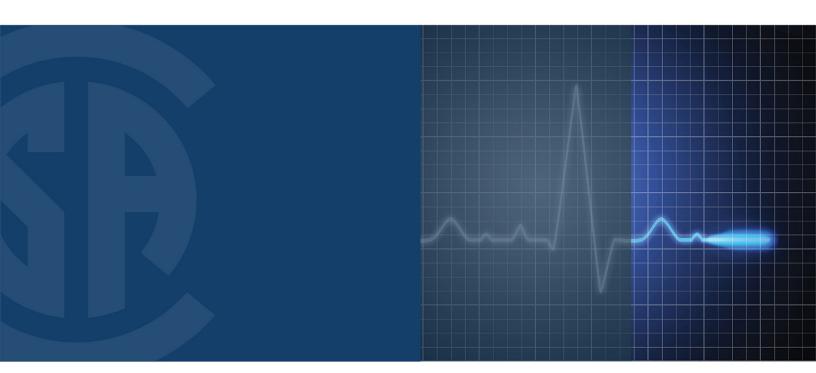
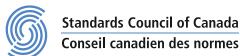






## Special requirements for heating, ventilation, and air-conditioning (HVAC) systems in health care facilities





## **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 licence 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 format.

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 Z317.2:19 December 2019* 

**Title:** Special requirements for heating, ventilation, and air-conditioning (HVAC) systems in health care facilities

To register for e-mail notification about any updates to this publication

- go to store.csagroup.org
- click on **Product Updates**

The **List ID** that you will need to register for updates to this publication is **2427647**.

If you require assistance, please e-mail techsupport@csagroup.org or call 416-747-2233.

Visit CSA Group's policy on privacy at <a href="www.csagroup.org/legal">www.csagroup.org/legal</a> 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.

Individuals, companies, and associations across Canada indicate their support for CSA Group's standards development by volunteering their time and skills to Committee work and supporting CSA Group's objectives through sustaining memberships. The more than 7000 committee volunteers and the 2000 sustaining memberships together form CSA Group's total membership from which its Directors are chosen. Sustaining memberships represent a major source of income for CSA Group's standards development activities.

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 eight 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 <a href="https://www.scc.ca">www.scc.ca</a>.

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 <a href="https://www.scc.ca">www.scc.ca</a>.

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





 $\label{lem:cette} \textbf{Cette Norme Nationale du Canada est disponible en versions française et anglaise}.$ 

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 Z317.2:19

# Special requirements for heating, ventilation, and air-conditioning (HVAC) systems in health care facilities



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



Published in December 2019 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 <a href="store.csagroup.org">store.csagroup.org</a> or call toll-free 1-800-463-6727 or 416-747-4044.

ICS 97.040.10 ISBN 978-1-4883-2588-5

© 2019 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.

This is a preview. Click here to purchase the full publication.

9

## **Contents**

Technical Committee on Health Care Facilities 6  Subcommittee on Special Requirements for HVAC Systems in Health Care Facilities  Preface 11  0 Introduction 13  1 Scope 13  2 Reference publications 14  3 Definitions and abbreviations 17 3.1 Definitions 17 3.2 Abbreviations 22  4 General 23  5 General design requirements 25 5.1 General 25 5.2 Ventilation 26 5.3 Infection control 26 5.4 Fire protection and smoke management 26 5.5 Continuity of systems 27 5.6 Monitoring 27 5.7 Energy management and sustainability 27 5.8 Existing systems and equipment 28  6 Detailed design requirements 29 6.1.1 Temperature, relative humidity, relative pressurization, and air flow 29 6.1.2 Class of health care facility 29 6.1.3 Heating and cooling design requirements by Class 29 6.1.4 Space 29 6.1.5 Access 30 6.1.6 Replacement 30 6.1.7 Isolation valves and connections 30 6.1.8 Maintenance 30
Preface 11  O Introduction 13  1 Scope 13  2 Reference publications 14  3 Definitions and abbreviations 17 3.1 Definitions 17 3.2 Abbreviations 22  4 General 23  5 General design requirements 25 5.1 General 25 5.2 Ventilation 26 5.3 Infection control 26 5.4 Fire protection and smoke management 26 5.5 Continuity of systems 27 5.6 Monitoring 27 5.7 Energy management and sustainability 27 5.8 Existing systems and equipment 28  6 Detailed design requirements 29 6.1.1 Temperature, relative humidity, relative pressurization, and air flow 29 6.1.2 Class of health care facility 29 6.1.3 Heating and cooling design requirements by Class 29 6.1.4 Space 29 6.1.5 Access 30 6.1.6 Replacement 30 6.1.7 Isolation valves and connections 30
1 Scope 13  2 Reference publications 14  3 Definitions and abbreviations 17 3.1 Definitions 17 3.2 Abbreviations 22  4 General 23  5 General design requirements 25 5.1 General 25 5.2 Ventilation 26 5.3 Infection control 26 5.4 Fire protection and smoke management 26 5.5 Continuity of systems 27 5.6 Monitoring 27 5.7 Energy management and sustainability 27 5.8 Existing systems and equipment 28  6 Detailed design requirements 29 6.1.1 Temperature, relative humidity, relative pressurization, and air flow 29 6.1.2 Class of health care facility 29 6.1.3 Heating and cooling design requirements by Class 29 6.1.4 Space 29 6.1.5 Access 30 6.1.6 Replacement 30 6.1.7 Isolation valves and connections 30
1 Scope 13  2 Reference publications 14  3 Definitions and abbreviations 17 3.1 Definitions 17 3.2 Abbreviations 22  4 General 23  5 General design requirements 25 5.1 General 25 5.2 Ventilation 26 5.3 Infection control 26 5.4 Fire protection and smoke management 26 5.5 Continuity of systems 27 5.6 Monitoring 27 5.7 Energy management and sustainability 27 5.8 Existing systems and equipment 28  6 Detailed design requirements 29 6.1.1 Temperature, relative humidity, relative pressurization, and air flow 29 6.1.2 Class of health care facility 29 6.1.3 Heating and cooling design requirements by Class 29 6.1.4 Space 29 6.1.5 Access 30 6.1.6 Replacement 30 6.1.7 Isolation valves and connections 30
2 Reference publications 14  3 Definitions and abbreviations 17 3.1 Definitions 17 3.2 Abbreviations 22  4 General 23  5 General design requirements 25 5.1 General 25 5.2 Ventilation 26 5.3 Infection control 26 5.4 Fire protection and smoke management 26 5.5 Continuity of systems 27 5.6 Monitoring 27 5.7 Energy management and sustainability 27 5.8 Existing systems and equipment 28  6 Detailed design requirements 29 6.1.1 Temperature, relative humidity, relative pressurization, and air flow 29 6.1.2 Class of health care facility 29 6.1.3 Heating and cooling design requirements by Class 29 6.1.4 Space 29 6.1.5 Access 30 6.1.6 Replacement 30 6.1.7 Isolation valves and connections 30
2 Reference publications 14  3 Definitions and abbreviations 17 3.1 Definitions 17 3.2 Abbreviations 22  4 General 23  5 General design requirements 25 5.1 General 25 5.2 Ventilation 26 5.3 Infection control 26 5.4 Fire protection and smoke management 26 5.5 Continuity of systems 27 5.6 Monitoring 27 5.7 Energy management and sustainability 27 5.8 Existing systems and equipment 28  6 Detailed design requirements 29 6.1.1 Temperature, relative humidity, relative pressurization, and air flow 29 6.1.2 Class of health care facility 29 6.1.3 Heating and cooling design requirements by Class 29 6.1.4 Space 29 6.1.5 Access 30 6.1.6 Replacement 30 6.1.7 Isolation valves and connections 30
3 Definitions and abbreviations 17 3.1 Definitions 17 3.2 Abbreviations 22  4 General 23  5 General design requirements 25 5.1 General 25 5.2 Ventilation 26 5.3 Infection control 26 5.4 Fire protection and smoke management 26 5.5 Continuity of systems 27 5.6 Monitoring 27 5.7 Energy management and sustainability 27 5.8 Existing systems and equipment 28  6 Detailed design requirements 29 6.1.1 Temperature, relative humidity, relative pressurization, and air flow 29 6.1.2 Class of health care facility 29 6.1.3 Heating and cooling design requirements by Class 29 6.1.4 Space 29 6.1.5 Access 30 6.1.6 Replacement 30 6.1.7 Isolation valves and connections 30
3 Definitions and abbreviations 17 3.1 Definitions 17 3.2 Abbreviations 22  4 General 23  5 General design requirements 25 5.1 General 25 5.2 Ventilation 26 5.3 Infection control 26 5.4 Fire protection and smoke management 26 5.5 Continuity of systems 27 5.6 Monitoring 27 5.7 Energy management and sustainability 27 5.8 Existing systems and equipment 28  6 Detailed design requirements 29 6.1.1 Temperature, relative humidity, relative pressurization, and air flow 29 6.1.2 Class of health care facility 29 6.1.3 Heating and cooling design requirements by Class 29 6.1.4 Space 29 6.1.5 Access 30 6.1.6 Replacement 30 6.1.7 Isolation valves and connections 30
3.1 Definitions 17 3.2 Abbreviations 22  4 General 23  5 General design requirements 25 5.1 General 25 5.2 Ventilation 26 5.3 Infection control 26 5.4 Fire protection and smoke management 26 5.5 Continuity of systems 27 5.6 Monitoring 27 5.7 Energy management and sustainability 27 5.8 Existing systems and equipment 28  6 Detailed design requirements 29 6.1 General 29 6.1.1 Temperature, relative humidity, relative pressurization, and air flow 29 6.1.2 Class of health care facility 29 6.1.3 Heating and cooling design requirements by Class 29 6.1.4 Space 29 6.1.5 Access 30 6.1.6 Replacement 30 6.1.7 Isolation valves and connections 30
4 General 23  5 General design requirements 25 5.1 General 25 5.2 Ventilation 26 5.3 Infection control 26 5.4 Fire protection and smoke management 26 5.5 Continuity of systems 27 5.6 Monitoring 27 5.7 Energy management and sustainability 27 5.8 Existing systems and equipment 28  6 Detailed design requirements 29 6.1 General 29 6.1.1 Temperature, relative humidity, relative pressurization, and air flow 29 6.1.2 Class of health care facility 29 6.1.3 Heating and cooling design requirements by Class 29 6.1.4 Space 29 6.1.5 Access 30 6.1.6 Replacement 30 6.1.7 Isolation valves and connections 30
<b>5 General design requirements</b> 25 5.1 General 25 5.2 Ventilation 26 5.3 Infection control 26 5.4 Fire protection and smoke management 26 5.5 Continuity of systems 27 5.6 Monitoring 27 5.7 Energy management and sustainability 27 5.8 Existing systems and equipment 28 <b>6 Detailed design requirements</b> 29 6.1 General 29 6.1.1 Temperature, relative humidity, relative pressurization, and air flow 29 6.1.2 Class of health care facility 29 6.1.3 Heating and cooling design requirements by Class 29 6.1.4 Space 29 6.1.5 Access 30 6.1.6 Replacement 30 6.1.7 Isolation valves and connections 30
5 General design requirements 25 5.1 General 25 5.2 Ventilation 26 5.3 Infection control 26 5.4 Fire protection and smoke management 26 5.5 Continuity of systems 27 5.6 Monitoring 27 5.7 Energy management and sustainability 27 5.8 Existing systems and equipment 28  6 Detailed design requirements 29 6.1.1 Temperature, relative humidity, relative pressurization, and air flow 29 6.1.2 Class of health care facility 29 6.1.3 Heating and cooling design requirements by Class 29 6.1.4 Space 29 6.1.5 Access 30 6.1.6 Replacement 30 6.1.7 Isolation valves and connections 30
5.1 General 25 5.2 Ventilation 26 5.3 Infection control 26 5.4 Fire protection and smoke management 26 5.5 Continuity of systems 27 5.6 Monitoring 27 5.7 Energy management and sustainability 27 5.8 Existing systems and equipment 28  6 Detailed design requirements 29 6.1 General 29 6.1.1 Temperature, relative humidity, relative pressurization, and air flow 29 6.1.2 Class of health care facility 29 6.1.3 Heating and cooling design requirements by Class 29 6.1.4 Space 29 6.1.5 Access 30 6.1.6 Replacement 30 6.1.7 Isolation valves and connections 30
5.2 Ventilation 26 5.3 Infection control 26 5.4 Fire protection and smoke management 26 5.5 Continuity of systems 27 5.6 Monitoring 27 5.7 Energy management and sustainability 27 5.8 Existing systems and equipment 28  6 Detailed design requirements 29 6.1 General 29 6.1.1 Temperature, relative humidity, relative pressurization, and air flow 29 6.1.2 Class of health care facility 29 6.1.3 Heating and cooling design requirements by Class 29 6.1.4 Space 29 6.1.5 Access 30 6.1.6 Replacement 30 6.1.7 Isolation valves and connections 30
5.3 Infection control 26 5.4 Fire protection and smoke management 26 5.5 Continuity of systems 27 5.6 Monitoring 27 5.7 Energy management and sustainability 27 5.8 Existing systems and equipment 28  6 Detailed design requirements 29 6.1 General 29 6.1.1 Temperature, relative humidity, relative pressurization, and air flow 29 6.1.2 Class of health care facility 29 6.1.3 Heating and cooling design requirements by Class 29 6.1.4 Space 29 6.1.5 Access 30 6.1.6 Replacement 30 6.1.7 Isolation valves and connections 30
5.4 Fire protection and smoke management 26 5.5 Continuity of systems 27 5.6 Monitoring 27 5.7 Energy management and sustainability 27 5.8 Existing systems and equipment 28  6 Detailed design requirements 29 6.1 General 29 6.1.1 Temperature, relative humidity, relative pressurization, and air flow 29 6.1.2 Class of health care facility 29 6.1.3 Heating and cooling design requirements by Class 29 6.1.4 Space 29 6.1.5 Access 30 6.1.6 Replacement 30 6.1.7 Isolation valves and connections 30
5.5 Continuity of systems 27 5.6 Monitoring 27 5.7 Energy management and sustainability 27 5.8 Existing systems and equipment 28  6 Detailed design requirements 29 6.1 General 29 6.1.1 Temperature, relative humidity, relative pressurization, and air flow 29 6.1.2 Class of health care facility 29 6.1.3 Heating and cooling design requirements by Class 29 6.1.4 Space 29 6.1.5 Access 30 6.1.6 Replacement 30 6.1.7 Isolation valves and connections 30
5.6 Monitoring 27 5.7 Energy management and sustainability 27 5.8 Existing systems and equipment 28  6 Detailed design requirements 29 6.1 General 29 6.1.1 Temperature, relative humidity, relative pressurization, and air flow 29 6.1.2 Class of health care facility 29 6.1.3 Heating and cooling design requirements by Class 29 6.1.4 Space 29 6.1.5 Access 30 6.1.6 Replacement 30 6.1.7 Isolation valves and connections 30
5.6 Monitoring 27 5.7 Energy management and sustainability 27 5.8 Existing systems and equipment 28  6 Detailed design requirements 29 6.1 General 29 6.1.1 Temperature, relative humidity, relative pressurization, and air flow 29 6.1.2 Class of health care facility 29 6.1.3 Heating and cooling design requirements by Class 29 6.1.4 Space 29 6.1.5 Access 30 6.1.6 Replacement 30 6.1.7 Isolation valves and connections 30
5.7 Energy management and sustainability 27 5.8 Existing systems and equipment 28  6 Detailed design requirements 29 6.1 General 29 6.1.1 Temperature, relative humidity, relative pressurization, and air flow 29 6.1.2 Class of health care facility 29 6.1.3 Heating and cooling design requirements by Class 29 6.1.4 Space 29 6.1.5 Access 30 6.1.6 Replacement 30 6.1.7 Isolation valves and connections 30
6 Detailed design requirements 29 6.1 General 29 6.1.1 Temperature, relative humidity, relative pressurization, and air flow 29 6.1.2 Class of health care facility 29 6.1.3 Heating and cooling design requirements by Class 29 6.1.4 Space 29 6.1.5 Access 30 6.1.6 Replacement 30 6.1.7 Isolation valves and connections 30
6.1 General 29 6.1.1 Temperature, relative humidity, relative pressurization, and air flow 29 6.1.2 Class of health care facility 29 6.1.3 Heating and cooling design requirements by Class 29 6.1.4 Space 29 6.1.5 Access 30 6.1.6 Replacement 30 6.1.7 Isolation valves and connections 30
6.1 General 29 6.1.1 Temperature, relative humidity, relative pressurization, and air flow 29 6.1.2 Class of health care facility 29 6.1.3 Heating and cooling design requirements by Class 29 6.1.4 Space 29 6.1.5 Access 30 6.1.6 Replacement 30 6.1.7 Isolation valves and connections 30
<ul> <li>6.1.2 Class of health care facility 29</li> <li>6.1.3 Heating and cooling design requirements by Class 29</li> <li>6.1.4 Space 29</li> <li>6.1.5 Access 30</li> <li>6.1.6 Replacement 30</li> <li>6.1.7 Isolation valves and connections 30</li> </ul>
<ul> <li>6.1.2 Class of health care facility 29</li> <li>6.1.3 Heating and cooling design requirements by Class 29</li> <li>6.1.4 Space 29</li> <li>6.1.5 Access 30</li> <li>6.1.6 Replacement 30</li> <li>6.1.7 Isolation valves and connections 30</li> </ul>
<ul> <li>6.1.3 Heating and cooling design requirements by Class 29</li> <li>6.1.4 Space 29</li> <li>6.1.5 Access 30</li> <li>6.1.6 Replacement 30</li> <li>6.1.7 Isolation valves and connections 30</li> </ul>
<ul> <li>6.1.4 Space 29</li> <li>6.1.5 Access 30</li> <li>6.1.6 Replacement 30</li> <li>6.1.7 Isolation valves and connections 30</li> </ul>
<ul> <li>6.1.5 Access 30</li> <li>6.1.6 Replacement 30</li> <li>6.1.7 Isolation valves and connections 30</li> </ul>
<ul><li>6.1.6 Replacement 30</li><li>6.1.7 Isolation valves and connections 30</li></ul>
6.1.7 Isolation valves and connections 30
6.1.9 Identification of piping and ductwork 30
6.1.10 Surface materials 30
6.1.11 Waterproofing <i>31</i>
6.1.12 Recirculation flexibility in 100% outside air systems 31
6.2 Heating source 31
6.2.1 General <i>31</i>
6.2.2 Design load - heating 31
6.2.3 Boilers and other heating units 31

6.2.4

External heating supply

32

6.2.6 Secondary fuel requirements 32 6.2.7 Standby fuel 32 6.2.8 Ancillary equipment for heating units 32 6.2.9 Essential electrical system 33 6.2.10 Chemicals 33 6.2.11 Water supply 33 6.2.11 Water supply 33 6.2.12 Parallel steam traps 33 6.3 Cooling source 34 6.3.1 General 34 6.3.2 Design load - cooling 34 6.3.3 Cooling system 34 6.3.4 Maintenance of essential cooling functions 34 6.3.5 Design considerations 35 6.3.6 Ancillary equipment for cooling systems 35 6.3.7 Sizing of cooling sources 36 6.3.8 Cooling towers and cooling condensers 36 6.3.9 Temporary connection 37 6.3.10 Cooling sources 37 6.4 Piping locations 38 6.4.1 Piping locations 38 6.4.2 Piping shafts 38 6.4.3 Shut-off valves 38 6.4.4 Supply and return connections 38 6.5.1 General 38 6.5.2 Requirements for areas of different use 38 6.5.3 Return air systems 39 6.5.4 Minimum operation 39 6.5.5 Variable air volume (VAV) systems 41 6.5.6 Air handling units 45 6.6.1 Construction 45 6.6.2 Water removal 46 6.6.3 Ultraviolet disinfection systems 47 6.6.4 Access 47 6.7 Air filtration 48 6.8 Humidification 49 6.8.1 General 49 6.8.2 Chemical treatment 50 6.8.3 Central air handling 50 6.8.4 Humidification controls 50 6.8.5 Duct-mounted humidifiers 51 6.9.1 General 51 6.9.2 Ceiling space 51 6.9.3 Circulation, transfer, and recirculation 52	6.2.5	Temporary supply 32
6.2.7 Standby fuel 32 6.2.8 Ancillary equipment for heating units 32 6.2.9 Essential electrical system 33 6.2.10 Chemicals 33 6.2.11 Water supply 33 6.2.12 Parallel steam traps 33 6.3 Cooling source 34 6.3.1 General 34 6.3.2 Design load - cooling 34 6.3.3 Cooling system 34 6.3.4 Maintenance of essential cooling functions 34 6.3.5 Design considerations 35 6.3.6 Ancillary equipment for cooling systems 35 6.3.7 Sizing of cooling sources 36 6.3.8 Cooling towers and cooling condensers 36 6.3.9 Temporary connection 37 6.3.10 Cooling sources 37 6.4 Piped HVAC distribution 38 6.4.1 Piping locations 38 6.4.2 Piping shafts 38 6.4.3 Shut-off valves 38 6.4.4 Supply and return connections 38 6.5.1 General 38 6.5.2 Requirements for areas of different use 38 6.5.3 Return air systems 39 6.5.4 Minimum operation 39 6.5.5 Variable air volume (VAV) systems 41 6.5.6 Air handling unit redundancy 41 6.5.7 Outdoor air intakes 44 6.6 Air handling units 45 6.6.1 Construction 45 6.6.2 Water removal 46 6.6.3 Ultraviolet disinfection systems 47 6.6.4 Access 47 6.7 Air filtration 48 6.8 Humidification 49 6.8.1 General 49 6.8.2 Chemical treatment 50 6.8.3 Central air handling 50 6.8.4 Humidification controls 50 6.8.5 Duct-mounted humidifiers 51 6.9.1 General 51 6.9.2 Ceiling space 51 6.9.2 Ceiling space 51 6.9.3 Circulation, transfer, and recirculation 52		
6.2.8 Ancillary equipment for heating units 32 6.2.9 Essential electrical system 33 6.2.10 Chemicals 33 6.2.11 Water supply 33 6.2.12 Parallel steam traps 33 6.3.1 Goneral 34 6.3.2 Design load - cooling 34 6.3.3 Cooling system 34 6.3.4 Maintenance of essential cooling functions 34 6.3.5 Design considerations 35 6.3.6 Ancillary equipment for cooling systems 35 6.3.6 Ancillary equipment for cooling systems 35 6.3.7 Sizing of cooling sources 36 6.3.8 Cooling towers and cooling condensers 36 6.3.9 Temporary connection 37 6.3.10 Cooling sources 37 6.4 Piped HVAC distribution 38 6.4.1 Piping locations 38 6.4.2 Piping shafts 38 6.4.3 Shut-off valves 38 6.4.4 Supply and return connections 38 6.5.1 General 38 6.5.2 Requirements for areas of different use 38 6.5.3 Return air systems 39 6.5.4 Minimum operation 39 6.5.5 Variable air volume (VAV) systems 41 6.5.6 Air handling unit redundancy 41 6.5.7 Outdoor air intakes 44 6.6 Air handling units 45 6.6.1 Construction 45 6.6.2 Water removal 46 6.6.3 Ultraviolet disinfection systems 47 6.6.4 Access 47 6.7 Air filtration 48 6.8 Humidification 49 6.8.1 General 49 6.8.2 Chemical treatment 50 6.8.3 Central air handling 50 6.8.4 Humidification controls 50 6.8.5 Duct-mounted humidifiers 51 6.9.1 General 51 6.9.2 Ceiling space 51 6.9.3 Circulation, transfer, and recirculation 52		
6.2.9 Essential electrical system 33 6.2.10 Chemicals 33 6.2.11 Water supply 33 6.2.12 Parallel steam traps 33 6.3.1 General 34 6.3.2 Design load - cooling 34 6.3.3 Cooling system 34 6.3.4 Maintenance of essential cooling functions 34 6.3.5 Design considerations 35 6.3.6 Ancillary equipment for cooling systems 35 6.3.7 Sizing of cooling sources 36 6.3.8 Cooling towers and cooling condensers 36 6.3.9 Temporary connection 37 6.3.10 Cooling sources 37 6.4 Piped HVAC distribution 38 6.4.1 Piping locations 38 6.4.2 Piping shafts 38 6.4.3 Shut-off valves 38 6.4.4 Supply and return connections 38 6.5.1 General 38 6.5.2 Requirements for areas of different use 38 6.5.3 Return air systems 39 6.5.4 Minimum operation 39 6.5.5 Variable air volume (VAV) systems 41 6.5.6 Air handling unit redundancy 41 6.5.7 Outdoor air intakes 44 6.6 Air handling units 45 6.6.1 Construction 45 6.6.2 Water removal 46 6.6.3 Ultraviolet disinfection systems 47 6.6.4 Access 47 6.7 Air filtration 48 6.8 Humidification 49 6.8.1 General 49 6.8.2 Chemical treatment 50 6.8.3 Central air handling 50 6.8.4 Humidification controls 50 6.8.5 Duct-mounted humidifiers 51 6.9.1 General 51 6.9.2 Ceiling space 51 6.9.3 Circulation, transfer, and recirculation 52		,
6.2.10 Chemicals 33 6.2.11 Water supply 33 6.2.12 Parallel steam traps 33 6.3.1 General 34 6.3.2 Design load - cooling 34 6.3.3 Cooling system 34 6.3.4 Maintenance of essential cooling functions 34 6.3.5 Design considerations 35 6.3.6 Ancillary equipment for cooling systems 35 6.3.7 Sizing of cooling sources 36 6.3.8 Cooling towers and cooling condensers 36 6.3.9 Temporary connection 37 6.3.10 Cooling sources 37 6.4 Piped HVAC distribution 38 6.4.1 Piping locations 38 6.4.2 Piping shafts 38 6.4.3 Shut-off valves 38 6.4.4 Supply and return connections 38 6.5.1 General 38 6.5.2 Requirements for areas of different use 38 6.5.3 Return air systems 39 6.5.4 Minimum operation 39 6.5.5 Variable air volume (VAV) systems 41 6.5.6 Air handling unit redundancy 41 6.5.7 Outdoor air intakes 44 6.6 Air handling units 45 6.6.1 Construction 45 6.6.2 Water removal 46 6.6.3 Ultraviolet disinfection systems 47 6.6.4 Access 47 6.7 Air filtration 48 6.8 Humidification 49 6.8.1 General 49 6.8.2 Chemical treatment 50 6.8.3 Central air handling 50 6.8.4 Humidification controls 50 6.8.5 Duct-mounted humidifiers 51 6.9 Air distribution 51 6.9.1 General 51 6.9.2 Ceiling space 51 6.9.3 Circulation, transfer, and recirculation 52		
6.2.11 Water supply 33 6.2.12 Parallel steam traps 33 6.3 Cooling source 34 6.3.1 General 34 6.3.2 Design load - cooling 34 6.3.3 Cooling system 34 6.3.4 Maintenance of essential cooling functions 34 6.3.5 Design considerations 35 6.3.6 Ancillary equipment for cooling systems 35 6.3.7 Sizing of cooling sources 36 6.3.8 Cooling towers and cooling condensers 36 6.3.9 Temporary connection 37 6.3.10 Cooling sources 37 6.4 Piped HVAC distribution 38 6.4.1 Piping locations 38 6.4.2 Piping shafts 38 6.4.3 Shut-off valves 38 6.4.4 Supply and return connections 38 6.5.1 General 38 6.5.2 Requirements for areas of different use 38 6.5.3 Return air systems 39 6.5.4 Minimum operation 39 6.5.5 Variable air volume (VAV) systems 41 6.5.6 Air handling unit redundancy 41 6.5.7 Outdoor air intakes 44 6.6 Air handling units 45 6.6.1 Construction 45 6.6.2 Water removal 46 6.6.3 Ultraviolet disinfection systems 47 6.6.4 Access 47 6.7 Air filtration 48 6.8 Humidification 49 6.8.1 General 49 6.8.2 Chemical treatment 50 6.8.3 Central air handling 50 6.8.4 Humidification controls 50 6.8.5 Duct-mounted humidifiers 51 6.9 Air distribution 51 6.9.1 General 51 6.9.2 Ceiling space 51 6.9.3 Circulation, transfer, and recirculation 52		•
6.2.12 Parallel steam traps 33 6.3 Cooling source 34 6.3.1 General 34 6.3.2 Design load - cooling 34 6.3.3 Cooling system 34 6.3.4 Maintenance of essential cooling functions 34 6.3.5 Design considerations 35 6.3.6 Ancillary equipment for cooling systems 35 6.3.7 Sizing of cooling sources 36 6.3.8 Cooling towers and cooling condensers 36 6.3.9 Temporary connection 37 6.3.10 Cooling sources 37 6.4 Piped HVAC distribution 38 6.4.1 Piping locations 38 6.4.2 Piping shafts 38 6.4.3 Shut-off valves 38 6.4.4 Supply and return connections 38 6.5 Air handling systems 38 6.5.1 General 38 6.5.2 Requirements for areas of different use 38 6.5.3 Return air systems 39 6.5.4 Minimum operation 39 6.5.5 Variable air volume (VAV) systems 41 6.5.6 Air handling unit redundancy 41 6.5.7 Outdoor air intakes 44 6.6 Air handling units 45 6.6.1 Construction 45 6.6.2 Water removal 46 6.6.3 Ultraviolet disinfection systems 47 6.6.4 Access 47 6.7 Air filtration 48 6.8 Humidification 49 6.8.1 General 49 6.8.2 Chemical treatment 50 6.8.3 Central air handling 50 6.8.4 Humidification controls 50 6.8.5 Duct-mounted humidifiers 51 6.9 Air distribution 51 6.9.1 General 51 6.9.2 Ceiling space 51 6.9.3 Circulation, transfer, and recirculation 52		
6.3. Cooling source 34 6.3.1 General 34 6.3.2 Design load - cooling 34 6.3.3 Cooling system 34 6.3.4 Maintenance of essential cooling functions 34 6.3.5 Design considerations 35 6.3.6 Ancillary equipment for cooling systems 35 6.3.7 Sizing of cooling sources 36 6.3.8 Cooling towers and cooling condensers 36 6.3.9 Temporary connection 37 6.3.10 Cooling sources 37 6.4 Piped HVAC distribution 38 6.4.1 Piping locations 38 6.4.2 Piping shafts 38 6.4.3 Shut-off valves 38 6.4.4 Supply and return connections 38 6.5.1 General 38 6.5.2 Requirements for areas of different use 38 6.5.3 Return air systems 39 6.5.4 Minimum operation 39 6.5.5 Variable air volume (VAV) systems 41 6.5.6 Air handling unit redundancy 41 6.5.7 Outdoor air intakes 44 6.6 Air handling units 45 6.6.1 Construction 45 6.6.2 Water removal 46 6.6.3 Ultraviolet disinfection systems 47 6.6.4 Access 47 6.7 Air filtration 48 6.8 Humidification 49 6.8.1 General 49 6.8.2 Chemical treatment 50 6.8.3 Central air handling 50 6.8.4 Humidification controls 50 6.8.5 Duct-mounted humidifiers 51 6.9 Air distribution 51 6.9.1 General 51 6.9.2 Ceiling space 51 6.9.3 Circulation, transfer, and recirculation 52		· · ·
6.3.1 General 34 6.3.2 Design load - cooling 34 6.3.3 Cooling system 34 6.3.4 Maintenance of essential cooling functions 34 6.3.5 Design considerations 35 6.3.6 Ancillary equipment for cooling systems 35 6.3.7 Sizing of cooling sources 36 6.3.8 Cooling towers and cooling condensers 36 6.3.9 Temporary connection 37 6.3.10 Cooling sources 37 6.4 Piped HVAC distribution 38 6.4.1 Piping locations 38 6.4.2 Piping shafts 38 6.4.3 Shut-off valves 38 6.4.4 Supply and return connections 38 6.5.1 General 38 6.5.2 Requirements for areas of different use 38 6.5.3 Return air systems 39 6.5.4 Minimum operation 39 6.5.5 Variable air volume (VAV) systems 41 6.5.6 Air handling unit redundancy 41 6.5.7 Outdoor air intakes 44 6.6 Air handling units 45 6.6.1 Construction 45 6.6.2 Water removal 46 6.6.3 Ultraviolet disinfection systems 47 6.6.4 Access 47 6.7 Air filtration 48 6.8 Humidification 49 6.8.1 General 49 6.8.2 Chemical treatment 50 6.8.3 Central air handling 50 6.8.4 Humidification controls 50 6.8.5 Duct-mounted humidifiers 51 6.9 Air distribution 51 6.9.1 General 51 6.9.2 Ceiling space 51 6.9.3 Circulation, transfer, and recirculation 52		•
6.3.2 Design load - cooling 34 6.3.3 Cooling system 34 6.3.4 Maintenance of essential cooling functions 34 6.3.5 Design considerations 35 6.3.6 Ancillary equipment for cooling systems 35 6.3.7 Sizing of cooling sources 36 6.3.8 Cooling towers and cooling condensers 36 6.3.9 Temporary connection 37 6.3.10 Cooling sources 37 6.4 Piped HVAC distribution 38 6.4.1 Piping locations 38 6.4.2 Piping shafts 38 6.4.3 Shut-off valves 38 6.4.4 Supply and return connections 38 6.5.1 General 38 6.5.2 Requirements for areas of different use 38 6.5.3 Return air systems 39 6.5.4 Minimum operation 39 6.5.5 Variable air volume (VAV) systems 41 6.5.6 Air handling unit redundancy 41 6.5.7 Outdoor air intakes 44 6.6 Air handling units 45 6.6.1 Construction 45 6.6.2 Water removal 46 6.6.3 Ultraviolet disinfection systems 47 6.6.4 Access 47 6.7 Air filtration 48 6.8 Humidification 49 6.8.1 General 49 6.8.2 Chemical treatment 50 6.8.3 Central air handling 50 6.8.4 Humidification controls 50 6.8.5 Duct-mounted humidifiers 51 6.9 Air distribution 51 6.9.1 General 51 6.9.2 Ceiling space 51 6.9.3 Circulation, transfer, and recirculation 52		3
6.3.3 Cooling system 34 6.3.4 Maintenance of essential cooling functions 34 6.3.5 Design considerations 35 6.3.6 Ancillary equipment for cooling systems 35 6.3.7 Sizing of cooling sources 36 6.3.8 Cooling towers and cooling condensers 36 6.3.9 Temporary connection 37 6.3.10 Cooling sources 37 6.4 Piped HVAC distribution 38 6.4.1 Piping locations 38 6.4.2 Piping shafts 38 6.4.3 Shut-off valves 38 6.4.4 Supply and return connections 38 6.5 Air handling systems 38 6.5.1 General 38 6.5.2 Requirements for areas of different use 38 6.5.3 Return air systems 39 6.5.4 Minimum operation 39 6.5.5 Variable air volume (VAV) systems 41 6.5.6 Air handling unit redundancy 41 6.5.7 Outdoor air intakes 44 6.6 Air handling units 45 6.6.1 Construction 45 6.6.2 Water removal 46 6.6.3 Ultraviolet disinfection systems 47 6.6.4 Access 47 6.7 Air filtration 48 6.8 Humidification 49 6.8.1 General 49 6.8.2 Chemical treatment 50 6.8.3 Central air handling 50 6.8.4 Humidification controls 50 6.8.5 Duct-mounted humidifiers 51 6.9 Air distribution 51 6.9.1 General 51 6.9.2 Ceiling space 51 6.9.3 Circulation, transfer, and recirculation 52		
6.3.4 Maintenance of essential cooling functions 34 6.3.5 Design considerations 35 6.3.6 Ancillary equipment for cooling systems 35 6.3.7 Sizing of cooling sources 36 6.3.8 Cooling towers and cooling condensers 36 6.3.9 Temporary connection 37 6.3.10 Cooling sources 37 6.4 Piped HVAC distribution 38 6.4.1 Piping locations 38 6.4.2 Piping shafts 38 6.4.3 Shut-off valves 38 6.4.4 Supply and return connections 38 6.5.1 General 38 6.5.2 Requirements for areas of different use 38 6.5.3 Return air systems 39 6.5.4 Minimum operation 39 6.5.5 Variable air volume (VAV) systems 41 6.5.6 Air handling unit redundancy 41 6.5.7 Outdoor air intakes 44 6.6 Air handling units 45 6.6.1 Construction 45 6.6.2 Water removal 46 6.6.3 Ultraviolet disinfection systems 47 6.6.4 Access 47 6.7 Air filtration 48 6.8 Humidification 49 6.8.1 General 49 6.8.2 Chemical treatment 50 6.8.3 Central air handling 50 6.8.4 Humidification controls 50 6.8.5 Duct-mounted humidifiers 51 6.9 Air distribution 51 6.9.1 General 51 6.9.2 Ceiling space 51 6.9.2 Ceiling space 51 6.9.3 Circulation, transfer, and recirculation 52		-
6.3.5 Design considerations 35 6.3.6 Ancillary equipment for cooling systems 35 6.3.7 Sizing of cooling sources 36 6.3.8 Cooling towers and cooling condensers 36 6.3.9 Temporary connection 37 6.3.10 Cooling sources 37 6.4 Piped HVAC distribution 38 6.4.1 Piping locations 38 6.4.2 Piping shafts 38 6.4.3 Shut-off valves 38 6.4.4 Supply and return connections 38 6.5 Air handling systems 38 6.5.1 General 38 6.5.2 Requirements for areas of different use 38 6.5.3 Return air systems 39 6.5.4 Minimum operation 39 6.5.5 Variable air volume (VAV) systems 41 6.5.6 Air handling unit redundancy 41 6.5.7 Outdoor air intakes 44 6.6 Air handling units 45 6.6.1 Construction 45 6.6.2 Water removal 46 6.6.3 Ultraviolet disinfection systems 47 6.6.4 Access 47 6.7 Air filtration 48 6.8 Humidification 49 6.8.1 General 49 6.8.2 Chemical treatment 50 6.8.3 Central air handling 50 6.8.4 Humidification controls 50 6.8.5 Duct-mounted humidifiers 51 6.9 Air distribution 51 6.9.1 General 51 6.9.2 Ceiling space 51 6.9.3 Circulation, transfer, and recirculation 52		
6.3.6 Ancillary equipment for cooling systems 35 6.3.7 Sizing of cooling sources 36 6.3.8 Cooling towers and cooling condensers 36 6.3.9 Temporary connection 37 6.3.10 Cooling sources 37 6.4 Piped HVAC distribution 38 6.4.1 Piping locations 38 6.4.2 Piping shafts 38 6.4.3 Shut-off valves 38 6.4.4 Supply and return connections 38 6.5 Air handling systems 38 6.5.1 General 38 6.5.2 Requirements for areas of different use 38 6.5.3 Return air systems 39 6.5.4 Minimum operation 39 6.5.5 Variable air volume (VAV) systems 41 6.5.6 Air handling unit redundancy 41 6.5.7 Outdoor air intakes 44 6.6 Air handling units 45 6.6.1 Construction 45 6.6.2 Water removal 46 6.6.3 Ultraviolet disinfection systems 47 6.6.4 Access 47 6.7 Air filtration 48 6.8 Humidification 49 6.8.1 General 49 6.8.2 Chemical treatment 50 6.8.3 Central air handling 50 6.8.4 Humidification controls 50 6.8.5 Duct-mounted humidifiers 51 6.9 Air distribution 51 6.9.1 General 51 6.9.2 Ceiling space 51 6.9.3 Circulation, transfer, and recirculation 52		
6.3.7 Sizing of cooling sources 36 6.3.8 Cooling towers and cooling condensers 36 6.3.9 Temporary connection 37 6.3.10 Cooling sources 37 6.4 Piped HVAC distribution 38 6.4.1 Piping locations 38 6.4.2 Piping shafts 38 6.4.3 Shut-off valves 38 6.4.4 Supply and return connections 38 6.5.1 General 38 6.5.2 Requirements for areas of different use 38 6.5.3 Return air systems 39 6.5.4 Minimum operation 39 6.5.5 Variable air volume (VAV) systems 41 6.5.6 Air handling unit redundancy 41 6.5.7 Outdoor air intakes 44 6.6 Air handling units 45 6.6.1 Construction 45 6.6.2 Water removal 46 6.6.3 Ultraviolet disinfection systems 47 6.6.4 Access 47 6.7 Air filtration 48 6.8 Humidification 49 6.8.1 General 49 6.8.2 Chemical treatment 50 6.8.3 Central air handling 50 6.8.4 Humidification controls 50 6.8.5 Duct-mounted humidifiers 51 6.9 Air distribution 51 6.9.1 General 51 6.9.2 Ceiling space 51 6.9.3 Circulation, transfer, and recirculation 52		-
6.3.8 Cooling towers and cooling condensers 36 6.3.9 Temporary connection 37 6.3.10 Cooling sources 37 6.4 Piped HVAC distribution 38 6.4.1 Piping locations 38 6.4.2 Piping shafts 38 6.4.3 Shut-off valves 38 6.4.4 Supply and return connections 38 6.5.1 General 38 6.5.2 Requirements for areas of different use 38 6.5.3 Return air systems 39 6.5.4 Minimum operation 39 6.5.5 Variable air volume (VAV) systems 41 6.5.6 Air handling unit redundancy 41 6.5.7 Outdoor air intakes 44 6.6 Air handling units 45 6.6.1 Construction 45 6.6.2 Water removal 46 6.6.3 Ultraviolet disinfection systems 47 6.6.4 Access 47 6.7 Air filtration 48 6.8 Humidification 49 6.8.1 General 49 6.8.2 Chemical treatment 50 6.8.3 Central air handling 50 6.8.4 Humidification controls 50 6.8.5 Duct-mounted humidifiers 51 6.9 Air distribution 51 6.9.1 General 51 6.9.2 Ceiling space 51 6.9.3 Circulation, transfer, and recirculation 52		
6.3.9 Temporary connection 37 6.3.10 Cooling sources 37 6.4 Piped HVAC distribution 38 6.4.1 Piping locations 38 6.4.2 Piping shafts 38 6.4.3 Shut-off valves 38 6.4.4 Supply and return connections 38 6.5 Air handling systems 38 6.5.1 General 38 6.5.2 Requirements for areas of different use 38 6.5.3 Return air systems 39 6.5.4 Minimum operation 39 6.5.5 Variable air volume (VAV) systems 41 6.5.6 Air handling unit redundancy 41 6.5.7 Outdoor air intakes 44 6.6 Air handling units 45 6.6.1 Construction 45 6.6.2 Water removal 46 6.6.3 Ultraviolet disinfection systems 47 6.6.4 Access 47 6.7 Air filtration 48 6.8 Humidification 49 6.8.1 General 49 6.8.2 Chemical treatment 50 6.8.3 Central air handling 50 6.8.4 Humidification controls 50 6.8.5 Duct-mounted humidifiers 51 6.9 Air distribution 51 6.9.1 General 51 6.9.2 Ceiling space 51 6.9.3 Circulation, transfer, and recirculation 52		
6.3.10 Cooling sources 37 6.4 Piped HVAC distribution 38 6.4.1 Piping locations 38 6.4.2 Piping shafts 38 6.4.3 Shut-off valves 38 6.4.4 Supply and return connections 38 6.5 Air handling systems 38 6.5.1 General 38 6.5.2 Requirements for areas of different use 38 6.5.3 Return air systems 39 6.5.4 Minimum operation 39 6.5.5 Variable air volume (VAV) systems 41 6.5.6 Air handling unit redundancy 41 6.5.7 Outdoor air intakes 44 6.6 Air handling units 45 6.6.1 Construction 45 6.6.2 Water removal 46 6.6.3 Ultraviolet disinfection systems 47 6.6.4 Access 47 6.7 Air filtration 48 6.8 Humidification 49 6.8.1 General 49 6.8.2 Chemical treatment 50 6.8.3 Central air handling 50 6.8.4 Humidification controls 50 6.8.5 Duct-mounted humidifiers 51 6.9 Air distribution 51 6.9.1 General 51 6.9.2 Ceiling space 51 6.9.3 Circulation, transfer, and recirculation 52		
6.4 Piped HVAC distribution 38 6.4.1 Piping locations 38 6.4.2 Piping shafts 38 6.4.3 Shut-off valves 38 6.4.4 Supply and return connections 38 6.5 Air handling systems 38 6.5.1 General 38 6.5.2 Requirements for areas of different use 38 6.5.3 Return air systems 39 6.5.4 Minimum operation 39 6.5.5 Variable air volume (VAV) systems 41 6.5.6 Air handling unit redundancy 41 6.5.7 Outdoor air intakes 44 6.6 Air handling units 45 6.6.1 Construction 45 6.6.2 Water removal 46 6.6.3 Ultraviolet disinfection systems 47 6.6.4 Access 47 6.7 Air filtration 48 6.8 Humidification 49 6.8.1 General 49 6.8.2 Chemical treatment 50 6.8.3 Central air handling 50 6.8.4 Humidification controls 50 6.8.5 Duct-mounted humidifiers 51 6.9 Air distribution 51 6.9.1 General 51 6.9.2 Ceiling space 51 6.9.3 Circulation, transfer, and recirculation 52		·
6.4.1 Piping locations 38 6.4.2 Piping shafts 38 6.4.3 Shut-off valves 38 6.4.4 Supply and return connections 38 6.5 Air handling systems 38 6.5.1 General 38 6.5.2 Requirements for areas of different use 38 6.5.3 Return air systems 39 6.5.4 Minimum operation 39 6.5.5 Variable air volume (VAV) systems 41 6.5.6 Air handling unit redundancy 41 6.5.7 Outdoor air intakes 44 6.6 Air handling units 45 6.6.1 Construction 45 6.6.2 Water removal 46 6.6.3 Ultraviolet disinfection systems 47 6.6.4 Access 47 6.7 Air filtration 48 6.8 Humidification 49 6.8.1 General 49 6.8.2 Chemical treatment 50 6.8.3 Central air handling 50 6.8.4 Humidification controls 50 6.8.5 Duct-mounted humidifiers 51 6.9 Air distribution 51 6.9.1 General 51 6.9.2 Ceiling space 51 6.9.3 Circulation, transfer, and recirculation 52		
6.4.2 Piping shafts 38 6.4.3 Shut-off valves 38 6.4.4 Supply and return connections 38 6.5 Air handling systems 38 6.5.1 General 38 6.5.2 Requirements for areas of different use 38 6.5.3 Return air systems 39 6.5.4 Minimum operation 39 6.5.5 Variable air volume (VAV) systems 41 6.5.6 Air handling unit redundancy 41 6.5.7 Outdoor air intakes 44 6.6 Air handling units 45 6.6.1 Construction 45 6.6.2 Water removal 46 6.6.3 Ultraviolet disinfection systems 47 6.6.4 Access 47 6.7 Air filtration 48 6.8 Humidification 49 6.8.1 General 49 6.8.2 Chemical treatment 50 6.8.3 Central air handling 50 6.8.4 Humidification controls 50 6.8.5 Duct-mounted humidifiers 51 6.9 Air distribution 51 6.9.1 General 51 6.9.2 Ceiling space 51 6.9.3 Circulation, transfer, and recirculation 52		•
6.4.4 Supply and return connections 38 6.5.1 General 38 6.5.2 Requirements for areas of different use 38 6.5.3 Return air systems 39 6.5.4 Minimum operation 39 6.5.5 Variable air volume (VAV) systems 41 6.5.6 Air handling unit redundancy 41 6.5.7 Outdoor air intakes 44 6.6 Air handling units 45 6.6.1 Construction 45 6.6.2 Water removal 46 6.6.3 Ultraviolet disinfection systems 47 6.6.4 Access 47 6.7 Air filtration 48 6.8 Humidification 49 6.8.1 General 49 6.8.2 Chemical treatment 50 6.8.3 Central air handling 50 6.8.4 Humidification controls 50 6.8.5 Duct-mounted humidifiers 51 6.9 Air distribution 51 6.9.1 General 51 6.9.2 Ceiling space 51 6.9.3 Circulation, transfer, and recirculation 52		•
6.4.4 Supply and return connections 38 6.5 Air handling systems 38 6.5.1 General 38 6.5.2 Requirements for areas of different use 38 6.5.3 Return air systems 39 6.5.4 Minimum operation 39 6.5.5 Variable air volume (VAV) systems 41 6.5.6 Air handling unit redundancy 41 6.5.7 Outdoor air intakes 44 6.6 Air handling units 45 6.6.1 Construction 45 6.6.2 Water removal 46 6.6.3 Ultraviolet disinfection systems 47 6.6.4 Access 47 6.7 Air filtration 48 6.8 Humidification 49 6.8.1 General 49 6.8.2 Chemical treatment 50 6.8.3 Central air handling 50 6.8.4 Humidification controls 50 6.8.5 Duct-mounted humidifiers 51 6.9 Air distribution 51 6.9.1 General 51 6.9.2 Ceiling space 51 6.9.3 Circulation, transfer, and recirculation 52	6.4.2	Piping shafts 38
6.5 Air handling systems 38 6.5.1 General 38 6.5.2 Requirements for areas of different use 38 6.5.3 Return air systems 39 6.5.4 Minimum operation 39 6.5.5 Variable air volume (VAV) systems 41 6.5.6 Air handling unit redundancy 41 6.5.7 Outdoor air intakes 44 6.6 Air handling units 45 6.6.1 Construction 45 6.6.2 Water removal 46 6.6.3 Ultraviolet disinfection systems 47 6.6.4 Access 47 6.7 Air filtration 48 6.8 Humidification 49 6.8.1 General 49 6.8.2 Chemical treatment 50 6.8.3 Central air handling 50 6.8.4 Humidification controls 50 6.8.5 Duct-mounted humidifiers 51 6.9 Air distribution 51 6.9.1 General 51 6.9.2 Ceiling space 51 6.9.3 Circulation, transfer, and recirculation 52	6.4.3	Shut-off valves 38
6.5.1 General 38 6.5.2 Requirements for areas of different use 38 6.5.3 Return air systems 39 6.5.4 Minimum operation 39 6.5.5 Variable air volume (VAV) systems 41 6.5.6 Air handling unit redundancy 41 6.5.7 Outdoor air intakes 44 6.6 Air handling units 45 6.6.1 Construction 45 6.6.2 Water removal 46 6.6.3 Ultraviolet disinfection systems 47 6.6.4 Access 47 6.7 Air filtration 48 6.8 Humidification 49 6.8.1 General 49 6.8.2 Chemical treatment 50 6.8.3 Central air handling 50 6.8.4 Humidification controls 50 6.8.5 Duct-mounted humidifiers 51 6.9 Air distribution 51 6.9.1 General 51 6.9.2 Ceiling space 51 6.9.3 Circulation, transfer, and recirculation 52	6.4.4	Supply and return connections 38
6.5.2 Requirements for areas of different use 38 6.5.3 Return air systems 39 6.5.4 Minimum operation 39 6.5.5 Variable air volume (VAV) systems 41 6.5.6 Air handling unit redundancy 41 6.5.7 Outdoor air intakes 44 6.6 Air handling units 45 6.6.1 Construction 45 6.6.2 Water removal 46 6.6.3 Ultraviolet disinfection systems 47 6.6.4 Access 47 6.7 Air filtration 48 6.8 Humidification 49 6.8.1 General 49 6.8.2 Chemical treatment 50 6.8.3 Central air handling 50 6.8.4 Humidification controls 50 6.8.5 Duct-mounted humidifiers 51 6.9 Air distribution 51 6.9.1 General 51 6.9.2 Ceiling space 51 6.9.3 Circulation, transfer, and recirculation 52	6.5	Air handling systems 38
6.5.3 Return air systems 39 6.5.4 Minimum operation 39 6.5.5 Variable air volume (VAV) systems 41 6.5.6 Air handling unit redundancy 41 6.5.7 Outdoor air intakes 44 6.6 Air handling units 45 6.6.1 Construction 45 6.6.2 Water removal 46 6.6.3 Ultraviolet disinfection systems 47 6.6.4 Access 47 6.7 Air filtration 48 6.8 Humidification 49 6.8.1 General 49 6.8.2 Chemical treatment 50 6.8.3 Central air handling 50 6.8.4 Humidification controls 50 6.8.5 Duct-mounted humidifiers 51 6.9 Air distribution 51 6.9.1 General 51 6.9.2 Ceiling space 51 6.9.3 Circulation, transfer, and recirculation 52	6.5.1	General 38
6.5.4 Minimum operation 39 6.5.5 Variable air volume (VAV) systems 41 6.5.6 Air handling unit redundancy 41 6.5.7 Outdoor air intakes 44 6.6 Air handling units 45 6.6.1 Construction 45 6.6.2 Water removal 46 6.6.3 Ultraviolet disinfection systems 47 6.6.4 Access 47 6.7 Air filtration 48 6.8 Humidification 49 6.8.1 General 49 6.8.2 Chemical treatment 50 6.8.3 Central air handling 50 6.8.4 Humidification controls 50 6.8.5 Duct-mounted humidifiers 51 6.9 Air distribution 51 6.9.1 General 51 6.9.2 Ceiling space 51 6.9.3 Circulation, transfer, and recirculation 52	6.5.2	Requirements for areas of different use 38
6.5.5 Variable air volume (VAV) systems 41 6.5.6 Air handling unit redundancy 41 6.5.7 Outdoor air intakes 44 6.6 Air handling units 45 6.6.1 Construction 45 6.6.2 Water removal 46 6.6.3 Ultraviolet disinfection systems 47 6.6.4 Access 47 6.7 Air filtration 48 6.8 Humidification 49 6.8.1 General 49 6.8.2 Chemical treatment 50 6.8.3 Central air handling 50 6.8.4 Humidification controls 50 6.8.5 Duct-mounted humidifiers 51 6.9 Air distribution 51 6.9.1 General 51 6.9.2 Ceiling space 51 6.9.3 Circulation, transfer, and recirculation 52	6.5.3	Return air systems 39
6.5.6 Air handling unit redundancy 41 6.5.7 Outdoor air intakes 44 6.6 Air handling units 45 6.6.1 Construction 45 6.6.2 Water removal 46 6.6.3 Ultraviolet disinfection systems 47 6.6.4 Access 47 6.7 Air filtration 48 6.8 Humidification 49 6.8.1 General 49 6.8.2 Chemical treatment 50 6.8.3 Central air handling 50 6.8.4 Humidification controls 50 6.8.5 Duct-mounted humidifiers 51 6.9 Air distribution 51 6.9.1 General 51 6.9.2 Ceiling space 51 6.9.3 Circulation, transfer, and recirculation 52	6.5.4	Minimum operation 39
6.5.7 Outdoor air intakes 44 6.6 Air handling units 45 6.6.1 Construction 45 6.6.2 Water removal 46 6.6.3 Ultraviolet disinfection systems 47 6.6.4 Access 47 6.7 Air filtration 48 6.8 Humidification 49 6.8.1 General 49 6.8.2 Chemical treatment 50 6.8.3 Central air handling 50 6.8.4 Humidification controls 50 6.8.5 Duct-mounted humidifiers 51 6.9 Air distribution 51 6.9.1 General 51 6.9.2 Ceiling space 51 6.9.3 Circulation, transfer, and recirculation 52	6.5.5	Variable air volume (VAV) systems 41
6.6 Air handling units 45 6.6.1 Construction 45 6.6.2 Water removal 46 6.6.3 Ultraviolet disinfection systems 47 6.6.4 Access 47 6.7 Air filtration 48 6.8 Humidification 49 6.8.1 General 49 6.8.2 Chemical treatment 50 6.8.3 Central air handling 50 6.8.4 Humidification controls 50 6.8.5 Duct-mounted humidifiers 51 6.9 Air distribution 51 6.9.1 General 51 6.9.2 Ceiling space 51 6.9.3 Circulation, transfer, and recirculation 52	6.5.6	Air handling unit redundancy 41
6.6.1 Construction 45 6.6.2 Water removal 46 6.6.3 Ultraviolet disinfection systems 47 6.6.4 Access 47 6.7 Air filtration 48 6.8 Humidification 49 6.8.1 General 49 6.8.2 Chemical treatment 50 6.8.3 Central air handling 50 6.8.4 Humidification controls 50 6.8.5 Duct-mounted humidifiers 51 6.9 Air distribution 51 6.9.1 General 51 6.9.2 Ceiling space 51 6.9.3 Circulation, transfer, and recirculation 52	6.5.7	Outdoor air intakes 44
6.6.2 Water removal 46 6.6.3 Ultraviolet disinfection systems 47 6.6.4 Access 47 6.7 Air filtration 48 6.8 Humidification 49 6.8.1 General 49 6.8.2 Chemical treatment 50 6.8.3 Central air handling 50 6.8.4 Humidification controls 50 6.8.5 Duct-mounted humidifiers 51 6.9 Air distribution 51 6.9.1 General 51 6.9.2 Ceiling space 51 6.9.3 Circulation, transfer, and recirculation 52	6.6	Air handling units 45
6.6.3 Ultraviolet disinfection systems 47 6.6.4 Access 47 6.7 Air filtration 48 6.8 Humidification 49 6.8.1 General 49 6.8.2 Chemical treatment 50 6.8.3 Central air handling 50 6.8.4 Humidification controls 50 6.8.5 Duct-mounted humidifiers 51 6.9 Air distribution 51 6.9.1 General 51 6.9.2 Ceiling space 51 6.9.3 Circulation, transfer, and recirculation 52	6.6.1	Construction 45
6.6.4 Access 47 6.7 Air filtration 48 6.8 Humidification 49 6.8.1 General 49 6.8.2 Chemical treatment 50 6.8.3 Central air handling 50 6.8.4 Humidification controls 50 6.8.5 Duct-mounted humidifiers 51 6.9 Air distribution 51 6.9.1 General 51 6.9.2 Ceiling space 51 6.9.3 Circulation, transfer, and recirculation 52	6.6.2	Water removal 46
6.7 Air filtration 48 6.8 Humidification 49 6.8.1 General 49 6.8.2 Chemical treatment 50 6.8.3 Central air handling 50 6.8.4 Humidification controls 50 6.8.5 Duct-mounted humidifiers 51 6.9 Air distribution 51 6.9.1 General 51 6.9.2 Ceiling space 51 6.9.3 Circulation, transfer, and recirculation 52	6.6.3	Ultraviolet disinfection systems 47
6.8 Humidification 49 6.8.1 General 49 6.8.2 Chemical treatment 50 6.8.3 Central air handling 50 6.8.4 Humidification controls 50 6.8.5 Duct-mounted humidifiers 51 6.9 Air distribution 51 6.9.1 General 51 6.9.2 Ceiling space 51 6.9.3 Circulation, transfer, and recirculation 52	6.6.4	Access 47
6.8.1 General 49 6.8.2 Chemical treatment 50 6.8.3 Central air handling 50 6.8.4 Humidification controls 50 6.8.5 Duct-mounted humidifiers 51 6.9 Air distribution 51 6.9.1 General 51 6.9.2 Ceiling space 51 6.9.3 Circulation, transfer, and recirculation 52	6.7	Air filtration 48
<ul> <li>6.8.2 Chemical treatment 50</li> <li>6.8.3 Central air handling 50</li> <li>6.8.4 Humidification controls 50</li> <li>6.8.5 Duct-mounted humidifiers 51</li> <li>6.9 Air distribution 51</li> <li>6.9.1 General 51</li> <li>6.9.2 Ceiling space 51</li> <li>6.9.3 Circulation, transfer, and recirculation 52</li> </ul>	6.8	Humidification 49
<ul> <li>6.8.3 Central air handling 50</li> <li>6.8.4 Humidification controls 50</li> <li>6.8.5 Duct-mounted humidifiers 51</li> <li>6.9 Air distribution 51</li> <li>6.9.1 General 51</li> <li>6.9.2 Ceiling space 51</li> <li>6.9.3 Circulation, transfer, and recirculation 52</li> </ul>	6.8.1	General 49
<ul> <li>6.8.3 Central air handling 50</li> <li>6.8.4 Humidification controls 50</li> <li>6.8.5 Duct-mounted humidifiers 51</li> <li>6.9 Air distribution 51</li> <li>6.9.1 General 51</li> <li>6.9.2 Ceiling space 51</li> <li>6.9.3 Circulation, transfer, and recirculation 52</li> </ul>	6.8.2	Chemical treatment 50
6.8.4 Humidification controls 50 6.8.5 Duct-mounted humidifiers 51 6.9 Air distribution 51 6.9.1 General 51 6.9.2 Ceiling space 51 6.9.3 Circulation, transfer, and recirculation 52		Central air handling 50
<ul> <li>6.8.5 Duct-mounted humidifiers 51</li> <li>6.9 Air distribution 51</li> <li>6.9.1 General 51</li> <li>6.9.2 Ceiling space 51</li> <li>6.9.3 Circulation, transfer, and recirculation 52</li> </ul>		_
<ul> <li>6.9 Air distribution 51</li> <li>6.9.1 General 51</li> <li>6.9.2 Ceiling space 51</li> <li>6.9.3 Circulation, transfer, and recirculation 52</li> </ul>		
<ul> <li>6.9.1 General 51</li> <li>6.9.2 Ceiling space 51</li> <li>6.9.3 Circulation, transfer, and recirculation 52</li> </ul>		
<ul><li>6.9.2 Ceiling space 51</li><li>6.9.3 Circulation, transfer, and recirculation 52</li></ul>		
6.9.3 Circulation, transfer, and recirculation 52		
	6.9.4	Duct surfaces 52

6.9.5	Lining of HVAC elements 53
6.9.6	Duct access 53
6.9.7	Duct cleaning 54
6.10	Air separation, air flow, and relative space pressurization 54
6.10.1	General 54
6.10.2	Low-level air separation by means of air flow 55
6.10.3	Medium level air separation 55
6.10.4	Airborne isolation rooms (AIRs), protective environment rooms (PERs), and other special
	precaution rooms requiring high-level air separation 55
6.10.5	Portable or fixed HEPA filtration units 60
6.11	Room and space requirements 61
6.11.1	General 61
6.11.2	Directional airflow 61
6.11.3	Type I areas 62
6.11.4	Scavenging systems 63
6.11.5	Specialized rooms 63
6.11.6	Mental health facilities 64
6.11.7	Hemodialysis 64
6.11.8	Normally unoccupied service areas 65
6.12	HVAC heating/cooling terminals and local heating/cooling units 65
6.12.1	Access 65
6.12.2	Finned elements 65
6.12.3	Local heating or cooling units 65
6.12.4	Noncentral air handling units 66
6.12.5	Water removal for local cooling and non-central air handling units 66
6.13	Exhaust systems 67
6.13.1	General 67
6.13.2	Alarms 67
6.13.3	Dedicated exhaust 67
6.13.4	Discharge locations 68
6.13.5	Filtration and treatment 68
6.13.6	Nitrous oxide cylinder storage 68
6.13.7	Ethylene oxide exhaust 68
6.13.8	Fans 68
6.14	Controls 68
6.14.1	Individual temperature controls 68
6.14.2	Area humidity controls 69
6.14.3	Essential electrical system 69
6.14.4	Indicators 69
6.15	Smoke management 69
6.15.1	General 69
6.15.2	Special considerations 69
6.15.3	Sleeping rooms 69
6.15.4	Smoke dampers 70
6.15.5	Coordination 70
6.15.6	Smoke management zoning 70
6.15.7	Functionality 70
6.15.8	Testing 70

Priority

70

6.15.9

6.15.10	Sequence 70
6.15.11	Response time 70
6.15.12	Sealing 70
6.16	Catastrophic event management 71
6.16.1	General 71
6.16.2	Air exchange rates 73
6.16.3	Design conditions for heating and cooling 74
6.17	Acoustics and vibration control 77
6.17.1	Acoustics 77
6.17.2	Vibration control 77
6.18	System balancing and adjustments 77
6.18.1	General 77
6.18.2	Airflow 77
6.19	Energy efficiency and sustainability 78
6.19.1	System design 78
6.19.2	Unoccupied periods 78
6.19.3	Energy recovery 78
6.19.4	Free cooling 79
6.19.5	Direct digital controls 79
6.19.6	Environmental aspects 79
6.19.7	Rainwater collection 79
6.19.8	Demand-controlled ventilation 79
6.19.9	Alternative energy 79
6.19.10	Glazing 80
6.19.11	Chillers 80
6.19.12	Kitchens 81

### 7 Commissioning 81

### 8 Operation, maintenance, and monitoring 81

- 8.1 General *81*
- 8.2 Operation and monitoring of HVAC systems and components 82
- 8.2.1 General *82*
- 8.2.2 Calibration 82
- 8.2.3 Records 82
- 8.2.4 HVAC performance 83
- 8.2.5 Operational monitoring and replacement of filters and seals 83
- 8.2.6 Fan coils, drain pans, and induction units 85
- 8.2.7 Fire and smoke dampers 85
- 8.3 Maintenance of HVAC systems and components 85
- 8.3.1 General *85*
- 8.3.2 Maintenance and monitoring 86
- 8.3.3 Consultation 86
- 8.3.4 Chemical treatment 86
- 8.3.5 Dust generated during construction, renovations, and maintenance 86
- 8.3.6 Sustainability 86
- 8.3.7 Other monitoring activities 86
- 8.3.8 Duct cleaning *86*
- 8.3.9 Cooling towers 87

8.3.10	Existing systems and equipment 88	
8.4	Energy management 88	
8.4.1	General 88	
8.4.2	Adverse environmental impact analysis 88	
8.4.3	Sustainability 88	
8.5	Construction, renovation, or maintenance provisions to prevent the spread of infection	88
8.5.1	General 88	
8.5.2	Construction air handling units 88	
8.6	Continuity of service 88	
8.7	Catastrophic events 89	

```
Annex A (informative) — Guidelines for HVAC design 121
```

Annex B (informative) — Health care facility examples according to class 124

Annex C (normative) — Condensate trap depth chart 129

Annex D (informative) — Examples of configurations designed to meet redundancy requirements in Clause  $\underline{6.5.6.1.3}$  130