EUG Reference: 13E137

Distribution date: 2023-12-14
Document version: 1.14

ERTMS/ATO OPERATIONAL REQUIREMENTS

VERSIONS & MODIFICATIONS

Version No.	Date of distribution	Comments on the modification	Responsible for the modification
0.1	31/08/2012	First Draft for information to EUG	Graham Scott/Carine Marin
0.2	15/01/2013	Updated following operational principles update and EUG review	Graham Scott/Carine Marin
0.3	06/03/2013	Updated following EUG review of 0.2 and addressing comments raised	Graham Scott/Carine Marin/Ken Chan/Mark Evans/Glyn Roberts
0.4	30/04/2013	Updated following EUG review of 0.3 and addressing comments raised	Carine Marin/Ken Chan/Mark Evans/Glyn Roberts
0.5	24/05/2013	Updated following EUG review of 0.4 and addressing comments raised	Carine Marin/Ken Chan/Mark Evans/Glyn Roberts
0.6	20/06/2013	Updated following EUG review of 0.5 and addressing comments raised and operating scenarios draft	Carine Marin
0.7	22/07/2013	Updated following EUG and UNISIG review of 0.6 and addressing comments raised	Carine Marin/Ken Chan
0.7b	30/07/2013	Updated following review of scenarios	Carine Marin/Ken Chan
1.0	22/08/2013	Official Issue	Ken Chan
1.1	06/09/2013	Updated following EUG/UNISIG joint workshop and EUG review	Carine Marin
1.2	30/09/2013	Updated following EUG review	Carine Marin
1.3	11/12/2014	Updated following EUG and UNISIG meetings	Carine Marin
1.4	17/12/2014	Updated following EUG ATO WG review	Carine Marin
1.5	28/10/2016	Current Working Version	Aidan McGrady
1.6	18/11/2016	Update to include C-DAS requirements and other minor modifications	Aidan McGrady
1.7	20/12/2016	Update following review comments by EUG and review comments received through the European Union Agency for Railways	Roman Treydel
1.8	20/01/2017	Updated following review comments from EUG ATO WG and Shift2Rail IP5 ARCC WP1 (ATO for Freight)	Roman Treydel
1.9	19/05/2017	Update following review comments by UNISIG and EUG ATO WG	Roman Treydel
1.10	21/12/2017	Update to reflect EECT decisions, review by ATO suppliers and EUG ATO WG review, architecture updated	Roman Treydel

1.11	15/07/2019	Update to reflect review by Suppliers, changes as an outcome of the Traceability Matrix and Driving Styles activity. Additionally, deleted requirements were marked as “intentionally deleted” and “standstill” was changed to “(a) stand” due to the different definition of “standstill” in the TSI LOC & PAS.	Fabian Kirschbauer/Katherine Stowe
1.12	18/082020	Update to reflect various changes	Fabian Kirschbauer
1.13	2021-11-29	Update to ATO-OR-088	Arvid Bäärnhielm
1.14	2022-02-24	Update following ATO-WP review. Including agreement of previous update to ATO-OR-088 as well as changes to ATO-OR-003 and ATO-OR-008. Additionally, also the name change ATO over ETCS to ERTMS/ATO.	ATO-WP
2-	2023-12-14	Version for inclusion in the CCS TSI Application Guide. A forgotten agreement to update Figure 1 was also resolved.	Arvid Bäärnhielm

Contents

1 INTRODUCTION

The European Railways are currently in the process of implementing ETCS. The railways have identified an opportunity to achieve improved capacity, on-time performance and make energy efficiency improvements through developing and implementing Automatic Train Operation (ATO). ATO is the sub-system which performs some or all of the functions of automatic speed regulation, accurate stopping, door opening and closing, performance level regulation, and other functions assigned to a train driver or train attendant.

2 SCOPE

This document defines the ERTMS/ATO Operational Requirements derived from the top level ERTMS/ATO Operational Principles [RD2] and ERTMS/ATO Operational Scenarios [RD3]. The ERTMS/ATO Operational Requirements cover ATO systems that shall be able to operate in GoA1, GoA2, GoA3 and GoA4; or a combination of these different GoAs.

The ERTMS/ATO Operational Requirements define an interoperable ATO that shall realise the benefits of ATO when applied to different railway infrastructures; urban, suburban, main line and high speed railways.

The ERTMS/ATO Operational Requirements shall cover requirements for different types of rolling stock; passenger trains, freight trains, maintenance trains and engineering vehicles.

The current version of this document is valid and commonly agreed for GoA1 and GoA2. The requirements for GoA3 and GoA4 are included for information, but further development is in progress, especially for the automation of all driver functions as well as the definition of the system architecture.

3 ERTMS/ATO SYSTEM OVERVIEW

The ERTMS/ATO system is based on two sub-systems: the ATP system (ETCS, see [RD4]) and the ATO system. Unlike ETCS the ATO system cannot operate in isolation; it can only drive the train automatically in areas where ETCS is guaranteeing the safe movement of the train. Both ETCS and ATO include on-board and trackside constituents. ETCS supervises the train ensuring that speed and movement limits are observed and the train proceeds only when it is allowed by the trackside to do so. The ATO on-board automatically drives trains, through control of traction and braking, including but not limited to accurate stopping at specified stopping positions using operational data provided by a traffic management system (TMS) and infrastructure data provided by trackside equipment.

The ATO trackside interfaces with the Traffic Management System which can automate normal signaller operations such as route setting and train regulation. ATO and TMS work together to maintain a train within a defined tolerance of the operational timetable whilst managing conflicts to ensure that overall train operation is optimised.

ATO is not a safety critical system and therefore any identified safety requirements as a result of the ATO operational requirements shall be assigned to other safety systems e.g. ETCS or Train Control Management Systems.

The table below provides an overview of the different Grades of Automation (GoA) that an ATO system can operate. In the context of this specification, GoA1 refers to manual driving with driver advisory information and is covered in this document by requirements for C-DAS using the same principles as ATO in GoA2 upwards.

GoA	GoA Name	On-board Train Operator	Description
GoA1	**Non-automated train operation**	Train driver in the cab	The train is driven manually; but protected by automatic train protection (ATP). This GoA includes providing advisory information to assist manual driving.
GoA2	**Semi-automated train operation**	Train driver in the cab	The train is driven automatically, stopping is automated but a driver in the cab is required to start automatic driving of the train, the driver can operate the doors (although this can also be done automatically), the driver is still in the cab to check the track ahead is clear and carry out other manual functions. The driver can take over in emergency or degraded situations.
GoA3	**Driverless train operation**	Train attendant on-board the train	The train is operated automatically including automatic departure, a train attendant has some operational tasks, e.g. operating the train doors (although this can also be done automatically) and can assume control in case of emergency or degraded situations.
GoA4	**Unattended train operation**	No staff on-board competent to operate the train	Unattended train operation; all functions of train operation are automatic with no staff on-board to assume control in case of emergencies or degraded situations.

Table 1 – Grades of Automation high level description

All the interoperable interfaces for the ATO system in GoA1&2 are shown in Figure 1. The figure does generally not show interfaces which are defined in other specifications like the ETCS track-train interface.

Note: The figure shows the standard architecture for ATO. This does not exclude the possibility to implement another architecture, as long as the specifications relevant for interoperability are respected. A different architecture could especially be used for the integration of ATO with existing ETCS on-boards or rolling stock.

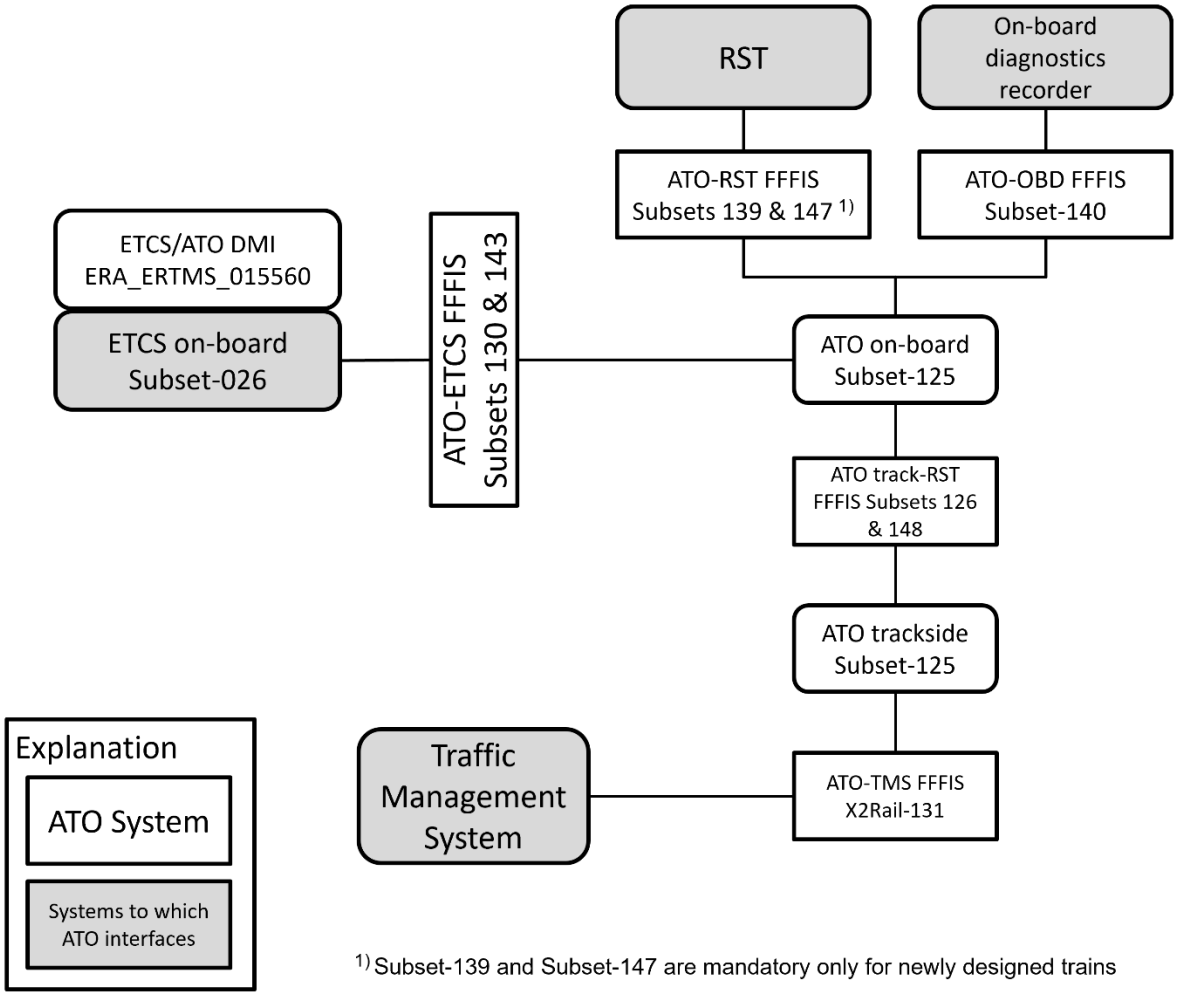

Figure 1 – ERTMS/ATO System Architecture for GoA2

Note: The ATO specification is developed with ETCS as the ATP system. ATO in combination with a Class B ATP system is not in the scope of this specification. It is possible to re-use this specification for the development of ATO over Class B.

4 REFERENCES

[RD1] ERTMS/ATO Glossary, 13E154
[RD2] ERTMS/ATO Operational Principles, 12E108
[RD3] ERTMS/ATO Operational Scenarios, 13E151
[RD4] Commission Regulation (EU) 2016/919 of 27 May 2016 on the technical specification for interoperability relating to the 'control-command and signalling' subsystems of the rail system in the European Union

5 TERMS, DEFINITIONS AND ABBREVIATIONS

The terms, definitions and abbreviations used in this document are defined in [RD1].

6 REQUIREMENTS: APPLICABILITY AND IDENTIFICATION

This section explains how the ATO operational requirements are structured and how they apply for the different Grades of Automation.

6.1 Requirement Identifier

To enable traceability with the ERTMS/ATO Operational Principles [RD2], the requirements within this document are organised in a structure according to the ERTMS/ATO Operational Principles [RD2]. Each requirement is identified by a three-digit number preceded by the prefix “ATO-OR-” which links the identifier to this ERTMS/ATO Operational Requirements document.

Note: The requirement number is not necessarily sequential, i.e., if the order of requirements is changed in further document versions, the identifier will not change. Never changing the identifier of a requirement ensures unambiguous identification also across different document versions.

6.2 Applicability of Requirements

Applicability for each requirement is defined for each GoA. This means that any ATO on-board that complies with all the requirements for that GoA shall be able to operate in that GoA. For example, an ATO on-board that complies with all the ATO operational requirements for GoA4 but not for GoA2 and 3 shall only be able to operate automatically on a GoA4 equipped line.

ATO operational requirements can be mandatory or optional for a particular GoA. Those that are identified as Mandatory are indicated with an “X”, while those that are optional are indicated with an “O”.

This document does not determine how the requirements identified for each GoA are implemented in the ATO system.

7 REQUIREMENTS

7.1 General Principles: Interoperability, Interchangeability, Compatibility, Adaptability and Safety

These requirements have been derived from the ERTMS/ATO Operational Principles [RD2] to manage interoperability, interchangeability, compatibility and adaptability for Grades of Operation 1-4.

Requirement ID	Requirement	Applicability			
		GoA1	GoA2	GoA3	GoA4
General Principle 1: Interoperability in a given grade of automation					
ATO-OR-001	The ATO on-board function and the ATO trackside function shall be interoperable.	X	X	X	X
ATO-OR-002	The ATO on-board shall be compliant with all of the ERTMS/ATO Operational Requirements for the GoAs operated.	X	X	X	X
ATO-OR-003	The ATO on-board can be equipped for any GoA or combination of GoAs. Implementing a GoA shall not mandate implementing lower GoAs.			X	X
ATO-OR-004	Any interoperable interfaces shall be compliant with all of the ERTMS/ATO Operational Requirements for the supported GoAs.	X	X	X	X
General Principle 2: Interoperability between ATO tracksides					
ATO-OR-005	The ATO function shall support a seamless handover between adjacent ATO tracksides.	X	X	X	X
ATO-OR-006	The ATO trackside shall support data exchange with planning systems, e.g. Traffic Management Systems.	X	X	X	X
General Principle 3: Interoperability with different grades of automation					
ATO-OR-007	It shall always be possible to operate in the highest Grade of Automation supported by both the ATO trackside and the ATO on-board.	X	X	X	X
General Principle 4: Interchangeability					
ATO-OR-008	The ATO constituents shall be interchangeable (FFFIS) and designed to the same interface specifications.	X	X	X	X

General Principle 5: Adaptability					
ATO-OR-009	The ATO system shall be configurable to enable line extensions, modifications of track layout and trackside or rolling stock performance changes.	X	X	X	X
General Principle 6: Backward compatibility					
ATO-OR-010	The ATO on-board and the ATO trackside shall operate the highest system version supported by both. Backward compatibility shall be possible by allowing the ATO on-board and the ATO trackside to support several system versions.	X	X	X	X
General Principle 7: Safety					
ATO-OR-011	The ATO function is not a safety critical system. Any safety functionality required for the ATO to operate automatically shall be managed by other safety systems, e.g. ETCS.	X	X	X	X

7.2 ATO Principle 1: Performance and Energy Efficiency.

These requirements have been derived from the ERTMS/ATO Operational Principles [RD2] to manage the overall ATO system performance and the delivery of an energy efficient system.

Requirement ID	Requirement	Applicability			
		GoA1	GoA2	GoA3	GoA4
ATO 1.1 - Defining performance parameters					
ATO-OR-012	The ATO function shall achieve the specified performance requirements for interoperability.	X	X	X	X
ATO-OR-013	The ATO trackside function shall be able to generate Journey Profiles and Segment Profiles from operational and infrastructure data.	X	X	X	X
ATO-OR-014	The ATO trackside function shall send the Journey Profiles and Segment Profiles to the ATO on-board function.	X	X	X	X
ATO-OR-015	The ATO on-board function shall stop the train when required at all defined Stopping Points within the Journey Profile.		X	X	X
ATO-OR-016	The ATO function shall support trains operating across a varied range of adhesion.	X	X	X	X
ATO-OR-017	The available wheel – rail adhesion (transmitted by ATO trackside function) shall be taken into account by the ATO on-board function.	X	X	X	X
ATO-OR-018	Intentionally deleted.				
ATO-OR-019	The ATO on-board function shall inform the ATO trackside in real time when changes in adhesion condition during the journey are detected.	X	X	X	X
ATO-OR-020	If adhesion conditions in an area require an update of the Journey Profile, updated Journey Profiles shall be sent to all ATO trains running in this area.	X	X	X	X
ATO-OR-021	The ATO on-board function shall regulate train speed in a way that minimises transitions between traction and braking consistent with achieving the required performance.		X	X	X
ATO-OR-022	The ATO on-board function shall be configurable to ensure its traction, coast and brake commands are adapted to the rolling stock to enable control of the vehicle to meet the defined performance levels.		X	X	X

ATO-OR-023	Intentionally deleted.				
ATO 1.2 - Energy efficiency					
ATO-OR-024	The ATO on-board function shall calculate the most energy efficient ATO Operational Speed Profile meeting the Journey Profile and within the ETCS safe envelope.	X	X	X	X

7.3 ATO Principle 2: Supervision and Regulation

These requirements have been derived from the ERTMS/ATO Operational Principles [RD2] to manage and supervise the operation of a whole line or a complete network and cover functionality necessary to:

- Supervise train operations;
- Manage the train service.

Requirement ID	Requirement	Applicability			
		GoA1	GoA2	GoA3	GoA 4
ATO 2.1 - Supervise train operations					
ATO-OR-025	The ATO on-board function shall report its position to the ATO trackside.	X	X	X	X
ATO 2.2 - Manage the train service					
ATO-OR-026	The Journey Profile times shall use UTC.	X	X	X	X
ATO-OR-027	It shall be possible to assign specific Journey Profiles to specific ATO trains.	X	X	X	X
ATO-OR-028	A Journey Profile shall include times and identifiers for each Timing Point.	X	X	X	X
ATO-OR-029	It shall be possible in the Journey Profile to require driving at a constant speed between two Timing Points.	X	X	X	X
ATO-OR-030	The ATO on-board function shall accept a valid Journey Profile sent by the ATO trackside function.	X	X	X	X
ATO-OR-031	An ATO train shall be uniquely identified for a journey and Journey Profile.	X	X	X	X
ATO-OR-032	At any time if the ATO on-board function cannot comply with the timings of the Journey Profile, it shall send to the ATO trackside function an estimated time for reaching the next Timing Points.	X	X	X	X
ATO-OR-033	Upon receipt of the estimated deviation for reaching the next Timing Points from the ATO on-board function, the ATO trackside function shall be able to send an updated Journey Profile.	X	X	X	X
ATO-OR-034	The ATO function shall support cancelling or amending a Journey Profile automatically when a new Journey Profile is assigned.	X	X	X	X
ATO-OR-035	If the Segment Profile is not consistent with the expected data, the ATO on-board function shall inform the ATO trackside function.	X	X	X	X

ATO-OR-036	If the Segment Profile is not consistent with the expected data, the ATO trackside function shall be able to send an updated Journey Profile and/or Segment Profile to the ATO on-board function.	X	X	X	X
ATO-OR-037	If the infrastructure data from the Segment Profile is not consistent with the infrastructure encountered then the ATO shall disengage, until a consistent Segment Profile is received.	X	X		
ATO-OR-038	Intentionally deleted.				
ATO-OR-039	The ATO on-board function shall inform the ATO trackside function when it reaches the end of the Journey Profile.	X	X	X	X
ATO-OR-040	Intentionally deleted.				
ATO-OR-041	Intentionally deleted.				
ATO-OR-042	The ATO on-board function shall support any changes to the intended final destination of the Journey Profile before departure or at any time during the journey.	X	X	X	X
ATO-OR-043	The ATO on-board function shall support any changes to the intended routing before departure or at any time during the journey.	X	X	X	X
ATO-OR-044	The ATO on-board function shall support any changes to the passing, arrival or departure times for Timing Points before departure or at any time during the journey.	X	X	X	X
ATO-OR-046	ATO and non-ATO trains shall be able to operate on the same line at the same time.	X	X	X	X
ATO-OR-047	When an ATO train leaves an ATO trackside area the ATO on-board function can continue to calculate the ATO Operational Speed Profile as long as it has a valid Journey Profile and Segment Profile.	X	X	X	X

7.4 ATO Principle 3: Yards, Depots and Stabling Areas

The operation in yards, depots and stabling areas with ATO is not different from operation on the mainline and covered by the requirements in other sections. No additional requirements are needed to cover ATO Principle 3 from [RD2].

7.5 ATO Principle 4: Ensure safe movement of trains

The requirements in this section have been derived from the ERTMS/ATO Operational Principles [RD2] and cover the safety functionality necessary to operate ATO. ATO is not a safety critical system therefore safety functions shall be managed by other systems e.g. ETCS:

- Ensure safe route, safe separation of trains, safe speed and authorise train movement;
- Change the driving direction;
- Joining and splitting a train.

Requirement ID	Requirement	Applicability			
		GoA1	GoA2	GoA3	GoA4
ATO-OR-048	National systems, rules, processes and ETCS shall be responsible for ensuring the safe movement of ATO trains in all directions of travel (including rollback).	X	X	X	X

7.6 ATO Principle 5: Operate Train

The requirements in this section have been derived from the ERTMS/ATO Operational Principles [RD2] so that the ATO system starts, stops, coasts, and controls the speed of the train such that acceleration, deceleration, and jerk rates are within passenger comfort limits or freight/maintenance train design limits and the train operating speed is below the speed limit imposed by the ERTMS on-board (ETCS) sub-system.

The requirements cover functionality to include:

- Preparation and stabling;
- Train Data entry;
- Ensure starting conditions;
- Operate a train between two operational Timing Points;
- Manage GoA and transitions;
- Change the driving direction;
- Joining and splitting a train;

Requirement ID	Requirement	Applicability			
		GoA 1	GoA 2	GoA 3	GoA 4
ATO 5.1 - Preparation and stabling					
ATO-OR-049	De-energising or energising the ATO on-board function shall be possible by a command from the train driver.	X	X		
ATO-OR-050	Intentionally deleted.				
ATO-OR-051	It shall be possible to de-energise or energise the ATO on-board function by the rolling stock.	X	X	X	X
ATO-OR-052	When the ATO on-board function is energised, it shall be possible to assign a new journey to the ATO train by sending a Journey Profile to the ATO on-board function.	X	X	X	X
ATO 5.2 - Train Data entry					
ATO-OR-053	Any additional train data entry for ATO shall be kept to a minimum.	X	X	X	X
ATO-OR-054	The ATO on-board function shall acquire train data from the ETCS on-board and shall be able to acquire additional train data from external sources. Note: The external source may support remote data entry.	X	X	X	X
ATO-OR-055	The ATO function shall support the automatic entry of data, including remote entry.			X	X

ATO-OR-056	A change of the train running number at a stand or while moving shall trigger a request for an updated Journey Profile.	X	X	X	X
ATO-OR-057	It shall be possible to transmit train data from the ATO trackside function via ATO on-board function to the ETCS on-board.			X	X
ATO 5.3 - Ensure starting conditions					
ATO-OR-058	ATO trains shall be authorised to depart from a Stopping Point, at the start of a journey or while moving when all of the following conditions are met: • The train is not immobilised by emergency braking or service braking by a safe system. • The start of the train is not inhibited by the ATO trackside function. • The train is not held for traffic regulation purposes (including for connecting services). • The dwell time has elapsed or departure time at the start of a journey is reached. • The train is assigned a valid Journey Profile with valid Segment Profiles. • Train doors are confirmed closed and locked (if applicable). • Platform barrier systems are closed (if this information is available). • Freight train is secured for moving		X	X	X
ATO-OR-059	When all applicable conditions are met for the authorisation of the ATO train, the ATO on-board function shall start automatic driving of the train following a command executed by the train driver.		X		
ATO-OR-060	When all applicable conditions are met for the authorisation of the ATO train, the train shall start automatic driving of the train following either a command from the train attendant or from the ATO trackside function.			X	
ATO-OR-061	When all applicable conditions are met for the authorisation of the ATO train, automatic driving shall be automatically initiated.				X
ATO 5.4 - Operate a train between two operational Timing Points					
ATO-OR-062	The ATO on-board function shall command traction and brakes of the rolling stock in order to comply with the ATO Operational Speed Profile and the jerk rate limits.		X	X	X
ATO-OR-062A	The ATO on-board function shall ensure the requirements of the air brakes are met before applying traction/braking commands.	X	X	X	X

ATO-OR-062B	For ATO-Trains, it shall be possible to delay brake release during a hill start.	X	X	X	X
ATO-OR-063	Intentionally deleted.				
ATO-OR-064	The ATO on-board function shall deliver variable brake commands without the use of emergency braking.		X	X	X
ATO-OR-065	For ATO trains, it shall be possible to operate the train at its maximum capability if required by the Journey Profile by ignoring specific not safety relevant ETCS curves (i.e., Permitted, Warning and SBI in Target Speed Monitoring) since they are not relevant for ATO application.		X	X	X
ATO-OR-066	The ATO on-board function shall automatically stop the train at the Stopping Point if the stop is part of the Journey Profile and no “Stopping Point Skip” command for the Stopping Point has been received by the ATO on-board function.		X	X	X
ATO-OR-067	The ATO on-board function shall be able to stop the train to a positional accuracy that supports the operation of the platform/train interface or loading/unloading system.		X	X	X
ATO-OR-068	Automatic driving shall be disengaged when the train has stopped at a Stopping Point.		X		
ATO-OR-069	When the train is being driven automatically, if the Traction Brake Lever is moved to traction the command shall be ignored and the ATO on-board function shall inform the train driver by an audible warning.		X		
ATO-OR-070	If a command modifying the status of a Stopping Point from "Stopping Point Skip" to "Stopping Point Stop" is received by the ATO on-board function, the ATO on-board function shall command the train to stop in the station only if the stop can be achieved.		X	X	X
ATO-OR-071	An indication shall be provided to the train driver to indicate when the train has undershot, overshot or stopped within the Stopping Point tolerance. This applies only in the vicinity of the Stopping Point.	X	X		
ATO-OR-072	An indication shall be provided to the train attendant and also reported to the ATO trackside function to indicate when the train has undershot or overshot the Stopping Point tolerance.			X	

ATO-OR-073	It shall be reported to the ATO trackside function to indicate when the train has undershot or overshot the Stopping Point tolerance.				X
ATO-OR-074	The minimum dwell time defined for each station stop shall be sent by the ATO trackside function to the ATO on-board function to be applied during normal or degraded operation to aid service recovery.	X	X	X	X
ATO-OR-075	When an ATO train is performing a “Stopping Point Skip”, the ATO on-board function shall not automatically open the train doors and the platform barrier system (if present) even if the train came to a stand at the stopping point to be skipped.		X	X	X
ATO-OR-076	At defined stopping locations, if the ATO train fails to reach the Stopping Point, the ATO on-board function shall automatically jog forward the train, maintaining the train doors closed and locked, until the train is correctly aligned.		X	X	X
ATO-OR-077	At defined stopping locations, if the ATO train overruns the Stopping Point by a distance less than the acceptable limit (the rollback tolerance), the ATO on-board function shall automatically jog backward the train, maintaining the train doors closed and locked, until the train is correctly aligned.		X	X	X
ATO-OR-078	An ATO train that overruns the Stopping Point by more than the rollback tolerance shall remain stationary with the doors closed until commanded otherwise by the train driver.		X		
ATO-OR-079	An ATO train that overruns the Stopping Point by more than the rollback tolerance shall remain stationary with the doors closed until commanded otherwise by the infrastructure, operations staff or train attendant.			X	X
ATO-OR-080	The ATO train shall be held at the Stopping Point if an "ATO train hold" request is received by the ATO on-board function.		X	X	X
ATO-OR-081	The "ATO train hold" information shall be displayed to the train driver.	X	X		
ATO-OR-082	The "ATO train hold" information shall be provided to the train attendant.			X	

ATO-OR-083	The "ATO train hold" information shall be sent by the ATO trackside function to the ATO on-board function.	X	X	X	X
ATO-OR-084	Intentionally deleted.				
ATO-OR-085	Intentionally deleted.				
ATO-OR-086	The ATO on-board function shall provide the “Stopping Point Skip” status to the ATO trackside function.	X	X	X	X
ATO-OR-087	ATO trains shall skip a Stopping Point if commanded by the train driver.		X		
ATO-OR-088	It shall always be possible to revoke a “Stopping Point Skip” initiated by the ATO trackside function either by request from the driver, or by updating the Journey Profile.	X	X	X	X
ATO-OR-089	“Stopping Point Skip” information shall be displayed to the train driver on the DMI.	X	X		
ATO-OR-090	“Stopping Point Skip” information shall be displayed to the train attendant.			X	
ATO-OR-091	A “Stopping Point Skip” initiated by the train driver shall only be revoked by the train driver.	X	X		
ATO-OR-092	The ATO trackside function shall be able to command a “Stopping Point Skip” by updating the Journey Profile.	X	X	X	X
ATO-OR-093	Automatic driving shall remain engaged on protected Level Crossings.		X	X	X
ATO-OR-094	For unprotected Level Crossings the ATO on-board shall disengage when the Level Crossing is announced to the driver on the DMI.		X	X	X
ATO-OR-095	Intentionally deleted.				
ATO 5.5 - Manage GoA transitions					
ATO-OR-096	Intentionally deleted.				
ATO-OR-097	Intentionally deleted.				

ATO-OR-098	The ATO trackside function shall be able to order a transition to another GoA which will be executed by the ATO on-board (including possible acknowledgements).			X	X
ATO-OR-098A	The ATO trackside function shall be able to order a transition to a lower GoA which will be executed by the ATO on-board" and checklist for all levels of GoA	X	X		
ATO-OR-099	The driver shall be able to select another available GoA on the move.	X	X		
ATO-OR-100	The train attendant shall be able to select an available GoA on the move.			X	
ATO-OR-101	Automatic driving shall be disengaged automatically when the train driver applies the brakes; or by a specific action on the DMI or when a safe system applies the brakes.		X		
ATO-OR-102	An ATO train’s GoA shall be reported to the ATO trackside function.	X	X	X	X
ATO-OR-103	It shall be possible to inhibit a designated GoA on specific sections of the line.	X	X	X	X
ATO-OR-104	It shall be possible to inhibit a designated GoA on a specific ATO train.	X	X	X	X
ATO-OR-104A	Intentionally deleted.				
ATO-OR-105	Intentionally deleted.				
ATO-OR-106	Intentionally deleted.				
ATO-OR-107	A transition to a lower GoA on the move shall be acknowledged by the person taking on responsibilities for operating the train before the transition is implemented.		X	X	X
ATO-OR-108	If no acknowledgement of the transition to a lower GoA is received from the train driver or train attendant after a reaction time, then the ATO on-board function shall brake the train until the acknowledgement is received or the train is brought to a stand.		X	X	X
ATO-OR-109	Intentionally deleted.				

ATO-OR-110	The ATO on-board function shall disengage automatic driving if it does not have both a valid Journey Profile and Segment Profile for the track section in front of the train. This disengagement can be done on the move.		X		
ATO-OR-111	Automatic disengagement of ATO shall be clearly indicated to the train driver.		X		
ATO-OR-112	Intentionally deleted.				
ATO-OR-113	The ATO on-board function shall stop the train as soon as automatic driving is to become disengaged.			X	X
ATO-OR-114	The ATO train shall be brought to a stand if it does not have both a valid Journey Profile and Segment Profile for the route ahead.			X	X
ATO-OR-115	Intentionally deleted.				
ATO-OR-115A	Intentionally deleted.				
ATO-OR-116	When a train safety system applies the emergency brakes, automatic driving shall be automatically disengaged.		X	X	X
ATO-OR-117	When a train system connected to the ATO on-board applies the emergency brakes, the ATO on-board function shall inform the ATO trackside function.			X	X
ATO-OR-118	When automatic driving is disengaged, the ATO on-board function shall inform the ATO trackside function.		X		
ATO-OR-119	When the train attendant disengages automatic driving in an ATO area, the ATO on-board function shall inform the ATO trackside function.			X	
ATO 5.6 - Change the driving direction					
ATO-OR-120	It shall be possible to automatically change the train orientation (i.e., automatic Start of Mission and End of Mission) at a stand where required by the Journey Profile.	O	X	X	X
ATO-OR-121	Upon detection of change of train orientation, the ATO on-board function shall automatically update the required travel direction based on the Journey Profile.	X	X	X	X

ATO-OR-122	The travel direction shall be changed automatically by the ATO on-board function when required for an operational movement by the Journey Profile.		X	X	X
ATO-OR-123	The ATO function shall support automatic turnback.		X	X	X
ATO-OR-124	Automatic turnback moves will only be available when specifically allowed for by the ATO function in predefined areas.		X	X	X
ATO-OR-125	For automatic turnback moves, the travel direction shall only be changed by the ATO on-board function when the train is stationary in a predefined area.		X	X	X
ATO-OR-126	If the active cabin and the required travel direction are conflicting, the ATO on-board function shall report it to the ATO trackside function.	X	X		
ATO-OR-127	The train driver shall be informed if the active cabin and the required travel direction are conflicting.	X	X		
ATO-OR-128	In automatic turnback, an ATO train shall commence automatic operation upon receiving an updated Journey Profile or a command from operations staff.		X	X	X
ATO 5.7 - Joining and splitting a train					
ATO-OR-129	Intentionally deleted.				
ATO-OR-130	Automatic joining of trains shall be supported by the ATO function.		X	X	X
ATO-OR-131	If automatic joining is used, before actual joining, the train speed shall be continuously controlled, to ensure that it is below the maximum allowable joining speed, up to the joining event.		X	X	X
ATO-OR-132	Automatic joining shall commence after the train is at a stand in a pre-defined area and after receiving a command from the train driver. Note: The driver is responsible for checking the pre-conditions for joining.		X		
ATO-OR-133	Automatic joining shall commence after the train is at a stand in a pre-defined area and optionally after receiving a command from authorised staff.			X	

ATO-OR-134	Automatic joining shall commence after the train is at a stand in a pre-defined area.				X
ATO-OR-135	During automatic joining, one train shall remain stationary.		X	X	X
ATO-OR-136	Post joining, there shall be an automatic update of train data required for ATO for the new train consist.		X	X	X
ATO-OR-137	Post joining, the ATO on-board function shall inform the train driver of the new train consist.		X		
ATO-OR-138	Automatic splitting shall commence after the train is at a stand in a pre-defined area and after receiving a command from the train driver.		X		
ATO-OR-139	Automatic splitting shall commence after the train is at a stand in a pre-defined area and optionally after receiving a command from authorised staff.			X	
ATO-OR-140	Automatic splitting shall commence after the train is at a stand in a pre-defined area.				X
ATO-OR-141	Prior to automatic splitting, the ATO train shall remain stationary.		X	X	X
ATO-OR-142	During automatic splitting, one train shall remain stationary.		X	X	X
ATO-OR-143	Post splitting, there shall be an automatic update of train data required for ATO for the new train consists.		X	X	X
ATO-OR-144	Post splitting the ATO on-board function shall inform the train driver of the new train consist.		X		
ATO-OR-145	Post joining and splitting, the ATO trackside shall inform the Traffic Management Systems of the new train consists.		X	X	X
ATO 5.8 – Advisory Information					
ATO-OR-146	The ATO on-board function shall provide a Target Advice Speed to the driver on the DMI based on the ATO Operational Speed Profile.	X			
ATO-OR-147	The ATO on-board function shall ensure that a change in the Target Advice Speed happens at a frequency that allows for efficient operation of the train.	X			

ATO-OR-148	The ATO on-board function shall display on the DMI the distance to a change in the Target Advice Speed information.	X			
ATO-OR-149	The ATO on-board function shall display on the DMI when coasting will achieve the Journey Profile.	X			
ATO-OR-150	The ATO on-board function shall display on the DMI the distance to the next Stopping Point.	X	X		
ATO-OR-151	The ATO on-board function shall display on the DMI the next Stopping Point name.	X	X		
ATO-OR-152	The ATO on-board function shall display on the Train Attendant's HMI the next Stopping Point name.			X	
ATO-OR-153	The ATO on-board function shall display on the DMI the estimated arrival time for the next Stopping Point.	X	X		
ATO-OR-154	The ATO on-board function shall display on the Train Attendant's HMI the estimated arrival time for the next Stopping Point.			X	
ATO-OR-155	Intentionally deleted.				
ATO-OR-156	Intentionally deleted.				
ATO-OR-157	The Driver shall be informed of the remaining dwell time on the DMI	X	X		
ATO-OR-158	The Train Attendant shall be informed of the remaining dwell time to facilitate efficient train departure.			X	
ATO-OR-159	Intentionally deleted.				
ATO-OR-160	Intentionally deleted.				

7.7 ATO Principle 6: Control traction power

The requirements in this section have been derived from the ERTMS/ATO Operational Principles [RD2] to manage control traction power. These requirements cover the functionality necessary for:

- Efficient power consumption;
- Transitions between different sources of traction power in the operational area;
- Loss of traction power.

Requirement ID	Requirement	Applicability			
		GoA1	GoA2	GoA3	GoA4
ATO-OR-161	The ATO on-board function shall calculate the ATO Operational Speed Profile in such a way that drawing of traction power is avoided whilst the train is passing a neutral/powerless section. Note: For a train with distributed power, this may result in individual traction commands per traction unit.	X	X	X	X
ATO-OR-162	The ATO on-board function shall calculate the ATO Operational Speed Profile taking into account limits to the current consumption.	X	X	X	X
ATO-OR-163	Intentionally deleted.				
ATO-OR-164	Intentionally deleted.				
ATO-OR-165	The ATO on-board function shall calculate the ATO Operational Speed Profile according to the traction system characteristics (AC/DC/Diesel)	X	X	X	X

7.8 ATO Principle 7: Supervise railway

The requirements in this section have been derived from the ERTMS/ATO Operational Principles [RD2] and cover functionality necessary to:

- Supervise border between platform tracks and other tracks;
- Supervise obstacle detection devices.

Requirement ID	Requirement	Applicability			
		GoA1	GoA2	GoA3	GoA4
ATO-OR-167	The ATO on-board shall be capable of interfacing with external obstacle detection and railway supervision systems.	O	O	X	X

7.9 ATO Principle 8: Supervise loading and unloading

The requirements in this section have been derived from the ERTMS/ATO Operational Principles [RD2] and cover functionality necessary to:

- Supervise passengers on platforms;
- Provide Interface with the communication system for passengers and staff;
- Provide interface with passenger surveillance system.

For freight operations, functionality is covered by:

- Stopping an ATO operated train at a precise location for loading / unloading;
- Interfacing with external systems for loading and unloading whilst the train is moving.

Requirement ID	Requirement	Applicability			
		GoA1	GoA2	GoA3	GoA4
ATO-OR-168	The ATO on-board function can be configured so that doors shall be opened or closed either automatically or manually.	X	X	X	X
ATO-OR-169	If configured for automatic door opening, the ATO on-board shall send the command to open the doors when the train is at standstill at the Stopping Point.	X	X	X	X
ATO-OR-170	If configured for automatic door closing, the ATO on-board shall command the doors to close when the remaining dwell time is equal to the train configuration time to perform normal door closure.	X	X	X	X
ATO-OR-171	The driver shall be informed on the DMI whether the doors are to be opened/closed automatically or manually.	X	X		
ATO-OR-172	The driver shall be informed on the DMI on which side the doors have to be opened if manual opening is required.	X	X		
ATO-OR-173	For freight operations, the ATO function shall allow the accurate positioning of an ATO fitted train to align with external freight handling systems for loading and unloading.			X	X
ATO-OR-174	Intentionally deleted.				

7.10 ATO Principle 9: ATO Status and Failures

The requirements in this section have been derived from the ERTMS/ATO Operational Principles [RD2] and cover functionality necessary to:

- Supervise the status of the ATO
- Manage degraded operations;
- Manage failures affecting all trains operating within a particular area of control;
- Manage failures affecting a particular train operating within any area of control;
- Manage service disruption and perturbation.

Requirement ID	Requirement	Applicability			
		GoA1	GoA2	GoA3	GoA4
ATO 9.1 - Supervise the status of the ATO					
ATO-OR-175	Intentionally Deleted.	X	X	X	X
ATO-OR-176	The ATO on-board function shall perform self-tests periodically when powered to ensure all systems and interfaces necessary for its operation are operating correctly.	X	X	X	X
ATO-OR-176A	Any ATO self-tests shall only cover ATO and not impact systems connected to it, e.g. ETCS.	X	X	X	X
ATO-OR-177	All self-tests shall be performed automatically, without requiring any additional action by staff.	X	X	X	X
ATO-OR-177A	The ATO on-board function shall report the train running number and the driver ID to the ATO trackside function.	X	X		
ATO-OR-178	The operationally relevant failures shall be notified to the train driver and the ATO trackside function if possible.	X	X		
ATO-OR-179	The operationally relevant failures shall be notified to the train attendant and the ATO trackside function.			X	
ATO-OR-180	The operationally relevant failures shall be reported to the ATO trackside function.				X
ATO-OR-181	Self-tests shall not compromise performance of an ATO on-board.	X	X	X	X
ATO-OR182	Intentionally deleted.				
ATO-OR-183	Selected ATO on-board data shall be remotely accessible in real-time during operation within the ATO area.			X	X

ATO-OR-184	All ATO on-board data shall be recorded and stored for subsequent retrieval to support maintenance or incident investigations.	X	X	X	X
ATO 9.2 - Management of degraded operations					
ATO-OR-185	In the case of failure of the ATO function it shall be possible to continue operation in manual driving under ETCS protection.	X	X	O	O
ATO-OR-186	The ATO function shall identify any degraded ATO replaceable unit and make the information available to all relevant train or infrastructure sub-systems.	X	X	X	X
ATO-OR-187	Intentionally deleted.				
ATO-OR-188	In case of a progressive shut down of the ATO train service, an ATO train shall be permitted to reach the next station or other designated safe location and be immobilised there.			X	X
ATO-OR-189	In case of progressive shutdown of the ATO train service, a command by a designated person (on the train or on the trackside) shall allow an immobilized train to leave the station or other designated safe location, provided that conditions for safe movement of train are fulfilled.			X	X
ATO-OR-190	Intentionally deleted.				
ATO-OR-191	Intentionally deleted.				
ATO-OR-192	If ATO functionality is suppressed, appropriate indications and/or alarms shall be given to the train attendant to allow him/her to react and take control of the train.			O	
ATO-OR-193	Intentionally deleted.				
ATO-OR-195	Operational processes and procedures shall be detailed to manage degraded situations based on the degraded mode operational scenarios.	X	X	X	X
ATO-OR-196	In the event of a failure affecting ATO functionality the ATO function shall not impact on other safety systems.	X	X	X	X

ATO-OR-197	In degraded situations, an ATO train shall be stopped at the next safe location or if not possible, the train shall automatically be brought to a stand until further instructions / authorisation is provided by the infrastructure.			X	X

7.11 ATO Principle 10: Manage further unsafe conditions

The status of the train related to safety of passengers, freight or assets during operation will be supervised. Failures or incidents will be managed to optimise performance during degraded mode and emergency situation and return operations to normal as quickly as possible.
The system will present suggested corrective actions to support the operator in recovering from most degraded situations.
ATO will aid recovery from timetable deviations and optimise the time to return to scheduled operation.
The requirements in this section have been derived from ATO 10 of the ERTMS/ATO Operational Principles [RD2].

The following requirements cover functionality necessary to:

- React to detected fire/smoke;
- React to detected broken rail;
- Manage passenger requests;
- Further unsafe conditions.

Requirement ID	Requirement	Applicability			
		GoA1	GoA2	GoA3	GoA4
ATO-OR-198	The ATO function shall be capable of interfacing with external safety systems such as fire / smoke detection and initiating appropriate action.			X	X
ATO-OR-199	In the event of fire or smoke detection, once the emergency situation has been resolved, automatic operation shall only be reinstated following a safety command from authorised staff.			X	X
ATO-OR-200	The ATO function shall be capable of interfacing with external systems for detecting unsafe conditions on the railway, such as derailment, broken rail or significant obstruction.			X	X
ATO-OR-201	An ATO train shall be stopped immediately if a passenger alarm device is actuated after the departure of the train, if the train is expected to stop within the platform area.			X	X