



Finnish Transport Agency

**FINNISH INTERLOCKING REQUIREMENTS 2010  
QUALITATIVE REQUIREMENTS**

Document title

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Revision history

Revision	Date	Revision description
1.2	18.2.2014	Small changes, mostly in terminology (see the list below)
1.1	15.11.2010	Editorial correction to this document and Appendix 2.
1	1.11.2010	Final version

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FIR-QR243, 266: reference to standard EN 50159 changed

FIR-QR267: removed

FIR-QR321, 322, 323: EIR changed to FIR

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FIR-QR1434: one item added (fixed infrastructure)

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FIR-QR001-Com	<b>1 Overview</b>
FIR-QR002-Com	<b>1.1 Purpose</b>
FIR-QR003-Com	Purpose of Interlocking System Qualitative Requirements is to establish a generic framework for Qualitative Requirements in railway interlocking system undertakings.
FIR-QR004-Com	Interlocking System Qualitative Requirements promotes good engineering practices in order to achieve RAMS targets for an Interlocking System.
FIR-QR005-Com	Hazard identification, risk analysis, risk management, quality management, safety management and other related processes which are necessary to fulfil the non-technical requirements of CENELEC standards (i.e. EN 50126, EN 50128 and EN 50129) have to be defined for each specific application. Contents of this document are intended to be used to appropriately plan and manage qualitative aspects of a specific application.
FIR-QR006-Com	Interlocking System Qualitative Requirements sets numerous technical performance requirements, which have to be complied or separately specified. In most cases the Interlocking System technical performance has to be specified considering the system size, technology used and other performance aspects in the specific application.
FIR-QR007-Com	Those generic requirements, which need additional specification in a specific application, are highlighted with <i>curative</i> text. Exact performance values or specification of technical solutions are expected for these requirements.
FIR-QR008-Com	Interlocking System Qualitative Requirements is based on a structured document collection combined in this single document. Where 'document' is referred to in the text, the reference is made to the chapter including the content of the 'document' unless exact reference is given in the references chapter.
FIR-QR009-Com	Generic Hazard List for hazard identification is presented in Appendix 1. The hazard list defines common hazards to be considered in scope of Interlocking Systems but is not exhaustive. Hazards specific to the installations, technologies and products used have to be considered in an appropriate manner for each specific application.
FIR-QR010-Com	Requirements for physically separate juridical recorder are presented in Appendix 2.
FIR-QR011-Com	<b>1.2 Scope</b>
FIR-QR012-Com	Related CENELEC and IEC standards are listed in Chapter 3.9 'High Level Requirements - References'.
FIR-QR013-Com	Qualitative Requirements does not void or relieve any of the requirements of referenced standards.
FIR-QR014-Com	Qualitative Requirements is intended to be used in scope of railway Interlocking Systems.
FIR-QR015-Com	The scope of the RAMS requirements is the interlocking system.
FIR-QR016-Com	Additional guidance on the non-technical requirements of related CENELEC standards (i.e. EN 50126, EN 50128 and EN 50129) can be found for example in 'The Yellow Book' published by Rail Safety and Standards Board on behalf of the UK rail industry ( <a href="http://www.yellowbook-rail.org.uk/">http://www.yellowbook-rail.org.uk/</a> ).

FIR-QR017-Com	<b>2 Hazard Log</b>
FIR-QR018-Com	The CENELEC standard EN 50126 “Railway Application: The specification and demonstration of Reliability, Availability, Maintainability and Safety (RAMS)” describes a life cycle process for developing a safe and dependable system. The life cycle is divided into several phases, and in phase three a Hazard Log should be set up.
FIR-QR019-Com	This document is set up according to the instructions in EN 50126.
FIR-QR020-Com	<b>2.1 Purpose</b>
FIR-QR021-Req	The Hazard Log is a document in which all safety management activities, hazards identified, decisions made and solutions adopted are recorded or referenced.
FIR-QR022-Req	The Hazard Log is aimed as a basis for on-going risk management. The Hazard Log shall be updated, whenever a change to any identified hazard occurs or a new hazard is identified, throughout the lifecycle. The Hazard Log shall also be updated if any modification or alteration is made to the system, sub-system or equipment.
FIR-QR023-Com	Information gathered in the Hazard Log should actively be used as input in the management level decision process. The information should also be a basis for estimation of the risks involved in the action.
FIR-QR024-Com	<b>2.1.1 A process for on-going risk and accident reporting</b>
FIR-QR025-Req	Any existing management documents within the organisation that describe the routine for handling with safety critical faults shall be identified.
FIR-QR026-Com	<b>2.1.2 A process for management of the Hazard Log</b>
FIR-QR027-Req	The Hazard Log will appear as a binder of documents, one document for each logged hazard. This umbrella document should be placed in the very beginning of the binder. The binder shall be found either at the office of the customer or at the office of the supplier, dependent on responsibility for different life cycle development phases.
FIR-QR028-Req	The part currently responsible for a specific phase is also responsible for the management of the Hazard Log and that it is used in the intended way.
FIR-QR029-Com	<b>2.2 Content</b>
FIR-QR030-Req	Hazard Log shall include details of:
FIR-QR031-Req	Date of the logging and reference (name)
FIR-QR032-Req	Each hazardous event and contributing components
FIR-QR033-Req	Likely consequences and frequencies of the sequence of events associated with each hazard

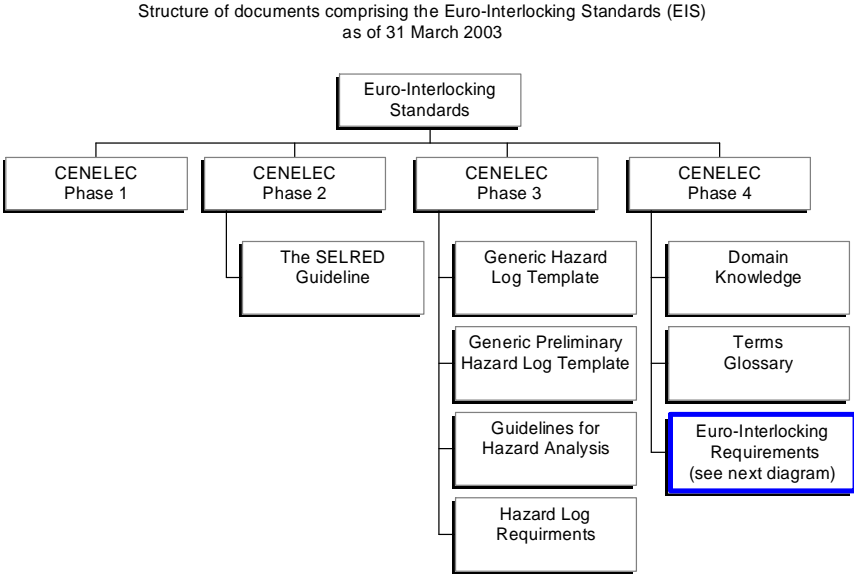
FIR-QR034-Req	The risk of each hazard . (The risk is defined as the product of the frequency (or probability) and the consequence of a specified hazardous event).
FIR-QR035-Req	The measures taken to reduce to a tolerable level, or remove, the risk for each hazardous event
FIR-QR036-Req	A description of any analysis carried out, its limits, any assumptions made during it or any confidence limits applying to data used within it
FIR-QR037-Req	The methods, tools and techniques used
FIR-QR038-Req	The personnel, and their competencies, involved in the process.
FIR-QR039-Com	<b>2.3 Results of the risk analysis</b>
FIR-QR040-Com	<b>2.4 Risk Tolerability</b>
FIR-QR041-Com	Tolerable risk is defined as the maximum level of risk of a product that is acceptable to the customer.
FIR-QR042-Com	<b>2.4.1 Risk Tolerability criteria for the application</b>
FIR-QR043-Com	<b>2.4.2 A process to review risk tolerability</b>
FIR-QR044-Com	<b>2.5 A process to review the effectiveness of risk reduction measures</b>
FIR-QR045-Com	<b>2.6 Hazard Log - References</b>
FIR-QR046-Com	EN 50126 Railway Applications: The specification and demonstration of Reliability, Availability, Maintainability and Safety (RAMS). CENELEC



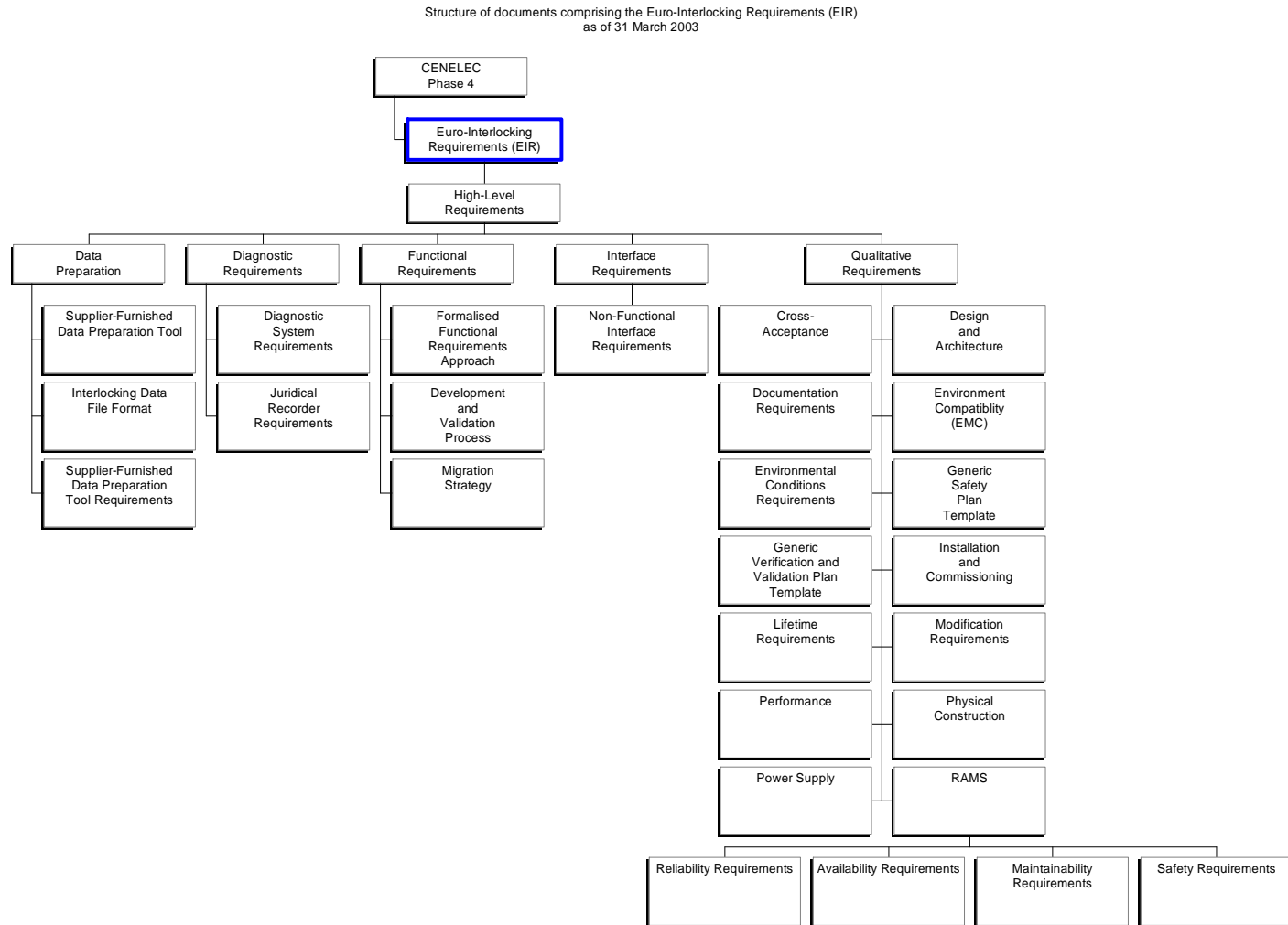
FIR-QR047-Com	<b>3 High Level Requirements</b>
FIR-QR048-Com	<b>3.1 Background</b>
FIR-QR049-Com	The idea behind the structure is to build a tree that relates all documents to each other and supports traceability for each document's content.
FIR-QR050-Com	The document "Project Declaration" presents the project's objectives and strategy. These have also been developed over time in the document "'Synthesis' and Strategy Report". The two documents prescribe what the project basically should deliver.
FIR-QR051-Com	One of the key assignments is to conform to the European standard EN 50126, "Specification and Demonstration of Reliability, Availability, Maintainability and Safety (RAMS)."
FIR-QR052-Com	The document structure has therefore been chosen so that it fulfils EN 50126 in a clear and logical way. The structure is a natural consequence of the life cycle EN 50126 describes.
FIR-QR053-Com	The EN 50126 life cycle is divided into 14 phases. In each phase, certain tasks are mandatory. The initial phases 1 to 4 are preparation phases, including investigations, planning, eliciting information and writing requirements for the system in question. The middle phases (5 to 9) are development phases in which the system is designed, constructed and validated. The last phases (10 to 14) are operation and recycling phases, dealing with maintenance, modification, and finally disposal of the life-expired system.
FIR-QR054-Com	Each phase has a top document entitled the "Phase n document" (where n runs from 1 to 14). It presents the tasks and corresponding deliverables for the phase. The document either contains the deliverable itself or refers to a document that does.
FIR-QR055-Com	Here are two examples from the Phase 1 document:
FIR-QR056-Com	Example A: The following is a required task in phase 1 (according to EN 50126, section 6.1.3.3): "Identify sources of hazards which could affect the RAMS performance of the system." This task is fulfilled directly in the Phase 1 document, which contains the corresponding deliverable (see the Phase 1 Document).
FIR-QR057-Com	Example B: Another required task in phase 1 is the following (according to EN 50126 section 6.1.3.2 a): "Review of any financial analysis of the system." This task is not fulfilled directly in the Phase 1 document. Instead, the document refers to the separate report, "Business Case for the European Railways, December 2000" (see the Phase 1 Document).
FIR-QR058-Com	EN 50126 provides no guidelines on how to structure the requirements themselves. Therefore, the methods used when writing the requirements will influence their structure. One important goal of the structure is to enable traceability of all requirements.
FIR-QR059-Com	<b>3.2 Purpose</b>
FIR-QR060-Com	This document states high-level requirements for the interlocking system and its supporting systems.

FIR-QR061-Com	A guideline has been to link all lower-level requirements to a general, high-level requirement. The high-level requirements in this document are intended to give the reader an overall picture what the system shall be capable of performing. It may be impossible to verify or validate a high-level requirement without referring to the more detailed, lower-level requirements to which it links.
FIR-QR062-Com	In most cases, a rationale supports the associated requirement. The rationale is in some cases based on the phase documents for phases 1 through 4 or the Euro-interlocking document, "Business Case for the European railways".
FIR-QR063-Com	One major intent of the requirements in this document - taken together with the linked lower-level requirements - is to fulfil the task, "Specify the overall RAMS requirement for the total system" (EN 50126 section 6.4.3.1).
FIR-QR064-Com	<b>3.3 Scope</b>
FIR-QR065-Com	This document comprises all the high-level requirements for an interlocking system, diagnostic system, juridical recorder and data preparation system.
FIR-QR066-Com	The requirements in this document are linked in a hierarchical structure. This structure includes both links between objects in this document, and links between objects in lower-level documents and objects in this document.
FIR-QR067-Com	<b>3.4 Structure</b>
FIR-QR068-Com	The following diagrams show the structure of the documents in the Euro-Interlocking Standards (EIS) and the Euro-Interlocking Requirements (EIR).

FIR-QR069-Diag



FIR-QR070-Diag



FIR-QR071-Com	The top document in the requirements hierarchy is this “High Level Requirements” document. Two other documents provide support at this level: “Terms” and “Domain Knowledge”.
FIR-QR072-Com	The document “Terms” defines all the terms needed to be able to express the requirements. The document “Domain Knowledge” expresses all the assumptions about the world that we assume to be true.
FIR-QR073-Com	Each document contains an introduction (Section 1), domain knowledge (Section 2), document contents (in one or more sections) and references (last section in the document).
FIR-QR074-Com	The introduction gives an overview of the document and puts it in context.
FIR-QR075-Com	Domain knowledge provides basic background information specifically related to the document. See also the Domain Knowledge document.
FIR-QR076-Com	The document contents present the document’s essential deliverable material.
FIR-QR077-Com	References support the reader with information about other documents to which the present one refers.
FIR-QR078-Com	<b>3.5 Terms and notations</b>
FIR-QR079-Com	All words in the Euro-Interlocking Standards (EIS) shall be interpreted as in the Oxford Dictionary except terms and notations of special relevance to the EIS.
FIR-QR080-Com	Terms of special relevance to the Euro-Interlocking Standards (EIS) are defined in the dedicated Euro-Interlocking Glossary of Terms.
FIR-QR081-Com	Terms and definitions in the Glossary of Terms are taken from glossaries of other signalling projects or have been developed by the Euro-Interlocking project.
FIR-QR082-Com	<b>3.6 Unique identification of each statement in the Euro-Interlocking Standard (EIS)</b>
FIR-QR083-Com	To allow the unique identification of statements from the high-level requirement document within the EIS, the letters “HL” (high level) precede the number for each object in this document. Each statement has a unique number.
FIR-QR084-Com	The purpose of each statement is in one of the following categories: - Comment (Com) for introductory text and headings - Requirement (Req) for requirements - Term (Term) for words defined especially for the Euro-Interlocking project. - Diagram (Diag) for context diagrams - Scenario (Scene) for a definition of a sequence of events - Domain Knowledge (DK) for background information.
FIR-QR085-Com	<b>3.7 High Level Requirements – Domain knowledge</b>
FIR-QR086-Com	This chapter contains facts about the application domain in which the interlocking system will operate.

FIR-QR087-Com	This chapter describes properties in the real world (seen from the user's viewpoint) that are (or are assumed to be) true. In contrast, requirements describe properties the railways want to be true.
FIR-QR088-Com	The Domain Knowledge document contains context diagrams describing the system boundary, major parts of the system, and information flows.
FIR-QR089-DK	Factors outside the interlocking system - such as track layout and train characteristics - limit the level of rail traffic in a given time period.
FIR-QR090-Com	<b>3.7.1 Users</b>
FIR-QR091-Com	An interlocking system has the following human users:
FIR-QR092-DK	- Signallers
FIR-QR093-DK	- Train drivers
FIR-QR094-DK	- Train staff
FIR-QR095-DK	- Signalling maintenance technician
FIR-QR096-DK	- Passengers
FIR-QR097-DK	- Persons crossing tracks in level
FIR-QR098-DK	A signaller is assumed to observe national operating rules when carry out the activities related to the responsibilities as signaller.
FIR-QR099-DK	A train driver is assumed to observe national operating rules when carry out the activities related to the responsibilities as train driver.
FIR-QR100-DK	Train staff is assumed to observe national operating rules when carry out the activities related to the responsibilities as train staff.
FIR-QR101-DK	A signalling maintenance technician is assumed to observe national operating rules when carry out the activities related to the responsibilities as signalling maintenance technician.
FIR-QR102-DK	Passengers are assumed to act responsibly when entering, travelling and leaving the train.
FIR-QR103-DK	Persons crossing tracks in level are assumed only to do this in areas specially designated for this. When crossing the track they are assumed to observe national operating rules.
FIR-QR104-Com	<b>3.8 High Level Requirements – Requirements</b>
FIR-QR105-Com	<b>3.8.1 Safety requirements</b>
FIR-QR106-Req	The interlocking system shall protect its human users from hazardous situations and prevent the creation of hazardous situations.
FIR-QR107-Req	The interlocking system equipment shall be first and foremost safe.
FIR-QR108-Req	In addition to safety, also reliability and availability is required from the interlocking system.
FIR-QR109-Com	It must be noted that safety is opposite target to reliability and availability.
FIR-QR110-Com	Objective for safety is to eliminate dangerous faults (safety faults), typically at the cost of reliability and availability.

FIR-QR111-Req	Principal rule is that the highest safety integrity level (SIL4) is complied with in the railways. Deviation from this rule is specified in the invitation for tenders.
FIR-QR112-Com	<b>3.8.2 Interoperability requirements</b>
FIR-QR113-Req	The interlocking system shall fulfil specified standards in applicable Technical Specifications for Interoperability (TSIs) for the conventional rail system.
FIR-QR114-Com	<b>3.8.3 Train operation requirements</b>
FIR-QR115-Req	<i>The interlocking system shall enable a defined density of rail traffic in a given time period, with a specified punctuality.</i>
FIR-QR116-Com	<b>3.8.4 Functional requirements</b>
FIR-QR117-Req	The signaller shall be able to send commands to and get statuses from the interlocking system via a traffic control system in order to support planned and required train movements in a safe manner.
FIR-QR118-Com	<b>3.8.4.1 Safety functions</b>
FIR-QR119-Com	The interlocking system shall have safety functions that:
FIR-QR120-Req	- Prevent a collision between trains.
FIR-QR121-Req	- Prevent derailment of a train.
FIR-QR122-Req	- Prevent a collision between a train and traffic at a level crossing.
FIR-QR123-Req	- Prevent a collision between a train and railway maintenance staff.
FIR-QR124-Req	- Prevent a collision between a train and fixed infrastructure.
FIR-QR125-Com	<b>3.8.4.2 Commands, statuses, detected values and steering values</b>
FIR-QR126-Req	The interlocking system's functionality shall support the commands and statuses required in the interface to the traffic control system.
FIR-QR127-Req	The interlocking system's functionality shall support the physical detected values and physical steering values required in the interface to physical elements and external elements.
FIR-QR128-Com	<b>3.8.4.3 Route life cycle</b>
FIR-QR129-Req	The interlocking system's functionality shall support a route life cycle consisting of pre-test, marking, locking, monitoring, releasing and cancellation.
FIR-QR130-Com	<b>3.8.4.4 Physical elements and external elements</b>
FIR-QR131-Req	The interlocking system's functionality shall support the physical elements identified in the interface section.
FIR-QR132-Req	The interlocking system's functionality shall support the external elements identified in the interface section.

FIR-QR133-Com	<b>3.8.5 System requirements</b>
FIR-QR134-Req	The interlocking system and its supporting systems shall be implemented on technical platforms that minimise life cycle costs whilst still satisfying performance requirements.
FIR-QR135-Com	<b>3.8.5.1 Design and architecture</b>
FIR-QR136-Req	The design and architecture of the interlocking system shall support a distinction between a generic product (for several railways), a generic application (for a single railway) and a specific application (for a specific site).
FIR-QR137-Com	<b>3.8.5.2 Physical construction</b>
FIR-QR138-Req	It shall be possible to connect the interlocking system to existing and future adjacent systems, physical elements and external elements.
FIR-QR139-Com	<b>3.8.5.3 Requirements for diagnostic system</b>
FIR-QR140-Req	The interlocking system shall be provided with an efficient diagnostic system supporting preventive and corrective maintenance.
FIR-QR141-Com	<b>3.8.5.3.1 Diagnostic system contributing requirements</b>
FIR-QR142-Req	The diagnostic system shall be independent of the interlocking system.
FIR-QR143-Req	The diagnostic system shall be configurable for each particular customer and specific application.
FIR-QR144-Req	The access to the diagnostic system shall be efficiently security protected.
FIR-QR145-Req	The diagnostic system shall allow the user to efficiently observe, locally or remotely, on-line or off-line, the state of any diagnosed object of the interlocking system.
FIR-QR146-Req	The diagnostic system shall efficiently identify and log all diagnostic events and faults in the interlocking system.
FIR-QR147-Req	The diagnostic system shall support a high level of maintainability and consequently high level of availability and safety for the interlocking system.
FIR-QR148-Com	The diagnostic system can interact with safety related elements in the following two ways:
FIR-QR149-Req	- Safety related elements (such as IL-K) shall never be influenced by the diagnostic system.
FIR-QR150-Req	- Safety related elements (such as IL-K) shall never be influenced by the diagnostic system, except for the execution of commands which a user is allowed, within defined procedures, to put into the interlocking system via the diagnostic system.
FIR-QR151-Req	Communication equipment and communication interfaces used by the diagnostic system shall conform to the overall interface requirements for the interlocking system.
FIR-QR152-Req	The diagnostic system shall support functions for cooperation with systems at higher diagnostic levels.
FIR-QR153-Com	<b>3.8.5.4 Requirements for juridical recorder</b>
FIR-QR154-Req	The interlocking system shall be provided with an efficient juridical recorder.



FIR-QR155-Com	<b>3.8.5.4.1 Juridical recorder contributing requirements</b>
FIR-QR156-Req	A juridical recording function shall be associated with each interlocking system.
FIR-QR157-Req	The events to be stored on the juridical recorder shall allow an efficient backward juridical analysis of the cause of an accident.
FIR-QR158-Req	The juridical recorder function shall be used only to record and allow the downloading of recorded data that may be used for legal purposes after hazardous situations.
FIR-QR159-Req	All subsystems of the interlocking system shall automatically provide the juridical recorder with all necessary juridical data.
FIR-QR160-Req	Access to the juridical recorder shall be efficiently security protected.
FIR-QR161-Req	The juridical recorder's data shall not be altered.
FIR-QR162-Req	The juridical recorder shall never influence the safe working of the interlocking system.
FIR-QR163-Req	Communication interfaces and communication equipment used by the juridical recorder shall conform to the overall interface requirements for the communication interfaces of the interlocking system.
FIR-QR164-Com	<b>3.8.5.5 Power supply</b>
FIR-QR165-Req	The interlocking system shall have a power supply.
FIR-QR166-Com	<b>3.8.5.6 Environmental conditions</b>
FIR-QR167-Req	<i>The Interlocking system shall operate correctly under the environmental conditions that may be reasonably expected to occur during its operational lifetime.</i>
FIR-QR168-Com	<b>3.8.5.7 Electromagnetic compatibility (EMC)</b>
FIR-QR169-Req	<i>The interlocking system shall produce no electromagnetic interference that could affect surrounding systems and shall be protected against electromagnetic interference from surrounding systems.</i>
FIR-QR170-Com	<b>3.8.5.8 RAM</b>
FIR-QR171-Req	<i>The interlocking system shall have high reliability, high availability and shall require minimal maintenance.</i>
FIR-QR172-Req	For the interlocking system central part a total operational break shall not occur more often than once in 30 years.
FIR-QR173-Req	For the operating and HMI equipment of interlocking system a total operational break shall not occur more often than once in 30 years.
FIR-QR174-Req	For the operating and HMI equipment of interlocking system a partial operational break shall not occur more often than once in a year.
FIR-QR175-Req	Geographical allocation of interlocking system controllers' areas shall aim at creating parallel routes through the railway yard, so that single interlocking system controller failure shall not stop rail traffic on the whole width of the yard. Geographical redundancy shall be thus applied.
FIR-QR176-Req	All RAM requirements shall be applicable for a specific application.

FIR-QR177-Com	<b>3.8.5.8.1 RAM contributing requirements</b>
FIR-QR178-Req	There shall be no degradation in the performance of the interlocking system over its lifetime.
FIR-QR179-Req	Maintenance of the interlocking system shall be possible throughout its operational lifetime.
FIR-QR180-Req	Maintenance of the interlocking system shall be possible without interrupting safe operation of the railway.
FIR-QR181-Req	Allowed MTTR for the interlocking system is no more than 12 hours including travel time of maintenance personnel. Effective repair time shall be tens of minutes at most (this is not basis for calculations).
FIR-QR182-Com	<b>3.8.5.9 Lifetime</b>
FIR-QR183-Req	<i>The interlocking system shall have a long operational lifetime (at least 25 years).</i>
FIR-QR184-Com	<b>3.8.5.9.1 Lifetime contributing requirements</b>
FIR-QR185-Req	<i>A given interlocking system model shall be available from its supplier for a significant number of years (model lifetime at least 15 years).</i>
FIR-QR186-Req	The interlocking system shall have guaranteed spare parts availability during operational lifetime. Spare parts need not be of same type provided that they are compatible with the operational interlocking system and fulfil the requirements for the original interlocking parts.
FIR-QR187-Req	The original software of interlocking system must be functional in the new hardware without such modifications which could have effect on safety.
FIR-QR188-Com	<b>3.8.5.10 Performance</b>
FIR-QR189-Req	<i>A model of interlocking system shall have satisfying response times for site-specific applications of an appropriately wide range of sizes.</i>
FIR-QR190-Com	<b>3.8.6 Procedural requirements</b>
FIR-QR191-Req	All work during the life cycle of the interlocking system shall be efficient and be performed with high quality and the required safety.
FIR-QR192-Com	<b>3.8.6.1 RAMS management</b>
FIR-QR193-Req	The life-cycle activities related to the interlocking system shall comply with the European norms in the area of railway safety. This involves the following activities:
FIR-QR194-Req	- The interlocking system shall be developed and used in accordance with EN 50126.
FIR-QR195-Req	- If the interlocking system uses safety-related software, it shall be developed and used in accordance with EN 50128.
FIR-QR196-Req	- Safety acceptance and approval shall take place in accordance with EN 50129.

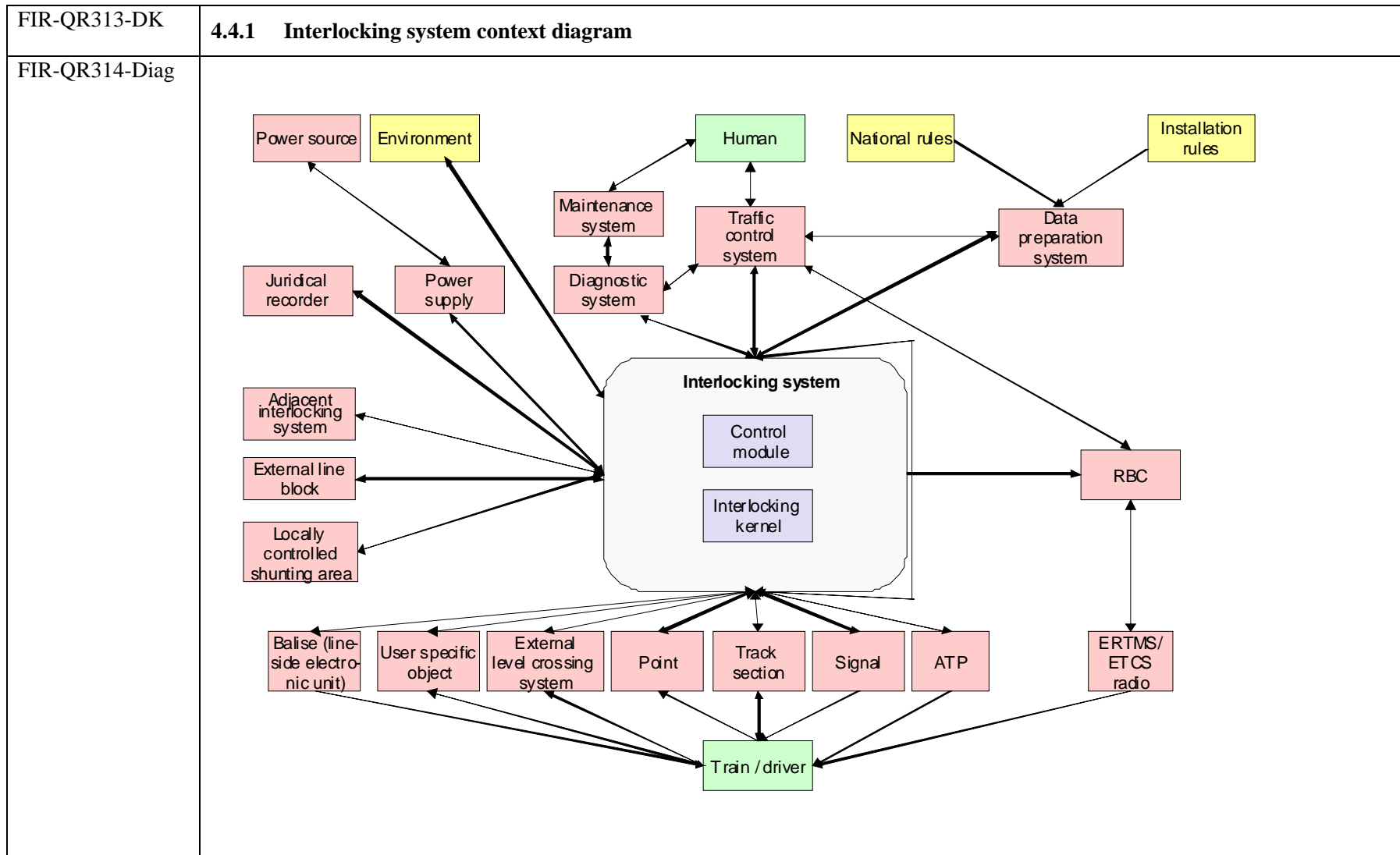
FIR-QR197-Req	Methods shall be adopted to ensure traceability of all aspects and components of the interlocking system throughout its life cycle.
FIR-QR198-Com	<b>3.8.6.2 Verification and validation</b>
FIR-QR199-Req	A process shall be established that ensures verification and validation of all requirements at the required phases of the system lifecycle in accordance with European Norms.
FIR-QR200-Com	<b>3.8.6.3 Data preparation</b>
FIR-QR201-Req	Configuration of the interlocking system to reflect a particular set of signalling principles as well as a particular track and signal layout shall occur on the basis of a standardised data preparation process.
FIR-QR202-Com	<b>3.8.6.4 Installation and commissioning</b>
FIR-QR203-Req	The interlocking system shall provide for efficient installation and commissioning without affecting railway safety.
FIR-QR204-Com	<b>3.8.6.5 Modification</b>
FIR-QR205-Req	The interlocking system shall provide for efficient modification with minimal influence on rail traffic.
FIR-QR206-Com	<b>3.8.6.6 Cross-acceptance</b>
FIR-QR207-Req	Acceptance of a generic product of interlocking system shall be possible in a number of countries.
FIR-QR208-Com	<b>3.8.6.7 Documentation</b>
FIR-QR209-Req	The interlocking system's documentation shall support its users efficiently throughout the life cycle.
FIR-QR210-Com	<b>3.8.7 Interface requirements</b>
FIR-QR211-Req	<i>The interlocking system shall provide open, generally-known, standardised interfaces for communication between the interlocking system and other electronic systems and components.</i>
FIR-QR212-Com	<b>3.8.7.1 Interface contributing requirements</b>
FIR-QR213-Req	Interfaces of the interlocking system shall be internal interfaces, communications interfaces, physical external interfaces, and data interfaces.
FIR-QR214-Req	Internal interfaces shall interface subsystems within the interlocking system.
FIR-QR215-Req	<i>Communications interfaces shall interface the interlocking system with other electronic systems using standardised communication equipment and transmission protocols. This interface shall allow the systems to be physically remote from one another, and/or produced by different suppliers.</i>
FIR-QR216-Req	Physical external interfaces shall interface the interlocking system to electrical lamps, point machines, relays etc. in a fail-safe manner.
FIR-QR217-Req	<i>Data interfaces shall interface the interlocking system with its data preparation system, using either standardised communication equipment and transmission protocols, or standardised removable memory media.</i>

FIR-QR218-Com	<b>3.8.7.1.1 Required Interfaces</b>
FIR-QR219-Com	When necessary, interfaces shall be provided to the following:
FIR-QR220-Com	Physical elements:
FIR-QR221-Req	- <i>signal</i>
FIR-QR222-Req	- <i>point</i>
FIR-QR223-Req	- <i>diamond crossing</i>
FIR-QR224-Req	- <i>track segment</i>
FIR-QR225-Req	- <i>user specific object</i>
FIR-QR226-Req	- <i>ATP</i>
FIR-QR227-Req	- <i>ETCS Lineside Electronic Unit (LEU)</i>
FIR-QR228-Req	- <i>level crossing system (internally controlled)</i>
FIR-QR229-Req	- <i>local 'control' area</i>
FIR-QR230-Com	External elements:
FIR-QR231-Req	- <i>external level crossing system</i>
FIR-QR232-Req	- <i>external line block</i>
FIR-QR233-Req	- <i>adjacent interlocking system</i>
FIR-QR234-Req	- <i>ERTMS/ETCS radio block centre</i>
FIR-QR235-Com	Other systems:
FIR-QR236-Req	- <i>traffic control system</i>
FIR-QR237-Req	- <i>diagnostic system</i>
FIR-QR238-Req	- <i>juridical recorder</i>
FIR-QR239-Req	- <i>data preparation system</i>
FIR-QR240-Com	<b>3.8.7.1.2 Required compliance with standards</b>
FIR-QR241-Req	All interfaces (communication interfaces as well as physical external interfaces) shall fulfil specified standards in applicable Technical Specifications for Interoperability (TSIs) for the conventional rail system.
FIR-QR242-Req	<i>Communication interfaces shall use standardised communication equipment and transmission protocols compliant with ITU-T (CCITT), ETSI, IETF or CENELEC standards.</i>
FIR-QR243-Req	<i>A communication interface shall be designed in accordance with EN 50159.</i>
FIR-QR244-Req	All interfaces (communication interfaces as well as physical external interfaces) shall be designed and constructed in accordance with the EN 50122-1, EN50121, IEC 60364-1, EN 50081-2 and EN 50082.

FIR-QR245-Com	<b>3.9 High Level Requirements – References</b>	
FIR-QR246-Com	<b>3.9.1 Purpose of this chapter</b>	
FIR-QR247-Com	This chapter presents an overview of the standards used in the Qualitative Requirements.	
FIR-QR248-Com	Dated references to the referenced standards are not given. Currently valid revision of the standard shall be used.	
FIR-QR249-Com	In lower-level documents, the references appear as part of requirements (Req).	
FIR-QR250-Com	<b>3.9.2 European Standards (EN)</b>	
FIR-QR251-Com	EN 50081-2	EMC - Generic Emission Standard.
FIR-QR252-Com	EN 50082-2	EMC - Generic Immunity Standard.
FIR-QR253-Com	EN 50091-1-1	Uninterruptible power systems (UPS) Part 1-1: General and safety requirements for UPS used in operator access areas
FIR-QR254-Com	EN 50121-1	Railway application: Electromagnetic compatibility - Part 1: General.
FIR-QR255-Com	EN 50121-2	Railway application: Electromagnetic compatibility - Part 2: Emission of the whole railway system to the outside world.
FIR-QR256-Com	EN 50121-3-2	EMC - Railway application: Electromagnetic compatibility - Part 3-2: Rolling stock - Apparatus.
FIR-QR257-Com	EN 50121-4	Railway application: Electromagnetic compatibility - Part 4: Emission and Immunity of the signalling and telecommunication apparatus.
FIR-QR258-Com	EN 50121-5	Railway application: Electromagnetic compatibility - Part 5: Emission and Immunity of fixed power supply installations and apparatus.
FIR-QR259-Com	EN 50122-1	Railway Applications - Fixed Installations - Protective provisions relating to electrical safety and earthing.
FIR-QR260-Com	EN 50124-1	Railway applications - Insulation coordination - Part 1: Basic requirements - Clearances and creepage distances.
FIR-QR261-Com	EN 50124-2	Railway Applications: Insulation coordination - Part 2: Overvoltages and related protection.
FIR-QR262-Com	EN 50125-3	Railway Applications: Environmental conditions for equipment - Part 3: Equipment for signalling and telecommunications.
FIR-QR263-Com	EN 50126	Railway Applications - The Specification and Demonstration of Reliability, Availability, Maintainability and Safety (RAMS).
FIR-QR264-Com	EN 50128	Railway Applications - Communications, signalling and processing systems - Software for railway control and protection systems.
FIR-QR265-Com	EN 50129	Railway Applications - Communications, signalling and processing systems - Safety related electronic systems for signalling.

FIR-QR266-Com	EN 50159-1 communication in	Railway Applications - Communication, signalling and Processing Systems - Safety related transmission systems.
FIR-QR268-Com	EN 50160	Voltage characteristics of electricity supplied by public distribution systems
FIR-QR269-Com	EN 50272-2	Safety requirements for secondary batteries and battery installations Part 2: Stationary batteries
FIR-QR270-Com	EN 60446	Identification of conductors by colours or numerals.
FIR-QR271-Com	EN 61000-3-2	EMC - Limits of harmonic current emissions.
FIR-QR272-Com	EN 61000-3-3 rated current <	EMC - Limitation of voltage fluctuations and flicker in low voltage supply systems for equipment with 16 A.
FIR-QR273-Com	EN 61140	Protection against electric shock - Common aspects for installation and equipment
FIR-QR274-Com	<b>3.9.3 International Electrotechnical Commission Standards (IEC)</b>	
FIR-QR275-Com	IEC 60068-2-1	Environmental testing - Part 2: Tests. Tests A: Cold.
FIR-QR276-Com	IEC 60068-2-2	Environmental testing - Part 2: Tests. Tests B: Dry heat.
FIR-QR277-Com	IEC 60068-2-3	Environmental testing - Part 2: Tests. Test Ca: Damp heat, steady state.
FIR-QR278-Com	IEC 60068-2-11	Environmental testing - Part 2: Tests. Test Ka: Salt mist.
FIR-QR279-Com	IEC 60068-2-14	Environmental testing - Part 2: Tests. Test N: Change of temperature.
FIR-QR280-Com	IEC 60068-2-17	Basic environmental testing procedures - Part 2: Tests - Test Q: Sealing.
FIR-QR281-Com	IEC 60068-2-20	Environmental testing. Part 2: Tests. Test T: Soldering.
FIR-QR282-Com	IEC 60068-2-21	Environmental testing - Part 2-21: Tests - Test U: Robustness of terminations and integral mounting devices.
FIR-QR283-Com	IEC 60068-2-27	Environmental testing. Part 2: Tests. Test Ea and guidance: Shock.
FIR-QR284-Com	IEC 60068-2-45 solvents.	Basic environmental testing procedures - Part 2: Tests - Test Xa and guidance : Immersion in cleaning
FIR-QR285-Com	IEC 60068-3-1	Environmental testing - Part 3: Background information - Section One: Cold and dry heat tests.
FIR-QR286-Com	IEC 60068-3-1	A Environmental testing - Part 3: Background information - First supplement.
FIR-QR287-Com	IEC 60364-1	Electrical insulations of buildings - Part 1: Fundamental principles, assessment of general characteristics, definitions.
FIR-QR288-Com	IEC 60364-4-41	Electrical insulations of buildings - Part 4-41: Protection for safety - Protection against electric shock.
FIR-QR289-Com	IEC 60364-4-42	Electrical insulations of buildings - Part 4-41: Protection for safety - Protection against thermal effects.
FIR-QR290-Com	IEC 60364-7-707 Earthing	Electrical insulations of buildings - Part 7: Requirements for special installations or locations. Section 707: requirements for the installation of data processing equipment.
FIR-QR291-Com	IEC 60364-7-714 lighting	Electrical insulations of buildings - Part 7 Requirements for special installations - Section 714: External insulations.

FIR-QR292-Com	IEC 60617-1	Graphical symbols for diagrams. Part 1: General information, general index. Cross-reference tables.
FIR-QR293-Com	IEC 60617-2	Graphical symbols for diagrams. Part 2: Symbol elements, qualifying symbols and other symbols having general application.
FIR-QR294-Com	IEC 60617-3	Graphical symbols for diagrams. Part 3: Conductors and connecting devices.
FIR-QR295-Com	IEC 60617-4	Graphical symbols and diagrams. Part 4: Passive components.
FIR-QR296-Com	IEC 60617-5	Graphical symbols and diagrams. Part 5: Semiconductors and electron tubes.
FIR-QR297-Com	IEC 60617-6	Graphical symbols and diagrams. Part 6: Production and conversion of electrical energy.
FIR-QR298-Com	IEC 61024-1	Protection of structures against lightning - Part 1: General principles.
FIR-QR299-Com	IEC 61024-1-1	Protection of structures against lightning - Part 1: General principles - Guide A: Selection of protection levels for lightning protection systems.
FIR-QR300-Com	IEC 61024-1-2	Protection of structures against lightning - Part 1-2: General principles - Guide B - Design, installation, maintenance and inspection of lightning protection system.
FIR-QR301-Com	IEC 61558-1	Safety of power transformers, power supply units and similar. Part 1: General requirements and tests
FIR-QR302-Com	<b>3.9.4 Other standards</b>	
FIR-QR303-Com	X.200	Information technology - Open Systems Interconnection - Basic reference model: The basic model.
FIR-QR304-Com	<b>4 Domain Knowledge</b>	
FIR-QR305-Com	<b>4.1 Background</b>	
FIR-QR306-Com	The documents in the Euro-Interlocking Requirements (EIR) describe a set of generic requirements for a generic product and a generic application.	
FIR-QR307-Com	<b>4.2 Purpose</b>	
FIR-QR308-Com	The purpose of this document is to present facts about the application domain in which the interlocking system will operate.	
FIR-QR309-Com	The current state of the Domain Knowledge is meant to support the approved qualitative documents. It will be revised later to accompany interface and functional requirements. At that time, some elements may be added; others may moved to the interface and functional requirements.	
FIR-QR310-Com	<b>4.3 Scope</b>	
FIR-QR311-Com	Within the EIS, the document for a given area contains the domain knowledge specific to that area.	
FIR-QR312-Com	<b>4.4 Domain Knowledge – Context diagrams</b>	





FIR-QR315-DK	Diagram DK-1247 presents the interlocking system context diagram. The data flows correspond to the interfaces between the interlocking system (the grey box) and physical elements and other systems.
FIR-QR316-Com	<b>4.5 Domain Knowledge – Context diagram definitions</b>
FIR-QR317-Com	<b>4.5.1 Introduction</b>
FIR-QR318-Com	The context diagram in previous Chapter describes the interlocking system. The diagram shows the interlocking system in its correct environment and present the data flows between the interlocking system, physical elements and other systems.  A main purpose of this document is to explain the context diagram in previous Chapter.
FIR-QR319-Com	It is emphasised that a context diagram is not a design.
FIR-QR320-Com	<b>4.5.2 Scope</b>
FIR-QR321-Com	The context diagram in previous Chapter describes the scope of FIR in the following main ways:
FIR-QR322-Com	- The boundary of the interlocking system context diagram (DK-1247) is applicable to the qualitative requirements in FIR.
FIR-QR323-Com	- As the diagrams show, FIR does not specify the human-machine interface.
FIR-QR324-Com	<b>4.5.3 Description of the fields in the context diagram</b>
FIR-QR325-Com	<b>4.5.3.1 General</b>
FIR-QR326-Com	The context diagram in previous Chapter has the following colour scheme: - Blue is for functional objects. - Pink is for tangible, physical, non-abstract objects. - Yellow is for more abstract areas. - Green is for secondary areas (such as trains and human actors) that interact with the interlocking system.
FIR-QR327-Com	The arrows in the context diagram in previous Chapter symbolise data flows (interfaces) between the areas. The flows fall into the following classes: - some are physical in nature (such as current, voltage, load, and temperature), - some will use standard data protocols, and - some are external, and thus outside the scope of this project (such as flows between national rules and the data preparation

	system).
FIR-QR328-Com	<b>4.5.3.2 Functional objects</b>
FIR-QR329-Com	In EIR, the interlocking system includes both an 'interlocking kernel' and a set of functions called the 'control module'.
FIR-QR330-Com	<b>4.5.3.2.1 Interlocking kernel</b>
FIR-QR331-Com	Current interlocking systems often mix safety and non-safety functions within the same system.
FIR-QR332-DK	Safety related (SIL 4) functions and interfaces are in the interlocking kernel.
FIR-QR333-DK	The interlocking kernel contains detection and steering systems.
FIR-QR334-Com	Examples of possible interlocking kernel functions are locking functions and movement authority.
FIR-QR335-Com	<b>4.5.3.2.2 Control module</b>
FIR-QR336-DK	The control module contains functions that are not SIL 4 and are outside the interlocking kernel.
FIR-QR337-Com	The control module allows the TCS and the interlocking system to be independent of each other. The TCS and the interlocking system can come from different suppliers and can be replaced at different times.
FIR-QR338-DK	The control module sends requests to the interlocking kernel, such as "change point position" and "lock and reserve". The interlocking kernel informs the control module about the status of physical elements and external elements.
FIR-QR339-DK	The control module can override the interlocking kernel under certain circumstances.
FIR-QR340-DK	It is assumed that the functions of the control module are consistent with the relevant ERTMS/ETCS level.
FIR-QR341-Com	<b>4.5.3.3 Traffic Control System (TCS)</b>
FIR-QR342-DK	Signallers, remote control systems, automatic route-setting systems and possibly other systems give commands to the traffic control system (TCS). The TCS passes commands to the interlocking system, which in turn sends all required status information to the TCS.
FIR-QR343-DK	Depending on the design of the interlocking system, the functionality of the control module can be implemented within the TCS.
FIR-QR344-Com	<b>4.5.3.4 Diagnostic system</b>
FIR-QR345-DK	The Diagnostic System logs state changes and faults within the interlocking system and provides this information for external use. The failure may be temporary or permanent. The diagnostic system can give certain special orders to the interlocking system that the TCS cannot give.
FIR-QR346-DK	The diagnostic system can inform the control module about faults within the interlocking system, and the control module may be able to give special orders to the diagnostic system. (In the context diagram, the data-flow arrow therefore goes both ways.)
FIR-QR347-DK	Detailed information on faults can flow directly from physical elements and other systems to the diagnostic system, bypassing the interlocking kernel, if the customer so requires.

FIR-QR348-Com	<b>4.5.3.5 Maintenance system</b>
FIR-QR349-DK	The maintenance system is an external system which treats states and faults recorded by the diagnostic system according to the railway's requirements.
FIR-QR350-Com	<b>4.5.3.6 Power source</b>
FIR-QR351-DK	The power source is the external utility or device providing electrical power to the power supply within the interlocking system and its physical elements.
FIR-QR352-DK	<b>4.5.3.7 Power supply</b>
FIR-QR353-DK	The Interlocking Power Supply derives from the Source, all necessary power to run the interlocking system including supplies to external components and track elements.
FIR-QR354-DK	The power supply can be seen as the interface between the external power source and the interlocking system. In some cases, the interlocking system power supply also directly powers physical elements such as signal lamps
FIR-QR355-Com	<b>4.5.3.8 Data preparation system</b>
FIR-QR356-DK	The data preparation system provides a standardised way of creating data for the configuration of a specific interlocking system on the basis of national and installation rules.
FIR-QR357-DK	Unlike the other systems, a data preparation system does not run online. After preparation and validation, the data is loaded into the traffic control system, diagnostic system, maintenance system, and the interlocking system. Depending on the design of the interlocking system and the data preparation system, the involved data may be safety-critical.
FIR-QR358-Com	<b>4.5.3.9 Adjacent interlocking system</b>
FIR-QR359-DK	An adjacent interlocking system is an interlocking system controlling an adjacent area.
FIR-QR360-DK	Extension of train routes to and from an adjacent interlocking system is possible on the basis of information and permissions from the two interlocking systems.
FIR-QR361-Com	<b>4.5.3.10 Line block</b>
FIR-QR362-DK	A Line Block or Block System is a safety system that controls train operations between Interlocking areas and to the Open Line.
FIR-QR363-DK	<b>4.5.3.10.1 External Line Block</b>
FIR-QR364-DK	An External Line Block is a Line Block system that is not an integral part of the Interlocking System, but that interfaces to it.
FIR-QR365-DK	<b>4.5.3.10.2 Internal Line Block</b>
FIR-QR366-DK	An Internal Line Block is a Line Block system that is integral to the Interlocking System

FIR-QR367-Com	<b>4.5.3.11 Balise (lineside electronic unit)</b>
FIR-QR368-DK	A balise (lineside electronic unit - LEU) can be either a Eurobalise, Euroloop, or radio infill unit. The balise (LEU) communicates with a passing train to provide ETCS track-to-train data transmission. The balise (LEU) receives information from the interlocking system.
FIR-QR369-Com	<b>4.5.3.12 Radio block centre (RBC)</b>
FIR-QR370-DK	The interlocking system sends information (e.g. about movement authority or emergency stop) to the ERTMS/ETCS radio block centre, which transmits the information by radio to the train. Conversely, the train transmits information (e.g. about train position and train characteristics) to the radio block centre, which forwards this information to the interlocking system. Radio block centre can be included in the interlocking system.
FIR-QR371-DK	ERTMS/ETCS level 2 and 3 use the radio block centre.
FIR-QR372-DK	<b>4.5.3.13 ERTMS/ETCS radio</b>
FIR-QR373-DK	ERTMS/ETCS radio transmits information between train and radio block centre.
FIR-QR374-Com	<b>4.5.3.14 Automatic train protection (ATP)</b>
FIR-QR375-DK	ATP provides additional information to the train and/or train driver about movement authority. Depending on the design of the interlocking system, this information comes either from the signals or directly from the interlocking system. ATP also informs the interlocking system about its status.
FIR-QR376-Com	<b>4.5.3.15 Track section</b>
FIR-QR377-DK	A track section is the basis for track vacancy proving. It informs the interlocking system about its status and tells the interlocking system that a particular piece of track is unoccupied. It determines this by means of devices such as track circuits or axle counters.
FIR-QR378-Com	<b>4.5.3.16 Signal</b>
FIR-QR379-DK	In EIR, the term signal covers all type of signals, including shunting, main, and others. A signal provides a signal aspect that conveys movement authority. A signal also informs the interlocking system about its status.
FIR-QR380-Com	<b>4.5.3.17 Point</b>
FIR-QR381-DK	A point routes trains. The interlocking system sends steering values to the point. In turn, the point transmits its position and status to the interlocking system.
FIR-QR382-Com	<b>4.5.3.18 External level crossing system</b>
FIR-QR383-DK	The interlocking system can send steering information to the external level crossing system, which in turn may inform the interlocking system about its state.
FIR-QR384-DK	EIR covers both external and internal level-crossing systems, in other words those built either as a part of the interlocking system or

	as a stand-alone system.
FIR-QR385-Com	<b>4.5.3.19 User-specific object (USO)</b>
FIR-QR386-DK	A user-specific object (USO) informs the interlocking system about its state. The interlocking system sends steering values to the USO. Examples of USOs include automatic warning systems, hot box detectors and monitors for point-handle housings.
FIR-QR387-Com	<b>4.5.3.20 Environment</b>
FIR-QR388-DK	The environment can be the source of environmental influences (such as temperature, vibration, and electromechanical interference) on the interlocking system. Likewise, the interlocking system can exert such influences on the environment.
FIR-QR389-Com	<b>4.5.3.21 National rules</b>
FIR-QR390-DK	National rules stipulate the operating and signalling rules for each railway. A subset of this information is derived into functional requirements and can be fed to the data preparation system. These rules and the corresponding database are outside the scope of EIR.
FIR-QR391-Com	<b>4.5.3.22 Installation rules</b>
FIR-QR392-DK	Installation rules provide information for the implementation of a specific interlocking system. They are outside the scope of EIR.
FIR-QR393-Com	<b>5 Description and deliverables according to EN-50126 Phase 1 Concept</b>
FIR-QR394-Com	<b>5.1 Objectives phase 1</b>
FIR-QR395-Com	The objective of this phase shall be to develop a level of understanding of the system sufficient to enable all subsequent RAMS lifecycle tasks to be satisfactorily performed.
FIR-QR396-Com	<b>5.2 Acquire, in the context of RAMS performance, an understanding of the concept</b>
FIR-QR397-Com	<b>5.2.1 The Scope, context and purpose of the system</b>
FIR-QR398-Com	The scope of the system will be defined as an interlocking system. That is a subsystem of what within a Railway Authority is called an 'interlocking'. It will also cover some support systems, e.g. Maintenance system, data preparation system etc.
FIR-QR399-Com	The purpose of an interlocking system is to enable rail traffic flow in a given time and in a safe way.
FIR-QR400-Com	An interlocking system shall be based on the Euro-Interlocking Standards where the life cycle costs are expected to be significantly reduced.
FIR-QR401-Com	<b>5.2.2 The Environment of the system</b>
FIR-QR402-Com	The environment of the system must be considered as a railway environment, e.g. interference from traction current etc. The environment of the system could be different from country to country.

FIR-QR403-Com	<b>5.2.3 The general RAMS implications of the system (6.1.3.1 c)</b>
FIR-QR404-Com	The reliability and/or availability of interlocking systems and related systems expected to be improved.
FIR-QR405-Com	Interlocking systems expected to be able to handle a higher traffic density and more efficient traffic management in connection with ETCS/ERTMS.
FIR-QR406-Com	<b>5.3 Review of the RAMS implications</b>
FIR-QR407-Com	<b>5.3.1 Review of any financial analysis of the system</b>
FIR-QR408-Com	<b>5.3.2 Review of the RAMS implications of any system feasibility studies</b>
FIR-QR409-Com	<b>5.4 Identify sources of hazards which could affect the RAMS performance of the system</b>
FIR-QR410-Com	At this stage three sources are identified:
FIR-QR411-Com	- the application domain
FIR-QR412-Com	- the system itself
FIR-QR413-Com	- the RAMS management process
FIR-QR414-Com	<b>5.5 Obtain information</b>
FIR-QR415-Com	<b>5.5.1 Obtain information about previous RAMS requirements and past RAMS performance of similar and/or related systems</b>
FIR-QR416-Com	<b>5.5.2 Obtain information about identified sources of hazards to RAMS performance</b>
FIR-QR417-Com	Application Domain: The Application Domain could be different from country to country. It is important that the Domain knowledge for each and every country will be a part of the EIS.
FIR-QR418-Com	System itself: It is very difficult for the Railway Authority to give information about the system itself. It will be very much the responsibility of the supplier. The important issue for the Railway Authority is to validate the requirements, so there is no doubt that the right requirements are written.
FIR-QR419-Com	RAMS Management process: The EN 50126 [FIR-QR424-Com] and EN 50129 [FIR-QR425-Com] will be used.
FIR-QR420-Com	<b>5.5.3 Obtain information about current Railway Authority Safety Policy and Targets</b>

FIR-QR421-Com	<b>5.5.4 Obtain information about safety legislation</b>
FIR-QR422-Com	<b>5.6 Define the scope of the management requirements for subsequent system life cycle RAMS tasks</b>
FIR-QR423-Com	<b>5.7 Phase 1 - References</b>
FIR-QR424-Com	CENELEC European Committee for Electrotechnical Standardisation, EN 50126 - The specification and demonstration of the Reliability, Availability, Maintainability and Safety (RAMS).
FIR-QR425-Com	CENELEC European Committee for Electrotechnical Standardisation, EN 50129 - Railway applications – Communication, signalling and processing systems – Safety related electronic systems for signalling.
FIR-QR426-Com	<b>6 Descriptions and deliverables according to EN-50126 Phase 2 System definition and application conditions</b>
FIR-QR427-Com	<b>6.1 Objectives phase 2 System definition and application conditions</b>
FIR-QR428-Com	The objectives of this phase are to:
FIR-QR429-Com	- define the mission profile of the system
FIR-QR430-Com	- define the boundary of the system
FIR-QR431-Com	- establish the application conditions influencing the characteristics to the system
FIR-QR432-Com	- define the scope of system hazard analysis
FIR-QR433-Com	- establish the RAMS policy for the system
FIR-QR434-Com	- establish the Safety Plan for the System
FIR-QR435-Com	in so far as the affect the potential RAMS performance of the system.
FIR-QR436-Com	<b>6.2 Definitions of the system</b>
FIR-QR437-Com	<b>6.2.1 Define the system mission profile</b>
FIR-QR438-Com	<b>6.2.1.1 Performance requirements</b>
FIR-QR439-Com	The performance requirements shall be written at a level of not endangering the safety in an interlocking system. The level shall also be defined so that the users do not find it irritating to use due to long waiting times.
FIR-QR440-Com	<b>6.2.1.2 RAMS Targets</b>
FIR-QR441-Com	<b>6.2.1.3 Long term operating strategy and conditions</b>
FIR-QR442-Com	Interlocking systems have today and should in the future have a long life time. It could be expected that new interlocking systems

	need compatible systems or subsystems after the expected operational life-time expired. The operational life-time shall be at least equal or longer than it is today.
FIR-QR443-Com	<b>6.2.1.4 Long term maintenance strategy and conditions</b>
FIR-QR444-Com	Maintenance work can affect the life cycle costs in a negative way. That is why there shall be a minimum of maintenance work needed.
FIR-QR445-Com	Either the Railway Authority shall be able to maintain the system itself or it shall be possible to use some other by the safety authority approved maintenance organisation.
FIR-QR446-Com	To be able to achieve and maintain a high level of availability there should be diagnostic systems and maintenance systems available for efficient maintenance.
FIR-QR447-Com	<b>6.2.1.5 System life considerations, including lifecycle costing issues</b>
FIR-QR448-Com	An interlocking system shall have a long operational life-time. The system and or subsystems should as much as possible be standardized both to function and interface. The benefits will possibly be lower investment costs per interlocking system due to the fact, that the development costs could be distributed over larger series of interlocking systems and/or generic products for interlocking systems. The life cycle costs shall be at least equal or lower than they are today.
FIR-QR449-Com	An interlocking system shall also be designed with a modular construction, so that it is easily adjustable to future applications.
FIR-QR450-Com	<b>6.2.1.6 Logistic considerations</b>
FIR-QR451-Com	<b>6.2.2 Define the system boundary</b>
FIR-QR452-Com	<b>6.2.2.1 Interfaces with physical environment</b>
FIR-QR453-Com	<b>6.2.2.2 Interfaces with other technological systems</b>
FIR-QR454-Com	<b>6.2.2.3 Interfaces with humans</b>
FIR-QR455-Com	<b>6.2.2.4 Interfaces with other Railway Authorities</b>
FIR-QR456-Com	<b>6.2.3 Define the scope of application conditions influencing the system</b>
FIR-QR457-Com	<b>6.2.3.1 Constraints imposed by existing infrastructure</b>
FIR-QR458-Com	<b>6.2.3.2 System operating conditions</b>
FIR-QR459-Com	<b>6.2.3.3 System maintenance conditions</b>
FIR-QR460-Com	<b>6.2.3.4 Logistic support conditions</b>



FIR-QR461-Com	<b>6.2.3.5 Review of past experience data for similar systems</b>
FIR-QR462-Com	<b>6.2.4 Define the scope of the system hazard analysis</b>
FIR-QR463-Com	<b>6.2.4.1 Hazards inherent within the process to be controlled</b>
FIR-QR464-Com	<b>6.2.4.2 Environmental hazards</b>
FIR-QR465-Com	<b>6.2.4.3 Security hazards</b>
FIR-QR466-Com	<b>6.2.4.4 The influence of external events</b>
FIR-QR467-Com	<b>6.2.4.5 The boundaries of the system to be analyzed</b>
FIR-QR468-Com	The scope of the system hazard analysis will be limited for the Railway Authorities. The system hazard analysis will be on a high level. The idea is that the supplier shall do a more thoroughly system hazard analysis.
FIR-QR469-Com	The scope of the system hazard analysis must cover certain consequences.
FIR-QR470-Com	The following consequences are to be avoided:
FIR-QR471-Com	-Train collides with other train
FIR-QR472-Com	-Train derails
FIR-QR473-Com	-Train collides with car/truck etc.
FIR-QR474-Com	-Train collides with human being
FIR-QR475-Com	<b>6.2.4.6 The influence of RAMS of existing infrastructure constraints</b>
FIR-QR476-Com	The infrastructure constraints are limited to vibrations, EMC and Power supply.
FIR-QR477-Com	<b>6.3 Preliminary analysis and identifications</b>
FIR-QR478-Com	<b>6.3.1 RAM analysis to support targets</b>
FIR-QR479-Com	<b>6.3.2 Preliminary hazard identification</b>
FIR-QR480-Com	Hazards, which can lead to consequences in chapter “Scope of the system hazard analyses”, are identified as the following:  Rationale: The hazards in the list are assumed to be the Core Hazards in the interface. The interface is assumed to be between a translation box and the Physical Element. The interface is at the moment National Specific.
FIR-QR481-Com	-An excessive steering value is sent from the translation box to the Physical Element Signal.

	Rationale: The hazard could lead to that a signal aspect shows a higher speed than is allowed according to the data preparation.
FIR-QR482-Com	-An excessive steering value is sent from the translation box to the Physical Element ATP. Excessive ATP message to train driver  Rationale: The hazard could lead to that the ATP message shows a higher speed than is allowed according to the data preparation.
FIR-QR483-Com	-A steering value is sent from the translation box to the Physical Element Point at the same time a detected value “occupied” is received to the translation box from the Physical Element Track Segment related to that specified point.  Rationale: The hazard could lead to that a point is moved under a train.
FIR-QR484-Com	-A not correct steering value is sent from the translation box to the Physical Element Level Crossing System. Excessive message in a level crossing system  Rationale: The hazard could lead to that a train travels with too high speed or two trains use the same track segment.
FIR-QR485-Com	-A not correct steering value is sent from the translation box to the Physical Element Radio.  Rationale: The hazard could lead to that a train travels with too high speed or two trains use the same track segment.
FIR-QR486-Com	-A not correct steering value is sent from the translation box to the Physical Element User Specific Object.  Rationale: The hazard could lead to that a train travels with too high speed or two trains use the same track segment.
FIR-QR487-Com	-A not correct steering value is sent from the interlocking system to an adjacent interlocking system. Rationale: The hazard could lead to that a train travels with too high speed or two trains use the same track segment.
FIR-QR488-Com	-A not correct steering value is sent from the interlocking system to the line block.  Rationale: The hazard could lead to that a train travels with too high speed or two trains use the same track segment.
FIR-QR489-Com	-An excessive steering value is sent from the interlocking system to ERTMS/ETCS Trackside.  Rationale: The hazard could lead to that a train travels with too high speed or two trains use the same track segment.
FIR-QR490-Com	<b>6.4 Establish the general RAMS policy for the system</b>
FIR-QR491-Com	<b>6.5 Establish the Safety Plan for the system</b>
FIR-QR492-Com	<b>6.6 Phase 2 - References</b>

FIR-QR493-Com	CENELEC European Committee for Electrotechnical Standardisation, EN50126 - The specification and demonstration of the Reliability, Availability, Maintainability and Safety (RAMS).
FIR-QR494-Com	<b>7 Description and deliverables according to EN-50126 Phase 3 Risk Analysis</b>
FIR-QR495-Com	<b>7.1 Objectives of CENELEC Phase 3</b>
FIR-QR496-Com	The objectives of this phase are to:
FIR-QR497-Com	-identify all hazards associated with the system or subsystems.
FIR-QR498-Com	-identify all events leading to the identified hazards.
FIR-QR499-Com	-determine the level of risk associated with the identified hazards.
FIR-QR500-Com	-establish a process for ongoing risk management
FIR-QR501-Com	<b>7.2 Hazard identification and evaluation</b>
FIR-QR502-Com	<b>7.2.1 Systematically identify and prioritise all reasonably foreseeable hazards associated with the system in its application environment</b>
FIR-QR503-Com	<b>7.2.2 Identify those events leading to hazards</b>
FIR-QR504-Com	<b>7.2.3 Evaluate the frequency of occurrence of each hazard</b>
FIR-QR505-Com	<b>7.2.4 Evaluate the likely severity of the consequences of each hazard</b>
FIR-QR506-Com	<b>7.2.5 Evaluate the risk to the system for each hazard</b>
FIR-QR507-Com	<b>7.3 Determine and classify risks by their acceptability</b>
FIR-QR508-Com	<b>7.4 Establish a hazard log</b>
FIR-QR509-Com	<b>7.5 Phase 3 - References</b>
FIR-QR510-Com	CENELEC European Committee for Electrotechnical Standardisation, EN 50126 - The Specification and Demonstration of Reliability, Availability, Maintainability and Safety (RAMS).
FIR-QR511-Com	UIC - Infrastructure Department, February 2007, Generic Hazard list methodology for railway signalling. ISBN 2-7461-1264-7

FIR-QR512-Com	<b>8 Descriptions and deliverables according to EN50126 Phase 4 System requirements</b>
FIR-QR513-Com	<b>8.1 Objectives phase 4 System requirement</b>
FIR-QR514-Com	The objectives of this phase are to:
FIR-QR515-Com	-specify the overall RAMS requirements for the system
FIR-QR516-Com	-specify the overall demonstration and acceptance criteria for RAMS for the system
FIR-QR517-Com	-establish the RAM programme for controlling RAM tasks during subsequent lifecycle phases
FIR-QR518-Com	<b>8.2 Specify the overall RAMS requirement for the total system</b>
FIR-QR519-Com	<b>8.3 Specify the overall requirements RAMS requirements for the total system</b>
FIR-QR520-Com	<b>8.3.1 Specify acceptance criteria</b>
FIR-QR521-Com	<b>8.3.2 Specify demonstration and acceptance process including RAMS validation plan</b>
FIR-QR522-Com	<b>8.4 Establish the detailed RAM programme for the remaining lifecycle tasks</b>
FIR-QR523-Com	<b>8.5 Amend the Safety Plan</b>
FIR-QR524-Com	<b>8.6 Phase 4 - References</b>
FIR-QR525-Com	CENELEC European Committee for Electrotechnical Standardisation, EN50126 - The specification and demonstration of the Reliability, Availability, Maintainability and Safety (RAMS).
FIR-QR526-Com	<b>9 Cross-acceptance</b>
FIR-QR527-Com	<b>9.1 Background</b>
FIR-QR528-Com	The introduction of EN 50129 states that the: "aim of European railway authorities and European railway industry is to develop compatible railway systems based on common standards. Therefore cross-acceptance of Safety Approvals for sub-systems and equipment by the different national railway authorities is necessary."
FIR-QR529-Com	In Europe today, the design and construction of interlocking systems differs significantly from one country to another.
FIR-QR530-Com	The verification and validation tasks required to obtain acceptance are a significant cost driver for an interlocking system.
FIR-QR531-Com	To reduce costs, customers would like, to the greatest extent possible, to procure and use interlocking systems that have already

	been accepted in other countries.
FIR-QR532-Com	The major economic benefits expected to be gained from this policy result from the reuse of work and documents in the acceptance process.
FIR-QR533-Com	To the greatest extent possible, the basis of the design of an interlocking system should be a generic product.
FIR-QR534-Com	The IRSE International Technical Committee's 6th report, entitled "Proposed Cross Acceptance Processes for Railway Signalling Systems and Equipment.", presents potential problems in and possibilities of a cross-acceptance process.  Rationale: The report could be a help of getting a better understanding of what is possible in the area of cross-acceptance and what kind of problems could be faced along the process of cross-acceptance. The report put among other things cross-acceptance in its context.
FIR-QR535-Com	<b>9.2 Purpose</b>
FIR-QR536-Com	This document outlines the cross-acceptance requirements for interlocking systems.
FIR-QR537-Com	The main purpose of these requirements is to minimise the life-cycle costs of products by reducing the costs of the acceptance process.
FIR-QR538-Com	<b>9.3 Scope</b>
FIR-QR539-Com	This document comprises the cross-acceptance requirements for interlocking systems.
FIR-QR540-Com	All the requirements in this document are linked to requirements in the High-Level Requirements document.
FIR-QR541-Com	The cross-acceptance requirements in this document are applicable within the boundary of the interlocking system (see also the interlocking system context diagram in the Euro-Interlocking Domain Knowledge document).
FIR-QR542-Com	<b>9.4 Cross-acceptance - Domain knowledge</b>
FIR-QR543-DK	In this document, "system approval" corresponds to what CENELEC EN 50129 calls the "generic product safety approval" and "generic application safety approval" of an interlocking system or subsystem on a specific railway network.
FIR-QR544-Com	See the Design and Architecture Requirements for interpretation of the terms "generic product", "generic application", and "specific application".
FIR-QR545-Com	<b>9.4.1 Context diagram</b>
FIR-QR546-DK	The interlocking system context diagram in the Domain Knowledge document shows the boundary of the interlocking system.
FIR-QR547-Com	<b>9.5 Cross-acceptance - Requirements</b>
FIR-QR548-Req	The supplier of an interlocking system shall show how the cross-acceptance process will minimise life-cycle costs. This cross-

	<p>acceptance process shall include such elements and concepts as:</p> <ul style="list-style-type: none"> <li>- generic product;</li> <li>- generic application;</li> <li>- specific application;</li> <li>- functionality;</li> <li>- hazard analysis;</li> <li>- safety case;</li> <li>- performance;</li> <li>- reliability;</li> <li>- availability;</li> <li>- maintenance;</li> <li>- interface specifications and standards;</li> <li>- environmental conditions;</li> <li>- testing;</li> <li>- verification &amp; validation;</li> <li>- data preparation;</li> <li>- use of international standards; and</li> <li>- system approval process and acceptance process.</li> </ul> <p>Rationale: To encourage the supplier to use cross-acceptance for as many parts of the interlocking system as possible.</p> <p>Guidelines: Prove reuse of documents, systems, processes or tools from customer to customer.</p>
FIR-QR549-Req	<p>The supplier shall inform the customer of the status and results of any past and current product approval or acceptance concerning the interlocking system.</p> <p>Rationale: To let the customer know whether a generic product, generic application or specific application relating to this interlocking system has been approved or accepted elsewhere.</p>
FIR-QR550-Req	<p>The supplier shall inform the customer of derogations or cases of non-compliance to requirements or standards in any past or present product approval or acceptance.</p> <p>Rationale: To let the customer know of derogations or cases of non-compliance elsewhere.</p>
FIR-QR551-Req	<p>The supplier shall provide information to the customer concerning those organisations involved in past and current product approval and acceptance processes, including the roles of the organisations.</p>

	Rationale: To let the customer know whether or not the approval or acceptance of a generic product, generic application or specific application relating to this interlocking system is expected elsewhere.
FIR-QR552-Req	The supplier shall operate a competence assessment system for all staff working on the product and its approval and acceptance processes. The supplier shall make available to the customer the details of the assessments for all involved staff.  Rationale: To let the customer know competence of the staff.
FIR-QR553-Req	The supplier shall make available to the customer such approval and acceptance documents as he may require, and these shall include Assessment Reports & Safety Cases and related documentation. Documentation concerning the conditions of use of the accepted product shall also be provided.  Rationale: To let the customer evaluate whether an approval or acceptance result elsewhere is transferable to the customer's railway network.
FIR-QR554-Req	The supplier shall inform the customer of all changes to, or withdrawals of, product acceptance or approval.  Rationale: To let the customer know changes or withdrawals.
FIR-QR555-Req	The supplier shall inform the customer of all changes to the conditions of use of an accepted or approved product.  Rationale: To let the customer know changes of conditions.
FIR-QR556-Req	The supplier shall inform the customer of the current status of safety acceptance and approval processes as follows:  Rationale: To let the customer know what acceptance and approval processes the supplier plans to use or reuse on the customer's railway network.
FIR-QR557-Req	- Safety relevant systems or subsystems which are approved by the national railway safety authority as a generic application for the railway's network;
FIR-QR558-Req	- Safety relevant systems or subsystems which are approved by a foreign railway safety authority as a generic application for use under comparable conditions as encountered on the railway's network;
FIR-QR559-Req	- Safety relevant systems or subsystems which have no approval from a railway safety authority.
FIR-QR560-Req	The supplier shall inform the customer of the process for attaining system approval and acceptance for the product, including information about: - safety case(s); - schedule of the approval process, including milestones;

	<ul style="list-style-type: none"> <li>- role of the customer;</li> <li>- interaction with relevant railway safety authorities; and</li> <li>- resources needed from the customer (quantity, skills, when needed).</li> </ul> <p>Rationale: To let the customer know how the supplier plans to obtain approval and acceptance for the interlocking system (including all sub-systems) on the customer's railway network.</p>
FIR-QR561-Com	<b>9.6 Cross-acceptance - References</b>
FIR-QR562-Com	<p>CENELEC European Committee for Electrotechnical Standardisation, EN 50129 - Railway applications - Communication, signalling and processing systems - Safety related electronic systems for signalling.</p> <p>Guidelines: In a request for tenders, the customer shall supply the applicable version and date of EN 50129.</p>
FIR-QR563-Com	IRSE International Technical Committee, 6th Report - Proposed Cross Acceptance Processes for Railway Signalling Systems and Equipment.
FIR-QR564-Com	<b>10 Design and Architecture</b>
FIR-QR565-Com	<b>10.1 Background</b>
FIR-QR566-Com	<p>The design and architecture of an interlocking system reflect the characteristics that customers require.</p> <p>Rationale: Characteristics such as performance and maintainability depend on design and architecture.</p>
FIR-QR567-Com	This document presents constraints that customers have placed on the design and architecture of an interlocking system.
FIR-QR568-Com	<b>10.2 Purpose</b>
FIR-QR569-Com	The requirements in this document shall ensure that the design and architecture of the interlocking system provide the required characteristics of the interlocking system throughout its operational lifetime.
FIR-QR570-Com	These design and architecture constraints shall be considered in the design phase of an interlocking system.
FIR-QR571-Com	Customers expect standardised equipment to help reduce life cycle costs in the future.
FIR-QR572-Com	This document also contains guidelines to ensure that design and architecture take into account the long-term signalling strategies of the customer.
FIR-QR573-Com	<b>10.3 Scope</b>
FIR-QR574-Com	This document presents the design and architecture requirements for an interlocking system.



	<p>Rationale: See the system structure diagram in [FIR-QR589-Diag].</p>
<p>FIR-QR575-Com</p>	<p>The requirements in this document should be considered together with the closely-related requirements for physical construction, environmental conditions, lifetime characteristics, and maintainability.</p> <p>Rationale: These requirements contain information for the design phase, which yields decisions on the architecture and system design.</p>
<p>FIR-QR576-Com</p>	<p><b>10.4 Design and Architecture – Domain knowledge</b></p>
<p>FIR-QR577-Com</p>	<p><b>10.4.1 System structure</b></p>
<p>FIR-QR578-DK</p>	<p>The following diagram shows the system structure of an interlocking system.</p>
<p>FIR-QR579-Diag</p>	<p>The diagram illustrates the system structure of an interlocking system. At the center is a teal box labeled "Interlocking system" containing "LANGUAGE / CLASS LIBRARIES / TOOLS", "OPERATING SYSTEM / MIDDLEWARE", and "HARDWARE".</p> <p>Surrounding this central box are several interfaces and data flows:</p> <ul style="list-style-type: none"> <li><b>Interface with traffic control system</b> (top): Includes "Technical interface", "Type of data", and "Specific data".</li> <li><b>Interface with adjacent EIR interlocking system</b> (top-left): Includes "Technical interface", "Type of data", and "Specific data".</li> <li><b>Interface with adjacent interlocking system</b> (middle-left): Includes "Technical interface", "Type of data", and "Specific data".</li> <li><b>Diagnostic system</b> (bottom-left): Includes "Tool", "National rules", and "Specific data".</li> <li><b>Interface with physical elements and other systems</b> (bottom): Includes "Technical interface", "Type of data", and "Specific data/cabling".</li> <li><b>Supplier data preparation system</b> (middle-right): Includes "Process" and "Functional requirements".</li> <li><b>Functional generic requirements (for a specific customer)</b> (bottom-right): A grey box.</li> <li><b>Data File Format</b> (top-right): A red box containing "Data and functional requirements for specific track layout".</li> </ul> <p>Arrows indicate data flow: from the central system to the traffic control system; from the EIR and adjacent interlocking systems to the central system; from the diagnostic system to the central system; from the physical elements interface to the central system; from the supplier data preparation system to the central system; and from the functional generic requirements to the central system. A large teal arrow also points from the supplier data preparation system towards the Data File Format box.</p> <p>Legend:</p> <ul style="list-style-type: none"> <li>Generic product: teal text</li> <li>Generic application: grey text</li> <li>Specific application: red text</li> </ul>

FIR-QR580-Com	<p>The following sections define the relationships among three essential concepts:</p> <ul style="list-style-type: none"> <li>- the generic product</li> <li>- the generic application</li> <li>- the specific application</li> </ul>
FIR-QR581-Com	<p><b>10.4.1.1 The generic product</b></p>
FIR-QR582-DK	<p>The generic product consists of:</p> <ul style="list-style-type: none"> <li>- qualitative requirements</li> <li>- the generic platform and tools (including hardware, operating system, middleware, class libraries, and tools)</li> <li>- the process for integrating a generic application</li> <li>- the technical traits of interfaces with adjacent interlocking systems</li> <li>- a diagnostic tool to monitor the elements of the system</li> <li>- a data preparation process</li> <li>- the conditions for integrating the generic application within the generic product</li> </ul> <p>Rationale: A generic product is generic only with respect to a specific type of generic application. This type must be clearly defined.</p> <p>Guidelines: A choice must be made here concerning the interface between the generic product and generic application. There are two options:</p> <p>A) The supplier defines the interface. In this case, the supplier’s generic product works only with the supplier’s own technical solutions for the generic application.</p> <p>B) The project defines the interface. In this case, the supplier’s generic product works with other suppliers’ technical solutions for the generic application.</p>
FIR-QR583-Com	<p><b>10.4.1.2 The generic application</b></p>
FIR-QR584-DK	<p>The generic application consists of :</p> <ul style="list-style-type: none"> <li>- the functional requirements for a specific customer</li> <li>- interfaces for a specific customer's trackside equipment ( technical interface and type of data), for the diagnostic system (national rules), for adjacent interlocking systems (technical interface and type of data) and for the traffic control system (TCS - technical interface and type of data)</li> <li>- the process for integrating the specific application</li> <li>- the conditions for integrating the specific application into the generic application</li> </ul>

	<p>Rationale: A generic application is generic only with respect to a certain type of specific application. This type must be clearly defined.</p> <p>Guidelines: A choice must be made here concerning the interface between the generic application and the specific application. There are two options:</p> <p>A) The supplier defines the interface. The supplier's generic application therefore works only with the supplier's own technical solutions for the specific application.</p> <p>B) The project defines the interface. The supplier's generic application therefore works with other suppliers' technical solutions for the specific application.</p>
FIR-QR585-Com	<b>10.4.1.3 The specific application</b>
FIR-QR586-DK	<p>A specific application consists of a generic application together with the specific data for the following elements:</p> <ul style="list-style-type: none"> <li>- a specific track layout, including trackside equipment items, other systems, and cabling</li> <li>- a diagnostic system</li> <li>- interfaces with adjacent interlocking systems</li> <li>- an interface with the traffic control &amp; communication system</li> <li>- an interface with the ETCS radio block centre</li> </ul>
FIR-QR587-Com	<b>10.4.2 System design</b>
FIR-QR588-DK	The system structure shall consist of system hardware, application hardware, system software, application software and application data.
FIR-QR589-Diag	

	<p>The diagram illustrates a three-level hierarchy of system components:</p> <ul style="list-style-type: none"> <li><b>Specific application:</b> A box labeled 'Application data' at the top level.</li> <li><b>Generic application:</b> A rounded rectangle containing 'Application software' and 'Application hardware'.</li> <li><b>Generic product:</b> A rounded rectangle containing 'System software' and 'System hardware'.</li> </ul>
<p>FIR-QR590-Com</p>	<p><b>10.4.2.1 System hardware</b></p>
<p>FIR-QR591-DK</p>	<p>The system hardware consists of processors, electronics, and related elements that transmit information. The hardware can be viewed as a section containing one or more central processors, a section with processors for other tasks (auxiliary hardware), and the input/output interface.</p>

FIR-QR592-Com	<b>10.4.2.2 The application hardware</b>
FIR-QR593-DK	An example of application hardware is the technical interface between an interlocking system and a traffic control system (TCS).
FIR-QR594-Com	<b>10.4.2.3 The system software</b>
FIR-QR595-DK	The system software guarantees the safe operation of the interlocking system. It includes the operating system and (cyclic) test, service and diagnostic functions.
FIR-QR596-Com	<b>10.4.2.4 The application software</b>
FIR-QR597-DK	The application software is an assembly of programs that guarantees - together with the correct application data - the correct and safe functioning of the generic application. Such software contains a standard application protocol for the generic functions of an interlocking system.
FIR-QR598-Com	<b>10.4.2.5 Application data</b>
FIR-QR599-DK	Application data specifies the required functions of a specific application and configures a generic application as the interlocking system for a specific site.
FIR-QR600-Com	<b>10.5 Design and Architecture - Requirements</b>
FIR-QR601-Com	<b>10.5.1 General</b>
FIR-QR602-Req	The basis for the design and the architecture of an interlocking system shall be the following standard systems and objectives:
FIR-QR603-Req	- portability of application development tools
FIR-QR604-Req	- portability of applications
FIR-QR605-Req	- standard communication protocols
FIR-QR606-Req	- standard hardware platforms
FIR-QR607-Req	- standard operating system software
FIR-QR608-Req	- standard user interface
FIR-QR609-Req	- standard network management
FIR-QR610-Req	- standard application protocols.
FIR-QR611-Com	The customer and supplier should agree on the details or level of these requirements.
FIR-QR612-Com	<b>10.5.2 System architecture</b>
FIR-QR613-Req	The structure of the interlocking system shall reflect its division into a generic product, generic application, and specific application; these divisions are the same as for safety cases in EN 50129.
FIR-QR614-Req	The supplier shall define the conditions and the process for implementation of the generic product, generic application and specific

	application.  Rationale: Modifying the generic application should not mean redoing the generic product's safety case. Modifying the specific application should not mean redoing the generic application's safety case.
FIR-QR615-Req	The supplier shall describe the principles of the interlocking system architecture as it relates to safety.
FIR-QR616-Req	The interlocking system shall have a modular structure to enable system modifications and extensions.
FIR-QR617-Com	<b>10.5.3 System design</b>
FIR-QR618-Com	<b>10.5.3.1 General</b>
FIR-QR619-Com	The customer and supplier should agree on the details or level of the requirement.
FIR-QR620-Req	The design of the interlocking system shall minimise the need for modifications in the existing infrastructure.
FIR-QR621-Req	The interlocking system design shall minimise maintenance effort both at trackside and in buildings.
FIR-QR622-Req	Communication solutions shall be limited to standard available technologies and protocols.
FIR-QR623-Com	<b>10.5.3.2 Hardware</b>
FIR-QR624-Req	The hardware design shall allow update or change of communications technology and the mixing of hardware technologies.
FIR-QR625-Req	To facilitate commissioning, the interlocking system's design shall minimise the changeover time from old to new hardware.
FIR-QR626-Req	The design of the interlocking system's interfaces shall allow their modification without changes to the generic product.
FIR-QR627-Com	<b>10.5.3.3 Software</b>
FIR-QR628-Req	The structure of software shall allow adoption of new hardware.
FIR-QR629-Com	<b>10.5.3.3.1 Application software and data</b>
FIR-QR630-Req	The application software shall be adaptable to changes in functional requirements and interfaces.
FIR-QR631-Req	The application software shall allow the addition of new functions without altering the existing functions.
FIR-QR632-Com	<b>11 Documentation</b>
FIR-QR633-Com	<b>11.1 Background</b>
FIR-QR634-Com	The documentation of an interlocking system is a central basis for safe and cost-efficient training, configuration, installation, operation, and maintenance.
FIR-QR635-Com	<b>11.2 Purpose</b>
FIR-QR636-Com	This document states documentation requirements for the interlocking system.

	Rationale: To state what the customer needs in the documents that the supplier furnishes.
FIR-QR637-Com	The main task of this document is to define the requirements for user documentation, which is crucial for configuration, installation, operation, and maintenance. Users of the documentation include all those whose carry out these functions.
FIR-QR638-Com	<b>11.3 Scope</b>
FIR-QR639-Com	This document comprises the documentation requirements for an interlocking system.
FIR-QR640-Com	The requirements intend to cover the documents that the supplier shall deliver together with the interlocking system, and all required updates.
FIR-QR641-Req	Documents which are required in standards are not included in the requirements.  Rationale: It is no use to write requirements that are included in standards which suppliers are required to follow. The required documents are included indirectly because a certain standard has been required to follow.
FIR-QR642-Com	All the requirements in this document are linked to requirements in the High-Level Requirements document.
FIR-QR643-Com	The documentation requirements in this document are applicable within the boundary of the interlocking system.
FIR-QR644-Com	<b>11.4 Documentation - Domain knowledge</b>
FIR-QR645-DK	The interlocking system context diagram in the Domain Knowledge document shows the boundary of the interlocking system.
FIR-QR646-Com	<b>11.5 Documentation - Requirements</b>
FIR-QR647-Com	<b>11.5.1 General documentation requirements</b>
FIR-QR648-Req	All documents shall be delivered according a documentation plan agreed on with the customer.
FIR-QR649-Req	The documentation plan shall include a complete list of all documents, to be delivered by the supplier, including both existing and planned documents.  Rationale: To always have an overview of existing and future documents. The documentation plan shows the customer delivered documents, any overdue documents, and coming documents.
FIR-QR650-Req	All documentation shall take into account the entire life cycle of the interlocking system.
FIR-QR651-Req	The customer and the supplier shall agree on: - a procedure for updating the documentation and who is responsible - a configuration management process (the procedure for updating the documentation and who is responsible) - the documents the supplier shall also deliver in an alterable electronic form (incl. changes in the text, figures, or any other part of

	the document)
FIR-QR652-Req	The documentation shall be delivered in both electronic and paper form, in an unalterable format suitable for easy reading, printing, and copying on ordinary office equipment.
FIR-QR653-Req	The electronic and paper forms of the documentation shall be such that all text and diagrams remain legible throughout the interlocking system's operational lifetime.
FIR-QR654-Req	The format (including font sizes, sharpness, and colours) of the electronic and paper versions of the document shall be such that all text and diagrams remain legible on a black-and-white copy produced on an ordinary office printer or copier.
FIR-QR655-Req	The delivered documentation shall fulfil the following requirements:
FIR-QR656-Req	<ul style="list-style-type: none"> <li>- The customer shall be able to make changes in the text, figures, or any other part of the document.</li> <li>- Every document shall have a clearly defined purpose.</li> <li>- Every document shall have a clearly defined target group.</li> <li>- Every document shall be self-contained.</li> </ul> <p>Guidelines: Dependent upon contract between supplier and customer.</p>
FIR-QR657-Req	Every document shall be self-contained.
FIR-QR658-Req	The supplier shall work out a detailed agreement with the customer concerning the purpose, target group, level of detail and language of each document.
FIR-QR659-Req	All documents whose target group is railway experts shall be either in English or Finnish.
FIR-QR660-Req	All documents whose target group is signallers or maintenance staff shall be in Finnish.
FIR-QR661-Com	Care shall be taken to avoid irrelevant or superfluous information.
FIR-QR662-Req	As an option, it shall be possible to have any document in the local language.
FIR-QR663-Req	The customer shall approve documentation in accordance with the documentation plan.
FIR-QR664-Com	<b>11.5.2 System documentation</b>
FIR-QR665-Req	The following system documentation shall be delivered to the customer:
FIR-QR666-Req	- an overall description of the interlocking system to give the reader a technical understanding of the interlocking system at a high level without having to read all documents
FIR-QR667-Req	- a detailed functional and technical description of the interlocking system to give the reader a detailed understanding of the design, configuration, reconfiguration, installation, testing, commissioning, operation, maintenance (preventive and corrective), modification, decommissioning, and disposal of the interlocking system
FIR-QR668-Req	- validation documents in accordance with the validation plan to ensure that required validation documents are available to the customer
FIR-QR669-Req	- a user manual on preventive and corrective maintenance



FIR-QR670-Req	- a user manual on how to operate the interlocking system and in particular its human-machine interface
FIR-QR671-Req	- a user manual for the data-preparation tool, including needed input data, if such a tool is supplied with the interlocking system.
FIR-QR672-Req	Any graphical symbols in diagrams shall comply: -with IEC 60617, "Graphical symbols for diagrams" -in the absence of international standards,with national standards
FIR-QR673-Req	The supplier shall work out with the customer an agreement on the graphical symbols to describe signalling objects.
FIR-QR674-Com	<b>11.5.3 Application documentation</b>
FIR-QR675-Com	The documentation for a specific application describes a particular installation. It is called application documentation, and normally consists of drawings, layout plans, and output from data preparation.
FIR-QR676-Req	The supplier shall provide - at the interlocking system location - the application documentation required to install, commission, maintain and troubleshoot the interlocking system.
FIR-QR677-Req	After commissioning, the documentation shall reflect the current state of the interlocking system, including all modifications, at all times, in accordance with an advance agreement between customer and supplier.
FIR-QR678-Req	The supplier shall provide a recommended spare parts list together with each commissioned interlocking system.
FIR-QR679-Req	The spare parts list shall specify both a basic set of spare parts and a three-year supply of parts likely to regularly wear out or otherwise expire.
FIR-QR680-Com	<b>12 Domain Knowledge Data on Environmental Conditions</b>
FIR-QR681-Com	<b>12.1 Background</b>
FIR-QR682-Com	This document contains data related to the EN50125-3 standard.
FIR-QR683-Com	<b>12.2 Purpose</b>
FIR-QR684-Com	The purpose of this document is to compile the environmental conditions encountered in the interlocking system's field of operation.
FIR-QR685-Com	<b>12.3 Scope</b>
FIR-QR686-Com	The scope of this module is to include the overall domain knowledge on environmental conditions relevant for all railway authorities.
FIR-QR687-Com	<b>12.4 Related European Standard</b>
FIR-QR688-Com	EN50125-3 Railway Applications: Environmental conditions for signalling and telecommunications.

FIR-QR689-Com	12.5 Comment
FIR-QR690-Com	Whenever possible, this document states environmental in terms of the classes defined in the EN50125-3 standard, but if other conditions apply for a particular railway authority, then these are stated.
FIR-QR691-DK	Pressure - A2
FIR-QR692-DK	Altitude - A2
FIR-QR693-DK	Pulse pressure
FIR-QR694-DK	Temperature - T2
FIR-QR695-DK	External ambient - T2
FIR-QR696-DK	Cubicle - T2
FIR-QR697-DK	Shelter - T2
FIR-QR698-DK	Without climatic control - T2
FIR-QR699-DK	Climatic control - T2
FIR-QR700-DK	Building - T2
FIR-QR701-DK	Without climatic control - T2
FIR-QR702-DK	Climatic control - T2
FIR-QR703-DK	Humidity
FIR-QR704-DK	External ambient - T2
FIR-QR705-DK	Cubicle - T2
FIR-QR706-DK	Shelter - T2
FIR-QR707-DK	Without climatic control - T2
FIR-QR708-DK	Climatic control - T2
FIR-QR709-DK	Building - T2
FIR-QR710-DK	Without climatic control - T2
FIR-QR711-DK	Climatic control - T2
FIR-QR712-DK	Wind - EN50125-3
FIR-QR713-DK	Rain - 6 mm/mn
FIR-QR714-DK	Snow and hail
FIR-QR715-DK	Ice
FIR-QR716-DK	Signal
FIR-QR717-DK	Solar radiation - EN50125-3
FIR-QR718-DK	Lightning - EN50124-2

FIR-QR719-DK	Pollution
FIR-QR720-DK	Chemical, active substances - 4C2
FIR-QR721-DK	Biological, active substances - 4B1
FIR-QR722-DK	Mechanical, active substances - 4S2
FIR-QR723-DK	Fire protection - No
FIR-QR724-DK	Vibrations and shocks - EN50125-3
FIR-QR725-DK	Vibrations - EN50125-3
FIR-QR726-DK	Shocks - EN50125-3
FIR-QR727-Com	<b>13 Domain Knowledge Data on Power supply</b>
FIR-QR728-Com	<b>13.1 General</b>
FIR-QR729-Com	The purpose of this chapter is to compile the domain knowledge applicable to an interlocking system's power supply.
FIR-QR730-Com	Standards - EN61000-2-4
FIR-QR731-DK	AC Frequency - 50 Hertz
FIR-QR732-DK	Tolerance: Voltages - +/- 10 %, Un 230 Volts
FIR-QR733-DK	Frequency
FIR-QR734-Com	<b>13.2 Power Source</b>
FIR-QR735-Com	<b>13.2.1 External power source</b>
FIR-QR736-DK	Voltage - 230 V AC, from 3x400 V AC (3 phases)
FIR-QR737-DK	Standard / norms - EN 50160
FIR-QR738-Com	<b>13.2.2 External backup power source</b>
FIR-QR739-Com	<b>13.2.2.1 UPS</b>
FIR-QR740-DK	Battery capacity - 2...10 hours
FIR-QR741-Com	<b>13.2.2.2 Diesel generator</b>
FIR-QR742-DK	Only medium/large sized interlocking fixed installation, small interlocking inlet for transportable units.
FIR-QR743-Com	<b>13.3 Interlocking system</b>

FIR-QR744-Com	<b>13.3.1 Floating power supply</b>
FIR-QR745-Req	Interlocking system DC power supplies shall be floating type.
FIR-QR746-Com	<b>13.3.2 Power supply earthing</b>
FIR-QR747-Req	Earth leakage indicator is mandatory.
FIR-QR748-Req	Operational earthing switch is mandatory for main power supply.
FIR-QR749-Com	<b>13.3.3 Main interlocking system</b>
FIR-QR750-DK	60 V DC
FIR-QR751-Com	<b>14 Electromagnetic Compatibility EMC</b>
FIR-QR752-Com	<b>14.1 Background</b>
FIR-QR753-Com	The main task of these requirements is to define the immunity and emission requirements for interlocking system in relation to the electromagnetic disturbances likely to be experienced in the railway environment.
FIR-QR754-Com	<b>14.2 Purpose</b>
FIR-QR755-Com	This document states EMC requirements for the interlocking system.
FIR-QR756-Com	<b>14.3 Scope</b>
FIR-QR757-Com	This document comprises all the EMC requirements for an interlocking system.
FIR-QR758-Com	All the requirements in this document are linked to requirements in the high-level requirements document.
FIR-QR759-Com	<b>14.4 Electromagnetic Compatibility - Domain Knowledge</b>
FIR-QR760-Com	<b>14.5 Electromagnetic Compatibility - EMC requirements</b>
FIR-QR761-Req	The interlocking system equipment shall fulfil the requirements specified in EN 50121-1, General.
FIR-QR762-Req	The interlocking system equipment shall fulfil the requirements specified in EN 50121-2, Emission of the whole railway system to the outside world.
FIR-QR763-Req	The interlocking system equipment shall fulfil the requirements specified in EN 50121-4, Emission and immunity of the signalling and telecommunications apparatus.
FIR-QR764-Com	<b>15 Environmental Conditions</b>

FIR-QR765-Com	<b>15.1 Background</b>
FIR-QR766-Com	This document presents requirements concerning environmental conditions that an interlocking system can encounter.
FIR-QR767-Com	The main task of these requirements is to set the range of physical, chemical, electrical and biological conditions external to the interlocking system that the system shall withstand. Examples include temperature, humidity, wind, rain, snow, hail, pressure, shock, vibration and pollution.
FIR-QR768-Com	These requirements are applicable to an Interlocking System and its subsystems. (They are thus requirements concerning environmental conditions for a generic product.)
FIR-QR769-Com	<b>15.2 Purpose</b>
FIR-QR770-Com	The main purpose of this module is to describe requirements that ensure that the interlocking system operates safely and reliably in the environmental conditions encountered in Europe.
FIR-QR771-Com	<b>15.3 Scope</b>
FIR-QR772-Com	This document includes all requirements on environmental conditions applicable to the interlocking system.
FIR-QR773-Com	<b>15.4 Environmental Conditions - Domain Knowledge</b>
FIR-QR774-Com	<b>15.4.1 General</b>
FIR-QR775-DK	The material and structure of each component of an interlocking shall undergo transport, storage and installation undamaged and in working order. They shall also remain undamaged and in working order while operating under the environmental conditions prevailing in the operational environment of each component.
FIR-QR776-DK	During transportation, storage, installation and operation the components can undergo stresses caused by the following conditions:
FIR-QR777-DK	- Climatic conditions,
FIR-QR778-DK	- Mechanic conditions,
FIR-QR779-DK	- Chemically active substances,
FIR-QR780-DK	- Mechanically active substances,
FIR-QR781-DK	- Electromagnetic conditions.
FIR-QR782-DK	The components can undergo extreme values of temperature, air pressure and mechanical and electro-magnetic stress simultaneously.
FIR-QR783-Com	Railway specific data related to the European standard EN 50125-3 is located in the document "Domain Knowledge: Data on environmental conditions".

FIR-QR784-Com	<b>15.5 Environmental Conditions - Applicable Standards</b>
FIR-QR785-Com	The following standards are applicable:
FIR-QR786-Req	EN 50125-3: Railway Applications: Environmental Conditions for Signalling and Telecommunications
FIR-QR787-Req	IEC 60068: Environmental testing
FIR-QR788-Req	IEC 60721: Classification of environmental conditions
FIR-QR789-Com	<b>15.6 Environmental Conditions - Requirements</b>
FIR-QR790-Com	<b>15.6.1 General</b>
FIR-QR791-Req	The interlocking system shall operate correctly under the environmental conditions that may be expected to occur during its operational lifetime.
FIR-QR792-Req	The interlocking system shall be designed according to and operate correctly under the conditions stated in the EN 50125-3 standard.
FIR-QR793-Req	The interlocking system shall function correctly under the climatic influences stated in the EN 50125-3 standard
FIR-QR794-Req	The interlocking system shall comply with the existing international environmental laws.
FIR-QR795-Req	The interlocking system shall comply with the existing national environmental laws.
FIR-QR796-Com	<b>15.6.2 Storage</b>
FIR-QR797-Req	The interlocking system shall suffer no damage from the environmental conditions likely to be encountered during storage for any period within the operational life time.
FIR-QR798-Com	<b>15.6.3 Transportation</b>
FIR-QR799-Req	The interlocking system shall suffer no damage from the environmental conditions likely to be encountered during transportation.
FIR-QR800-Req	During transportation free fall (with packing) can be encountered:
FIR-QR801-Req	100 cm, if mass is less than 25kg,
FIR-QR802-Req	25 cm, if mass is 25 - 100 kg.
FIR-QR803-Com	<b>15.7 Environmental Conditions - Additional requirements</b>
FIR-QR804-Req	<b>15.7.1 Fire protection</b>
FIR-QR805-Req	All material contained in the interlocking system shall be either non-flammable or self-extinguishing.
FIR-QR806-Req	Under no circumstances shall they give off corrosive fumes such as chlorine when heated.

FIR-QR807-Com	<b>15.7.2 Vibration and impacts</b>
FIR-QR808-Com	<b>15.7.2.1 In use</b>
FIR-QR809-Req	In use, the equipment items of the interlocking system shall be capable of withstanding mechanical stresses inherent in the installation location of each item.
FIR-QR810-Req	Examples of sources of such stress are passing trains, moving points and maintenance activities on the equipment itself or nearby elements of railway infrastructure.
FIR-QR811-Com	<b>15.7.2.2 During transport</b>
FIR-QR812-Req	During transport in its packing, the interlocking system's equipment shall withstand mechanical stresses resulting from events such as the following:
FIR-QR813-Req	Vibrations occurring in the course of transport
FIR-QR814-Req	Impacts
FIR-QR815-Com	<b>15.7.3 Acoustic interference and vibrations (noise)</b>
FIR-QR816-Req	The noise level of the interlocking installation as a whole, which is generally expressed in dB(A), shall not exceed the values legally imposed or specially indicated in the supplier's specifications for the equipment.
FIR-QR817-Req	Noise from the equipment shall not be of a level or type that disturbs signallers or maintenance staff working in the equipment room.
FIR-QR818-Com	<b>15.7.4 Corrosion</b>
FIR-QR819-Req	Parts or subsystems of the interlocking system that are subject to corrosion shall be protected.
FIR-QR820-Com	<b>15.7.5 Environmental tests</b>
FIR-QR821-Req	The interlocking system shall undergo tests to prove conformity with the environmental requirements.
FIR-QR822-Req	The environmental tests shall be compliant with the IEC 60068 standard.
FIR-QR823-Com	<b>16 Installation, Test and Commissioning</b>
FIR-QR824-Com	<b>16.1 Background</b>
FIR-QR825-Com	Commissioning is a collective term for the activities undertaken to prepare a system or product prior to demonstrating that it meets its specified requirements. Installation and commissioning requirements are closely related to several phases of EN50126 and also to the validation, verification and system acceptance processes.

FIR-QR826-Com	<b>16.2 Purpose</b>
FIR-QR827-Com	This document presents requirements for the installation and subsequent commissioning of an interlocking system.
FIR-QR828-Com	<b>16.3 Scope</b>
FIR-QR829-Com	This document presents generic installation and commissioning requirements for the interlocking system. More detailed national requirements shall be a list of activities for installation and commissioning (resulting in several national documents) demonstrating that all requirements are fulfilled.
FIR-QR830-Com	The requirements in this document are linked to requirements in the high-level requirements document.
FIR-QR831-Com	<b>16.4 Installation, Test and Commissioning - Domain Knowledge</b>
FIR-QR832-Com	<b>16.5 Installation, test and commissioning requirements</b>
FIR-QR833-Com	<b>16.5.1 Installation</b>
FIR-QR834-Req	The electrical installations shall comply with the National Electrical Safety Regulations.  Rationale: The interlocking system shall be installed according to national regulations.
FIR-QR835-Req	The electrical installations shall fulfil the customer's installation standards.  Rationale: Installation shall be performed according to existing installation guidelines and process descriptions.
FIR-QR836-Req	Installation activities shall be possible while existing signalling systems remain in operation.  Rationale: This results in a higher availability of the existing infrastructure, when installing a new interlocking system as replacement or expansion. Existing signalling system can be a TCS or an old interlocking system.
FIR-QR837-Com	<b>16.5.2 Test</b>
FIR-QR838-Req	It shall be possible to carry out all logical and performance testing of a specific application before actual installation.
FIR-QR839-Req	It shall be possible to test all site-specific data off-site before installation.
FIR-QR840-Com	<b>16.5.3 Commissioning</b>
FIR-QR841-Req	The supplier shall provide a commissioning plan to demonstrate that all requirements are fulfilled.



FIR-QR842-Req	It shall be possible to carry out commissioning in stages.  Rationale: To be sure that the supplier provides support for software and hardware commissioning or decommissioning during the operational lifetime of an interlocking system.
FIR-QR843-Com	<b>17 Lifetime</b>
FIR-QR844-Com	<b>17.1 Scope</b>
FIR-QR845-Com	This document presents all the detailed lifetime requirements for an interlocking system.
FIR-QR846-Com	A hierarchical structure links all the requirements. If applicable, requirements in this document link to other requirements either in this document or in the High Level Requirements document.
FIR-QR847-Com	The requirements should be considered together with those for Maintainability, Modification and Diagnostics because they are all closely related.
FIR-QR848-Com	<b>17.2 Lifetime – Domain knowledge</b>
FIR-QR849-Com	EN50129 distinguishes between a generic product (independent of application), generic application (a class of application) and a specific application.
FIR-QR850-Com	<b>17.3 Lifetime – Terms</b>
FIR-QR851-Com	The following terms are of particular interest here:
FIR-QR852-Term	- the model lifetime of an interlocking system is the number of years for which the corresponding generic product and generic application shall be available from the supplier
FIR-QR853-Term	- the operational lifetime is the lifetime of a specific application at a site. The specific application's operational lifetime is the number of years after commissioning for which replacement parts and service shall be available from the supplier
FIR-QR854-Com	<b>17.4 Lifetime – Requirements</b>
FIR-QR855-Req	The model lifetime for the whole interlocking system shall be at least 15 years.
FIR-QR856-Req	An identical generic product and generic application of an interlocking system shall be available from the supplier during the model lifetime.
FIR-QR857-Req	It shall be possible for the specific application to vary to ensure the applicability of the same generic product and generic application to different geographic layouts.
FIR-QR858-Req	It shall be possible to commission an interlocking system on the last day of the model's lifetime.
FIR-QR859-Req	In case the supplier plans to end the production of any components of the interlocking system, the customers shall be informed at least one year before and customers shall be given the opportunity to place an order for the component in question.

FIR-QR860-Req	In case a part is not possible to repair anymore the supplier shall propose a new part with the same functionality and the same interfaces.
FIR-QR861-Req	The customer shall approve upgrades or changes, even if they are compatible with the original interlocking system.
FIR-QR862-Req	If an upgrade is approved, then the supplier shall be responsible for all associated tasks, in his scope of work.
FIR-QR863-Req	The operational lifetime of an interlocking system at a site shall be at least 25 years.
FIR-QR864-Req	The supplier shall propose a maintenance and support contract for the operational lifetime. Different levels of maintenance and support shall be possible.
FIR-QR865-Req	Maintenance support shall be available for the whole operational lifetime
FIR-QR866-Req	Modification support shall be available at least 10 years after the model lifetime has expired.
FIR-QR867-Req	If for any reasons beyond its control the supplier is unable to uphold its obligations regarding lifetime it shall notify the customer as soon as possible.
FIR-QR868-Com	<b>17.4.1 Optional requirements for LT-163-Req, LT-530-Req and LT-159-Req</b>
FIR-QR869-Req	If the supplier is unable to fulfil LT-163-Req, LT-530-Req and LT-159-Req then the following requirements shall be fulfilled:
FIR-QR870-Req	- The supplier of an interlocking system shall state figures for the interlocking system's model lifetime and operational lifetime.
FIR-QR871-Req	- Throughout the stated model lifetime and operational lifetime, a generic product and a generic application functionality according to the original form fit functional specification shall be available for the interlocking system from the supplier.  Rationale: The model lifetime and operational lifetime requirements can be difficult to fulfil if they are expressed in terms of physical components and products, which have a short lifecycle. To ensure a compatible generic product and a generic application during the model and operational lifetime.
FIR-QR872-Req	The supplier shall present a plan for fulfilment of requirements LT-163-Req, LT-530-Req and LT-159- Req.  Rationale: The goal is to keep the interlocking system's functionality unchanged. One way to do this is to require ongoing availability of identical physical parts and components. However, there may be other ways of accomplishing the same goal that result in lower life-cycle costs. The supplier should propose a solution, show the customer the associated risk, and show the supplier's commitment to making the risk reasonable.
FIR-QR873-Req	The plan shall include a task list of all tasks that need to be carried out and the estimated costs for the customer and the supplier. Costs shall be broken down by generic product, generic application and specific application.  Rationale: The supplier should present its strategy for supporting the customer throughout the model lifetime and operational lifetime of interlocking systems. The strategy should reflect both technical needs and life-cycle costs.
FIR-QR874-Com	<b>18 Modification</b>

FIR-QR875-Com	<b>18.1 Background</b>
FIR-QR876-Com	<p>Small-scale modifications of an interlocking system should be possible after installation without major cost. Such modifications should mainly involve changes in the configuration data of a specific application. This sets constraints on the possible architecture of the interlocking system.</p> <p>Rationale: Modifications that involve major changes of topology or introduction of new functionality are not classified as small-scale modifications. Large-scale modifications of an interlocking system should be possible. Such modifications should mainly involve changes in the generic application and specific application.</p>
FIR-QR877-Com	Given that modification requirements are closely related to maintainability and lifetime requirements, these should be considered together.
FIR-QR878-Com	<b>18.2 Purpose</b>
FIR-QR879-Com	This document presents modification requirements for the interlocking system.
FIR-QR880-Com	A main purpose of the requirements is to ensure that modifications to the interlocking system be possible throughout its operational lifetime without major investment.
FIR-QR881-Com	<b>18.3 Scope</b>
FIR-QR882-Com	This document covers the modification requirements for an interlocking system as a generic product, generic application and specific application.
FIR-QR883-Com	The requirements in this document are linked to requirements in the high-level requirements document.
FIR-QR884-Com	<b>18.4 Modification - Domain knowledge</b>
FIR-QR885-Com	EN 50129 distinguishes between a generic product (independent of application), generic application (a class of applications) and a specific application.
FIR-QR886-Com	<b>18.5 Modification - Requirements</b>
FIR-QR887-Com	<b>18.5.1 General requirements</b>
FIR-QR888-Com	Modifications to an interlocking system should cost less than the same modification in an interlocking system that uses current relay technology.
FIR-QR889-Com	The design and development of all software in an interlocking system should facilitate modifications and fault removal.

	Rationale: Modifications will appear after installation and use of the system as a result on further demands of the customer. The ability to make modifications should be built into the system.
FIR-QR890-Req	A detailed solution for software modification shall be presented by the supplier and accepted by the customer.
FIR-QR891-Req	The supplier and customer shall agree on the extent to which the supplier shall furnish tools and processes for modifying the interlocking system.
FIR-QR892-Req	The supplier shall furnish tools and processes for modifying specific application.
FIR-QR893-Req	After initial implementation, an interlocking system shall be able to handle 20% more track elements or train routes during its operational lifetime without degrading performance.
FIR-QR894-Req	Technology migration of interlocking physical elements or adjacent systems shall be based on plans developed by the supplier and the customer.
FIR-QR895-Req	If the customer needs to modify the interlocking system, the supplier shall provide a cost and design proposal within an agreed period of time and if requested also carry out the modification.
FIR-QR896-Req	After carrying out the modifications, the supplier shall prove re-validation of any affected parts and that re-validation of all other parts is unnecessary.
FIR-QR897-Req	If a modification would require issuance of a new version of part or all of an interlocking system, the supplier shall ask authorisation from the customer.
FIR-QR898-Req	During the operational lifetime of the interlocking system, the supplier shall provide all needed support for the implementation of modifications.
FIR-QR899-Req	After a modification made by the supplier all the affected documentation shall be updated by the supplier.
FIR-QR900-Req	Any modifications shall be implemented following the life cycle model used by the supplier (e.g. EN-50126).
FIR-QR901-Com	<b>18.5.2 Generic product</b>
FIR-QR902-Req	For any modifications the supplier shall make sure that the operational and model lifetime are the same as or better than the unmodified system.
FIR-QR903-Req	The following changes shall involve only components that are hot swappable or hot changeable:
FIR-QR904-Req	- software updates for a specific application
FIR-QR905-Req	- replacement of the object controller of a physical element
FIR-QR906-Req	- replacement of any component that is present on a redundant basis to promote availability
FIR-QR907-Com	<b>18.5.3 Generic application</b>
FIR-QR908-Req	The software architecture must support modification work.
FIR-QR909-Req	It shall be possible to change, modify or add functions without impact on functions which are not concerned.
FIR-QR910-Req	Changing, modifying or adding functions must not require the validation of unaffected functions.

FIR-QR911-Req	Changes in the generic application shall require neither a new generic product safety case nor changes in the generic product.
FIR-QR912-Com	<b>18.5.4 Specific application</b>
FIR-QR913-Req	Adding a new track element in the specific application of an interlocking system shall require 16 person-hours at most for data preparation, factory acceptance pre-testing (pre-FAT) and updating the documentation.
FIR-QR914-Req	At an interlocking system in service, modification of a track element data shall entail 10 minutes downtime at most.  Rationale: 'Track Element' does not refer to the physical element in the field. The interlocking system should return to normal operation as soon as possible after starting such modification work.
FIR-QR915-Req	Changes in a specific application shall require neither a new generic safety case nor changes in the generic product or generic application.
FIR-QR916-Com	<b>19 Performance</b>
FIR-QR917-Com	<b>19.1 Background</b>
FIR-QR918-Com	It is important to note that the performance required for a particular line or corridor determines the performance demands on the interlocking and signalling system. The performance targets for a signalling system and the performance requirements for an interlocking system are therefore independent of their sizes.
FIR-QR919-Com	<b>19.2 Purpose</b>
FIR-QR920-Com	The main objectives of the performance requirements shall be:
FIR-QR921-Com	- to optimise the use of the railway's infrastructure
FIR-QR922-Com	- to minimise the life-cycle costs of interlocking systems  Rationale: Life cycle costs include such things as cost of train delays and investments for new interlocking systems, often in connection with new traffic control and automation systems and ERTMS/ETCS.
FIR-QR923-Com	<b>19.3 Scope</b>
FIR-QR924-Com	This document defines performance targets for signalling systems and the performance requirements for the interlocking system.  Rationale: To ensure that the performance of the interlocking system is consistent with and does not degrade the performance of the signalling system of which it is a part.
FIR-QR925-Com	This document defines four classes of performance targets and five classes of performance requirements, enabling customers and suppliers to implement interlocking systems that meet the performance needs of the railway networks.

FIR-QR926-Com	The targets and requirements within this document may apply to signalling and interlocking systems planned or implemented by metro operators.
FIR-QR927-Com	<b>19.3.1 Scope of performance targets</b>
FIR-QR928-Com	This document contains the performance targets for the signalling system as a whole (including both the interlocking system and other systems such as the TCS, ATP system and ERTMS/ETCS).
FIR-QR929-Com	Performance targets are a way of defining overall system performance by using the term 'headway'.
FIR-QR930-Com	The performance targets in this document are applicable within the project boundary.
FIR-QR931-Com	<b>19.3.2 Scope of performance requirements</b>
FIR-QR932-Com	All the requirements in this document are linked to requirements in the High-Level Requirements document.
FIR-QR933-Com	The performance requirements in this document are applicable within the boundary of the interlocking system. (See also the interlocking system context diagram in the Domain Knowledge document.)
FIR-QR934-Com	Performance requirements for other systems (such as the TCS, ATP system and ERTMS/ETCS) are outside the scope of the requirements in this document.
FIR-QR935-Com	<b>19.4 Performance - Domain knowledge</b>
FIR-QR936-Com	<b>19.4.1 Performance targets</b>
FIR-QR937-Com	The "signalling system as a whole" includes the interlocking system, physical elements with cabling and other systems such as the TCS, RBC, ATP system and ERTMS/ETCS, and the communication between them.
FIR-QR938-Com	The performance targets for the signalling system as a whole, and performance requirements for an interlocking system depend on the performance and line capacity demands of a particular line or corridor.
FIR-QR939-Com	The performance targets are based on the following assumptions:
FIR-QR940-DK	- that the signalling system is working in normal operating mode (operation free of major and significant failures)
FIR-QR941-DK	- that the interlocking system and all its components are working properly
FIR-QR942-DK	- that the track layout has been optimised to allow the headways defined in the performance targets
FIR-QR943-DK	- that the operating rules and procedures of the customer allow the headways defined in the performance targets
FIR-QR944-DK	- that the performance of the trains operating on the line or corridor is compatible with the headways defined in the performance targets
FIR-QR945-Com	<b>19.4.2 Performance requirements</b>
FIR-QR946-DK	The "interlocking system" does not include cabling to physical elements, physical elements or other systems such as the TCS or

	ATP system.
FIR-QR947-DK	The Performance requirements are based on the assumption that the interlocking system is working in either normal operating mode or degraded mode.
FIR-QR948-DK	Degraded mode needs to be taken into account when calculating the average response time.
FIR-QR949-Com	<b>19.5 Performance - Performance targets</b>
FIR-QR950-Com	<b>19.5.1 General</b>
FIR-QR951-Com	This document includes performance targets as information about railways' high-level performance objectives.
FIR-QR952-Com	The response times of an interlocking system must be viewed from a wider perspective: that of the combination of all systems involved in the signalling process. This can include such systems as the TCS and the RBC. The combination of all of these systems must meet the performance demands of a particular line or corridor.
FIR-QR953-Com	The system must respond to commands input by the signaller and provide correct information to the signaller within a reasonable period of time. A slow response to the signaller may not only reduce the effective performance of the line but, depending on operating rules, may also be a safety risk since the operator may not know the true status of the signalling system.
FIR-QR954-Com	The system must provide correct information to train drivers within a reasonable period of time. Delays in the update of information to the train driver - especially if differing response times lead different systems to display conflicting information - can lead to loss of line capacity, driver mistrust of the signalling system, or unnecessary emergency braking.
FIR-QR955-Com	<pre> graph LR     Signaller((Signaller)) --&gt; TCS[TCS]     TCS --&gt; Interlocking[Interlocking system]     Interlocking --&gt; Trackside[Trackside element]     Trackside --&gt; Train((Train and driver))     TCS -.-&gt; Signaller     Interlocking -.-&gt; Signaller     Trackside -.-&gt; Signaller     Train -.-&gt; Trackside     </pre>

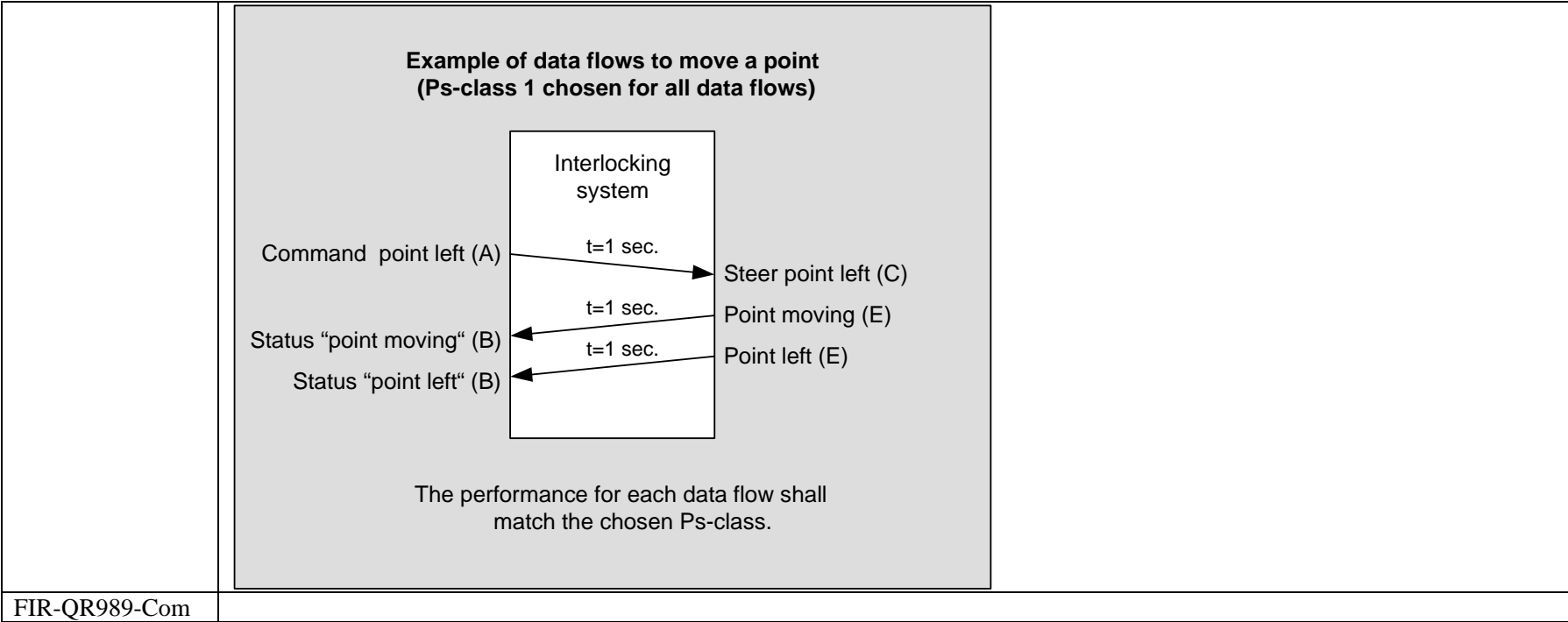
FIR-QR956-Com	<b>19.5.2 Performance targets (P-targets)</b>
FIR-QR957-Com	Performance targets (P-targets) are informative in nature - as opposed to being requirements - and describe the performance needed for the signalling system as a whole (including other systems such as the TCS, ATP system and ERTMS/ETCS) to enable a specific level of line capacity for a particular line or corridor.
FIR-QR958-Com	The customer will state the performance target for a specific application.
FIR-QR959-Targ	The performance of the signalling system as a whole (including both the interlocking system and other systems such as the TCS, ATP system and ERTMS/ETCS) shall at least be able to handle the following headways:
FIR-QR960-Targ	- P-target 60 => 60 seconds.
FIR-QR961-Targ	- P-target 90 => 90 seconds.
FIR-QR962-Targ	- P-target 120 => 120 seconds.
FIR-QR963-Targ	- P-target 180 => 180 seconds.
FIR-QR964-Targ	Based on consideration of the signaller, the following response times are typical expectations of customers from the viewpoint of the signalling system as a whole:  Rationale: To show expected response times for the complete environment in which the interlocking system will run.
FIR-QR965-Targ	- The response time for setting a route should not exceed 5 seconds if the points are in the position required by the route. The response time is measured from when the signaller enters a command in the TCS until the TCS displays the correct statuses.
FIR-QR966-Targ	- The response time for a single command such as "set a signal to stop" should not exceed two seconds. The response time is measured from when the signaller enters the command in the TCS until the TCS displays the correct status.
FIR-QR967-Com	<b>19.6 Performance - Requirements</b>
FIR-QR968-Com	<b>19.6.1 Interlocking system data flows</b>
FIR-QR969-Com	The following figure shows how data flows concerning commands, statuses and changes of statuses internally in an interlocking system may use different paths through the interlocking system.
FIR-QR970-Com	



	<p>The diagram shows a central box labeled "Interlocking system". On the left side, there are two arrows: arrow A points into the box from the left, and arrow B points out of the box to the left. On the right side, there are four arrows: arrows C and D point out of the box to the right, and arrows E and F point into the box from the right. Inside the box, dashed arrows indicate a cycle of state transitions: a top horizontal arrow points right, a right vertical arrow points down, a bottom horizontal arrow points left, and a left vertical arrow points up.</p>
<p>FIR-QR971-Com</p>	<p>The following are the definitions of the inputs and outputs shown in the figure above (Perf-588-Com):</p> <p>A = A command that the interlocking system receives at its boundary, typically from a TCS.</p> <p>B = The interlocking system sends a status update to a TCS after an internal change of state in the interlocking system.</p> <p>C = The interlocking system sends a physical driving value to a physical element.</p> <p>D = The interlocking system sends a command or status update to other systems (for example a RBC or adjacent interlocking system).</p> <p>E = The interlocking system receives a detected value at its boundary from a physical element.</p> <p>F = The interlocking system receives a command or status update at its boundary from other systems (for example a RBC or adjacent interlocking system).</p>

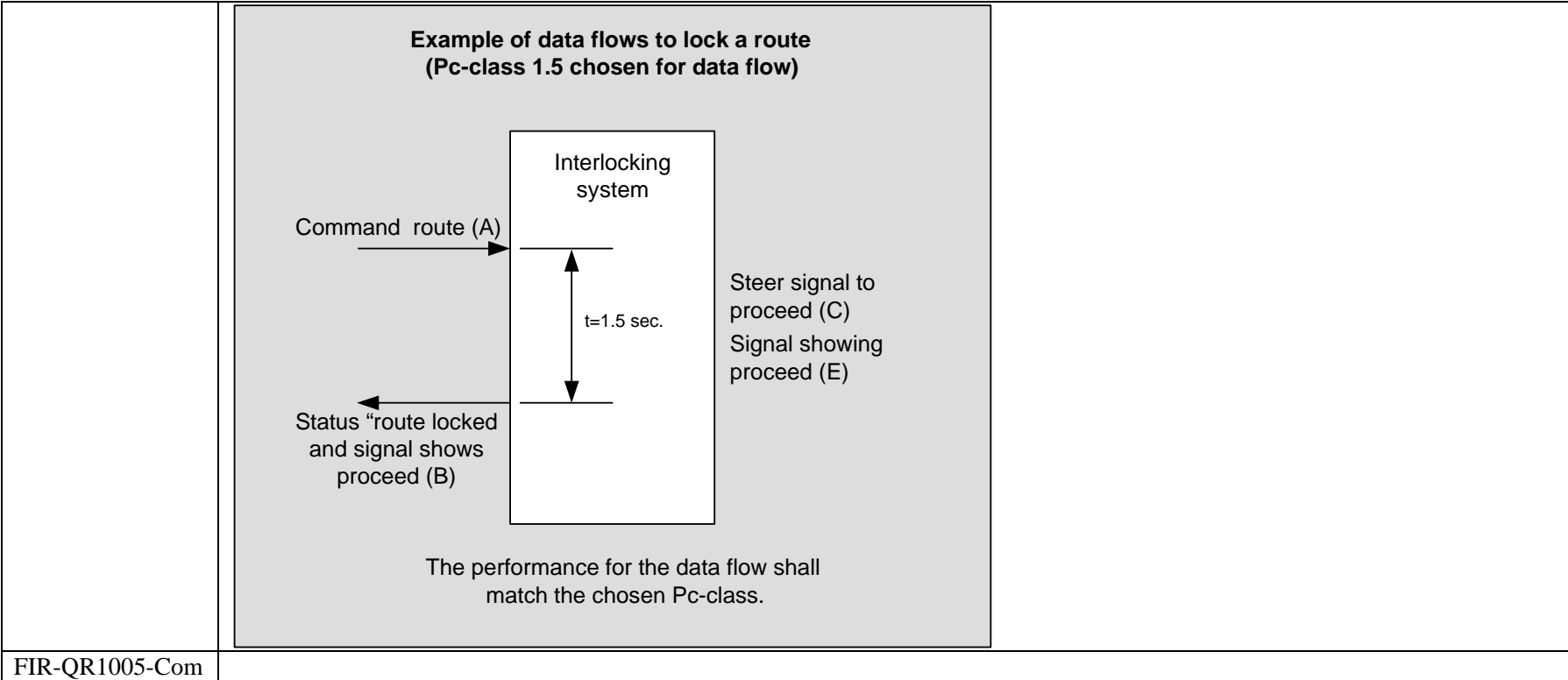
FIR-QR972-Com	<p>The following are examples of data flows: (TVP = track vacancy proving)</p> <p>A=&gt;B: The interlocking system rejects a command.</p> <p>A=&gt;C: The TCS sends a command to set a signal to stop to the interlocking system, which steers the signal to the stop aspect.</p> <p>A=&gt;D: The TCS sends a command to set a signal to stop in an adjacent interlocking system.</p>								
FIR-QR973-Com	<p>E=&gt;B: The interlocking system detects the occupation of a TVP section and sends the corresponding status information to the TCS.</p> <p>E=&gt;C: The interlocking system detects the occupation of a TVP section and drives a signal to the stop aspect.</p> <p>E=&gt;D: The interlocking system detects the occupation of a TVP section and sends the corresponding status information to an adjacent interlocking system.</p>								
FIR-QR974-Com	<p>F=&gt;B: An adjacent interlocking system detects the occupation of a TVP section and sends the corresponding status information to the TCS.</p> <p>F=&gt;C: An adjacent interlocking system sends the status of an occupied TVP section to the interlocking system, which drives a signal to the stop aspect.</p> <p>F=&gt;D: An adjacent interlocking system sends the status of an occupied TVP section to the interlocking system, which forwards this status to another adjacent interlocking system.</p>								
FIR-QR975-Com	<b>19.6.2 Performance classes for single events (Ps-classes)</b>								
FIR-QR976-Com	This section presents performance classes for single events (Ps-classes).								
FIR-QR977-Com	A function involving the driving of or the detection of status information for one object (for example set a signal to stop) is a single event.								
FIR-QR978-Req	<p>For single events, the response time of the interlocking system shall be measured for the following data flows. The response time for the following data flows shall be (unless differently specified in request for quotation):</p> <table data-bbox="528 1198 940 1326"> <tr> <td>A =&gt; B</td> <td>Ps-class 0.5</td> </tr> <tr> <td>A =&gt; C</td> <td>Ps-class 0.5</td> </tr> <tr> <td>A =&gt; D</td> <td>Ps-class 0.5</td> </tr> <tr> <td>E =&gt; B</td> <td>Ps-class 0.5</td> </tr> </table>	A => B	Ps-class 0.5	A => C	Ps-class 0.5	A => D	Ps-class 0.5	E => B	Ps-class 0.5
A => B	Ps-class 0.5								
A => C	Ps-class 0.5								
A => D	Ps-class 0.5								
E => B	Ps-class 0.5								

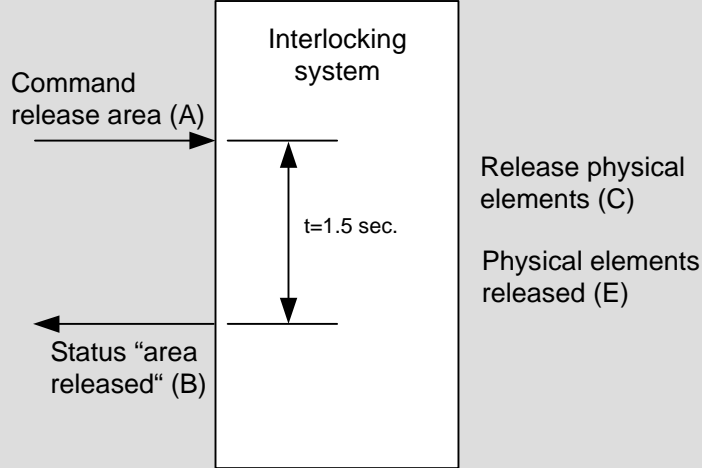
	E => C E => D F => B F => C F => D	Ps-class 0.5 Ps-class 0.5 Ps-class 0.5 Ps-class 0.5 Ps-class 0.5
FIR-QR979-Req	The customer shall state which events are in each Ps-class.	
FIR-QR980-Req	Average measured times for each data flow shown in the figure in Perf-588-Req shall not exceed the following:	
FIR-QR981-Req	- Ps-class 0.5 => 0.5 seconds	
FIR-QR982-Req	- Ps-class 1 => 1 second.	
FIR-QR983-Req	- Ps-class 1.5 => 1.5 seconds.	
FIR-QR984-Req	- Ps-class 3 => 3 seconds.	
FIR-QR985-Req	- Ps-class 5 => 5 seconds.	
FIR-QR986-Com	<b>19.6.3 Examples of data flows for the Ps-classes</b>	
FIR-QR987-Req	This section presents examples of the performance requirements based on Ps-classes.	
FIR-QR988-Com		



	<p style="text-align: center;"><b>Example of data flows to set a signal to stop (Ps-class 0.5 chosen for all data flows)</b></p> <p style="text-align: center;">The performance for each data flow shall match the chosen Ps-class.</p>	
<p>FIR-QR990-Com</p>	<p><b>19.6.4 Performance classes for combined events (Pc-classes)</b></p>	
<p>FIR-QR991-Com</p>	<p>This section presents performance classes for combined events (Pc-classes).</p>	
<p>FIR-QR992-Com</p>	<p>A function involving steering of or status information for more than one object (for example route setting) is a combined event.</p>	
<p>FIR-QR993-Req</p>	<p>Performance time for combined events shall be measured from when a command enters the interlocking system (for example from a TCS, A in Perf-588) until the interlocking system has sent all status information concerning the completed function to another system (such as the TCS, B in Perf-588). This time excludes operation of physical elements such as moving of points.</p>	

FIR-QR994-Req	The customer shall be able to assign a Pc-class to each type of combined event that the customer considers important.
FIR-QR995-Req	The default class for a combined event shall be Pc-class 1.5 (unless differently specified).
FIR-QR996-Req	Average measured times for combined functions (such as route setting) shall not exceed the following:
FIR-QR997-Req	- Pc-class 1.5 => 1.5 seconds
FIR-QR998-Req	- Pc-class 3 => 3 second.
FIR-QR999-Req	- Pc-class 5 => 5 seconds.
FIR-QR1000-Req	- Pc-class 8 => 8 seconds.
FIR-QR1001-Req	- Pc-class 10 => 10 seconds.
FIR-QR1002-Com	<b>19.6.5 Examples of data flows for the Pc-classes</b>
FIR-QR1003-Com	This section presents examples of performance requirements based on Pc-classes.
FIR-QR1004-Com	



	<p style="text-align: center;"><b>Example of data flow to release a shunting area for local control (Pc-class 1.5 chosen for data flows)</b></p>  <p style="text-align: center;">The performance for each data flow shall match the chosen Pc-class.</p>
<p>FIR-QR1006-Com</p>	<p><b>19.6.6 Transmission of all statuses to a TCS</b></p>
<p>FIR-QR1007-Req</p>	<p>When working in normal operating mode, the interlocking system shall be able to transmit all status updates to the TCS (from the interlocking system to B in Perf-588-Req) at a minimum interval of every 2 seconds.</p>
<p>FIR-QR1008-Req</p>	<p>When working in degraded mode, the interlocking system shall be able to transmit all status updates to the TCS (from the interlocking system to B in Perf-588) at a minimum interval of every 5 seconds.</p>
<p>FIR-QR1009-Com</p>	<p>As an alternative to, or in combination with transmitting all status updates at regular intervals, the interlocking system can transmit status updates on an event-driven basis.</p>
<p>FIR-QR1010-Com</p>	<p><b>20 Physical Construction</b></p>



FIR-QR1011-Com	<b>20.1 Background</b>
FIR-QR1012-Com	These requirements are based on the inputs and national requirements received from participating customers.
FIR-QR1013-Com	The requirements for physical construction depend in part on the interlocking system's site.
FIR-QR1014-Com	<b>20.2 Purpose</b>
FIR-QR1015-Com	The purpose of this document is to present the constraints that customers have expressed concerning physical construction.
FIR-QR1016-Com	These constraints shall be considered in the design phase together with the requirements in the Environmental Conditions document and Design and Architecture document.
FIR-QR1017-Com	<b>20.3 Scope</b>
FIR-QR1018-Com	This document presents requirements specific to physical construction of an interlocking system.
FIR-QR1019-Com	<b>20.4 Physical Construction - Domain knowledge</b>
FIR-QR1020-Com	<b>20.4.1 Generic product, generic application and specific application</b>
FIR-QR1021-DK	A generic product is common to a number of railway networks. Modifications during its lifetime will be rare. A generic product consists of hardware, an operating system, middleware, class libraries, and tools.
FIR-QR1022-DK	A generic application is common to a number of sites on one railway network. It can be modified during the lifetime of the generic product. A generic application is the application of a generic product to the functional requirements and interfaces of a specific railway network.
FIR-QR1023-DK	A specific application is specific to one site, and reflects engineering data for a specific track layout.
FIR-QR1024-Com	<b>20.5 Physical Construction - Applicable standards</b>
FIR-QR1025-Com	Among other relevant standards, the following standards are applicable:
FIR-QR1026-Req	EN 50122-1 Railway Application: Fixed installations - Part 1: Protective provisions relating to electrical safety and earthing.
FIR-QR1027-Req	EN 50124-1 Railway Applications: Insulation coordination - Part 1: Insulation coordination
FIR-QR1028-Req	EN 50124-2 Railway Applications: Insulation coordination - Part 2: Overvoltages and related protection.
FIR-QR1029-Req	IEC 60529 Degrees of protection provided by enclosures (IP Code)
FIR-QR1030-Req	IEC 60603 Connectors for frequencies below 3 MHz for use with printed boards
FIR-QR1031-Req	IEC 60603-2 Connectors for frequencies below 3 MHz for use with printed boards - Part 2:
FIR-QR1032-Req	(DIN 41612) Detailed specification for two-part connectors with assessed quality, for printed boards, for basic grid of

	2.54 mm with common mounting features.
FIR-QR1033-Req	IEC 60446 Electrical conductors
FIR-QR1034-Req	EN 50125-3 Ambient temperature limits
FIR-QR1035-Com	<b>20.6 Physical Construction - Requirements</b>
FIR-QR1036-Com	<b>20.6.1 Hardware</b>
FIR-QR1037-Req	Individual hardware modules of an interlocking system shall be designed for easy insertion, removal and movement by one person.
FIR-QR1038-Com	<b>20.6.2 Installation</b>
FIR-QR1039-Req	Installation of the equipment of the interlocking system shall be possible:
FIR-QR1040-Req	- in sub-units.
FIR-QR1041-Req	- in cases or in modular equipment cabinets.
FIR-QR1042-Req	Installation of a modular equipment cabinet shall be possible without cutting off the power supply or de-activating the inputs/outputs of the equipment into which it is fitted.
FIR-QR1043-Req	In favour of factory testing transportable containers or equipment rooms (unless otherwise specified) and pre-mounted modules shall be used in order to facilitate local installation and validation work.
FIR-QR1044-Com	<b>20.6.2.1 Installation of sub-units</b>
FIR-QR1045-Req	Sub-units shall be installed either directly in racks or in cases.
FIR-QR1046-Com	<b>20.6.2.2 Mounting of cases</b>
FIR-QR1047-Req	Cases shall be installed in racks or in cabinets.
FIR-QR1048-Com	<b>20.6.2.3 Mounting of modular equipment cabinets</b>
FIR-QR1049-Req	Modular equipment cabinets shall be mounted on frames or plates.
FIR-QR1050-Com	<b>20.6.3 Housing</b>
FIR-QR1051-Req	The housing of the interlocking system shall provide:
FIR-QR1052-Req	- protection from environmental influences
FIR-QR1053-Req	- security against unauthorised access
FIR-QR1054-Req	- safe access and a safe working area for authorised people
FIR-QR1055-Req	- a stable foundation for the equipment
FIR-QR1056-Req	Equipment of the interlocking system or its subsystems alongside the track shall not be placed within the structure gauge.

FIR-QR1057-Req	Trackside equipment of the interlocking system or its subsystems alongside the track shall be located in a way to allow maintenance access.
FIR-QR1058-Req	Equipment of the interlocking system or its subsystems shall not inhibit operations or maintenance processes on or alongside the track.
FIR-QR1059-Req	Cabinets containing the equipment of the interlocking system or subsystems shall allow all maintenance and repair work on the equipment.
FIR-QR1060-Req	Interlocking system equipment located in technical areas shall take as little floor space as possible. The customer shall specify the maximum available space.
FIR-QR1061-Req	All parts of the interlocking system containing indicators or controls for people's use shall be located between 50 and 200 centimetres above floor level.
FIR-QR1062-Com	<b>20.6.3.1 Position</b>
FIR-QR1063-Req	The shielding or separation between the interlocking system and other systems shall enable compliance with:
FIR-QR1064-Req	- requirements for protection from electromagnetic interference
FIR-QR1065-Req	- requirements for protection from corrosive gases and substances
FIR-QR1066-Req	- requirements for protection from mechanical shock and vibration
FIR-QR1067-Req	- local and national regulations (e.g. electrical safety requirements)
FIR-QR1068-Req	At initial installation, the interlocking system's equipment shall leave room in the available space for 30% more equipment in the future.
FIR-QR1069-Req	The interlocking system's equipment shall be mounted in the way not requiring removal of other equipment or their wires during maintenance and repair.
FIR-QR1070-Com	<b>20.6.4 Identification</b>
FIR-QR1071-Req	The identification of all elements (including the interlocking system, subsystems and individual parts) shall make it easy to find the elements both in the documentation and in the field.
FIR-QR1072-Req	Each part of the interlocking system shall bear clear identification of its type and serial number in compliance with the customer's requirements.
FIR-QR1073-Req	All modules of the interlocking system that contain electronics shall provide an indication of the equipment's status.
FIR-QR1074-Com	<b>20.6.5 Extensions</b>
FIR-QR1075-Req	The physical construction of the interlocking system shall enable efficient modification and extension.
FIR-QR1076-Com	<b>20.6.6 Cabinets/cases</b>

FIR-QR1077-Req	The supplier shall use cabinet types accepted by the customer.
FIR-QR1078-Req	The casing of all parts of an interlocking system shall be robust and protective.
FIR-QR1079-Req	The customer shall specify the required degree of protection for devices or subsystems.
FIR-QR1080-Com	<b>20.6.7 Connectors</b>
FIR-QR1081-Req	Involved connectors shall comply with the IEC 60603-2 standard.
FIR-QR1082-Req	Both parts of mating connectors shall bear a unique identification mark.
FIR-QR1083-Req	Methods to prevent false insertion of connectors shall be provided.
FIR-QR1084-Com	<b>20.6.8 Components</b>
FIR-QR1085-Req	The supplier shall present which standards are satisfied by the components.
FIR-QR1086-Com	<b>20.6.9 Cables</b>
FIR-QR1087-Req	Cable distributors shall be available for mounting the cables that enter the interlocking system's area.
FIR-QR1088-Req	The customer shall approve the type of cables and wires before any installation.
FIR-QR1089-Req	Electrical conductors shall comply with the EN 60446 standard.
FIR-QR1090-Req	Conductors outside system cabinets shall use numbering for identification.
FIR-QR1091-Com	<b>20.6.10 Earthing</b>
FIR-QR1092-Req	A reliable earth connection shall be available.
FIR-QR1093-Req	The modules of an interlocking system shall be provided with appropriate earthing arrangements.
FIR-QR1094-Com	<b>20.6.11 Lightning</b>
FIR-QR1095-Req	The interlocking system shall be protected against lightning in accordance with the EN 50124-2 standard.
FIR-QR1096-Com	<b>20.6.12 System specific tools</b>
FIR-QR1097-Req	The supplier shall be responsible for the system specific tools for installation and maintenance of the interlocking system.
FIR-QR1098-Com	<b>20.7 Physical Construction - Additional requirements</b>
FIR-QR1099-Com	<b>20.7.1 Access</b>
FIR-QR1100-Req	All parts of the interlocking system shall be protected against unauthorised access. This applies to both physical spaces and computer systems and networks.

FIR-QR1101-Com	<b>20.7.2 Ventilation</b>
FIR-QR1102-Req	Natural ventilation of equipment shall be possible in all equipment housings.
FIR-QR1103-Req	Where climate control equipment is required for temperature or humidity control, the air inlets shall have filters.
FIR-QR1104-Req	If climate control equipment is needed to control temperature or humidity, the equipment shall:
FIR-QR1105-Req	- not exceed overall noise level from a distance of one meter: 50dB(A) as a general rule and 40 dB(A) in rooms where people regularly work
FIR-QR1106-Req	- consume a maximum of 100 VA
FIR-QR1107-Req	- run on 230 VAC
FIR-QR1108-Req	- be fitted with a dust filter that is easy to remove and to clean and that does not require shutoff of the climate control equipment
FIR-QR1109-Req	- not impede access to equipment
FIR-QR1110-Req	- indicate its failure states
FIR-QR1111-Req	Failure of climate control equipment shall not affect operation of the interlocking system for at least two hours after the monitoring system notifies of the failure.
FIR-QR1112-Com	<b>20.7.3 Vandalism</b>
FIR-QR1113-Req	The interlocking system's location shall resist and not provoke vandalism or sabotage.
FIR-QR1114-Com	<b>20.7.4 Assembly and wiring</b>
FIR-QR1115-Req	The supplier shall present which standards are fulfilled for the assembly and the wiring of an interlocking system.
FIR-QR1116-Com	<b>21 Power Supply</b>
FIR-QR1117-Com	<b>21.1 Background</b>
FIR-QR1118-Com	This document presents requirements for the power supply, which is located within boundary of the interlocking system in the context diagram. See the 'interlocking system context diagram' in the Domain Knowledge document. The power supply provides the interlocking system with appropriate feeds.
FIR-QR1119-Com	These requirements are applicable to an interlocking system and its subsystems regardless of external power feed. (They are thus power supply requirements for a generic product.)
FIR-QR1120-Com	The power supply is supplied by an external power source located outside the boundary of the interlocking system, shown in the context diagram.
FIR-QR1121-Com	<b>21.2 Purpose</b>

FIR-QR1122-Com	The main purpose of this document is to express power supply requirements ensuring that the interlocking system operates safely and reliably.
FIR-QR1123-Com	The requirements in this document should be applicable to an interlocking system regardless of the system's architecture.
FIR-QR1124-Com	<b>21.3 Scope</b>
FIR-QR1125-Com	This document includes all power supply requirements applicable to an interlocking system.
FIR-QR1126-Com	These requirements are until further notice only applicable if the power supply and the interlocking system are procured at the same time as a single system.  Rationale: The interlocking context diagram gives the specification this limitation.
FIR-QR1127-Com	<b>21.4 Power Supply - Domain knowledge</b>
FIR-QR1128-Com	<b>21.4.1 Context diagram interlocking system</b>
FIR-QR1130-DK	This diagram gives an overview of the context of the project and has been used as an input to the context diagram for the power supply.
FIR-QR1131-DK	However, the 'interlocking system context diagram' does not fully describe the boundaries of the power supply. Therefore we present the boundaries of the power supply in the next section.
FIR-QR1132-Com	<b>21.4.2 Context diagram power supply</b>
FIR-QR1133-DK	The following context diagram shows the domain boundaries for power supply.

	<div style="text-align: center;"> <pre> graph LR     subgraph Power_Supply [Power Supply]         EP[External Power Source]         BPS[Backup Power Supply]         IS[Interlocking system]         EP --&gt; IS         BPS --&gt; IS     end         </pre> <p>The diagram illustrates the power supply architecture. An 'External Power Source' box is connected by an arrow to an 'Interlocking system' box. A 'Backup Power Supply' box is also connected to the 'Interlocking system' box. A dashed-line box labeled 'Power Supply' encloses the 'External Power Source', 'Backup Power Supply', and 'Interlocking system' components.</p> </div> <ul style="list-style-type: none"> <li style="display: inline-block; width: 45%; vertical-align: top;"> <ul style="list-style-type: none"> <li>• High Voltages</li> <li>• 220 - 240V</li> <li>• 3 x 380 - 400V</li> <li>• Railway specific</li> </ul> </li> <li style="display: inline-block; width: 45%; vertical-align: top;"> <ul style="list-style-type: none"> <li>• Centralised Interlocking system</li> <li>• Decentralised Interlocking system</li> <li>• Object Controller</li> <li>• Radio Block Centre</li> </ul> </li> </ul>
FIR-QR1134-DK	The external power source is an external utility or device providing electrical power to the system power supply equipment.
FIR-QR1135-DK	The system power supply equipment provides all necessary power to the interlocking system, including power that the interlocking system may supply to other components. The power supply can be seen as the interface between the external power source and the interlocking system. In some cases the interlocking system's power supply also powers physical elements.
FIR-QR1136-DK	The system power supply shall consist of a main power supply and a backup power supply.
FIR-QR1137-DK	The main power supply shall run during normal conditions and the backup power supply shall operate during failures in the external power sources or during changeover from one external power source to another.
FIR-QR1138-Com	<b>21.4.3 General</b>
FIR-QR1139-DK	The external power source can be a standard national supply provided by the local utility network, or a railway-specific supply.
FIR-QR1140-DK	The local utility network provides a public electricity grid that is available for the public, industry and the railway authorities.
FIR-QR1141-DK	A customer's specific supply is the customer's own electricity grid or the overhead lines (25 kV AC, 1500 V DC, 3000 V DC or 15 kV AC 16 2/3 Hz).
FIR-QR1142-DK	Some railway authorities also have mobile power sources in addition to their specific supplies.
FIR-QR1143-DK	Railway specific data on power supply can be found in the module "Data Power Supply - Domain Knowledge".

FIR-QR1144-Com	<b>21.5 Power Supply - Applicable standards</b>
FIR-QR1145-Com	In the area of power supply the following standards apply:
FIR-QR1146-Req	EN 50110-1: Operation of electrical installations, General
FIR-QR1147-Req	EN 50110-2: Operation of electrical installations, National Annexes
FIR-QR1148-Req	EN 50121-4: EMC - Railway Application: Electromagnetic compatibility - Part 4 Signalling and Communications
FIR-QR1149-Req	EN 50121-5: EMC - Railway Application: Electromagnetic compatibility - Part 5 fixed power supply installations and apparatus
FIR-QR1150-Req	EN 50122-1: Railway Applications - Fixed Installations - Protective provisions relating to electrical safety and earthing.
FIR-QR1151-Req	EN 50125-3: Railway Applications: Environmental conditions for signalling and telecommunications
FIR-QR1152-Req	EN 50160: Voltage characteristics of electricity supplied by public distribution systems.
FIR-QR1153-Req	IEC 60038: Standard Voltages
FIR-QR1154-Req	IEC 60059: Standard Current Ratings
FIR-QR1155-Req	IEC 60196: Standard Frequencies
FIR-QR1156-Req	IEC 60364: Electrical installations of buildings
FIR-QR1157-Com	<b>21.6 Power Supply - Requirements</b>
FIR-QR1158-Com	<b>21.6.1 General</b>
FIR-QR1159-Req	The power supply shall provide the correct voltages for the interlocking system.
FIR-QR1160-Req	The power supply shall be able to withstand a short circuit at the output.
FIR-QR1161-Req	The interlocking system shall be able to operate on one or more of the following:
FIR-QR1162-Req	- 220-240V AC, 50 HZ
FIR-QR1163-Req	- 3 x 380-400 V, AC, 50 HZ
FIR-QR1164-Req	The interlocking system shall operate properly on an input voltage within a range specified in the relevant standards.
FIR-QR1165-Req	Automatic synchronisation and automatic power cut-off of devices or subsystems shall be included.
FIR-QR1166-Req	The power supply shall provide diagnostic information to systems outside the power supply (Diagnostic systems, TCS or other).
FIR-QR1167-Req	The power supply shall meet the requirements of electromagnetic compatibility (EMC).
FIR-QR1168-Req	The power supply shall meet the requirements of EN 50110.
FIR-QR1169-Req	A power supply shall not fail during a supply voltage dip, a temporary power frequency overvoltage, transient overvoltage and a harmonic voltage pursuant EN 50160.(EMC).
FIR-QR1170-Com	<b>21.6.2 Power sources</b>
FIR-QR1171-Req	The railway authorities shall deliver the characteristics of railway specific supplies.



FIR-QR1172-Req	The user shall be able to monitor which of the power sources are in use and which ones are available.
FIR-QR1173-Req	In operation, the power supply shall monitor the status of available power source and display it to the user.
FIR-QR1174-Com	<b>21.6.3 Connections</b>
FIR-QR1175-Req	It shall be possible to use the national external power sources without additional conversion.
FIR-QR1176-Req	The power taken from the external national power sources shall be equally divided among the phases.
FIR-QR1177-Req	It shall be possible to disconnect each available external power source individually from the power supply.
FIR-QR1178-Req	The power supply shall have at least two separate connections to the external power source.
FIR-QR1179-Req	The connection between the power supply and the external power source shall be suitable for three-phase external power source.
FIR-QR1180-Req	To feed the interlocking system, the power supply shall be able to connect to a backup power source.
FIR-QR1181-Req	Disconnection of the power supply and or specific supplies shall be possible by remote control and, in pre-defined situations such as fire, automatically.
FIR-QR1182-Com	<b>21.6.4 Backup power supply</b>
FIR-QR1183-Req	It shall be possible to monitor the status of the backup power supply.
FIR-QR1184-Com	<b>21.6.5 Monitoring voltages</b>
FIR-QR1185-Req	The power supply shall monitor all essential (power supply) voltages.
FIR-QR1186-Req	If an essential voltage disappears or becomes abnormal, then the power supply shall notify the user. Each customer shall specify which of the provided voltages shall be monitored.
FIR-QR1187-Com	<b>21.6.6 Dim facility</b>
FIR-QR1188-Req	The power supply shall be able to feed the signals with normal voltage during daytime and with reduced voltage at night and in tunnels.
FIR-QR1189-Com	<b>21.6.7 Earth leakage check</b>
FIR-QR1190-Req	The power supply shall be able to monitor the presence of earth leakage on the supplied interlocking system.
FIR-QR1191-Req	The earth leakage check shall be automatic.
FIR-QR1192-Req	The power supply will notify the user of any earth leakage.
FIR-QR1193-Com	<b>21.6.8 Overload</b>
FIR-QR1194-Req	Equipment must be used for preventing the power supply overload and the power supply shall notify the user of the equipment's status and of any defects.

FIR-QR1195-Req	The power distribution shall be designed so that in case of power supply overload as small part of the system as possible is affected.
FIR-QR1196-Com	<b>21.6.9 Interference affecting the power supply</b>
FIR-QR1197-Req	Possible sources of interference affecting the power supply include:
FIR-QR1198-Req	- Other items of equipment supplied from the same source and which were capable of giving rise to distortion, over-voltages or under-voltages in the differential mode
FIR-QR1199-Req	- Electromechanical equipment capable of generating common mode interference
FIR-QR1200-Req	- Lightning, which may generate atmospheric surges in the common or differential mode
FIR-QR1201-Req	- Other items of equipment supplied from the same battery, which may give rise to ripple at their operating frequency
FIR-QR1202-Com	<b>21.6.9.1 Distortion</b>
FIR-QR1203-Req	The overall harmonic distortion factor shall not exceed:
FIR-QR1204-Req	- 8% in the case of a standard national supply
FIR-QR1205-Com	<b>21.6.9.2 Over-voltages and under-voltages</b>
FIR-QR1206-Req	The power supply shall tolerate the following types of interference:
FIR-QR1207-Req	- voltage dips by 10% to 100% lasting up to 3 s
FIR-QR1208-Req	- voltages increases of 20% lasting up to 10 s
FIR-QR1209-Req	- brief interruptions in the case of a standard national supply
FIR-QR1210-Req	- surges of atmospheric origin: 2000 V with 1.2/50 $\mu$ s waves, in common and in differential mode
FIR-QR1211-Com	<b>21.6.9.3 Imbalance between positive and negative alternation</b>
FIR-QR1212-Req	The power supply shall tolerate 2 % positive and negative alternation in voltage.
FIR-QR1213-Com	<b>21.6.9.4 Ripple</b>
FIR-QR1214-Req	The ripple voltages measured at the terminals of the distributing bus bars of the supply may reach the following peak-to-peak amplitudes:
FIR-QR1215-Req	- 1 V with a 24 V battery
FIR-QR1216-Req	- 0.33 V with an 8 V battery
FIR-QR1217-Com	<b>21.7 Power Supply - Operational requirements</b>
FIR-QR1218-Req	If all external power sources become unavailable (in a significant failure of external power sources), the power supply of the interlocking system shall provide power for a period to be specified by each customer.
FIR-QR1219-Req	The power supply shall display its current status to the user.
FIR-QR1220-Req	The power supply shall support an unmanned mode of operation.

	Rationale: Shall operate automatically.
FIR-QR1221-Req	In case of disconnection of all available external power sources, the functional state of the interlocking system shall not be changed.
FIR-QR1222-Req	Any variations in the power from the external power source shall not affect the safe operation of the interlocking system.
FIR-QR1223-Req	If the power supply fails, or varies more than the relevant standards allow or varies more than specified by the customer, the power supply shall provide a back up power supply to continue operations.
FIR-QR1224-Req	During operation with a backup external power supply, the interlocking system shall be considered to be operating in a degraded mode specified by customer. The user shall be informed.  Rationale: To provide the user information about the power supply.
FIR-QR1225-Com	<b>21.7.1 Operation during failure of external power source</b>
FIR-QR1226-Req	During switchover from one external power source to another the operation of the interlocking system shall continue.  Rationale: This requirement provides for a seamless changeover (automatically or manually) between external power sources.
FIR-QR1227-Req	During operation with backup external power source or backup power supply, the power supply shall monitor the status of the main external power source.  Rationale: To provide the user information about the power supply. And to facilitate changeover.
FIR-QR1228-Req	As soon as the main external power source is restored, the power supply shall notify the user.
FIR-QR1229-Req	As soon as the main external power source is restored the power supply shall automatically switch back to this source, without influencing the operation of the interlocking system.
FIR-QR1230-Com	<b>21.7.2 Start-up</b>
FIR-QR1231-Req	At the first start-up and after a reset of the interlocking system, the power supply shall first check the availability of the external power source to sub systems of the interlocking system and physical elements.
FIR-QR1232-Com	<b>21.7.3 Changeover</b>
FIR-QR1233-Req	A changeover to another external power source shall not change the functional state of the interlocking system.
FIR-QR1234-Req	The changeover shall occur without resulting in an overload or interruption that would cause the interlocking system to malfunction.
FIR-QR1235-Req	If a failure occurs in the main external power source, the maintenance system and or TCS shall be notified.

	Rationale: The power supply shall give the people responsible for the power supply, for the TCS and for the maintenance the information that they need to resolve the problem.
FIR-QR1236-Req	If a failure occurs in the main external power source it shall be possible to changeover (automatically or manually) to alternative external power source, to backup power supply or to shut down.
FIR-QR1237-Com	<b>21.8 Power Supply - Supplies to the interlocking system</b>
FIR-QR1238-Com	<b>21.8.1 General</b>
FIR-QR1239-Req	The output of the power supply shall be filtered and galvanically isolated from the input.
FIR-QR1240-Com	<b>21.8.2 AC Supplies</b>
FIR-QR1241-Req	The power supply shall be able to provide alternating current for the interlocking system.
FIR-QR1242-Com	<b>21.8.3 DC Supplies</b>
FIR-QR1243-Req	The power supply shall be able to provide direct current for the interlocking system.
FIR-QR1244-Com	<b>21.8.4 Earth free Supplies</b>
FIR-QR1245-Req	The power supply shall be able to provide earth free (floating) direct and alternating current for the interlocking system.
FIR-QR1246-Com	<b>21.8.5 Pulsed Supplies</b>
FIR-QR1247-Req	The power supply shall be able to provide pulsed alternating current for the interlocking system (for example for flashing aspects).
FIR-QR1248-Com	<b>21.8.6 Specific supplies</b>
FIR-QR1249-Req	Railway authorities shall specify their supplies requirements.
FIR-QR1250-Com	<b>21.9 Power Supply - Additional requirements</b>
FIR-QR1251-Com	<b>21.9.1 Rectifiers</b>
FIR-QR1252-Com	The following requirements apply when rectifiers are used in the power supply.
FIR-QR1253-Req	Rectifiers shall be able to operate on the same voltage alternatives as is required for the interlocking system.
FIR-QR1254-Req	Rectifiers shall operate properly on an input voltage within a range specified in the relevant standards, or within a range specified by each customer.
FIR-QR1255-Req	If the input voltage is outside the specified limits, the rectifier ceases to operate. When the input returns to normal, the rectifier shall

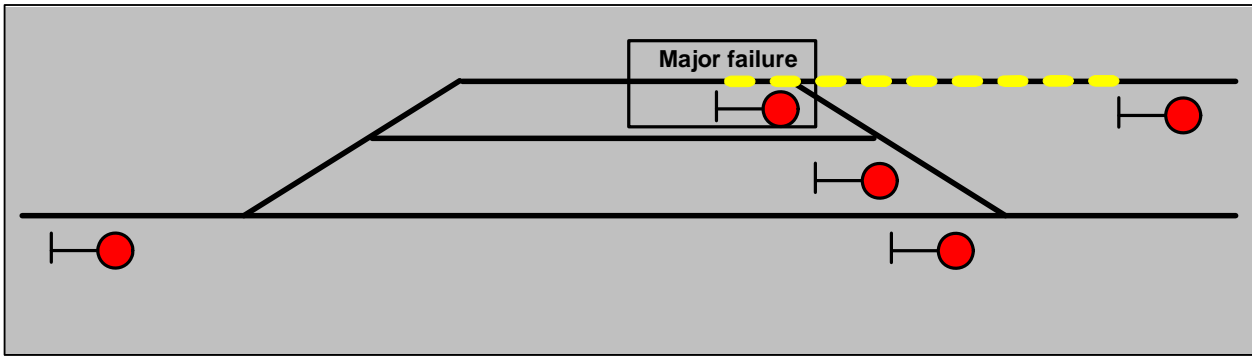
	automatically resume operation.
FIR-QR1256-Req	Rectifiers shall be capable of starting without batteries.
FIR-QR1257-Req	Rectifiers shall withstand short circuits on the output.
FIR-QR1258-Req	Rectifiers shall have plug connections to allow for easy disconnection from the power supply.
FIR-QR1259-Com	<b>21.9.2 Batteries</b>
FIR-QR1260-Com	The following requirements apply when batteries are used in the power supply.
FIR-QR1261-Req	The power supply shall monitor the status and performance of batteries and automatically charge and discharge them as appropriate.
FIR-QR1262-Req	Batteries shall have plug connections to allow for easy disconnection from the power supply.
FIR-QR1263-Com	<b>22 Reliability</b>
FIR-QR1264-Com	<b>22.1 Background</b>
FIR-QR1265-Com	Different railway networks use different approaches to derive figures for the reliability of an interlocking system.
FIR-QR1266-Com	In some cases a railway network has an overall figure for reliability and/or availability for the railway system (and not just for the railway's interlocking system.). A "budget" can be established and allocated among parts of the railway system.
FIR-QR1267-Com	In other cases, a railway network may cite the reliability and availability figures from existing interlocking systems and state that the reliability of a new interlocking system must be at least as good (this approach is known in French as "globalement au moins aussi bon" or GAMAB).
FIR-QR1268-Com	The reliability requirements for an interlocking system can result from the apportionment of the required line or corridor availability to an interlocking system of a certain size.
FIR-QR1269-Com	The intention of the reliability requirements is to allow the assignment of different reliability figures to different lines. For example, a high-speed line will likely have higher reliability demands on the interlocking system than a little-used branch line.
FIR-QR1270-Com	This document presents pre-defined reliability classes and a guideline for their use.
FIR-QR1271-Com	For each line, the customer can choose from pre-defined reliability classes and use the guideline to arrive at a certain reliability for a line or a corridor.
FIR-QR1272-Com	<b>22.2 Purpose</b>
FIR-QR1273-Com	The main objectives of the reliability requirements are:
FIR-QR1274-Com	- to optimise the use of the railway's infrastructure  Rationale: "Optimising" means achieving the highest possible traffic density, line capacity, network availability for train operators, and, maximum reliability for passengers and freight customers.

FIR-QR1275-Com	- to optimise the life-cycle costs of an interlocking system  Rationale: Including for example the cost of train delays and, maintenance costs (and modification costs).
FIR-QR1276-Com	- to set appropriate reliability requirements for an interlocking system for a generic product, generic application, specific application, or particular line or corridor.  Rationale: To form a basis for developing several reliability classes, ranging from high to normal. The customer will then assign one of these classes to each line.
FIR-QR1277-Com	<b>22.3 Scope</b>
FIR-QR1278-Com	This document presents reliability requirements for an interlocking system.
FIR-QR1279-Com	All the requirements in this document are linked to requirements in the high-level requirements document.
FIR-QR1280-Com	Within the interlocking system context diagram, the interlocking system boundary shows the boundary for the reliability requirements.
FIR-QR1281-Com	The power supply for the interlocking system is excluded from the scope of the reliability requirements.
FIR-QR1282-Com	<b>22.4 Reliability – Domain Knowledge</b>
FIR-QR1283-Com	<b>22.4.1 Context diagram</b>
FIR-QR1284-Com	The interlocking system context diagram in the Domain Knowledge document shows the boundary of the interlocking system.
FIR-QR1285-Com	<b>22.4.2 Reliability classes and definitions of failures</b>
FIR-QR1286-Com	This section describes reliability classes and defines RAM categories in the context of an interlocking system. Explanations and examples accompany the definitions. The section also describes the criticality of different failure types.
FIR-QR1287-Com	The following two reliability classes (R-classes) are defined in the Euro-Interlocking Reliability Requirements:  Rationale: On a railway network, different lines or corridors have different reliability requirements. The reliability of an interlocking system has a direct impact on the operational performance of these lines or corridors.
FIR-QR1288-Com	- R-class High
FIR-QR1289-Com	- R-class Normal
FIR-QR1290-DK	Each reliability class can apply to an interlocking system of any size.
FIR-QR1291-Com	EN 50126 defines RAM failure categories.
FIR-QR1292-Com	The definitions of RAM failure categories in this document differ from those in EN 50126. Whereas EN 50126 defines failures in

	terms of resulting delays and costs, this document defines failures in terms of affected parts in the interlocking system.
FIR-QR1293-Com	The failure categories in this document are specific to the context of the interlocking system.
FIR-QR1294-Com	As an exception, this document contains the definitions of the terms significant failure, major failure and minor failure. (Normally, definitions of terms appear in the Terms Glossary.)
FIR-QR1295-Term	A significant failure is a failure that - affects a large number of physical elements.
FIR-QR1296-Com	Explanatory comments for the term "significant failure": - A typical significant failure is a break-down in the central unit or in a common data link within the interlocking system. - A failure of the link to other systems such as the RBC or TCS is a significant failure. - A significant failure prevents the setting of many or all routes. - A significant failure affects physical elements on more than one section of track or affects more than one signal (see FIR-QR1301-Com). - An interlocking system contains certain parts whose failure would be a significant failure of the interlocking system. The number of such parts is independent of the interlocking system's size.
FIR-QR1297-Term	A major failure is a failure that -affects a small number of physical elements.
FIR-QR1298-Com	Explanatory comments for accompany the term "major failure": - A typical major failure is a failure in a single object controller or its corresponding data communication link. - A failure in the interface from an object controller to a physical element is a major failure. - A major failure affects physical elements on the same section of track and influences only one signal (see FIR-QR1301-Com). - An interlocking system contains certain parts whose failure would be a major failure of the interlocking system. The number of such parts increases with the interlocking system's size.
FIR-QR1299-Term	A minor failure is a failure that - is neither significant nor major and - does not affect operations.
FIR-QR1300-Com	Explanatory comments for the term "minor failure": - A typical minor failure is the failure in an object controller having redundancy. The presence of a second (redundant) object controller allows operation to continue unaffected. - An interlocking system contains certain parts whose failure would be a minor failure of the interlocking system. The number of such parts increases with the interlocking system's size.
FIR-QR1301-Com	

<p>FIR-QR1302-Com</p>	<p>As R-762-Term states, a significant failure - a failure affecting a large number of physical elements - always has the same type of impact on any interlocking system.</p>
<p>FIR-QR1303-Com</p>	<p>What can differ is the criticality of the significant failure, which depends essentially on train density. A significant failure is usually more critical on an important line than on a branch line. The customer therefore might require R-class "High" for significant failures on the important line but only R-class "Normal" for the branch.</p>
<p>FIR-QR1304-Com</p>	<p>As R-763-Term states, a major failure affects a small number of physical elements. The impact of such a failure thus depends on which of its parts are involved (see FIR-QR1306-Com and FIR-QR1307-Com).</p>
<p>FIR-QR1305-Com</p>	<p>The criticality of a major failure depends on which parts of the interlocking system are involved. For example, the failure of an entrance signal (see FIR-QR1306-Com) could affect more of the interlocking system's area - and perhaps more important parts of that area - than the failure of a signal for a little-used track (see FIR-QR1307-Com). The mix of critical and non-critical physical elements will determine the proportion of the interlocking system's parts that require R-class High as opposed to R-class Normal.</p>
<p>FIR-QR1306-Com</p>	



<p>FIR-QR1307-Com</p>	
<p>FIR-QR1308-Com</p>	<p>To enable the implementation of highly reliable interlocking systems, the customers intend to encourage the implementation and approval of systems that are fault-tolerant and whose functions display graceful degradation.</p> <p>Rationale: The implementation of fault tolerance and graceful degradation are viable alternatives or additions to system redundancy as a basis for high reliability. Fault tolerance means that the system's design minimises a failure's affect on normal operation mode. Graceful degradation means that if a failure occurs, the system's design allows the system to continue operating in a lower-capacity, degraded mode.</p>
<p>FIR-QR1309-Com</p>	<p style="text-align: center;"><b>22.5 Reliability – Requirements</b></p>
<p>FIR-QR1310-Com</p>	<p><b>22.5.1 Domain knowledge concerning the requirements</b></p>
<p>FIR-QR1311-Com</p>	<p>The domain knowledge in this section contains the assumptions underlying the requirements in this document.</p>
<p>FIR-QR1312-DK</p>	<p>For the purpose of the Euro-Interlocking reliability requirements, the number of signals and points determines the size of an interlocking system.</p> <p>Rationale: An interlocking system connects to different physical elements. As an order of magnitude, it is assumed that the size of the interlocking system is proportional to the number of signals and points together.</p>
<p>FIR-QR1313-DK</p>	<p>"Signal" means all signals (main, shunting, etc.)</p>
<p>FIR-QR1314-DK</p>	<p>Based on experience, one justification for R-894 is the fact that the number of signals and points largely determine the amount of hardware in an interlocking system.</p>
<p>FIR-QR1315-DK</p>	<p>If P is the number of points and S the number of signals, the MTBF for major and minor failures for the whole interlocking system</p>

	shall be calculated as $MTBF [from\ table]/(S+P)$ , where $MTBF[from\ table]$ comes from the table in FIR-QR1323-Req.  Rationale: The mean times between major and minor failures are dependent on the size of the interlocking system. Mean time between significant failures changes with the size of the interlocking system by less than an order of magnitude.
FIR-QR1316-DK	In calculating reliability it is assumed that the hardware in an interlocking system allows $8*(S+P)$ outputs and $8*(S+P)$ inputs
FIR-QR1317-DK	If a redundant system or subsystem is used, total time between failure of one redundant component and full restoration of the system or subsystem shall be taken into account. As a basis for reliability calculations the mean time to restoration MTTR is assumed to be 60 minutes.
FIR-QR1318-Com	<b>22.5.2 Requirements</b>
FIR-QR1319-Com	This section defines, for an interlocking system, reliability requirements for each of two reliability classes.
FIR-QR1320-Com	The requirements in this document are based on railways' needs.
FIR-QR1321-Com	To validate the requirements in this document, industry calculated what reliability levels can be achieved.
FIR-QR1322-Com	For each failure category (significant, major and minor), the customer will specify an R-class (either high or normal) for a specific application.
FIR-QR1323-Req	The mean time between the different types of failures in hours shall be at least the following:
FIR-QR1324-Req	R-class High
FIR-QR1325-Req	R-class Normal
FIR-QR1326-Req	Mean time between significant failures [h]
FIR-QR1327-Req	$5*10E6$ (about 600 years)
FIR-QR1328-Req	$10E4$ (about 1 year)
FIR-QR1329-Req	Mean time between major failures. [h]
FIR-QR1330-Req	$5*10E6$ (about 600 years)
FIR-QR1331-Req	$3*10E5$ (about 30 years)
FIR-QR1332-Req	The customer's choice of R-classes for significant and major failures will have an impact on the number of minor failures. The mean

	<p>time between minor failures shall be at least the following.</p> <p>Rationale: The higher the proportion of physical elements that are critical, the greater the extent of redundancy in the interlocking system. Redundancy reduces the rate of significant and major failures but - by increasing the number of parts - increases the rate of minor failures (those with no affect on operations) and maintenance costs. The number of minor failures for R-class High is derived from the number of minor failures from R-class Normal plus the double amount of major failures from R-class Normal. The doubling stems from the assumption that the system is redundant in R-class High.</p>
FIR-QR1333-Req	R-class High is chosen
FIR-QR1334-Req	R-class Normal is chosen
FIR-QR1335-Req	<p>Mean time between minor failures [h]</p> <p>Rationale: Mean time between minor failures [h]</p>
FIR-QR1336-Req	10E5
FIR-QR1337-Req	3*10E5
FIR-QR1338-DK	<p>All failures in the reliability requirements include failures caused by both random and systematic failures.</p> <p>Rationale: This definition varies from the description in EN 50126. When a railway infrastructure operator allocates part of its reliability requirements to an interlocking system, the operator must have a guarantee that the system will perform to the given requirements, independent of the cause of system failures.</p>
FIR-QR1339-Req	Before commissioning, the supplier shall apply and demonstrate use of methods for the reduction of systematic and random failures to the required level.
FIR-QR1340-Req	Before commissioning, the supplier shall mathematically demonstrate the expected level of random failures.
FIR-QR1341-Req	<p>After commissioning, the rate of systematic and random failures shall be measured.</p> <p>Rationale: The interlocking system will be observed to verify that the rate of failure is within requirements. It is not the purpose to measure that the requirement is fulfilled.</p> <p>Guidelines: It is suggested to insert a clause text in the procurement contract stating that if the number of observed failures exceeds the requirement, the supplier shall immediately take action to reduce the rate.</p>
FIR-QR1342-Req	<p>If the rate of systematic and random failures after commissioning exceeds requirements, the supplier shall take corrective action to meet the requirement.</p> <p>Guidelines: It is suggested to insert a clause in the procurement contract stating acceptance criteria.</p>

FIR-QR1343-Com	<b>23 Availability</b>
FIR-QR1344-Com	<b>23.1 Background</b>
FIR-QR1345-Com	Availability is influenced by reliability, maintainability and - to some degree - safety.
FIR-QR1346-Com	Requirements shall include no overall availability figure.
FIR-QR1347-Com	Instead, the supplier must provide in advance each customer with the availability figure for an interlocking system based on both the customer's maintenance organisation and the preventive maintenance required for the interlocking system.
FIR-QR1348-Com	<b>23.2 Purpose</b>
FIR-QR1349-Com	This document states availability requirements for an interlocking system.
FIR-QR1350-Com	<b>23.3 Scope</b>
FIR-QR1351-Com	This document presents all the availability requirements for an interlocking system.
FIR-QR1352-Com	All the requirements in this document are linked to requirements in the high-level requirements document.
FIR-QR1353-Com	Within the interlocking system context diagram, the interlocking system boundary shows the boundary for the availability requirements.
FIR-QR1354-Com	<b>23.4 Availability – Domain knowledge</b>
FIR-QR1355-DK	It is assumed that the mean time to restore the system (MTTR) is 60 minutes.
FIR-QR1356-Com	<b>23.5 Availability – Requirements</b>
FIR-QR1357-Req	Availability (A) shall be calculated on the basis of mean time to failure (MTTF) and mean time to restoration (MTTR) as $A = \frac{MTTR}{MTTR + MTTF}$ for each failure category and class (see Reliability Requirements document).
FIR-QR1358-Req	<i>The supplier shall specify the availability of the interlocking system in conjunction with an explicitly-defined maintenance and repair policy.</i>
FIR-QR1359-Req	The switchover time for hot standby (all or parts of the interlocking system) shall affect neither railway traffic nor the availability of the interlocking system.
FIR-QR1360-Req	Cold start-up for the interlocking system shall take less than 10 minutes.
FIR-QR1361-Com	<b>24 Maintainability</b>
FIR-QR1362-Com	<b>24.1 Background</b>
FIR-QR1363-Com	Different customers have different maintenance policies.

FIR-QR1364-Com	Maintainability and diagnostic requirements are closely related and thus must be considered together.
FIR-QR1365-Com	<b>24.2 Purpose</b>
FIR-QR1366-Com	This document presents maintainability requirements for an interlocking system.
FIR-QR1367-Com	The purpose of the requirements is to make sure that, throughout the interlocking system's operational lifetime, the system returns to normal operation quickly and at reasonable cost.
FIR-QR1368-Com	<b>24.3 Scope</b>
FIR-QR1369-Com	This document presents all the maintainability requirements for an interlocking system except the operation tools.
FIR-QR1370-Com	All the requirements in this document are linked to requirements in the High-Level Requirements document.
FIR-QR1371-Com	Within the interlocking system context diagram, the interlocking system boundary shows the boundary for the maintainability requirements.
FIR-QR1372-Com	The requirements for maintainability must be considered together with those for lifetime (longevity), modification and diagnostics because they are all closely related.
FIR-QR1373-Com	<b>24.4 Maintainability - Domain knowledge</b>
FIR-QR1374-Com	<b>24.5 Maintainability - Requirements</b>
FIR-QR1375-Com	<b>24.5.1 General</b>
FIR-QR1376-Com	Maintenance is one of the key tasks in fulfilment of the lifetime (longevity) requirements for an interlocking system.
FIR-QR1377-Com	Maintainability requirements must therefore be a key factor in design from the very start.
FIR-QR1378-Com	<b>24.5.2 Corrective maintenance</b>
FIR-QR1379-Req	The mean repair time, MRT, shall be less than 30 minutes for a specific application. (See also mean time to restoration.)  Rationale: To ensure that the system returns to normal operation quickly. To make sure design, construction, and support tools (such as the diagnostic system) make the cause of a failure easy to find.
FIR-QR1380-Com	<b>24.5.2.1 Corrective maintenance</b>
FIR-QR1381-Req	The supplier shall provide a detailed list of possible failures (including safety failures) and how to correct them.  Rationale: To ensure the maintenance technician can determine how to correct whatever fails.
FIR-QR1382-Req	The list shall be updated with the experience return.

	Rationale: As additional failures are known the list is updated to improve maintenance.
FIR-QR1383-Req	Using the diagnostic system the signalling maintenance technician shall be able under certain circumstances, to force, according to national operational rules, a limited set of internal variables of the interlocking system to a chosen state.  Rationale: To ensure that the operational rules are followed but also to be able to protect themselves during corrective of the failure.  Guidelines: The customer will provide a list of internal variables and a description of a process under which changes are allowed. The internal variable list shall include variables which are allowed to be changed.
FIR-QR1384-Req	The supplier shall provide a diagnostic system that supports the signal maintenance technicians in their work.
FIR-QR1385-Req	The number of different types of hardware components replaceable on site - and thus required in spare-parts inventory - shall be minimised.
FIR-QR1386-Req	During the replacement of a component, there shall be no further degradation of the interlocking system in terms of performance, functionality or any other aspect compared to the situation before starting the replacement procedure.
FIR-QR1387-Req	Changing one part shall repair at least 90% of all failures.
FIR-QR1388-Req	Changing two parts shall repair 95% of all failures.
FIR-QR1389-Req	Changing three parts shall repair 99% of all failures.
FIR-QR1390-Req	The failure of one part shall not affect adjacent or connected parts.
FIR-QR1391-Req	The replacement or repair of a failed part shall not expose adjacent or connected
FIR-QR1392-Req	The supplier shall provide a spare parts list, including a list of spare parts - in order of importance - that the signal maintenance technician should always have with him or her.
FIR-QR1393-Com	<b>24.5.3 Preventive maintenance</b>
FIR-QR1394-Req	The supplier shall specify the preventive maintenance work necessary to fulfil all the interlocking system's requirements throughout the system's operational lifetime. At least the following shall be included:
FIR-QR1395-Req	- Maintenance intervals: mean time between maintenance (MTBM), in years
FIR-QR1396-Req	- Duration of maintenance: mean time to maintain (MTTM), in hours
FIR-QR1397-Req	- Required organisation (call centre, on-call technicians)
FIR-QR1398-Req	- Required means of transport to site, access to site and access to equipment
FIR-QR1399-Req	- For each class of maintenance activity, required:
FIR-QR1400-Req	* number of staff and manpower (in person-hours)
FIR-QR1401-Req	* skills of signal maintenance technician

FIR-QR1402-Req	* types and quantities of spare parts
FIR-QR1403-Req	* test equipment
FIR-QR1404-Req	The supplier shall provide and update the following information on spare parts throughout the system's operational lifetime:
FIR-QR1405-Req	- Required preventive maintenance
FIR-QR1406-Req	- Type and quantity of all spare parts needed
FIR-QR1407-Req	- Order turnaround time for each spare part
FIR-QR1408-Req	- MTTF for each spare part
FIR-QR1409-Req	- How many of each type of spare part each specific application (installation of an interlocking system at a site) will need
FIR-QR1410-Com	<b>25 Safety</b>
FIR-QR1411-Com	<b>25.1 Background</b>
FIR-QR1412-Com	Different customers use different approaches to derive a figure for how often an interlocking system is allowed to have hazardous failures. This figure is called the tolerable hazard rate (THR). Some customers say that new systems should have the same THR as existing, comparable systems. Others derive a figure from a number people "allowed to be killed" in the country per year (or something similar). Not all hazardous failures lead to an accident. This has to be taken into account in the calculations. Some customers use other methods.
FIR-QR1413-Com	The figure for THR depends on how many of the hazardous failures lead to an accident, how many trains will pass the area where the interlocking system is used, how many passengers are in trains, or how many interlocking systems are in the country. All these considerations have already been taken into account when the THR for each function of a single interlocking system is derived.
FIR-QR1414-Com	The customers have agreed on the THR figures in this project but several approaches can lead to the same THR figures.
FIR-QR1415-Com	<b>25.2 Purpose</b>
FIR-QR1416-Com	This document states safety requirements for the interlocking system. Figures in this document describe how often hazardous failures are allowed to occur in an interlocking system.
FIR-QR1417-Com	According to EN50129 THR covers random and systematic integrity for system functions. A SIL is derived from the THR. Only the random integrity contribution to THR is quantified.
FIR-QR1418-Com	It must be possible to apply the THR figures to each function of one single interlocking system because the figure shall be proved at validation for the specific application.
FIR-QR1419-Com	<b>25.3 Scope</b>
FIR-QR1420-Com	This document comprises all the safety requirements for an interlocking system.
FIR-QR1421-Com	All the requirements in this document are linked to safety requirements in the high level requirements module.

FIR-QR1422-Com	The boundary of the interlocking system is the boundary of the safety requirements (see the context diagram for the interlocking system in the Domain Knowledge document).
FIR-QR1423-Com	<b>25.4 Safety – Domain knowledge</b>
FIR-QR1424-Com	<b>25.4.1 Context diagram</b>
FIR-QR1425-DK	The interlocking system context diagram in the domain knowledge document shows the boundary of the interlocking system.
FIR-QR1426-DK	The interlocking system context diagram provides an overview of the context of the project and is the basis for the RAMS context diagram. The RAMS context diagram shows more details relevant to the qualitative requirements.
FIR-QR1427-Com	<b>25.4.2 General</b>
FIR-QR1428-DK	A safety function is assumed to use about 10 inputs (as an order of magnitude), the whole interlocking kernel and about one output (as an order of magnitude).
FIR-QR1429-DK	The largest specific application interlocking system consists of 1500 routes, 350 signals, 400 points and 400 track circuits.
FIR-QR1430-Req	The interpretation of prEN50129 (Appendix A section A5) concerning corresponding Safety Integrity Levels: If figures lower than $1 \times 10^{-9}$ appears during the design process the Safety Integrity Level 4 shall be used.
FIR-QR1431-Com	<b>25.5 Safety – Requirements</b>
FIR-QR1432-Com	<b>25.5.1 General</b>
FIR-QR1433-Com	A separate document explains the derivation of the safety requirements in the present document.
FIR-QR1434-Req	<p>The specific application of the interlocking system shall have a THR for each safety function of less than <math>1 \times 10^{-9}</math> [1/h].</p> <p>Rationale: THR (tolerable hazard rate) prescribes the maximum frequency of hazardous failures. Note that this figure covers all hardware involved in the function.</p> <p>The safety functions are based on hazards that could lead to hazardous situations. A hazardous situation is considered as one that could lead to the following consequences:</p> <ul style="list-style-type: none"> <li>• Train derails.</li> <li>• Train collides with another train.</li> <li>• Train collides with car/truck/person at a level crossing controlled by the interlocking system.</li> <li>• Train collides with railway personnel expecting protection.</li> <li>• Train collides with fixed infrastructure.</li> </ul>



FIR-QR1435-Com	The figure in requirement S-261-Req implies that safety integrity level 4 apply during the full life cycle of the interlocking system, i.e. a level of management of quality and safety consistent with the THR.
FIR-QR1436-Req	Customers can require other THR (e.g. 1x10E-3 or 1x10E-6) for specified functions. The supplier shall consider this as an option.
FIR-QR1437-Com	The customers must define the THR for the specified functions, if they differ.
FIR-QR1438-Com	<b>25.5.2 Safety functions</b>
FIR-QR1439-Req	The following safety requirements shall be considered safety functions. The interlocking system shall not send:
FIR-QR1440-Req	- an excessive physical steering value to a signal
FIR-QR1441-Req	- an excessive physical steering value to the ATP.
FIR-QR1442-Req	- an incorrect physical steering value to a point machine.
FIR-QR1443-Req	- an incorrect steering value to a Radio Block Centre (RBC).
FIR-QR1444-Req	- an incorrect steering value to a level crossing system.
FIR-QR1445-Req	- an incorrect steering value to an adjacent interlocking.
FIR-QR1446-Req	- an incorrect steering value to a line block.
FIR-QR1447-Req	- an excessive physical steering value to ERTMS/ETCS trackside equipment.
FIR-QR1448-Req	- a physical steering value for a safety override without detecting a logical command for such an override.
FIR-QR1449-Req	- an incorrect status to the TCS.
FIR-QR1450-Req	Customers can require additional safety functions.
FIR-QR1451-Com	<b>26 Data Preparation Tool</b>
FIR-QR1452-Com	<b>26.1 Background</b>
FIR-QR1453-Com	A data preparation tool is needed for configuration process of an interlocking system for a specific location. Configuration concerns functionality and connection of the interfaces of an interlocking system in accordance with the track layout and other traits of a specific location.
FIR-QR1454-Com	The customer shall be able to use the data preparation tool to make modifications to their interlocking systems.
FIR-QR1455-Com	<b>26.2 Purpose</b>
FIR-QR1456-Com	The requirements in this document cover the data preparation tool that configures an interlocking system to a specific site.
FIR-QR1457-Com	<b>26.3 Scope</b>
FIR-QR1458-Com	These requirements refer to a data preparation tool that uses the EI Interlocking Location Data File Format or a customer-specific data preparation tool format as input. (EI means Euro-Interlocking.) In line with generic and national functional requirements, the

	tool converts this data into Interlocking Data File Format the form required to configure an interlocking system of a particular supplier and model for a specific location. The conversion process takes into account the characteristics and constraints of the specific supplier and model. After this stage, verification and validation must be possible.
FIR-QR1459-Com	These requirements are closely related to the data preparation process requirements and these should be considered together.
FIR-QR1460-Com	<b>26.4 Data Preparation Tool – Domain knowledge</b>
FIR-QR1461-Com	<b>26.5 Data Preparation Tool – Requirements</b>
FIR-QR1462-Com	<b>26.5.1 General requirements</b>
FIR-QR1463-Req	The data preparation tool shall generate the outputs that describe the configuration of the interlocking system of a specific site, and enable the configuration's implementation.
FIR-QR1464-Req	The conversion of the input data shall fulfil functional (generic or/and national) requirements.
FIR-QR1465-Req	Manual data input shall be possible.  Rationale: It may be too expensive to have only automatic conversion. Defining the inputs and outputs of a particular site may require manual inputs.
FIR-QR1466-Com	<b>26.5.2 System and interface requirements</b>
FIR-QR1467-Com	<b>26.5.2.1 Platform</b>
FIR-QR1468-Req	The data preparation tool shall run on a standard platform (computer and operating system).  Rationale: For example MS Windows, Unix
FIR-QR1469-Req	The tool platform shall support communication with other platforms via standard protocols.  Rationale: The customers must be able to use standard computer hardware and software to run the data preparation tool and exchange data with other applications.
FIR-QR1470-Com	<b>26.5.2.2 HMI and documentation</b>
FIR-QR1471-Req	The supplier shall develop the tool's human-machine interface (HMI) and the format and structure of documentation in cooperation with the customer. This shall include national language and national graphical symbols support.

	Rationale: Users must be able to use and communicate with the system in the national language(s) of the customer. Also the national signalling symbols must be used.
FIR-QR1472-Com	<b>26.5.2.3 Data File Formats</b>
FIR-QR1473-Req	The data preparation tool shall be able to generate output data in the standard EI Interlocking Data File Format.
FIR-QR1474-Req	The data preparation tool shall be able to read EI Location Data File Format as input data to the data preparation process.  Rationale: CAD- tool can be the source of input to the data preparation tool.
FIR-QR1475-Com	<b>26.5.3 Performance</b>
FIR-QR1476-Req	Data preparation for a completely new installation containing 15 trackside elements shall take one trained person no longer than one workday.
FIR-QR1477-Req	Data preparation for a completely new installation containing 1000 trackside elements shall take one trained person no longer than five workdays.
FIR-QR1478-Req	Data preparation for a change in up to three trackside elements in an existing application shall take one trained person no longer than one workday.
FIR-QR1479-Req	The tool shall be able to support the maximum number of trackside elements for which the supplier's interlocking system can be configured.  Rationale: To be able to configure the interlocking system for all sites for which it has been developed and to minimise development time and costs associated with configuring an interlocking system.
FIR-QR1480-Com	<b>26.5.4 Maintenance</b>
FIR-QR1481-Com	<b>26.5.4.1 Change management of the data</b>
FIR-QR1482-Req	It shall be possible to modify the data input to the data preparation tool and have it generate an impact analysis of a planned modification.
FIR-QR1483-Req	Each version of input and output data shall have a unique identification.
FIR-QR1484-Req	It shall be possible to make changes to an interlocking at a particular location throughout the operational lifetime of the interlocking system at that location.
FIR-QR1485-Req	The interlocking system shall remain fully operational in the other areas.
FIR-QR1486-Com	<b>26.5.4.2 Tool maintenance</b>
FIR-QR1487-Req	It shall be possible to adopt functional changes in the interlocking system, correct errors in the tool, and update the tool throughout the lifetime of the interlocking system without new certification of the data preparation process.

FIR-QR1488-Req	The tool shall be portable to future standard computer hardware and software.
FIR-QR1489-Req	The supplier shall provide support for people who use and maintain the tool.  Rationale: The supplier of the tool must support its use and maintenance.
FIR-QR1490-Com	<b>26.5.5 Verification, validation and testing of the data</b>
FIR-QR1491-Req	When a change is made to an application that has already been validated, it shall be possible to identify a set of validation activities adequate to validate the change.
FIR-QR1492-Com	<b>26.5.6 Training</b>
FIR-QR1493-Req	The supplier shall provide the needed training for users of the data preparation tool.
FIR-QR1494-Req	Training time shall not exceed 10 workdays for a competent signal engineer.  Rationale: The supplier must provide specific, adequate training for the tool.
FIR-QR1495-Com	<b>26.5.7 Documentation</b>
FIR-QR1496-Req	The supplier shall provide a full set of user and maintenance documentation for the data preparation tool.  Rationale: The documentation delivered with the tool must support maintenance and use of the tool.
FIR-QR1497-Com	<b>26.5.8 Safety of the data preparation process</b>
FIR-QR1498-Req	The data preparation process shall have a safety integrity level (SIL), which enables the SIL target expected for the interlocking system to be achieved.
FIR-QR1499-Req	The data preparation process of generating the site specific data from the source data shall not degrade the safety of the data.
FIR-QR1500-Req	During the data preparation process the generated data shall be checked that it is fulfilling national functional requirements.
FIR-QR1501-Com	<b>26.5.8.1 Configuration management</b>
FIR-QR1502-Req	The data preparation process shall trace and clearly report all changes between configurations.  Rationale: The tool must support a process to manage and track changes in the interlocking system's configuration. Elements removed and added must clearly appear in the validation documentation.
FIR-QR1503-Com	<b>26.5.8.2 Validation process</b>
FIR-QR1504-Req	The supplier shall document the validation of the entire data preparation process and make this information available to the

	customer.  Rationale: The supplier must demonstrate the safety integrity level of the tool and process.
FIR-QR1505-Req	The process for verifying and validating data preparation shall be well defined, properly documented, and validated with respect to safety. The supplier shall define a strategy for full testing of these processes.
FIR-QR1506-Req	The data preparation process shall include means of verifying data by simulation or a similar method.  Rationale: Process requirement. Plausibility of the data shall be checked during the data preparation either continuously or after finishing one data preparation session.
FIR-QR1507-Com	<b>27 Supplier-furnished Data Preparation Tool</b>
FIR-QR1508-Com	<b>27.1 Background</b>
FIR-QR1509-Com	The supplier of an interlocking system shall furnish a data preparation tool that configures an interlocking system for a specific location. Configuration concerns functionality and connection of the interfaces of an interlocking system in accordance with the track layout and other traits of a specific location.
FIR-QR1510-Com	The customer shall be able to use the supplier-furnished data preparation tool to make modifications to their interlocking systems.
FIR-QR1511-Com	<b>27.2 Purpose</b>
FIR-QR1512-Com	The requirements in this document cover the supplier-furnished data preparation tool that configures an interlocking system of a specific model to a specific site.
FIR-QR1513-Com	<b>27.3 Scope</b>
FIR-QR1514-Com	These requirements refer to a data preparation tool that uses the EI Interlocking Data File Format or a customer-specific data preparation tool format as input. (EI means Euro-Interlocking.) In line with generic and national functional requirements, the tool converts this data into the form required to configure an interlocking system of a particular supplier and model for a specific location. The conversion process takes into account the characteristics and constraints of the specific supplier and model. After this stage, verification and validation must be possible.
FIR-QR1515-Com	These requirements are closely related to the data preparation requirements and these should be considered together.
FIR-QR1516-Com	<b>27.4 Supplier-furnished data preparation tool – Domain knowledge</b>
FIR-QR1517-Com	<b>27.5 Supplier-furnished data preparation tool – Requirements</b>

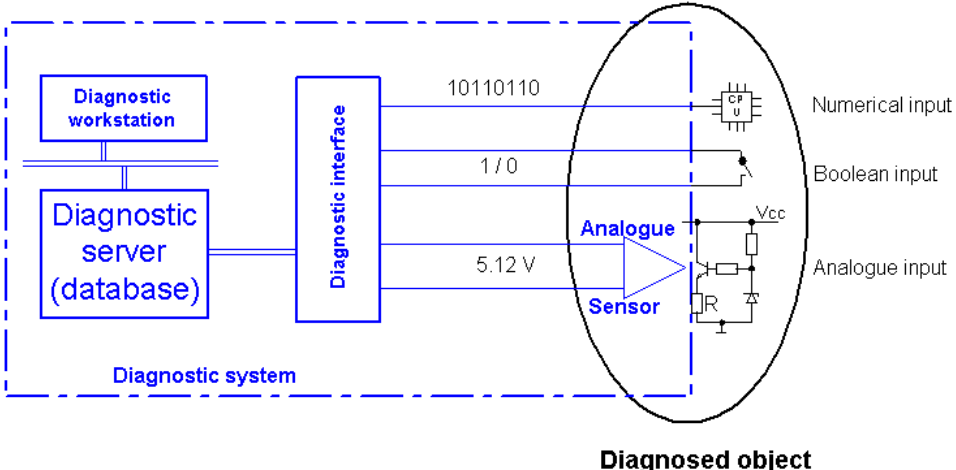
FIR-QR1518-Com	<b>27.5.1 General requirements</b>
FIR-QR1519-Req	<p>The supplier-furnished data preparation tool shall generate the outputs that describe the configuration of the interlocking system of a specific supplier, model and site, and enable the configuration's implementation.</p> <p>Rationale: To make sure that the customers are able to use configuration data for all required purposes and to give outputs for data preparation of the linked systems. Examples of such outputs for each site are: Data files for the interlocking system, electrical schemas, configuration drawings, cable design, list of components / parts, configuration management information, description of internally-implemented functionality (for maintenance), validation documentation to check the process and description of impacts on other, linked systems (specific interface information).</p>
FIR-QR1520-Req	The conversion of the input data shall fulfil functional (generic or/and national) requirements.
FIR-QR1521-Req	<p>Manual data input shall be possible.</p> <p>Rationale: It may be too expensive to have only automatic conversion. Defining the inputs and outputs of a particular site may require manual inputs.</p>
FIR-QR1522-Com	<b>27.5.2 System and interface requirements</b>
FIR-QR1523-Com	<b>27.5.2.1 Platform</b>
FIR-QR1524-Req	The supplier-furnished tool shall run on a standard platform (computer and operating system).
FIR-QR1525-Req	<p>The tool platform shall support communication with other platforms via standard protocols.</p> <p>Rationale: The customers must be able to use standard computer hardware and software to run the data preparation tool and exchange data with other applications.</p>
FIR-QR1526-Com	<b>27.5.2.2 HMI and documentation</b>
FIR-QR1527-Req	<p>The supplier shall develop the tool's human-machine interface (HMI) and the format and structure of documentation in cooperation with the customer. This shall include national language support.</p> <p>Rationale: Users must be able to use and communicate with the system in the national language(s) of the customer.</p>
FIR-QR1528-Com	<b>27.5.2.3 Interlocking Data File Format</b>

FIR-QR1529-Req	The supplier-furnished tool shall be able to read input data in the standard EI Interlocking Data File Format.
FIR-QR1530-Req	The supplier-furnished tool shall be able to read input data in the format of the customer-specific data preparation tool.  Rationale: An existing tool can be the source of input to the supplier-furnished tool.
FIR-QR1531-Com	<b>27.5.3 Performance</b>
FIR-QR1532-Req	Data preparation for a completely new installation containing 15 trackside elements shall take one trained person no longer than one workday.
FIR-QR1533-Req	Data preparation for a completely new installation containing 1000 trackside elements shall take one trained person no longer than five workdays.
FIR-QR1534-Req	Data preparation for a change in up to three trackside elements in an existing application shall take one trained person no longer than one workday.
FIR-QR1535-Req	The tool shall be able to support the maximum number of trackside elements for which the supplier's interlocking system can be configured.  Rationale: To be able to configure the interlocking system for all sites for which it has been developed and to minimise development time and costs associated with configuring an interlocking system.
FIR-QR1536-Com	<b>27.5.4 Maintenance</b>
FIR-QR1537-Com	<b>27.5.4.1 Change management of the data</b>
FIR-QR1538-Req	It shall be possible to modify the data input to the data preparation tool and have it generate an impact analysis of a planned modification.
FIR-QR1539-Req	Each version of input and output data shall have a unique identification.
FIR-QR1540-Req	It shall be possible to make changes to an interlocking at a particular location throughout the operational lifetime of the interlocking system at that location.
FIR-QR1541-Req	The interlocking system shall remain fully operational in the other areas.
FIR-QR1542-Req	The supplier's data preparation process shall trace and clearly report all changes between configurations.  Rationale: The tool must support a process to manage and track changes in the interlocking system's configuration. Elements removed and added must clearly appear in the validation documentation.
FIR-QR1543-Com	<b>27.5.4.2 Tool maintenance</b>
FIR-QR1544-Req	It shall be possible to adopt functional changes in the interlocking system, correct errors in the tool, and update the tool throughout

	the lifetime of the interlocking system without new certification of the data preparation process.
FIR-QR1545-Req	The tool shall be portable to future standard computer hardware and software.
FIR-QR1546-Req	The supplier shall provide support for people who use and maintain the tool.  Rationale: The supplier of the tool must support its use and maintenance.
FIR-QR1547-Com	<b>27.5.5 Verification, validation and testing of the data</b>
FIR-QR1548-Req	When a change is made to an application that has already been validated, it shall be possible to identify a set of validation activities adequate to validate the change.
FIR-QR1549-Req	The data preparation process shall include means of verifying data by simulation or a similar method.  Rationale: Process requirement. Plausibility of the data shall be checked during the data preparation either continuously or after finishing one data preparation session.
FIR-QR1550-Req	The process for verifying and validating data preparation shall be well-defined, properly-documented, and validated with respect to safety. The supplier shall define a strategy for full testing of these processes.
FIR-QR1551-Req	In order to minimise testing, especially when data is changed at a site installation already in service, the data structure and loading method shall ensure the fail-safe entry of valid data into the interlocking system.  Rationale: Both the configuration data and change process for the supplier-furnished data preparation tool must be safety-validated.
FIR-QR1552-Com	<b>27.5.6 Training</b>
FIR-QR1553-Req	The supplier shall provide the needed training for users of the data preparation tool.
FIR-QR1554-Req	Training time shall not exceed 10 work days for a competent signal engineer.  Rationale: The supplier must provide specific, adequate training for the tool.
FIR-QR1555-Com	<b>27.5.7 Documentation</b>
FIR-QR1556-Req	The supplier shall provide a full set of user and maintenance documentation for the data preparation tool.  Rationale: The documentation delivered with the tool must support maintenance and use of the tool.
FIR-QR1557-Com	<b>27.5.8 Safety integrity level</b>
FIR-QR1558-Req	The supplier's data preparation process shall have a safety integrity level (SIL) which enables the SIL target expected for the



	interlocking system to be achieved.
FIR-QR1559-Req	The supplier shall document the validation of the entire data preparation process and make this information available to the customer.  Rationale: The supplier must demonstrate the safety integrity level of the tool and process.
FIR-QR1560-Com	<b>28 Diagnostic Systems</b>
FIR-QR1561-Com	<b>28.1 Background</b>
FIR-QR1562-Com	This document presents requirements for the diagnostic system, which provides maintenance services for the interlocking system.
FIR-QR1563-Com	The statuses from the interlocking system that shall be received by the diagnostic system or the TCS, are defined in the Euro-Interlocking functional requirements.
FIR-QR1564-Com	<b>28.2 Purpose</b>
FIR-QR1565-Com	The purpose of the diagnostic system's functions is to facilitate maintenance. The main goal of these requirements is thus to provide a diagnostic system that helps users to monitor and view statistics on the interlocking system and connected physical elements, and to diagnose and repair any failures.
FIR-QR1566-Com	Monitoring seeks information about system performance, both to detect imminent failures and to determine the opportune moment for preventive maintenance.
FIR-QR1567-Com	Diagnosis shows whether a failure has occurred and where the failure is located.
FIR-QR1568-Com	A main way in which the diagnostic system helps restore interlocking functions is by showing the signal maintenance technician in which sequence he or she should perform actions to repair a failure.
FIR-QR1569-Com	The collection and analysis of statistical data over a period of time can facilitate improvement of the infrastructure or of maintenance processes.
FIR-QR1570-Com	<b>28.3 Scope</b>
FIR-QR1571-Com	This document includes the requirements and domain knowledge for the diagnostic system of an interlocking system.
FIR-QR1572-Com	<b>28.4 Diagnostic systems – Domain knowledge</b>
FIR-QR1573-DK	As the following diagram shows, a diagnostic system consists of the following functional subsystems: - diagnostic sensors; - diagnostic interfaces (physical interface between the diagnostic system and the diagnosed object); - communication interfaces linking to the: - diagnostic server (database);

<p>FIR-QR1574-Diag</p>	<p>- diagnostic workstation (every workstation using the diagnostic database);</p>  <p>The diagram illustrates a diagnostic system. On the left, a 'Diagnostic workstation' and a 'Diagnostic server (database)' are connected to a 'Diagnostic interface'. This interface is connected to a 'Diagnosed object' (circled in blue). The interface provides three types of inputs to the object: a 'Numerical input' (labeled '10110110'), a 'Boolean input' (labeled '1/0'), and an 'Analogue input' (labeled '5.12 V'). The analogue input section shows a sensor connected to an analogue-to-digital converter (ADC) circuit, which includes a resistor (R) and a reference voltage (V<sub>CC</sub>).</p>
<p>FIR-QR1575-DK</p>	<p>A diagnostic system provides information about its inputs. The inputs can be numeric, Boolean or analogue.</p>
<p>FIR-QR1576-DK</p>	<p>The information about numeric inputs is one of the states or within one of the ranges defined for each input.</p>
<p>FIR-QR1577-DK</p>	<p>The information about Boolean inputs is binary (states "1" or "0").</p>
<p>FIR-QR1578-DK</p>	<p>The information about analogue inputs can be either a value of a measured variable (such as voltage, current, or frequency) or an indication that the level of the input is:</p> <ul style="list-style-type: none"> <li>- zero;</li> <li>- within the normal working range;</li> <li>- outside the normal working range;</li> <li>- outside the acceptable range.</li> </ul>
<p>FIR-QR1579-DK</p>	<p>The diagnostic system is usually accessible locally (via a workstation connected directly to the diagnostic system) or remotely (via a workstation connected via Internet or via a modem).</p>
<p>FIR-QR1580-Com</p>	<p><b>28.5 Diagnostic systems – Requirements</b></p>
<p>FIR-QR1581-Com</p>	<p><b>28.5.1 General</b></p>
<p>FIR-QR1582-Com</p>	<p><b>28.5.1.1 System</b></p>
<p>FIR-QR1583-Req</p>	<p>The diagnostic system shall continuously monitor the condition and behaviour of the interlocking system, its related subsystems and</p>

	the communication between them.
FIR-QR1584-Req	The diagnostic system shall diagnose the interlocking system, its related subsystems and the communication between them.
FIR-QR1585-Req	The diagnostic system shall help the signal maintenance technician to find failures in the interlocking system, its related subsystems and the communication between them by indicating where, how and in which sequence actions have to be performed.
FIR-QR1586-Req	The diagnostic system shall be able to identify the loaded software versions of the interlocking system and its subsystems.
FIR-QR1587-Req	The diagnostic system shall identify all elements of the interlocking system that are defect and that must be replaced.
FIR-QR1588-Req	The diagnostic system shall be able to record all states within the memory range of each variable in the interlocking system.
FIR-QR1589-Com	<b>28.5.1.2 Diagnostic events</b>
FIR-QR1590-Req	The diagnostic system shall detect and log all diagnostic events.
FIR-QR1591-Req	The diagnostic system shall allow the customer to define the duration of the shortest detected diagnostic event.
FIR-QR1592-Req	The diagnostic system shall log all diagnostic events along with the precise time of their start and end (the diagnostic event duration).
FIR-QR1593-Req	The recorded time of the start and end of each diagnostic event (the diagnostic event duration) shall be accurate to within one tenth of a second.
FIR-QR1594-Com	<b>28.5.1.3 Time stamping</b>
FIR-QR1595-Req	The diagnostic system shall use a system clock to record the date and time of detection of each diagnostic event or failure.
FIR-QR1596-Req	The system clock shall be synchronised automatically using a reliable external clock (as for example DCF 77.5).
FIR-QR1597-Req	The date stamp shall consist of day, month and year. The time stamp shall consist of hour, minute, second and one tenth of a second.
FIR-QR1598-Req	The diagnostic system shall be able to work as a master for the time synchronisation of other systems (such as the interlocking system), if the customer so requires.
FIR-QR1599-Com	<b>28.5.1.4 Measurements and calibration</b>
FIR-QR1600-Req	If analog inputs are required, the diagnostic system shall support calibration of all elements which influence the accuracy of measured values.
FIR-QR1601-Req	Along with the diagnostic system, the supplier shall supply instructions for its calibration.
FIR-QR1602-Req	All required variables shall be measured with the following accuracy:
FIR-QR1603-Req	- AC voltage: $\pm 5\%$ of the measured value;
FIR-QR1604-Req	- DC voltage: $\pm 5\%$ of the measured value;
FIR-QR1605-Req	- Insulation states (if measured): $\pm 20\%$ of the measured value.
FIR-QR1606-Com	<b>28.5.2 RAMS requirements for diagnostic system</b>

FIR-QR1607-Req	The maximum rate of falsely detected failures shall be less than 2% of all detected failures, unless the customer requires a lower rate.
FIR-QR1608-Req	The mean time between failures of the diagnostic system shall be at least 1x10e+4 hours (1.1 years), unless the customer requires a longer mean time between failures. The MTBF figure includes all kind of failures.
FIR-QR1609-Req	The lifetime of the diagnostic system shall be at least as long as the lifetime of the interlocking system.
FIR-QR1610-Com	<b>28.5.3 Data storage</b>
FIR-QR1611-Req	For diagnostic analysis purposes, a detailed diagnostic log of all activities shall be retained for at least D days. The customer shall be able to specify a value for D between 3 days and 28 days.
FIR-QR1612-Req	If required by the customer, the diagnostic system shall allow the user to define the storage time of statistical information for each type of diagnosed object.
FIR-QR1613-Req	The diagnostic system shall log data on a reliable, commercial, off-the-shelf (COTS) data carrier.
FIR-QR1614-Req	The diagnostic system shall provide for an off-the-shelf (COTS) system to back up the diagnostic database on at least one independent data carrier.
FIR-QR1615-Req	Removing the data carrier from the diagnostic system for separate storage shall be possible. Changing the data carrier shall not result in loss of diagnostic information.
FIR-QR1616-Req	It shall be possible to retain statistic diagnostic data for the entire lifetime of the interlocking system for purposes such as preventive maintenance and monitoring infrastructure of improvements.
FIR-QR1617-Com	<b>28.5.4 Required diagnostic information</b>
FIR-QR1618-Req	The diagnostic information associated with the diagnosed object or object type shall consist of two parts: - common (mandatory) information, and - <i>additional specific information (depending on the specific application).</i>
FIR-QR1619-Com	<b>28.5.4.1 Interlocking system</b>
FIR-QR1620-Req	The diagnostic system shall monitor and log all the current internal states of the interlocking system such as for example :
FIR-QR1621-Req	- every state or position of track elements;
FIR-QR1622-Req	- internal diagnostic variables supporting failure detection (depends on the design of the interlocking system and the diagnostic system);
FIR-QR1623-Req	- information about currently active and inactive subsystems of redundant, backup subsystems (if the interlocking system includes redundant subsystems);
FIR-QR1624-Req	- the status of the communication network;
FIR-QR1625-Req	- technical operational status of the steering and detection system.

FIR-QR1626-Com	<b>28.5.4.2 Physical elements</b>
FIR-QR1627-Req	The diagnostic system shall monitor and log at least the following information about physical elements, if required by the customer:
FIR-QR1628-Req	- the current detected values;
FIR-QR1629-Req	- the current steering values;
FIR-QR1630-Req	- detailed information about physical elements (such as feed voltage of a signal bulb or the turning current of a point motor);
FIR-QR1631-Req	- failure information received from physical elements (if they provide such information);
FIR-QR1632-Com	<b>28.5.4.3 Power supply</b>
FIR-QR1633-Req	If a supplier delivers an interlocking system that uses an existing power supply or if another supplier delivers the power supply, the diagnostic system shall be able to continuously monitor the power supply and inform the interlocking system's users if the power supply fails or if measured values are out of range. The customer and supplier shall agree on the kinds of failure the diagnostic system is to detect and on the values it is to monitor.
FIR-QR1634-Req	If a supplier delivers both the power supply and the interlocking system, the diagnostic system shall continuously monitor the power supply and inform its users if a failure occurs or if measured values are out of range. The diagnostic system shall in this case monitor at least the following information about the power supply:
FIR-QR1635-Req	The diagnostic system shall monitor voltage at the following places:
FIR-QR1636-Req	- external power source
FIR-QR1637-Req	- all supplies for the interlocking system and its subsystems
FIR-QR1638-Req	- backup power supply (supply voltage, charging voltage).
FIR-QR1639-Req	The diagnostic system shall measure current at the following places:
FIR-QR1640-Req	- external power source
FIR-QR1641-Req	- all supplies for the interlocking system and its subsystems
FIR-QR1642-Req	- backup power supply (supply current, charging current).
FIR-QR1643-Req	The diagnostic system shall monitor load (as a percentage of available power) at the following places:
FIR-QR1644-Req	- external power source
FIR-QR1645-Req	- all supplies for the interlocking system and its subsystems
FIR-QR1646-Req	- backup power supply (supplied load).
FIR-QR1647-Req	The interlocking system shall monitor internal temperatures in power-supply cabinets and rooms.
FIR-QR1648-Com	<b>28.5.4.4 Commands and statuses</b>
FIR-QR1649-Req	The diagnostic system shall record all commands that the interlocking system receives (including those from elements such as the TCS, maintenance system, RBC or adjacent interlocking).
FIR-QR1650-Req	The diagnostic system shall record all statuses of commands that the interlocking system rejects or accepts.

FIR-QR1651-Req	The information about a command shall consist of:
FIR-QR1652-Req	- command identification (type, required operation)
FIR-QR1653-Req	- time of issuance
FIR-QR1654-Req	- identification of the person or system issuing the command
FIR-QR1655-Req	- identification of the source system (such as TCS, maintenance system, local post, RBC or adjacent interlocking).
FIR-QR1656-Req	The diagnostic system shall record all status information that the interlocking system sends (including those to elements such as the TCS, maintenance system, RBC or adjacent interlocking).
FIR-QR1657-Req	Information about a status shall consist of:
FIR-QR1658-Req	- event identification (type, unique identifier)
FIR-QR1659-Req	- time of event
FIR-QR1660-Req	- identification of the source causing the event
FIR-QR1661-Req	- identification of the destination of the status information (such as the TCS, maintenance system, RBC or adjacent interlocking).
FIR-QR1662-Com	<b>28.5.5 Information display and user functions</b>
FIR-QR1663-Com	<b>28.5.5.1 Information display</b>
FIR-QR1664-Req	At any time, the diagnostic system shall be able to present all diagnostic information it records during the time that DR-154 specifies.
FIR-QR1665-Req	The diagnostic system shall be able to display diagnostic data in real time or for between two dates defined by the user.
FIR-QR1666-Req	Print versions of all outputs from the diagnostic system shall be available.
FIR-QR1667-Req	At any time, the diagnostic system shall be able to display diagnostic information of the user's choice.
FIR-QR1668-Req	The supplier shall provide a mock-up of the layout and user functions of the diagnostic system's user screens in the language of the customer (unless the customer agrees to another language). The customer and supplier shall agree on the mock-up before implementation.
FIR-QR1669-Com	<b>28.5.5.2 Diagnostic user functions</b>
FIR-QR1670-Req	The user shall be able to request the logging of diagnostic events and other changes in the state of the interlocking system. The diagnostic system shall log all such events in the exact order of their detection within the interlocking system.
FIR-QR1671-Req	The diagnostic system shall allow the user to append comments to each diagnostic event (diagnostic record) and register them as a part of the diagnostic record or store them separately and link them to the record.
FIR-QR1672-Req	The diagnostic system shall provide its user with a troubleshooting system, including a comprehensive set of help tips.
FIR-QR1673-Req	Where appropriate, the diagnostic system shall allow the user to enter data manually for maintenance purposes.
FIR-QR1674-Com	<b>28.5.5.3 Maintenance user functions</b>

FIR-QR1675-Com	The diagnostic system shall be able to provide the maintenance user functions described below in this chapter, if required by the customer:
FIR-QR1676-Req	The diagnostic system shall provide a function that makes it possible for the user (for example a signal maintenance technician) to pre-define a diagnostic event. The diagnostic system shall automatically emit an alarm and inform the user if it detects this event.
FIR-QR1677-Req	The customer shall define how the diagnostic system informs the user when a pre-defined diagnostic event is detected. For example, the diagnostic system could send a message describing the event and its location to a signal maintenance technician's mobile phone.
FIR-QR1678-Req	The diagnostic system shall provide a function that makes it possible for the user to pre-define summary data. The diagnostic system shall be able to report this data to a central system (for example to a maintenance system).  Rationale: To support the efficient work of the user.
FIR-QR1679-Req	The diagnostic system shall provide user-friendly functions and statistical tools allowing the user to, for example, search for or view events, obtain statistics on elements, and manage the diagnostic database. These functions shall be defined with the customer.
FIR-QR1680-Req	The diagnostic system shall provide tools to sort and search for data within the diagnostic database using at least the following criteria:
FIR-QR1681-Req	- time of event's detection
FIR-QR1682-Req	- type of diagnosed object
FIR-QR1683-Req	- diagnosed object
FIR-QR1684-Req	- fault type
FIR-QR1685-Req	- fault frequency of an object for which the user has requested diagnosis
FIR-QR1686-Req	- specific information (defined by the user).
FIR-QR1687-Req	The diagnostic system shall allow the user to define routines for supervision of different parts of the interlocking system or physical elements.
FIR-QR1688-Req	The diagnostic system shall have a function allowing an authorised specialist to set internal variables of the interlocking system to a specific state.  The customer shall explicitly define the specific circumstances in which the authorised specialist can set internal variables of the interlocking system to a specific state. Such circumstances may, for example, involve special procedures specific to the customer's railway.
FIR-QR1689-Com	<b>28.5.6 Failures</b>
FIR-QR1690-Req	A failure, breakdown or shutdown of the interlocking system shall not lead to a failure or breakdown of the diagnostic system.
FIR-QR1691-Req	A failure or breakdown of the diagnostic system shall not lead to failure or breakdown of the interlocking system.
FIR-QR1692-Req	As the basis for informing the user of any breakdown of the diagnostic system, the diagnostic system shall regularly inform an

	adjacent system (such as the TCS or maintenance system) that it is functioning.
FIR-QR1693-Com	<b>28.5.7 Access to the diagnostic system</b>
FIR-QR1694-Req	The diagnostic system shall provide the possibility to define different access levels and access rights. The customer shall define the number of access levels and the access rights to the different access levels.
FIR-QR1695-Req	The diagnostic system shall enable the customer to configure particular access rights for different users or groups of users.
FIR-QR1696-Req	The diagnostic system shall allow more than one user to be logged in at the same time.
FIR-QR1697-Req	Remote access (for example from another diagnostic workstation or via the Internet) of the diagnostic system shall be possible.
FIR-QR1698-Req	The diagnostic system shall be able to record any access to it, if required by the customer.
FIR-QR1699-Req	The record of each access to the diagnostic system shall at least contain:
FIR-QR1700-Req	- Identification or inscription of the name of natural person who accesses the system;
FIR-QR1701-Req	- Type of access/what kind of user;
FIR-QR1702-Req	- The time and date of access (start/end);
FIR-QR1703-Req	- Reason for access.
FIR-QR1704-Com	<b>28.5.8 Communication interfaces</b>
FIR-QR1705-Req	The diagnostic system shall provide for communication with outside systems for consulting data by any usual means (internal or public network, wire or radio link) using a communication protocol shared by the manufacturers.
FIR-QR1706-Req	The design of communication interfaces for remote access shall be consistent with the interface requirements for the interlocking system as a whole.
FIR-QR1707-Req	If connecting the diagnostic system to an existing interlocking system or to an interlocking system from another supplier requires a special physical interface, the customer and supplier shall agree on the design of the interface.
FIR-QR1708-Req	The diagnostic system shall be remotely accessible at least via the following commercial, off-the-shelf (COTS) communication media:
FIR-QR1709-Req	- a COTS analogue modem (such as a V.90 analogue modem)
FIR-QR1710-Req	- a COTS network (such as Ethernet via a LAN or WAN)
FIR-QR1711-Req	- a COTS digital modem (such as an ISDN digital modem)
FIR-QR1712-Req	- a COTS communication media for wireless communication (such as GSM-R).
FIR-QR1713-Com	<b>28.5.9 Diagnostic system structure</b>
FIR-QR1714-Req	The software for the diagnostic database (diagnostic server) and for users' diagnostic terminals (including software for the human-machine interface, HMI) shall be based on a commercial, off-the-shelf hardware set and operational system.