TS 04977:0.1

T HR HF 00001 ST

Standard

Human Factors Integration – Rolling Stock

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Document history

Revision	Effective date	Summary of changes
1.0		First issue, 22 August 2014
2.0		Second issue. Update to expand driver only operation (DOO) and automatic train protection (ATP)
3.0		Adoption of AS/RISSB 7470:2024 Human Factors Integration and Technical Requirements for Rail Engineering Projects
0.1	05/08/2025	Renumbered as TS 04977:0.1. Version number recommenced in line with new designation. Re-templated and minor revision.

Preface

This standard is the first issue as TS 04977. It supersedes T HR HF 00001 ST *Human Factors Integration – Rolling Stock – Version 2.0*.

This document provides HFI requirements specific to rolling stock projects, in addition to the general requirements for HFI provided in TS 04978.

This document details the minimum requirements for demonstrating HFI in the procurement of new rolling stock or alterations made to existing rolling stock.

The objective of this HF standard is to ensure assurance of the delivered asset, including the following:

- safe, effective and efficient use and maintenance of a delivered asset
- validation and verification of the HF requirements for operability and maintainability.

For railway rolling stock to deliver the expected levels of benefits to our customers, it is essential that human interactions with the system are well designed through the application of established HF principles and knowledge. HFI is the process for achieving this.

TAOs and other organisations undertaking work for TfNSW need to ensure that the assets they provide to TfNSW are safe to operate and maintain, and that all safety risks have been eliminated or minimised SFAIRP during the design process, in addition to their professional duty of care.

Supporting evidence demonstrating HFI activities within the safety risk management will provide an important part of the overall safety assurance argument in most cases.

HFI in the engineering design process produces tangible benefits in safety as well as efficiency and effectiveness in operability and maintainability of the asset over its life cycle.

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1 Scope

This standard details the minimum requirements for demonstrating HFI in the procurement of new rolling stock or alterations made to existing rolling stock.

The objective of this document is to ensure assurance of the delivered asset, including the following:

- safe, effective and efficient use and maintenance of a delivered asset
- validation and verification of the HF requirements for operability and maintainability.

This document provides the requirements for HFI within the following activities:

- procurement of new rolling stock
- alterations to existing rolling stock (changes to operational context or physical alterations to rolling stock other than those due to maintenance activities, including decommissioning and removal of rolling stock from service)
- HFI in manufacture, construction, installation, or commissioning phases of rolling stock projects.

This document does not cover the following activities:

- HFI in manufacture, construction, installation, or commissioning phases of rolling stock projects
- HFI relating to the organisation of the day-to-day operation or maintenance of the rolling stock following its handover to the operating and maintenance entities
- the design or alteration of road-rail vehicles.

Although this document does not apply to 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.

2 Application

This document applies to the TAOs and other organisations undertaking work for TfNSW. This document is intended for use by HF specialists, design professionals including engineers, and managers acting on behalf of organisations contracted to provide new or altered rolling stock to TfNSW.

This document should be read in conjunction with other applicable TfNSW standards including, but not limited to the following:

- TS 04978
- TS 04976
- TS 04981
- TS 05266
- TS 10504.

TS 04978 provides the generic requirements for HFI and applies to rolling stock projects. TS 04976 provides guidance on implementing these requirements.

3 Referenced documents

The following documents are cited in the text. For dated references, only the cited edition applies. For undated references, the latest edition of the referenced document applies.

Australian standards

AS/RISSB 7470 *Human Factors Integration and Technical Requirements for Rail Engineering Projects*

AS/RISSB 7470:2024 *Human Factors Integration and Technical Requirements for Rail Engineering Projects*

AS/RISSB 7533 *Driving cabs*

Transport for NSW standards

TS 03986 (T HR RS 04001 ST) *Passenger Rolling Stock Access and Egress*

TS 04053 (T HR RS 00100 ST) *RSU 100 Series – Minimum Operating Standards for Rolling Stock – General Interface Requirements*

TS 04976 (T MU HF 00001 GU) *Guide to Human Factors Integration*

TS 04978 *Human Factors Integration – General Requirements*

TS 04981 *System Safety Standard for New or Altered Assets*

TS 05266 *ETCS Onboard Equipment*

TS 10504 *AEO Guide to Engineering Management*

Legislation

Disability Standards for Accessible Public Transport 2002 (Cth)

4 Terms, definitions and abbreviations

The following terms, definitions and abbreviations apply in this document.

ATO automatic train operations

ATP automatic train protection

crew operational personnel who operate the rolling stock

Note: Examples of crew include the train driver, train guard

DMI driver-machine interface

DOO driver only operation

end user individuals interacting with or affected by an asset during its operation, including crew, staff, maintenance personnel, customers, and the public, classified based on their level of interaction or impact (Source: AS/RISSB 7470:2024)

HCI human-computer interface

HF human factors

HFI human factors integration

HFIP human factors integration plan

human error an action (or inaction) that can result in an unintended outcome (Source: AS/RISSB 7470:2024)

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 optimize human well-being and system performance. (Source: AS/RISSB 7470:2024)

Note: The term ‘human factors’ is synonymous with the term ‘ergonomics’ as defined in AS 7470:2024

human factors integration the process of adding human needs and abilities into system design to balance technology and user requirements for safety and effectiveness. See also human systems integration (Source: AS/RISSB 7470)

maintainability the ease with which equipment or systems can be fixed and returned to normal operation within a set time using the correct methods, while ensuring maintenance is safe, effective, efficient, and tolerant of human errors (Source: AS/RISSB 7470:2024)

maintenance personnel a personnel role to maintain an asset

Note: Examples of maintenance personnel include equipment technicians, locomotive maintenance technicians and infrastructure workers

negative transfer a situation in which a user applies skills from one system or equipment to another where they don't fit, leading to mistakes like missing tasks, using wrong controls, or operating the right controls incorrectly (Source: AS/RISSB 7470:2024)

operability 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 (Source: AS/RISSB 7470:2024)

> Note: From a human factors perspective, this means operational tasks can be carried out safely, effectively and efficiently, and are tolerant to human error

SFAIRP so far as is reasonably practicable

TAO technically assured organisation

TfNSW Transport for NSW

5 Rolling stock-specific human factors integration

TAOs and other organisations contracted to supply new or altered rolling stock to TfNSW shall apply an HFI process to all contracts with TfNSW in line with AS/RISSB 7470.

The TAOs and other organisations undertaking work for TfNSW shall document the HFI process.

The organisation undertaking work for TfNSW shall provide an HFIP covering, but not limited to, the following areas:

- driving and crew cabs in accordance with AS/RISSB 7533
- crew and other personnel interfaces not in the cab. Typically, these include but are not limited to the following:
  - crew and other personnel workstations and controls outside of the cab
  - catering provisions
  - internal equipment lockers, emergency equipment, and any external equipment access points including coupling equipment, required by operational and maintenance personnel
  - expectations of crew relating to familiarity of other rolling stock they drive, including the introduction to crew of new systems or operations not currently used by them and integration of the different elements and tasks that drivers and other personnel will be required to carry out.
- access and egress

- passenger areas on the rolling stock and their interfaces to infrastructure including platforms
- simulators and emulators
- maintenance considerations.

6 Human factors design requirements for rolling stock

Rolling stock design requirements relating to HF involve identifying and considering end users and human interactions, including different interfaces and human-system interactions, and creating an HFIP.

All rolling stock designs shall comply with TS 04978. In addition to the requirements of that standard, there are HF requirements that apply specifically to rolling stock. This document lists these requirements.

Rolling stock shall be designed to cater for the needs of all end users, which typically include but are not limited to passengers, crew, maintenance personnel, cleaners, controllers, signallers, trainers, managers, and the public.

The organisation contracted to supply new or altered rolling stock to TfNSW shall identify all the end users as part of the HFI process.

The rolling stock shall be designed to interact and interface with the infrastructure including, but not limited to, track, signalling, stations and platforms, control centres, yards and depots, and the end users associated with these areas and activities.

The HF planning for all rolling stock projects shall be described and demonstrated in an HFIP. Different projects will have varying levels of impact on human interactions in different areas and therefore the scale, complexity, and focus of the HFIP will vary according to the specific project.

6.1 Lessons learned for rolling stock

Incorporating lessons learned from past projects regarding HF for rolling stock is helpful for new projects.

The organisation contracted to supply new or altered rolling stock to TfNSW shall source both positive and negative lessons learned from previous rolling stock projects and apply the knowledge to their current project. To better understand the NSW context and improve its solution for TfNSW, the organisation should consult TfNSW about HF lessons learned on previous rolling stock procurement and alteration projects.

Examples of specific areas for consultation and review for lessons learned include, but are not limited to, the following:

- train (driver) safety system including the following:
  - vigilance systems, including the task linking aspects
  - operator enable system
  - ATP.
- glare and reflection problems within cabs including issues experienced with commercially available display screens and the resulting impact on HCI design
- haze and reduced visibility through the windscreen
- provision of alarms and alerts
- use of closed circuit television (CCTV) systems for monitoring the interface between the platform and the train
- provision of space for writing and electronic tablet tasks and for equipment required to be carried by crew, trainers, examiners, and other personnel with crew
- crew access steps
- roles of operational personnel other than the driver (for example, train guard, crew trainers, station staff)
- handrail and grab pole placement for crew when carrying out standing tasks
- train management system HCI
- equipment, systems, and actions for emergencies
- provisions for ancillary personnel including maintenance personnel, cleaners, and those carrying out security and revenue protection duties
- passenger areas, including provisions required by the *Disability Standards for Accessible Public Transport 2002*.

To ensure consistency for crew when moving between sets and to reduce negative transfer implications and training needs, the design process shall include reviews of the look, functionality and location of crew controls and displays in relation to other sets of a similar generation. Knowledge of crew rotations between different rolling stock during shifts is imperative in this regard.

Organisations undertaking work for TfNSW shall incorporate reviews by a range of end users including drivers, crew, and other operational and maintenance personnel and organisational stakeholder representatives into the design and engineering process.

The organisations undertaking work for TfNSW shall determine the level of review and consultation required for the project based on the risk and the amount and complexity of the human interactions required or changed.

6.2 Design of driving and crew cabs

6.2.1 General

The design of rolling stock driving and crew cabs has specific HF requirements. These requirements relate to areas including, but not limited to:

- lessons learned
- driving and crew positions and tasks
- controls and displays
- ensuring that there is no conflicting information being presented to the crew
- the quantity and method used to provide information, including the design of alarm provisions and the provision of screen text messages
- visibility including consideration of glare and reflection
- cab interior design including environment
- crew access and egress
- ease of accessing and maintaining equipment.

These requirements shall be met by adopting AS/RISSB 7533.

6.2.2 Driving and crew positions

Safety and comfort shall be taken into account when designing for driving and crew positions.

The primary driving position shall be the seated. All drivers within the anthropometric design range shall be able to operate safely, effectively and efficiently from the primary driving position. To enable a substantial change in posture, it is often appropriate to cater for a standing driving posture. For the purposes of this document, this is deemed a secondary driving position.

Any secondary driving position shall cater comfortably for a substantial percentage of the anthropometric design range of drivers.

All drivers within the anthropometric design range shall be able to operate safely from all positions.

When other personnel need to work in the cab simultaneously with the driver, then the personnel shall be able to do so without any physical or task conflicts occurring between them and the driver.

6.2.3 Human factors for controls in driving and crew cabs

HF considerations shall be taken into account in the design of controls in driving and crew cabs.

If a design incorporates a combined traction and brake controller, then the braking range should be forward and the power range backwards.

The design of any control associated with train (driver) safety systems shall minimise the potential to circumvent the control so far as is reasonably practicable (SFAIRP). Consideration shall be made for actions that cause a less safe method of operation.

Any safety system override control that a second person needs to operate shall not be operable from the driving position.

6.2.4 Visibility from driving and crew cabs

Suitable visibility shall be provided for drivers and crew in various driving conditions when in seated and standing position.

Signal visibility shall comply with TS 04053 unless otherwise specified in the contract.

Signals and associated signal indications shall be visible from the driving position when the train is in operation. The organisation contracted to supply new or altered rolling stock to TfNSW shall achieve this visibility with all cab equipment and furnishings in place.

The clarity of vision through the front windscreens shall meet the required level for all sun positions, brightness levels, and other external light conditions.

The organisation shall provide equipment to maintain visibility through the front windows in all driving conditions including frost, ice, rain, large temperature differential between cab and exterior, debris, and insects. This equipment shall not impede visibility under normal conditions.

6.2.5 Cab interior design

HF considerations for interior design for cabs include providing a safe and comfortable environment that is easy to maintain and free from unnecessary distractions.

The interior finishes shall provide for a pleasant working environment for the personnel and shall not introduce reflections and glare on controls or displays.

The organisation contracted to supply new or altered rolling stock to TfNSW, when choosing the finishes and materials, shall take into account the ease of cleaning, repairing, and replacing as well as ensuring durability.

6.2.6 Crew access and egress

Crew access and egress from rolling stock has important HF safety considerations.

The organisation contracted to supply new or altered rolling stock to TfNSW shall provide a safe means of access to and egress from the cab from either side of the train.

Crew shall be able to use the provided means of access and egress under all foreseeable normal, degraded, and emergency scenarios, including to and from track level including areas that are ballasted.

For passenger multiple unit rolling stock, the organisation shall provide a means of access and egress for personnel between the crew cab and the passenger area, with appropriate security to eliminate unwanted access.

6.3 Driver only operation

DOO refers to trains operated by one-person crew who is responsible for all safety operations. DOO for freight operations refers to operating freight trains with only one crew member, in the form of a driver. For passenger services this means operating with a driver but no guard. Other crew may be on board passenger services, but remain responsible for customer services only and not train safety. DOO has important HF considerations for the changed operating and maintenance practices, including functionality such as driver operated passenger doors.

Where DOO is implemented for passenger services, the driver shall have ease of visibility of the platform train interface to ensure safety of passengers boarding and alighting the train, and be able to safely operate the relevant doors from all driving positions. Technology shall be available to assist the driver in completing a thorough safety check of the door status and platform train interface area to confirm the area is free of any potential hazards. The technology should consider the appropriate coverage area and at a minimum provide the driver with visibility of the full length of the body side doors.

Any customer focused roles that are included in driver tasks should be assessed, and technology used where appropriate. This includes tasks such as the following:

- help point management
- emergency situations
- customer focused tasks.

Where DOO is implemented, the driver shall be assisted by appropriate technology to support them in their tasks and minimise workload impacts. Consideration should be given to the available systems to support out of course driver actions, such as having to leave the cab.

6.4 Automatic train protection

ATP has important HF considerations including consistency between rail operator sets for procedures and functionality, the DMI and user interactions, including operations and maintenance.

Where an ATP system is to be implemented, any inconsistencies between the base ATP standard and rail operator requirements shall be addressed, particularly in relation to the following:

- driver start of mission procedures through the DMI
- wording of text messages on the DMI
- provision of icons – meaning colour, position, status (steady or flashing)
- location of information on the screen
- DMI screen technology.

Text messages shall be configured to have sufficient meaning for each stakeholder to action the message.

6.5 Automatic train operations

For rolling stock that is generally not driven by a person, for example those operated under ATO Grade of Automation (GoA) 2 or 3 that requires a person to move the train in some circumstances, a position shall be identified from which people within the anthropometric design range are able to safely operate and move the train for the periods anticipated. For this work position, AS/RISSB 7533 shall apply. In circumstances where it is not necessary to provide a driver's seat, a justification for a standing driving position shall be provided that includes consideration of driver tasks, including duration of tasks.

6.6 Crew and other personnel interfaces not in the cab

Interfaces for crew and other personnel not in the cab have HF considerations.

The organisations contracted to supply new or altered rolling stock to TfNSW shall apply appropriate aspects of AS/RISSB 7533 to these interfaces. This includes fault management processes.

For any crew and other personnel interfaces not in the cab, TS 04978 shall apply.

6.7 Rolling stock passenger areas

Rolling stock areas for passengers have HF considerations including access and egress, and interior finishes and materials.

For passenger areas, TS 04978 shall apply, including any means of access and egress to and from the vehicle for normal, degraded, and emergency use. For passenger rolling stock, refer to TS 03986.

If the contract does not define egress rates, the organisation contracted to supply new or altered rolling stock to TfNSW shall determine these based on the operational context, including but not limited to expected peak passenger numbers, emergency scenarios, and routes the rolling stock will service.

The interior finishes shall provide customers with a pleasant travelling environment.

The interior finishes shall minimise reflections and glare.

When choosing the finishes and materials, the organisation shall take into account the ease of cleaning, repairing, and replacing, and ensuring durability and resistance to vandalism.

Where any equipment is located in the passenger areas, it shall not impede passenger access or egress or impact passenger safety or the travelling environment.

6.8 Mock-ups used for design evaluation

A mock-up is a representation of a design solution. It can range in fidelity from a simple paper prototype of a computer interface, a rough sketch model, or a cardboard and paper representation of a particular aspect of a physical interface, to a highly finished high-fidelity mock-up using some real controls and finishes to represent a full work or passenger area. A working prototype can be viewed as a mock-up, as it is a representation of the proposed design, However, typically as the mock-up fidelity increases, the opportunity to change the design reduces. The mock-up process can often start with simple rough mock-ups, and progress through to a higher fidelity mock-ups as the design matures.

Design evaluation can involve the use of mock-ups, which have requirements such as suitability, fidelity, and opportunity to generate feedback for improving design.

The organisation contracted to supply new or altered rolling stock to TfNSW shall use mock-ups throughout the design process.

Mock-ups shall be appropriate for the scale and scope of the project. Different aspects of the project can have different needs for mock-ups. The fidelity of any mock-ups used should be reflective of the tested information and the design’s maturity.

The organisation contracted to supply new or altered rolling stock to TfNSW shall incorporate feedback gained from mock-ups and reviews into design. Reasons that should warrant changes to the proposed design include but are not limited to the following:

- non-compliance with standards, legislation, specifications, or requirements
- potential for significant discomfort, dissatisfaction, or operational or maintenance difficulties experienced by the crew, maintenance, cleaning, and other personnel carrying out required tasks
- potential for negative transfer to have adverse effects on safety, operational, or maintenance tasks including cleaning performance
- design features that do not cater for the full anthropometric design range, and are considered to have a negative impact on the operability and maintainability of the system
- demonstrated lack of error tolerance within the system design, including normal and emergency operations
- demonstrated potential for inadvertent operation of controls that would impact operations or safety
- potential for significant discomfort, dissatisfaction, or potential significant vandalism or misuse by passengers
- identification of common work, health and safety (WHS) hazards such as slips, trips, pinch points, sharp edges, catch points, and closing traps.

6.9 Rolling stock simulators and emulators

Simulators and emulators for rolling stock have HF considerations regarding ease of use, safety, customisation, and feedback.

Simulators and emulators shall comply with TS 04978.

Simulators and emulators used for training and evaluation shall do the following:

- be easy to run and assess and evaluate trainees
- allow trainers to develop and alter many scenarios

  Note: Simulators and emulators should allow the easy input and modification of a range of track layouts and environmental conditions, and other operational movements including degraded and emergency situations.
- provide immediate feedback on trainee performance to enable the trainer to identify performance improvement requirements
- reflect the characteristics of the real asset given its intended use.

Organisations shall design simulators and emulators to ensure safe operation and good environmental conditions for both trainers and trainees. Simulators and emulators shall be easy to maintain and update.