedicated DC infrastructures:

$$E_{heat} = E_{heat,DC}$$

$$E_{cooling} = E_{cooling,DC}$$

Figure 1 shows the relationship between the different energy forms for dedicated DC infrastructures.



where

$E_{DC} = E_{IT} + E_{losses} + E_{cooling, DC}$

Figure 1 — Dedicated cooling system

The calculation of the heat load of the DC is based on the assumption that all electrical energy used in the DC is transferred to heat:

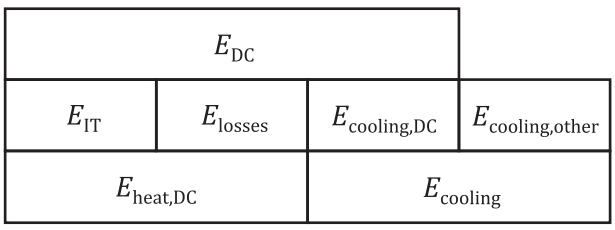
$$E_{heat,DC} = E_{IT} + E_{losses}$$

E_{IT} shall be measured in accordance with ISO/IEC 30134-2.

If available, E_{losses} shall include all other electrical losses, e.g. electrical energy of UPS, energy storage, transformers, power cables or lighting transferred to heat within the DC boundaries.

For shared cooling systems in multi-purpose buildings, which include a DC, the energy consumption of the cooling system is determined from the energy consumption from the shared cooling system.

Figure 2 shows the relationship between the different energy forms for shared cooling systems in multi-purpose buildings including a DC.



Where

$E_{cooling,DC}$ is the part of the energy use for the entire shared cooling system to remove the DC related heat loads;

$E_{cooling,other}$ is the part of the energy use for the entire shared cooling system to remove non-DC related heat loads.

Figure 2 — Shared cooling system

6 Measurement of CER

6.1 General

The calculation of CER requires the recording and documenting of total heat removed and electrical energy used for cooling over a coincident period of 12 months. This document does not specify the frequency of measurements of total heat removed and electrical energy used for cooling, since CER is calculated on an annual timeframe. However, the frequency of measurement employed will define the timing of subsequent CER calculations on a rolling annual basis.

6.2 Requirements

The measurement of CER requires the measurement of the total heat removed and the electrical energy used in the same period.

In order to measure the heat removed, the volume of the coolant and its heat capacity shall be measured. In cases like direct free cooling, every parameter influencing the heat capacity (like humidity) shall be measured for an acceptable accuracy of the calculation of the heat removed. In case of redundant pipes, every pipe shall be measured.

For the electrical energy use all components of the cooling infrastructure (like pumps) valves etc., shall be measured and included in the energy used. Electrical metering shall be based on kWh, not on power in kW. In the case of energy reuse, the energy consumption of additional systems for distributing the reused heat in the building shall not be part of the electrical energy consumption. Annex B shall apply.

In cases where it is necessary to describe versions of the CER for measurement periods of less than 12 months or for DC subsystems, the measurements described in Annex D shall be used.

6.3 Recommendations

DCs should implement meters with remote reading and data history storage capabilities.

7 Application of CER

CER can be used by DC managers to report the efficiency of the cooling system used to control the temperature of the spaces within the DC. This KPI can be used independently, but to achieve a more holistic picture of the resource efficiency of the DC, other KPIs described in the ISO/IEC 30134 series should be considered. When using CER, the PUE in particular should be considered. Where CER is reported, the corresponding PUE value should also be reported.