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Z412-17

Office ergonomics — An application standard for workplace ergonomics



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The Technical Committee would like to thank the individuals who participated in the acoustic working group for their valuable contributions to the development of this Standard.

Preface

This is the third edition of CSA Z412, *Office ergonomics — An application standard for workplace ergonomics*. It supersedes previous editions published as guidelines in 2000 and 1989 under the title *Guideline on Office Ergonomics*. The present edition includes updates to reflect new technology and work practices, and is now presented in the form of a standard rather than a guideline.

The objective of this Standard is to apply ergonomics to enhance user health, safety, and well-being and to optimize system performance in order to prevent occupational injuries and illnesses or to reduce the severity of harm related to occupational activities in offices.

This Standard was prepared by the Technical Committee on Office Ergonomics, under the jurisdiction of the Strategic Steering Committee on Occupational Health and Safety, and has been formally approved by the Technical Committee.

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 and include “Request for interpretation” in the subject line:*
 - a) *define the problem, making reference to the specific clause, and, where appropriate, include an illustrative sketch;*
 - 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 the CSA Directives and guidelines governing standardization and are available on the Current Standards Activities page at standardsactivities.csa.ca.
- 5) *This Standard is subject to review within five years from the date of publication. Suggestions for its improvement will be referred to the appropriate committee. To submit a proposal for change, please send the following information to inquiries@csagroup.org and include “Proposal for change” in the subject line:*
 - a) *Standard designation (number);*
 - b) *relevant clause, table, and/or figure number;*
 - c) *wording of the proposed change; and*
 - d) *rationale for the change.*

Z412-17

Office ergonomics — An application standard for workplace ergonomics

0 Introduction

0.1 General

Ergonomics (or human factors) is a discipline concerned with the interactions among humans and other elements of a system, and the application of theories, principles, data, and methods of design to enhance user well-being and to optimize system performance. For the purposes of this Standard, the term “ergonomics” is considered interchangeable with the term “human factors”. This Standard provides requirements for applying ergonomics in office work systems.

Ergonomics

- a) enhances user health, safety, and well-being;
- b) enhances workspace usability by improving ease of use and ease of learning;
- c) facilitates user performance by encouraging task proficiency and error recovery;
- d) accommodates users of various physical sizes, capabilities, skills, knowledge, and experience;
- e) maintains user performance by minimizing excessive or awkward loads and postures; and
- f) optimizes the interaction between the user and the workspace environment.

Ergonomics provides the greatest benefit when it is applied early in the design of a work system rather than as a solution to problems discovered after the design is complete. It is also most beneficial when applied early in the redesign of an existing work system. The user-centred approach of the Ergonomics Process ensures that a broad range of user characteristics and needs are accommodated.

This Standard adopts the approach outlined in CSA Z1004 to effect the integration of ergonomics into an occupational health and safety system and into the design or redesign of office work systems.

0.2 Structure of this Standard

The description of the Ergonomics Process in Clause 4 is followed in Clause 5 by a description of the Application of Ergonomics in an office work system, which is the “front line” implementation of the Ergonomics Process.

Most of this Standard (Clause 6 and Annex A) provides normative (mandatory) requirements for the Application of Ergonomics in an office workspace and include requirements for

- a) furniture;
- b) accessories;
- c) equipment;
- d) layout and use of furniture, accessories, and equipment;
- e) environmental conditions;
- f) manual materials handling; and
- g) psychosocial workplace factors and psychological health factors.

1 Scope

1.1

This Standard specifies requirements for the Application of Ergonomics in offices. It applies to all office users in office workspaces in new and existing buildings, and includes some requirements for non-traditional workspaces (i.e., vehicles and home offices). Whenever “office” is used in this Standard, it refers to users in one or more of these settings.

1.2

This Standard does not apply to medical management programs or to practices that could be considered part of a medical management program, such as therapeutic or clinical interventions.

This Standard does not contain information pertaining to the design of software or information technology devices and displays.

This Standard does not contain requirements pertaining to electromagnetic forces (EMFs).

This Standard is not a product compliance standard and therefore does not address safety, durability, and structural adequacy of products.

This Standard does not contain information on acoustics related to the construction of building shells or exterior noise sources.

Notes:

- 1) *Design and presentation of software can play a large role in promoting efficient and healthy office work. ISO 9241, Parts 11 to 16, Part 110, and Part 143 provide guidance in this area.*
- 2) *Requirements for the safety, durability, and structural adequacy of furniture products are provided in ANSI/BIFMA X5.5, ANSI/BIFMA X5.6, ANSI/BIFMA X5.9, CAN/CGSB-44.227, and CAN/CGSB-44.229.*

1.3

This Standard is intended for those who are involved in health, safety, ergonomics, and the design/build and operations of office workspaces, including

- a) employer representatives;
- b) office users and their representatives;
- c) architects, designers, facility planners, building service providers, and purchasing personnel involved in the design of new office work systems, the renovation of existing office work systems, or the procurement of new furniture, accessories, and equipment;
- d) professional groups (ergonomists, industrial hygienists, engineers, and related specialists); and
- e) designers and manufacturers of products.

This Standard may be used as a reference by health and safety agencies and regulatory agencies.

1.4

In this Standard, “shall” is used to express a requirement, i.e., a provision that the user is obliged to satisfy in order to comply with the Standard; “should” is used to express a recommendation or that which is advised but not required; and “may” is used to express an option or that which is permissible within the limits of the Standard.

Notes accompanying clauses do not include requirements or alternative requirements; the purpose of a note accompanying a clause is to separate from the text explanatory or informative material.

Notes to tables and figures are considered part of the table or figure and may be written as requirements.

Annexes are designated normative (mandatory) or informative (non-mandatory) to define their application.

2 Reference publications

This Standard refers to the following publications, and where such reference is made, it shall be to the editions listed below, including all amendments published thereto.

CSA Group

CAN/CSA-Z1000-14

Occupational health and safety management

CAN/CSA-Z1001-13

Occupational health and safety training

CAN/CSA-Z1002-12 (R2017)

Occupational health and safety — Hazard identification and elimination and risk assessment and control

Z1004-12 (R2017)

Workplace ergonomics — A management and implementation standard

Z1006-16

Management of work in confined spaces

Z1007-16

Hearing loss prevention program (HLPP) management

CAN/CSA-ISO 9241-5:00 (R2016)

Ergonomic requirements for office work with visual display terminals (VDTs) — Part 5: Workstation layout and postural requirements

CAN/CSA-ISO 19011:12 (R2017)

Guidelines for auditing management systems

CSA Group and BNQ (Bureau de normalisation du Québec)

CAN/CSA-Z1003-13/BNQ 9700-803/2013

Psychological health and safety in the workplace — Prevention, promotion, and guidance to staged implementation

ANSI/BIFMA (American National Standards Institute/Business and Institutional Furniture Manufacturers Association)

X5.1-2017

General Purpose Office Chairs — Tests

X5.5-2014

Desk Products

X5.6-2016
Panel Systems — Tests

X5.9-2012
Storage Units

ASHRAE
55-2013
Thermal environmental conditions for human occupancy

ASTM International
D523-89 (1999)
Standard Test Method for Specular Gloss

BIFMA (Business and Institutional Furniture Manufacturers Association)
CMD-1-2013
Universal Measurement Procedure for the Use of the BIFMA Chair Measuring Device (CMD)

G1-2013
Ergonomics Guideline for Furniture Used in Office Work Spaces Designed for Computer Use

CGSB (Canadian General Standards Board)
CAN/CGSB-44.227-2008
Free-standing Office Desk Products and Components

CAN/CGSB-44.229-2008
Interconnecting Panel Systems and Supported Components

CAN/CGSB-44.232-2008
Task Chairs for Office Environments

Government of United States
2010 ADA Standards for Accessible Design. Available at
<https://www.ada.gov/regs2010/2010ADASTandards/2010ADASTandards.htm>

IESNA (Illuminating Engineering Society of North America)
Lighting Handbook, 10th edition, 2011

ILO (International Labour Organization)
Audit Matrix for the ILO Guidelines on Occupational Safety and Health Management Systems (ILO-OSH 2001), 2013

ISO (International Organization for Standardization)
2017-1:2005
Mechanical vibration and shock — Resilient mounting systems — Part 1: Technical information to be exchanged for the application of isolation systems

2631-1:1997

Mechanical vibration and shock — Evaluation of human exposure to whole-body vibration — Part 1: General requirements

9241-11:1998

Ergonomic requirements for office work with visual display terminals (VDTs) — Part 11: Guidance on usability

9241-12:1998

Ergonomic requirements for office work with visual display terminals (VDTs) — Part 12: Presentation of information

9241-13:1998

Ergonomic requirements for office work with visual display terminals (VDTs) — Part 13: User guidance

9241-14:1997

Ergonomic requirements for office work with visual display terminals (VDTs) — Part 14: Menu dialogues

9241-15:1997

Ergonomic requirements for office work with visual display terminals (VDTs) — Part 15: Command dialogues

9241-16:1999

Ergonomic requirements for office work with visual display terminals (VDTs) — Part 16: Direct manipulation dialogues

9241-110:2006

Ergonomics of human-system interaction — Part 110: Dialogue principles

9241-143:2012

Ergonomics of human-system interaction — Part 143: Forms

9241-303:2011

Ergonomics of human-system interaction — Part 303: Requirements for electronic visual displays

9241-400:2007

Ergonomics of human-system interaction — Part 400: Principles and requirements for physical input devices

24496:2017

Office furniture — Office work chairs — Methods for the determination of dimensions

ISO/IEC (International Organization for Standardization/International Electrotechnical Commission)

DIR 2:2016

ISO/IEC Directives Part 2: Principles and rules for the structure and drafting of ISO and IEC documents

NIOSH (National Institute for Occupational Safety and Health)

Waters T.R., Putz-Anderson V., and Garg A. 1994. *Applications manual for the revised NIOSH lifting equation*. DHHS (NIOSH) Publication 94-110. National Institute for Occupational Safety and Health, Centers for Disease Control and Prevention

SAE International
CAESAR® (Civilian American and European Surface Anthropometry Resource Project)
CAESAR 3-D Anthropometric Database, North American Edition

Other publications

Bartha, M.C., Allie, P., Kokot, D., and Roe, C.P. 2015. *Field observations of display placement requirements and character size for presbyopic and prepresbyopic computer users*. *Work*, 52(2): 329–342.

Chau, L. and Wells, R. 2015. *Biomechanical Loading on the Hand, Wrist, and Forearm When Holding a Tablet Computer*. *IIE Transactions on Occupational Ergonomics and Human Factors*, Volume 3, Issue 2: 105–114.

Eastman Kodak Company. 1983. *Ergonomic Design for People at Work*. Volume 1, Van Nostrand Reinhold: New York.

Gordon, C.C., Churchill, T., Clauser, B., Bradtmiller, B., McConville, J.T., Tebbetts, I., and Walker, R.A. “1988 Anthropometric Survey of U.S. Army Personnel: Methods and Summary Statistics”. NATICK/TR-89/044.

Mital, A., Ayoub, M.M., and Nicholson, A.S. *Guide to Manual Materials Handling*, 2nd Ed. Taylor & Francis, 1997.

3 Definitions

The following definitions shall apply in this Standard:

Accessories — items such as document supports, palm supports, and footrests.

Application of Ergonomics — the use of ergonomics principles to identify and eliminate hazards, and assess and control risks at each stage of the design of a work system to enhance user health, safety, and well-being, and to optimize system performance. It is an element of the Ergonomics Process.

Note: *This definition is aligned with CSA Z1004.*

Armrest — support for the lower arms that includes the arm post and any pads/caps that the lower arm contacts. An armrest is typically attached to the seat, back, or base of the chair and may be fixed, adjustable, or removable.

Armrest height — the vertical distance from the top of the arm support surface to the compressed seat cushion. It is derived from the height of the elbow above a hard seat surface.

Armrest length — the horizontal distance (front to back) on the armrest surface in the approximate area under the user’s elbow/forearm.

Armrest positioning — the position of the armrest relative to the backrest, as well as the movement front to back, side to side, and pivot/rotation of the armrest.

Armrest width — the horizontal distance (side to side) on the armrest surface in the approximate area under the user’s elbow/forearm.

Audit — a systematic, documented process to obtain and objectively evaluate evidence for the purpose of determining the extent to which the audit criteria are fulfilled.

Note: *This definition is aligned with CAN/CSA-Z1000.*

Backrest — the vertical part of the chair above the seat. The backrest includes the lumbar support and, where applicable, neck/head rests.

Backrest height — the distance from the top of the seat (compressed) to the top of the backrest.

Backrest to seat angle — the angle of the front of the backrest relative to the compressed seat.

Backrest width — the distance from one side of the backrest to the other in the approximate area of the user's lower back (lumbar spine area).

Clearance envelope under work surfaces — legs/feet — the area under the work surface defined by the vertical, horizontal, and lateral measurements of the space.

Cognitive — relating to “cognition”, which is

- a) the process people use for remembering, awareness, perception, reasoning, understanding, and using judgement; and
- b) the ability to think and make sense out of what is seen, heard, felt, and experienced in order to take appropriate actions.

Note: *This definition is aligned with CSA Z1004.*

Cognitive demands — stressors associated with cognitive aspects of tasks being performed (see **Cognitive**).

Note: *This definition is aligned with CSA Z1004.*

Competent person — a person who has the knowledge to perform a specific duty as required in this Standard by reason of education, training, experience, or a combination thereof, and has a demonstrated ability to apply this knowledge.

Note: *This definition is aligned with CSA Z1004.*

Conformance — meeting the requirements of the organization's occupational health and safety management system (OHSMS) and this Standard.

Note: *This definition is aligned with CAN/CSA-Z1000.*

Contact stress — stress that occurs when the skin and underlying tissues of a body part (e.g., elbow, wrist, back of the knee) are exposed to pressure from resting or rubbing against a hard or sharp object.

Note: *Over time contact stress can result in damaged skin, muscles, tendons, and nerves. It can also compress and possibly damage blood vessels.*

Continual improvement — the process of enhancing the Ergonomics Process to achieve ongoing improvement in overall occupational health and safety (OHS) performance.

Note: *This definition is aligned with CSA Z1004.*

Design — the process of changing existing or developing new work systems, ranging from individual tasks to complex systems.

Note: *This definition is aligned with CSA Z1004.*

Employer — a person who employs (or contracts for the services of) one or more users including temporary users.

Note: *This definition is aligned with CSA Z1007.*

Ergonomics — the scientific discipline concerned with the understanding of interactions among humans and other elements of a system, and the profession that applies theory, principles, data, and methods to design in order to enhance human well-being and optimize overall system performance.

Notes:

- 1) *Ergonomics is also referred to as “human factors”.*
- 2) *This definition is aligned with CSA Z1004.*

Ergonomics Process — the commitment, leadership, planning, implementation, and continuous improvement necessary to identify and eliminate hazards, and to assess and control risks using ergonomics principles. It operates within the OHSMS, where one exists, and in the design and operation of new or existing work systems.

Note: *This definition is aligned with CSA Z1004.*

Ergonomist — a competent person whose knowledge and skills are applied to the analysis of human-system interactions and the design of the system in order to enhance human well-being and optimize overall system performance.

Note: *This definition is aligned with CSA Z1004.*

Evidence-based — derived from a systematic process of identifying, appraising, and using research findings and workplace experience as the basis for decision making.

Note: *This definition is aligned with CSA Z1004.*

Gloss — the mode of appearance by which reflected highlights of objects are perceived as superimposed on the surface due to the directionally selective properties of that surface.

Note: *This definition is aligned with CAN/CSA-ISO 9241-5.*

Hazard — a source of potential harm to a user.

Note: *This definition is aligned with CSA Z1004.*

High stool — a type of work chair characterized by a seat height greater than 610 mm (24 in) intended to allow the user to sit at standing-height work surfaces such that the user’s feet are not supported by the floor.

Source: *ANSI/BIFMA X5.1.*

Human factors — see **Ergonomics**.

Illuminance — the amount of light falling on a surface.

Incident — an occurrence arising in the course of work that resulted in or could have resulted in an injury, illness, adverse effect to health, or fatality.

Note: *This definition is aligned with CAN/CSA-Z1000.*

Lagging indicators — a measurable factor, such as lost-time injuries, that changes after health or safety has already begun to follow a particular pattern or trend.

Notes:

- 1) *Lagging indicators confirm long-term trends, but they do not predict them.*
- 2) *This definition is aligned with CSA Z1004.*

Leading indicators — a measurable factor (e.g., preventive measures to eliminate hazards) that changes before incidents, injuries, or disorders occur and start to follow a particular pattern or trend.

Notes:

- 1) *Leading indicators can be used to predict changes in disorders and injuries, but they are not always accurate.*

2) *This definition is aligned with CSA Z1004.*

Legal requirements — requirements of applicable OHS federal, provincial/territorial, and municipal laws, regulations, and bylaws, and, where applicable, provisions of the organization's collective agreements that relate to health and safety.

Note: *This definition is aligned with CAN/CSA-Z1000.*

Lumbar support — a protrusion in the lower portion of the backrest. Lumbar height is measured as the distance of this protrusion above the compressed seat.

Luminance — a measure of the amount of light emitted or reflected from a surface.

Mobile technology — portable devices such as mobile phones, tablets, and laptops.

Musculoskeletal disorders (or injuries) — injuries and disorders of the musculoskeletal system (the muscles, tendons, tendon sheaths, nerves, bursa, blood vessels, bones, joints/spinal discs, and ligaments) that can be caused or aggravated by various hazards or risk factors in the workplace.

Notes:

- 1) *"Musculoskeletal disorders" is a term used to describe a number of diagnoses including strains, sprains, carpal tunnel syndrome, repetitive strain injury, tendonitis, etc.*
- 2) *This definition is aligned with CSA Z1004.*

Occupational health and safety — the promotion in the workplace of the physical, mental, and social well-being of users and the protection of users from, and the prevention of, workplace conditions and factors adverse to users' health and safety.

Note: *This definition is aligned with CAN/CSA-Z1000.*

Occupational health and safety management system (OHSMS) — part of the overall management of the organization that addresses the occupational health and safety hazards and the risks associated with its activities.

Note: *CAN/CSA-Z1000 is an example of an OHSMS.*

Office — see **Work system** and **Workspace**.

Organization — a company, operation, undertaking, establishment, enterprise, institution, or association, or a part or combination thereof, that has its own management. An organization may be incorporated or unincorporated, public or private.

Notes:

- 1) *For organizations with more than one operating unit, a single operating unit may be defined as an organization.*
- 2) *This definition is aligned with CAN/CSA-Z1000.*

Procedure — a documented process to carry out an activity.

Note: *This definition is aligned with CSA Z1004.*

Process — a set of interrelated or interacting activities that transforms inputs into outputs.

Note: *This definition is aligned with CSA Z1004.*

Record — a document that states results achieved or provides evidence of activities performed.

Note: *This definition is aligned with CAN/CSA-Z1000 and CSA Z1004.*

Reference posture — posture specified for the purpose of defining relative positions and dimensions.

Note: *This definition is aligned with CAN/CSA-ISO 9241-5.*

Requirement — a provision that conveys criteria to be fulfilled if compliance with the Standard is to be claimed and from which no deviation is permitted. (Adapted from ISO/IEC DIR 2)

Residual risk — the risk remaining after a hierarchy of controls has been implemented.

Note: *This definition is aligned with CAN/CSA-Z1000.*

Risk — combination of the likelihood of the occurrence of harm and the severity of that harm.

Note: *This definition is aligned with CAN/CSA-Z1000, CAN/CSA-Z1001, CAN/CSA-Z1002, CAN/CSA-Z1003/BNQ 9700-803, CSA Z1004, and CSA Z1006.*

Risk analysis — a process for comprehending the nature of hazards and determining the level of risk.

Notes:

- 1) *Risk analysis provides a basis for risk evaluation and decisions about risk control.*
- 2) *Information can include current and historical data, theoretical analysis, informed opinions, and the concerns of stakeholders.*
- 3) *Risk analysis includes risk estimation.*
- 4) *This definition is aligned with CAN/CSA-Z1002.*

Risk assessment — the overall process of hazard identification, risk analysis, and risk evaluation.

Note: *This definition is aligned with CAN/CSA-Z1002.*

Seat — the horizontal part of the chair.

Seat angle — the slope of the top of the seat cushion (compressed) to the horizontal.

Seat depth — the maximum depth from the seat front to the most prominent point of the lumbar support of the backrest.

Seat height — the distance from the floor to the top of the seat cushion (compressed).

Seat width — the distance from one side to the other of the seat cushion approximately in the area under the widest portion of the user's hips.

Semi-standing posture — a posture in which the pelvis is rotated in such a way that users' weight is distributed between their buttocks and their feet, while having their feet flat on the floor.

Notes:

- 1) *Typically, the thigh to trunk angle is 135° or greater in a semi-standing posture.*
- 2) *See Figure A.1.*

Senior management — the person(s) at the highest level of an organizational structure responsible for leading, managing, and/or directing an organization.

Note: *This definition is aligned with CAN/CSA-Z1000.*

Sit stand stool — a piece of furniture that enables a person to semi-stand, with a forward sloping seat that rotates the pelvis and provides for an open torso-to-thigh angle with the feet flat on the floor or other surface. A portion of users' weight is supported by their buttocks and feet. This piece of furniture can also provide pelvic or lumbar support.

Support surface — a surface that provides support for information technology devices (e.g., input devices and visual displays). See also **Work surface**.

System — a set of interrelated or interacting elements.

Note: *This definition is aligned with CAN/CSA-Z1000.*

Training — any structured activity with measurable outcomes provided to gain, improve, or retain a trainee's specified knowledge, skills, and abilities or to influence attitude.

Note: *This definition is aligned with CAN/CSA-Z1001.*

Trial — the test of an item or a set of circumstances with the purpose of evaluating its effectiveness or usefulness, or for other purposes.

Notes:

- 1) *Trials can involve testing an item before it is permanently procured or the use of a mock-up.*
- 2) *This definition is aligned with CSA Z1004.*

User — a person employed by the organization or a person under the day-to-day control of the organization, whether paid or unpaid.

Notes:

- 1) *This definition of “user” includes employees, supervisors, managers, team leaders, contractors, service providers, volunteers, students, and any others actively engaged in undertaking activities for the organization.*
- 2) *This definition is aligned with CAN/CSA-Z1000.*

User-centred — a type of approach to designing or developing products, systems, layouts (and other items) that seeks to use information from users who are affected by the process.

Notes:

- 1) *This approach is used rather than forcing the users to change how they work to accommodate the developers' approach.*
- 2) *This definition is aligned with CSA Z1004.*

Viewing distance — the distance between the centre of the screen image area and the nasal bridge, in any reference posture.

Work chair — a chair that is used for sitting posture in an office environment and that is appropriate for the tasks or activities being performed.

Work organization — the manner in which work is structured, supervised, and carried out.

Note: *This definition is aligned with CSA Z1004.*

Worker — see **User**.

Worker representative — a non-managerial user who is

- a) a member of a workplace health and safety committee;
- b) a representative of other users according to the requirements of law or collective agreements; or
- c) selected by non-managerial users for other reasons.

Note: *This definition is aligned with CAN/CSA-Z1000.*

Workplace — any location in which work-related activities under the control of the organization are performed.

Note: *This definition is aligned with CAN/CSA-Z1000.*

Workspace — any location where a person's work is performed, including traditional office spaces and non-traditional office spaces (e.g., home offices, vehicles, and temporary locations), as well as the furniture, accessories, equipment, environmental conditions, and psychosocial workplace factors within these locations.

Workstation — the part of a workspace outfitted with the furniture, accessories, and equipment needed for users to perform a particular job.

Multi-user workstation — a workstation that is used by more than one user (e.g., shared for part of a day or shift or on alternate shifts).

Single-user workstation — a workstation that is dedicated to one person.

Work surface — a surface where work is performed (typically paper-based or computer-based work tasks). The work surface is commonly used to support technology and associated equipment and materials.

Work system — a system comprised of one or more users and the workspace acting together to perform the system function in a workplace, under the conditions imposed by the work tasks.

Note: *This definition is aligned with CSA Z1004.*

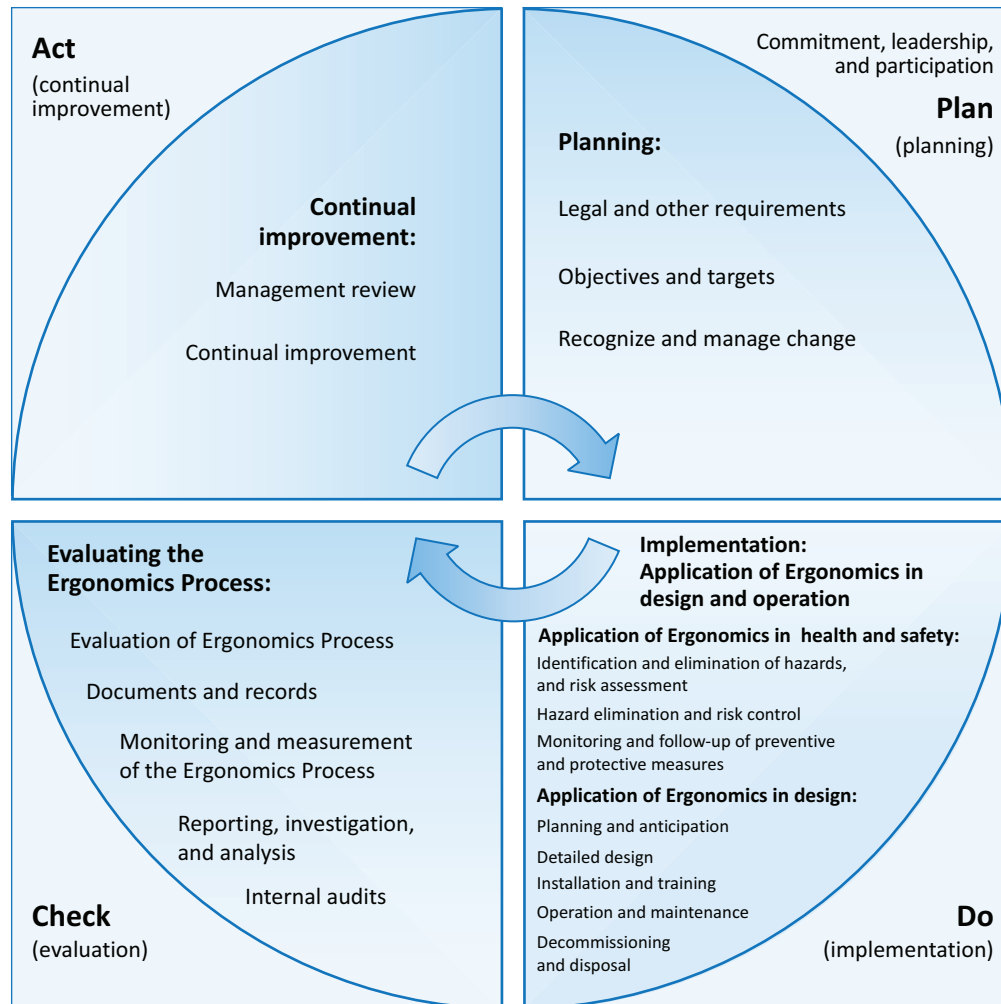
4 The Ergonomics Process

4.1 General

The Ergonomics Process described in CSA Z1004 is a framework that involves both senior management and worker (and their representative) responsibilities and actions designed to ensure that ergonomics is implemented in the occupational health and safety management system (OHSMS). It is based on the “Plan-Do-Check-Act” (PDCA) process (Figure 1).

The PDCA model ensures the sustainability and efficiency of an Ergonomics Process within an organization, which, in turn, provides the foundation on which the Application of Ergonomics (Clause 5) can take place throughout the workplace.

Figure 1
Ergonomics Process
(See Clauses 4.1 and 5.1 and Figure 2.)



4.2 Infrastructure and resources

4.2.1 General

The organization shall determine, provide, and maintain the infrastructure and resources needed to achieve conformity to this Standard, including the appropriate financial, human, and organizational resources. The organization shall access persons competent to implement this Standard.

4.2.2 Management commitment and leadership

Senior management shall provide leadership, shall ensure that the Ergonomics Process is established in the office work environment and shall document their commitment, leadership, and participation with regard to the development, implementation, and maintenance of an effective Ergonomics Process, as described in this Standard and in CSA Z1004.

4.2.3 Worker and user participation

The organization shall

- a) provide workers, worker representatives, and users with the time and resources to participate effectively in the Ergonomics Process associated with their work, or the workplace that they represent, including, at a minimum, participation in
 - i) planning;
 - ii) implementation; and
 - iii) evaluation, corrective action, and preventive action;
- b) provide workers, worker representatives, and users with timely access to information relevant to the Ergonomics Process; and
- c) encourage worker, worker representative, and user participation by providing mechanisms that
 - i) support worker, worker representative, and user participation, such as identifying and removing barriers to participation;
 - ii) engage existing workplace health and safety committees or worker representatives; and
 - iii) ensure that workers, worker representatives, and users are informed and consulted about, and given opportunities to participate in, all aspects of OHS associated with their work.

Note: *Worker participation is an essential aspect of the Ergonomics Process in the organization for optimal office work system performance.*

4.2.4 Communication

The organization shall establish and maintain procedures to communicate information about the Ergonomics Process and the progress of the implementation plan to all affected levels of the organization. The procedures shall include methods of obtaining workers', worker representatives', and users' input regarding ergonomics and incorporating this input into the Ergonomics Process. In addition, the procedures shall ensure that concerns, ideas, and input are responded to in a timely fashion, and shall incorporate a forum for workplace OHS committees or worker representatives to facilitate communication.

4.2.5 Awareness and training

Persons competent in ergonomics shall be involved in the design and redesign of office work systems, and shall focus attention on providing optimal working conditions for human well-being, safety, and health. The organization shall ensure that its workers, worker representatives, and users are aware of the hazards and risks inherent in each job, shall define the training requirements, shall provide training to address those hazards and risks through the use of the Ergonomics Process, and shall ensure that its users are aware of the importance of compliance with the applicable procedures and legal and other requirements.

Notes:

- 1) *This might require the enhancement of existing skills and development of new skills.*
- 2) *See CAN/CSA-Z1001 for detailed guidance on this topic.*

4.3 Planning, objectives, and targets

The organization shall develop a plan to identify resource requirements, current legal requirements, and other requirements, and to apply ergonomics to the design of systems and procurement of materials, to the recognition and management of change, and to the setting of objectives and targets.

The organization shall establish and document measurable objectives and targets, which should be reviewed on a regular basis and modified as required, to demonstrate that the Ergonomics Process is established and utilized effectively. Objectives and targets shall be determined by considering legal and other requirements, plans for change, technological options, the organization's health and safety

records and operational and business requirements, the hazards and risks identified in Clause 5.5, and any incidents or injuries.

The organization shall establish and maintain a plan for achieving its objectives and targets. The plan should include the

- a) designation of responsibility for achieving objectives and targets; and
- b) identification of the means by, and time frame within which, the objectives and targets are to be achieved.

4.4 Implementation

The organization shall implement the Ergonomics Process throughout their OHSMS (where one exists), from the most senior level through to the front lines (see Clause 5), in order to systematically identify, assess, eliminate, and control the physical, cognitive, and organizational hazards that can be present in the office work system.

4.5 Evaluation

4.5.1 General

The organization shall, in conjunction with worker representatives, regularly evaluate its Ergonomics Process to

- a) determine the extent to which the objectives and targets are met;
- b) determine that appropriate preventive measurements are taken and assess their effectiveness; and
- c) enable continual improvement.

The organization shall use the documents and records required in Clause 4.5.2 to evaluate the Ergonomics Process.

4.5.2 Documents and records

The organization shall create and maintain documents and records to clearly demonstrate compliance with, and activity in, the Ergonomics Process. Records and documents should be used to assist with implementation and the monitoring of the Ergonomics Process. Documents and records should include the following:

- a) objectives and targets required in Clause 4.3;
- b) assignment of duties and responsibilities;
- c) procedures required in Clauses 4.2 to 4.4;
- d) high-level direction required in Clause 4.2.2;
- e) documents required in Clause 4.5.4 for audits if the organization chooses to conduct internal audits;
- f) records of internal and external communication required in Clause 4.2.4;
- g) training records required in Clause 4.2.5;
- h) monitoring and measurement records required in Clause 4.5.3;
- i) supporting documents and records required by the organization to ensure the effective planning, implementation, operation, and control of the Ergonomics Process; and
- j) other documents and records required to assess compliance with legal and other requirements.

Workers, worker representatives, and users shall have access to documents and records relevant to the Ergonomics Process, while respecting the need for confidentiality. These documents and records shall be legible, readily identifiable, and retrievable.

4.5.3 Monitoring and measurements

Measures for monitoring the Ergonomics Process shall be developed and recorded. These shall

- a) be appropriate to the needs, size, and nature of the organization;
- b) be developed with the participation of workers, worker representatives, and users;
- c) include both qualitative and quantitative measures; and
- d) be used as input to the process review.

4.5.4 Audits

Audits conducted at planned intervals can be used to determine whether the Ergonomics Process, including the Application of Ergonomics in the office work environment, conforms to the requirements of this Standard and whether the Ergonomics Process is effectively implemented and maintained.

If the organization chooses to use internal audits, it shall determine and document the audit scope, frequency of audits, the audit methodology, reporting mechanisms, and the criteria for auditor competency.

Note: See *CAN/CSA-Z1000*, *CAN/CSA-ISO 19011*, and the *International Labour Organization's audit matrix guide for information on conducting internal audits*.

4.6 Continual improvement

The organization shall have an ongoing process to assess opportunities for continual improvement, including the reduction of residual risk. This shall include

- a) review of current control strategies;
- b) review of best available methods, technologies, and procedures to address residual risks; and
- c) implementation strategy to ensure continual improvement.

5 Application of Ergonomics

5.1 General

The Application of Ergonomics is the practical, “front line” implementation of the Ergonomics Process and comes under the “Do” section of the “Plan-Do-Check-Act” management model. (See Figure 1).

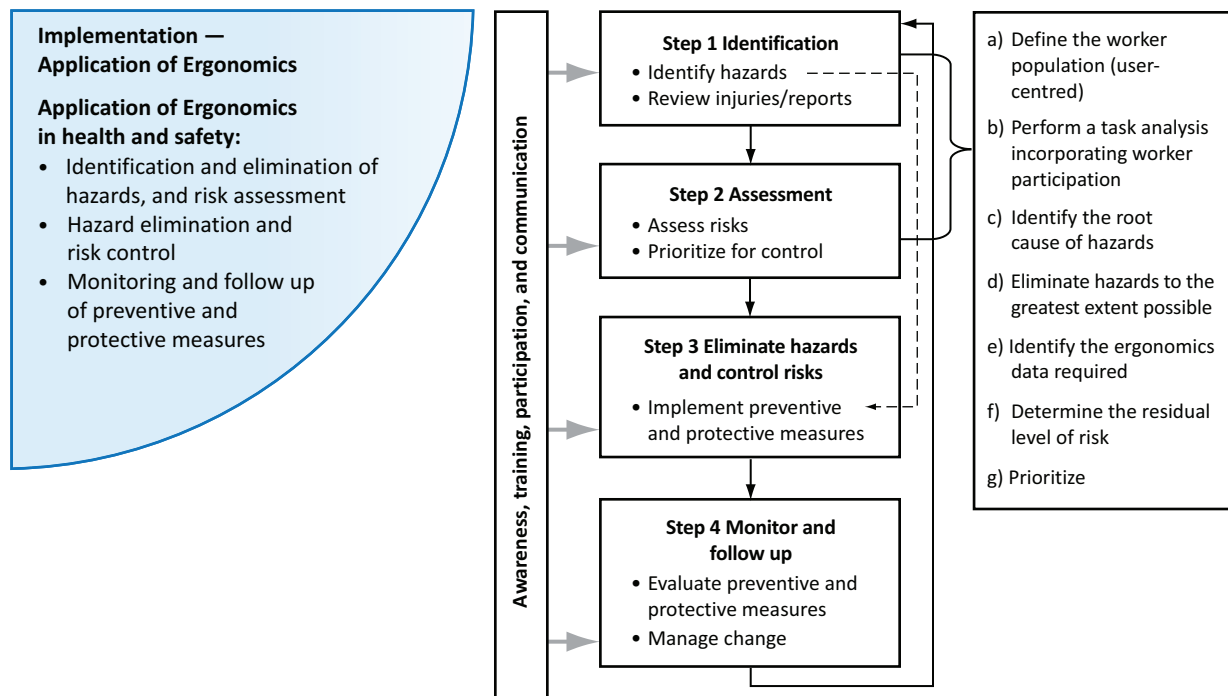
The objective of the Application of Ergonomics is to enhance user health, safety and well-being and to optimize system performance by eliminating or controlling poorly designed aspects of work and by designing work systems that prevent injuries.

5.2 Application of Ergonomics in health and safety

The organization shall apply ergonomics to establish, implement and maintain a process (Figure 2) that uses ergonomics principles to

- a) identify and eliminate hazards (Clauses 5.5, 5.6, 5.7);
- b) where hazards cannot be eliminated, assess and control risks (Clause 5.8); and
- c) monitor and follow-up on preventive and protective measures (Clause 5.8).

Figure 2
Application of Ergonomics in health and safety
(See Clauses 5.2 and 5.5.2 and Figure 3.)



Note: Commonly, these steps are part of “Implementation — Application of Ergonomics” as per Figure 1.

5.3 Application of Ergonomics in design and operation

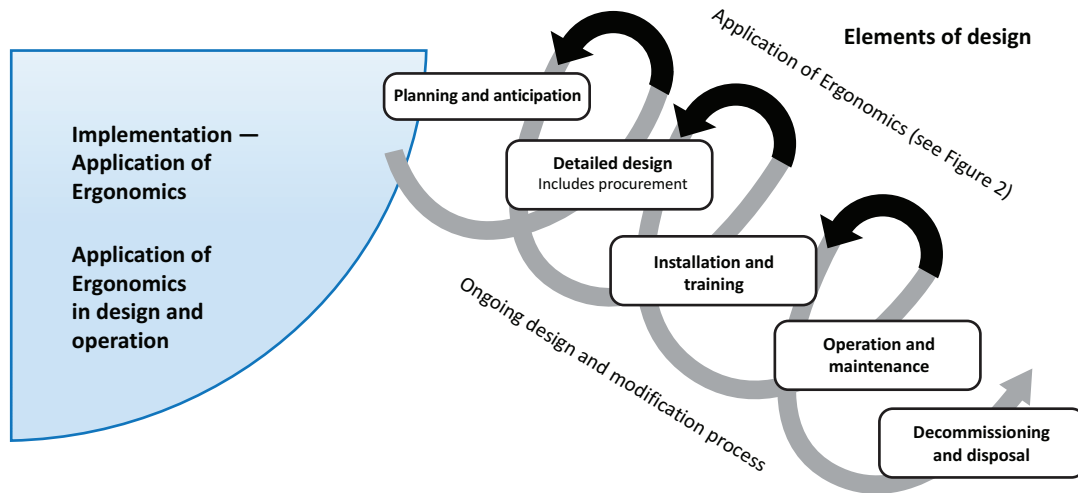
5.3.1 Stages in the design of work systems

The organization shall apply ergonomics at all stages in the design of work systems (see Figure 3), including

- planning and anticipation;
- detailed design process;
- installation and training;
- operation and maintenance; and
- decommissioning and disposal.

Persons competent in ergonomics shall be involved in the stages indicated in Items a) to e).

Figure 3
Application of Ergonomics in design and operation
(See Clause 5.3.1.)



Note: The Application of Ergonomics is an ongoing process, operating at each stage of the design, operation, decommissioning, and disposal of a work system. Its application prevents injuries; enhances user health, safety, and well-being; and optimizes system performance. The earlier in the design stages that ergonomics is applied, the more likely it is that the system will effectively meet the needs of users and that injuries or concerns can be prevented. Also, since work performance can change with the introduction of new people, equipment, tools, products, or services, the task of monitoring to identify and eliminate new hazards, and to assess and control risks is a process that, as indicated in this Figure, is ongoing.

5.3.2 Use of tools, methods, checklists, and standards

Evidence-based tools, methods, checklists, and standards shall be used to effectively eliminate hazards and control risks, to enhance human health and well-being, and to optimize system performance. These shall be applied in conjunction with data, which shall be collected through consultation with user groups or operators of other similar systems, where necessary.

5.3.3 Procedure to review designs

The organization shall establish, implement, and maintain a procedure to review designs. The design reviews should be used at the following stages of design and/or redesign:

- a) during concept formulation and initial drawings;
- b) during preliminary design;
- c) during engineering development;
- d) during construction;
- e) during operation and maintenance; and
- f) during, or in anticipation of, decommissioning and disposal.

5.3.4 User trials or mock-ups

User trials or mock-ups should be conducted to confirm preliminary designs and during procurement procedures for furniture, accessories, and equipment.

5.4 Procurement

5.4.1 Evaluation

The organization shall establish a process to evaluate furniture, accessories, equipment, other products, supplies, raw materials, and services to be procured in order to identify and eliminate potential hazards; to control risk before the items to be procured are brought into the workplace; to prevent injuries; to enhance user health, safety, and well-being; and to optimize system performance.

5.4.2 Process

The organization shall

- a) develop ergonomics specifications to be used during procurement that take physical, cognitive, and work organization demands into consideration;
- b) include a user-centred approach to the development of procurement specifications;
- c) ensure that procured goods conform to established specifications and that suppliers are made aware of these specifications when required; and
- d) include user participation in the development of specifications and in the evaluation of procured goods, as appropriate.

5.5 Hazard identification and risk assessment process

5.5.1 General

The organization shall establish, implement, and maintain a hazard identification and risk assessment process that takes into account the nature of the hazards and level of risk. The process shall include

- a) hazard identification;
- b) elimination of hazards;
- c) risk analysis associated with remaining hazards; and
- d) risk evaluation.

The scope, nature, and timing of the hazard identification and risk assessment shall be proactive.

Note: *CAN/CSA-Z1002 should be followed for hazard identification and elimination, and risk assessment and control.*

5.5.2 Performing hazard identification and elimination, and risk assessment

Hazard identification and elimination, and risk assessment should include the following activities (shown in Figure 2) at all stages of the ongoing design and modification process:

- a) defining the user population;
- b) performing a task analysis incorporating user participation;
- c) identifying the root cause of hazards (system nonconformities);
- d) eliminating the hazards to the greatest extent possible;
- e) identifying the required ergonomics data;
- f) assessing the level of residual risk; and
- g) prioritizing the residual risk.

5.6 Identification of hazards

5.6.1 General

5.6.1.1

The organization shall establish, implement, and maintain a procedure to identify the following types and sources of hazards:

- a) physical hazards, including
 - i) musculoskeletal hazards; and
 - ii) environmental hazards;
- b) psychosocial hazards; and
- c) other hazards;

5.6.1.2

The procedure shall

- a) be conducted by competent persons;
- b) include participation by workers, worker representatives, and users;
- c) use leading and lagging indicators; and
- d) include infrequently performed tasks and tasks performed only in emergency situations.

Where there is an incident or where there are signs or symptoms of an injury attributable to workplace hazards, immediate interim preventive and protective measures shall be implemented before the completion of the risk assessment.

5.6.1.3

Task characteristics shall be recognized and addressed in the process of hazard identification. This can be done by documenting

- a) the detailed listing of tasks (known as task description);
- b) total time spent for each activity;
- c) the nature of the interaction between the user and the computer, tablet, or other office equipment;
- d) information required by users;
- e) equipment action requirements;
- f) material requirements;
- g) physical workstation parameters;
- h) environmental parameters;
- i) organizational and procedural practices;
- j) work scheduling and shiftwork;
- k) employment conditions (part-time work, permanent work, job sharing, etc.);
- l) workload and overtime; and
- m) work/rest breaks.

5.6.2 Physical hazards

The organization shall establish, implement, and maintain a procedure to identify physical hazards in the office environment. These hazards can include, but are not limited to,

- a) force requirements;
- b) awkward and sustained postures;
- c) repetitive movements;

- d) forceful gripping;
- e) contact stress;
- f) manual materials handling;
- g) lighting;
- h) temperature;
- i) noise; and
- j) vibration.

5.6.3 Psychosocial hazards

The organization shall establish, implement, and maintain a procedure to identify psychosocial workplace factors which, if not addressed, are hazards in an office environment (e.g., factors associated with work organization and job design). These factors can include, but are not limited to,

- a) expectations that are not clearly expressed (performance measures and accountability);
- b) very high psychological job demands (cognitive);
- c) lack of involvement and influence (employee control and autonomy);
- d) ineffective opportunities for workload management;
- e) poor employee engagement (evidenced in user participation and feedback); and
- f) lack of protection of physical safety.

5.6.4 Other hazards

The organization should establish, implement, and maintain a procedure to identify other hazards in the office work environment, such as chemical and biological agents.

Note: *It is outside the scope of this document to provide specific requirements for chemical and biological contaminants; however, contaminants can be present in office work environments and are a key concern. Sources of chemical and biological contaminants include*

- a) *emissions from indoor sources (such as recently installed carpets, ceiling tiles, wall coverings, and furniture);*
- b) *occupant activities and equipment (such as photocopiers and cleaning products);*
- c) *infiltration of outdoor contaminants (such as vehicle exhaust);*
- d) *bioaerosols due to persistent moisture or standing water (e.g., condensation from indoor heating);*
- e) *poor ventilation and air-conditioning (HVAC) system; and*
- f) *inadequate outside air supply or circulation.*

5.7 Hazard elimination and risk control

The organization shall implement preventive and protective measures to eliminate the hazards and control the risks identified during the Application of Ergonomics in order to promote physical, cognitive, and organizational well-being. Preventive and protective measures shall be designed to eliminate hazards where possible. Where hazards cannot be eliminated, risks shall be controlled (i.e., minimized). In determining risk control measures, the organization in consultation with workers, worker representatives, and users shall take into account the following:

- a) the causes, nature, and extent of the hazards and risks identified;
- b) the elimination or control of hazards and risks by following a hierarchy of preventive and protective measures (see Clause 5.8.2);
- c) applicable legal and other requirements;
- d) applicable standards, codes, guidelines, and best practices;
- e) the availability of suitable technology; and
- f) opportunities to improve the design of work systems.

When hazards that cannot be immediately eliminated are identified, interim controls shall be implemented until the risk assessment is complete and permanent controls can be implemented.

5.8 Risk assessment and prioritization

5.8.1 General

Risk assessment shall be carried out for each hazard or hazardous situation in the work environment. The organization shall establish, implement, and maintain a procedure to assess the identified hazards. Where hazards cannot be eliminated, the organization shall establish, implement, and maintain a procedure to prioritize, address, and minimize the risks through the implementation of preventive and protective measures.

5.8.2 Hierarchy of preventive and protective measures

Elimination or control of hazards and risks shall be achieved by designing preventive and protective measures in the following priority:

- a) elimination or substitution, where either the hazard is removed from the workplace or the source of the hazard is replaced by a safer alternative;
- b) engineering measures representing change to the arrangement and design of equipment, tools, machinery, materials, or processes; and
- c) administrative measures, such as those that affect the performance, duration, or organization of the tasks.

5.8.3 Residual risk

Where residual risk has been identified, the organization shall

- a) communicate with users and provide opportunities for workers, worker representatives, and users to participate in decisions regarding how to address the residual risk;
- b) communicate and consult with external stakeholders regarding the residual risk;
- c) provide information to workers, worker representatives, and users that details the hazards identified, the risks associated with the hazards, and the risk controls used to effectively reduce risk;
- d) establish and maintain a procedure for promptly reporting workplace injuries, illnesses, incidents, hazards, and risks; and
- e) provide training to affected workers, worker representatives, and users on the risk controls that will be used to effectively reduce risk and the activities required to address residual risk.

5.8.4 Monitoring and follow-up of preventive and protective measures

The organization shall

- a) evaluate the effectiveness of the preventive and protective measures implemented;
- b) identify any newly created hazards resulting from the preventive and protective measures implemented;
- c) expedite action on inadequately controlled risks; and
- d) follow up on actions taken to ensure their effective implementation.

In determining preventive and protective measures, the organization shall consider input from performance monitoring and measurement, recommendations from workers, worker representatives, and users, audits, and management reviews.

6 Requirements for the workspace

6.1 General

Workspaces shall accommodate the individual user in accordance with the requirements specified in Annex A. A competent person shall determine the furniture, accessories, and equipment requirements for persons where physical, sensory, or other medical accommodations are required. Input from a competent person can be required in any or all complex furniture, accessories, and equipment selections.

Note: *Dimensional information provided in the tables in Annex A is intended for use solely as a reference and might not accommodate all users in a given user population.*

Workspaces typically include the following:

- a) furniture, including work chairs, work surfaces, and storage and filing systems (see Clause 6.2);
- b) accessories, including document supports, palm supports, footrests, monitor arms, and task lights (see Clause 6.3) and materials used to perform tasks (e.g., paper, boxes);
- c) equipment, including input devices and visual displays (see Clause 6.4);
- d) environmental conditions, including lighting, noise, vibration, temperature, and indoor air quality (see Clause 6.6);
- e) task-oriented expectations relevant to the work activities, including material-handling activities (see Clause 6.7); and
- f) psychosocial workplace factors and psychological health (see Clause 6.8).

6.2 Furniture

6.2.1 General

The furniture shall accommodate the relevant anthropometric characteristics of the user using the workstation. The requirements in Clause A.3 shall be fulfilled for compliance with this Clause.

6.2.2 Work chair

The work chair shall accommodate the relevant anthropometric characteristics of the user, allow movement through multiple postures, provide stable body support, and be appropriate for the tasks or activities being performed.

6.2.3 Work and support surfaces

Work and support surfaces shall provide support for the technology used and associated equipment/materials, allow adequate clearances for the user's legs and feet, and allow movement through multiple postures. The work surfaces shall be appropriate for the tasks or activities being performed.

6.3 Accessories

Accessories shall accommodate the relevant anthropometric characteristics of the intended user population, be compatible with other equipment in the workstation, and be placed to accommodate movement through multiple postures. The requirements in Clause A.4 shall be fulfilled for compliance with this Clause.

Note: *Accessories refers to items such as document supports, palm supports, and footrests.*

6.4 Equipment

6.4.1 General

Clauses 6.4.2 to 6.4.4 shall apply during the selection, purchase, use, and maintenance of computer hardware in the workplace environment.

The requirements of Clause A.5 shall be fulfilled for compliance with this Clause.

Note: *Information technology devices include desktop hardware (visual displays, keyboards), mobile hardware, non-keyboard input devices, and notebook and laptop computers.*

6.4.2 Input devices

Input devices shall be suited to the anthropometric characteristics of the intended user population, be compatible with other equipment in the workspace, and be placed so the user can achieve the reference posture.

The requirements in Clause A.5.1 shall be fulfilled for compliance with this Clause.

6.4.3 Visual displays

Visual displays or monitors shall display information in a legible and readable format that is easy to use and shall be positioned so the user can achieve the reference posture.

The requirements in Clause A.5.2 shall be fulfilled for compliance with this Clause.

Note: *It is beyond the scope of this Standard to provide specifications for the design of visual displays.*

6.4.4 Mobile technology

Mobile technology devices shall not be used individually for extended periods unless the user is able to achieve a reference posture.

Mobile technology shall display information in a legible and readable format that is easy to use. See Clause A.7.

Note: *It is beyond the scope of this Standard to provide design specifications for mobile technology devices.*

6.5 Layout and use of furniture, accessories, and equipment

Furniture, accessories, and equipment shall be arranged to accommodate the working postures (see Clause A.1) and fulfill workstation principles (see Clause A.2).

The requirements given in Clause A.6 for the layout and use of furniture, accessories, and equipment shall be fulfilled.

6.6 Environmental conditions

Environmental conditions in the workspace shall be controlled. The requirements in Clause A.10 shall be fulfilled for

- a) lighting;
- b) acoustics;
- c) vibration;
- d) thermal environment; and
- e) indoor air quality.

6.7 Manual materials handling

Manual materials handling tasks in an office environment shall be designed, organized, and implemented in a manner that ensures a user can perform the activities of lifting, lowering, carrying, pushing, and pulling without an increased risk of injury.

The requirements in Clause A.11 for manual materials handling shall be fulfilled for compliance with this Clause.

6.8 Psychosocial workplace factors and psychological health

The workplace shall be designed and organized to ensure that psychosocial workplace factors are not a risk to user health. The requirements in Clause A.12 shall be fulfilled for compliance with this Clause.

Note: *Psychological health and safety is affected (both positively and negatively) by psychosocial workplace factors. Some factors are related to the manner in which work is organized and jobs are designed, which in turn affects how employees interact within their work system and with each other. Psychosocial workplace factors can also include management practices, including the methods by which decisions are made and communicated in the workplace. If these factors are not well understood or controlled, they can pose a hazard to psychological health (psychosocial hazard). A very strong link has been shown to exist between the presence of psychosocial hazards in the workplace and the onset or aggravation of musculoskeletal disorders (MSDs).*

This Standard addresses psychosocial hazards and workplace factors that can be minimized and controlled through ergonomics.

For more information on psychological health and safety in the workplace and the management of psychosocial workplace factors, see CAN/CSA-Z1003/BNQ 9700-803.

Annex A (normative)

Detailed requirements for the workspace

Note: This Annex is a mandatory part of this Standard.

A.1 Working postures

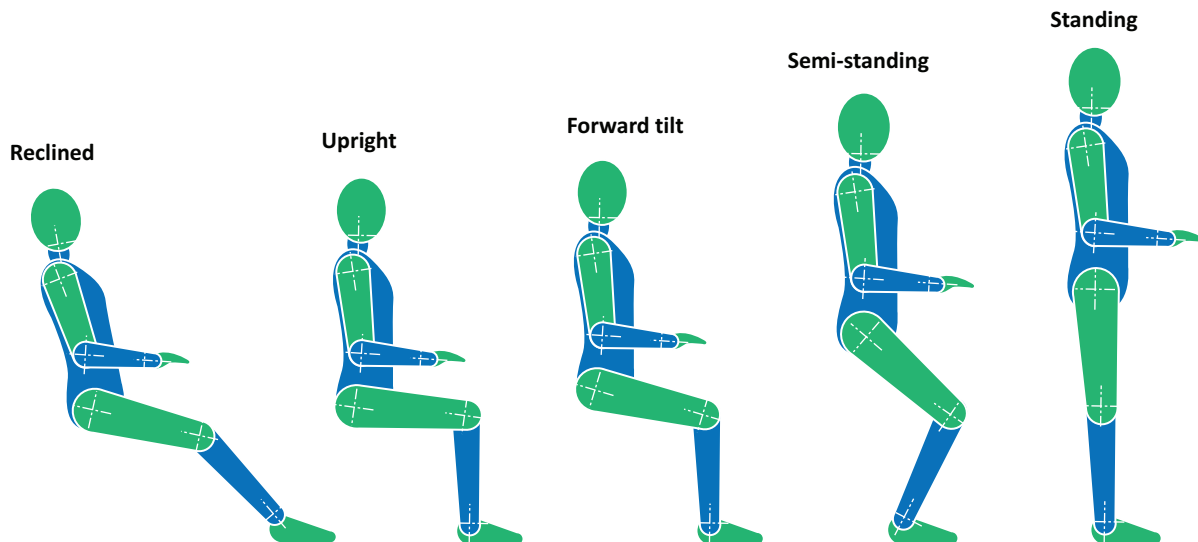
A.1.1 General

Job and task organization shall allow for postural variety (see Figure A.1).

Notes:

- 1) Alternating between sitting and standing, or variations on sitting and standing postures (e.g., reclining, forward tilting, and semi-standing) are encouraged in order to avoid the negative effects of prolonged sitting or standing in one posture.
- 2) There is no uniquely correct working posture that fits a user for an extended period of time and/or accommodates every personal work habit.
- 3) Some approaches to achieving postural variety include changes in tasks, individual work practices, and the use of alternative workstation layouts and adjustable furniture, equipment, and accessories.

Figure A.1
Examples of working postures
(See Clauses 3 and A.1.1.)



A.1.2 Reference posture for sitting

The workspace shall allow a person to achieve the reference posture for sitting. The reference posture for sitting (see Figure A.2) shall be used as the standard reference posture for defining relative positions and dimensions in office workstations. Characteristics of the reference posture (free form posture in space) for sitting are as follows:

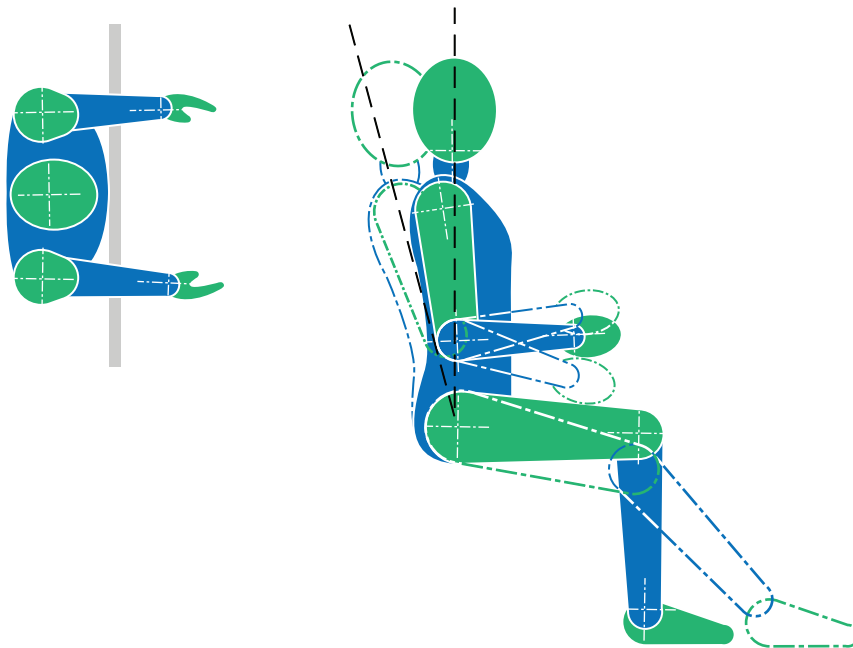
- a) soles of the feet making an angle of 90° with the lower legs;
- b) thighs approximately in a horizontal position and lower legs vertical with feet resting on the floor or a footrest;
- c) an erect or upright spine;
- d) a straight (not twisted) upper torso;

- e) upper arms hanging vertically alongside the torso with shoulders relaxed, forearms horizontal, and elbows close to the body;
- f) straight (not bent) wrists; and
- g) neck is upright (i.e., not turned, tilted, flexed, or extended).

Note: While this posture can be comfortable for users performing tasks for a short period of time, movement through multiple postures is paramount to enhance human health and well-being. See Clause A.6.1 d).

See Table A.1 for guidance as to when a seated posture is deemed suitable.

Figure A.2
Reference posture for sitting
(See Clauses A.1.2, A.3.2.2.2, A.3.2.4, A.3.3.6, and A.4.3.1.)



A.1.3 Reference posture for standing

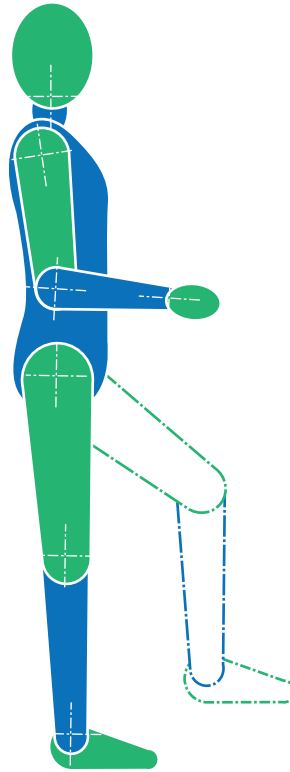
The workstation shall allow a person to achieve the reference posture for standing. This posture (see Figure A.3) shall be used as the standard reference posture for defining relative positions and dimensions in office workstations. Characteristics of the reference posture for standing (free form posture in space) are as follows:

- a) head, neck, torso, and legs approximately in line and vertical (one leg may be raised intermittently on a foot support); and
 - Note:** The height of a foot support provided for the seated posture might not be the appropriate height to support one foot while standing.
- b) for computer tasks,
 - i) upper arms hanging vertically, with the forearms horizontal and elbows close to the body; and
 - ii) straight (not bent) wrists.

Note: While this posture can be comfortable for users performing tasks for a short period of time, avoiding long durations of static postures is necessary to enhance human health and well-being (see Clause A.1).

See Table A.1 for guidance as to when a standing posture is deemed suitable.

Figure A.3
Reference posture for standing
(See Clauses A.1.3 and A.3.3.6.)



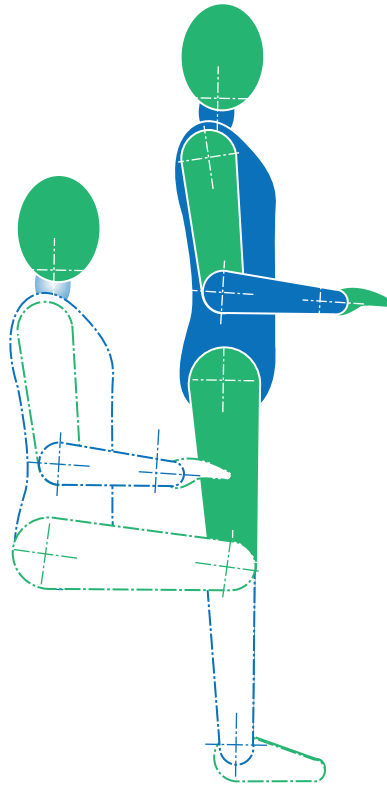
A.1.4 Alternating working postures between sitting and standing

Where it is required by the work task, the work organization, or the user, furniture, accessories, and equipment shall accommodate the need to alternate between sitting and standing postures. See Table A.1 for guidance on when alternating between sitting and standing is deemed suitable.

Note: *Moving from a fully seated to a standing posture enhances blood flow, and minimizes fatigue and static muscle effort. Alternating between sitting and standing should be implemented where practicable.*

Sit-to-stand furniture and/or accessories may be used to achieve appropriate postures when alternating between sitting and standing (see Figure A.4).

Figure A.4
Fully seated to fully standing
(See Clause A.1.4 and Table A.1.)



A.1.5 Choosing the work posture

Considerations for determining the suitability of sitting, standing, or semi-standing positions, or the need to alternate between sitting, standing, or semi-standing positions shall include

- tasks being performed;
- task duration;
- work flow; and
- users' needs.

See Table A.1 for sample considerations.

Table A.1
Sample considerations for determining suitable postures
(See Clauses A.1.2, A.1.3, A.1.4, and A.1.5.)

| Postures | Considerations |
|---|---|
| Sitting | <ul style="list-style-type: none"> concentrated and focused work is performed; can include demanding visual requirements (e.g., computer work, proofing documents, combined telephone and computer tasks) majority of tasks are performed while seated but allow for movement through multiple postures and brief periods of standing (including microbreaks) little, if any, reaching into tertiary zones [Clause A.6.1 a) and Figure A.8]; few, if any, high reaches for equipment or items user does not lift or handle items weighing more than 4.5 kg |
| Standing | <ul style="list-style-type: none"> job requires considerable movement away from the workstation or movement within the workstation user lifts or handles items weighing more than 4.5 kg (e.g., while working in a shipping and receiving office setting and handling incoming materials) frequent reaching into tertiary zones [Clause A.6.1 a) and Figure A.8] to equipment or items |
| Semi-standing (e.g., on a sit stand stool) | <ul style="list-style-type: none"> user performs a variety of tasks, the majority of which are suited to standing but some of which are better suited to semi-standing user needs to be at eye level with clients/customers who are standing it can be an accommodation for a user who cannot fully sit and/or fully stand |
| Sit to stand: | |
| a) Alternating between sitting and standing (see Figure A.4) | <ul style="list-style-type: none"> long durations of concentrated and focused work performed in seated posture few alternative tasks or opportunities occur that require getting up from the seated posture |
| b) Alternating between sitting (e.g., on a high stool) and standing at a standing height workstation | <ul style="list-style-type: none"> user needs to be at eye level with clients who are standing user performs a variety of tasks, the majority of which are suited to standing but some of which are better suited to sitting job requires movement away from the workstation to other equipment (e.g., a printer) user lifts or handles items weighing more than 4.5 kg user performs frequent reaching to exchange items with customers who are standing slow periods of service are common during which the user can benefit from sitting |

A.2 Workstation principles

A.2.1 General

A workstation comprises furniture, accessories, and equipment.

A workstation shall be suitable for the tasks performed by the user and the need for movement through multiple postures.

The following interrelated principles shall be used to determine the configuration of furniture, accessories, and equipment:

- versatility and flexibility;
- fit;
- postural change;
- user education and training; and
- maintainability and adaptability.

Note: These principles are adapted from CAN/CSA-ISO 9241-5.

A.2.2 Versatility and flexibility

The workstation shall allow users to perform their assigned tasks comfortably and efficiently.

Note: *It is unlikely that one workstation layout will be suitable for all types of users and tasks. Workstations with adjustable and interchangeable/modular furniture components will accommodate a wider variety of user tasks.*

A.2.3 Fit

The workstation shall fit the user needs, characteristics, and tasks.

Fit can be achieved by providing furniture, accessories, and equipment that

- a) are adjustable;
- b) have a range of sizes; or
- c) are customized for a specific use or user.

Note: *“Fit” refers to the extent to which furniture, accessories, and equipment accommodate individual user needs.*

A.2.4 Postural variation

The work organization, job design, and workstation shall enable the user to move through multiple postures while sitting and should also include opportunities to alternate between sitting, semi-standing, and standing.

A.2.5 Education and training

The organization shall provide education about the important role that workstation selection and layout play in contributing to health, well-being, and productivity. Users shall be trained on how to adjust furniture and arrange other aspects of the workstation (accessories and equipment).

The education and training program shall include the following:

- a) awareness of appropriate working heights and reach zones (see Figure A.10) for placement of equipment and materials;
- b) importance of movement through multiple postures throughout the work day;
- c) awareness of all adjustments/controls and how to use them; and
- d) potential health risks related to technology use and/or improper adjustment.

A.2.6 Adaptability and maintainability

The workstation shall be adaptable to changing workplace requirements and circumstances (e.g., frequent relocation of users).

The workstation selection and layout should allow maintenance of the furniture, accessories, and equipment and ensure components are accessible.

A.3 Furniture

A.3.1 General

Clause A.3 supplies requirements for work chairs (Clause A.3.2), and work and support surfaces (Clause A.3.3).

A.3.2 Work chair

A.3.2.1 General

Criteria for determining whether a work chair accommodates a single user when seated are provided in Clauses A.3.2.2 to A.3.2.9.

Chair parameters are provided in Table A.3 and Figures A.5 and A.6.

Notes:

- 1) Clauses A.3.2.2 to A.3.2.9 apply to single users. Where a single workstation is used by more than one person, it might be necessary to use more than one chair if fit cannot be achieved for all users of a single chair.
- 2) ANSI/BIFMA X5.1 specifies structural and stability tests to ensure safety.

A.3.2.2 Seat

A.3.2.2.1 User interaction with the seat

Seats shall

- a) provide stable support;
- b) avoid creating localized pressure points that restrict blood circulation in the lower limbs;
- c) allow for movement through multiple postures while sitting;
- d) provide a sufficient level of friction to avoid sliding off the seat; and
- e) have a breathable surface for comfort, unless restricted by application (e.g., in clinical, laboratory, or industrial settings).

A.3.2.2.2 Seat height

Users shall be able to sit with their feet comfortably on the floor or footrest without undue pressure on the underside of the thighs. The torso-to-thigh angle shall not be less than 90° (see Figure A.2).

Seat height shall be readily adjustable by the user to allow for postural variation.

The range of seat height adjustability should accommodate the lower to the higher percentile popliteal heights of the intended user population. Variation in footwear and variation in sitting postures shall be considered. Where the user extends their legs out in sitting (beyond 90° at the knee), their feet should be able to reach the floor or footrest.

A.3.2.2.3 Seat depth

Users shall be able to sit in the chair without undue pressure at the back of the knees, with their back properly supported by the backrest, and with adequate buttock and thigh support.

Note: Chairs with adjustable seat depths accommodate a greater number of users and allow for personal preferences. Seat depth adjustments can be accomplished by movement of either the seat and/or the backrest.

A.3.2.2.4 Seat width

Seat width shall be wide enough to allow users to maintain comfortable pressure distribution across the seat and adjust their posture.

Note: Seat width will often affect the armrest position. Depending on the seat width, this can impact ingress/egress (for larger users) or arm support (for smaller users).

Seat widths that accommodate users with a larger seated contact area might not adequately accommodate smaller users and vice versa.

A.3.2.2.5 Seat angle

The angle of the seat shall allow users to support their feet on the floor or footrest. Chairs with forward seat angles, including forward-sloping seats in sit-stand stools, shall have seating surfaces with sufficient friction to help prevent sliding out of the chair or shifting too much weight to the feet. Seats may have an adjustable or fixed seat angle. (See Figure A.5.)

Notes:

- 1) *Adjustable seat angles allow for postural changes.*
- 2) *An excessive rearward seat angle, especially if accompanied by an excessive rise in its front edge of the seat, might not allow users to keep their feet firmly on the floor or footrest. This can result in compression under the thighs, decreased blood flow, and discomfort.*

A.3.2.2.6 Front edge of seat

The front edge of the seat shall be designed to minimize compression of the underside of the thigh and behind the knee.

Note: *This is typically accomplished by a rounded or declining front edge.*

A.3.2.3 Backrest

A.3.2.3.1 General

Backrests shall

- a) provide support to the lumbar region of the user's back;
- b) avoid creating localized pressure points that restrict blood circulation;
- c) allow for movement through multiple postures; and
- d) have a breathable surface for comfort, unless restricted by application (e.g., in clinical, laboratory, or industrial settings).

A.3.2.3.2 Backrest height

A backrest shall be high enough to support the back in a variety of postures. For rearward postures, backrest height shall provide support for the shoulders and, depending on the recline angle, the neck/head.

For tasks requiring upper body mobility, the backrest height shall provide adequate support of the user's back but not interfere with movement of the user's arms.

A.3.2.3.3 Lumbar support

Chairs shall have a height-adjustable lumbar support. The lumbar support shall be of such a height and shape as to support the user's lower back (the lumbar region of the spine). The support shall not cause localized pressure points.

Note: *Adequate lumbar support helps maintain the natural curvature of the spine at the small of the back, encourages postures that evenly distribute pressure within the intervertebral discs, and minimizes back strain.*

A.3.2.3.4 Backrest width

The backrest shall be wide enough to provide adequate support for the user's back without causing localized pressure points.

Lateral concave curvature of the backrest should not be so extreme as to be uncomfortable for the user.

A.3.2.3.5 Backrest-to-seat angle

The backrest-to-seat angle shall not cause the user's torso-to-thigh angle to be less than 90°. (See Figure A.5.)

A.3.2.4 Movements and positions of seat and backrest

The movements and positions of the seat and backrest shall allow the user to sit in postures where the torso-to-thigh angle is equal to or greater than 90° (See Figure A.2) and shall accommodate the varying postures assumed by the user throughout the day. Work chair seat angle movement shall not force the user's feet to remain off the floor or footrest. When reclining, the backrest should stay in contact with the user's back, especially in the lumbar area.

Notes:

- 1) *Positions of the seat and backrest are measured as angles relative to each other throughout their movement. These measures approximate the user's torso-to-thigh angle.*
- 2) *Changes in posture while sitting are encouraged and can be achieved through movements of the seat and backrest. The movements of the seat and backrest are typically determined by the type of tilt mechanism.*
- 3) *Tilt mechanisms should either allow the backrest to tilt concurrently with the seat in a ratio greater than 1:1 (i.e., a "synchro-tilt", where the backrest reclines more than 1° when the seat reclines 1°) or allow the seat and backrest to tilt in unison (a 1:1 ratio).*

The seat, the backrest, or both shall be stoppable or lockable at various positions within the range of movement.

A.3.2.5 Armrests

A.3.2.5.1 General

A competent person in ergonomics shall determine if a work chair without armrests is appropriate.

When a work chair is equipped with armrests, the armrests shall

- a) support the arms;
- b) allow access to the workstation, equipment, and materials;
- c) distribute forces evenly over the area of contact; and
- d) allow the user to sit in a variety of postures.

A.3.2.5.2 Armrest height

Armrests shall be

- a) adjustable in height; and
- b) include a height setting that allows users to support their forearms and/or elbows in a manner that avoids
 - i) lifting the shoulders (armrest too high); or
 - ii) leaning to the side or dropping the shoulders to reach the armrest (armrest too low).

A.3.2.5.3 Armrest (pad/cap) length, width, and positioning

The length, width, and positioning of the armrests shall allow users to support their forearms properly while sitting close enough to the work surface to perform their tasks and shall not be a source of contact stress.

The armrest (pad/cap) should not be so long and/or wide that it impedes access to the work surface or impedes wrist movement, nor should the armrest be so narrow that it creates pressure on the forearm.

The user shall be able to

- a) adjust the armrests inward or outward to achieve a comfortable arm posture; and
- b) support their forearms and/or elbows in a manner that avoids lifting the shoulders and/or forcing the elbows away from the body.

A.3.2.5.4 Distance between armrests

The distance between the armrests shall allow users to

- a) easily enter and exit the chair; and
- b) comfortably fit their hips between the armrests.

A.3.2.6 Work chair base

A.3.2.6.1 Legs

The legs of the work chair shall ensure stability without creating a trip hazard.

Note: *Stability testing protocols can be found in CAN/CGSB-44.232 and ANSI/BIFMA X5.1.*

A.3.2.6.2 Casters

The casters on the base of the work chair shall be appropriate for the type of surface on which the chair is used (see Table A.2).

Table A.2
Caster types, characteristics, and typical use
(See Clause A.3.2.6.2.)

| Types of casters | Characteristics | Typical use |
|---------------------------|--|---|
| Hard-wheeled | Lower rolling resistance | Carpeted floors |
| Soft-wheeled | Higher rolling resistance | Hard-surfaced floors |
| Roll-controlled | Higher rolling resistance in unoccupied chairs | Hard-surfaced floors |
| Braking — when occupied | Difficult to roll occupied chairs | Carpeted or hard-surfaced floors, to minimize chair movement when the user is seated |
| Braking — when unoccupied | Difficult to move unoccupied chairs | Hard-surfaced and/or uneven floors, to minimize unintended movement of unoccupied chair |
| Manual locking | Allows manual locking to prevent rolling of occupied chairs or movement of unoccupied chairs | Carpeted or hard-surfaced floors, to prevent movement of the chair when manually locked |

A.3.2.6.3 Swivel

The seat, backrest, and armrests (if the chair has armrests) shall swivel in unison relative to the base.

The chair shall enable the user to swivel while seated to get close to equipment, accessories, or materials.

A.3.2.7 Controls

Controls shall

- a) be operable from the usual seated working position, with the exception of controls for raising seat height and adjusting tilt tension, which can be adjusted by users with their weight out of the chair;
- b) be logical in their placement and intuitive in their use;
- c) be marked to indicate function;
- d) where appropriate, have control markings visible from a seated position;
- e) not pose a safety hazard;
- f) prevent unintentional activation;
- g) not create pinch points; and
- h) not require undue force or tools to operate.

A.3.2.8 Work chair — Other considerations

A.3.2.8.1 Cushioning and surface material

When foam cushioning materials are used in the seat and backrest, they should be expanded flexible urethane foam of either flat slab, sculpted slab, or moulded construction. For comfort, the surface should be breathable to minimize heat and moisture buildup.

Seating surfaces should have sufficient friction to help prevent sliding out of the chair.

Armrests should be made of soft, durable, and non-abrasive material.

Notes:

- 1) *Use of breathable surfaces might not be possible for specific tasks/settings (e.g., where impermeable materials are required for ease of cleaning or in healthcare settings for infection control).*
- 2) *CAN/CGSB-44.232 provides cushioning compliance requirements.*

A.3.2.8.2 High stools

High stools shall have a footrest or footring that supports the user's feet. Footrests/footrings should adjust in height to accommodate a range of users.

The work chair requirements in this Standard (see Clause A.3.2) are applicable to all high stools, with the exception of requirements for

- a) seat height; and
- b) movements of the seat and backrest (especially those allowing movement in the rearward position since such movement can create a safety hazard in a high stool).

Note: *A high stool is not intended for use at a sit-to-stand work surface.*

A.3.2.9 User accommodation and work chair selection

The selection criteria for the work chair shall be established based on the requirements in Clause A.3.2. Depending on the user population, appropriate work chair selection can be complex and should be performed by a competent person.

Notes:

- 1) *Chairs that have been designed to accommodate the 5th percentile female body dimensions to the 95th percentile male body dimensions will accommodate a large number of intended users (see Table A.3).*
- 2) *The information in Table A.3 is derived from the anthropometric data in the CAESAR anthropometric database (North American Edition, 2002). For information regarding how the anthropometric data was used to derive the chair dimensions and adjustment ranges, see BIFMA G1. The dimensions given Table A.3 are based on the measures taken by BIFMA CMD-1, which uses a weighted chair-measuring device (CMD). ISO 24496 is an acceptable alternative measuring device/protocol.*

- 3) While this Standard is not a product compliance standard, products that meet the dimensional criteria listed in Table A.3 aim to accommodate the 5th percentile female body dimensions to the 95th percentile male body dimensions. In some cases, multiple product solutions can be required to accommodate every user.

Table A.3
Work-chair-related dimensions and adjustment ranges to accommodate 5th percentile female body dimensions to the 95th percentile male body dimensions
(See Clauses A.3.2.1 and A.3.2.9.)

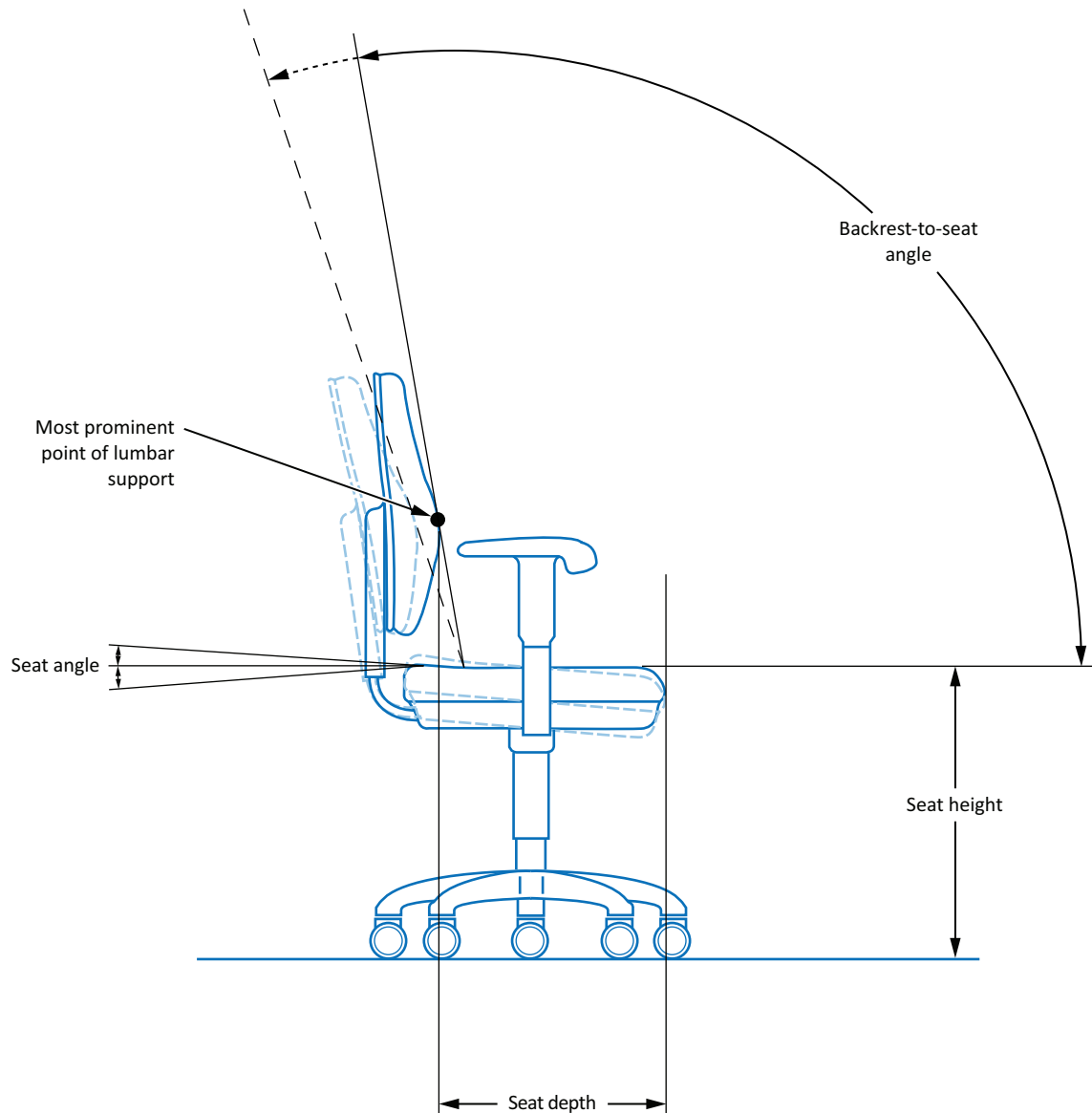
| Clause no. | Chair parameter (with anthropometric measurement) See Figures A.5 and A.6 for work chair parameters | Dimensions and adjustment ranges (mm) | Notes, considerations, and additional information |
|------------|--|---|---|
| A.3.2.2.2 | Seat height (popliteal height) | Include 376 to 512 (136 range) | Mechanical restrictions in the design of height adjustment mechanisms often make the 136 mm range difficult to achieve in a single chair. Typically shorter individuals require lower range cylinders. Taller individuals might require higher range cylinders. The adjustment range is also applicable to high stools. |
| A.3.2.2.3 | Seat depth (buttock-popliteal length) | Adjustable: include 415 and adjust by at least 50 Fixed: ≤ 415 | Typically shorter individuals require a shallower seat depth. Taller individuals might require a deeper seat depth. Seat depth fit can be achieved either by adjustability or by using different sizes of chairs. |
| A.3.2.2.4 | Seat width (hip breadth) | ≥ 489 | This accommodates up to the 90 th percentile female's hip width. Some individuals might require a wider seat; however, this can affect armrest position/use. |
| A.3.2.2.5 | Seat angle (n/a) | Fixed: fall within a range of 0° (horizontal) to 4° rearward Adjustable: include some part of the range between 0° (horizontal) to 4° rearward | Research does not agree on the exact limits of either forward or rearward seat angles, or the appropriate amount of adjustment. The recommendation, therefore, is based on industry practice. |
| A.3.2.3.2 | Backrest height (tenth rib mid-spine, sitting and acromial height, sitting) | ≥ 354 | This accommodates up to the 95 th percentile female. No research has shown sufficient evidence to support a recommendation for minimum backrest height, but the backrest should at least support the lumbar region. Higher backrests are recommended for chairs that recline in order to support the upper back/shoulder region. |
| A.3.2.3.3 | Lumbar support height (n/a) | Adjustable: include at least part of the range between 150 to 250 above the seat | There is no database available for proper positioning of the lumbar support. For this reason, the range given is based on industry practice. In general, more adjustability of lumbar support height is preferable. |

(Continued)

Table A.3 (Concluded)

| Clause no. | Chair parameter (with anthropometric measurement) See Figures A.5 and A.6 for work chair parameters | Dimensions and adjustment ranges (mm) | Notes, considerations, and additional information |
|------------|---|--|--|
| A.3.2.3.4 | Backrest width (waist breadth) | ≥ 360 in lumbar region | In the absence of an anthropometric measurement representative of the lumbar width, the dimension given is based on Gordon et al. (1988) data and is now industry practice. |
| A.3.2.3.5 | Backrest-to-seat angle (n/a) | A minimum adjustment range of 15° within 90° to 120° relative to the horizontal | |
| A.3.2.4 | Chair tilt lock (n/a) | Lock or stop at various positions within the tilt range | |
| A.3.2.5.2 | Armrest height (elbow height, sitting) | Adjustable: include range of 195 to 289 | This range can be achieved through a single set of armrests, or multiple sets of armrests each covering a portion of the adjustment range. |
| A.3.2.5.3 | Armrest length, width and positioning (n/a) | No dimensional recommendation | See Clause A.3.2.5.3 for guidance. |
| A.3.2.5.4 | Distance between armrests (hip breadth) | Include 493 with horizontal adjustment of at least 50 per side (100 total) | This accommodates the 90 th percentile female. |

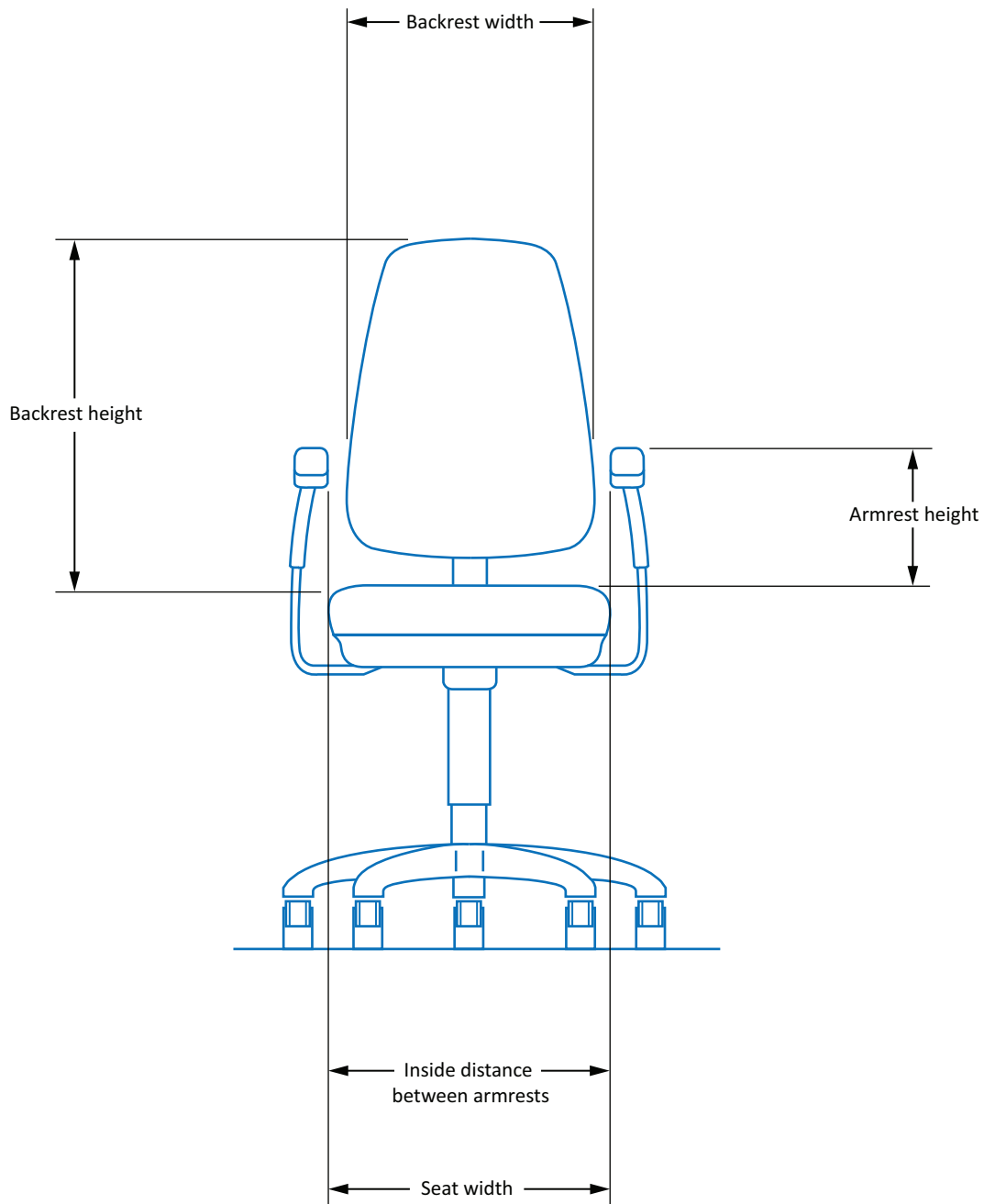
Figure A.5
Chair parameters — Side view
(See Clauses A.3.2.1, A.3.2.2.5, and A.3.2.3.5, and Table A.3.)



Notes:

- 1) The chair illustration is meant to be generic and does not represent any particular manufacturer's product.
- 2) Parameters shown on the drawing are for visual reference only.

Figure A.6
Chair parameters — Front view
(See Clause A.3.2.1 and Table A.3.)



Note: The chair illustration is meant to be generic and does not represent any particular manufacturer's product.

A.3.3 Work and support surfaces

A.3.3.1 General

Clauses A.3.3.2 to A.3.3.9 shall be used to determine user accommodation at work and support surfaces. Where there are multiple users, work and support surfaces shall have the necessary features of adjustment to accommodate each user quickly and easily. See Table A.4.

A.3.3.2 Clearance envelope under work and support surfaces (legs and feet) — Sitting and standing

The clearance envelope under the work surface shall

- a) allow the user to sit and/or stand directly in front of, or close to, the work surface in an upright posture without obstruction; and
- b) allow the user to freely move through multiple postures while seated, including extending the lower legs, or, to stand without obstruction.

Notes:

- 1) *Common sources of obstruction include workstation components such as desk drawers, supports for the work surface (including table legs), and personal items.*
- 2) *Table A.4 shows the parameters that define the clearance envelopes under work surfaces for seated postures and standing postures.*
- 3) *The clearance width for seated work might need to be increased to accommodate chair swivel movements and armrest clearance from adjacent surfaces (in "L" configurations or other structures) and to allow for direct access beneath defined work areas where chair travel occurs.*

A.3.3.3 Heights for work surfaces and support surfaces — Sitting and standing

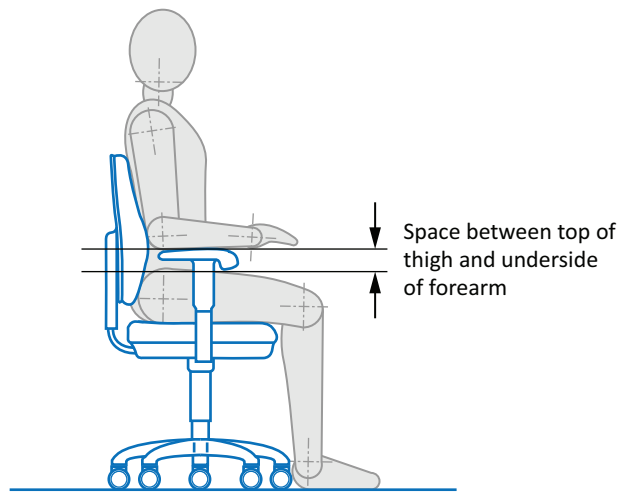
The surface height shall enable users to sit and/or stand with their feet comfortably supported on the floor in a variety of positions with their shoulders, elbows, and wrists in neutral postures, and without exposure to contact stress. See Clauses A.1.2 and A.1.3 and Notes 2) and 3) below. A footrest may be used if the surface cannot be adjusted so that the feet are on the floor.

Adjustable support surfaces shall not unintentionally move. See Note 1) below.

Notes:

- 1) *Movement of an adjustable support surface is typically accomplished using a control such as a knob or lever or by a built-in mechanism that allows the user to unlock and move the surface. A separate control for adjusting the slope of the keyboard might be required. Adjustable support surfaces can have continuous or incremental adjustment capabilities. Other features can be provided, such as specific support surface sizes for different keyboards and input devices, resilient palm rests, and non-slip surfaces.*
- 2) *Users are not accommodated by a "sit to stand" height adjustable support surface when they are unable to achieve the sitting and standing reference postures.*
- 3) *There can be some cases in which height adjustable support surfaces will not accommodate users because there is little or no space between the top of their thigh and the underside of their forearm in which to fit the keyboard and support surface (see Figure A.7). A competent person can provide specific guidance.*

Figure A.7
Space between top of thigh and underside of forearm
 (See Clause A.3.3.3.)



Source: BIFMA G1.

A.3.3.4 Width for work surfaces and support surfaces

The work or support surface width shall be wide enough to accommodate the keyboard and input device on the appropriate side of the keyboard in such a way that users maintain their shoulders, elbows, and wrists in neutral postures.

A.3.3.5 Heights for support structures for visual displays — Sitting or standing

Structures used to support visual displays shall enable the user to assume the reference posture when seated or standing and to view the entire monitor display without excessive turning, tilting, flexing, or extending the neck. The top of the screen should not be closer to the eyes than the bottom of the screen. See Figures A.8 and A.9.

Note: See Clauses A.6.2.3 and A.6.4 for touch screens.

A.3.3.6 Distance for viewing visual displays — Sitting or standing

The distance from the user's eyes to the monitor (i.e., the viewing distance) shall allow the user to focus on the screen images in such a way that they are legible and readable when the user assumes the reference posture. See Figures A.2 and A.3.

A.3.3.7 Controls

A.3.3.7.1

Work and support surface controls shall

- a) prevent unintentional activation;
- b) be operable from the seated and/or standing positions;
- c) not pose a safety hazard;
- d) not create pinch points; and
- e) not intrude into the leg and foot clearance spaces.

A.3.3.7.2

Work and support surface controls should

- a) be conveniently placed to encourage correct use;
- b) be intuitive in their use;
- c) not require undue force or tools to operate;
- d) have control markings visible from a seated and/or standing positions; and
- e) not interfere with users' typical work activities.

A.3.3.8 Other considerations

A.3.3.8.1 Cable management

Cables shall be placed to allow correct and safe operation of workstation components and devices.

Cable length shall be sufficient to accommodate user needs, including powered equipment requirements. If adjustable surfaces are provided, the cabling shall be capable of covering the total adjustment range.

The distribution of wiring and cables (mains, data, telephone, etc.) shall allow easy access for maintenance and cleaning.

Additional cable characteristics to consider in workstation configurations include weight, tension, flexibility, and location.

Where job tasks require access to power/data receptacles, the location shall be such that the outlets are positioned within the safe reach of the user.

A.3.3.8.2 Finish of the work surface

The finish of the work surface is categorized by both gloss and reflectivity.

To minimize specular reflections, the gloss of the surface finish should not exceed 45 gloss units when tested in accordance with ASTM D523 and measured at the 60° incidence angle.

If the degree of gloss on surfaces exceeds 45 gloss units, it might be necessary to adopt some or all of the following measures:

- a) changing the direction of light by suitable positioning of the equipment, workstation, and/or luminaires (see Figures A.10 to A.12);
- b) use of suitable luminaires; and
- c) reorientation of the workstation.

A.3.3.8.3 Radius of work surface edges

All user contact edges shall have a minimum radius of 2 mm. The minimum radius on edges on which a user is expected to rest the forearm, hand, or wrist should be 3 mm.

Note: *The edge of the keyboard tray closest to the user is an example of a surface where a minimum 3 mm radius is recommended.*

A.3.3.8.4 Pinch points

With the exception of adjustable keyboard support surfaces, the clearance between a surface that is vertically adjustable by the user and any adjacent surface shall be

- a) greater than 25 mm to minimize potential for pinch/crush hazards; or
- b) less than 8 mm where the clearance is maintained throughout the travel of the adjusting surface.

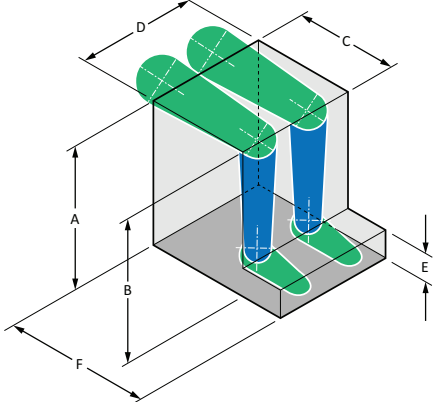
A.3.3.8.5 Storage

All drawers and extendable shelves shall have stops to prevent their accidental removal but shall be removable when required.

A.3.3.9 User accommodation and work and support surface selection

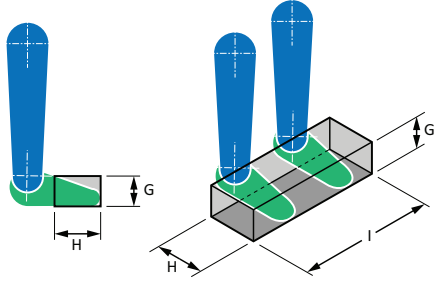
The selection criteria for the work and support surfaces shall be established based on the requirements in Clause [A.3.3](#). Depending on the user population, the selection of appropriate work and support surfaces can be complex and should be performed by a competent person.

Table A.4
Work-surface-related dimensions and ranges to accommodate the 5th percentile female body dimensions to the 95th percentile male body dimensions
 (See Clauses A.3.3.1 and A.3.3.2.)

| Clause no. | Parameter (anthropometric measurement) | Dimensions and adjustment ranges (mm) | Notes, considerations, and additional information |
|------------|---|--|--|
| A.3.3 | Work and support surfaces | — | — |
| A.3.3.2 | Clearance envelope under work surfaces — sitting | — | The height clearances include a shoe heel height allowance of 30 mm. |
| |  | | |
| | Height clearance for legs and knees — sitting (thigh height, popliteal height, knee height) ^{A,B} | — | — |
| | — if fixed | ≥ 698 at the front edge of the work surface (for thighs) and ≥ 643 at 434 away from the front edge of the work surface (for knees) | Other clearances shall be used to accommodate specific populations when known. For example, the clearance dimension for the 95th percentile female is 617 mm. |
| | — if adjustable | Include 698 as part of the adjustment range | — |
| | Depth clearance for knees (buttock-knee length and abdominal extension depth) ^C | ≥ 434 | The depth clearances include a movement allowance of 45 mm. |
| | Width clearance for legs (thighs) (bilateral femoral epicondyle breadth, sitting) ^D | ≥ 619 | This dimension is based on the width measured across the outside of the knees when the user is seated in a relaxed seated position and includes a movement allowance of 45 mm. |
| | Height clearance at foot level (lateral malleolus height or ankle height) ^E | ≥ 114 | The height clearance includes a shoe heel height allowance of 30 mm. |
| | Depth clearance at foot level (buttock-popliteal length, foot length, and abdominal extension depth) ^F | ≥ 589 | The depth clearance includes a movement allowance of 45 mm. This is a minimum requirement based on the existence of a 90° angle between the lower leg and the thigh and the placement of the user in an upright posture, positioned nearly |

(Continued)

Table A.4 (Continued)

| Clause no. | Parameter (anthropometric measurement) | Dimensions and adjustment ranges (mm) | Notes, considerations, and additional information |
|----------------|---|---------------------------------------|---|
| | | | flush to the front edge of the work or input device support surface. Additional clearance will be required for long-legged users should they extend their legs while positioned nearly flush with the work surface edge. |
| A.3.3.2 | Clearance envelope under work surfaces — standing | — | — |
| |  | | |
| | Height clearance for feet (lateral malleolus height or ankle height) ^G | ≥ 114 | The height clearance includes a shoe heel height allowance of 30 mm. |
| | Depth clearance for feet ^H | ≥ 152 | In the absence of anthropometric data, this dimension is adopted from the <i>2010 ADA Standards for Accessible Design</i> . |
| | Width clearance for feet (hip breadth, sitting) ^I | ≥ 566 | The width clearance includes a movement allowance of 45 mm. |
| A.3.3.3 | Heights for work surfaces and surfaces for keyboards and other input devices | — | — |
| | Support surface height for input devices — sitting (popliteal height, elbow height sitting) | | |
| | – if adjustable | 575 to 747 | Height range takes into account a shoe heel height allowance of 30 mm and input device thickness of 25 mm. |
| | – if fixed | ≥ 747 | Height takes into account a shoe heel height allowance of 30 mm and input device thickness of 25 mm. Note: Other heights might be required to accommodate specific populations, when known. For example, the fixed work surface height to accommodate the 95th percentile female is 690 mm. |
| A.3.3.3 | Support surface height for input devices — standing (elbow height, standing) | — | — |
| | – if adjustable | 973 to 1237 | Height range takes into account a shoe heel height allowance of 30 mm and input device thickness of 25 mm. |

(Continued)

Table A.4 (Continued)

| Clause no. | Parameter (anthropometric measurement) | Dimensions and adjustment ranges (mm) | Notes, considerations, and additional information |
|----------------|---|---|--|
| | | | If the support surface is tilt-adjustable, an additional height adjustment range will be required. |
| | – if fixed | Height should fall within range given above | Height range takes into account a shoe heel height allowance of 30 mm and input device thickness of 25 mm. |
| | Support surface height for input devices — from sitting to standing | 575 to 1237 | — |
| A.3.3.5 | Heights for support structures for visual displays | — | — |
| | Monitor height range — sitting | Adjustable from 1091 to 1371 from floor to top line of screen | — |
| | Monitor height range — standing | Adjustable from 1442 to 1813 from floor to top line of screen | — |
| | Work surface depth | Allow for minimum viewing distance | — |
| A.3.3.6 | Distance to monitor (viewing distance) — sitting or standing | ≥ 500 to 1000 | — |

Legend:

| | |
|-----------------|--|
| Sitting | <p>A = height clearance for legs (thighs) — the vertical distance from the floor to the underside of the work surface above the thighs</p> <p>B = height clearance for knees — the vertical distance from the floor to the underside of the structure above the knees</p> <p>C = depth clearance for knees — the horizontal distance from the front of the work surface to the support structure in front of the knees</p> <p>D = width clearance for legs (thighs) — the horizontal distance between support structures of the work surface</p> <p>E = height clearance at foot level — the vertical distance from the floor to the structure above the feet</p> <p>F = depth clearance at foot level — the horizontal distance from the front edge of the surface to the support structure in front of the feet.</p> |
| Standing | <p>G = height clearance for feet — the vertical distance from the floor to the structure above the feet</p> <p>H = depth clearance for feet — the horizontal distance from the edge of the opening to the structure in front of the feet</p> <p>I = width clearance for feet — the horizontal distance between the structures nearest the outside of the feet</p> |

Notes:

- 1) *The information in this Table, with the exception of the distance to monitor, is derived from the anthropometric data in the CAESAR 3-D Anthropometric Database (North American Edition). “Distance to monitor” from Bartha et al. (2015).*

- 2) Product compliance can be achieved by falling within the dimensions and adjustment ranges listed. Unless otherwise noted, these ranges accommodate the 5th percentile female body dimensions to the 95th percentile male body dimensions.
- 3) Furniture components that have been designed to accommodate the 5th percentile female body dimensions to the 95th percentile male body dimensions will accommodate a large number of intended users (see this Table).
- 4) Meeting the requirements in Clauses A.3.3 through A.3.3.5 for all users in a population can require dimensions and ranges outside of this Table. These determinations can be complex and should be performed by a competent person.

A.4 Accessories

A.4.1 Document supports

For tasks where the user reads or refers to source documents for extended periods (including time spent entering information from a document), a document support shall be provided to enable the user to assume the reference posture.

The document support shall be of a size that accommodates the size of the documents.

Where there is a frequent need to enter information from a source document as well as to write on the document, a sloped document support shall be provided that allows the documents to be positioned for viewing and writing in order to enable the user to assume the reference posture. The ability to write on a document while it is on the document holder shall not be impeded by the ledge that supports the document.

If the user performs primarily paper-based tasks, a sloped document support or sloped work surface can be provided.

Note: The reference posture can be achieved by placing the source document beside the monitor screen at a similar height (where writing on the document is not required) or between the monitor and the keyboard such that the monitor, document support, keyboard, and user's body are in a straight line.

A.4.2 Palm supports

A.4.2.1 Palm support and input device

A palm support can be

- a) incorporated into the design of the input device; or
- b) separate from the input device.

Note: The necessity and usefulness of a palm support will depend upon

- a) the characteristics of the workstation and computer equipment (especially the design of the keyboard);
- b) the keying skills of the user (e.g., less skilled users might pause more frequently and/or drop their wrists while keying);
- c) the type of task performed; and
- d) the preferred posture of the user.

A.4.2.2 Use of palm support

A palm support shall not result in wrist extension or deviation (e.g., from anchoring the wrist).

A.4.3 Footrests

A.4.3.1 Footrest characteristics

A footrest should

- a) adequately support the feet;
- b) have sufficient surface size ;
- c) have a nonslip surface; and
- d) have adequate friction against the floor so that it does not slide unintentionally.

Note: *It is preferable that a user be able to achieve the reference sitting posture (see Clause A.1.2 and Figure A.2) without the use of a footrest. This is typically accomplished by adjusting the height of the chair and/or work surfaces. Footrests can restrict movement through multiple postures and also make it more difficult for a user to adjust chair features such as seat height.*

A.4.3.2 Need for a footrest

Where users must position their seat height so that their feet are no longer resting flat on the floor, a footrest shall be provided. If users move their chair frequently between work surfaces, more than one footrest should be provided.

A.4.3.3 Ankle position

The footrest shall enable the user to achieve a neutral ankle position (at an angle close to 90°).

A.4.3.4 Foot-activated controls

The footrest shall not interfere with the use of other foot-activated controls/technology.

A.4.3.5 Footrest angle

The footrest may allow adjustable angles between the legs and feet as a means of providing variations in work postures or options for preferred ankle position.

A.5 Equipment

Note: *This Clause covers the use of devices by which the user communicates with the computer. The most common input devices are the alphanumeric keyboard and mouse. The positioning of these devices is discussed in Clause A.6.2 with reference to the appropriate posture for the user. Failure to position the devices appropriately can result in user fatigue and injury. The intrinsic properties of the devices can have an impact on the positioning of the device and user posture. Mobile technology is discussed in Clause A.7.*

A.5.1 Input devices

A.5.1.1 Keyboards

Keyboards shall meet the needs of individuals who are carrying out specified tasks and shall allow the user to locate and operate the appropriate keys accurately, quickly, and without discomfort. Auditory and tactile feedback from the keyboard shall be considered for users that require such feedback.

Keyboards without a numeric keypad should be considered for individuals who infrequently use the numeric keypad and operate the mouse with their right hand.

Notes:

- 1) *For example, a split keyboard can be used to reduce ulnar deviation for a user suffering from carpal tunnel syndrome, and a tented keyboard can be used to help someone with epicondylitis assume a more neutral forearm posture.*

- 2) *It is beyond the scope of this Standard to provide specifications for the design of keyboards. See ISO 9241-400 for more details.*

A.5.1.2 Non-keyboard input devices

Non-keyboard input devices shall meet the needs of individuals carrying out specified tasks and shall allow the user to locate the cursor and operate software/programs accurately, quickly, and without discomfort. Devices shall support either left- or right-handed use, where applicable. The usability of the non-keyboard input device should be tested to confirm it meets the needs of the user.

Notes:

- 1) *Non-keyboard input devices include a mouse, trackpad, cursor control device, etc.*
- 2) *Driver controls allow users to appropriately adjust the settings of the device to meet their requirements.*
- 3) *For touch screens, see Clause [A.6.4](#).*

A.5.2 Visual displays

A.5.2.1 General

Monitors or electronic visual displays shall allow the user to view information without error and with little effort.

Notes:

- 1) *ISO 9241-303 establishes image-quality requirements and requirements for electronic visual displays.*
- 2) *If the monitor is also used as a touch screen, see also Clause [A.5.1.2](#).*

A.5.2.2 Screen size

The appropriate minimum screen size should be based on

- a) the task requirements;
- b) the screen resolution;
- c) the viewing distance (see Clause [A.3.3.6](#)); and
- d) the time the user will spend viewing the display.

Note: *A screen size that is too small can cause a user to lean forward to read the text, thus incurring neck and upper back fatigue and strain. A monitor that is too large can result in visual discomfort if the monitor cannot be placed at an appropriate distance from the user due to workplace design restrictions. The objective is to optimize the extraction of visual information from the screen while minimizing visual fatigue.*

A.5.2.3 Brightness, contrast, and uniformity

Visual displays shall have separate controls for brightness and contrast. This will accommodate differences in user preferences and a range of ambient illumination conditions.

Note: *For design specifications for display luminance (brightness), contrast of character details, luminance balance, and display luminance uniformity, see ISO 9241-303.*

A.5.2.4 Image quality requirements in luminous environments

For visual displays used in luminous environments, the applicable image quality requirements from ISO 9241-303 should be complied with for the design or purchase of direct-view electronic office displays for office tasks such as data entry, text processing, and interactive inquiry using monochrome and multicolour displays

Note: *ISO 9241-303 establishes image quality requirements for visual displays used in luminous environments. For those involved in the design or purchase of direct-view electronic displays for office tasks, such as data entry, text processing, and interactive inquiries using monochrome and multicolour displays, ISO 9241-303 and its test methods provide guidance.*

A.5.2.5 Requirements for displayed colours

Where the primary objective of presenting information in colour is to enhance a user's ability to process information, colours shall be easily detectable, identifiable, and discriminated from other colours.

Where alphanumeric and symbols are presented in negative polarity (light symbols on a dark background), blue on a dark background shall not be used. Red on a dark background should be avoided, and red shall not be used on a spectrally extreme blue background. Spectrally extreme blue shall not be used on a spectrally extreme red background where positive polarity displays (dark symbols on a light background) are used.

The number of colours displayed on one screen should be minimized. For accurate identification, a colour set should have no more than eleven colours. When a rapid visual search based on colour discrimination is required or where the meaning of each colour must be recalled from memory, no more than six colours should be used.

Specifications for colour uniformity, misconvergence, character height, object size, and colour differences in ISO 9241-303 should be followed.

Colours used for aesthetic purposes should not impede visual performance and information processing. In choosing colours for display screen images and their background, the physical characteristics of the images, such as size, should also be addressed.

A.6 Layout and use of furniture, accessories, equipment, and work materials

A.6.1 General considerations

Furniture, accessories, equipment, and work materials shall be set up to meet the requirements for working postures (Clause A.1) and workstation principles (Clause A.2).

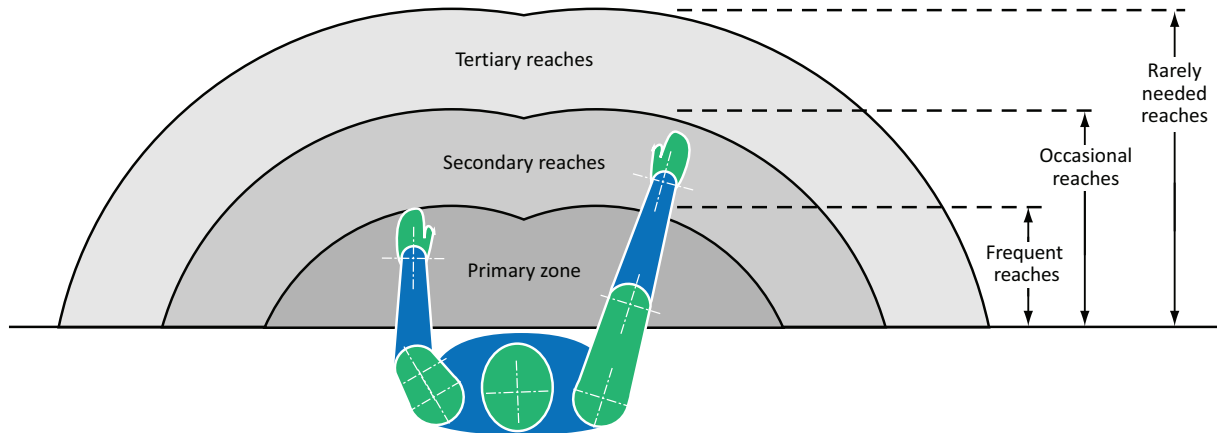
Specifically, the following shall be considered when placing furniture, accessories, equipment, and materials within the workstation:

- a) reach — equipment and work materials should be placed according to importance and frequency of use (see Figure A.8) as follows:
 - i) the primary zone (i.e., the area within immediate reach of the user) should be used for items of highest importance and those that are needed most frequently);
 - ii) the secondary zone (i.e., the area at arm's reach from user) should be used for items of lower importance and those that are needed occasionally; and
 - iii) the tertiary zone (i.e., the area farthest from user), which requires that the user bend forward to gain access, should be used for rarely needed items;
- b) working height(s) — equipment and work materials should be placed according to the visual requirements of the task, hand/arm activities, equipment or items used in the task, and the frequency and duration of the task (see Clauses A.3.3.3 and A.3.3.5);
- c) sequence of use — sequentially related items should be grouped and placed in order of use;
- d) movement — there should be enough space within the work area for users to get into and out of the work area, to move through multiple postures while sitting or standing at their workstation, and to access storage if used frequently;
- e) communication — the environment should allow for clear communication within the workstation while performing tasks (see Clause A.10.3);

- f) safety — safe use of the furniture and equipment should be ensured (e.g., elimination of pinch points, trip hazards, awkward postures, contact stress, repetitive movements, vibrations, and excessive forces); and
- g) access for maintenance — sufficient space should be allowed around the furniture and equipment for maintenance purposes.

Figure A.8 Reach dimensions

(See Clauses A.3.3.5, A.6.1, A.6.2.2.1, and A.8.3 and Table A.1.)



Note: This Figure illustrates reach dimensions for primary, secondary, and tertiary zones. If awkward postures are observed, adjustments should be made.

A.6.2 Layout and use of input devices

A.6.2.1 General

Input devices shall be placed in such a way that users can achieve the reference posture (see Clauses A.1.2 and A.1.3) and maintain neutral joint angles as they change their posture. If the mouse or other input device is used intensely or for long periods of time, the forearm(s) may be supported to minimize static effort of the shoulder muscles.

A.6.2.2 Layout and use of keyboards

A.6.2.2.1 Horizontal placement

The keyboard shall be movable so that the most frequently used keys can be centred in front of users within their primary reach zone (see Figure A.8) and users can maintain neutral torso and head/neck postures (see Clauses A.1.2 and A.1.3 for reference postures).

Note: For example, when only alpha keys are used on a traditional keyboard, the “Y” key is centred in front of the user.

A.6.2.2.2 Height and angle

The keyboard shall be located at an appropriate height and angle to ensure the user can maintain neutral hand, arm, and shoulder postures (see Clauses A.1.2 and A.1.3 for reference postures).

This may be achieved by adjusting the surface supporting the keyboard (desk or tray) and/or the chair up or down. In a case where the chair is moved up, if the user's feet are no longer resting flat on the floor, a footrest shall be provided.

A.6.2.3 Layout and use of non-keyboard input devices

Non-keyboard input devices, when used with a keyboard, shall be placed in the user's primary reach zone at the same height and as close to the keyboard as possible to maintain neutral hand, arm, and shoulder postures (see Clauses A.1.2 and A.1.3 for reference postures).

Possible options to reduce the reach to the non-keyboard input device that should be considered include

- a) use of a keyboard without a numeric keypad, in accordance with Clause A.5.1.2;
- b) placement of the mouse on the left of the keyboard so that the users use the mouse with their left hand; and

Note: Users can go to the operating system control panel to make adjustments. The button assignment can be changed so that the primary button is the one closest to the keyboard, and the tracking speed of the mouse can be slowed initially and gradually increased over time.

- c) providing a mouse support surface that allows the user to slide the surface over numeric keys when the mouse is in heavy use, then slide it to the right for access to the numeric keys as required, provided that it does not significantly increase the height of the mouse.

A.6.3 Layout and use of visual displays

A.6.3.1 General

The critical considerations for positioning visual displays are height, monitor viewing angle, horizontal placement, and distance. Proper positioning of the monitor may be achieved by adjustability built into one, or a combination, of the following:

- a) monitor hardware;
- b) the work surface or structure (e.g., monitor stand or monitor arm) that supports the monitor; and
- c) the work surface.

Monitors shall have swivel or tilt capability such that the screen can be positioned to reduce or eliminate unwanted glare.

Monitor contrast and brightness controls should be adjusted to the minimum contrast that yields text that can be read comfortably. The screen brightness may be adjusted to approximately match other sources of visual information, such as documents. In addition, under conditions of high illumination, the screen brightness should be increased, and of low illumination, decreased.

A.6.3.2 Placement

A.6.3.2.1 Screen height

The height of the screen shall enable the user to assume the reference posture while viewing the active area of the screen. The top of the active area of the screen shall be no higher than the user's horizontal eye height (see Figure A.9) when seated in an upright posture.

For those who wear corrective lenses with multiple foci, the active viewing area of the monitor shall be positioned to enable the user to assume the reference posture.

Note: This can be accomplished by

- a) adjusting the height of the monitor itself; or

b) repositioning the active area viewed on the screen.

A.6.3.2.2 Viewing angle

The entire visual area of the visual display, including items other than the display such as the keyboard, should be located between 0° (horizontal eye level) and 60° below eye level when the user assumes the reference working postures described in Clauses A.1.2 and A.1.3.

A.6.3.2.3 Horizontal placement of visual display

A single monitor shall be located directly in front of the user so there is no twisting of the head/neck and/or torso.

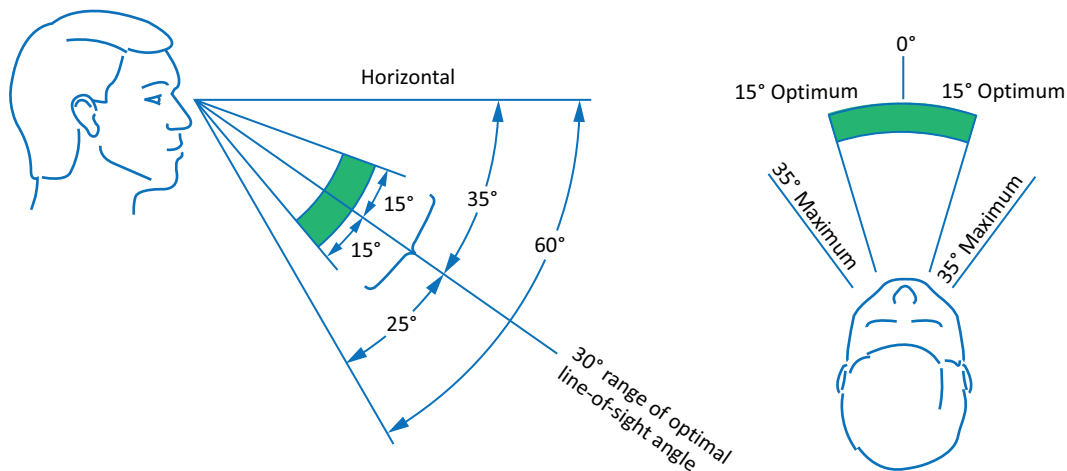
Where two monitors are used and one is used more frequently than the other, the primary monitor shall be located directly in front of the user.

Where two monitors are used equally, both monitors shall be positioned side by side, touching each other, and the point where they meet shall be directly in front of the user.

Where more than two monitors are used, a person competent in ergonomics should be consulted.

All information viewed on single screens (including those of large monitors), or dual screens when viewed equally, shall be within 35° to either side of the midline (see Figure A.9).

Figure A.9
Line of sight angles
(See Clauses A.3.3.5, A.6.3.2.1, and A.6.3.2.3.)



A.6.3.2.4 Viewing distance

For users with normal visual capabilities, the display shall allow users to adjust the viewing distance between their eyes and the visual display within the range of 50 to 100 cm (19.7 to 39.4 in).

Note: Software can allow the user to change the size of screen images (e.g., font size). This can affect the distance required for users to maintain neutral postures when viewing the monitor. (Larger images will require greater distance, while smaller images will require less distance.) This distance will likely also be affected by the user's visual capabilities (Bartha et al., 2015).

A.6.4 Layout and use of fixed-location touch screens

A competent person shall determine if and how it is appropriate to use a fixed-location touch screen for work tasks. Fixed-location touch screens shall be used only for short durations.

An external keyboard should be used with a touch screen to reduce non-neutral wrist postures while the touch screen remains within the range of comfortable tapping operations.

Users of touch-screen keyboards should take more frequent rest breaks to prevent the development of neck and visual fatigue.

Note: *Use of a touch screen in a preferred position for display tapping can lead to greater neck discomfort due to a low display height. In addition, touch-screen users can experience greater or more rapid development of visual fatigue due to a viewing distance that is shorter than the typically recommended minimum viewing distance for a regular display. In situations where a touch screen is used as an input device and is positioned at a standard monitor height, the user might experience discomfort due to shoulder flexion during use.*

A.6.5 Storage of items and materials

Storage shall be placed in such a way that it

- a) does not encroach on the clearance envelope for legs/feet under the work surface (see Clause A.3.3.2); and
- b) does not interfere with the height adjustability of work surfaces.

A.6.6 Layout and use of task lighting

If a task light is in use, it shall be positioned so that it does not cause direct or indirect glare, or result in inappropriate contrast ratios.

Note: *For additional requirements on lighting, see Clause A.10.2.*

A.6.7 Layout and use of documents

When the work task is primarily data entry from documents, the documents shall be positioned so users can view the information while maintaining neutral head and neck postures.

A.7 Mobile technology

A.7.1 General

Mobile technology use shall be for very limited durations before a change in posture. With the exception of vehicles, external equipment shall be used with the mobile technology where longer durations of work will be required.

Note: *The best way to avoid potential hazards is to limit the duration of work time spent on mobile technology and to take rest breaks. If this is not possible, other measures to position the equipment more appropriately can include a docking station possibly with a separate monitor or a separate keyboard and mouse used in conjunction with a mobile device.*

A.7.2 Mobile phones and tablets

For users of a mobile phone or tablet, holding a static posture while viewing or inputting shall be limited to short durations. In the case of tablets, static postures shall be limited to 10 min or less (Chau and Wells, 2015).

The following measures should be considered:

- a) using hands-free devices during long phone calls;
- b) using a neutral grip when holding the device (i.e., wrists as straight as possible);

- c) alternating between using thumbs and other fingers to type. Whenever possible, the fingers should be used to type instead of the thumbs (this can be arranged by placing the mobile phone/tablet down on a hard surface if texting, or holding the device in one hand and texting with the other as opposed to using one hand only). If using the thumbs to type, the pad of the thumb should be used as opposed to the tip of the thumb, as using the tip can create an awkwardly bent position for the thumb;
- d) reducing keystrokes by keeping text entries short and using abbreviations, text shortcuts, and predictive text;
- e) maintaining a neutral upright spinal posture when using the device;
- f) alternating hands when holding the device;
- g) providing an external keyboard for typing, especially for tasks requiring extensive inputting; and
- h) using a stylus.

A.7.3 Laptop computers

With the exception of vehicles, where laptops are used for extended durations, the user shall be provided with one of the following:

- a) a docking station with an external monitor, keyboard, and non-keyboard input device (e.g., mouse);
or
- b) an external keyboard and non-keyboard input device, with the laptop screen used as the monitor and positioned accordingly.

A.8 Office equipment

A.8.1 General

The placement of office equipment that is used in workspaces shall be based on the anthropometric characteristics of the intended user population. The user interface and software shall be compatible with the other electronic equipment used in the workplace.

A.8.2 Location of equipment

Where equipment such as photocopiers, printers, scanners, or fax machines are used exclusively by an individual, it shall be placed at a distance and height suitable to its importance and frequency of use. When the use is not frequent, consideration should be given to placing the equipment at some distance from the user's seated or standing location to encourage occasional postural change (see Clause [A.6.1](#)).

Where equipment is to be used by several individuals, the following shall be considered:

- a) placement away from single-user workstations due to the noise generated and the traffic flow around the device;
- b) sufficient space for access to paper trays and drawers;
- c) location of stored paper (ideally, paper should be stored close to the device and at storage heights that minimize bending or reaching overhead);
- d) sufficient space for routine maintenance; and
- e) ventilation.

Where a photocopier is located in a workroom, consideration shall be given to appropriate airflow. Ventilation for the extraction of heat, particulate matter, and volatile organic compounds generated by the photocopier shall be provided.

A.8.3 Telephones

Where telephone use is extensive and simultaneous with keyboarding or writing, the telephone shall be equipped with a headset. The selection of the specific headset shall be done with input from the user.

For frequent use, the telephone should be located on the side corresponding to the preferred hand to pick up and hold the telephone and within the primary reach zone (see Figure A.8). For frequent outbound/outgoing calls (versus inbound/incoming calls), it can be preferable to locate the telephone on the same side as the dominant hand, so that this hand can comfortably operate the numeric and function buttons.

The use of the various functions on the telephone, such as redial and the storage of commonly used numbers, may be used to improve efficiency and minimize time on the telephone.

A.8.4 Hand-held office equipment

Repeated or prolonged use of hand-held office equipment such as staplers, staple removers, hole punches, and pens shall be minimized.

A.9 Home-based offices and vehicles

A.9.1 Home-based offices

Clauses A.1 and A.2 shall apply to home-based offices.

A.9.2 Vehicles

A competent person shall be consulted for the use of the workspace in vehicles.

A.10 Environmental conditions

A.10.1 General

A.10.1.1 User comfort and performance

Clause A.10 shall be used to determine the appropriate environmental conditions in an office to enhance user comfort and performance.

A.10.1.2 Environmental factors

The following environmental factors shall be considered:

- a) daylighting and electric lighting;
- b) sound and noise;
- c) indoor air quality; and
- d) thermal environment.

A.10.1.3 Space organization and workplace layout

The influence of the space organization and workplace layout of an office shall be considered in determining appropriate environmental conditions. These considerations should be raised in the office design process.

A.10.1.4 Integrated solutions

Integrated solutions and possible interactions shall be considered in addressing workplace environmental problems to ensure that adjusting one parameter does not adversely affect another.

Environmental conditions should be dealt with simultaneously, so as to develop an integrated solution with acceptable trade-offs among different aspects. The environmental design shall be viewed from a systems approach perspective, along with other aspects of design, to achieve the objective of an ergonomically designed office.

Note: *Sound and noise performance depends on the appropriate zoning of potential noise sources, whether they are people, office and building systems, or equipment. Similarly, daylight and electric lighting performance depends, among other things, on how workstations and computers can be arranged to eliminate the possibility of glare.*

A.10.1.5 Individual control

Where possible, environmental design, whether early on in the design process or following investigation into environmental problems, should give individuals adequate control over their environmental conditions.

A.10.1.6 Assessing specific needs

Due to the technical nature of this area, a competent person should assess specific needs and assist with design or redesign recommendations pertaining to

- a) daylighting and electric lighting;
- b) sound and noise;
- c) indoor air quality; and
- d) thermal environment.

A.10.2 Lighting

A.10.2.1 General

The visual environmental considerations within an office shall include

- a) examining windows and the amount of light they let in;
- b) examining the characteristics of the electric lighting;
- c) examining the colours and finishes used on walls, ceiling, and other surfaces;
- d) ensuring that sufficient light (or illuminance) is coming from the right direction, without causing obscuring shadows;
- e) providing good, but not excessive, contrast between the visual task and its background;
- f) limiting glare and extreme contrasts in brightness that cause visual discomfort; and
- g) providing the right type of light for colour rendering and modelling (the three-dimensional appearance of objects).

The design of lighting systems should fulfill various user needs and have sufficient flexibility to answer the needs of those who view monitors, those who view paper media, and those who view a combination of the two.

Notes:

- 1) *Correct lighting will not compensate for situations where a user's vision is not adequate or has not been adequately corrected for the task. Some computer users are surprised to learn, when they begin working on a computer, that they require corrective lenses. When the reading distance to a computer differs from that to written text on a desk, there is sometimes a need for corrective lenses, or a corrective lens specific to computer tasks. Regular vision testing for computer users is important.*
- 2) *For further guidance on lighting, consult the IESNA Lighting Handbook.*

A.10.2.2 Basic lighting design objectives

A.10.2.2.1 General

The basic design objectives for lighting should include

- a) making it easy to see what needs to be seen;
- b) maintaining an appropriate level of user performance;
- c) making a pleasant work environment;
- d) guaranteeing maximum safety; and
- e) providing acceptable visual comfort.

Selection of a type of light fixture (direct, direct-indirect, or indirect — see Figure A.12) shall be in accordance with the design objectives above.

Note: *The lighting of most work environments is produced by a combination of daylighting and electrical light. Windows perform a dual function: they provide visual contact with the outside environment, and they help create an agreeable level of luminance or brightness on the inside.*

A.10.2.2.2 Daylight and electric light integration

The effects of uncontrolled daylight on lighting design objectives shall be considered.

Considerations for the integration of electric light and daylight should include

- a) lamp and luminaire selections;
- b) window treatments;
- c) room surface reflectance; and
- d) local controls that allow users to fine-tune the system to their own needs.

The lighting system should be flexible and take into account expected changes in workstation layout and equipment, and individual user needs.

A.10.2.3 Illuminance

Adequate lighting shall be provided to perform the work tasks. The following factors shall be taken into account:

- a) physical factors affecting visual performance, including
 - i) the visual task;
 - ii) the background;
 - iii) the visual field in which the task lies;
 - iv) the nature of the task; and
 - v) the difficulty of the task; and
- b) individual factors, including
 - i) age of users;
 - ii) individual vision needs of users; and
 - iii) type, speed, and accuracy requirements of the task.

The IESNA *Lighting Handbook* should be followed for lighting requirements based on the tasks being performed.

Table A.5 includes typical illuminance based on type of activity.

Table A.5
Typical Illuminance based on type of activity
(See Clause A.10.2.3.)

| Intensity — Type of activity | Range, lx |
|---|------------------|
| Simple orientation for short temporary visits | 50-100* |
| Working spaces where visual tasks are performed only occasionally | 100-200* |
| Performance of computer tasks Note: <i>Range is based on screen type and polarity.</i> | 75-300 |
| Performance of visual tasks of high contrast or large size (e.g., reading printed materials of good quality) | 200-500† |
| Performance of visual tasks of medium contrast or small size (e.g., reading medium-pencil handwriting, and poorly printed or reproduced material) | 500-1000† |
| Performance of visual tasks of low contrast or very small size (e.g., reading handwriting in hard pencil on poor quality paper and very poorly reproduced material) | 1000-2000† |

* General lighting throughout room.

† Illumination on task.

Notes:

- 1) All values except for "Performance of computer tasks" come from Eastman Kodak Company, 1983.
- 2) Values for "Performance of computer tasks" come from the IESNA Lighting Handbook.

A.10.2.4 Luminance distribution and balance (contrast)

A.10.2.4.1 General

Particular attention shall be paid to luminance balance at workstations with computers, especially if computers have negative contrast displays (i.e., the characters are darker than the background).

A.10.2.4.2 Sources of luminance differences

The following potential sources of differences in luminance should be considered:

- a) luminaires and ceiling;
- b) ceiling and walls with windows (either due to daylight or due to a black window after dark);
- c) monitor and furnishings or finishes;
- d) monitor and wall; and
- e) monitor and window.

A.10.2.4.3 Measuring luminance differences

Luminance differences shall be measured in terms of the ratio between one luminance and another. In an office environment, luminances near each task and in other parts of the office interior within the field of view should be balanced against the task luminance. Recommended luminance ratios should not exceed the following (with the exception of small visual areas of interest):

- a) 3 to 1 between paper task and adjacent dark computer screen;
- b) 1 to 3 between paper task and adjacent light computer screen;
- c) 3 to 1 between task and adjacent dark surroundings;
- d) 1 to 3 between task and adjacent light surroundings;

- e) 10 to 1 between task and more remote dark surfaces; and
- f) 1 to 10 between task and more remote light surfaces.

Small areas of visual interest that exceed the recommended values may be provided to give the eye something on which to focus at a distance and relax the eye muscle. These areas can include but are not limited to small windows of moderate luminance, accent finishes on the principal surfaces and furniture, and illuminated art pieces.

Note: Luminance differences can be measured using a light meter.

A.10.2.5 Glare

A.10.2.5.1 General

Glare occurs when there is a large difference in luminance between an object and its background. Glare shall be avoided in the design of the work environment and the design and installation of work equipment. Clauses A.10.2.5.2 to A.10.2.5.8 shall apply to methods for controlling the various types of glare. These methods shall consider differences in

- a) work surfaces;
- b) equipment; and
- c) lighting environment.

The methods selected for glare control shall not impose any postural restrictions on the user.

Note: Typical sources of glare are bright sunlight, luminaires in the field of view, and shiny surfaces.

A distinction is made between direct glare and indirect glare or glare by reflection. Direct glare refers to glare from luminaires and other light-emitting surfaces (lamps, illuminated ceilings, sky, and obstructions such as adjacent buildings with reflecting glass surfaces). Glare by reflection can be due to the lighting or can be on working surfaces and work equipment such as monitors, printed documents, keyboards, etc.

A.10.2.5.2 Glare due to daylight

Direct glare due to daylight is typically caused by a direct view of the sun or clouds and by their reflections on adjacent buildings through windows or skylights.

Engineered controls can be most effective in controlling direct glare due to daylight and should be considered in the design of the space. These can include.

- a) low-transmittance tinted glass to reduce sky luminance;
- b) reduction of the contrast between the window and its surroundings (such as painting the window wall a light colour); and
- c) partial walls or partitions.

Note: The introduction of screening between workstations might reduce daylight glare, but it will also reduce the availability of daylight.

A.10.2.5.3 Movable devices

Where engineered controls are not appropriate or available, movable devices should allow for user control and, where possible, maintain the user's visual contact with the outside. These devices may include window treatments such as

- a) curtains;
- b) roller blinds;
- c) venetian blinds; and

d) awnings.

A.10.2.5.4 Window treatment considerations

Where window treatments are used, the material should be chosen with care in order to avoid further issues with brightness when the material is illuminated by bright sun. Window treatments used to limit glare should not influence the perception of colours within the workstation or the visual appearance of the outside world.

Note: *Some movable devices can cause more glare than the brightest lamps used for office work (e.g., the luminance of curtains or of other vertically aligned devices under direct exposure to sun). Partially open venetian blinds can be particularly troublesome, since they produce light and dark stripes.*

A.10.2.5.5 Luminaires and direct glare

Direct glare due to electric lighting, which can be caused by luminaires or by illuminated room surfaces with high luminance, shall be controlled. Where possible, luminaire selection and positioning shall be considered at the design stage in order to control glare.

A.10.2.5.6 Additional measures for restricting glare

Additional measures should be considered to restrict glare due to electric lighting, where required. These may include, but are not limited to,

- a) shielding the glare source by installing movable partitions;
- b) removing or disabling light fixtures; and
- c) repositioning display and workstation.

Equipment features such as glare guarding or hoods, or methods such as shielding the light source by movable partitions should be used only if other measures are not applicable.

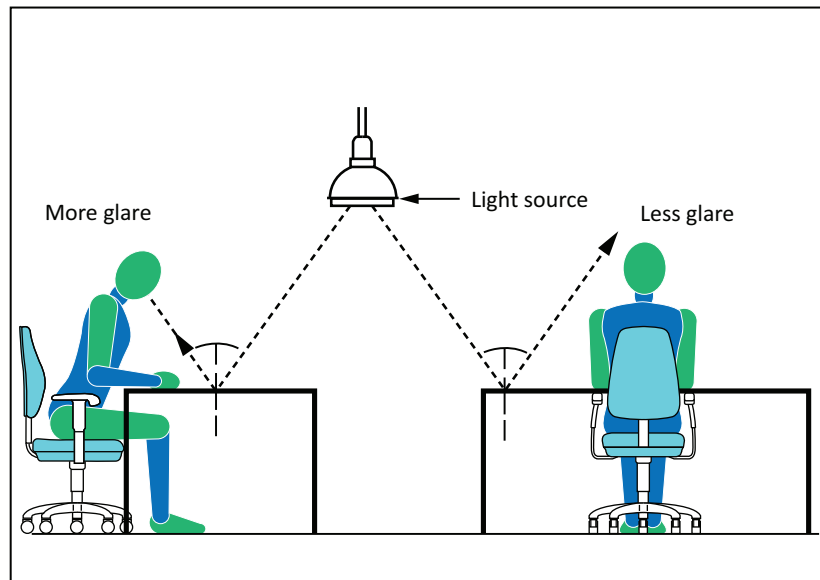
Note: *Removing or disabling light fixtures might require the addition of task lighting.*

A.10.2.5.7 Glare due to reflection

Glare due to reflections that can be caused by luminaires, by illuminated room surfaces with high luminance, or by daylight shall be controlled.

Where possible luminaire selection and positioning shall be considered at the design stage in order to control indirect glare due to reflection. See Figure A.10 for the optimal relative position of luminaire and workstation to reduce reflected glare.

Figure A.10
Reflected glare
(See Clauses A.2.5, A.3.3.8.2, and A.10.2.5.7.)



A.10.2.5.8 Glare from horizontal surfaces

Glare reflected from horizontal surfaces should be avoided by

- using indirect lighting or a combination of direct and indirect lighting; and
- ensuring uniform luminance distribution on the reflecting surfaces, such that there are no bright spots or light patterns that disturb the user.

The finish of desk surfaces and the surfaces of work equipment, including documents, should be kept matte, where possible. Figures A.11 and A.12 illustrate various types of direct and indirect light, and show an acceptable workstation arrangement that minimizes unwanted glare.

Note: Glare by reflection can be caused by specular reflections on curved surface elements of equipment (e.g., keycaps) or by equipment with more than one reflecting surface element (e.g., control panels containing various visual displays). In such cases, a combination of measures might be needed to avoid reflected glare.

Figure A.11
Light sources
(See Clauses [A.3.3.8.2](#) and [A.10.2.5.8](#).)

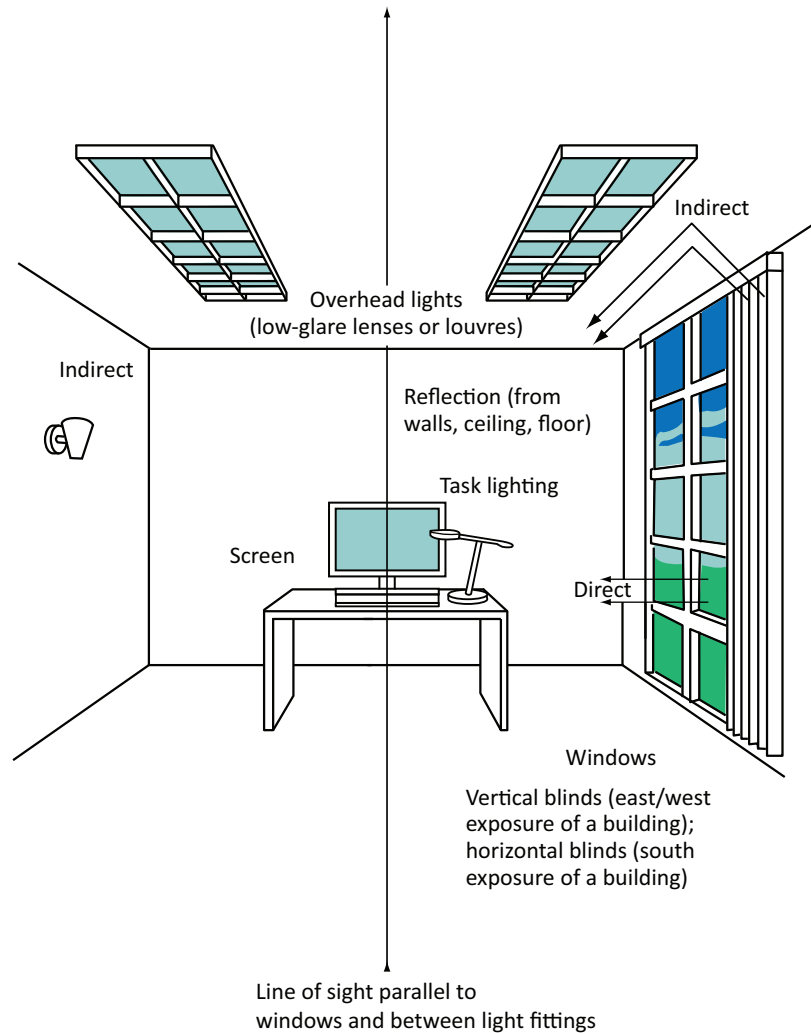
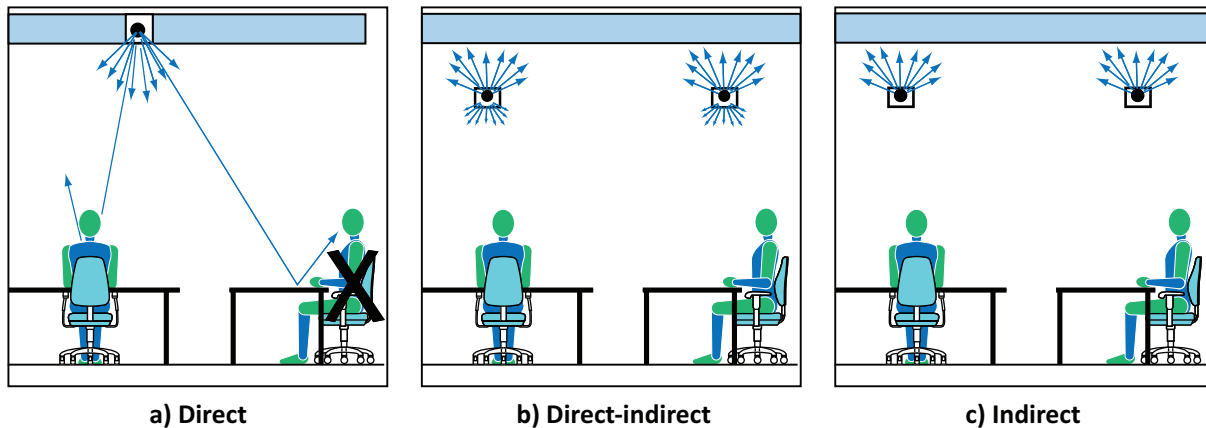


Figure A.12
Luminaire types
(See Clauses A.3.3.8.2, A.10.2.2.1, and A.10.2.5.8.)



A.10.2.6 Colour discrimination

When colour discrimination is critical to a task, equipment and materials shall facilitate colour recognition as required for the task.

Note: *Colour rendering refers to the appearance of colours when seen under the light from a particular source, as specified by the colour rendering index (CRI). For most offices, a lamp with a minimum CRI of 75 is appropriate. When colour discrimination is an important part of the work (e.g., colour matching in an advertising agency), a source with a CRI of 90 or higher should be used. Reference should be made to manufacturer's specifications for correlated colour temperature (CCT) and CRI values.*

A.10.2.7 Emergency lighting

Local jurisdictional requirements shall be followed for emergency lighting.

A.10.2.8 Light exposure and circadian rhythms

A.10.2.8.1 Blue-enriched light

Lighting should contribute to the optimization of circadian rhythms and minimization of sleep restriction.

Notes:

- 1) *Daytime light exposure — Photoreceptors in the eye are sensitive to colour wave lengths. Short wave lengths (blue light) affect circadian rhythms the most. Artificially blue-enriched lights such as compact fluorescent light (CFL) and light-emitting diodes (LED) can strengthen circadian timing, enhance human performance and learning, and improve psychological health when exposure occurs during daytime hours in an indoor environment. Blue-enriched light provides better accommodation for older users who need significantly more bright light exposure during the day to synchronize their circadian rhythms.*
- 2) *Evening and nighttime light exposure — When used during darker hours, blue-enriched lights delay circadian rhythms and reduce the production of melatonin, the body's natural sleep hormone. Blue light has been linked to sleep disturbances, cardiovascular disorders, some cancers, and mental health issues including certain dementias and Alzheimer's disease. Long wavelength light (red light) is least likely to disrupt circadian rhythms at night. However, red light is not always practical given the type of visual tasks that might be performed. Nor does it accommodate older users, who require brighter lights to see their task. In such instances, white light with no blue enhancement is preferred to minimize negative circadian impact.*

A.10.2.8.2 Blue-enriched artificial light at nighttime

Where possible, blue-enriched artificial light should be avoided during nighttime use. Where it is not possible to avoid blue-enriched artificial light at nighttime, consideration should be given to installing dimmer switches and providing users with blue-blocking glasses that have an orange tint in order to reduce desynchronization of the circadian rhythms.

A.10.2.8.3 Backlit electronic devices

Backlit electronic devices such as laptops, tablets, monitors, and mobile phones utilize blue-enriched light. Due to the proximity of these devices to the eyes, they have a more significant impact on the reduction of melatonin production if they are used during evening and nighttime hours.

The settings of these devices should be adjusted to automatically turn down the blue light spectrum during these hours. If the device does not offer such settings, then software applications that incorporate blue-blocking by adjusting to the time of day and height of the sun should be implemented to minimize circadian disruption.

A.10.3 Acoustics

A.10.3.1 Acoustical design

The acoustical design of a workspace shall support the tasks performed and reduce the risk to the users in an office environment by providing

- a) appropriate levels of speech intelligibility, speech privacy, and freedom from distraction;
- b) minimal dynamic range;
- c) comfortable background, average, and peak sound levels;
- d) reverberation control; and
- e) acoustical consistency from one location to another.

Notes:

- 1) *Numerous studies have shown that noise is one of the most commonly cited and significant impediments to employee satisfaction and productivity, even when it is below the level of sound-related hearing loss concerns.*
- 2) *Possible risks include affecting psychological well-being and cardiovascular health while working in a noisy environment.*

A.10.3.2 Acoustical control

Acoustical control shall be achieved using a balanced application of

- a) noise source reduction or elimination;
- b) physical barriers;
- c) sound absorption; and
- d) sound masking.

A.10.3.3 Noise intrusions

Possible noise intrusions to consider should include

- a) external noise — caused by transit systems (automobile, aircraft, and rail traffic), construction, and other exterior sources of sound;
- b) building system noise — caused by heating and air-conditioning systems, electrical systems, plumbing, elevators, and other building support and operational equipment;
- c) office equipment noise — caused by telephones, printers, copiers, and other office equipment; and
- d) occupant noise — caused by the conversations, activities, and movements of office occupants.

Speech privacy and noise intrusion is the number one complaint in most open plan offices.

A.10.3.4 Speech intelligibility

Speech intelligibility in partitioned open offices shall be managed with the intent of reducing audible distraction for focus and productivity and optimizing speech privacy.

A.10.3.5 Raised-voice industrial or multimedia presentation rooms

Project teams should seek the advice of a competent person for secure raised-voice industrial or multimedia presentation rooms.

Note: *Secure raised-voice industrial or multimedia presentation rooms are used for activities that produce higher than normal noise levels and/or that require secure, and possibly regulated, levels of speech privacy. While the elements of the acoustical design will be similar to those listed in Clause B.3, the specifications required will differ and depend on the exact nature of the room and activities.*

A.10.3.6 Corridors and circulation areas

A corridor or similar circulation area shall provide privacy for activities occurring inside adjoining closed rooms and mitigate the travel of noise along the corridor and between spaces connected by it. Footfall noise shall be addressed and controlled in the acoustical design of these high-traffic areas.

A.10.3.7 Reception waiting areas

Reception and waiting areas shall provide an appropriate level of speech privacy with respect to overhearing reception activities. Footfall noise and transmission of sound into adjoining spaces shall be addressed and controlled when designing acoustic environments in these typically high-activity areas.

A.10.3.8 Design recommendations

Annex B provides design recommendations to achieve the performance intent pertaining to specific areas of the office workspace. In the absence of a project-specific consultation on acoustics, Annex B should be followed for recommendations on

- a) typical closed rooms/offices (Clause B.3);
- b) remote-conference and large meeting/training rooms (Clause B.4);
- c) open offices — partitioned (Clause B.5);
- d) open offices — unpartitioned (Clause B.6);
- e) corridors and circulation areas (Clause B.7); and
- f) reception and waiting areas (Clause B.8).

A.10.3.9 Alternative designs

Alternative designs meeting the performance intent of Clause A.10.3.8 may be adopted following project-specific consultation with a competent person.

A.10.3.10 Sound masking

A.10.3.10.1

A sound masking system should be provided in all occupant spaces to achieve desired background sound levels. Sound masking may be excluded only where it would otherwise compromise the acoustic design in such a way that the design would no longer support the tasks of the occupants, as required by this Standard. A competent person shall be consulted regarding the design and commissioning of sound masking systems. See Table A.6.

Note: *Sound masking is the process of adding a low-level, unobtrusive background sound to an environment to reduce the intelligibility of human speech and reduce noise distractions in that environment. The sound is typically introduced through speakers installed in or above the ceiling.*

Table A.6
Sound masking spectrum
(See Clause [A.10.3.10.1](#) and Tables [B.1](#) to [B.6](#).)

| Frequency (Hz) | Level (dB) |
|----------------|------------|
| 100 | 46.9 |
| 125 | 45.9 |
| 160 | 44.7 |
| 200 | 43.9 |
| 250 | 42.7 |
| 315 | 41.4 |
| 400 | 40.4 |
| 500 | 38.9 |
| 630 | 37.4 |
| 800 | 35.4 |
| 1,000 | 33.7 |
| 1,250 | 31.4 |
| 1,600 | 29.4 |
| 2,000 | 27.4 |
| 2,500 | 24.9 |
| 3,150 | 22.4 |
| 4,000 | 19.4 |
| 5,000 | 16.4 |

Note: The levels in this Table are for an overall level of 45 dBA and are derived from the optimum masking spectrum of the National Research Council of Canada. To adjust for varying levels, add or subtract a quantity from each one-third octave level equivalent to the difference in overall level (e.g., for 48 dBA, add 3 dB to each band level).

A.10.3.10.2

Where provided in accordance with Clause [A.10.3.2](#), the sound masking in each control zone shall be measured

- a) in the unoccupied but occupancy-ready facility;
- b) using a contemporaneously calibrated ANSI Type I analyzer;
- c) with the analyzer set to an A-weighted equivalent average level (Leq);
- d) for a minimum 15-s period;
- e) at a height of 1.2 to 1.4 m above the floor;
- f) at least 1 m away from any vertical or horizontal surface, where possible; and
- g) while continuously moving the analyzer through a horizontal arc of at least 60 cm.

A.10.3.10.3

Where provided in accordance with Clause A.10.3.2, sound masking shall include commissioning and reporting. Written system documentation shall include

- a) system design drawings;
- b) identification of test equipment, procedures, and locations;
- c) results for each masking control zone, including a graph and table of overall and third-octave levels compared to specified targets; and
- d) an explanation for deviations exceeding specified tolerances, including measurements of any existing noises that interfere with meeting specified targets.

A.10.4 Vibration

A.10.4.1 Vibration effects

User exposure to vibration shall be minimized to avoid negative impacts to well-being, health and safety, and performance.

Vibrations present in an office environment can originate from outside (e.g., nearby industrial activities or traffic), or from inside the office itself (e.g., HVAC systems, elevators, electronic devices, and nearby walking traffic). Depending upon the intensity of the vibration, the transmission to a user's body through the feet, buttocks, hands, or head can be perceived as a nuisance and can have negative impacts on health and safety. Vibration exposure can also affect performance by impairing the perception of information on displays, and can affect speed and accuracy in the use of controls such as keyboards.

A.10.4.2 Reduction of vibration effects

A method, or a combination of methods, to control exposure to vibration along transmission paths should be used. Such methods include

- a) eliminating or reducing mechanical vibrations at the source;
- b) where elimination or reduction is not possible, using measures to reduce vibration employed along the transmission paths;
- c) selecting low-vibration-producing equipment, implementing vibration dampening, or selecting vibration-reducing work processes, where possible;
- d) isolating workstations or entire working areas from the sources of vibration excitation; and
- e) scheduling work to minimize potential exposure to vibration (e.g., by avoiding times when there is exposure to vibration from the outside).

Note: For information on vibration reduction, see ISO 2017-1. Measurements for assessing whole-body vibration should be in accordance with ISO 2631-1.

A.10.5 Thermal environment

A.10.5.1 General

Thermal conditions at the workstation directly influence the comfort and performance of users. Clause A.10.5 shall be reviewed to identify the relevant thermal parameters and to determine the changes required to provide an acceptable thermal environment that prevents possible adverse effects to comfort and health.

Conditions shall be such that a building occupant will not feel

- a) uncomfortably warm or cold;
- b) irritation of mucous membranes (eyes, sinuses, respiratory tract) or skin due to dryness;

- c) excessive humidity; and
- d) drafts.

ASHRAE 55 shall be consulted, along with a qualified professional and users in the area, in the determination of design and operation criteria for the optimal thermal comfort of building occupants.

Note: *The relevant parameters affecting users are*

- a) *personal parameters, including*
 - i) *thermal insulation of clothing; and*
 - ii) *activity level; and*
- b) *suboptimal temperature and relative humidity, including*
 - i) *air temperature too high/too low;*
 - ii) *excess solar loading;*
 - iii) *wind infiltration through building envelope;*
 - iv) *unbalanced air distribution;*
 - v) *air velocity too high/too low; and*
 - vi) *humidity.*

A.10.5.2 Optimizing thermal comfort

The following factors should be considered to optimize thermal comfort:

- a) seasonal temperature and clothing differences;
- b) occupational activities level;
- c) building layout;
- d) thermal control options including individual options for control; and
- e) individual preferences, where practicable.

See Table A.7.

Table A.7
Range of optimal temperatures
(See Clause A.10.5.2.)

| Ranges of optimal temperatures* | Winter conditions | Summer conditions |
|---------------------------------|-------------------|-------------------|
| Optimum temperature | 22 °C | 24.5 °C |
| Acceptable range | 20–23.5 °C | 23–26 °C |

* From Table 3 of ASHRAE 55, at 50% relative humidity and mean air speed of < 0.15 m/s.

A.10.6 Indoor air quality (IAQ)

A.10.6.1 General

The organization shall maintain indoor air quality such that user health is maintained and performance optimized.

Indoor environmental conditions in the workplace are a function of the interactions among the site, the building systems, contaminant sources inside and outside of the building, and the activities of the occupants. As such, the following IAQ variables shall be considered in the design and operation of buildings and use of occupant spaces:

- a) fresh air inputs;
- b) stale air exhausts;
- c) air distribution rates;

- d) number of contaminant sources;
- e) exhaust ventilation; and
- f) policies addressing personal use items.

The organization shall have a process to receive complaints or concerns with indoor air quality and shall engage a competent person to assess complex air quality issues.

A.10.6.2 Control of IAQ issues

The organization shall implement one or a combination of the following methods to adequately control IAQ issues:

- a) controlling at the source by
 - i) selecting materials that will not contribute to IAQ problems; and
 - ii) isolating activities that contribute to poor IAQ (e.g., photocopiers);
- b) controlling along the path by increasing ventilation and air exchange; and
- c) ensuring regular and appropriate maintenance of ventilation systems.

Notes:

- 1) *Different jurisdictions can have legislative requirements for indoor air quality in the workplace, which must be fulfilled.*
- 2) *Off-gassing of furniture can affect indoor air quality.*

A.11 Manual materials handling

A.11.1 General

Manual materials handling (MMH) can include a number of types of movements, including lifting, lowering, carrying, pushing, and pulling. These are not the primary function of most office users; however, some MMH can be required (e.g., moving boxes of paper, mailroom work, handling water containers, carrying supplies to and from vehicles).

The application of evidence-based tools, methods, checklists, and standards shall be used to effectively design MMH tasks, eliminate hazards or control risks, enhance human health and well-being, and optimize system performance.

These shall be employed in conjunction with data, which shall be collected through consultation with user groups or operators of similar systems where necessary.

Notes:

- 1) *Some evidence-based tools are provided in this Annex; however, this Annex is not intended to be exhaustive and other tools demonstrated to be equally effective may also be used where applicable.*
- 2) *Injuries due to MMH can occur as a result of a single heavy exertion or through lower-force exertions done repetitively.*

A.11.2 Lifting and lowering

A.11.2.1 General

A.11.2.1.1

Where lifting and lowering tasks take place, the risk of injury shall be assessed and minimized at all stages, including the design or redesign of the workspace.

A.11.2.1.2

The following aspects of lifting and lowering shall be considered when assessing if the task poses a risk of injury:

- a) weight of the load;
- b) horizontal distance for grasping the load (forward reach to load should not exceed 500 mm);
- c) vertical distance of the lift (heights when grasping or putting down the load);
- d) shape, size, awkwardness, and stability of the load;
- e) frequency of lifting;
- f) grip or coupling;
- g) duration of lifting;
- h) asymmetric lifting (lifting one-handed or with twisting of the spine);
- i) workplace geometry (such as congested areas, limited headroom, etc.);
- j) temperature; and
- k) individual variables such as strength, age, gender, physical training/fitness, and previous injury.

A.11.2.1.3

The following aspects shall be considered when designing lifting and lowering tasks:

- a) knowing the weight of the load;
- b) removal of all obstacles between the user and the object being lifted and lowered;
- c) ensuring lifting and lowering occurs between knee height and shoulders;
- d) placing the largest and heaviest items on shelves near waist height;
- e) placing smaller, lighter supplies on very low or very high shelves if there is no space to do so at shelves near waist height;
- f) providing a safe means to access items placed above shoulder height, such as an appropriate stepstool;
- g) safely lifting or lowering larger or bulkier loads by
 - i) reducing in size in order to get the load closer to the body;
 - ii) using aids such as carts or hand trucks; or
 - iii) using two or more people to perform the lift or lower;
- h) providing accessible handles that
 - i) allow for good grip (i.e., are not too slippery);
 - ii) have a round/oval shape where possible (to avoid sharp edges); and
 - iii) have a minimum diameter of 1.9 cm for objects weighing more than 9 kg;
- i) designing work spaces, including storage spaces, to provide room for users to turn their whole body or take a step, rather than to twist at the waist;
- j) providing enough space in front of filing cabinets or any other equipment that involves loading or unloading (e.g., a photocopier) to enable users to have the space to safely access a fully opened bottom drawer;
- k) arranging delivery schedules to allow for paced, less frequent, lifting tasks in one shift;
- l) planning and designing work processes to reduce movement of materials to a minimum;
- m) maximizing quantity, weight, and size of material wherever this would lend itself to economic transport by machines, if available (e.g., for recycling or garbage); and
- n) providing lighter weight mobile IT equipment (e.g., laptops) for field staff.

A.11.2.2 Determining recommended lifting weights

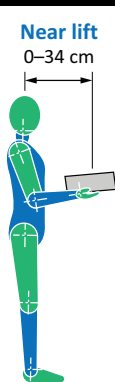
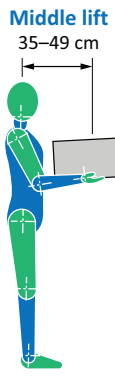
Lifting and lowering risk assessments may be performed using the tools in Tables A.8 and A.9.

For more complicated lifts, a competent person who is knowledgeable in ergonomics shall be consulted.

Notes:

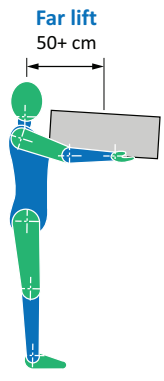
- 1) *Users of this Standard might also want to consult the revised NIOSH lifting equation (1993).*
- 2) *Tables A.8 and A.9 a) to g) provide recommended weights for simple lifting of two-handed, symmetrical load lifts, which safely accommodates 90% of the industrial population.*
- 3) *Table A.9 a) to g) provides “multipliers”, which are correction factors used to adjust the recommended limit of the weight when variables such as asymmetry, heat stress, lack of headroom, etc., are making the lift more difficult or less safe. Table A.9 h) provides recommended weight limits for one-handed horizontal lifting.*
- 4) *The Tables are used as follows:*
 - a) *Choose the correct table:*
 - i) *if the task is performed while using both hands, use Table A.8 with the correction factors given in Table A.9 a) to g); and*
 - ii) *if the task is performed while using one hand, and involves a horizontal lift, use Table A.9 h). If the task is a vertical lift and it is performed while using one hand, the lift should not exceed 9 kg (standing) and 8 kg (sitting) for males, and 6 kg (standing or sitting) for females. These weights will be too high if the lift is frequent or the lift is far away.*
 - b) *Determine whether the distance of the load from the body is near, medium, or far, as follows:*
 - i) *near — hands are horizontally 34 cm or less from the shoulders at all times during the lift;*
 - ii) *medium — hands are horizontally 35 cm to 49 cm from the shoulders at all times during the lift; or*
 - iii) *far — hands are horizontally 50 cm or more from the shoulders at any time during the lift.*
 - c) *Determine the starting and ending height of the lift as follows:*
 - i) *floor to 80 cm (knuckle height);*
 - ii) *80 cm to 132 cm (knuckle to shoulder height); and*
 - iii) *132 cm to 183 cm (shoulder to overhead height).*
 - d) *Determine the user population. If the user population is male only, use the male data. If the user population is female or mixed, use the female data.*
 - e) *Determine how often the object is lifted/lowered: once every 4 s, 5 s, 7.5 s, 15 s, 1 min, or 30 min, or once in 8 h.*
 - f) *Using the information from Items a) to e), determine the recommended weight using Table A.8.*
 - g) *Determine if there are any additional factors that would affect the lift, and if so apply the correct multiplier from Table A.9 a) to g) as follows:*
 - i) *limited headroom multiplier (the user is working in a stooped posture);*
 - ii) *asymmetrical lifting multiplier (users must twist while lifting, without moving their feet);*
 - iii) *load asymmetry multiplier (load is unbalanced);*
 - iv) *heat stress multiplier (the user is working in a warm/hot environment);*
 - v) *coupling multiplier (the object being lifted does not have good handholds);*
 - vi) *load clearance multiplier (load must be moved into a small space, such as a shelf); and*
 - vii) *work duration multiplier.*
 - h) *Compare the final recommended weight, derived from Items a) to g), to the actual weight of the object being lifted. If the actual weight of the object being lifted is heavier than the recommended weight, then controls should be put in place.*

Table A.8
Recommended weight of lifts to safely accommodate 90% of
the industrial population (in kg)
 (See Clauses A.11.2.2 and A.11.2.3.)

| | Lifting height, cm | Gender | Lifting frequency | | | | | | | |
|--|--------------------|--------|-------------------|--------------|-------------|-----------|-----------|-----------|------------|------------|
| | | | 1 per 8 h | 1 per 30 min | 1 per 5 min | 1 per min | 4 per min | 8 per min | 12 per min | 15 per min |
|  <p>Near lift 0–34 cm</p> | 80 to 132 | Male | 22 | 20 | 18 | 17 | 14 | 7 | 6 | 5 |
| | | Female | 14 | 12 | 11 | 10 | 9 | 7 | 6.5 | 6.5 |
| | 80 to 183 | Male | 18 | 17 | 15 | 14 | 12 | 7 | 6 | 5 |
| | | Female | 12 | 10.5 | 10 | 9 | 8 | 6 | 6 | 6 |
| | 132 to 183 | Male | 20 | 18 | 17 | 16 | 13 | 7 | 6 | 5 |
| | | Female | 12 | 11 | 10 | 9 | 8 | 6 | 6 | 6 |
| | Floor to 80 | Male | 23 | 19 | 19 | 15 | 11 | 7 | 7 | 6.5 |
| | | Female | 15 | 11 | 10 | 9 | 9 | 8 | 7 | 6 |
| | Floor to 132 | Male | 22 | 18 | 18 | 14 | 11 | 6 | 6 | 5 |
| | | Female | 12.5 | 9 | 8 | 7.5 | 7.5 | 6.5 | 6 | 5 |
| | Floor to 183 | Male | 20 | 16 | 16 | 13 | 9 | 6 | 6 | 4 |
| | | Female | 11 | 8 | 7 | 7 | 7 | 6 | 5 | 4.5 |
|  <p>Middle lift 35–49 cm</p> | 80 to 132 | Male | 19 | 18 | 16 | 15 | 13 | 7 | 6 | 5 |
| | | Female | 13 | 11 | 10 | 9 | 8 | 6 | 6 | 5 |
| | 80 to 183 | Male | 16 | 15 | 13 | 12 | 11 | 7 | 6 | 5 |
| | | Female | 11 | 9.5 | 9 | 8 | 7 | 5 | 5 | 4.5 |
| | 132 to 183 | Male | 18 | 16 | 14 | 14 | 11 | 7 | 7 | 5 |
| | | Female | 10 | 9 | 8 | 7 | 7 | 5 | 4 | 3 |
| | Floor to 80 | Male | 20 | 17 | 16 | 13 | 10 | 7 | 7 | 6.5 |
| | | Female | 13 | 9 | 8 | 8 | 8 | 7 | 6 | 5 |
| | Floor to 132 | Male | 18 | 16 | 15 | 12.5 | 9 | 6 | 6 | 5 |
| | | Female | 11 | 7.5 | 6.5 | 6.5 | 6.5 | 6 | 5 | 4 |
| | Floor to 183 | Male | 17 | 15 | 14 | 11 | 9 | 6 | 6 | 4 |
| | | Female | 10 | 7 | 6 | 6 | 6 | 5.5 | 4.5 | 3.5 |

(Continued)

Table A.8 (Concluded)

| | Lifting height, cm | Lifting frequency | | | | | | | | |
|---|--------------------|-------------------|-----------|--------------|-------------|-----------|-----------|-----------|------------|------------|
| | | Gender | 1 per 8 h | 1 per 30 min | 1 per 5 min | 1 per min | 4 per min | 8 per min | 12 per min | 15 per min |
|  | 80 to 132 | Male | 19 | 18 | 16 | 15 | 13 | 7 | 6 | 5 |
| | | Female | 13 | 11 | 10 | 9 | 8 | 6 | 6 | 5 |
| | 80 to 183 | Male | 16 | 15 | 13 | 12 | 11 | 7 | 6 | 5 |
| | | Female | 11 | 9.5 | 9 | 8 | 7 | 5 | 5 | 4.5 |
| | 132 to 183 | Male | 15 | 14 | 12 | 12 | 9 | 7 | 6 | 4 |
| | | Female | 9 | 8 | 7 | 7 | 7 | 5 | 4 | 3 |
| | Floor to 80 | Male | 17 | 14 | 14 | 11 | 9 | 7 | 6 | 4.5 |
| | | Female | 12 | 9 | 8 | 7 | 7 | 6 | 5 | 4 |
| | Floor to 132 | Male | 15 | 13 | 13 | 10 | 8 | 6 | 6 | 4 |
| | | Female | 10 | 7.5 | 6.5 | 6 | 6 | 5 | 4 | 3 |
| | Floor to 183 | Male | 15 | 12 | 12 | 9.5 | 8 | 6 | 5 | 3 |
| | | Female | 9 | 6 | 6 | 5 | 5 | 4.5 | 4 | 3 |

Note: See Table A.9 a) to g) if lifting is to be performed with limited headroom, asymmetry, heat stress, or clearance or duration issues.

Source: Mital, Ayoub, and Nicholson (1997).

A.11.2.3 Multipliers

Table A.9 a) to g) provides multipliers or “correction factors” that are applied when lifts are not straightforward, simple tasks. Weights in Table A.8 should be multiplied by the correction factors when the ability to lift is affected by any of the following conditions.

Table A.9
Multipliers — Lifting
(See Clauses A.11.2.2 and A.11.2.3 and Table A.8.)

| a) Limited headroom multiplier | | b) Asymmetrical lifting multiplier | | c) Load asymmetry multiplier | | d) Heat stress multiplier | |
|---|-------------|---|-------------|---|-------------|--|-------------|
| Stature | Multiplier* | Angle of turn (°) | Multiplier* | Load asymmetry | Multiplier* | Heat stress (WBGT) | Multiplier* |
| Fully upright | 1 | 0–30 | 1 | 0 | 1 | Up to 27 °C | 1 |
| 95% upright | 0.6 | 30–60 | 0.924 | 10 | 0.96 | At 32 °C | 0.88 |
| 90% upright | 0.4 | 60–90 | 0.848 | 20 | 0.89 | | |
| 85% upright | 0.38 | Above 90 | 0.8 | 30 | 0.84 | | |
| 80% upright | 0.36 | | | | | | |

| e) Coupling multiplier | | f) Load clearance multiplier | | g) Work duration multiplier | | |
|---|-------------|---|-------------|--|-------|-------|
| Coupling | Multiplier* | Load clearance (mm) | Multiplier* | Time, h | Men | Women |
| Good and comfortable handles/firm hold to initiate lift | 1 | ≥ 30 | 1 | 1 | 1.238 | 1.140 |
| Poor quality handles/limited or slippery hold | 0.925 | 15 | 0.91 | 4 | 1.136 | 1.080 |
| No handles/holds to initiate the lift | 0.85 | 3 | 0.87 | 8 | 1.000 | 1.000 |
| | | | | 12 | 0.864 | 0.920 |

* Interpolate for intermediate values.

h)
Maximum frequency (cycles/min) acceptable for one-handed horizontal lifting

| Posture | Maximum frequency of lift | | | | | | | | | | | |
|----------------|---------------------------|-----|-----|-----|-----|-----|----------|-----|-----|-----|-----|-----|
| | Sitting | | | | | | Standing | | | | | |
| Max reach (cm) | 38 | | | 60 | | | 38 | | | 60 | | |
| Load (kg) | 2.3 | 4.5 | 6.8 | 2.3 | 4.5 | 6.8 | 2.3 | 4.5 | 6.8 | 2.3 | 4.5 | 6.8 |
| Male | 11 | 8 | 6 | 10 | 8 | 6 | 11 | 9 | 6 | 10 | 8 | 6 |
| Female | 9 | 7 | — | 7 | 5 | — | 9 | 5 | — | 8 | 5 | — |

A.11.3 Carrying

A.11.3.1 General

A.11.3.1.1

Where carrying tasks take place, the risk of injury shall be assessed and minimized at all stages, including when designing or redesigning workspaces.

A.11.3.1.2

The following aspects of carrying shall be considered when assessing if a task poses a risk of injury:

- a) weight of the load;
- b) horizontal distance of the load from the body during carrying;
- c) height of the hands while the load is carried;
- d) shape, size, awkwardness, and stability of the load;
- e) frequency of carrying;
- f) duration of carrying;
- g) grip or coupling;
- h) carrying with one hand or two;
- i) workplace geometry (such as congested areas, limited headroom, etc.);
- j) temperature; and
- k) individual variables such as strength, age, gender, physical training/fitness, and previous injuries.

A.11.3.1.3

The following aspects shall be considered when designing carrying tasks:

- a) transferring the following items with a cart if the distance takes more than 10 s to travel:
 - i) bulky items;
 - ii) items with poor handholds; and
 - iii) uneven or shifting loads;
- b) removing all obstacles between the user and the destination of the carry;
- c) safely carrying large and bulky loads by
 - i) limiting the capacity of the container;
 - ii) reducing the weight of the load; or
 - iii) splitting the load into smaller parts;
- d) designing or redesigning the workspace to reduce the carrying distance (e.g., bringing the stock area closer);
- e) installing automatic doors where there is considerable carrying;
- f) avoiding travelling over changes in surface, such as
 - i) staircases;
 - ii) changes in slopes;
 - iii) cracks in the floor;
 - iv) uneven ground; and
 - v) slippery/wet surfaces;
- g) ensuring the load does not
 - i) impede full movement of the legs during the carrying; and
 - ii) block users' view of their path of travel;
- h) providing accessible handles that
 - i) allow for good grip (i.e., not too slippery);
 - ii) have a round/oval shape where possible (avoid sharp edges); and

- iii) have a minimum diameter of 1.9 cm for objects weighing more than 9 kg;
- i) removing edges that can cut or surfaces that are rough on the skin;
- j) wrapping/boxing/bagging objects with cutting or rough edges, or which are too hot, cold, or dirty;
- k) ensuring carrying tasks can be performed with two hands;
- l) arranging delivery schedules to allow for paced, less frequent, carrying tasks in one shift;
- m) planning and designing work processes to reduce movement of materials to a minimum; and
- n) maximizing quantity, weight, and size of material wherever this would lend itself to economical transport by machines, if available (e.g., roller conveyors, ball casters).

A.11.3.2 Determining recommended carrying weights

Table A.10 may be used to provide recommended weights for simple carrying tasks.

For more complicated carrying tasks, a competent person who is knowledgeable in ergonomics shall be contacted.

Notes:

- 1) Table A.10 is based on recommendations in the Guide to Manual Materials Handling for two-handed symmetrical load carries for 90% of the industrial population.
- 2) Table A.11 a) to f) contains “multipliers”, which are correction factors used to adjust the recommended limit of the weight when variables such as asymmetry, heat stress, lack of headroom, etc., make the carrying task more difficult or less safe.
- 3) Table A.10 is used as follows:
 - a) Determine the height at which the object is being carried (from the floor).
 - b) Determine how far the object is being carried.
 - c) Determine how often the carrying task is performed.
 - d) Determine the user population. If the user population is male only, use the male data. If the user population is female or mixed, use the female data. Based on the gender of the user and the information from Items a) to c), locate the recommended carrying weight limit in the chart.
 - e) Determine if there are any additional factors that would affect the carrying task, and, if so, apply the correct multiplier from Table A.11 a) to f), as follows:
 - i) limited headroom multiplier (the user is working in a stooped posture);
 - ii) asymmetrical lifting multiplier (users must twist while lifting, without moving their feet);
 - iii) load asymmetry multiplier (load is unbalanced);
 - iv) heat stress multiplier (the user is working in a warm/hot environment);
 - v) coupling multiplier (the object being lifted does not have good handholds); and
 - vi) work duration multiplier.
 - f) Compare the final recommended weight derived from Items a) to e) to the actual weight of the object being carried. If the actual weight of the object being carried is heavier than the recommended weight, controls should be put in place.

Table A.10
Recommended weight of two-handed carrying to safely accommodate
90% of the industrial population (kg)
 (See Clauses A.11.3.2 and A.11.3.3.)

| Carrying height, cm | Carrying distance, m | Gender | Frequency | | | | | | |
|---------------------|----------------------|--------|-----------|-------------|-----------|-------------|-----------|-----------|------------|
| | | | 1 per 8 h | 1 per 5 min | 1 per min | 3.3 per min | 5 per min | 6 per min | 10 per min |
| 105–111 | 2.1 | Male | 25 | 19 | 17 | — | 14 | — | 10 |
| | | Female | 18 | 13 | 13 | — | 12 | — | 11 |
| | 4.3 | Male | 22 | 17 | 15 | — | — | 9 | — |
| | | Female | 18 | 13 | 13 | — | — | 9 | — |
| | 8.5 | Male | 20 | 15 | 13 | 10 | — | — | — |
| | | Female | 16 | 12 | 12 | 10 | — | — | — |
| 72–79 | 2.1 | Male | 27 | 23 | 21 | — | 17 | — | 13 |
| | | Female | 20 | 16 | 16 | — | 14 | — | 11 |
| | 4.3 | Male | 27 | 21 | 18 | — | — | 11 | — |
| | | Female | 20 | 14 | 14 | — | — | 10 | — |
| | 8.5 | Male | 26 | 20 | 17 | 13 | — | — | — |
| | | Female | 19 | 14 | 14 | 10 | — | — | — |

Source: Mital, Ayoub, and Nicholson (1997).

A.11.3.3 Multipliers

Table A.11 provides “correction factors” to use when the characteristics of carrying tasks are not straightforward. The weights in Table A.10 should be multiplied by the correction factors when the ability to carry will be affected by any of the conditions described.

Table A.11
Multipliers — Carrying
(See Clauses A.11.3.2 and A.11.3.3.)

| a) Limited headroom multiplier | | b) Asymmetrical carrying multiplier | | c) Load asymmetry multiplier | | d) Heat stress multiplier | |
|--------------------------------|-------------|-------------------------------------|-------------|------------------------------|-------------|---------------------------|-------------|
| Stature | Multiplier* | Angle of turn (°) | Multiplier* | Load asymmetry (%) | Multiplier* | Heat stress (WBGT) | Multiplier* |
| Fully upright | 1 | 0–30 | 1 | 0 | 1 | Up to 27 °C | 1 |
| 95% upright | 0.6 | 30–60 | 0.924 | 10 | 0.96 | At 32 °C | 0.88 |
| 90% upright | 0.4 | 60–90 | 0.848 | 20 | 0.89 | | |
| 85% upright | 0.38 | Above 90 | 0.8 | 30 | 0.84 | | |
| 80% upright | 0.36 | | | | | | |

| e) Coupling multiplier | | f) Work duration multiplier | | |
|---|-------------|-----------------------------|-------|-------|
| Coupling | Multiplier* | Time | Men | Women |
| Good and comfortable handles/firm hold to initiate lift | 1 | 1 h | 1.238 | 1.140 |
| Poor quality handles/limited or slippery hold | 0.925 | 4 h | 1.136 | 1.080 |
| No handles/holds to initiate the lift | 0.85 | 8 h | 1.000 | 1.000 |
| | | 12 h | 0.864 | 0.920 |

* Interpolate for intermediate values.

A.11.4 Pushing and pulling

A.11.4.1 General

A.11.4.1.1

Where pushing and pulling tasks take place, the risk of injury shall be assessed and minimized at every stage, including when designing or redesigning work areas.

A.11.4.1.2

The following aspects of pushing and pulling shall be considered when assessing if a task poses a risk of injury

- force required to push or pull;
- height of the handles;
- distance moved;
- frequency of the pushing and pulling;
- duration of the task;
- grade and condition of the floor, including the slipperiness; and
- individual variables such as strength, age, gender, physical training/fitness, and previous injuries.

A.11.4.1.3

The following aspects shall be considered when designing pushing and pulling tasks:

- a) providing motorized carts or conveyers for heavy loads [see Table A.12 a) to d)] to be moved over long distances;
- b) pushing the load where possible rather than pulling;
- c) designing and redesigning the work area to ensure
 - i) adequate space to manoeuvre carts/equipment; and
 - ii) the distance to push or pull is minimized;
- d) ensuring the casters are appropriate for the type of surface and the amount of weight loaded on the cart;
- e) installing automatic doors where there is considerable pushing and pulling;
- f) designing or redesigning the cart or task to ensure
 - i) line of sight is not obstructed;
 - ii) hands are not above shoulder or below waist level;
 - iii) handles are at about elbow height for straight horizontal pushing or just above elbow height where manoeuvring of the cart or equipment is necessary (vertical handles may be used to accommodate a larger range of user heights); and
 - iv) handles have sufficient clearance for the gloved hand;
- g) placing four swivel casters with swivel lock on the cart; and
- h) ensuring the surface is not slippery or uneven.

A.11.4.2 Determining recommended push/pull forces

Table A.12 a) to d) may be used to provide recommended forces (initial and sustained) for simple push/pull tasks for 90% of the industrial population.

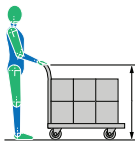
For more complicated push/pull tasks, a competent person who is knowledgeable in ergonomics shall be consulted.

Notes:

- 1) *The values in Table A.12 a) to d) are based on Mital, Ayoub, and Nicholson (1997) and are designed to protect 90% of the industrial user population.*
- 2) *The values for the recommended maximum “initial force” required to get an object moving and the “sustained force” required to keep the object moving differ from one another.*
- 3) *Table A.12 is used as follows:*
 - a) *Determine the correct Table to use, based on whether the task is a pushing task or pulling task and whether the forces in question are initial (getting the object moving) or sustained (keeping the object moving) forces, as follows:*
 - i) *Table A.12 a) for initial push force;*
 - ii) *Table A.12 b) for sustained push force;*
 - iii) *Table A.12 c) for initial pull force; and*
 - iv) *Table A.12 d) for sustained pull force.*
 - b) *Determine the height of the handle on the cart being pushed/pulled.*
 - c) *Determine how far the object is being pushed/pulled.*
 - d) *Determine how often the object is pushed/pulled.*
 - e) *Determine the user population. If the user population is male only, use the male data. If the user population is female or mixed, use the female data. Based on the gender of the user and the information from Items a) to d), locate the recommended push/pull forces in the chart.*
 - f) *Using the push/pull strain gauge or dynamometer, measure the force needed to move the cart or equipment.*
 - g) *Compare the force level from the table to the actual amount of force required to initiate or sustain the push/pull of the object. If the actual force required to push/pull the object is greater than that*

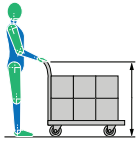
recommended by Table A.12 a) to d), then controls should be put in place to limit the actions or the forces required should be lowered.

Table A.12 a)
Recommended initial forces for two-handed push (kg) for
90% of the industrial population
(See Clauses A.11.4.1.3 and A.11.4.2.)



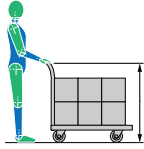
| Handle height, cm | Push distance, m | Gender | 1 per 8 h | 1 per 5 min | 1 per min | 2.4 per min | 4 per min | 5 per min | 10 per min | |
|-------------------|------------------|--------|-----------|-------------|-----------|-------------|-----------|-----------|------------|----|
| 135–144 | 2.1 | Male | 31 | 26 | 25 | — | — | 22 | 20 | |
| | | Female | 22 | 20 | 17 | — | — | 15 | 14 | |
| | 7.6 | Male | 26 | 22 | 21 | — | 15 | — | — | |
| | | Female | 20 | 18 | 16 | — | 15 | — | — | |
| | 15.2 | Male | 25 | 20 | 19 | 16 | — | — | — | |
| | | Female | 17 | 15 | 14 | 12 | — | — | — | |
| | 30.5 | Male | 24 | 19 | 15 | — | — | — | — | |
| | | Female | 17 | 14 | 12 | — | — | — | — | |
| | 45.7 | Male | 20 | 16 | 13 | — | — | — | — | |
| | | Female | 17 | 14 | 12 | — | — | — | — | |
| | 61 | Male | 18 | 14 | 12 | — | — | — | — | |
| | | Female | 15 | 13 | 12 | — | — | — | — | |
| | 89–95 | 2.1 | Male | 34 | 28 | 26 | — | — | 24 | 21 |
| | | | Female | 22 | 20 | 17 | — | — | 15 | 14 |
| 7.6 | | Male | 30 | 25 | 23 | — | 16 | — | — | |
| | | Female | 21 | 19 | 16 | — | 14 | — | — | |
| 15.2 | | Male | 28 | 23 | 22 | 18 | — | — | — | |
| | | Female | 17 | 16 | 14 | 11 | — | — | — | |
| 30.5 | | Male | 27 | 22 | 17 | — | — | — | — | |
| | | Female | 18 | 15 | 12 | — | — | — | — | |
| 45.7 | | Male | 23 | 19 | 14 | — | — | — | — | |
| | | Female | 18 | 15 | 12 | — | — | — | — | |
| 61 | | Male | 20 | 16 | 14 | — | — | — | — | |
| | | Female | 16 | 13 | 12 | — | — | — | — | |
| 57–64 | | 2.1 | Male | 31 | 25 | 24 | — | — | 22 | 19 |
| | | | Female | 18 | 16 | 14 | — | — | 12 | 11 |

(Continued)

Table A.12 a) (Concluded)

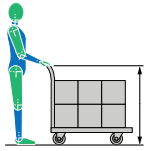
| Handle height, cm | Push distance, m | Gender | 1 per 8 h | 1 per 5 min | 1 per min | 2.4 per min | 4 per min | 5 per min | 10 per min |
|-------------------|------------------|--------|-----------|-------------|-----------|-------------|-----------|-----------|------------|
| | 7.6 | Male | 26 | 21 | 20 | — | 13 | — | — |
| | | Female | 17 | 16 | 14 | — | 11 | — | — |
| | 15.2 | Male | 24 | 20 | 19 | 15 | — | — | — |
| | | Female | 15 | 13 | 12 | — | — | — | — |
| | 30.5 | Male | 23 | 19 | 14 | — | — | — | — |
| | | Female | 15 | 12 | 11 | — | — | — | — |
| | 45.7 | Male | 20 | 16 | 12 | — | — | — | — |
| | | Female | 15 | 12 | 11 | — | — | — | — |
| | 61 | Male | 17 | 14 | 12 | — | — | — | — |
| | | Female | 13 | 11 | 10 | — | — | — | — |

Table A.12 b)
Recommended sustained forces for two-handed push (kg) for
90% of the industrial population
 (See Clauses [A.11.4.1.3](#) and [A.11.4.2.](#))



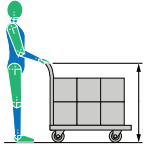
| Handle height, cm | Push distance, m | Gender | 1 per 8 h | 1 per 5 min | 1 per min | 2.4 per min | 4 per min | 5 per min | 10 per min | |
|-------------------|------------------|--------|-----------|-------------|-----------|-------------|-----------|-----------|------------|----|
| 135–144 | 2.1 | Male | 22 | 18 | 15 | — | — | 13 | 10 | |
| | | Female | 14 | 11 | 10 | — | — | 8 | 5 | |
| | 7.6 | Male | 18 | 15 | 13 | — | 6 | — | — | |
| | | Female | 11 | 8 | 7 | — | 5 | — | — | |
| | 15.2 | Male | 16 | 13 | 11 | 6 | — | — | — | |
| | | Female | 9 | 7 | 4 | 4 | — | — | — | |
| | 30.5 | Male | 16 | 12 | 6 | — | — | — | — | |
| | | Female | 8 | 6 | 4 | — | — | — | — | |
| | 45.7 | Male | 13 | 10 | 5 | — | — | — | — | |
| | | Female | 8 | 5 | 4 | — | — | — | — | |
| | 61 | Male | 11 | 8 | 7 | — | — | — | — | |
| | | Female | 6 | 4 | 3 | — | — | — | — | |
| | 89–95 | 2.1 | Male | 23 | 19 | 16 | — | — | 13 | 10 |
| | | | Female | 13 | 10 | 9 | — | — | 7 | 5 |
| 7.6 | | Male | 18 | 15 | 13 | — | 6 | — | — | |
| | | Female | 11 | 9 | 8 | — | 5 | — | — | |
| 15.2 | | Male | 16 | 13 | 11 | 6 | — | — | — | |
| | | Female | 10 | 7 | 4 | 4 | — | — | — | |
| 30.5 | | Male | 16 | 12 | 6 | — | — | — | — | |
| | | Female | 9 | 6 | 4 | — | — | — | — | |
| 45.7 | | Male | 13 | 9 | 5 | — | — | — | — | |
| | | Female | 8 | 6 | 4 | — | — | — | — | |
| 61 | | Male | 11 | 8 | 7 | — | — | — | — | |
| | | Female | 6 | 4 | 3 | — | — | — | — | |
| 57–64 | | 2.1 | Male | 23 | 18 | 16 | — | — | 13 | 10 |
| | | | Female | 12 | 9 | 8 | — | — | 6 | 4 |
| | 7.6 | Male | 18 | 14 | 12 | — | 6 | — | — | |
| | | Female | 11 | 8 | 7 | — | 5 | — | — | |

(Continued)

Table A.12 b) (Concluded)

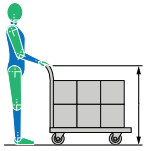
| Handle height, cm | Push distance, m | Gender | 1 per 8 h | 1 per 5 min | 1 per min | 2.4 per min | 4 per min | 5 per min | 10 per min |
|-------------------|------------------|--------|-----------|-------------|-----------|-------------|-----------|-----------|------------|
| | 15.2 | Male | 15 | 12 | 11 | 6 | — | — | — |
| | | Female | 9 | 7 | 4 | 4 | — | — | — |
| | 30.5 | Male | 15 | 11 | 6 | — | — | — | — |
| | | Female | 8 | 6 | 4 | — | — | — | — |
| | 45.7 | Male | 13 | 9 | 5 | — | — | — | — |
| | | Female | 7 | 5 | 4 | — | — | — | — |
| | 61 | Male | 10 | 8 | 7 | — | — | — | — |
| | | Female | 6 | 4 | 3 | — | — | — | — |

Table A.12 c)
Recommended initial forces for two-handed pull (kg) for
90% of the industrial population
 (See Clauses [A.11.4.1.3](#) and [A.11.4.2.](#))



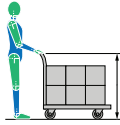
| Handle height, cm | Push distance, m | Gender | 1 per 8 h | 1 per 5 min | 1 per min | 2.4 per min | 4 per min | 5 per min | 10 per min | |
|-------------------|------------------|--------|-----------|-------------|-----------|-------------|-----------|-----------|------------|----|
| 135–144 | 2.1 | Male | 23 | 19 | 18 | — | — | 16 | 14 | |
| | | Female | 22 | 19 | 17 | — | — | 16 | 13 | |
| | 7.6 | Male | 21 | 17 | 16 | — | 11 | — | — | |
| | | Female | 20 | 17 | 16 | — | 11 | — | — | |
| | 15.2 | Male | 20 | 16 | 15 | 13 | — | — | — | |
| | | Female | 17 | 15 | 13 | 10 | — | — | — | |
| | 30.5 | Male | 19 | 15 | 12 | — | — | — | — | |
| | | Female | 17 | 14 | 12 | — | — | — | — | |
| | 45.7 | Male | 16 | 13 | 10 | — | — | — | — | |
| | | Female | 16 | 14 | 10 | — | — | — | — | |
| | 61 | Male | 14 | 11 | — | — | — | — | — | |
| | | Female | 14 | 11 | — | — | — | — | — | |
| | 89–95 | 2.1 | Male | 32 | 27 | 25 | — | — | 22 | 19 |
| | | | Female | 23 | 21 | 18 | — | — | 16 | 14 |
| 7.6 | | Male | 29 | 24 | 23 | — | 15 | — | — | |
| | | Female | 21 | 19 | 16 | — | 14 | — | — | |
| 15.2 | | Male | 28 | 23 | 21 | 18 | — | — | — | |
| | | Female | 18 | 16 | 14 | 10 | — | — | — | |
| 30.5 | | Male | 26 | 21 | 16 | — | — | — | — | |
| | | Female | 18 | 15 | 13 | — | — | — | — | |
| 45.7 | | Male | 23 | 18 | 14 | — | — | — | — | |
| | | Female | 18 | 15 | 13 | — | — | — | — | |
| 61 | | Male | 19 | 16 | 13 | — | — | — | — | |
| | | Female | 16 | 13 | 12 | — | — | — | — | |
| 57–64 | | 2.1 | Male | 36 | 30 | 28 | — | — | 25 | 22 |
| | | | Female | 24 | 22 | 19 | — | — | 17 | 15 |
| | 7.6 | Male | 33 | 27 | 26 | — | 18 | — | — | |
| | | Female | 22 | 20 | 17 | — | 15 | — | — | |

(Continued)

Table A.12 c) (Concluded)

| Handle height, cm | Push distance, m | Gender | 1 per 8 h | 1 per 5 min | 1 per min | 2.4 per min | 4 per min | 5 per min | 10 per min |
|-------------------|------------------|--------|-----------|-------------|-----------|-------------|-----------|-----------|------------|
| 15.2 | | Male | 31 | 26 | 24 | 20 | — | — | — |
| | | Female | 19 | 17 | 15 | 11 | — | — | — |
| 30.5 | | Male | 30 | 24 | 18 | — | — | — | — |
| | | Female | 19 | 15 | 13 | — | — | — | — |
| 45.7 | | Male | 26 | 21 | 16 | — | — | — | — |
| | | Female | 19 | 15 | 13 | — | — | — | — |
| 61 m | | Male | 22 | 18 | 15 | — | — | — | — |
| | | Female | 17 | 14 | 13 | — | — | — | — |


Table A.12 d)
Recommended sustained forces for two handed pull (kg) for
90% of the industrial population
 (See Clauses A.11.4.1.3 and A.11.4.2.)



| Handle height, cm | Push distance, m | Gender | 1 per 8 h | 1 per 5 min | 1 per min | 2.4 per min | 4 per min | 5 per min | 10 per min | |
|-------------------|------------------|--------|-----------|-------------|-----------|-------------|-----------|-----------|------------|----|
| 135–144 | 2.1 | Male | 18 | 15 | 12 | — | — | 10 | 8 | |
| | | Female | 15 | 11 | 10 | — | — | 8 | 5 | |
| | 7.6 | Male | 15 | 12 | 10 | — | 6 | — | — | |
| | | Female | 13 | 10 | 9 | — | 6 | — | — | |
| | 15.2 | Male | 13 | 10 | 9 | 6 | — | — | — | |
| | | Female | 11 | 8 | 6 | 4 | — | — | — | |
| | 30.5 | Male | 13 | 8 | 7 | — | — | — | — | |
| | | Female | 10 | 7 | 5 | — | — | — | — | |
| | 45.7 | Male | 10 | 8 | 5 | — | — | — | — | |
| | | Female | 9 | 7 | 5 | — | — | — | — | |
| | 61 | Male | 9 | 6 | 6 | — | — | — | — | |
| | | Female | 7 | 5 | 4 | — | — | — | — | |
| | 89–95 | 2.1 | Male | 24 | 19 | 16 | — | — | 13 | 10 |
| | | | Female | 14 | 11 | 10 | — | — | 8 | 5 |
| 7.6 | | Male | 19 | 16 | 13 | — | 6 | — | — | |
| | | Female | 13 | 10 | 9 | — | 6 | — | — | |
| 15.2 | | Male | 17 | 14 | 12 | 7 | — | — | — | |
| | | Female | 11 | 8 | 6 | 4 | — | — | — | |
| 30.5 | | Male | 17 | 12 | 7 | — | — | — | — | |
| | | Female | 10 | 7 | 5 | — | — | — | — | |
| 45.7 | | Male | 14 | 10 | 6 | — | — | — | — | |
| | | Female | 9 | 6 | 4 | — | — | — | — | |
| 61 | | Male | 12 | 9 | 7 | — | — | — | — | |
| | | Female | 7 | 5 | 4 | — | — | — | — | |
| 57–64 | | 2.1 | Male | 25 | 20 | 17 | — | — | 14 | 11 |
| | | | Female | 13 | 10 | 9 | — | — | 8 | 4 |
| | 7.6 | Male | 20 | 17 | 14 | 7 | — | — | — | |
| | | Female | 12 | 9 | 8 | 5 | — | — | — | |
| | 15.2 | Male | 18 | 15 | 12 | 7 | — | — | — | |

(Continued)

Table A.12 d) (Concluded)



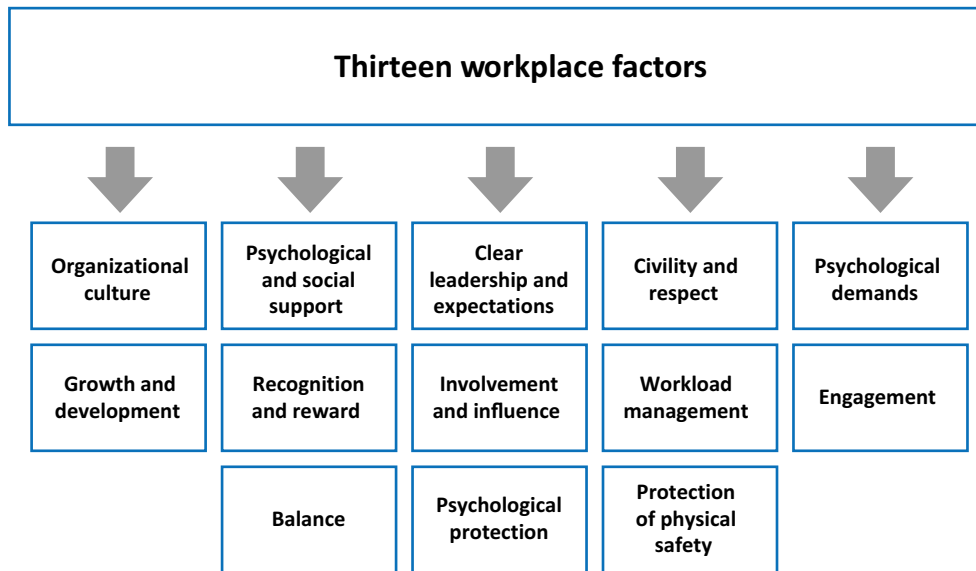
| Handle height, cm | Push distance, m | Gender | 1 per 8 h | 1 per 5 min | 1 per min | 2.4 per min | 4 per min | 5 per min | 10 per min |
|-------------------|------------------|--------|-----------|-------------|-----------|-------------|-----------|-----------|------------|
| | 30.5 | Female | 10 | 7 | 6 | 4 | — | — | — |
| | | Male | 18 | 13 | 7 | — | — | — | — |
| | 45.7 | Female | 9 | 6 | 5 | — | — | — | — |
| | | Male | 15 | 11 | 6 | — | — | — | — |
| | 61 | Female | 8 | 6 | 4 | — | — | — | — |
| | | Male | 12 | 9 | 8 | — | — | — | — |
| | | Female | 6 | 5 | 3 | — | — | — | |

A.12 Psychosocial workplace factors and psychological health

A.12.1 General

CAN/CSA-Z1003/BNQ 9700-803 identifies workplace factors that are known to affect workplace psychological health. Depending on their nature, they can pose a psychosocial hazard in the workplace. These factors are illustrated in Figure A.13.

Figure A.13
Thirteen workplace factors known to affect workplace psychological health
 (See Clauses A.12.1 and A.12.2.)



Note: Adapted from CAN/CSA-Z1003/BNQ 9700-803, a model of a planned approach to address work factors known to impact psychological health.

A.12.2 Psychosocial workplace factors and ergonomics

Ergonomics principles address work organization and job design (among other conditions), which, in turn, can positively influence psychosocial workplace factors and decrease their potential to cause harm (psychosocial hazards).

Among the workplace factors shown in Figure A.13, the following factors can be directly influenced through the use of ergonomics, which promotes optimum physical and psychosocial health:

- a) expectations (performance measurements and accountability);
- b) psychological job demands (cognitive);
- c) involvement and influence (employee control and autonomy);
- d) workload management;
- e) engagement (user participation and feedback); and
- f) protection of physical safety.

A.12.3 Work organization and job design — Documentation

When examining work organization and job design in order to identify psychosocial hazards and control their associated risk to psychological health (as required by Clause 5.6.3), the organization shall develop, implement, and maintain documented processes as outlined in Table A.13.

Table A.13
Required documentation and processes
(See Clause A.12.3.)

| Psychosocial workplace factors | Documented processes shall be developed, implemented, and maintained in order to |
|---|---|
| Expectations (performance measurement and accountability) | <ul style="list-style-type: none"> • provide clear expectations on job/task requirements and responsibilities • provide timely and constructive feedback on performance • ensure that the promotion of health and well-being in the workplace is a key component of performance for all levels of the organization • develop a review process that deals with management performance and accountability |
| Psychological job demands (cognitive demands, monotony, and the nature of the work) | <ul style="list-style-type: none"> • improve engagement by taking into account work capacities and feedback from users (i.e., have processes to identify jobs with a lack of variety and opportunities for job enlargement, enrichment, or enhancement) • facilitate a process whereby suggestions can be made to supervisors regarding new opportunities and challenges, and whereby supervisors can address the suggestions appropriately within the organization to all employees • communicate opportunities for advancement within the organization to all users |
| Involvement and influence (employee control and autonomy) | <ul style="list-style-type: none"> • provide employees with control over the pace of their work where possible • provide opportunities for employees to develop and use their skills and initiative • provide flexibility for employee control regarding work patterns such as breaks and task sequence where possible and safe • provide opportunities for employee consultation and participation with respect to work processes and workstation design |
| Workload management (time constraints, breaks/rest periods, hours of work) | <ul style="list-style-type: none"> • review the scope of work and time demands before setting a schedule • adapt organization and technical procedures to limit the frequency of rush situations • set and document clear roles and responsibilities so that when workload is high, employees are able to focus on key activities • integrate safety into production planning processes to avoid unmanageable work quotas • educate employees on the necessity and advantages of taking the regular breaks that are offered them, and make it clear that breaks are expected to be taken |

(Continued)

Table A.13 (Concluded)

| Psychosocial workplace factors | Documented processes shall be developed, implemented, and maintained in order to |
|--|--|
| | <ul style="list-style-type: none"> • schedule and provide shorter and more frequent breaks for highly repetitive work tasks (rather than long infrequent breaks) • provide for regular postural breaks from sitting or standing or other statically maintained postures • identify the need for, and develop, physical and cognitive fatigue-management strategies • maintain adequate staffing levels to cover predictable workloads and provide the appropriate number of staff during predicted busy periods • communicate to prospective and current employees the likelihood or frequency of overtime and extra hour assignments • maximize employee autonomy to self-select shifts or to trade with colleagues to optimize their personal schedule (when possible, and within the parameters of the fatigue-management strategies) • involve employees in the design and assignment of regular and extra-hour shift assignments without increasing risk of physical or cognitive fatigue (within the parameters of fatigue-management strategies) |
| Engagement (employee participation and feedback, changes in management practices, safety reporting mechanisms) | <ul style="list-style-type: none"> • provide employees with timely information to understand the reasons for proposed changes • ensure adequate employee consultation on changes and provide opportunities for employees to influence proposals • inform employees on the probable impact of any changes to their jobs • inform employees of timetables for changes • provide employees with access to relevant support during changes • promote employee suggestions and ideas for job improvement • promote the reporting of errors, incidents, near misses, and concerns without the risk of repercussion • report errors, incidents, near misses, or concerns • respond to reports of errors, incidents, near misses, or concerns |
| Protection of physical safety (demands of the job) | <ul style="list-style-type: none"> • ensure that the physical job demands eliminate or minimize associated hazards, meet the design requirements of this Standard, and are safe and appropriate to the skills and abilities of the employees • ensure that employees are properly educated and trained in all physical aspects of their job • provide a process for employees to report errors or concerns without the risk of repercussion • ensure that workstation design and work processes are safe and appropriate for the physical safety of employees |

Annex B (informative)

Detailed requirements for acoustics

Note: *This Annex is not a mandatory part of this Standard.*

B.1 Minimum acoustical control

To meet the objectives stated in Clause A.10.3, Tables B.1 to B.6 provide design recommendations and should be followed for the following areas of the office workspace:

- a) typical closed room/office (Clause B.3);
- b) remote-conference and large meeting/training rooms (Clause B.4);
- c) open offices — partitioned (Clause B.5);
- d) open offices — unpartitioned (Clause B.6);
- e) corridors and circulation areas (Clause B.7); and
- f) reception and waiting areas (Clause B.8).

B.2 Design recommendations for office workspaces

Clauses B.3 to B.8 and Tables B.1 to B.6 provide criteria for achieving the desired acoustical performance in a variety of office workspaces and may be used for design. Where Tables B.1 to B.6 are used for design criteria, all criteria in the relevant table should be met. Alternative designs meeting the performance intent may be adopted following project-specific consultation with a competent acoustical specialist.

B.3 Typical closed room/office

Table B.1 provides design recommendations that should be met in typical closed rooms with normal voice levels and activities, and with typical surrounding office activity (as opposed to industrial activity). Where Table B.1 is used for design criteria, all criteria in the table should be met. Alternative designs meeting the performance intent may be adopted following project-specific consultation with a competent person.

Note: *For the purposes of the design recommendations in this Clause, a typical closed room/office includes private offices, small meeting rooms (≤ 12 persons), small conferencing rooms (≤ 12 persons), breakout rooms, focus rooms, and exam rooms. The minimum requirements are expected to provide working comfort and confidential levels of speech privacy, with an articulation index of 0.05 or less to adjoining rooms, with the door closed. With the door open, the loss of isolation is partially offset by sound masking inside and around the room.*

Table B.1
Design recommendations for typical closed room/office
(See Clauses B.1, B.2, and B.3.)

| Design element | Design recommendations/notes |
|---|---|
| Interior walls | |
| Sound transmission class (STC) | 40 |
| Seals | Wall sections and joints to structure are acoustically sealed |
| Height | Constructed to the suspended ceiling |
| Penetrations | Light switches, outlets, and similar penetrations do not back onto each other |
| Doors | |
| Sound transmission class (STC) | 30 |
| Acoustic seals | To sides and top of door frame |
| Location | Stagger opposing doors where possible |
| Note: Open doors virtually eliminate the isolation performance of the room. | |
| Interior windows (less than 10% of wall area) | |
| Sound transmission class (STC) | 26 |
| Suspended ceilings | |
| Noise reduction coefficient (NRC) | 0.70 |
| Ceiling attenuation class (CAC) | 35 |
| Note: If there is an open ceiling, seek advice of a competent acoustical specialist. The ceiling should be covered by sufficient absorptive material; walls should be built to structure; and air supply and returns should be appropriately ducted. | |
| Heating, ventilation, and air-conditioning (HVAC) | |
| Noise limits | Maximum NC 30 (35 dBA) |
| Supply ducts | No direct connection between rooms |
| Plenum air return grilles | Located minimum 60 cm from wall |
| Sound masking | |
| Overall level | Field tested to 42 dBA \pm 0.5 dBA * |
| Masking spectrum | Field tested to Table A.6, \pm 2.0 dB per 1/3 octave band * |

(Continued)

Table B.1 (Concluded)

| Design element | Design recommendations/notes |
|--|---|
| Control zone for volume and 1/3 octave equalization (EQ) | Individual control zone per room |
| | * <i>Masking systems should be properly field commissioned, verified, and reported to ensure performance. See requirements in Clause A.10.3.10.3.</i> |
| Flooring | |
| Impact isolation class (below or adjacent) | IIC 45 for offices or less sensitive places, IIC 50 for meeting rooms, IIC 55 for remote-conference rooms Carpet meets the requirements of this Standard and reduces chair/footfall noise, though it has minimal impact on overall room sound absorption |
| Raised Floors (if present) | |
| Impact isolation rating | IIC 45 for offices or less sensitive places, IIC 50 for meeting rooms, IIC 55 for remote-conference rooms |
| Sound transmission rating | STC 45 for offices, STC 50 for meeting rooms, STC 55 for remote-conference rooms, STC 60 for mechanical system rooms |

B.4 Remote-conference and large meeting/training rooms

Table B.2 provides design recommendations that should be met in remote-conference and large meeting/training rooms. Where Table B.2 is used for design, all criteria in the table should be met. Alternative designs meeting the performance intent may be adopted following project-specific consultation with a competent person.

Note: *Activities in remote-conference and large meeting/training rooms (including large meeting or training rooms for more than 12 persons) can produce higher-than-normal noise levels and require clarity for microphone pickup and speech comprehension. Greater levels of absorption and lower background sound levels from HVAC and sound masking ensure higher speech intelligibility. The higher level of noise generated inside the room calls for higher isolation performance.*

Table B.2
Design recommendations for remote-conference and large meeting/training rooms
(See Clauses B.1, B.2, and B.4.)

| Design element | Design recommendation/notes |
|--|---|
| Interior walls | |
| Sound transmission class (STC) | 45 |
| Seals | Wall sections and joints to structure are acoustically sealed |
| Height | Constructed to the building structure |
| Penetrations | Light switches, outlets, and similar penetrations do not back onto each other |
| Doors | |
| Sound transmission class (STC) | 40 |
| Acoustic seals | To sides and top of door frame; acoustical door sweep along bottom |
| Location | Stagger opposing doors where possible |
| Note: <i>Open doors virtually eliminate the isolation performance of the room.</i> | |
| Interior windows | |
| Sound transmission class (STC) | 34 |
| Suspended ceilings | |
| Noise reduction coefficient (NRC) | 0.80 |
| Ceiling attenuation class (CAC) | 35 |
| Note: <i>If open ceiling, seek advice of acoustical engineer. Ceiling should be covered by sufficient absorptive material, walls must be built to structure, and air supply and returns must be appropriately ducted.</i> | |
| Acoustical panels | Cover 25% of each of two adjacent walls with minimum NRC 0.80 |
| Heating, ventilation, and air-conditioning (HVAC) | |
| Noise limits | Maximum NC 30 (35 dBA) for conference and large meeting rooms, maximum NC 25 (30 dBA) for remote-conference rooms |
| Supply ducts | No direct connection between rooms |
| Air return | Ducted |

(Continued)

Table B.2 (Concluded)

| Design element | Design recommendation/notes |
|---|---|
| Sound masking | |
| Overall level | Field tested to specified level between 35–42 dBA, ± 0.5 dBA * |
| Masking spectrum | Field tested to Table A.6, ± 2.0 dB per 1/3 octave band * |
| Control zone for volume and 1/3 octave EQ | Individual zone per room |
| | * <i>Masking systems should be properly field commissioned, verified, and reported to ensure performance. See requirements in Clause A.10.3.10.3.</i> |
| Flooring | |
| Impact isolation class (IIC), below or adjacent | IIC 45 for offices or less sensitive places, IIC 50 for meeting rooms, IIC 55 for remote-conference rooms Carpet meets the requirements of this Standard and reduces chair/footfall noise, though it has minimal impact on overall room sound absorption |
| Raised floors (if present) | |
| Impact isolation rating | IIC 45 for offices or less sensitive places, IIC 50 for meeting rooms, IIC 55 for remote-conference rooms |
| Sound transmission rating | STC 45 for offices, STC 50 for meeting rooms, STC 55 for remote-conference rooms, STC 60 for mechanical system rooms |

B.5 Open offices — Partitioned

Table B.3 provides design recommendations that should be met in partitioned open office spaces. Where Table B.3 is used for design criteria, all criteria in the table should be met. Alternative designs meeting the performance intent may be adopted following project-specific consultation with a competent person.

Note: *For the purposes of the design recommendations in this Clause, these open office workspaces include individual workstations separated by 1.5 m or taller partitions. These spaces support focus work, phone activity, and one-on-one collaboration.*

Table B.3
Design recommendations for open offices — Partitioned
(See Clauses B.1, B.2, and B.5.)

| Design element | Design recommendation/notes |
|---|---|
| Workstation partitions | |
| Height | 1.5 m (above 95th percentile male seated head height of 1.47 m). May consist of 1.5 m partition or 1.2 m partition topped with 0.3 m glass sealed panel |
| Sound transmission class (STC) | 20 |
| Sound absorption | Sound absorptive panel on interior of workstation above work surface with minimum NRC 0.60 |
| Enclosure and sightlines | Partitions substantially enclose occupant on three sides and minimize line-of-sight to adjoining workstations where possible |
| Seals and openings | Joints between partition panels gasketed, gaps between partitions and floor minimized |
| Suspended ceilings | |
| Noise reduction coefficient (NRC) | 0.80 |
| Articulation class | ≥ 170 |
| Note: <i>If open ceiling, seek advice of acoustical engineer. Ceiling should be covered by sufficient absorptive material to compensate for the loss of absorption from the omission of acoustical ceiling tile.</i> | |
| Heating, ventilation, and air-conditioning (HVAC) | |
| Noise limits | Maximum NC 40 (45 dBA) |
| Sound masking | |
| Overall level | Field tested to specified level 46.0–47.5 dBA, ± 0.5 dBA * |
| Masking spectrum | Field tested to Table A.6, ± 2.0 dB per 1/3 octave band * |
| Control zone for volume and 1/3 octave EQ | Individual zone per each area of 60 m ² or less |
| | * <i>Masking systems should be properly field commissioned, verified, and reported to ensure performance. See requirements in Clause A.10.3.10.3.</i> |
| Overhead lighting | |
| Fixtures | Avoid use of reflective flat-lensed light fixtures |

(Continued)

Table B.3 (Concluded)

| Design element | Design recommendation/notes |
|---|---|
| Flooring | |
| Impact isolation class (IIC), below or adjacent | IIC 45 for offices or less sensitive places, IIC 50 for meeting rooms, IIC 55 for remote-conference rooms Carpet meets the requirements of this Standard and reduces chair/footfall noise, though it has minimal impact on overall room sound absorption |
| Raised floors (if present) | |
| Impact isolation rating | IIC 45 for offices or less sensitive places, IIC 50 for meeting rooms, IIC 55 for remote-conference rooms |
| Sound transmission rating | STC 45 for offices, STC 50 for meeting rooms, STC 55 for remote-conference rooms, STC 60 for mechanical system rooms |
| Layout | |
| Separation | Design space to avoid adjacency of noise-producing areas and those requiring quiet |

B.6 Open offices — Unpartitioned

Table B.4 provides design recommendations that should be met in unpartitioned open office spaces. Where Table B.4 is used for design criteria, all criteria in the table should be met. Alternative designs meeting the performance intent may be adopted following project-specific consultation with a competent person.

Note: For the purposes of the design recommendations in this Clause, these open office workspaces include individual unseparated workstations and those separated by partitions of less than 1.5 m. These areas support larger group collaborative tasks.

Table B.4
Design recommendations for open offices — Unpartitioned
(See Clauses B.1, B.2, and B.6.)

| Design element | Design recommendation/notes |
|---|---|
| Suspended ceilings | |
| Noise reduction coefficient (NRC) | 0.95 |
| Articulation class | ≥ 170 |
| Note: <i>If open ceiling, seek advice of acoustical engineer. Ceiling should be covered by sufficient absorptive material to compensate for the loss of absorption from the omission of acoustical ceiling tile.</i> | |
| Heating, ventilation, and air-conditioning (HVAC) | |
| Noise limits | Maximum NC 40 (45 dBA) |
| Sound masking | |
| Overall level | Field tested to 47.5 dBA, ± 0.5dBA * |
| Masking spectrum | Field tested to Table A.6, ± 2.0 dB per 1/3 octave band * |
| Control zone for volume and 1/3 octave EQ | Individual zone per each area of 60 m ² or less |
| | <i>* Masking systems should be properly field commissioned, verified, and reported to ensure performance. See requirements in Clause A.10.3.10.3.</i> |
| Overhead lighting | |
| Fixtures | Avoid use of reflective flat-lensed light fixtures |
| Flooring | |
| Impact isolation class (IIC), below or adjacent | IIC 45 for offices or less sensitive places, IIC 50 for meeting rooms, IIC 55 for remote-conference rooms Carpet meets the requirements of this Standard and reduces chair/footfall noise, though it has minimal impact on overall room sound absorption |
| Raised floors (if present) | |
| Impact isolation rating | IIC 45 for offices or less sensitive places, IIC 50 for meeting rooms, IIC 55 for remote-conference rooms. |
| Sound transmission rating | STC 45 for offices, STC 50 for meeting rooms, STC 55 for remote-conference rooms, STC 60 for mechanical system rooms |
| Layout | |
| Separation | Design space to avoid adjacency of noise-producing areas and those requiring quiet |

B.7 Corridors and circulation areas

Table B.5 provides design recommendations that should be met in corridors and circulation areas. Where Table B.5 is used for design criteria, all criteria in the table should be met. Alternative designs meeting the performance intent may be adopted following project-specific consultation with a competent person.

Table B.5
Design recommendations for corridors and circulation areas
(See Clauses B.1, B.2, and B.7.)

| Design element | Design recommendation/notes |
|--|---|
| Suspended ceilings | |
| Noise reduction coefficient (NRC) | 0.80 |
| <i>Note: If open ceiling, seek advice of acoustical engineer. Ceiling should be covered by sufficient absorptive material to compensate for the loss of absorption from the omission of acoustical ceiling tile.</i> | |
| Gypsum ceilings | |
| Offset lost absorption | Install acoustical panels |
| Heating, ventilation, and air-conditioning (HVAC) | |
| Noise limits | Maximum NC 40 (45 dBA) |
| Sound masking | |
| Overall level | Field tested to 47.5 dBA, ± 0.5dBA * |
| Masking spectrum | Field tested to Table A.6, ± 2.0 dB per 1/3 octave band * |
| Control zone for volume and 1/3 octave EQ | Individual zone per each area of 60 m ² or less |
| | <i>* Masking systems should be properly field commissioned, verified, and reported to ensure performance. See requirements in Clause A.10.3.10.3.</i> |
| Overhead lighting | |
| Fixtures | Avoid use of reflective flat-lensed light fixtures |
| Flooring | |
| Impact isolation class (IIC), below or adjacent | IIC 45 for offices or less sensitive places, IIC 50 for meeting rooms, IIC 55 for remote-conference rooms. Carpet meets the requirements of this Standard and reduces chair/footfall noise, though it has minimal impact on overall room sound absorption |

(Continued)

Table B.5 (Concluded)

| Design element | Design recommendation/notes |
|-----------------------------------|--|
| Raised floors (if present) | |
| Impact isolation rating | IIC 45 for offices or less sensitive places, IIC 50 for meeting rooms, IIC 55 for remote-conference rooms |
| Sound transmission rating | STC 45 for offices, STC 50 for meeting rooms, STC 55 for remote-conference rooms, STC 60 for mechanical system rooms |

B.8 Reception and waiting areas

Table B.6 provides design recommendations that should be met in reception and waiting areas. Where Table B.6 is used for design criteria, all criteria in the table should be met. Alternative designs meeting the performance intent may be adopted following project-specific consultation with a competent person.

Table B.6
Design recommendations for reception and waiting areas
(See Clauses B.1, B.2, and B.8.)

| Design element | Design recommendation/notes |
|--|--|
| Suspended ceilings | |
| Noise reduction coefficient (NRC) | 0.80 |
| <i>Note: If open ceiling, seek advice of acoustical engineer. Ceiling should be covered by sufficient absorptive material to compensate for the loss of absorption from the omission of acoustical ceiling tile.</i> | |
| Gypsum ceilings | |
| Offset lost absorption | Install acoustical wall and/or ceiling panels |
| Heating, ventilation, and air-conditioning (HVAC) | |
| Noise limits | Maximum NC 40 (45 dBA) |
| Sound masking | |
| Overall level | Field tested to 47.5 dBA, ± 0.5 dBA * |
| Masking spectrum | Field tested to Table A.6, ± 2.0 dB per 1/3 octave band * |
| Control zone for volume and 1/3 octave EQ | Individual zone per each area of 60 m ² or less |
| | * Masking systems should be properly field commissioned, verified, and reported to ensure performance. See requirements in Clause A.10.3.10.3. |

(Continued)

Table B.6 (Concluded)

| Design element | Design recommendation/notes |
|---|--|
| Overhead lighting | |
| Fixtures | Avoid use of reflective flat-lensed light fixtures |
| Flooring | |
| Impact isolation class (IIC), below or adjacent | IIC 45 for offices or less sensitive places, IIC 50 for meeting rooms, IIC 55 for remote-conference rooms. Carpet meets the requirements of this Standard and reduces chair/footfall noise, though it has minimal impact on overall room sound absorption |
| Hard flooring | High-traffic sections of floor should be carpeted |
| Acoustical panels | If floor and ceiling materials are hard surfaced, include sufficient absorptive panels on walls and ceilings |
| Raised floors (if present) | |
| Impact isolation rating | IIC 45 for offices or less sensitive places, IIC 50 for meeting rooms, IIC 55 for remote-conference rooms |
| Sound transmission rating | STC 45 for offices, STC 50 for meeting rooms, STC 55 for remote-conference rooms, STC 60 for mechanical system rooms |

