AS 7470:2016

Australian STANDARD®

Human Factors Integration in Engineering Design - General Requirements

RISSB

RAIL INDUSTRY SAFETY AND STANDARDS BOARD

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This Australian Standard® AS 7470 Human Factors Integration in Engineering Design - General Requirements was prepared by a RISSB Development Group consisting of representatives from the following organisations:

Acmena	ARTC	Asset Standards Authority (TfNSW)
AusSafe Consulting Pty Ltd	Brookfield Rail	Downer Group
FMGL	Metro Trains Melbourne	ONRSR
Pacific National	Queensland Rail	Sydney Trains
V/Line		

The Standard was approved by the Development Group and the Safety Standing Committee in October, 2016. On November 21, 2016 the RISSB Board approved the Standard for release.

This standard was issued for public consultation and was independently validated before being approved.

Development of the standard was undertaken in accordance with RISSB's accredited process. As part of the approval process, the Standing Committee verified that proper process was followed in developing the standard.

RISSB wishes to acknowledge the positive contribution of subject matter experts in the development of this standard. Their efforts ranged from membership of the Development Group through to individuals providing comment on a draft of the standard during the open review.

I commend this standard to the Australasian Rail Industry as it represents industry good practice and has been developed through a rigorous process.

Paul Daly
Chief Executive Officer
Rail Industry Safety and Standards Board

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Contents

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1 Introduction

1.1 Purpose

This Standard has been prepared to support Human Factors Integration (HFI) into the engineering design process within the Australian Rail Industry.

This standard describes the requirements for organisations conducting or procuring engineering design activities, services or products to —

- incorporate Human Factors within their engineering design processes,
- ensure their products comply with the generic Human Factors requirements set out in this standard, and
- use the HFI process to identify the specific Human Factors requirements of the system or asset being designed, procured or modified.

The aim of the requirements specified in this document is to optimise overall system performance through the systematic consideration of human capabilities and limitations as inputs to an iterative design process.

Adequate integration of Human Factors in all phases of a system's development lifecycle ensures its safety, performance and fitness for purpose.

For an operational system to deliver the expected benefits, it is essential that the human interactions with the system and system elements are well designed through the application of established HF principles, knowledge and methods. The process for achieving this is HFI.

The aim of the HFI process is to identify then mitigate and prevent Human Factors related risk and ensure that human-system interactions are optimised for system performance and safety. Incorporating HFI into the engineering design process also facilitates a high level of system acceptance amongst end users.

A supplier of engineered assets to the Australian rail industry is responsible for ensuring that the assets and systems they provide are safe to operate and maintain, and that all safety risks have either been eliminated or managed so far as is reasonably practicable (SFAIRP). Supporting evidence, demonstrating HFI in safety risk management activities, will provide an important contribution to an overall safety and operational assurance argument for most assets.

The benefits of considering HF in the design process are not limited to safety. Equally valuable benefits can be gained regarding the operation and maintenance of the system. These include but are not limited to —

- minimising errors,
- improving effectiveness,
- improved user comfort, and
- increased system acceptance.

To achieve these benefits, it is important to take HF into account early, starting with feasibility, solution optioneering, conceptualising, and throughout the full design process.

1.2 Scope

This standard provides the requirements for Human Factors Integration (HFI) within the following activities:

- Design or procurement of new or altered systems and assets to the rail industry. This includes any design changes to an asset throughout its lifecycle.
- Assurance of the suitability of like-for-like replacement of systems or assets within the rail industry in order to avoid promulgation of inefficiencies and error.
- Application of WHS Safe Design requirements.

Procurement of new or altered assets can involve design and manufacture, use of existing products or replacing like for like items. The requirements in this standard are focused around enabling effective Human Factors integration in the design phase of a design and manufacture project. However, they are also scalable to enable appropriate level of Human Factors integration into the other procurement strategies.

RISSB intends this standard for use by Human Factors specialists, design professionals including engineers, and managers within a Rail Transport Operator (RTO) or within an organisation that is contracted to provide engineering services and/or assets to an RTO.

This standard is not applicable to the following activities:

- The conduct of activities for manufacture, construction, installation, or commissioning of assets.
- HFI relating to the organisation of the day to day operation or maintenance of assets following hand over to the operating and maintenance organisations

Although this document does not cover these activities, there are benefits that an organisation conducting these activities can realise by applying an HFI process and HF knowledge in their day to day business.

- This standard is not intended for (although they are not prevented from using it): miniature railways and amusement railways; and
- Sugar cane, tourist, heritage and light rail networks such as urban tramways.

1.3 Compliance

There are two types of control contained within RISSB Standards:

(a) Mandatory requirements.

(b) Recommended requirements.

Each of these types of control address hazards that are deemed to require controls on the basis of existing Australian and international Codes of Practice and Standards.

A mandatory requirement is a requirement that the standard provides as the only way of treating the hazard.

Mandatory requirements are identified within the text by the term "shall".

A recommended requirement is one where the standard recognises that there are limitations to the universal application of the requirement and that there may be circumstances where the control cannot be applied or that other controls may be appropriate or satisfactory, subject to agreement with the Rolling Stock Operator, Rail Infrastructure Manager and/or Rail Safety Regulator.

Recommended clauses are mandatory unless the RIM or RSO can demonstrate a better method of controlling the risk.

Recommended requirements are to be considered when compliance with the standards is being assessed.

Recommended requirements are identified within the text by the term "should".

Hazards addressed by this standard are included in the RISSB Rail Hazard guideline. Refer to the RISSB website for the latest version of the RISSB Hazard Register Guideline: www.rissb.com.au

Hazards addressed by this standard are included in an Appendix A.

1.4 Referenced documents

1.4.1 Normative references

The following referenced documents are indispensable for the application of this Standard:

(a) Rail Safety National Law.

(b) Rail Safety National Law National Regulations.

(c) Disability (Access to Premises-Buildings) Standards.

(d) Disability Discrimination Act.

(e) Disability Standards for Accessible Public Transport.

(f) WHS Act 2011, Section 22.

(g) Any other relevant state based or design related legislation.

1.4.2 Informative references

The following referenced documents are used by this Standard for information only:

(a) RISSB ‘Safe Decisions’.

(b) ONRSR SFAIRP Guideline.

(c) ISO 31,000: 2009 Risk Management.

(d) International Ergonomics Association (IEA) 2016, Definition of Human Factors, accessed 01/03/2016.

1.5 Definitions

Anthropometric: is a reference to the data used in anthropometry

Anthropometry: is the science of measuring the variability of human physical characteristics. These include size, shape, weight, strength, range of motion, and working capacity

Asset: any good, product, equipment, facility or other tangible resource (excluding people) which comprises part of a rail system and which is under the control of a rail transport operator

DDA: Disability Discrimination Act

DSAPT: Disability Standards for Accessible Public Transport

End user: people who will interact with, or are affected by, an asset during the operational phase. Typical end users of a transport asset include crew, control room staff, cleaners, trainers, managers, signallers, maintenance personnel, customers, and the public including pedestrians, cyclists and road users. For a specific asset, all the end users need to be identified. Users may be considered primary, secondary, and tertiary end users depending on their level of interaction or impact on the system or parts of it

Ergonomics: see Human Factors

Error tolerant: ability of a system, through its design to minimise the potential for human error to occur, to reveal errors and/or to continue in safe operation despite erroneous inputs

HCI: human-computer interaction

HF: Human Factors

HFI: Human Factors integration

Human error: an action (or inaction) that may result in an unintended outcome

Human Factors: the scientific discipline concerned with understanding the interactions among humans and other elements of a system, and the profession that applies theory, principles, data, and methods to design in order to optimise human well-being and system performance. Synonymous with ergonomics

Human Factors integration: the formal process to integrate Human Factors into the system-engineering life cycle. It involves applying a systematic and scientific approach to the identification, tracking, and resolution of issues related to human-system interactions. Effective HFI ensures the balanced development of both the technological and human aspects of the system and delivers the desired safety and operational capability.

Human-system interaction: all instances where a human interacts with a delivered asset within the system

Like-for-like: a like-for-like replacement is a new item similar in form (shape, material, and so forth), fit (size and means of installation), and function (performs the same role) to the previous item

Maintainability: characteristics of a design and installation that determines the probability that a failed or non-compliant piece of equipment, machine, or system can be restored to its normal operating state within a given timeframe using the prescribed practices and procedures. From a Human Factors perspective, this means maintenance tasks can be carried out safely, effectively and efficiently and are tolerant to human error

Negative transfer: occurs when an end user who is familiar with a procedure or piece of equipment (learned skill) automatically transfers that skill to an alternate system or equipment when it is not appropriate. This can often result in tasks being omitted, operating the wrong controls, or operating the correct controls in the wrong direction

New or altered systems or assets: the changes made to assets other than those due to maintenance activities, including decommissioning and removal of assets.

Operability: is the ability to keep a piece of equipment, a system, or an entire industrial installation in a safe and reliable functioning condition, according to pre-defined operational requirements

Premises standards: Disability (Access to Premises-Buildings) Standards

Priority seating: seating for passengers with disabilities and other groups in need of special assistance (for example, the aging) as defined in DSAPT

Rail transport operator (RTO): an organisation that has responsibility for ensuring so far as is reasonably practicable, the safety of the operator's railway operation

SFAIRP: so far as is reasonably practicable as defined in the RSNL s47. The ONRSR's "Meaning of duty to ensure safety so far as is reasonably practicable" guideline provides further information

Stakeholder: the persons or groups that have claims on ownership, rights, or interest in a project or its activities in the past, present, or future

Supplier: any organisation providing engineering services or assets to a rail operator or maintainer

System: an asset and its context of use

Violations: deliberate but not necessarily reprehensible deviations from a rule or formal arrangement (such as a specified procedure).

2 Human Factors integration

2.1 Process requirements

Process requirements for Human Factors integration (HFI) include documentation, scalability, evidence, reporting, outcome verification and demonstrated competency:

(a) HFI process requirements shall apply to all engineering design and procurement contracts or projects.

(b) The HFI process shall form part of the RTO's and any supplier's engineering management procedures.

(c) The HFI process shall be scalable in its application, based on the risk, novelty, reliance on human performance, and complexity of each specific project to ensure the effectiveness and efficiency of its application.

(d) The HFI process shall be applied throughout the project design lifecycle, commencing with feasibility, solution optioneering, and/or conceptualising, and continue throughout the full design process to the completion of the operationally-ready system or asset. HFI activities and their deliverables shall be specified and integrated into the appropriate project documents and plans.

(e) Any project demonstration of the HFI process (including justification of its scale and scope) shall form part of the assurance of the project.

(f) HFI activities shall be reported at each of the defined project milestones. These may be contractual milestones or other internal milestones defined in the project plan.

(g) The HFI process and the results of HFI activity at each step in the process (see 2.2 and Figure 1) shall be documented.

(h) If through the application of its HFI process, an organisation determines that no additional HF activities are required, the organisation shall document and present this decision and reasoning as part of the overall assurance argument for the project at the first relevant project milestone, and re-evaluate at each subsequent project milestone.

(i) Organisations engaged in conducting or procuring engineering design activities, services or products on behalf of the Australian Rail Industry shall provide justification for any deviations from the process requirements set out in this standard.

(j) Recommendations or proposals for design changes shall be considered within the organisation's engineering design review process. Decisions regarding the adoption or rejection of such changes shall be documented.

(k) People undertaking any Human Factors (HF) activities shall be competent in Human Factors at a level appropriate to the activity being undertaken. The organisation shall be able to demonstrate the people are competent in Human Factors commensurate with the scale, scope and complexity of the products/services they are providing and with the ability to comply with the process and design requirements set out in this Standard.

2.2 Human Factors integration process

The HFI process described in this standard is compatible with the risk management process described within ISO 31,000 (an overview of the process is illustrated in figure 1). As a minimum, an organisation shall —

(a) establish and document the context of the use of the system, and in particular do the following:

  i. Identify how the new or altered system will integrate into the existing system or systems.

  ii. Identify all stakeholders and end user groups.

  iii. Identify all applicable regulatory requirements including the applicable requirements of the Disability Discrimination Act, Disability Standards for Accessible Public Transport and Disability (Access to Premises-Buildings) Standards legislation.

  iv. Identify end user attributes for example; population sectors, expected level of training, levels of use etc.

  v. Specify end user requirements.

  vi. Identify all human-system interactions as far as is reasonably practicable.

  vii. Characterise the criticality of HFI to project success by taking into account, among other relevant factors, the importance of human performance to system success, the extent of human-system interactions, and the extent of HF related risk.

(b) identify, record, and manage the HF issues to be addressed within the design of the asset or system. A list of common Human Factors topics that are particularly relevant to rail projects is described in Section 3 of this document,

(c) analyse, manage, and control the identified HF issues, including —

  i. conducting analyses to identify potential controls, using appropriate techniques and to the relevant level of detail, given the nature of the issue and the risk and complexity of the project,

  ii. demonstrating that HF is integrated in all risk and engineering design analyses that may have an impact on any human interactions with the system, and

  iii. demonstrating compliance with the generic Human Factors requirements set out in Sections 3.1 to 3.9 of this document.

(d) assess system design, including the adequacy of any identified HF controls, and determine whether changes to the design or additional controls are required,

(e) adopt and test the human interactions and HF controls within an iterative design process. This shall include the following:

i. Monitoring the effectiveness of these interactions and controls throughout the design development process (from early preliminary designs to later verification and validation phases).

ii. Closing out HF issues. Where this close out requires commitments from other parties, these commitments shall be agreed and documented prior to claim of the close out.

(f) communicate and consult with all stakeholders and end user groups throughout the design development or procurement process,

(g) monitor and review the effectiveness of its HFI process within a specific project and its deployment throughout the organisation,

(h) capture and record lessons learnt regarding the operability and maintainability of the design from each project, so the lessons learnt can be fed into other projects,

(i) the Human Factors integration process shall be iterative and shall regularly gather feedback from end users and stakeholders to incorporate into the system design,

(j) evidence that each of the above steps has been conducted and the results of each step, including the influence on the design, shall be documented. A Human Factors Integration plan (HFIP) is one method for documenting the Human Factors integration process.

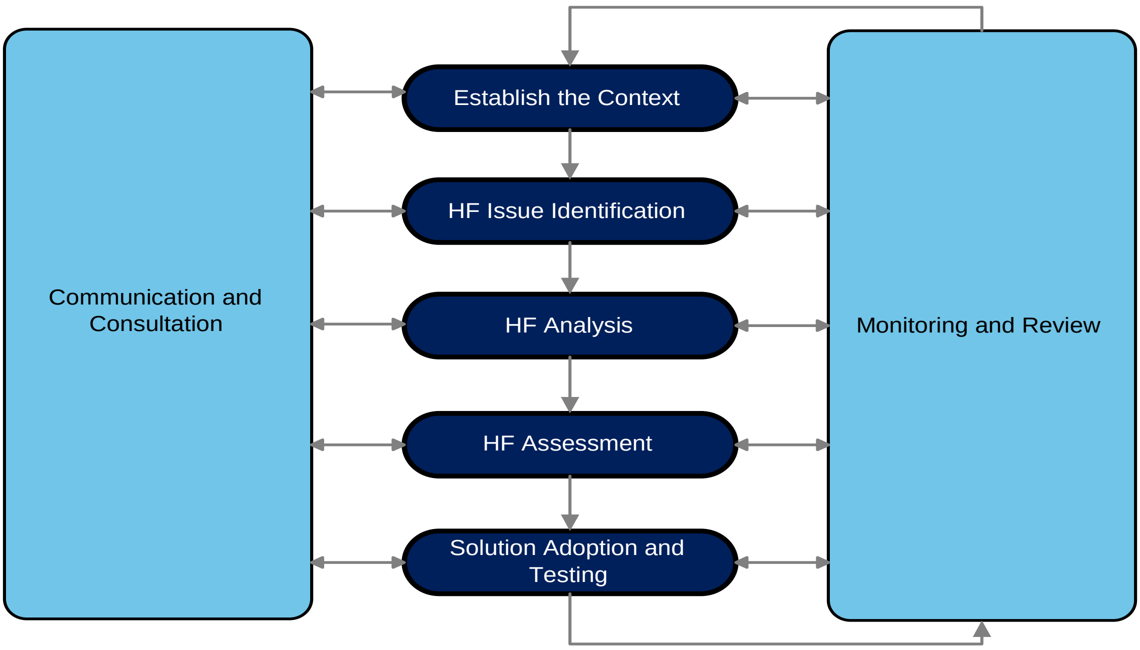

Figure 1 - Diagrammatic representation of the HFI process, which follows the structure of the risk management process described in ISO 31000:2009

3 Generic Human Factors requirements

Section 3.1 presents a list of design requirements which are mandatory for all projects.

The application of the HF requirements described in sections 3.2 – 3.9 are context specific and their application will be dependent on the nature of the system being designed. Therefore, not all of the requirements listed in these sections will be applicable to all projects. For requirements that are deemed to be applicable to a specific project, an organisation shall provide justification for any deviations from the generic HF requirements set out in this standard. Further, this is not a comprehensive list of all HF requirements. A project should use this list as a starting point and identify and address other applicable HF requirements or develop more detailed HF requirements based on the context of the system being designed.

Human Factors integration (HFI) aims to ensure optimisation of human-system interactions to provide effective system performance, safety and acceptability. Incorporating Human Factors (HF) through the life cycle, and particularly early in the design process, provides the most benefit. To aid this process, this section sets out a list of common generic Human Factors requirements that are likely to be applicable to most rail projects:

- Design requirements.
- Anthropometric data.
- Information content.
- Audibility and intelligibility of messages.
- Alarms and alerts.
- Controls and displays.
- Workspace and task design.
- Glare, reflections and line of sight.
- Customers and the public.

For each of the above issues a number of generic Human Factors requirements are described in the following sections. Other than the mandatory adherence to the design requirements set out in Section 3.1, there is no implied hierarchy or importance associated with the order of presentation of these HF requirements.

3.1 Design requirements

Integrating HF into the design/procurement process involves providing assurance through the form of physical and documented evidence to show that human capabilities, limitations, and other characteristics have been taken into account in order to ensure a safe and fit-for-purpose system or asset:

(a) The design shall be based on established Human Factors principles including but not limited to those set out in this section.

(b) The design of systems and equipment shall take into account the following:

i. The context of use; i.e., the context in which the system operates or will operate. Contextual details can include but are not limited to; objectives, means, end users, limitation, exceptions, stakeholders, physical and technology constraints and environmental consideration.

ii. Human variability, to ensure the system can cater for all specified ranges of end user characteristics, including the range of disability identified in the Disability Discrimination Act, as appropriate.

iii. Human physical and cognitive capabilities and limitations.

(c) The design, shall take into account the demands on, and the requirements of, end users during normal and degraded operations, routine and unplanned maintenance, cleaning, and emergency situations.

(d) The design shall include consideration of the overall environment for all end users. These considerations should include, but are not limited to, interior climate, the acoustic and visual environments, lighting and exposure to vibration.

(e) The design of a system shall ensure, to the extent feasible, that its correct use or operation is also the easiest or most obvious to the end user(s).

(f) The design of systems and equipment shall be error-tolerant and shall provide a means of error identification and recovery should an error occur. Where possible, a single human error should not result in system failure. Where a human error can result in a significant hazard multiple defences to control the hazard shall be provided.

(g) The potential for negative transfer to result in error or potential for system failure when an end user moves from one system (or operation within a system) to another shall be eliminated where practicable. If not eliminated the risk from potential negative transfer shall be managed SFAIRP.

(h) The reasons people might deliberately act incorrectly with the systems shall be identified and accounted for within the design in order to minimise violations.

(i) The design shall, where practicable, include features to prevent foreseeable misuse of the asset or minimise the consequences of misuse.

(j) The design shall not impose workload or create distractions that would impair performance of any primary or safety critical tasks.

(k) The design shall enable safe access to equipment for operations and maintenance.

(l) The design shall enable ease of maintenance tasks including cleaning, repair and replacement of components or systems.

(m) The design shall not allow parts to be installed incorrectly.

(n) The design shall incorporate provision for functional testing in order to reveal installation or maintenance errors prior to the equipment being accepted into service or returned to operation.

(o) Design reviews involving end users and stakeholders shall be part of the engineering design process. The number and level of review shall be appropriate to the nature of the project being undertaken and its impact on end users. These should be established as part of the HFI process set out in Section 2.

(p) The impact of design decisions on operational training requirements, staffing and resourcing shall be assessed during design reviews and as part of the end user consultation process.

(q) The design shall use relevant and valid Human Factors data where these are available. The use of data shall be justified as part of the design process.

3.2 Anthropometric data

(a) The physical design of the system shall use relevant and appropriate anthropometric data regarding size, shape, weight, strength, range of motion, and working capacity of the end users. In those cases, where these values are specified in legislation then the design shall comply with the legislative requirements.

(b) For all projects the minimum design anthropometric range for adults shall be from the 5th percentile female or male (whichever has the smaller value) to the 95th percentile male or female (whichever has the larger value). The RTO shall specify a broader anthropometric range where required.

(c) Where it is proposed that the design is to accommodate a lesser anthropometric range than that required under (b) above, this shall be fully justified on the basis of:

  i. physical constraints,

  ii. the end user population,

  iii. system performance requirements (e.g a trade-off between one requirement and another),

  iv. excessive cost.

(d) For assets, or parts of assets, designed for specific groups of users, the design shall include a wider range of end users in the design anthropometric range. Examples of such groups include children, people with ambulatory aids, and people in wheelchairs. These groups shall be identified as part of the design's context of use. Where values are specified in the Disability Standards for Accessible Public Transport or the Disability (Access to Premises-Buildings) Standards for specific uses, these shall be deemed a minimum requirement when applied for these specific uses.

(e) The design shall incorporate shoe, clothing, and personal protective equipment allowances as appropriate when determining anthropometric values, for example, dimensions, reach envelopes, and forces.

(f) The suitability of the anthropometric data chosen for use on the project shall be justified.

3.3 Information content

(a) Decisions regarding the design and content of the information presented to end users shall take into account its comprehension, visibility, legibility, importance, and adherence to established guidelines and standards.

(b) The project shall determine the end users' requirements for the information to be provided. A project shall ensure that the way information is provided caters for those end users. Different end users may have different requirements and this may require the design to provide more than one means of information presentation.

(c) Any information presented shall be comprehensible, visible, and legible, from the expected viewing distances and positions under all expected environmental conditions.

(d) The type of information displayed, the level of information required, the expected viewing distance, and the expected end user groups shall determine the size and type of the display and its contents.

(e) The design or provision of any information shall accommodate any specific requirements of the Disability Standards for Accessible Public Transport.

(f) All information provided shall be unambiguous and in English.

(g) Only information needed to enable an end user to effectively work or use the system in normal, degraded, and emergency situations shall be presented.

(h) Where non-operationally-important information may be required for other reasons (e.g., a supplier's logo or label may be a necessary identifier for maintenance purposes), it shall be inconspicuous.

Note: "Inconspicuous" in the above requirement means that the item shall not feature properties (such as size, movement, brightness or colour contrast) to the extent that it visually "stands out" from its background or is more conspicuous than operationally important information.

3.4 Audibility and intelligibility of messages

Auditory information, including messages delivered acoustically, shall be audible and comprehensible to the intended end users within the expected range of acoustic environments.

The delivery of auditory information shall not be at a level that could cause hearing damage.

3.5 Alarms and alerts

HF requirements for alarms and alerts involve safety, sufficient information, relevance, prioritisation, and accessibility. Methods of presenting alarms include, but are not limited to, audible, visual, and tactile means.

(a) Alarms shall enable the end users to take the required action to maintain the system in a safe and operable state or act appropriately in a degraded situation or emergency.

(b) The system shall comply with any specific requirements for alarms and alerts set out under the Disability Standards for Accessible Public Transport.

(c) Alarms and alerts should contain sufficient information to allow the end user to take the required action in a timely manner.

(d) Alarms and alerts shall, where feasible, only be directed to the end user who is required to take action upon that alarm. For some roles, for example in a control room, it may be useful for another end user to be made aware of an alarm.

(e) Alarms and alerts shall be prioritised according to their impact on the safety of the system and the required action by the end user.

(f) No more than three levels of prioritisation of alarms should be used.

(g) Alarms and alerts of different priorities shall be distinguishable by the end users.

(h) In the case that a single event raises multiple alarms or alerts, there should be a single method of acknowledging all the related alarms providing this does not delete information that the user must rely upon for subsequent action. Design decisions affecting alarm response and/or cancellation actions should be based on appropriate risk-based task analysis.

(i) End users shall be able to hear and, where applicable, distinguish between audible alarms within the expected range of acoustic environments.

(j) The volume level of alarms shall not be a level that could cause hearing damage.

3.6 Controls and displays

Controls and displays include all means by which a user can provide input to the system and the system provides information to the user. They include those provided on or through a computer or other graphic user interface and status indications on equipment.

(a) All human-computer interfaces shall be designed in accordance with established human computer interaction (HCI) and usability guidelines. A project shall identify which standards or guidelines have been used to develop their interface and justify their application for the specific project.

(b) The layout and position of controls and displays shall be determined based on the principles of frequency, sequence of use, importance, and functional groups.

(c) Primary controls shall be within reach of the normal operating position.

(d) Primary displays shall be visible from the normal operating position.

(e) Control and display selection and operation shall incorporate relevant user population stereotypes and expectations as far as is reasonably practicable when determining the appropriate operational movements and other qualities for example symbols, icons, colours and actions should be consistent with other equipment used by the same end users

(f) The type of display used shall be determined by the information requirements of the end user and the rate of change of the parameter being measured. Examples of types of display are digital, analogue, or moving pointer.

(g) The end user shall not have to convert displayed information into another format or unit to support task performance.

(h) End users shall be able to reach all relevant controls safely, including controls that are infrequently used.

(i) Controls shall be designed to minimise the potential for circumvention and inadvertent operation.

(j) It shall be impossible to place any control in a position that does not correspond to a designed state.

(k) In situations where controls may be used without direct viewing, the controls shall be differentiated using both visual and tactile means to minimise the risk of inadvertent operation.

(l) The control layout design and control selection shall minimise the likelihood of the inadvertent operation of a critical control.

(m) All labelling of controls and displays shall be comprehensible to end users.

(n) All labelling of controls and displays shall be visible and legible from the expected viewing positions and distances for the expected range of end users.

3.7 Workspace and task design

(a) Workspaces and tasks shall be designed to enable the end user to work safely, effectively and comfortably.

(b) The design process shall ensure that work space design —

i. accounts for the difficulty, importance, frequency and sequence of the tasks to be performed,

ii. accounts for workflow relating to interactions between groups of end users and/or different roles,

iii. eliminates or minimises the potential for hazardous tasks to be performed,

iv. eliminates or minimises the potential for constrained work positions to be adopted, and

v. accounts for the environmental conditions that are relevant to performance of the task.

(c) When an end user is required to maintain a stationary position for long periods, the workstation design shall allow the end user to maintain a comfortable working position with opportunities for substantial changes in posture, including alternation between sitting and standing, where feasible.

(d) Seating provided for the specified range of users shall be appropriate for the tasks to be conducted within the operating environment.

3.8 Glare, reflections and line of sight

(a) The design shall enable any line of sight requirements necessary for safe and effective operation of the system or asset. New structures or equipment shall not interfere with established operational line of sight requirements.

(b) Glare and reflections shall be eliminated where feasible. Where elimination of glare and reflections is not feasible, glare and reflections shall be minimised within and on workstations, controls, and displays.

(c) Methods shall be provided to eliminate or minimise reflections and glare in work areas, with particular attention given to crew cabs, control rooms and other dynamic or safety-critical locations.

3.9 Customers and the public

There are Human Factors (HF) generic requirements are also specifically applicable to customers and the public. These are set out in the following sections.

3.9.1 Users with disabilities

(a) Human Factors (HF) requirements for users with disabilities shall comply with legislation.

(b) The design of all systems and assets, including customer accessible areas, service provision, and other facilities that require customer interaction, shall meet the requirements of the Disability Discrimination Act (DDA), Disability Standards for Accessible Public Transport (DSAPT), and Disability (Access to Premises-Buildings) Standards (premises standards) legislation.

3.9.2 Information for customers and the public

Human Factors (HF) requirements for information for customers and the public relate to language use, clarity, ambiguity, symbols, and testing. Symbols and icons have been shown to be an effective way to convey information.

(a) All information for customers and the public shall be in English.

(b) Where necessary for safety, specified as a business requirement, or otherwise considered appropriate, equivalent information shall also be provided in the other specified language(s).

(c) Information provided for customers or the public for effective and safe navigation of the transport system or its environs, or to take action in response to any abnormal or emergency event, shall be clear and unambiguous.

(d) Established or well recognised symbols and icons shall be used when they are available.

(e) The effectiveness of the proposed way of presenting information, including the use of new symbols and icons, shall be verified through testing.

(f) The results of such tests shall be documented as evidence of their validity and conclusions.

3.9.3 Customer seating

The following applies to customer seating (including seating on transport vehicles):

(a) Seating dimensions shall be determined using anthropometric data for the specified end user population range. Any compromises to this requirement due to physical constraints (e.g., vehicle width limitations) shall be justified.

(b) Seat design and seating layout shall enable access and egress to all seats and thoroughfares (including through vehicles) under normal and emergency conditions.

(c) Handles and grips shall be associated with seating to help customers to get in and out of the seats and, in vehicles, to move through the vehicle.

(d) Assurance shall be provided of the suitability of customer seating and standing arrangements. This may be provided through one of the following options:

  i. User trialling with a representative sample of end users. The trialling should replicate the layout and context as closely as possible.

  ii. For off-the-shelf solutions, evidence of use in comparable contexts accompanied by appropriate justification of its use shall be acceptable

3.9.4 Handrails, poles and grab points on vehicles

On transport vehicles, handrails, poles and hand grabs shall be designed to enable the following:

(a) Assist passengers to safely access and egress the vehicle.

(b) Give steadying points for standing passengers whilst the vehicle is moving.

(c) Assist passengers to safely move around the vehicle.

(d) Lead people to the priority seating.

(e) Encourage movement away from obstructing doorways and passageways.

(f) Ensure smooth passenger movement without potential for catching clothes, bags or other personal items.

3.9.5 Passenger flows and wayfinding

Wayfinding systems aid users by providing information to support navigation, orientation, route decision-making, route progress monitoring and destination recognition.

Design of wayfinding systems shall include the following:

(a) Passenger flow modelling shall be used to support the design of publicly accessible areas.

(b) All signs used to support wayfinding shall be positioned to enable the user to easily locate, read, understand and act on the information provided in a timely manner and without obstructing passenger flow.

(c) Signs shall be positioned so they are legible from all directions and distances at which their information will be required.

(d) Signs shall be positioned at decision points to reduce stopping time and support continuous progression along a route.

(e) Wayfinding systems and signage shall be consistent and integrated with the existing built designs or purpose designed for new environments. principal routes through a space shall be clearly defined. This may be achieved by the use of signs, spatial planning, lighting and surface finishes.

(f) A logical sequence of wayfinding information shall be provided to support user journeys along a route, not just at the origin and destination points.

(g) Accessible information shall be provided throughout a space to provide inclusivity for users with a range of different needs.

(h) Wayfinding information shall be provided in multiple ways or formats to support different types of end users and reinforce route cues. This should include a combination of architectural features, graphics, dynamic displays, audible and tactile information, and text.

(i) Wayfinding systems and signage shall not impede operational sightlines.

Appendix A Hazards Addressed by this Standard

The nature of Human Factors is such that if a system is poorly designed from this perspective it can have an impact on the performance of any part or on the whole of the system.

The table below identifies the hazards listed in the RISSB Hazard Guideline that are addressed, at least, to some extent by the contents of this standard. In many cases other controls, for example technological etc., will also be required to mitigate the overall risk so far as reasonably practicable.

For this reason, the table below should be considered to be illustrative only.

Source	Related Factors	HF Standard Reference
4.1 Harm to the environment	4.1.1.17 Poor maintenance of locomotives 4.1.1.18 Poor maintenance of plant and equipment 4.1.1.19 Poor infrastructure maintenance	3.1 j, k, m
5.1 Harm to the environment (Rolling Stock)	5.9.1.2 Network control error 5.9.1.19 Poor cab vision so that the driver effectively 'ignores' signals	3.1 d, e, f
5.5 Harm to rolling stock related processes	5.5.1.45 Design deficiency causing the inability to operate trains	2.2 (All) 3.1 (All)
5.6 Out of Control Train	5.6.1.24 Background noise level in train being too high so that train crews are unable to hear the telecommunication system resulting in Train Control and train crews being unable to communicate 5.6.1.25 Speaker levels in trains are too soft so that train crews are unable to hear the telecommunication system resulting in Train Control and train crews being unable to communicate 5.6.1.37 Alarms being inadequate	3.4 a, b 3.4 a, b 3.5 (All)
5.8 Collision	5.8.1.5 Poor cab vision causing collision with stop blocks 5.8.1.21 Poor cab vision	3.8 (All) 3.8 (All)
5.9 SPAD	5.9.1.19 Poor cab vision so that the driver effectively 'ignores' signals	3.8 (All)
5.11Brakes ineffective when stationary	5.11.1.3 Hand / park brakes not being applied	3.1 e 3.6 j
5.14 Alerting System Failure	5.14.1.6 Alarms lacking visibility or audibility (Alerting system alarms not noticed) 5.14.1.7 Alarms lack differentiation to other alarms (Alerting system alarms not noticed) 5.14.1.14 Methods of monitoring not being applicable to all sizes, shapes, mass etc. of the driver population (Failure of the deadman system)	3.5 (All) 3.5 (All) 3.1 b (ii), b (iii) 3.2 (All)

5.17 Poor Cab Vision	5.17.1.2 Blinds restricting vision 5.17.1.3 Glare from cab instrument lighting 5.17.1.4 Glare from oncoming headlights 5.17.1.6 Glare from the sun through windscreens or off consoles 5.17.1.7 Windscreens being too small in area (Windscreens affecting vision) 5.17.1.8 Windscreens being badly scratched or cracked (Windscreens affecting vision) 5.17.1.9 The view from seating positions being affected by cab structures and / or equipment (Seating position affecting vision) 5.17.1.10 Short persons with low seats and high windscreens (Seating position affecting vision) 5.17.1.11 Tall persons and seats with low windscreens (Seating position affecting vision)	3.8a 3.8 b, c 3.8 c 3.8 a 3.8 a 3.2 b 3.2 b
5.20 Driver Fatigue	5.20.1.3 Complicated, continuous cognitive functioning being required to operate trains 5.20.1.8 Excessive cab control equipment forces 5.20.1.10 Uncomfortable temperature 5.20.1.11 Displays being difficult to read 5.20.1.13 Uncomfortable controls creating an uncomfortable driving position 5.20.1.14 Uncomfortable seats creating an uncomfortable driving position 5.20.1.15 Inadequate room for persons creating an uncomfortable driving position 5.20.1.16 Controls and footrests being too far from seating positions creating an uncomfortable driving position	3.1 B (iii) 3.1 B (iii), 3.2A 3.1 d 3.3 c & d 3.1 b (ii) & (iii) 3.7 a, d 3.2 a, b. 3.7a 3.2 a, b
5.21 Driver Distraction	5.21.1.1 Continual interruptions / messages from the train management system 5.21.1.5 Drivers being distracted by alarms or other controls and equipment	3.3 g 3.3 g, 3.5 (all)
5.22 Over speed	5.22.1.6 Speedometer arrangement being inconsistent with other rolling stock	3.1 g
5.45 Evacuation	5.45.1.3 No instructions being provided so persons don't know how to evacuate (Evacuation not successfully initiated)	3.3 b
5.47 Brakes applied too little to late	5.47.1.9 Brake controls not being within reach (Driver applies brakes too late) 5.47.1.10 Being unable to move brake controllers into higher rate positions (Driver applies insufficient brake)	3.2 b, 3.6 c 3.2 b, 3.6 c, h
5.50 Unintended brake application	5.50.1.1 Crews accidentally applying emergency brakes	3.6 i
5.51 Inadequate vehicular access	5.51.1.1 Trips and falls 5.51.1.2 Inadequate or missing hand rails or hand holds 5.51.1.3 No exterior stairs or ladders	3.9.4 (all) 3.9.4 (all) 3.1 c

	5.51.1.5 Access paths being too narrow or not tall enough 5.51.1.10 Not meeting DSAPT standards (Not suitable for persons with a disability, the elderly, prams, etc.).	3.1 b (ii) 3.1 b (ii)
6.6 Harm to infrastructure	6.6.1.33 Driver error	3.1 f, g, h
6.11 Collision	6.11.1.8 Poor cab vision	3.8 a
6.12 Poor cab vision	6.12.1.15 Short drivers with low seats and high windscreens 6.12.1.16 Tall drivers having seats with low windscreens 6.12.1.17 Driving position views being obstructed by cab structures and equipment	3.2 b 3.2b 3.8 a
6.18 Falls	6.18.1.44 Poor lighting	3.1 d
7.1 Collision 7.2 Harm to persons 7.3 Damage to Rolling Stock 7.4 Harm to environment	7.1.1.13 Poor ergonomic design 7.1.1.15 Poor equipment layout 7.2.1.13 Poor ergonomic design 7.2.1.15 Poor equipment layout 7.3.1.5 Poor resources and or excessive workload 7.3.1.13 Poor ergonomic design 7.3.1.15 Poor equipment layout 7.4.1.13 Poor ergonomic design 7.4.1.15 Poor equipment layout	3.1, 3.6 & 3.7 3.1 b (iii)
8.4.11.24 & 8.4.11.33 LPA Authorisation error by NCO	Blocking inadvertently removed	3.1 f, 3.6 i
9.5 Wireless Comms Failure	9.5.1.1 Human factors interfaces 9.5.1.12 Ergonomics	3.1, 3.6 & 3.7 3.1, 3.6 & 3.7
9.10 Signals failure	9.10.1.3 Failure to consider signal sighting	3.8 a
9.11 Train authority system failure	9.11.1.7 Human factors requirements not being considered	2.2 (All)
9.18 Control system failure	9.18.1.8 Ergonomics	3.1, 3.6 & 3.7

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