



**CSA C500.2:24**  
National Standard of Canada



# Benchmark energy factor (BEF) assessment of refrigerated facilities



# Legal Notice for Standards

Canadian Standards Association (operating as “CSA Group”) develops standards through a consensus standards development process approved by the Standards Council of Canada. This process brings together volunteers representing varied viewpoints and interests to achieve consensus and develop a standard. Although CSA Group administers the process and establishes rules to promote fairness in achieving consensus, it does not independently test, evaluate, or verify the content of standards.

## Disclaimer and exclusion of liability

This document is provided without any representations, warranties, or conditions of any kind, express or implied, including, without limitation, implied warranties or conditions concerning this document’s fitness for a particular purpose or use, its merchantability, or its non-infringement of any third party’s intellectual property rights. CSA Group does not warrant the accuracy, completeness, or currency of any of the information published in this document. CSA Group makes no representations or warranties regarding this document’s compliance with any applicable statute, rule, or regulation.

IN NO EVENT SHALL CSA GROUP, ITS VOLUNTEERS, MEMBERS, SUBSIDIARIES, OR AFFILIATED COMPANIES, OR THEIR EMPLOYEES, DIRECTORS, OR OFFICERS, BE LIABLE FOR ANY DIRECT, INDIRECT, OR INCIDENTAL DAMAGES, INJURY, LOSS, COSTS, OR EXPENSES, HOWSOEVER CAUSED, INCLUDING BUT NOT LIMITED TO SPECIAL OR CONSEQUENTIAL DAMAGES, LOST REVENUE, BUSINESS INTERRUPTION, LOST OR DAMAGED DATA, OR ANY OTHER COMMERCIAL OR ECONOMIC LOSS, WHETHER BASED IN CONTRACT, TORT (INCLUDING NEGLIGENCE), OR ANY OTHER THEORY OF LIABILITY, ARISING OUT OF OR RESULTING FROM ACCESS TO OR POSSESSION OR USE OF THIS DOCUMENT, EVEN IF CSA GROUP HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES, INJURY, LOSS, COSTS, OR EXPENSES.

In publishing and making this document available, CSA Group is not undertaking to render professional or other services for or on behalf of any person or entity or to perform any duty owed by any person or entity to another person or entity. The information in this document is directed to those who have the appropriate degree of experience to use and apply its contents, and CSA Group accepts no responsibility whatsoever arising in any way from any and all use of or reliance on the information contained in this document.

CSA Group is a private not-for-profit company that publishes voluntary standards and related documents. CSA Group has no power, nor does it undertake, to enforce compliance with the contents of the standards or other documents it publishes.

## Intellectual property rights and ownership

As between CSA Group and the users of this document (whether it be in printed or electronic form), CSA Group is the owner, or the authorized licensee, of all works contained herein that are protected by copyright, all trade-marks (except as otherwise noted to the contrary), and all inventions and trade secrets that may be contained in this document, whether or not such inventions and trade secrets are protected by patents and applications for patents. Without limitation, the unauthorized use, modification, copying, or disclosure of this document may violate laws that protect CSA Group’s and/or others’ intellectual property and may give rise to a right in CSA Group and/or others to seek legal redress for such use, modification, copying, or disclosure. To the extent permitted by treaty or by law, CSA Group reserves all intellectual property rights in this document.

## Patent rights

Attention is drawn to the possibility that some of the elements of this standard may be the subject of patent rights. CSA Group shall not be held responsible for identifying any or all such patent rights. Users of this standard are expressly advised that determination of the validity of any such patent rights is entirely their own responsibility.

## Authorized use of this document

This document is being provided by CSA Group for informational and non-commercial use only. The user of this document is authorized to do only the following:

If this document is in electronic form:

- load this document onto a computer for the sole purpose of reviewing it;
- search and browse this document; and
- print this document if it is in PDF form.

Limited copies of this document in print or paper form may be distributed only to persons who are authorized by CSA Group to have such copies, and only if this Legal Notice appears on each such copy.

In addition, users may not and may not permit others to

- alter this document in any way, or remove this Legal Notice from the attached standard;
- sell this document without authorization from CSA Group; or
- make an electronic copy of this document.

If you do not agree with any of the terms and conditions contained in this Legal Notice, you may not load or use this document or make any copies of the contents hereof, and if you do make such copies, you are required to destroy them immediately. Use of this document constitutes your acceptance of the terms and conditions of this Legal Notice.



# ***Standards Update Service***

***CSA C500.2:24***  
***October 2024***

**Title:** *Benchmark energy factor (BEF) assessment of refrigerated facilities*

To register for e-mail notification about any updates to this publication go to [updates.csagroup.org](https://updates.csagroup.org).

The **List ID** that you will need to register for updates to this publication is **2431507**.

If you require assistance, please e-mail [techsupport@csagroup.org](mailto:techsupport@csagroup.org) or call 416-777-2233.

Visit CSA Group's policy on privacy at [www.csagroup.org/legal](https://www.csagroup.org/legal) to find out how we protect your personal information.

**Canadian Standards Association (operating as “CSA Group”)**, under whose auspices this National Standard has been produced, was chartered in 1919 and accredited by the Standards Council of Canada to the National Standards system in 1973. It is a not-for-profit, nonstatutory, voluntary membership association engaged in standards development and certification activities.

CSA Group standards reflect a national consensus of producers and users — including manufacturers, consumers, retailers, unions and professional organizations, and governmental agencies. The standards are used widely by industry and commerce and often adopted by municipal, provincial, and federal governments in their regulations, particularly in the fields of health, safety, building and construction, and the environment.

More than 10 000 members indicate their support for CSA Group’s standards development by volunteering their time and skills to Committee work.

CSA Group offers certification and testing services in support of and as an extension to its standards development activities. To ensure the integrity of its certification process, CSA Group regularly and continually audits and inspects products that bear the CSA Group Mark.

In addition to its head office and laboratory complex in Toronto, CSA Group has regional branch offices in major centres across Canada and inspection and testing agencies in fourteen countries. Since 1919, CSA Group has developed the necessary expertise to meet its corporate mission: CSA Group is an independent service organization whose mission is to provide an open and effective forum for activities facilitating the exchange of goods and services through the use of standards, certification and related services to meet national and international needs.

For further information on CSA Group services, write to  
CSA Group  
178 Rexdale Boulevard  
Toronto, Ontario, M9W 1R3  
Canada

A National Standard of Canada is a standard developed by a Standards Council of Canada (SCC) accredited Standards Development Organization, in compliance with requirements and guidance set out by SCC. More information on National Standards of Canada can be found at [www.scc.ca](http://www.scc.ca).

SCC is a Crown corporation within the portfolio of Innovation, Science and Economic Development (ISED) Canada. With the goal of enhancing Canada’s economic competitiveness and social wellbeing, SCC leads and facilitates the development and use of national and international standards. SCC also coordinates Canadian participation in standards development, and identifies strategies to advance Canadian standardization efforts.

Accreditation services are provided by SCC to various customers, including product certifiers, testing laboratories, and standards development organizations. A list of SCC programs and accredited bodies is publicly available at [www.scc.ca](http://www.scc.ca).

Standards Council of Canada  
600-55 Metcalfe Street  
Ottawa, Ontario, K1P 6L5  
Canada



Cette Norme Nationale du Canada n’est disponible qu’en anglais.

*Although the intended primary application of this Standard is stated in its Scope, it is important to note that it remains the responsibility of the users to judge its suitability for their particular purpose.*

*®A trademark of the Canadian Standards Association, operating as “CSA Group”*

*National Standard of Canada*

*CSA C500.2:24*

***Benchmark energy factor (BEF)  
assessment of refrigerated facilities***



*®A trademark of the Canadian Standards Association,  
operating as "CSA Group"*



*Published in October 2024 by CSA Group  
A not-for-profit private sector organization  
178 Rexdale Boulevard, Toronto, Ontario, Canada M9W 1R3*

*To purchase standards and related publications, visit our Online Store at  
[www.csagroup.org/store/](http://www.csagroup.org/store/) or call toll-free 1-800-463-6727 or 416-747-4044.*

*ICS 97.130.20, 27.015  
ISBN 978-1-4883-5136-5*

*© 2024 Canadian Standards Association  
All rights reserved. No part of this publication may be reproduced in any form whatsoever  
without the prior permission of the publisher.*

# Contents

Technical Committee on Energy Efficiency of Industrial Equipment and Systems 3

Subcommittee on Industrial Refrigeration Systems 5

Preface 6

Sustainable Development Goals (SDG) Foreword 8

## 1 Scope 9

- 1.1 Inclusions 9
- 1.2 Exclusions 9
- 1.3 Terminology 9
- 1.4 Dual measurements 9

## 2 Reference publications 9

## 3 Definitions, abbreviations, and symbols 10

- 3.1 Definitions 10
- 3.2 Abbreviations 11
- 3.3 Symbols 11

## 4 Levels of assessment 14

- 4.1 General 14
- 4.2 Assessment levels 14
- 4.3 Data collection by level of assessment 16

## 5 System boundary 17

- 5.1 General 17
- 5.2 Typical refrigerated facility 18
  - 5.2.1 General 18
  - 5.2.2 Classification 19
  - 5.2.3 Refrigeration 20
- 5.3 Essential refrigerated facility 20
  - 5.3.1 General 20
  - 5.3.2 Essential refrigeration system 21
  - 5.3.3 Essential non-refrigeration end uses 26
  - 5.3.4 User-defined parameters and variables 27

## 6 Determining essential refrigeration load 28

- 6.1 General 28
- 6.2 Essential transmission load —  $Q_{transmission}$  28
- 6.3 Essential lighting load —  $Q_{lighting}$  29
- 6.4 Product load —  $Q_{product}$  30
- 6.5 Essential infiltration load —  $Q_{infiltration}$  32
- 6.6 People load —  $Q_{people}$  33
- 6.7 Supplementary load —  $Q_{supplementary}$  34
- 6.8 Essential material handling load —  $Q_{mat.handling}$  34

6.9	Essential evaporator fan motor load — $Q_{\text{evaporator}}$	35
6.10	Total essential load — $Q_{\text{total}}$	36
<b>7</b>	<b>Determining essential energy</b>	<b>36</b>
7.1	General	36
7.2	Essential refrigeration energy — $E_{\text{REF}}$	36
7.3	Essential non-refrigeration energy — $E_{\text{nonREF}}$	39
7.3.1	Entire facility essential non-refrigeration energy	39
7.3.2	Refrigerated zone lighting — $E_{\text{zonelighting}}$	39
7.3.3	Material handling — $E_{\text{mat.handling}}$	40
7.3.4	Office, common areas, utility rooms — $E_{\text{office}}$	40
7.3.5	Dry storage — $E_{\text{drystorage}}$	41
7.3.6	Exterior lighting — $E_{\text{exterior}}$	42
7.4	Total essential energy	43
<b>8</b>	<b>Actual energy use</b>	<b>43</b>
<b>9</b>	<b>Computing the benchmark energy factor (BEF)</b>	<b>43</b>
<b>10</b>	<b>Reporting BEF</b>	<b>44</b>
<b>11</b>	<b>Energy savings using BEF</b>	<b>44</b>
11.1	General	44
11.2	Technical conservation potential determination	44
11.3	Energy savings determination	44

---

Annex A (informative)	— Illustrative example	45
Annex B (informative)	— Bibliography	49

# Technical Committee on Energy Efficiency of Industrial Equipment and Systems

<b>M. Zeller</b>	BC Hydro Vancouver, British Columbia, Canada <i>Category: User Interest/Regulatory Authority</i>	<i>Chair</i>
<b>C. Benedetti</b>	Hydro-Québec Montréal, Québec, Canada <i>Category: User Interest/Regulatory Authority</i>	<i>Vice-Chair</i>
<b>P. Angers</b>	Concordia University Montréal, Québec, Canada <i>Category: General Interest</i>	
<b>R. Burge</b>	Natural Resources Canada Ottawa, Ontario, Canada	<i>Non-voting</i>
<b>A. J. Cordova</b>	V.J. Pamensky Canada Inc. Toronto, Ontario, Canada <i>Category: Producer Interest</i>	
<b>R. P. de Lhorbe</b>	North Vancouver, British Columbia, Canada <i>Category: Producer Interest</i>	
<b>J. V. Feldman</b>	Independent Electricity System Operator (IESO) Toronto, Ontario, Canada	<i>Non-voting</i>
<b>D. R. Friesen</b>	Midium Energy Winnipeg, Manitoba, Canada <i>Category: General Interest</i>	
<b>L. Gudbjartsson</b>	BC Hydro Vancouver, British Columbia, Canada	<i>Non-voting</i>
<b>S. Krsikapa</b>	Ontario Ministry of Energy Toronto, Ontario, Canada <i>Category: User Interest/Regulatory Authority</i>	
<b>Li</b>	Ontario Ministry of Energy Toronto, Ontario, Canada	<i>Non-voting</i>

<b>S. Mostafaei</b>	Danfoss Drives Canada Oakville, Ontario, Canada <i>Category: Producer Interest</i>	
<b>A. Orumwense</b>	Natural Resources Canada Ottawa, Ontario, Canada <i>Category: User Interest/Regulatory Authority</i>	
<b>C. Perrett</b>	Efficiency Manitoba Winnipeg, Manitoba, Canada	<i>Non-voting</i>
<b>C. D. Pitis</b>	ELEN-MECH. Consulting Inc. Vancouver, British Columbia, Canada <i>Category: General Interest</i>	
<b>P. Vinayagamoorthy</b>	Durham Catholic District School Board Oshawa, Ontario, Canada <i>Category: General Interest</i>	
<b>L. Contasti</b>	CSA Group Toronto, Ontario, Canada	<i>Project Manager</i>

# Subcommittee on Industrial Refrigeration Systems

<b>L. Gudbjartsson</b>	BC Hydro Vancouver, British Columbia, Canada	<i>Chair</i>
<b>Z. Al-Chalabi</b>	ASA Energy Consulting Ltd. Vancouver, British Columbia, Canada	
<b>J. Berney</b>	Copeland Oakville, Ontario, Canada	
<b>D. Dittburner</b>	Ferrero Brantford, Ontario, Canada	
<b>J. V. Feldman</b>	Independent Electricity System Operator (IESO) Toronto, Ontario, Canada	
<b>K. Khan</b>	Congebec Inc. Mississauga, Ontario, Canada	
<b>H. Nesreddine</b>	Hydro-Québec Shawinigan, Québec, Canada	
<b>C. Perrett</b>	Efficiency Manitoba Winnipeg, Manitoba, Canada	
<b>C. D. Pitis</b>	PLI-MECH. Consulting Inc. Vancouver, British Columbia, Canada	
<b>M. Zeller</b>	BC Hydro Vancouver, British Columbia, Canada	
<b>L. Contasti</b>	CSA Group Toronto, Ontario, Canada	<i>Project Manager</i>

# Preface

This is the first edition of CSA C500.2, *Benchmark energy factor (BEF) assessment of refrigerated facilities*. It replaces CSA C500, which was published in 2018 under the title *Monitoring and energy performance measurement of industrial refrigeration systems (IRS) using benchmark energy factor (BEF) concepts*.

CSA C500 has been separated into two Standards: CSA C500.1, which incorporates the requirements for refrigerated spaces and processes; and CSA C500.2, which incorporates the refrigeration requirements at a facility level.

The following are the major ways in which this Standard differs from the relevant corresponding parts of CSA C500:

- a) The Standard has been aligned with more recent BEF standards in terms of document structure, language, terminology, and definitions.
- b) Essential load and energy determination have been simplified and user inputs have been reduced to make the Standard more user-friendly.
- c) Essential performance factors used for essential load and energy have been confirmed or updated.
- d) Required corrections and recommendations identified from the validation study have been incorporated.

CSA Group acknowledges that the development of this Standard was made possible, in part, by the financial support of BC Hydro, Efficiency Manitoba, Electricity Canada, FortisBC, Hydro-Québec, Independent Electricity System Operator (IESO), and the Québec Ministère de l'Environnement, de la Lutte contre les changements climatiques, de la Faune et des Parcs.

This Standard was prepared by the Subcommittee on Industrial Refrigeration Systems, under the jurisdiction of the Technical Committee on Energy Efficiency of Industrial Equipment and Systems and the Strategic Steering Committee on Performance, Energy Efficiency, and Renewables, and has been formally approved by the Technical Committee.

This Standard has been developed in compliance with Standards Council of Canada requirements for National Standards of Canada. It has been published as a National Standard of Canada by CSA Group.

## Notes:

- 1) *Use of the singular does not exclude the plural (and vice versa) when the sense allows.*
- 2) *Although the intended primary application of this Standard is stated in its Scope, it is important to note that it remains the responsibility of the users of the Standard to judge its suitability for their particular purpose.*
- 3) *This Standard was developed by consensus, which is defined by CSA Policy governing standardization — Code of good practice for standardization as “substantial agreement. Consensus implies much more than a simple majority, but not necessarily unanimity”. It is consistent with this definition that a member may be included in the Technical Committee list and yet not be in full agreement with all clauses of this Standard.*
- 4) *To submit a request for interpretation of this Standard, please send the following information to [inquiries@csagroup.org](mailto:inquiries@csagroup.org) and include “Request for interpretation” in the subject line:*
  - a) *define the problem, making reference to the specific clause, and, where appropriate, include a graphical image;*
  - b) *provide an explanation of circumstances surrounding the actual field condition; and*
  - c) *where possible, phrase the request in such a way that a specific “yes” or “no” answer will address the issue.*

*Committee interpretations are processed in accordance with CSA Directives and guidelines governing standardization and are available on the Current Standards Activities page at [standardsactivities.csagroup.org](http://standardsactivities.csagroup.org).*