D3.1

System Requirements Specification FDFT

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1 Table of Contents

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2 Executive Summary

This document constitutes "Deliverable 3.1 System Requirements Specification FDFT" of ER JU Flagship Area 5 project FP5-TRANS4M-R. This document reports results from task 3.2 **Train reference system architecture**.

The objective of this document is to provide the functional system requirements based on the target operational procedures laid down in deliverable 2.1 "Preliminary Operational Procedures" of task 2.1 of ER JU FP5 TRANS4M-R. The functional system architecture will define the basis for the development of the innovations for WP5-WP12. It describes the **target of full automation of the freight sector**, as well as a subset based on the agreed technical enablers in FP5-TRANS4M-R.

The section Objective / Aim explains how WP3 intensively aligned the various aspects derived from the target operational procedures within the project.

At the centre of this document, are the Functional System Requirements derived from the deliverable 2.1 Preliminary Operational Procedures, describing what is necessary to **operate the Fully Digital Freight Train in Europe**. The functional requirements are added to the process descriptions as additional attributes, which have been kept unedited for consistency and ease of reading.

The functional requirements are followed by the **Functional reference system architecture** including an overview as well as the functional blocks required in FDFT traction units and FDFT wagons. To allow un-restrained innovations to be used, when designing the technical enablers in FP5-TRANS4M-R, the document focusses at the pure functional requirements, wherever possible.

Keywords: Functional System Requirements; Reference System Architecture; Full Automation; Technical Enabler

3 Abbreviations & Acronyms

Abbreviation / Acronym	Description
CPSS	Consist power supply system
DAC	Digital Automatic Coupler
EDDP	European DAC Delivery Programme
ER JU	Europe's Rail Joint Undertaking
FDFT	Full digital freight train
FDFTO	Full digital freight train Operation
F-TCN	Freight Train Communication Network
FPSE	Flagship Project System Engineers
HMI	Human Machine Interface for controlling and monitoring of a system (e.g.: lever, indicator, button, lamps, keyboard, display)
TSI	Technical Specifications for Interoperability
WP	Working package

4 Background

The present document constitutes the Deliverable D3.1 “System Requirements Specification FDFT” in the framework of the Flagship Project FP5 TRANS4M-R as described in the EU-RAIL MAWP. The document describes the results for the task 3.2 “Train reference system architecture”.

The project aims to boost innovation for the European rail freight sector, concretely by developing, validating, and demonstrating TRANS4M-R technical enablers listed in the following Table 1.

TRANS4M-R Technical Enablers	Initial TRL	Target TRL	Comments
EU-harmonized interoperable DAC Type 4 upgradable to interoperable DAC Type 5 and Hybrid Coupler for Loco/Consist	3-5	8	
Train functions for train Composition detection/management system, automated/automatic brake test, automatic uncoupling, train length determination and train integrity monitoring	3-5	8	
Train functions enabling, Automated parking brake systems, Digital Consist Inspection, DAC-based telematics applications, Distributed power system, electro-pneumatic brake	3-4	7	

Table 1: Technical enablers for the functional system architecture

Coming from the initial technical readiness level 3 (TRL 3) means that an experimental proof of concept exists for the technical enabler and TRL 4 refers to a technical enabler validated in laboratory. TRL 5 means it is also validated in a relevant environment and with TRL 6 it is demonstrated in relevant environment. The target TRL 7 refer to a technical enabler being demonstrated in operational environment. The target TRL 8 refer to technical enabler being complete and qualified through test and demonstration.

The work to reach this level of TRL is complex and thus divided into several work packages highly dependent on each other. See WP structure in Figure 1 below.

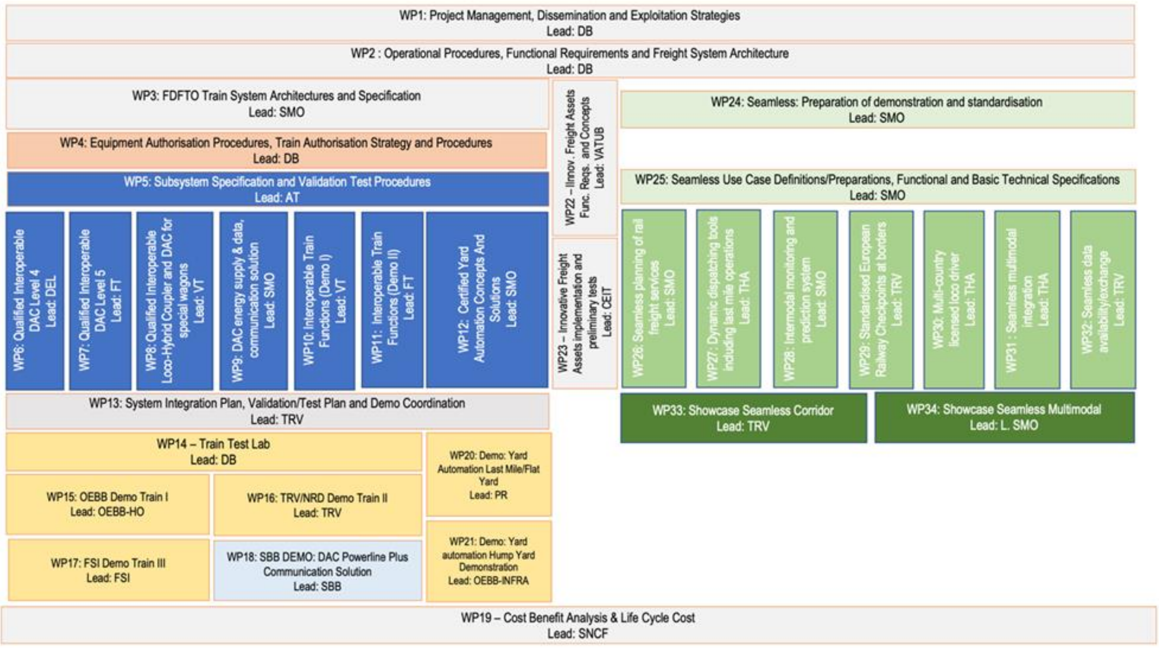


Figure 1: WP-structure in TRANS4M-R

WP3 is supporting the work packages WP2 & WP4 - WP21 by providing a functional system architecture for the FDFT train.

To develop the enabler in the outlined status of TRL a structured process and an architecture of the complete system and its interactions realized by the enablers is necessary.

Following the V-cycle (acc. to EN 50126-1:2017 ensuring the validation and authorisation of a development, this document defines the necessary input with the "Functional System requirements specification" defined in this document. This is acc. to Figure 7 – The V-cycle representation "System definition and operational context", "Life cycle phase" 2 acc. to EN 50126-1:2017.

Based on the outcomes of Task 3.2 (this document) a base system will be designed. A description and specification for a physical (wagon/locomotive/infrastructure) reference system (D3.2) as basis for implementation-design of every wagon and a specification for a digital/data (applications) reference system architecture (D3.3) will be developed.

5 Objective/Aim

The objective of this document is to provide the FDFT system architecture requirements for European rail freight. The system requirements document will define the basis for the development of the innovations for WP5-WP12. It describes the target of full automation of the European rail freight sector, as well as a subset based on the agreed technical enablers in TRANS4M-R.

The document is the first of a set of 3 documents for the system architecture of the FDFT. It is intended to collect the functional system requirements so that the system architecture can be described in the following documents Deliverable 3.2 and the data interfaces between the architectural function blocks can be defined in the third Deliverable 3.3.

For project-specific reasons, the valid user requirements are specified in Deliverable 2.2, which is planned to be published in February 2024. Therefore, at present it can only be referred to, and the user requirements will be included as a basis in the further course of the project when creating the physical system architecture. The requirements necessary from the point of view of the sub-components are named in the deliverables D5.1 - D5.5.

Remark: The functional system requirements are in line with the Target Processes. The later implementation of the required functional blocks depends on the scope of the Grant Agreement valid at that time.

The main input for deriving the system requirements, is contained in /WP2_D2.1/ preliminary operational procedures.

5.1 Methodology

A working team, consisting of the relevant experts of the various operators, system suppliers, and subsystem suppliers has been set up.

The working team defined the structure and contents of this document.

Several meetings have been performed, to gather the input of the experts of the involved domains.

The writing team as part of the working team provided the initial draft of the deliverable D3.1 to the working team for internal review. Incorporating the review feedback into the initial draft, was resulting in revision 1, "Draft for review".

The "Draft for review" went through the FP5 internal official review process by nominated reviewers. The received review feedback has been discussed and agreed upon in a final review meeting, resulting in revision 2, "Draft after review".

After formal review by the project management team, resulting in revision 1.0, the submission to the EU commission will follow.

All requirements will be put finally into the Polarion requirements management tool, as defined in Task 3.1 of the GA as follows:

- A common methodology for linking the functional requirements to the functional system architecture considering the actions and results of Task 3.1 will be established. The methodology will enable consistency and correlation checks on all defined requirements.
- For each release of the system architecture, the functions will be linked to the corresponding requirements, for the major releases.
- Requirements/Architecture fulfilment by clearly defined means of validation will be carried out and for each release. A permanent alignment with WP3 & WP25 on the functions and the means of validation will be carried out.

5.2 Task description

Task 3.2 started in month 3 and the output of this task is included in this document. The following table gives the direct match of the task definition from the proposal with the output and a link to the chapter where more details can be found.

	Task definition from proposal	**Output of WP3**
Task 3.2	A reference system architecture concept, integrating the functions of all technical enablers from WP6- WP12, will be designed with reference to the table in Section 1.1.2 of GA[1].	Background Definitions and explanations Functional Requirements from Operational Procedures Reference system architecture FDFT
Task 3.2	A System Requirement Specification (SRS) for the FDFTO incl. allocation of safety levels will be jointly developed, reviewed, and approved. It will be based on the interoperability and modularity principles enabling adjustments and enhancements at the later stages of the migration i.e., roll-out scenarios. The functional reference system architectures will serve as foundation for authorisation of FDFTO. For this reason, a strong collaboration with WP4 on the authorisation procedures is foreseen.	Upcoming deliverable D3.2: Physical reference system architecture FDFT Upcoming deliverable D3.3: Data reference system architecture FDFT

[1] Here only enabler 1 is relevant: "The solutions will be derived from operational procedures and functional requirements fitting to the overall freight system architecture."

6 Definitions and Explanations

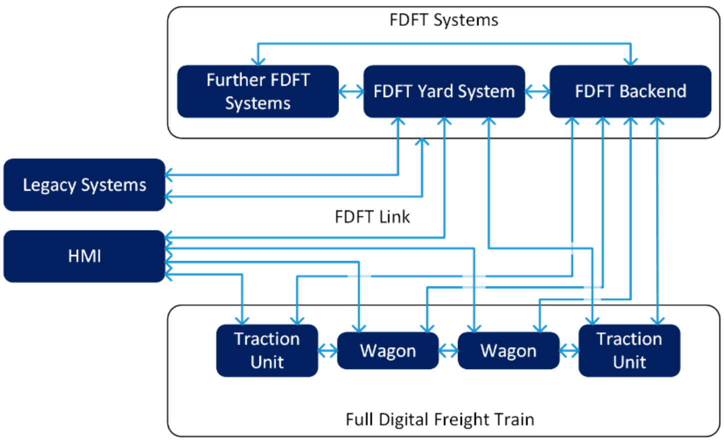
The following three tables provide definitions for terms used throughout the process descriptions and diagrams.

Table 2 describes commonly used terms; Table 3 describes actors of process diagrams and Table 4 lists data and information transmitted by components.

Remark: The following terms have been taken from /WP2_D2.1/ to ensure overall consistency.

6.1 Terms

Term	Description
Brake: Automated Parking Brake	An automated parking brake secures the wagon(s) against rolling away. Activation of applying and releasing is done via the FDFT link
Brake Calculation	Calculation of brake power according to national regulations.
Brake: Controllable Brake	The Controllable Brake can be one or more systems covering the following functions: 1) Securing the wagon(s) against rolling away. This function can be realised on the one hand by the Automated Parking Brake (especially longer parking periods) or by the service brake (shorter parking periods, depending on national regulations). 2) Targeted braking of the wagon(s) to a certain speed or standstill, which takes place after the wagon (set) has separated from the traction unit (e.g., braking of the wagon(s) after hump shunting/fly shunting). The status of the brake can be determined.
Brake: Legacy braking means to secure wagon(s) against rolling away	Today existing braking means like drag shoe, hand brake, track brake, etc.
Brake: Service Brake	The service brake is the braking system used today on freight trains (compressed air brake), which slows down the vehicles by lowering the air in the main brake pipe or, depending on national regulations, secure vehicles against rolling away for short periods of parking.
Consist composition	Consists coupled with DACs.

Term	Description
Coupling Point of Shunting Composition/Wagon Set	Identifies the future connection between two DAC coupler heads planned for coupling.
E-Coupler	The E-Coupler is used to connect the electrical power distribution line and communication / signal lines between the consists.
FDFT Function	Function that does not exist today and need to be developed to achieve the target state. Note: Example for a "FDFT Function" could be "FDFT function prevent coupling" or "train integrity monitoring"
FDFT function Prevent Coupling	While the FDFT function Prevent Coupling is activated, the DAC coupler head must not allow coupling. This function must be activated on both coupler heads. In case of electrical activation/deactivation, this function can only be activated in FDFT mode Shunting. Note: The required activation on both coupler heads results from current statements regarding the technical feasibility of the manufactures.
FDFT Link	Enables communication between FDFT Systems, mainly FDFT Backend, Legacy System, Traction Unit and Wagon with FDFT Wagon Base System. This connection can be physical (data connection between Traction Unit, Stationary Device and Wagon(s) via DAC coupler head) or wireless. Multiple FDFT Links can form a network so that FDFT Systems can communicate with each other using an intermediate FDFT System, e.g., FDFT Backend uses wireless FDFT Link to Traction Unit to communicate with FDFT Wagon Base System via a physical FDFT Link.  *Figure 2: FDFT Links*

Term	Description
	Note: The figure only shows possible connection combinations of FDFT Links, the real development can deviate from the representation depending on the time of development (fully or semi-automated state).
FDFT mode Shunting (Note: not ETCS Shunting Mode)	Allows electrical uncoupling of DAC coupler heads, electrical activation of function prevent coupling and activation of Automated Parking Brake. When uncoupled, no harmful electrical power on DAC coupler head is present, especially on electrical contacts. When uncoupling, electrical connections of DAC coupler head must be free of harmful electrical power or current prior to mechanical uncoupling. When coupling, harmful electrical power and current is only applied after successful mechanical coupling of both DAC coupler heads including electrical coupler. This mode is required for all consists (wagon and traction unit). All consists of one composition are in the same mode.
FDFT mode Train Run	Coupled DAC coupler heads of Train cannot be commanded to uncouple. First and last DAC coupler heads of Train must have FDFT function Prevent Coupling deactivated and this function cannot be activated. Power supply over DAC coupler heads can be enabled by Traction Unit. Automated Parking Brake cannot be activated (current state of discussion). This mode is required for all consists (wagon and traction unit). All consists of one composition are in the same mode. An operational train run is carried out in FDFT mode Train Run. This mode is not to be confused with train integrity monitoring.
FDFT System	Systems that do not exist today and need to be developed to achieve the target state. Note: Example for a “FDFT System” could be "FDFT Backend” or “FDFT Yard System”
FDFT Wagon Base System (WB)	FDFT Wagon Base System is a system on each wagon, which controls wagon components (e.g., DAC coupler

Term	Description
	heads, wagon wide power control system, battery management system, brake system, sensors). It can communicate via FDFT Link (network) e.g. with the Traction Unit, FDFT Backend (if available), landside systems, with personnel by using a Mobile HMI
Legacy process	Fallback to already in use processes without requiring (all) FDFT System components.
Legacy System	Today's technical systems in use by operators, wagon keepers, ...
M-Coupler[2]	The M-coupler connects two consists by mechanical means. It couples the main brake pipes as well of both consists.
Semi-automated State	During Semi-automated State the automated operations are not yet fully possible. Manual intervention on site will take place on a regular basis.
Shunting Composition	Traction Unit(s) coupled by DAC to a wagon (set). Wagon(s) and TU are in FDFT mode Shunting. This composition has no uniquely identifiable attribute, which is only assigned when all conditions for train preparation have to be fulfilled (see Processes).
Target State	The future of rail freight transport depends on fully automated operations in all processes for wagon handling from shunting preparation through wagon processing and train preparation until train run. Manual intervention on site will only take place in the event of deviations or malfunctions.
Train	Uniquely identifiable composition of Traction Unit(s) and optionally a Wagon (Set).
Train Run	The Train Run starts and ends regularly in yards (including sidings) and stations. Operational definition of Train moving or parked. Before the Train Run starts all conditions for train preparation must be fulfilled (see Processes).
Uncoupling Point of Shunting Composition/Wagon Set	Identifies the connection between two DAC coupler heads planned for uncoupling.

Table 2: Terms

[2] The term "M-Coupler" has been to this table, in relation to version from /WP2_D2.1/.

6.2 Actors

The following terms have been taken from /WP2_D2.1/ to ensure overall consistency.

Actor / Swimlane	Description
Brake Test Operator (BO)	On site personnel performing the brake test.
Consist (A) (B)	A consist is the smallest railway rolling stock entity for operation (e.g., wagon, traction unit…), containing one CCU representing one node on DAC network. It can be a traction unit, single wagon as a fixed set of single vehicles (segments) which are not disconnected while operation. A consist own a unique vehicle identification number.
FDFT Backend (BE)	Collection of new FDFT functions on land side. Receives, supplies, and stores Consist Data (e.g., Wagon Target Track Data, Traction Unit Status Data, Wagon Set Data and Additional Wagon Data). FDFT Backend provides and receives data to and from other systems (FDFT Yard, Traction Unit, etc.) FDFT Backend initiates different functions, e.g., coupling and uncoupling processes, in Target State.
FDFT Yard (FY)	FDFT Yard is infrastructure based and controls all infrastructure elements in its area. FDFT Yard provides current state of infrastructure to FDFT Backend if available. The interfaces between FDFT Backend and FDFT Yard will be defined in a later step.
Mobile HMI (HM)	(Locally) (remote) device for personnel to interact with FDFT Systems. Connection to FDFT Systems can be wireless and physical, even to FDFT Wagon Base System. For example, personnel can connect the Mobile HMI to a wagon in a wagon set and retrieve Wagon Status Data and Wagon Set Data of the entire Wagon Set.
Operator TU (O)	Personnel (remotely) controlling Traction Unit(s).
Personnel (P)	Only for subprocesses. Refers to the originating swim lane actor in the main process. E.g., if subprocess activity was on the *Yard Manager* swim lane, Personnel refers to *Yard Manager* in the subprocess context.
Signaller (S)	Performer in charge of the route setting of trains/shunting movements and of issuing instructions to Operator of Traction Unit (see TSI OPE).

Actor / Swimlane	Description
Stationary Device (SD)	Infrastructure-sided device that provides air for (automated) brake test and measurement data (e.g., air pressure). For target processes: Power and data are also supplied and connected. Over this device, a connection between Wagon(s) to FDFT Backend or Legacy Systems is possible.
Traction Unit (TU)	• A Traction Unit with DAC coupler heads that supplies traction power and moves itself and coupled vehicles. This also includes multiple traction units moving together. • The DAC coupler heads can also be hybrid couplers. • A Traction Unit can also have Distributed Power System functionalities. • ATO and ASO systems can be applied. • A Traction Unit can be equipped with FDFT functionalities, e.g., allows retrieving Wagon Status Data or Wagon Set Data and can initiate FDFT Wagon Base System's functions, like secure against rolling away, bleeding, etc. • An unpowered Traction Unit is considered and behaves like a wagon with FDFT Wagon Base System. • Traction Units can be main line locomotives, shunting locomotives, shunting devices, two-way vehicles, etc. • The traction unit (TU) supplies the electrical energy for all the wagons in a train, if technical available. • User Interface is available
Wagon Inspector (WI)	On site personnel performing technical inspection of wagon(s).
Wagon/Wagon Set (WWS)	Wagon: Single physical freight Wagon equipped with DAC coupler head at each end. Wagon(s) permanently coupled (just one UIC Number) together should behave like a single wagon and cannot be uncoupled. Wagon Set: Wagon(s) coupled together by DAC coupler heads.
Yard Legacy System (YL)	Today's technical systems used in yard operations.
Yard Manager (YM)	Personnel responsible for operation of shunting yards.
Yard Personnel (YP)	On site personnel needed for manual shunting operations, e.g., for uncoupling / coupling rolling stock,

Actor / Swimlane	Description
	for securing rolling stock and any other activities that require human intervention in shunting operation.

Table 3: Actor/swimlane definitions

6.3 Data

The following terms have been taken from /WP2_D2.1/ to ensure overall consistency.

Data/information type	Description
Additional Wagon Data	Additional Wagon Data consists of static (e.g., wagon length, empty wagon weight, master data) and dynamic (e.g., type of load, restrictions, total weight) data. The Consist is not capable of deriving these data by itself, e.g., by use of sensors.
Consist Status Data	Consists out of Wagon Status Data and Traction Unit Status Data.
Cut List Information	Information about the planned Uncoupling Points for a given Wagon Set. Based on this information, documents like cut lists can be created.
Traction Unit Status Data	Compiled data about the status of a Traction Unit (e.g. state of DAC coupler heads, state of hybrid coupler, state of brake system). If FDFT Backend is available and the Traction Unit can communicate with FDFT Backend, all changes in Traction Unit Status Data will be automatically sent from Traction Unit to FDFT Backend. If other actors need this information, it is actively pulled from Traction Unit.
Wagon Set Data	Information derived by Wagon Status Data to reflect orientation and order of each wagon in a wagon set.
Wagon Status Data	Compiled data about the status of a wagon and FDFT Wagon Base System can derive this data by itself (e.g., state of DAC coupler heads, state of brake system). If FDFT Backend is available and FDFT Wagon Base System can communicate with FDFT Backend, all changes in Wagon Status Data will be automatically sent from FDFT Wagon Base System to FDFT Backend. If other actors need this information, it is actively pulled from FDFT Wagon Base System.
Wagon Target Track Data	Information sufficient to determine the target track of each wagon in a shunting process (e.g., Hump Shunting).

Table 4: Data/information type definitions

6.4 Types of shunting

This document describes the following types of shunting:

- Flat shunting
- Fly shunting
- Hump shunting

The following explanations have been taken from /WP2_D2.1/ to ensure overall consistency.

6.4.1 Flat shunting

Flat shunting is the separation of wagons in a shunting yard by continuous forward and backward traction unit movements. The traction unit is always in control of the movement of the wagon(s) means that the wagon(s) are not moving independently at any time.

Shunting at workshop (maintenance):

The processes before the maintenance activities correspond to the delivery to the workshop and can be found in "TP07 - Flat Shunting Drop Off".

After maintenance has been carried out, the vehicles are transported out of the workshop in accordance with the "TP08 - Flat Shunting Pick Up".

Shunting in the frame within the workshop also corresponds to processes P07 and P08, whereby it can be assumed that only semi-automation will be implemented in the workshop and thus manual processes will be carried out in the same way as today.

Shunting at loading/unloading points:

Loading and unloading is carried out by shippers or the customers themselves. The processes before loading/unloading can be found in "TP07 - Flat Shunting Drop Off". After this process, loading and unloading takes place. After this has been completed, the wagon(s) are picked up again and the process "TP08 - Flat Shunting Pick Up" follows.

In the context of the loading process, further innovations can be considered, such as weighing sensors, measurement of load distribution or sensors for monitoring closure mechanisms.

6.4.2 Fly shunting

When fly shunting, the traction unit accelerates the shunting composition. Dedicated wagon(s) are uncoupled from the shunting composition and, after the traction unit decelerates, continue to run into the target track.

Today, the wagon(s) are braked in the destination track by e.g., brake shoes or/and hand brake.

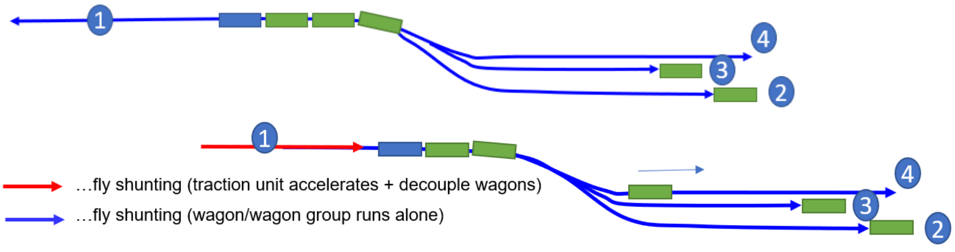


Figure 3: Fly Shunting

6.4.3 Hump shunting

The traction unit pushes the wagon(s) over the top of a so-called shunting hump, an artificially created hill. After uncoupling they roll down the slope on their own and are directed via the switch area to one of the directional tracks.

Depending on the infrastructure and national requirements, the wagon(s) are currently either uncoupled in the entrance group at standstill (e.g., France, ...) or on the hump at walking speed (e.g., Austria).

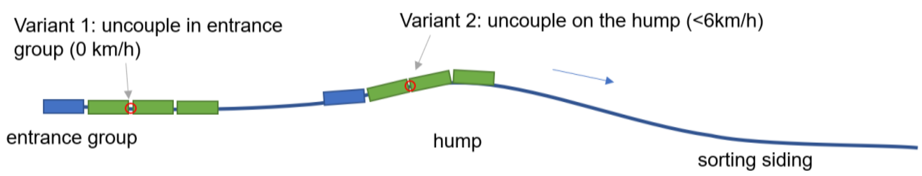


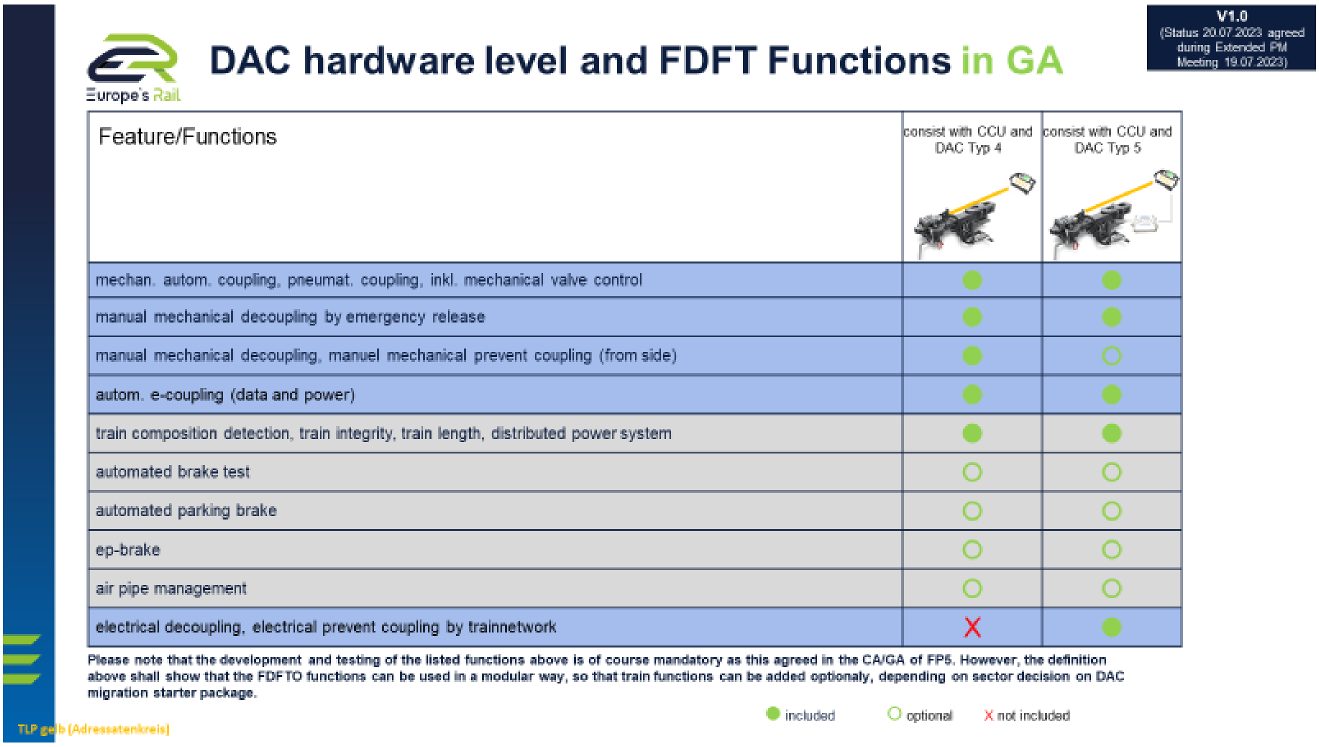
Figure 4: Hump shunting

7 General Assumptions and Premises

The current FDFT system requirements reflect the status of the discussion on common understanding of the operational procedures mainly used as base for input within the sector and specifically within FP5-TRANS4M-R.

7.1 DAC hardware level

The general and DAC level specific definitions of the hardware are shown in "Figure 5: DAC Hardware Level"



V1.0
(Status 20.07.2023 agreed during Extended PM Meeting 19.07.2023)

DAC hardware level and FDFT Functions in GA

Feature/Functions	consist with CCU and DAC Typ 4	consist with CCU and DAC Typ 5
mechan. autom. coupling, pneumat. coupling, inkl. mechanical valve control	●	●
manual mechanical decoupling by emergency release	●	●
manual mechanical decoupling, manuel mechanical prevent coupling (from side)	●	○
autom. e-coupling (data and power)	●	●
train composition detection, train integrity, train length, distributed power system	●	●
automated brake test	○	○
automated parking brake	○	○
ep-brake	○	○
air pipe management	○	○
electrical decoupling, electrical prevent coupling by trainnetwork	X	●

Please note that the development and testing of the listed functions above is of course mandatory as this agreed in the CA/GA of FP5. However, the definition above shall show that the FDFTO functions can be used in a modular way, so that train functions can be added optionaly, depending on sector decision on DAC migration starter package.

● included ○ optional X not included

TLP gelb [Adressatenkreis]

Figure 5: DAC Hardware Level

7.1 General Security requirements

The general security requirements to be applied on all functional requirements, as derived from the target operational procedures in chapter 8.4 are:

- Authentication
- Authorisation
- Access Control
- Data Security

That means, that all commands and data that will be exchanged between the FDFT systems, legacy systems, Mobile HMI and FDF train, shall consider these aspects in an adequate way, to allow safe and secure management of all functionality as described in chapter 8.4 and chapter 9.

All details to be considered from a physical and data perspective, will be described in /WP3_D3.2/ and /WP3_D3.3/.

7.2 Differences between Processes

The following explanations have been taken from /WP2_D2.1/ to ensure overall consistency.

As part of the politically intended mobility turnaround, there will be a significant increase in transport volumes in European rail freight transport.

The sector must provide the corresponding transport capacities for this. However, it will hardly be possible to build new routes or stations, so a significant part of the future transport volume will have to be handled by the existing infrastructure.

In order to provide significantly increased capacities, train lengths, loads and speeds on the line must be increased and the process times in the stations and operating points must be significantly decreased. All in all, this leads to accelerated cycle transfers, reduced resource consumption and faster transport times.

The future of rail freight transport depends on fully automated operations. Manual intervention on site will only take place in the event of deviations or malfunctions.

7.2.1 Differences between Target Process and Semi-Automated Process

The **target process** represents **fully automated operation**.

Processes that are only **partially automated**, are called **semi-automated processes**.

Possible reasons:

- the technical development is not yet ready.

- certain areas (e.g., customer siding) are not (yet) fully equipped with technology to support the fully automated operation.

Therefore, a differentiation is made between the "Target State", which represents the fully automated operations (Target Processes) and the "Semi-Automated State" (Semi-automated processes).

8 Functional Requirements from Operational Procedures

The preliminary operational procedures have been taken over from the deliverable /D2_1/ to ease the reading and to show transparently the derived functional systems requirements.

The approach used in this document is, to make the best out of the well-defined preliminary operational procedures as described in /WP2_D2.1/.

- The original descriptions of the activities have been left unchanged.
- The derived functional system requirements are highlighted by light green colour, framed with a thin black line.

BExx.1	As named in /WP2_D2.1//
Activity	Activity as described in /WP2_D2.1/
Precondition	▪ As described in /WP2_D2.1/
Conditions	▪ As described in /WP2_D2.1/
Tasks	▪ As described in /WP2_D2.1/
Remarks	▪ As described in /WP2_D2.1/
Rationale	▪ As described in /WP2_D2.1/
Postcondition	▪ As described in /WP2_D2.1/
Functional system requirements	▪ Derived **functional** systems requirements

8.1 Process description

The process description has been taken over from the deliverable /D2_1/ to ease the reading and to show transparently the derived functional systems requirements.

The operational procedures for the Full Digital Freight Train are described as flow charts with additional specific information in this document. The overall procedures are split into main *processes* and *subprocesses* for better understanding. Subprocesses describe a set of activities and can be reused in different parts of the main processes.

Figure 6 is giving an overview of the elements used in the flow charts of a process or subprocess.

At the top of each flow chart the different *actor* swim lanes – running from top to bottom – are indicated. An actor is the responsible person or system to carry out a specific *activity*. Only the actors needed for the process are listed.

The start of the activity is marked by a grey circle. From this starting point the activity flow (order of execution) is given by blue arrows. The path along green activities is describing the Target State.

Each activity is identified by a consecutive number in the centre (unique only for each process diagram) and an actor-activity-identifier in the lower half. The actor-activity-identifier is prefixed by the swim lane's actor abbreviation and followed by the Process-ID, a point and then the number. Transformational State activities follow the same pattern and are drawn in yellow. The consecutive number is prefixed by the character "T".

Activities with a red border marking are considered activities with an operational necessity (e.g., process traceability, safety relevant checks according to regulations). If a deviation is detected during this activity, error handling must start. Only when this has been successfully completed and this state allows for process continuation, the process can be continued.

Activities with a white flag in the top right corner refer to subprocesses. If a subprocess is drawn on a Transformational State actors swim lane, like *Yard Manager*, the swim lane called *Personnel* refers to the originating actor – *Yard Manager*. For other relevant actors inside a subprocess, see the subprocesses description.

Along the activity flow, decisions are marked as blue diamond shape. From there activity flow is branched depending on the evaluation of the decision. Only one path can be followed after the evaluation of a decision. Each decision is identified by a number prefixed by the character "D". After branching, decisions end with a smaller blue diamond shape.

Sequence-independent activity paths are shown by a horizontal thick line with at least two originating paths. Activities along these paths are executed in order but are executed independently to the other paths. Sequence-independent paths are joined by a horizontal thick line. Execution after the join is only possible after all paths are carried out completely.

If the path along the Target State activity flow is not possible, the alternative path using Transformational State activities is marked by a dotted yellow line. The return to the originating Target State path is also indicated by a dotted yellow line.

In some cases, information flow is explicitly shown by orange arrows. The swim lane of the sender or receiver without an activity uses a small blue rectangle as a symbol for the information interface.

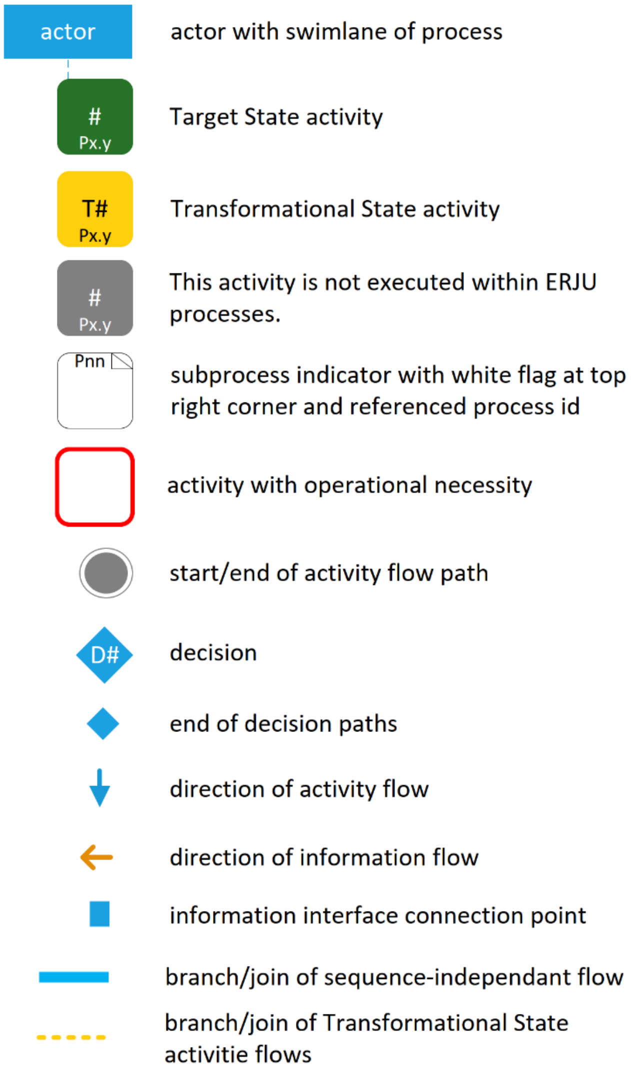


Figure 6: Process description symbols

8.2 Activity description

The activity description has been taken over from the deliverable /D2_1/ to ease the reading and to show transparently the derived functional systems requirements.

The following template table (Table 5) describes an activity in detail. An activity and its content are identified by the actor-activity-identifier: IDx.y. The *ID* is replaced with the swim lanes abbreviation (e.g., S for *Signaller*), *x* is the process id and *y* the consecutive number identifier. The colouring matches for Target State and Transformational State activities.

For each activity found in a process diagram, a corresponding table can be found in this document. Transformational activities are indicated by a yellow background in the top left corner of the table.

IDx.y	
Activity	*Short description of containing task(s)*
Precondition	▪ *conditions that must be fulfilled to begin the overall process*
Conditions	▪ *conditions that must be fulfilled to start the activity without degradation. If not, a reference to an alternative degraded activity is given here or is indicated by a dotted yellow line in the process diagram*
Tasks	▪ *description of tasks to be done in activity*
Remarks	▪ *additional information to understand the context of the tasks*
Rationale	▪ *additional reason for activity in process context*
Postcondition	▪ *states or information that must be reached/fulfilled/sent/received after finishing the scenario or activity*
Functional system requirements	▪ ***Functional** system requirements derived from "Tasks while considering precondition, conditions and postcondition* ▪ ***Remarks:*** ▪ *All requirements related to physical system architecture will be described in /WP3_D3.2/.* ▪ *All requirements related to data system architecture will be described in /WP3_D3.3/.*

Table 5: Template of derived systems requirements table

8.3 Decision description

The decision description has been taken over from the deliverable /D2_1/ to ease the reading and to show transparently the derived functional systems requirements.

The following template table (Table 6) describes a decision in detail. A decision and its content are identified by the decision identifier ID. The identifier is found in the process diagram.

For each decision found in a process diagram, a corresponding table can be found in this document.

ID	
Decision	*Short description of decision*
Branch 1	▪ *First option of branching according to decision*
Branch 2	▪ *Second option of branching according to decision*
…	▪ *Further options if necessary*
Remarks	▪ *additional information to understand the context of the decision*
Rationale	▪ *additional reason for condition in process context*

Table 6: Template of condition description table

8.4 Target Operational Procedures

The Target Operational Procedures description has been taken over from the deliverable /D2_1/ to ease the reading and to show transparently the derived functional systems requirements.

The Target Operational Procedures follow the main idea of a train arriving at a local yard, which then is prepared for shunting operations, the wagon(s) are sorted and finally the newly composed train is prepared for departure.

Figure 7 shows the four main processes: Shunting Preparation (TP01, see 8.4.2), Wagon Processing (TP02, see 8.4.3), Train Preparation (TP03, see 8.4.4) and Train Run (TP04, see 8.4.5). For the processes Train Run and Wagon Processing important subprocesses are also shown. Additional subprocesses are not shown here but shown in the detailed process description.

For an overview of all processes and subprocesses see Figure 8.

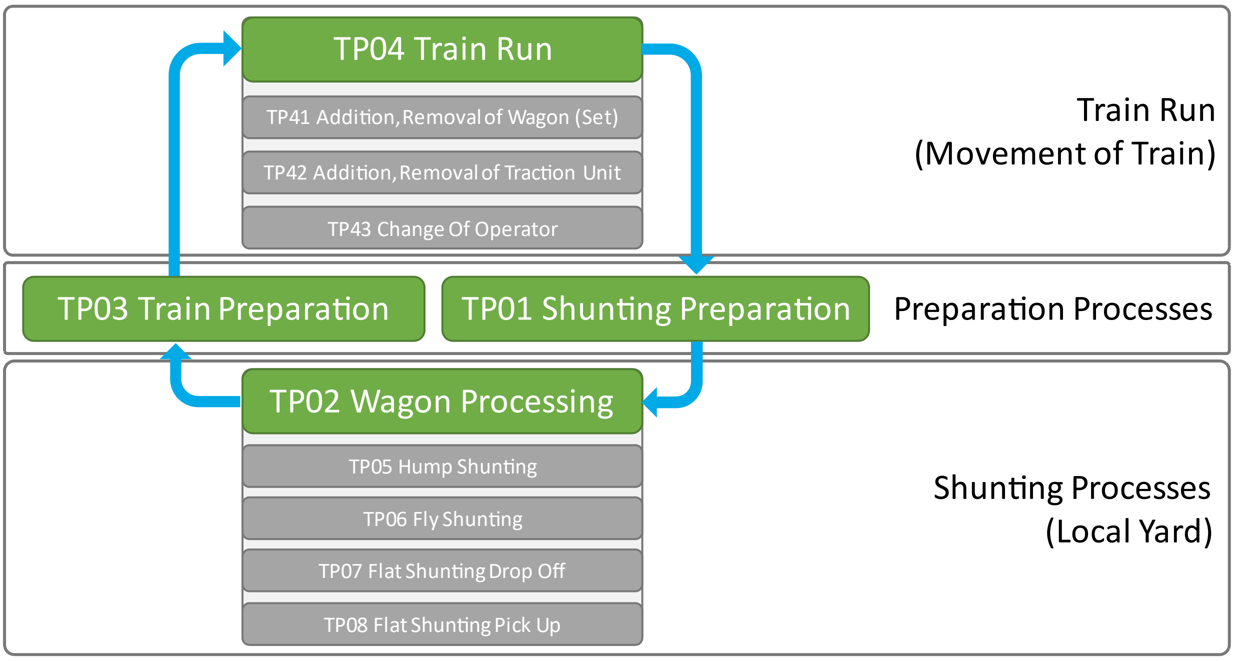


Figure 7: Process overview with four main processes

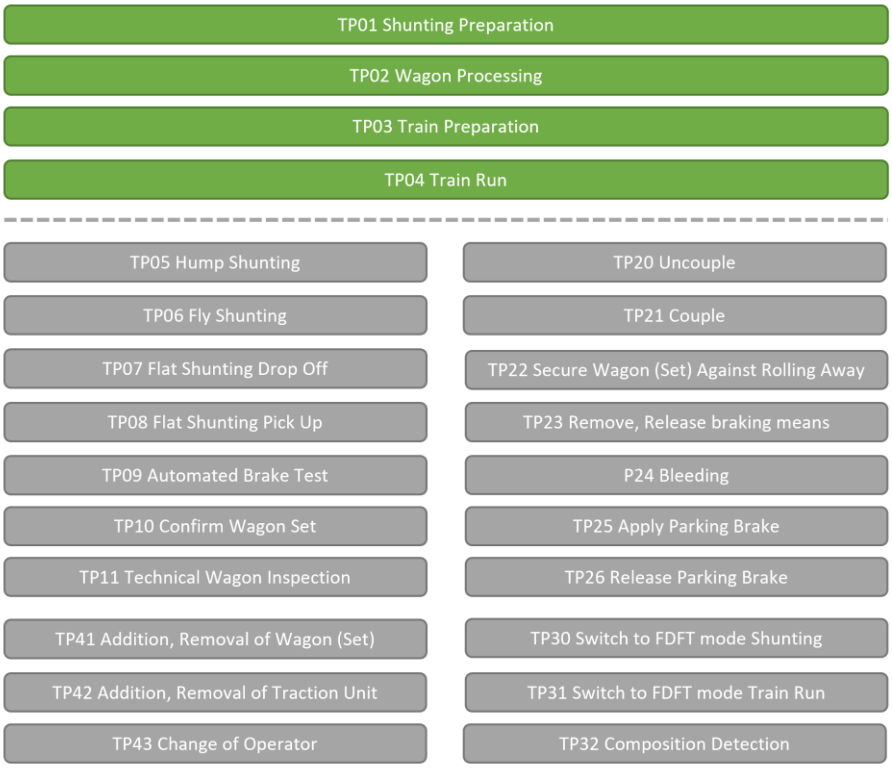


Figure 8: Process overview

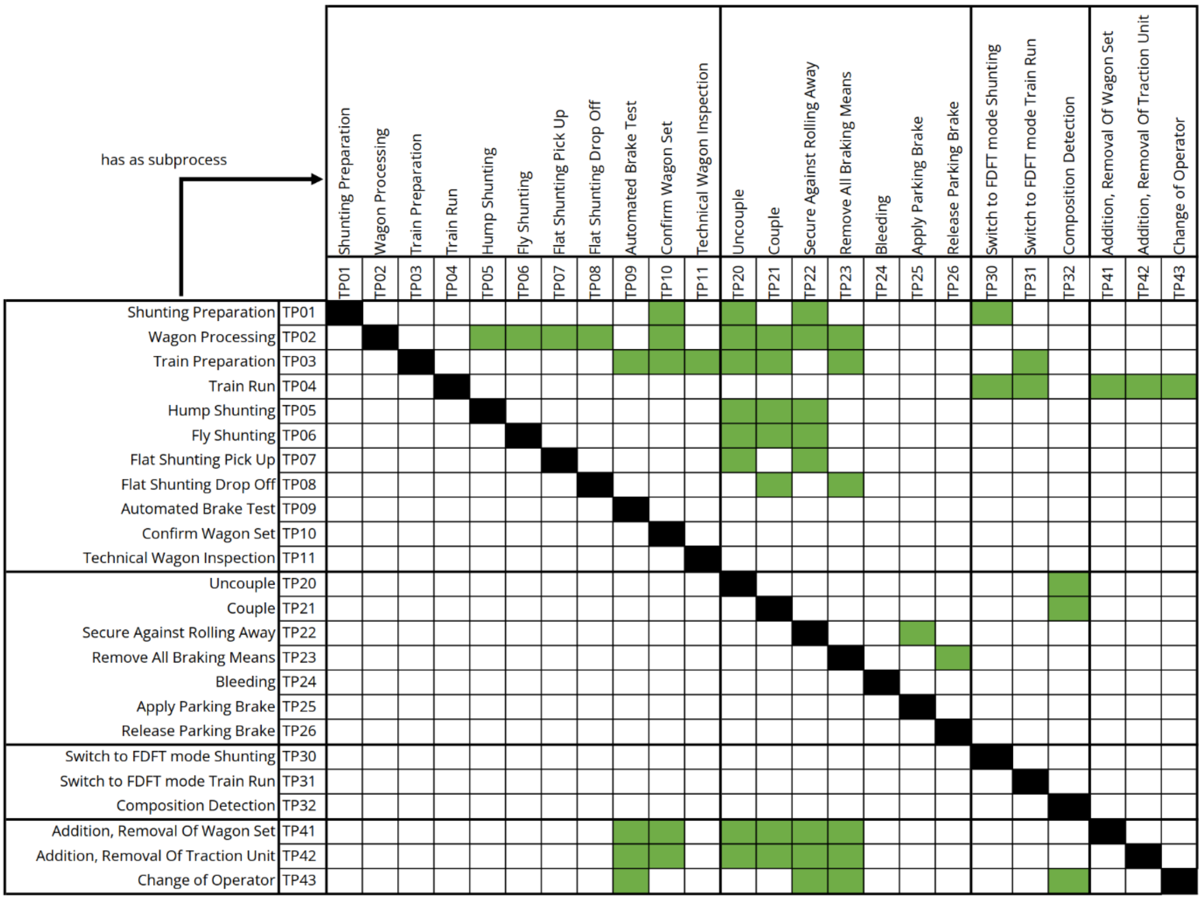


Figure 9: Process matrix

8.4.1 Process enumeration

Within the following table a complete list of processes and subprocesses and their versions are given.

ID	Description	Version
1	Shunting Preparation	Ed. 02P08 13.06.2023
2	Wagon Processing	Ed. 02P12 21.06.2023
3	Train Preparation	Ed. 02P10 19.06.2023
4	Train Run	Ed. 02P09 13.06.2023
5	Hump Shunting	Ed. 02P10 19.06.2023
6	Fly Shunting	Ed. 02P09 14.06.2023
7	Flat Shunting Drop Off	Ed. 02P08 13.06.2023
8	Flat Shunting Pick Up	Ed. 02P08 13.06.2023
9	Automated Brake Test	Ed. 02P09 13.06.2023
10	Confirm Wagon Set	Ed. 02P07 14.06.2023
11	Technical Wagon Inspection	Ed. 02P07 13.06.2023
20	Subprocess: Uncouple	Ed. 02P09 13.06.2023
21	Subprocess: Couple	Ed. 02P07 13.06.2023
22	Subprocess: Secure Against Rolling Away	Ed. 02P11 21.06.2023
23	Subprocess: Remove All Braking Means	Ed. 02P07 13.06.2023
24	Subprocess: Bleeding	Ed. 02P06 13.06.2023
25	Subprocess: Apply Parking Brake	Ed. 01P06 26.06.2023
26	Subprocess: Release Parking Brake	Ed. 01P05 26.06.2023
30	Subprocess: Switch to FDFT mode Shunting	Ed. 02P09 14.06.2023
31	Subprocess: Switch to FDFT mode Train Run	Ed. 02P07 14.06.2023
32	Subprocess: Composition Detection	Ed. 02P06 13.06.2023
41	Subprocess: Addition, Removal of Wagon (Set)	Ed. 02P10 14.06.2023
42	Subprocess: Addition, Removal of Traction Unit	Ed. 02P08 14.06.2023
43	Subprocess: Change of Operator	Ed. 02P04 13.06.2023

Table 7: Process enumeration

8.4.2 TP01 - Shunting Preparation

8.4.2.2 Target Process

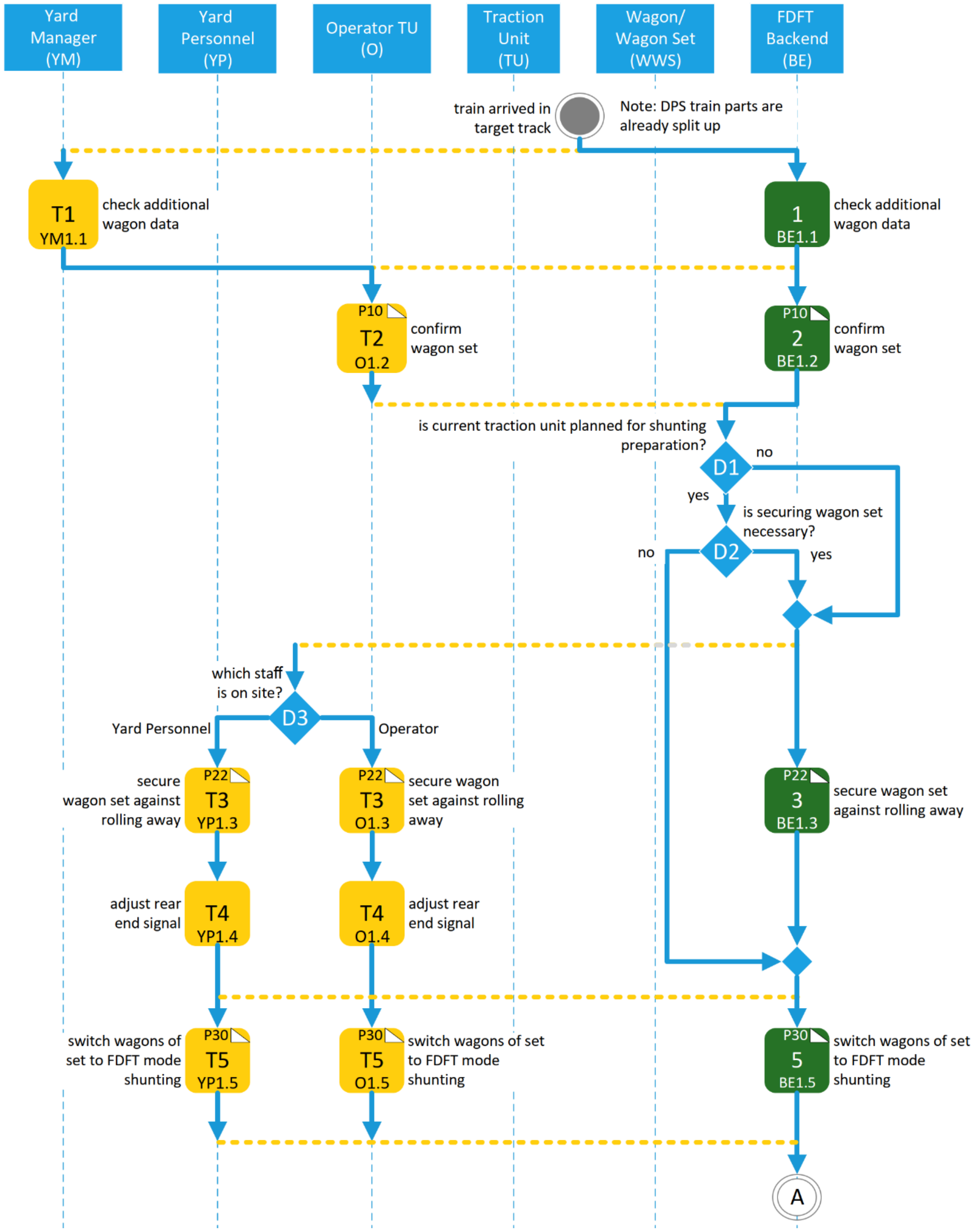


Figure 10: TP01 Shunting Preparation - 1 of 2

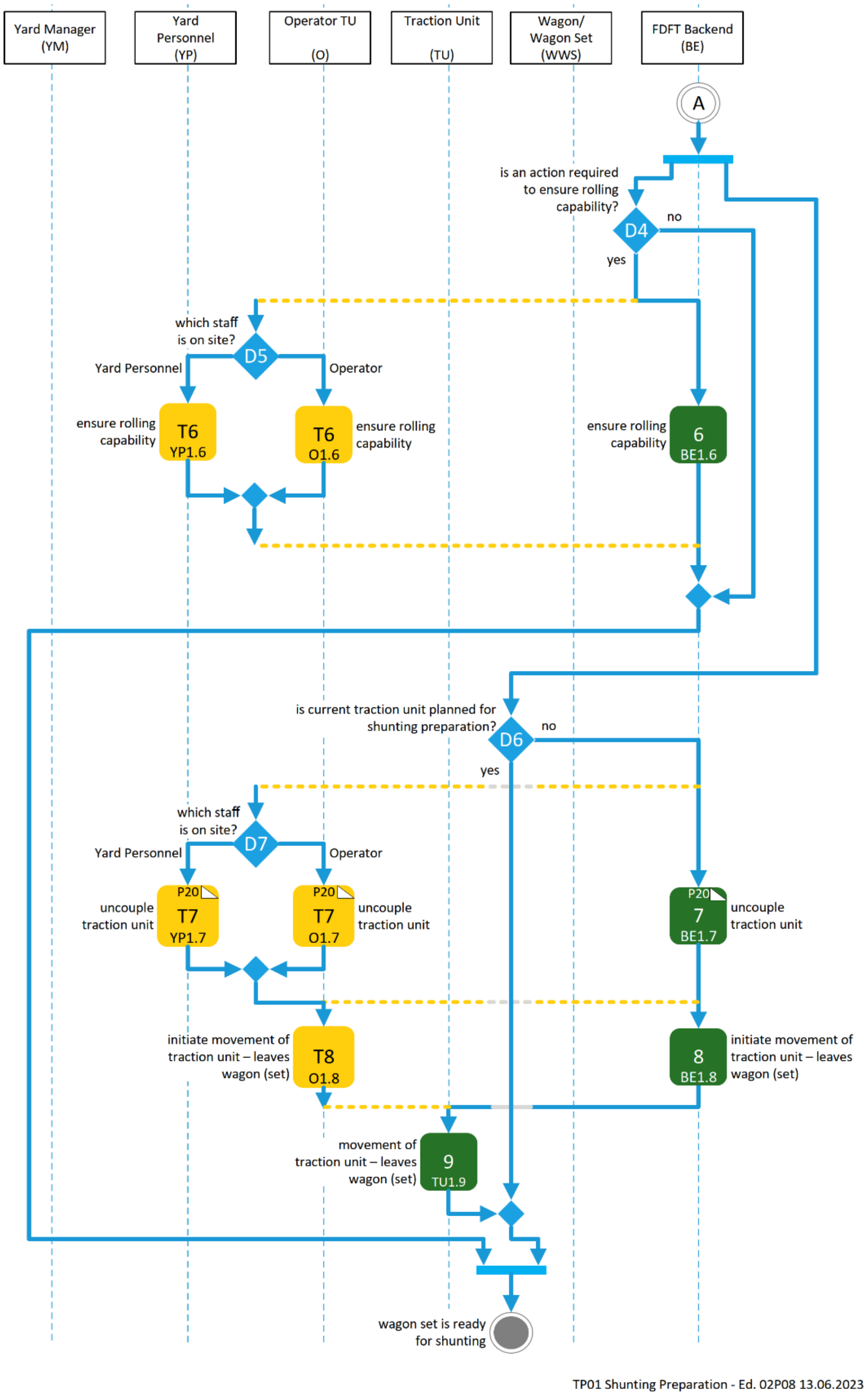


Figure 11: TP01 Shunting Preparation - 2 of 2

1. <u>Process-Description</u>

BE1.1

Activity	Check additional wagon data
Precondition	▪ DPS Train Parts are already split up.
Conditions	▪ FDFT Backend is available and communication between FDFT Backend and FDFT Wagon Base System is possible.
Tasks	▪ The FDFT Backend ensures that its set of additional Wagon Data is current.
Remarks	▪ All data that can be provided by other systems (e.g. FDFT Wagon Base System, landside systems, legacy systems...) should be checked in order to know the current status of the shunting composition and to ensure optimisation of the process at an early stage if necessary (e.g. damaged wagon processing).
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ The communication system of the traction unit (TU) shall be able to receive commands from FDFT backend system to query the additional wagon data from all FDFT wagon base systems in train. ▪ The FDFT wagon base system of each wagon in shunting composition shall report its additional wagon data to the TU. ▪ The FDFT base system of the TU shall report the additional wagon data to the FDFT-Backend.

YM1.1	
Activity	Check additional wagon data
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Yard manager inputs train and additional data into to FDFT Backend if available. ▪ If FDFT Backend is not available, use legacy processes.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ none

BE1.2	
Activity	Subprocess: Confirm wagon set
Precondition	▪ -
Conditions	▪ FDFT Backend is available and can confirm wagon set.
Tasks	▪ See subprocess description 8.4.11.
Remarks	▪ -
Rationale	▪ Information can be used to identify possibly malfunctioning (automation) components.
Postcondition	▪ FDFT Backend knows arrived train composition and has access to an updated version of wagon status data.
Functional system requirements	▪ See subprocess description 8.4.11

O1.2	
Activity	Subprocess: Confirm wagon set
Precondition	▪ -
Conditions	▪ -
Tasks	▪ See subprocess description 8.4.11.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ See subprocess description 8.4.11

D1	
Decision	Is current traction unit planned for shunting preparation?
Yes	▪ Arrived traction unit is used for following shunting activities. ▪ All needed requirements regarding the traction unit and its use in following processes are met before by planning.
Remarks	▪ -
Rationale	▪ Future tractions units allow for more flexibility (no difference between shunting loco or line loco). Then a traction unit change can be omitted.

D2	
Decision	Is securing wagon set necessary?
Yes	▪ Dependent on local environment and entity.
Remarks	▪ Depending on train weight, infrastructure requirements and duration of stillstand securing of wagon(s) may be necessary. ▪ This can be achieved by using the arriving traction unit.
Rationale	▪ -

BE1.3	
Activity	Subprocess: Secure wagon set against rolling away
Precondition	▪ -
Conditions	▪ FDFT Backend is available and can secure wagon (set) against rolling away. ▪ Every wagon in set can secure itself against rolling away by remote command.
Tasks	▪ See subprocess description 8.4.15
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ See subprocess description 8.4.15

D3	
Decision	Which staff is on site?
Yard Personnel	▪ Yard Personnel is on site.
Operator	▪ Operator is on site.
Remarks	▪ -
Rationale	▪ -

YP1.3	
Activity	Subprocess: Secure wagon set against rolling away
Precondition	▪ -
Conditions	▪ -
Tasks	▪ See subprocess description 8.4.15
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ See subprocess description 8.4.15

YP1.4	
Activity	Adjust rear end signal
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Yard Personnel adjusts rear end signals.
Remarks	▪ This step can be skipped if not necessary according to regulations. ▪ E.g., train integrity monitoring makes rear end signal obsolete.
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ none

O1.3	
Activity	Subprocess: Secure wagon set against rolling away
Precondition	▪ -
Conditions	▪ -
Tasks	▪ See subprocess description 8.4.15
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ none

O1.4	
Activity	Adjust rear end signal
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Operator adjusts rear end signals.
Remarks	▪ This step can be skipped if not necessary according to regulations. ▪ E.g., train integrity monitoring makes rear end signal obsolete.
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ none

BE1.5	
Activity	Subprocess: Switch wagon(s) of set to FDFT mode Shunting
Precondition	▪ -
Conditions	▪ FDFT Backend is available and can switch wagon(s) to FDFT mode shunting.
Tasks	▪ See subprocess description 8.4.19
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ The FDFT base system of the traction unit (TU) shall set its own operational to “shunting mode”. ▪ The FDFT base system of the traction unit (TU) shall send the command to switch into “shunting mode” to each wagon in train composition. ▪ The FDFT wagon base system of each wagon in train composition shall report its new operational mode “shunting mode” to the TU. ▪ The FDFT base system of the TU shall report the operational mode of each wagon in train composition to the FDFT-Backend.

YP1.5	
Activity	Subprocess: Switch wagon(s) of set to FDFT mode shunting
Precondition	▪ -
Conditions	▪ -
Tasks	▪ See subprocess description 8.4.19
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ See subprocess description 8.4.19

O1.5	
Activity	Subprocess: Switch wagon(s) of set to FDFT mode shunting
Precondition	▪ -
Conditions	▪ -
Tasks	▪ See subprocess description 8.4.19
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ See subprocess description 8.4.19

D4	
Decision	Is an action required to ensure rolling capability?
No	▪ No unintentional loss of air in system with negative influence on the rolling capability e.g., in the shunting processes.
Remarks	▪ The rolling capacity of the wagon(s) must be ensured, especially in the processes of fly and hump shunting. ▪ Today bleeding is use to achieve rolling capability (for Bleeding Process

	see P24 - Bleeding)[3] Generally bleeding should not be required.
Rationale	▪ More efficient process if bleeding can be avoided.

BE1.6	
Activity	Ensure rolling capability
Precondition	▪ In Case of Bleeding: Air supply of Traction Unit is shut off or disconnected.
Conditions	▪ FDFT Backend is available and can ensure rolling capability.
Tasks	▪ Make sure the rolling capability of the wagon(s) is given.
Remarks	▪ Wagon Set is still secured. ▪ Today bleeding is used to archive rolling capability (for Bleeding Process see P24 - Bleeding).
Rationale	▪ If the rolling capability is not ensured, there would be the risk of an unintentional stop of the wagon. This would lead to additional effort within shunting or possibly a collision of wagon(s).
Postcondition	▪ -
Functional system requirements	▪ none

D5	
Decision	Which staff is on site?
Yard Personnel	▪ Yard Personnel is on site.
Operator	▪ Operator is on site.
Remarks	▪ -
Rationale	▪ -

[3] Please refer to /WP2_D2.1/

O1.6

Activity	Ensure rolling capability
Precondition	▪ In Case of Bleeding: Air supply of Traction Unit is shut off or disconnected.
Conditions	▪ -
Tasks	▪ Make sure the rolling capability of the wagon(s) is given.
Remarks	▪ Wagon Set is still secured. Today bleeding is used to archive rolling capability (for Bleeding Process see P24 - Bleeding).
Rationale	▪ If the rolling capability is not ensured, there would be the risk of an unintentional stop of the wagon. This would lead to additional effort within shunting or possibly a collision of wagon(s).
Postcondition	▪ -
Functional system requirements	▪ none

YP1.6

Activity	Ensure rolling capability
Precondition	▪ In Case of Bleeding: Air supply of Traction Unit is shut off or disconnected.
Conditions	▪ -
Tasks	▪ Make sure the rolling capability of the wagon(s) is given.
Remarks	▪ Wagon Set is still secured. Today bleeding is used to archive rolling capability (for Bleeding Process see P24 - Bleeding).
Rationale	▪ If the rolling capability is not ensured, there would be the risk of an unintentional stop of the wagon. This would lead to additional effort within shunting or possibly a collision of wagon(s).
Postcondition	▪ -
Functional system requirements	▪ none.

D6	
Decision	Is current traction unit planned for shunting preparation?
Yes	▪ Shunting planning requires a traction unit change.
Remarks	▪ -
Rationale	▪ Future tractions units allow for more flexibility (no difference between shunting loco or line loco). Then a traction unit change can be omitted.

BE1.7	
Activity	Subprocess: Uncouple Traction Unit
Precondition	▪ -
Conditions	▪ FDFT Backend is available, can command FDFT Wagon Base System to uncouple.
Tasks	▪ See subprocess description 8.4.13.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ See subprocess description 8.4.13.

BE1.8	
Activity	Initiate movement of Traction Unit – leaves wagon (set)
Precondition	▪ Automated Parking Brake released, Controllable Brake released, traction is allowed and possible.
Conditions	▪ FDFT Backend is available and can initiate movement of Traction Unit.
Tasks	▪ Increase traction force and gain speed up to shunting yard regulatory maximum.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -

Functional system requirements	▪ none ▪ Remark: The FDFT Backend initiates the movement of the Traction Unit by controlling the TU ATO system (legacy) through the landside ATO system (legacy).

D7	
Decision	Which staff is on site?
Yard Personnel	▪ Yard Personnel is on site.
Operator	▪ Operator is on site.
Remarks	▪ -
Rationale	▪ -

O1.7	
Activity	Subprocess: Uncouple Traction Unit
Precondition	▪ -
Conditions	▪ -
Tasks	▪ See subprocess description 8.4.13
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ See subprocess description 8.4.13

YP1.7	
Activity	Subprocess: Uncouple Traction Unit
Precondition	▪ -
Conditions	▪ -
Tasks	▪ See subprocess description 8.4.13
Remarks	▪ -
Rationale	▪ -

Postcondition	▪ -
Functional system requirements	▪ See subprocess description 8.4.13
	▪

O1.8	
Activity	Initiate movement of traction unit – leaves wagon (set)
Precondition	▪ Automated Parking Brake released, Controllable Brake released, traction is allowed and possible.
Conditions	▪
Tasks	▪ Increase traction force and gain speed up to shunting yard regulatory maximum.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ none ▪ Remark: The Operator initiates the movement of the Traction Unit by controlling the TU through the local HMI (legacy).

TU1.9	
Activity	Movement of Traction Unit – leaves wagon (set)
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Uncoupled Traction Unit moves away from the wagon (set) to an assigned destination.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ none ▪ Remark: The FDFT Backend initiates the movement of the Traction Unit by controlling the TU ATO system (legacy) through the landside ATO system (legacy).

8.4.3 TP02 - Wagon Processing

Target Process

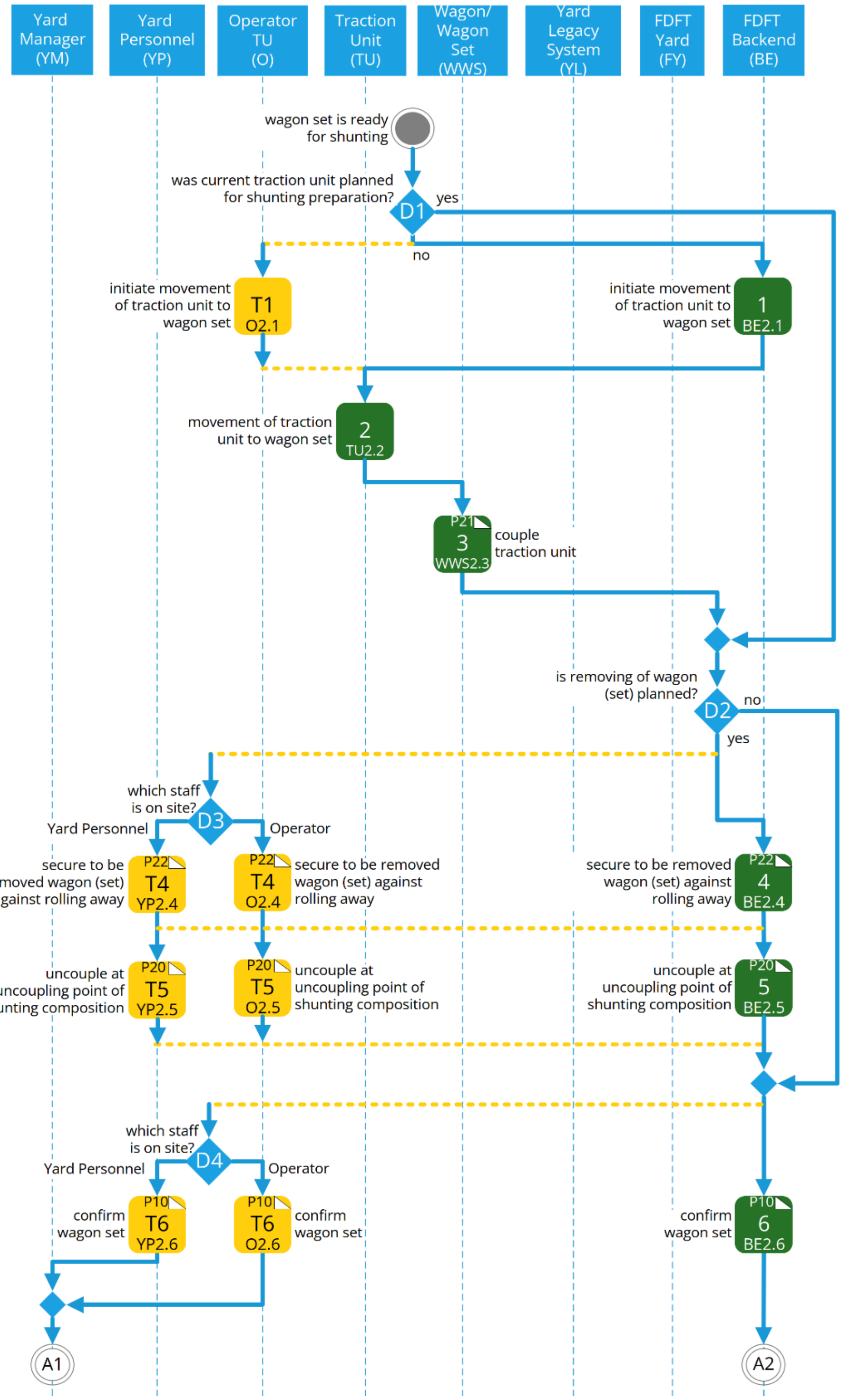


Figure 12: TP02 Wagon Processing - 1 of 4

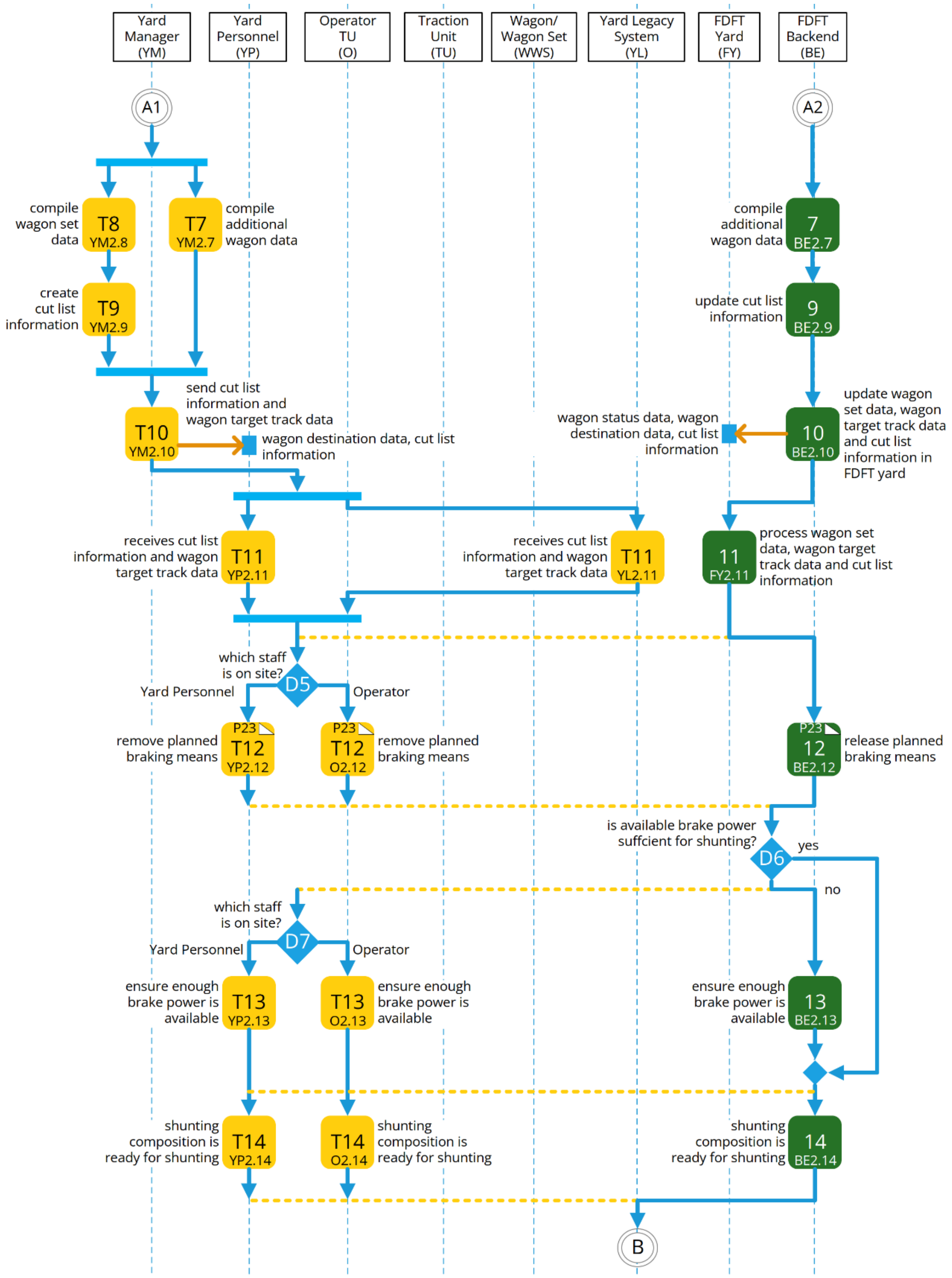


Figure 13: TP02 Wagon Processing - 2 of 4

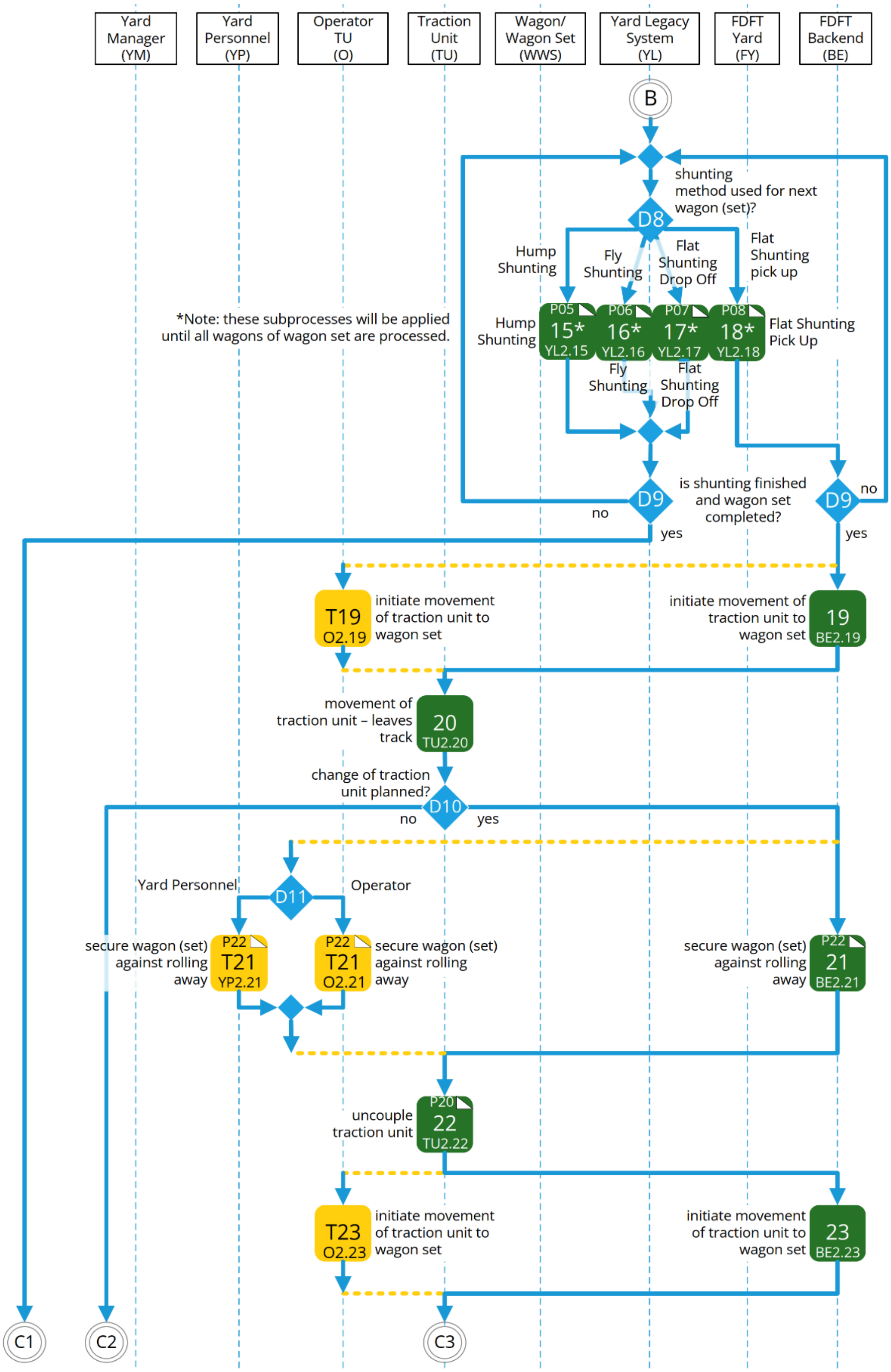


Figure 14: TP02 Wagon Processing - 3 of 4

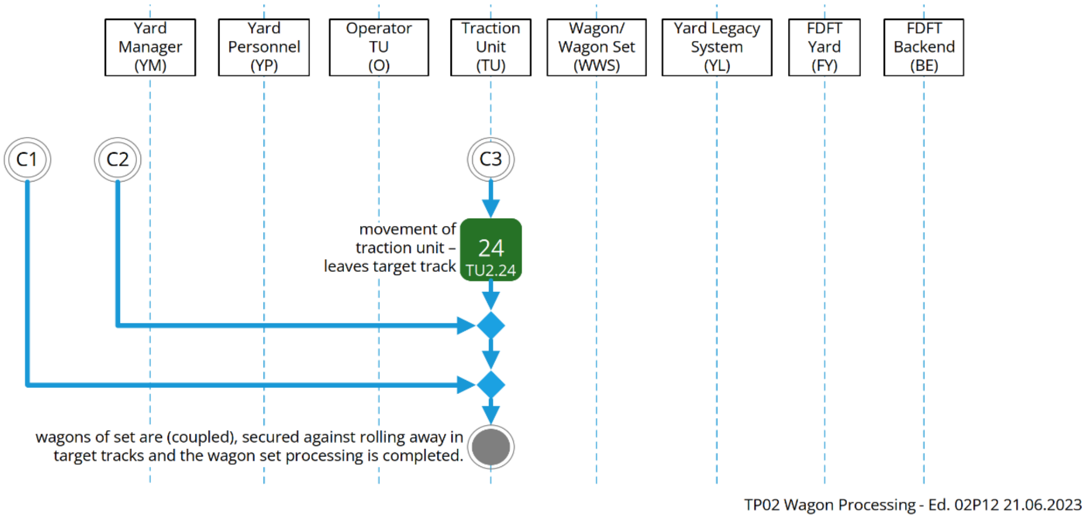


Figure 15: TP02 Wagon Processing - 4 of 4

8.4.3.2 Process-Description

D1	
Decision	Was Traction Unit change planned?
Yes	▪ In previous process, a traction unit change was planned and done.
No	▪ In previous process, a traction unit change was not planned and done.
Remarks	▪ -
Rationale	▪ -

BE2.1	
Activity	Initiate movement of traction unit to wagon set
Precondition	▪ Automated Parking Brake released, Controllable Brake released, traction is allowed and possible.
Conditions	▪ FDFT Backend is available and can initiate movement of Traction Unit.
Tasks	▪ Increase traction force and gain speed up to shunting yard regulatory maximum.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ none ▪ Remark: The FDFT Backend initiates the movement of the Traction Unit by controlling the TU ATO system (legacy) through the landside ATO system (legacy).

O2.1	
Activity	Initiate movement of traction unit to wagon set
Precondition	▪ Automated Parking Brake released, Controllable Brake released, traction is allowed and possible.
Conditions	▪ -
Tasks	▪ Increase traction force and gain speed up to shunting yard regulatory maximum.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -

Functional system requirements	▪ Remark: The Operator initiates the movement of the Traction Unit by controlling the TU ATO system (legacy) through the local HMI (legacy). ▪ Upon reception of the command from the loco driver, the traction unit (TU) shall increase traction force and gain speed up to shunting yard regulatory maximum.

TU2.2

Activity	Movement of Traction Unit to wagon set
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Traction Unit is moved to Wagon Set (without Traction Unit).
Remarks	▪ This Traction Unit is used for following shunting movements.
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ none ▪

WWS2.3

Activity	Subprocess: Couple Traction Unit
Precondition	▪ -
Conditions	▪ -
Tasks	▪ See subprocess description 8.4.14
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ See subprocess description 8.4.14

D2

Decision	Is removing of wagon (set) planned?

Yes	▪ Part of Wagon Set is planned to be removed.
No	▪ Wagon Set is ready for further processing.
Remarks	▪ -
Rationale	▪ -

BE2.4	
Activity	Subprocess: secure to be removed wagon (set) Against Rolling Away
Precondition	▪ -
Conditions	▪ FDFT Backend is available and can initiate securing against rolling away.
Tasks	▪ See subprocess description 8.4.15
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ See subprocess description 8.4.15

BE2.5	
Activity	Subprocess: uncouple at uncoupling point of shunting composition
Precondition	▪ -
Conditions	▪ FDFT Backend is available and can initiate uncoupling.
Tasks	▪ See subprocess description 8.4.13
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ See subprocess description 8.4.13

D3	
Decision	Which staff is on site?

Yard Personnel	▪ Yard Personnel is on site.
Operator	▪ Operator is on site.
Remarks	▪ -
Rationale	▪ -

O2.4	
Activity	Subprocess: secure to be removed wagon (set) against rolling away
Precondition	▪ -
Conditions	▪ -
Tasks	▪ See subprocess description 8.4.15
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ See subprocess description 8.4.15

YP2.4	
Activity	Subprocess: secure to be removed wagon (set) against rolling away
Precondition	▪ -
Conditions	▪ -
Tasks	▪ See subprocess description 8.4.15
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ See subprocess description 8.4.15

O2.5	
Activity	Subprocess: uncouple at uncoupling point of shunting composition
Precondition	▪ -
Conditions	▪ -
Tasks	▪ See subprocess description 8.4.13
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ See subprocess description 8.4.13

YP2.5	
Activity	Subprocess: uncouple at uncoupling point of shunting composition
Precondition	▪ -
Conditions	▪ -
Tasks	▪ See subprocess description 8.4.13
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ See subprocess description 8.4.13

BE2.6	
Activity	Subprocess: Confirm Wagon Set
Precondition	▪ -
Conditions	▪ FDFT Backend is available and can communicate with FDFT Wagon Base System on each wagon in composition. ▪ Through mentioned communication, each FDFT Backend can determine the order and orientation of each wagon in composition.

Tasks	▪ See subprocess description 8.4.11
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ FDFT Backend knows train composition: order and orientation of each wagon in set.
Functional system requirements	▪ The FDFT Base System of the TU shall trigger the function "Train Composition Detection". ▪ The FDFT Base system in each wagon in the train, shall support deriving the train composition by using their "Train Composition Detection Support function". ▪ The FDFT Base System of the TU shall compile the result of the "Train Composition Detection function" and make it available to the local HMI. ▪ The FDFT Base System of the TU shall compile the result of the "Train Composition Detection function" and shall send it to the FDFT-Backend.

BE2.7	
Activity	Compile additional wagon data
Precondition	▪ -
Conditions	▪ FDFT Backend is available.
Tasks	▪ FDFT Backend compiles Additional Wagon Data, e.g. load type, weight, operational shunting restrictions, special handling restriction.
Remarks	▪ This information is used for cut list information.
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ None ▪ Remark: the activity is related to the FDFT Backend only.

BE2.9	
Activity	Update Cut List Information
Precondition	▪ -
Conditions	▪ FDFT Backend is available.
Tasks	▪ With current Wagon Set Data and Destination and Additional Wagon Data, the Cut List Information may be updated if actual state differs from planned state.

Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ None ▪ Remark: the activity is related to the FDFT Backend only.

BE2.10

Activity	Update Wagon Set Data, Wagon Target Track Data and Cut List Information in FDFT Yard
Precondition	▪ -
Conditions	▪ FDFT Backend is available.
Tasks	▪ FDFT Backend sends Wagon Set Data, Wagon Target Track Data and Cut List Information to FDFT Yard.
Remarks	▪ This step is used to update FDFT Yard about possible wagon order and orientation or load changes which are not to plan.
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ None ▪ Remark: the activity is related to the FDFT Backend only.

FY2.11

Activity	Process Wagon Set Data, Wagon Target Track Data and Cut List Information
Precondition	▪ -
Conditions	▪ -
Tasks	▪ FDFT Yard receives Wagon Set Data, Wagon Target Track Data and Cut List Information from FDFT Backend and updates planned shunting processes if necessary.
Remarks	▪ FDFT Yard uses this information to plan, manages and executes following shunting processes. ▪ See also subprocesses hump 8.4.6, fly 8.4.7 and flat shunting 8.4.8/8.4.9.
Rationale	▪ -
Postcondition	▪ -

Functional system requirements	▪ None ▪ Remark: the activity is related to the FDFT Yard only.

BE2.12	
Activity	Subprocess: Release planned braking means
Precondition	▪ -
Conditions	▪ FDFT Backend is available and can initiate release braking means. ▪ Traction Unit is coupled to Wagon Set.
Tasks	▪ See subprocess description 8.4.16
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ See subprocess description 8.4.16

D4	
Decision	Which staff is on site?
Yard Personnel	▪ Yard Personnel is on site.
Operator	▪ Operator is on site.
Remarks	▪ -
Rationale	▪ -

O2.6	
Activity	Subprocess: Confirm Wagon Set
Precondition	▪ -
Conditions	▪ -
Tasks	▪ See subprocess description 8.4.11
Remarks	▪ -

Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ See subprocess description 8.4.11

YP2.6

Activity	Subprocess: Confirm Wagon Set
Precondition	▪ -
Conditions	▪ -
Tasks	▪ See subprocess description 8.4.11
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ See subprocess description 8.4.11

YM2.7

Activity	Compile additional wagon data
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Yard Manager compiles Wagon Target Track Data and Additional Wagon Data for each wagon in set.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ none

YM2.8

Activity	Compile Wagon Set Data
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Yard Manager compiles wagon set data (order and orientation).
Remarks	▪ This data can be provided by Yard Personnel or an existing legacy system.
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ none

YM2.9

Activity	Create Cut List Information
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Yard Manager derives Cut List Information from Wagon Set Data, Wagon Target Track Data and Additional Wagon Data.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ none

YM2.10

Activity	Send Cut List Information and Wagon Target Track Data
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Yard Manager sends Cut List Information and Wagon Target Track Data to personnel on site or legacy system.

Remarks	▪ This information can be used by Yard Personnel or trigger a (automatic) legacy process.
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ none

YL2.11	
Activity	Receive Cut List Information and Wagon Target Track Data
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Yard Legacy System receives Cut List Information and Wagon Target Track Data and starts legacy processes for shunting.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ none

YP2.11	
Activity	Receive Cut List Information and Wagon Target Track Data
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Cut List Information and Wagon Target Track Data are available through legacy processes (e.g. legacy mobile device) or the Mobile HMI.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -

Functional system requirements	▪ none

D5	
Decision	Which staff is on site?
Yard Personnel	▪ Yard Personnel is on site.
Operator	▪ Operator is on site.
Remarks	▪ -
Rationale	▪ -

O2.12	
Activity	Subprocess: Remove planned braking means
Precondition	▪ -
Conditions	▪ Traction Unit is coupled to Wagon Set.
Tasks	▪ See subprocess description 8.4.16 ▪ Operator removes planned braking means at wagon(s) in set.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ none

YP2.12	
Activity	Subprocess: Remove planned braking means
Precondition	▪ -
Conditions	▪ Traction Unit is coupled to Wagon Set.
Tasks	▪ See subprocess description 8.4.16 ▪ Yard personnel removes planned braking means at wagon(s) in set.

Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ none

D6	
Decision	Is available brake power sufficient for shunting?
Yes	▪ FDFT Backend calculates necessary brake power by using stored wagon data, traction unit data, topology, and operational requirements. ▪ If FDFT Backend is not available, necessary brake power is calculated by legacy processes.
Remarks	▪ It should be considered that Traction Unit can solely provide necessary brake power. ▪ Some Wagon(s) in Set may have their brake system in service to provide necessary brake power.
Rationale	▪ -

BE2.13	
Activity	Ensure enough brake power is available
Precondition	▪ -
Conditions	▪ Additional brake power can be utilised without the need for manual intervention at each wagon. FDFT Backend is available.
Tasks	▪ FDFT Backend uses Traction Unit and some Wagon(s) ‘FDFT Wagon Base Systems to provide brake power.
Remarks	▪ In preceding process all wagon(s) of set may have been bled. ▪ Today, necessary brake power is achieved by using some wagon(s) in front of the traction unit (air brake). In future, different solutions can be implemented. ▪ If additional wagon(s) are used as brake power (air brake), these wagon(s) must be bled before shunting.
Rationale	▪ -
Postcondition	▪ -

Functional system requirements	▪ The communication system of the traction unit (TU) shall be able to receive commands from FDFT backend system to query the status of available brakes from all FDFT wagon base systems in shunting composition. ▪ The FDFT wagon base system of each wagon in shunting composition shall report its current brake status to the TU. ▪ The FDFT base system of the TU shall report the brake status of all wagons in shunting composition to the FDFT-Backend.

BE2.14

Activity	Shunting composition is ready for shunting
Precondition	▪ -
Conditions	▪ FDFT Backend is available and can communicate with Yard Legacy System and/or FDFT Yard.
Tasks	▪ FDFT Backend sends information "shunting composition ready to shunt" to Yard Legacy System and/or FDFT Yard depending on availability.
Remarks	▪ This information is used to trigger following shunting processes in surrounding systems.
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ None ▪ Remark: all information is exchanged between FDFT System(s) and / or legacy systems

D7

Decision	Which staff is on site?
Yard Personnel	▪ Yard Personnel is on site.
Operator	▪ Operator is on site.
Remarks	▪ -
Rationale	▪ -

O2.13

Activity	Ensure enough brake power is available
Precondition	▪ -

Conditions	▪ -
Tasks	▪ Operator ensures that enough brake power is available through legacy process or by using FDFT Wagon Base Systems as additional brake power. ▪ Communication to FDFT Wagon Base Systems can be provided by Traction Unit or Mobile HMI.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ The communication system of the traction unit (TU) shall be able to receive commands from the local HMI or the connected Mobile HMI to query the status of available brakes from all FDFT wagon base systems in shunting composition. ▪ The FDFT wagon base system of each wagon in shunting composition shall report its current brake status to the TU. ▪ The FDFT base system of the TU shall forward the brake status of all wagons in shunting composition to the local HMI or to the connected Mobile HMI.

O2.14	
Activity	Shunting composition is ready for shunting
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Operator sends information “shunting composition ready to shunt” to Yard Legacy System and/or FDFT Yard depending on availability.
Remarks	▪ This information is used to trigger following shunting processes.
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ The communication system of the traction unit (TU) shall be able to send the information “shunting composition ready to shunt” to the FDFT backend. ▪ Remark: If the communication between TU and FDFT-Backend isn’t possible, the Yard legacy system shall be informed by legacy means, being not considered here.

YP2.13	
Activity	Ensure enough brake power is available
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Yard Personnel ensures that enough brake power is available through legacy process or by using FDFT Wagon Base Systems as additional brake power. ▪ Communication to FDFT Wagon Base Systems can be provided by Traction Unit or Mobile HMI.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -

Functional system requirements	▪ The communication system of the traction unit (TU) shall be able to query the status of available brakes from all FDFT wagon base systems in shunting composition. ▪ The FDFT wagon base system of each wagon in shunting composition shall report its current brake status to the TU. ▪ The FDFT base system of the TU shall forward the brake status of all wagons in shunting composition to the local HMI or Mobile HMI.

YP2.14	
Activity	Shunting composition is ready for shunting
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Yard personnel sends information "shunting composition ready to shunt" to Yard Legacy System and/or FDFT Yard depending on availability.
Remarks	▪ This information is used to trigger following shunting processes.
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ None ▪ Remark: In this activity, the yard personnel has only access to the Yard Legacy System.

D8	
Decision	Shunting method used for next wagon (set)?
Flat shunting Pick Up	▪ Flat shunting pick up planned for next wagon(s).
Flat shunting Drop Off	▪ Flat shunting drop off planned for next wagon(s).
Fly shunting	▪ Fly shunting planned for next wagon(s).
Hump shunting	▪ Hump shunting planned for next wagon(s).
Remarks	▪ Planned shunting method depends on available infrastructure and national operational regulations. ▪ This decision in conjunction with the four following shunting methods are run repeatedly until all wagon(s) of set are processed. ▪ This process does not differentiate between wagon and tractions units. Unpowered Traction Units are considered as a wagon and shunted accordingly.
Rationale	▪ -

YL2.15	
Activity	Subprocess: Hump Shunting
Precondition	▪ -
Conditions	▪ -
Tasks	▪ See subprocess definition 8.4.6
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ See subprocess definition 8.4.6

YL2.16	
Activity	Subprocess: Fly Shunting
Precondition	▪ -
Conditions	▪ -
Tasks	▪ See subprocess definition 8.4.7
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ See subprocess definition 8.4.7

YL2.17	
Activity	Subprocess: Flat Shunting Drop Off
Precondition	▪ -
Conditions	▪ -
Tasks	▪ See subprocess definition 8.4.8
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ See subprocess definition 8.4.8

YL2.18	
Activity	Subprocess: Flat Shunting Pick Up
Precondition	▪ -
Conditions	▪ -
Tasks	▪ See subprocess definition 8.4.9
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ See subprocess definition 8.4.9

D9	
Decision	Is shunting finished and wagon set completed?
yes	▪ Is shunting process finished and wagon set is completed according to the plan.
Remarks	▪ -
Rationale	▪ -

BE2.19

Activity	Initiate movement of traction unit to wagon set
Precondition	▪ Automated Parking Brake released, Controllable Brake released, traction is allowed and possible.
Conditions	▪ FDFT Backend is available.
Tasks	▪ increase traction force and gain speed up to shunting yard regulatory maximum.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ none ▪ Remark: The FDFT Backend initiates the movement of the Traction Unit by controlling the TU ATO system (legacy) through the landside ATO system (legacy). The Shunting path has to be ordered, set and sent to TU before (legacy).

O2.19

Activity	Initiate movement of traction unit to wagon set
Precondition	▪ Automated Parking Brake released, Controllable Brake released, traction is allowed and possible.
Conditions	▪ -
Tasks	▪ increase traction force and gain speed up to shunting yard regulatory maximum.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ none

TU2.20	
Activity	Movement of traction unit – leaves track
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Uncoupled Traction Unit moves away from the wagon (set) to an assigned destination.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ none ▪ Remark: The FDFT Backend initiates the movement of the Traction Unit by controlling the TU ATO system (legacy) through the landside ATO system (legacy).

D10	
Decision	Change of traction unit planned?
yes	▪ Change of Traction Unit is planned.
Remarks	▪ -
Rationale	▪ -

BE2.21	
Activity	Subprocess: Secure wagon (set) against rolling away
Precondition	▪ -
Conditions	▪ FDFT Backend is available and can initiate securing against rolling away.
Tasks	▪ Secure those wagons (set) against rolling away, which is currently connected to the traction unit. ▪ See subprocess description 8.4.15
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ See subprocess description 8.4.15

D11	
Decision	Which staff is on site?
Yard Personnel	▪ Yard Personnel is on site.
Operator	▪ Operator is on site.
Remarks	▪ -
Rationale	▪ -

YP2.21	
Activity	Subprocess: Secure wagon (set) against rolling away
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Secure those wagon (set) against rolling away, which is currently connected to the traction unit. ▪ See subprocess description 8.4.15
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ See subprocess description 8.4.15

O2.21	
Activity	Subprocess: Secure wagon (set) against rolling away
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Secure wagon (set) against rolling away, which is currently connected to the traction unit. ▪ See subprocess description 8.4.15
Remarks	▪ -
Rationale	▪ -

Postcondition	▪ -
Functional system requirements	▪ See subprocess description 8.4.15

TU2.22

Activity	Subprocess: uncouple Traction Unit
Precondition	▪ -
Conditions	▪ -
Tasks	▪ See subprocess description 8.4.13
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ See subprocess description 8.4.13

BE2.23

Activity	Initiate movement of traction unit to wagon set
Precondition	▪ Automated Parking Brake released, Controllable Brake released, traction is allowed and possible.
Conditions	▪ FDFT Backend is available.
Tasks	▪ increase traction force and gain speed up to shunting yard regulatory maximum.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ none ▪ Remark: The FDFT Backend initiates the movement of the Traction Unit by controlling the TU ATO system (legacy) through the landside ATO system (legacy).

O2.23	
Activity	Initiate movement of traction unit to wagon set
Precondition	▪ Automated Parking Brake released, Controllable Brake released, traction is allowed and possible.
Conditions	▪ -
Tasks	▪ increase traction force and gain speed up to shunting yard regulatory maximum.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ None ▪ Remark: activity is performed using legacy means

TU2.24	
Activity	Movement of Traction Unit – leaves target track
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Uncoupled Traction Unit moves away from the wagon (set) to an assigned destination.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ none ▪ Remark: The FDFT Backend initiates the movement of the Traction Unit by controlling the TU ATO system (legacy) through the landside ATO system (legacy).

8.4.4 TP03 - Train Preparation

8.4.4.2 Target Process

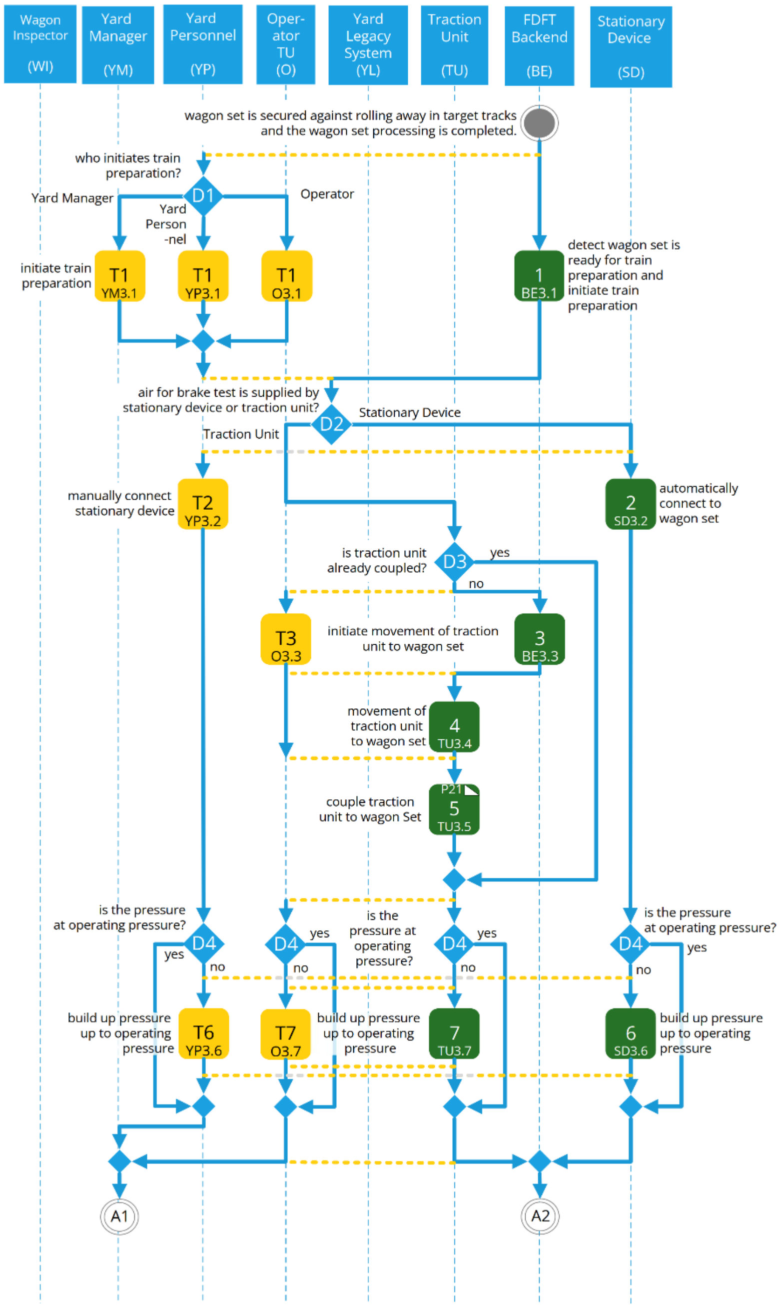


Figure 16: TP03 Train Preparation - 1 of 4

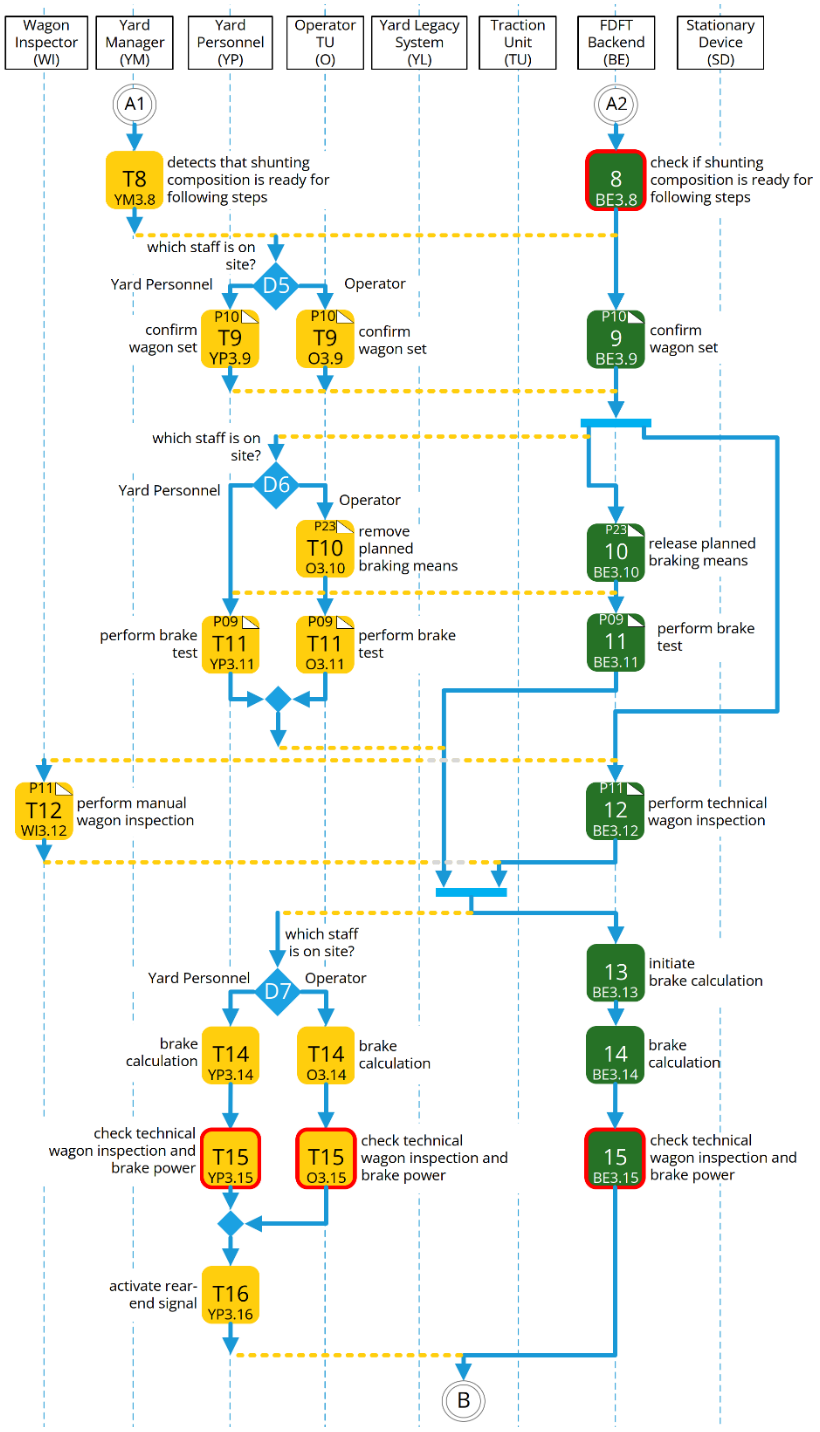


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Figure 17: TP03 Train Preparation - 2 of 4

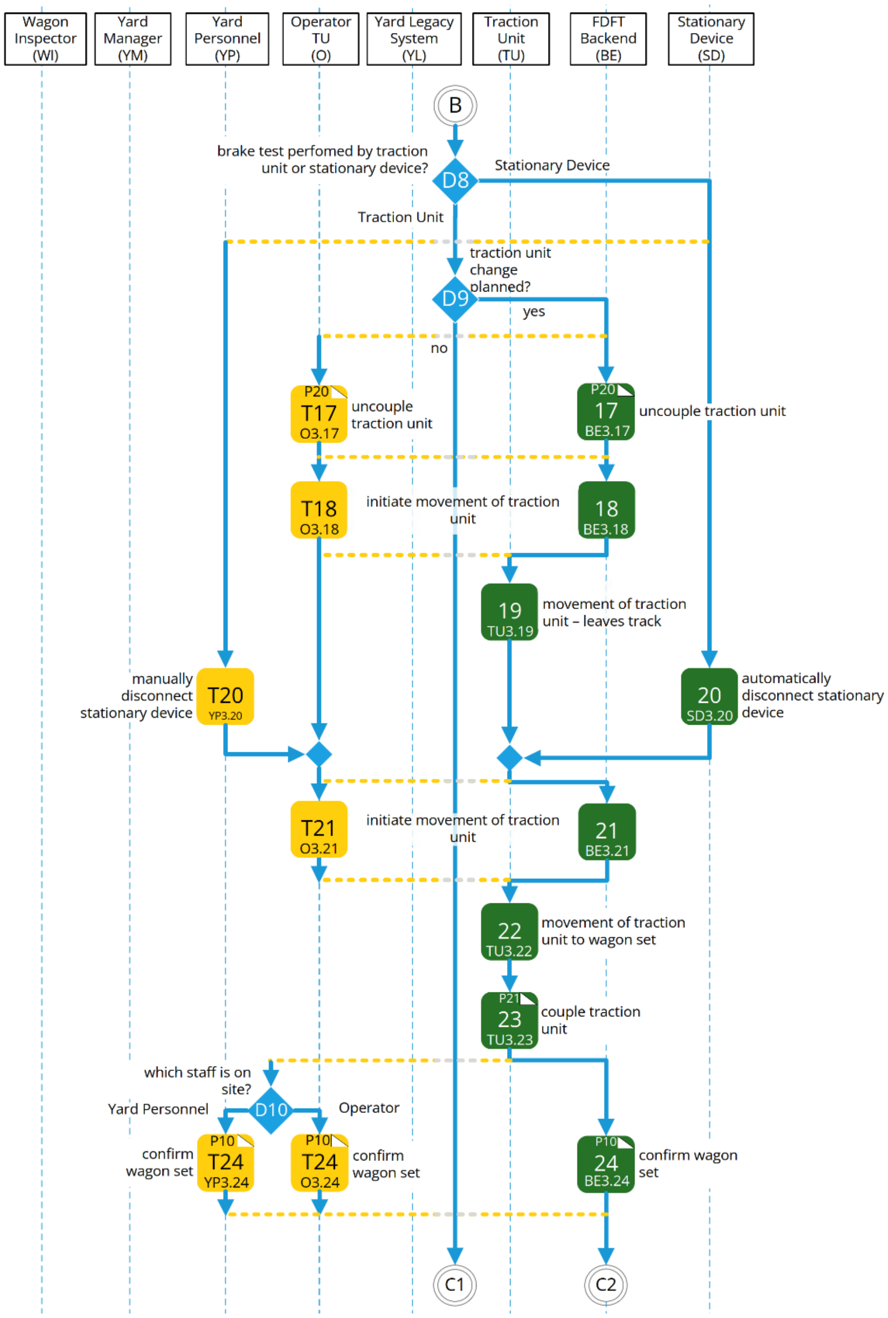


Figure 18: TP03 Train Preparation - 3 of 4

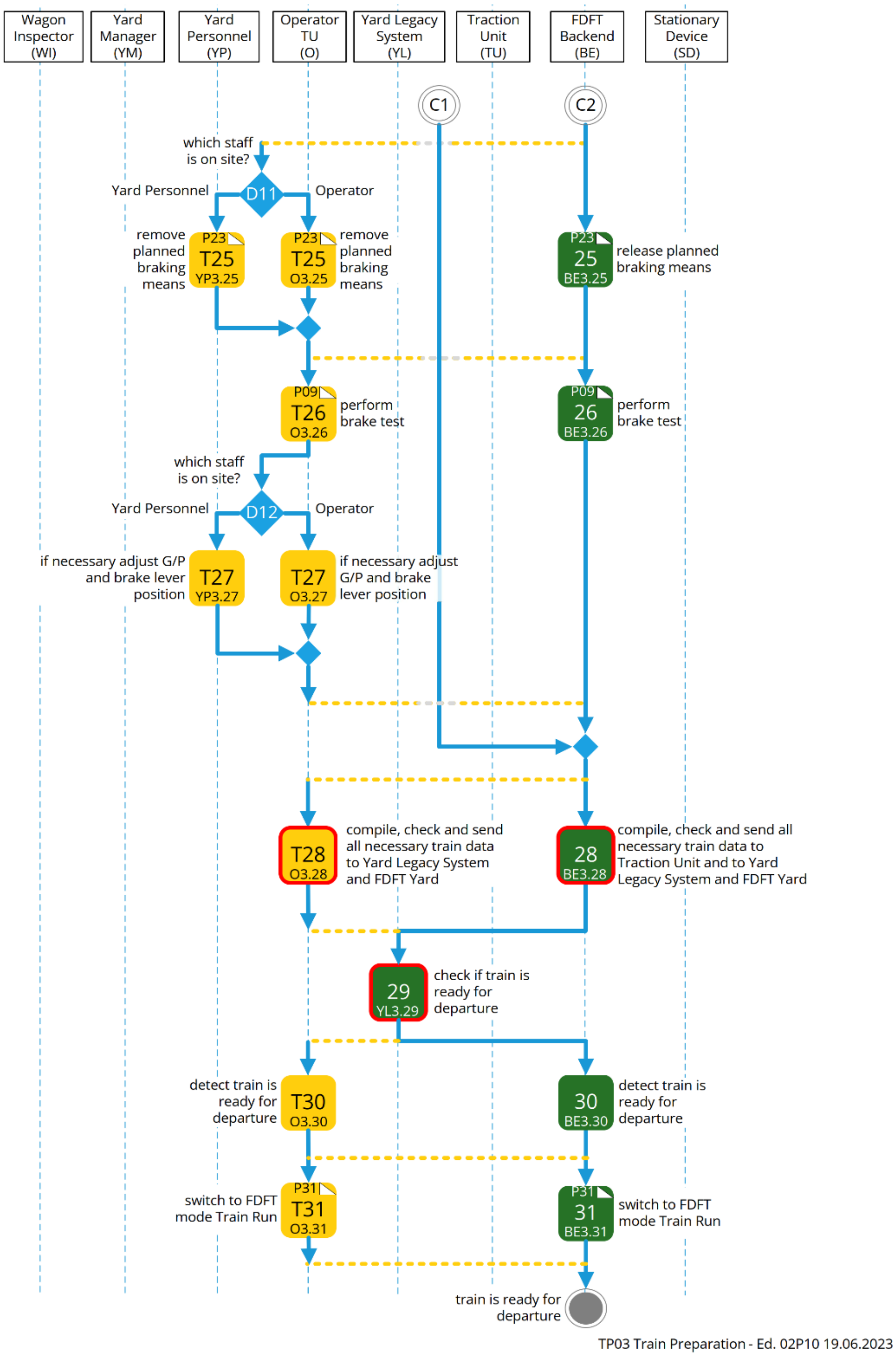


Figure 19: TP03 Train Preparation - 4 of 4

8.4.4.2 Process-Description

BE3.1	
Activity	Detect wagon set is ready for train preparation
Precondition	▪ Wagon Set is secured against rolling away in target track and the wagon processing is completed.
Conditions	▪ FDFT Backend is available and can automatically detect that wagon set is ready for train preparation.
Tasks	▪ FDFT Backend automatically detects that wagon set is ready for train preparation and initiates following processes.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ none ▪ Remark: This activity is to be handled purely in the FDFT Backend after having received the necessary information about the wagon set.

D1	
Decision	Who initiates train preparation?
Yard Manager	▪ Yard Manager initiates train preparation.
Yard Personnel	▪ Yard Personnel initiates train preparation.
Operator	▪ Operator initiates train preparation.
Remarks	▪ -
Rationale	▪ -

O3.1	
Activity	Initiate train preparation
Precondition	▪ -
Conditions	▪ -
Tasks	▪ If FDFT Backend is available, inform FDFT Backend that wagon set is ready for train preparation. ▪ If FDFT Backend is not available, start legacy train preparation processes.
Remarks	▪ -

Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ none ▪ Remark: This activity is to be handled purely by the legacy process.

YP3.1

Activity	Initiate train preparation
Precondition	▪ -
Conditions	▪ -
Tasks	▪ If FDFT Backend is available, inform FDFT Backend that wagon set is ready for train preparation. ▪ IF FDFT Backend is not available, start legacy train preparation processes.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ none ▪ Remark: This activity is to be handled purely in the FDFT Backend after having received the necessary information about the wagon set.

YM3.1

Activity	Initiate train preparation
Precondition	▪ -
Conditions	▪ -
Tasks	▪ If FDFT Backend is available, inform FDFT Backend that wagon set is ready for train preparation. ▪ IF FDFT Backend is not available, start legacy train preparation processes.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ none ▪ Remark: This activity is to be handled purely in the FDFT Backend after having received the necessary information about the wagon set.

D2	
Decision	Air for brake test is supplied by Stationary Device or Traction Unit?
Stationary Device	▪ Air for brake test is supplied by Stationary Device.
Traction Unit	▪ Air for brake test is supplied by Traction Unit.
Remarks	▪ -
Rationale	▪ Stationary Devices can be used to accelerate overall process as wating for traction unit is not needed. ▪ The usage of Stationary Devices does not bind traction units for preparation activities.

SD3.2	
Activity	Automatically connect to Wagon Set
Precondition	▪ -
Conditions	▪ Stationary Device can automatically connect to wagon set.
Tasks	▪ Stationary Device automatically moves to coupling position and connects air, and - if available - power and data at one of the outermost wagon(s).
Remarks	▪ Some of these activities may change depending on the automation of Stationary Device. e.g., the wagon set can be moved to the Stationary Device. ▪ Depending on the technical development it is possible that the Stationary Device connects to the wagon group at an earlier point in the process. ▪ Today a blow out of the main brake pipe of the SD is performed from some RUs. Whether this will be necessary in the future must be checked.
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ none ▪ Remark: This activity is to be handled purely by the Stationary Device in conjunction with the FDFT Backend.

D3	
Decision	Is Traction Unit already coupled?
Yes	▪ Traction Unit is already coupled to Wagon Set.
No	▪ Traction Unit is not coupled to Wagon Set.
Remarks	▪ -
Rationale	▪ Traction Unit could be coupled from process Flat Shunting Provide.

BE3.3	
Activity	Initiate movement of Traction Unit to wagon set
Precondition	▪ Automated Parking Brake released, Controllable Brake released, traction is allowed and possible.
Conditions	▪ FDFT Backend is available and can initiate movement of Traction Unit.
Tasks	▪ increase traction force and gain speed up to shunting yard regulatory maximum.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ none ▪ Remark: The FDFT Backend initiates the movement of the Traction Unit by controlling the TU ATO system (legacy) through the landside ATO system (legacy).

O3.3	
Activity	Initiate movement of traction unit to wagon set
Precondition	▪ Automated Parking Brake released, Controllable Brake released, traction is allowed and possible.
Conditions	▪ -
Tasks	▪ increase traction force and gain speed up to shunting yard regulatory maximum.
Remarks	▪
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ None ▪ Remark: Upon reception of the command from the local HMI (legacy) of the traction unit, the TU shall increase traction force and gain speed up to shunting yard regulatory maximum.

TU3.4	
Activity	Movement of traction unit to wagon set
Precondition	▪ -
Conditions	▪

Tasks	▪ Traction Unit leaves track.
Remarks	▪ Uncoupled Traction Unit moves away from the wagon (set) to an assigned destination.
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ None ▪ Remark: described Task is a description only ▪ Remark: Moving the TU to an assigned destination, is to be done by external means (e.g.: yard legacy system), to set all switches on the way to the destination into the right switching position, interlocking the switches, while respecting all regulatory requirements.

TU3.5

Activity	Subprocess: Couple Traction Unit to Wagon Set
Precondition	▪ -
Conditions	▪ -
Tasks	▪ See subprocess description 8.4.14
Remarks	▪ Today a blow out of the main brake pipe of the Traction Unit is performed from some RUs. Whether this will be necessary in the future must be checked.
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ See subprocess description 8.4.14

YP3.2

Activity	Manually connect Stationary Device
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Yard Personnel manually connects stationary device and connects air, and - if available - power and data at one of the outermost wagon(s).
Remarks	▪ Some of these activities may change depending on the automation of Stationary Device. E.g. the wagon set can be moved to the Stationary Device.

	▪ Today a blow out of the main brake pipe of the Stationary Device is performed from some RUs. Whether this will be necessary in the future must be checked.
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ none ▪ Remark: This activity is to be handled purely by the Stationary Device.

D4	
Decision	Is the pressure at operating pressure?
Conditions	▪ An Operator is available at the Traction Unit and Traction Unit is able to activate “build up pressure in main pipe to operating pressure”.
Yes	▪ Pressure in main brake pipe is at operating pressure.
No	▪ Pressure in main brake pipe is not at operating pressure.
Remarks	▪ -
Rationale	▪ -

SD3.6

Activity	Build up pressure up to operating pressure
Precondition	▪ -
Conditions	▪ Stationary Device is able to activate "build up pressure in main pipe to operating pressure".
Tasks	▪ Stationary Device builds up pressure in main brake pipe to operating pressure.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ none ▪ Remark: This activity is to be handled purely by the Stationary Device.

TU3.7

Activity	Build up pressure up to operating pressure
Precondition	▪ -
Conditions	▪ Traction Unit is able to activate "build up pressure in main pipe to operating pressure".
Tasks	▪ Traction Unit builds up pressure in main brake pipe to operating pressure automatically.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ The Base System of the TU shall be able to control the build-up of the pressure in the main brake by using the "Brake pipe Air Supply Control" function.

YP3.6

Activity	Build up pressure up to operating pressure
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Yard Personnel activates "build up pressure in main brake pipe to operating pressure" at Stationary Device.

Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ none ▪ Remark: This activity is to be handled purely by the Stationary Device.

O3.7	
Activity	Build up pressure up to operating pressure
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Operator activates "build up pressure in main brake pipe to operating pressure" at Traction Unit.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ After reception of the command from the local HMI, the Base System of the TU shall be able to control the build-up of the pressure in the main brake by using the "Brake pipe Air Supply Control" function.

BE3.8	
Activity	Check if shunting composition is ready for following steps
Precondition	▪ -
Conditions	▪ FDFT Backend is available.
Tasks	▪ FDFT Backend checks if either Stationary Device or Traction Unit is connected to Wagon Set and main brake pipe is at operational pressure. FDFT Backend initiates following processes.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -

Functional system requirements	▪ The Base System of the Traction Unit shall be able to communicate with the FDFT Backend. ▪ The Base System of the Traction Unit shall detect the status, whether the TU is connected to the Wagon Set and provide it to the FDFT Backend. ▪ The Base System of the Traction Unit shall measure the pressure of the air in the main brake pipe and provide it to the FDFT Backend.

YM3.8

Activity	Detects that shunting composition is ready for following steps
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Yard Manager checks if either Stationary Device or Traction Unit is connected to Wagon Set and main brake pipe is at operational pressure. Yard Manager then initiates following processes.
Remarks	▪ The Yard Manager notifies FDFT Backend on the current status of shunting composition if FDFT Backend cannot automatically detect or determine this.
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ None ▪ Remark: Is to be handled by legacy systems and / or involvement of the FDFT Backend or Stationary Device.

BE3.9

Activity	Subprocess: Confirm wagon set
Precondition	▪ -
Conditions	▪ FDFT Backend is available, can communicate with FDFT Wagon Base System and can initiate confirm wagon set.
Tasks	▪ See subprocess description 8.4.11
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -

Functional system requirements	▪ See subprocess description 8.4.11

D5	
Decision	Which staff is on site?
Yard Personnel	▪ Yard Personnel is on site.
Operator	▪ Operator is on site.
Remarks	▪ -
Rationale	▪ -

YP3.9	
Activity	Subprocess: confirm wagon set
Precondition	▪ -
Conditions	▪ -
Tasks	▪ See subprocess description 8.4.11
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ See subprocess description 8.4.11

O3.9	
Activity	Subprocess: confirm wagon set
Precondition	▪ -
Conditions	▪ -
Tasks	▪ See subprocess description 8.4.11
Remarks	▪ -

Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ See subprocess description 8.4.11

BE3.10

Activity	Subprocess: Release planned braking means
Precondition	▪ -
Conditions	▪ FDFT Backend is available, can communicate with FDFT Wagon Base System and can initiate release planned braking means.
Tasks	▪ See subprocess description 8.4.16 ▪ Only as many brakes may be released so that the shunting composition is sufficiently (planned) secured.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	• See subprocess description 8.4.16

BE3.11	
Activity	Subprocess: Perform brake test
Precondition	▪ -
Conditions	▪ FDFT Backend is available, can communicate with FDFT Wagon Base System and can initiate the Automatic Brake Test.
Tasks	▪ See subprocess description 8.4.10
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	• See subprocess description 8.4.10

D6	
Decision	Which staff is on site?
Yard Personnel	▪ Yard Personnel is on site.
Operator	▪ Operator is on site.
Remarks	▪ -
Rationale	▪ -

O3.10	
Activity	Subprocess: remove planned braking means
Precondition	▪ -
Conditions	▪ -
Tasks	▪ See subprocess description 8.4.16
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	• See subprocess description 8.4.16

O3.11	
Activity	Subprocess: perform brake test
Precondition	▪ -
Conditions	▪ -
Tasks	▪ See subprocess description 8.4.10
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	• See subprocess description 8.4.10

YP3.11	
Activity	Subprocess: Perform brake test
Precondition	▪ -
Conditions	▪ -
Tasks	▪ See subprocess description 8.4.10
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	• See subprocess description 8.4.10

BE3.12	
Activity	Subprocess: perform technical wagon inspection
Precondition	▪ -
Conditions	▪ FDFT Backend is available, can communicate with FDFT Wagon Base System and can initiate the wagon technical inspection.
Tasks	▪ See subprocess description 8.4.12

Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	• See subprocess description 8.4.12

WI3.12

Activity	Subprocess: perform manual wagon inspection
Precondition	▪ -
Conditions	▪ -
Tasks	▪ See subprocess description 8.4.12
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	• See subprocess description 8.4.12

BE3.13

Activity	Initiate brake calculation
Precondition	▪ -
Conditions	▪ FDFT Backend is available, can communicate with FDFT Wagon Base System and can initiate the brake calculation.
Tasks	▪ Compile all information needed to calculate brake power. This may include getting data from other systems (not part of FDFT System Environment).
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -

Functional system requirements	• See subprocess description 8.4.12

BE3.14	
Activity	Brake calculation
Precondition	▪ -
Conditions	▪ FDFT Backend is available.
Tasks	▪ FDFT Backend uses compiled data on wagon(s) of set and load and calculates available brake power.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	• None • Remark: activity is performed in FDFT Backend

BE3.15	
Activity	Check technical wagon inspection and brake power
Precondition	▪ -
Conditions	▪ FDFT Backend is available.
Tasks	▪ FDFT Backend checks that available brake power is sufficient for planned track. ▪ FDFT Backend checks technical wagon inspection data. ▪ FDFT Backend checks restrictions due to national requirements. E.g. wagon clearance, exceptional consignments.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	• None • Remark: activity is performed in FDFT Backend

D7	
Decision	Which staff is on site?
Yard Personnel	▪ Yard Personnel is on site.
Operator	▪ Operator is on site.
Remark	▪ -
Rationale	▪ -

O3.14	
Activity	Brake calculation
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Legacy process for calculation of available brake power.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	• None • Remark: legacy process shall be used

O3.15

Activity	Check technical wagon inspection and brake power
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Operator checks that available brake power is sufficient for planned track. ▪ Operator checks technical wagon inspection data. ▪ Operator checks restrictions due to requirements. E.g. wagon clearance, exceptional consignments, …
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	• None • Remark: legacy process shall be used

YP3.14

Activity	Brake Calculation
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Legacy process for calculation of available brake power.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	• None • Remark: legacy process shall be used

YP3.15

Activity	Check technical wagon inspection and brake power
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Yard personnel checks that available brake power is sufficient for planned track. ▪ Yard personnel checks technical wagon inspection data. ▪ Yard personnel checks restrictions due to requirements. E.g. wagon clearance, exceptional consignments, …
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	• None • Remark: legacy process shall be used

YP3.16

Activity	Activate rear-end signal
Precondition	▪ -
Conditions	▪ -
Tasks	▪ If trailing wagon has automatic rear-end signal capabilities, activate rear-end signal on wagon. ▪ This can also be achieved by using the mobile HMI. ▪ If not, use legacy process.
Remarks	▪ If rear-end signal is not necessary according to changes in regulations, this step can be skipped.
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	• If wagon has automatic rear-end signal capabilities, the FDFT Wagon Base System shall support the activation of the rear-end signal by reception of the adequate command from the Mobile HMI.

D8

Decision	Brake test performed by traction unit or stationary device?

Stationary Device	▪ Brake test was performed by Stationary Device.
Traction Unit	▪ Brake test was performed by Traction Unit.
Remark	▪ -
Rationale	▪ -

SD3.20

Activity	Automatically disconnect stationary device
Precondition	▪ -
Conditions	▪ Stationary Device disconnects automatically.
Tasks	▪ Automatically disconnect Stationary Device.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	• None • Remark: This activity shall be performed by the Stationary Device.

YP3.20

Activity	Manually disconnect Stationary Device
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Manually disconnect stationary device. ▪ This can either be achieved by manual interaction with stationary device or automatically triggered by mobile HMI. In each case, manual work must be done to physically remove stationary device.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	• None • Remark: This activity shall be performed by the Stationary Device.

D9	
Decision	Traction unit change planned
yes	▪ Traction Unit change is planned.
no	▪ Traction Unit change is not planned.
Remarks	▪ -
Rationale	▪ -

BE3.17

Activity	Subprocess: uncouple Traction Unit
Precondition	▪ -
Conditions	▪ FDFT Backend is available, can communicate with FDFT Wagon Base System and can initiate uncoupling of Traction Unit.
Tasks	▪ See subprocess description 8.4.13
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ See subprocess description 8.4.13

O3.17

Activity	Subprocess: Uncouple Traction Unit
Precondition	▪ -
Conditions	▪ -
Tasks	▪ See subprocess description 8.4.13
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	• See subprocess description 8.4.13

BE3.18

Activity	Initiate movement of traction Unit
Precondition	▪ Automated Parking Brake released, Controllable Brake released, traction is allowed and possible.
Conditions	▪ FDFT Backend is available, can communicate with FDFT Wagon Base System and can initiate movement of Traction Unit.
Tasks	▪ increase traction force and gain speed up to shunting yard regulatory maximum.

Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ none ▪ Remark: The FDFT Backend initiates the movement of the Traction Unit by controlling the TU ATO system (legacy) through the landside ATO system (legacy).

O3.18

Activity	Initiate movement of traction Unit
Precondition	▪ Automated Parking Brake released, Controllable Brake released, traction is allowed and possible.
Conditions	▪ -
Tasks	▪ increase traction force and gain speed up to shunting yard regulatory maximum.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ none ▪ Remark: The Operator initiates the movement of the Traction Unit by controlling the TU ATO system (legacy) through the local HMI (legacy).

TU3.19

Activity	Movement of traction unit – leaves track
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Traction Unit leaves track.
Remarks	▪ Uncoupled Traction Unit moves away from the wagon (set) to an assigned destination.
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ none ▪ Remark: The TU moves away from the wagon (set) to an assigned destination. This is controlled through an external system (legacy) (e.g.: ATO / ASO).

TU3.21

Activity	Initiate movement of traction Unit
Precondition	▪ Automated Parking Brake released, Controllable Brake released, traction is allowed and possible.
Conditions	▪ FDFT Backend is available, can communicate with FDFT Wagon Base System and can initiate movement of Traction Unit.
Tasks	▪ increase traction force and gain speed up to shunting yard regulatory

	maximum.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ none ▪ Remark: The FDFT Backend initiates the movement of the Traction Unit by controlling the TU ATO system (legacy) through the landside ATO system (legacy).

O3.21

Activity	Initiate movement of traction Unit
Precondition	▪ Automated Parking Brake released, Controllable Brake released, traction is allowed and possible.
Conditions	▪ -
Tasks	▪ increase traction force and gain speed up to shunting yard regulatory maximum.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ none ▪ Remark: The Operator initiates the movement of the Traction Unit by controlling the TU ATO system (legacy) through the local HMI (legacy).

TU3.22

Activity	Movement of Traction Unit to wagon set
Precondition	▪ -
Conditions	▪
Tasks	▪ Traction Unit moves to track with wagon set.
Remarks	▪ Traction Unit is moved to Wagon Set.
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ none ▪ Remark: The FDFT Backend initiates the movement of the Traction Unit by controlling the TU ATO system (legacy) through the landside ATO system (legacy).

TU3.23

Activity	Subprocess: Couple traction unit
Precondition	▪ -
Conditions	▪ -
Tasks	▪ See subprocess description 8.4.14
Remarks	▪ -

Rationale	▪ -
Postcondition	▪ -
Functional system requirements	• See subprocess description 8.4.14

BE3.24	
Activity	Subprocess: Confirm wagon set
Precondition	▪ -
Conditions	▪ Backend is available, can communicate with FDFT Wagon Base System and can initiate confirm wagon set.
Tasks	▪ See subprocess description 8.4.11
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	• See subprocess description 8.4.11

D10	
Decision	Which staff is on site?
Yard Personnel	▪ Yard Personnel is on site.
Operator	▪ Operator is on site.
Remark	▪ -
Rationale	▪ -

O3.24	
Activity	Subprocess: Confirm wagon set
Precondition	▪ -
Conditions	▪ -
Tasks	▪ See subprocess description 8.4.11
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	• See subprocess description 8.4.11

YP3.24	
Activity	Confirm wagon set
Precondition	▪ -
Conditions	▪ -
Tasks	▪ See subprocess description 8.4.11
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	• See subprocess description 8.4.11

BE3.25	
Activity	Subprocess: Release planned braking means
Precondition	▪ -
Conditions	▪ Backend is available, can communicate with FDFT Wagon Base System and can initiate release braking means.
Tasks	▪ See subprocess description 8.4.16
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	• See subprocess description 8.4.16

D11	
Decision	Which staff is on site?
Yard Personnel	▪ Yard Personnel is on site.
Operator	▪ Operator is on site.
Remark	▪ -
Rationale	▪ -

O3.25

Activity	Subprocess: Remove planned braking means
Precondition	▪ -
Conditions	▪ -
Tasks	▪ See subprocess description 8.4.16
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	• See subprocess description 8.4.16

YP3.25

Activity	Subprocess: Remove planned braking means
Precondition	▪ -
Conditions	▪ -
Tasks	▪ See subprocess description 8.4.16
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	• See subprocess description 8.4.16

BE3.26

Activity	Subprocess: perform brake test
Precondition	▪ -
Conditions	▪ FDFT Backend is available, can communicate with FDFT Wagon Base System and can initiate brake test.
Tasks	▪ See subprocess description 8.4.10
Remarks	▪ -

Rationale	▪ -
Postcondition	▪ -
Functional system requirements	• See subprocess description 8.4.10

O3.26

Activity	Subprocess: Perform brake test
Precondition	▪ It is ensured that main brake pipe is continuous from first to last wagon.
Conditions	▪ -
Tasks	▪ Perform legacy brake test according to regulations.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	• None • Remark: Shall be handled by legacy system

D12

Decision	Which staff is on site?
Yard Personnel	▪ Yard Personnel is on site.
Operator	▪ Operator is on site.
Remark	▪ -
Rationale	▪ -

O3.27

Activity	If necessary, adjust brake lever position
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Operator adjusts brake lever position if necessary.
Remarks	▪ This step can be skipped if wagon is equipped with a brake system not needing manual lever changes.
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	• None • Remark: Shall be handled by legacy system

YP3.27

Activity	If necessary, adjust brake lever position
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Operator adjusts brake lever position if necessary.
Remarks	▪ This step can be skipped if wagon is equipped with a brake system not needing manual lever changes.
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	• None • Remark: Shall be handled by legacy system

BE3.28

Activity	Compile, check and send all necessary train data to Traction Unit and to Yard Legacy System and FDFT Yard
Precondition	▪ -
Conditions	▪ FDFT Backend is available.
Tasks	▪ FDFT Backend compiles all necessary train data in preparation of train run. ▪ FDFT Backend performs checks according to national regulations. ▪ FDFT Backend sends train data to traction unit. ▪ FDFT Backend sends train data to Yard Legacy System and FDFT Yard if available.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	• The Base System of the Traction Unit shall be able to receive, store and display train data on the local HMI.

O3.28

Activity	Compile, check and send all necessary train data to Yard Legacy System and FDFT Yard
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Operator compiles all necessary train data in preparation of train run. ▪ Operator performs checks according to national regulations. ▪ Operator enters data into traction unit. ▪ Operator sends train data to Yard Legacy System and FDFT Yard if available.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	• The Base System of the Traction Unit shall support entering of train data by the Operator using the local HMI. • The entered train data shall be stored in the Base System of the Traction Unit.

YL3.29

Activity	Check if train is ready for departure
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Yard Legacy receives train data and initiates legacy processes, e.g. set route.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	• None • Activity shall be supported by the Yard Legacy system.

BE3.30

Activity	Detect train is ready for departure
Precondition	▪ -
Conditions	▪ FDFT Backend is available and can automatically detect that train is ready for departure.
Tasks	▪ FDFT Backend automatically detects that train is ready for departure and triggers following processes, e.g. train is allowed to start train run by infrastructure.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	• None • Activity shall be supported by the FDFT Backend

O3.30

Activity	Detect train is ready for departure
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Operator detects that train is ready for departure and informs FDFT Backend, if available. This can be achieved by using the mobile HMI. E.g. train is allowed to start train run by infrastructure.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	• The Base System of the Traction Unit shall support entering of "train ready to depart" by the Operator using the local HMI. • The entered train data shall be stored in the Base System of the Traction Unit and sent to the FDFT Backend upon availability.

BE3.31

Activity	Subprocess: Switch to FDFT mode Train Run
Precondition	▪ -
Conditions	▪ FDFT Backend is available and can initiate switch to FDFT mode Train Run

Tasks	▪ See subprocess description 8.4.20
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	• See subprocess description 8.4.20

O3.31	
Activity	Subprocess: Switch to FDFT mode Train Run
Precondition	▪ -
Conditions	▪ -
Tasks	▪ See subprocess description 8.4.20
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	• See subprocess description 8.4.20

8.4.5 TP04 - Train Run

8.4.5.2 Target Process

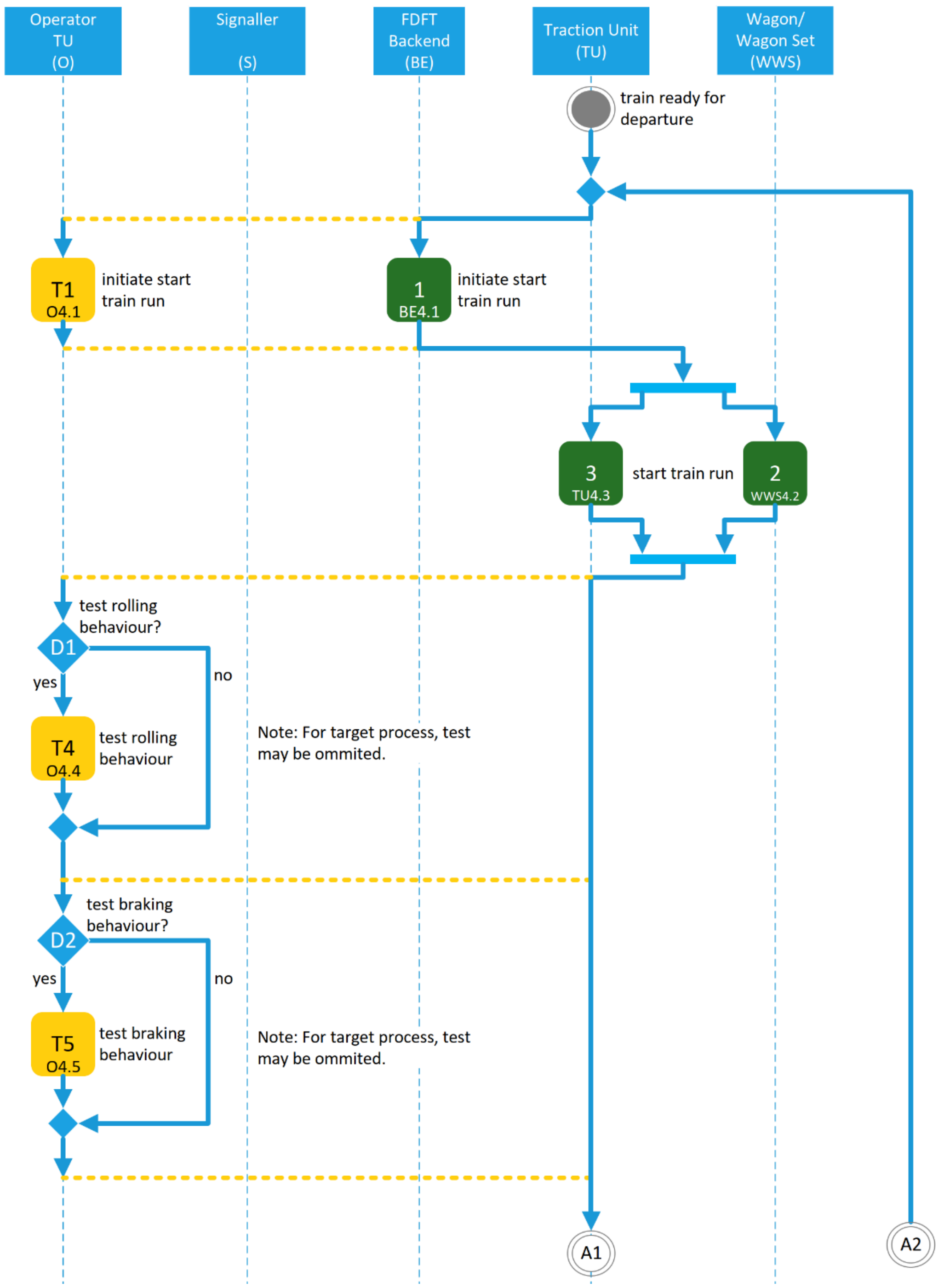


Figure 20: TP04 Train Run - 1 of 2

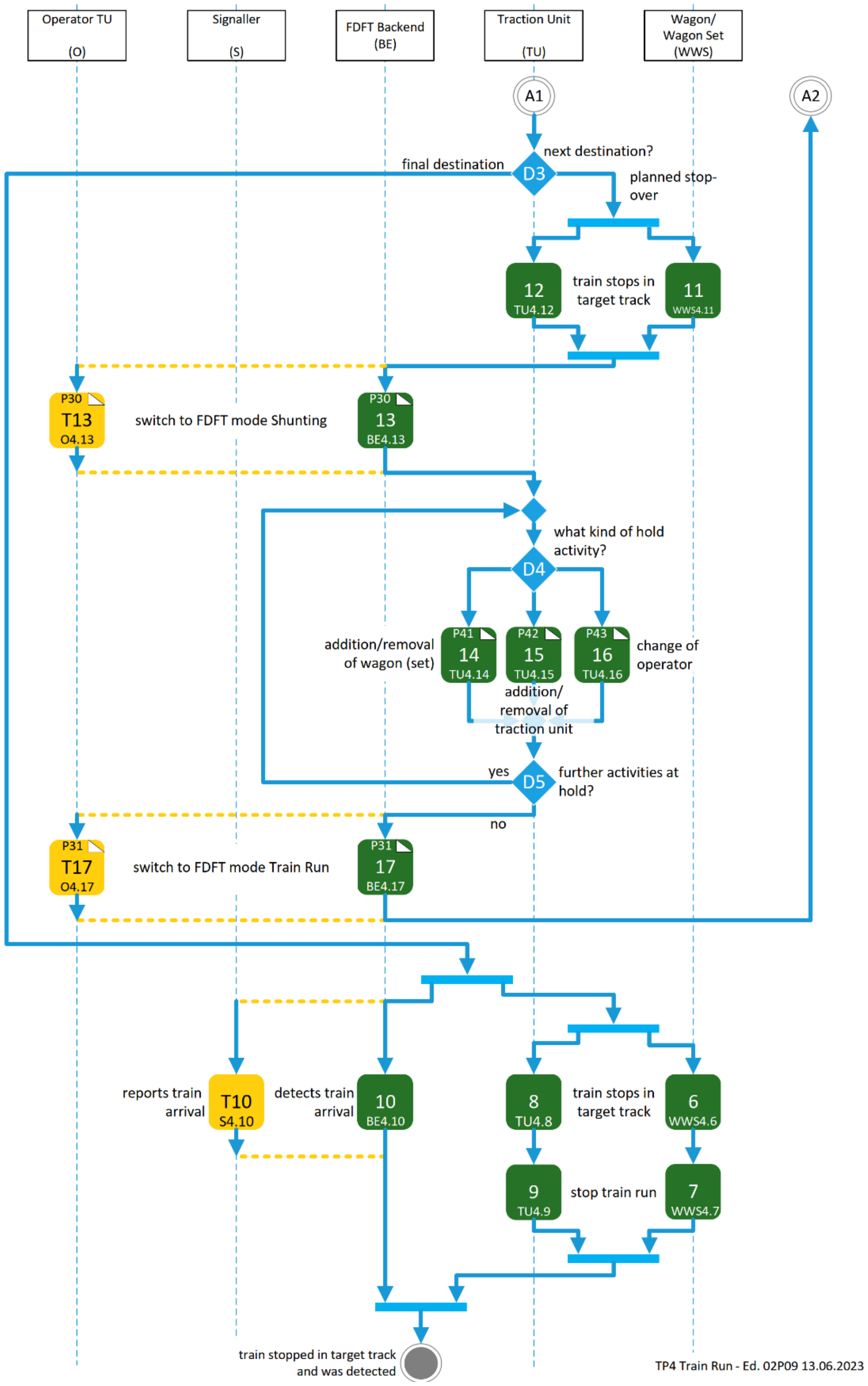


Figure 21: TP04 Train Run - 2 of 2

8.4.5.2 Process-Description

BE4.1

Activity	Initiate start train run
Precondition	▪ Train is ready to departure and operator reports readiness to departure
Conditions	▪ FDFT Backend is available and can initiate train run.
Tasks	▪ FDFT Backend triggers the operational start of train run (e.g. ensures that uniquely identifiable composition of Traction Unit and Wagon (set) is given) and initiates train movement.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	• Upon having received the operational start of train run from the FDFT Backend, the FDFT Base System of the Traction Unit stores the new operational mode "Train run". • The FDFT Traction Unit Base System shall send the new operational mode "Train run" to all wagons / consists in train. • The FDFT Traction Unit Base System shall send inform the ATO via the TU ATO interface about change in operational mode. • All Traction Units and wagons / consists in the train shall switch their operational mode into "Train run".

O4.1

Activity	Initiate start train run
Precondition	▪ Train is ready to departure and operator reports readiness to departure
Conditions	▪ -
Tasks	▪ Operator triggers the operational start of train run (e.g. ensures that uniquely identifiable composition of Traction Unit and Wagon (set) is given) and initiates train movement.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	• Upon having received the operational start of train run from the local HMI, the FDFT Base System of the Traction Unit stores the new operational mode "Train run". • The FDFT Traction Unit Base System shall send the new operational mode "Train run" to all wagons / consists in train. • The FDFT Traction Unit Base System shall send inform the ATO via the

	TU ATO interface about change in operational mode. • All Traction Units and wagons / consists in the train shall switch their operational mode into “Train run”.

WWS4.2	
Activity	Start train run
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Train starts moving.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	• None • Remark: Information only

TU4.3	
Activity	Start train run
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Train starts moving.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	• None • Remark: Information only

D1	
Decision	Test rolling behaviour?
Conditions	▪ Do regulations require testing of the rolling behaviour?
Yes	▪ Rolling behaviour should be tested.
No	▪ Rolling behaviour should not be tested.
Remarks	▪ -
Rationale	▪ -

O4.4	
Activity	Test rolling behaviour
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Operator tests rolling behaviour according to regulations and no unintentional braking means are applied.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	• None • Legacy process

D2	
Decision	Test braking behaviour?
Conditions	▪ Do regulations require testing of the braking behaviour?
Yes	▪ Braking behaviour should be tested.
No	▪ Braking behaviour should not be tested.
Remarks	▪ -
Rationale	▪ -

O4.5	
Activity	Test braking behaviour
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Operator tests braking behaviour according to regulations.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -

Functional system requirements	• None • Legacy process

D3	
Decision	Next destination?
Final Destination	▪ Next destination is the final stop of train run.
Planned Stop-Over	▪ Next destination is a planned stop-over of train run.
Remarks	▪ Unplanned stops (e.g. malfunctions) are not considered in this process.
Rationale	▪ -

WWS4.6	
Activity	Train stops in target track
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Train comes to a halt in target track.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	• None • Remark: Information only

WWS4.7	
Activity	Stop train run
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Train arrives in target track and the operational train run stops (e.g. resolves the uniquely identifiable number of the train, which means that the composition is a Shunting Composition).

Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	• Remark: Missing input from FDFT Backend or other FDFT System. • Assumption: FDFT Backend or other FDFT System informs the Base System of the Traction Unit about arrival at destination, via the FDFT Link • Upon reception of arrival information, the Base System of the TU shall set its operational to "Shunting mode". • Upon reception of arrival information, the Base System of the TU shall send the operational mode "Shunting mode" to all wagons / consists in train.

TU4.8

Activity	Train stops in target track
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Train comes to a halt in target track.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	• None • Remark: Information only

TU4.9

Activity	Stop train run
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Train arrives in target track and the operational train run stops (e.g. resolves the uniquely identifiable number of the train, which means that the composition is a Shunting Composition).
Remarks	▪ -

Rationale	▪ -
Postcondition	▪ -

Functional system requirements	• Remark: Missing input from FDFT Backend or other FDFT System. • Assumption: FDFT Backend or other FDFT System informs the Base System of the Traction Unit about arrival at destination, via the FDFT Link • Upon reception of arrival information, the Base System of the TU shall set its operational to “Shunting mode”. • Upon reception of arrival information, the Base System of the TU shall send the operational mode “Shunting mode” to all wagons / consists in train.

BE4.10

Activity	Detects train arrival
Precondition	▪ -
Conditions	▪ FDFT Backend is available and can automatically detect train arrival.
Tasks	▪ FDFT Backend detects train arrival.
Remarks	▪ This information can be used to trigger following processes.
Rationale	▪ -
Postcondition	▪ -

Functional system requirements	• Upon reception of arrival information from the FDFT Backend via the FDFT Link, the Base System of the TU shall set its operational to “Shunting mode”. • Upon reception of arrival information, the Base System of the TU shall send the operational mode “Shunting mode” to all wagons / consists in train.

S4.10

Activity	Reports train arrival
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Operator detects and reports train arrival.
Remarks	▪ This information can be used to trigger following processes.
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	• Upon reception of arrival information from the Signaller, the Operator shall enter the tarin arrival information into the FDFT TU Base System by using the local HMI. • Upon having gotten of arrival information, the Base System of the TU shall send the operational mode "Shunting mode" to all wagons / consists in train.

TU4.12

Activity	Train stops in target track
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Train comes to a halt in target track.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	• None • Remark: information only

WWS4.11

Activity	Train stops in target track
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Train comes to a halt in target track.

Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	• None • Remark: information only

BE4.13	
Activity	Subprocess: Switch to FDFT mode Shunting
Precondition	▪ -
Conditions	▪ FDFT Backend is available and can initiate switch to FDFT mode Shunting.
Tasks	▪ See subprocess description 8.4.19
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	• See subprocess description 8.4.19

O4.13	
Activity	Subprocess: Switch to FDFT mode Shunting
Precondition	▪ -
Conditions	▪ -
Tasks	▪ See subprocess description 8.4.19
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	• See subprocess description 8.4.19

D4	
Decision	What kind of hold activity?
Addition, removal of Wagon	▪ -
Addition, removal of Traction Unit	▪ -
Change Of Operator	▪ -
Remark	▪ -
Rationale	▪ -

TU4.14	
Activity	Subprocess: Addition, Removal of Wagon (Set)
Precondition	▪ -
Conditions	▪ -
Tasks	▪ See subprocess description 8.4.22
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	• See subprocess description 8.4.22

TU4.15	
Activity	Subprocess: Addition, Removal of Traction Unit
Precondition	▪ -
Conditions	▪ -
Tasks	▪ See subprocess description 8.4.22
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	• See subprocess description 8.4.22

TU4.16	
Activity	Subprocess: Change of Operator
Precondition	▪ -
Conditions	▪ -
Tasks	▪ See subprocess description 8.4.24
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	• See subprocess description 8.4.24

D5

Decision	Further activities at hold?
yes	▪ Further activities at hold are planned.
no	▪ All activities at hold are completed.
Remark	▪ -
Rationale	▪ -

BE4.17

Activity	Subprocess: Switch to FDFT mode train run
Precondition	▪ -
Conditions	▪ FDFT Backend is available and can initiate switch to FDFT mode Train Run.
Tasks	▪ See subprocess description 8.4.20
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	• See subprocess description 8.4.20

O4.17

Activity	Subprocess: Switch to FDFT mode train run
Precondition	▪ -
Conditions	▪ -
Tasks	▪ See subprocess description 8.4.20
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	• See subprocess description 8.4.20

8.4.6 TP05 - Hump Shunting

8.4.6.2 Target Process

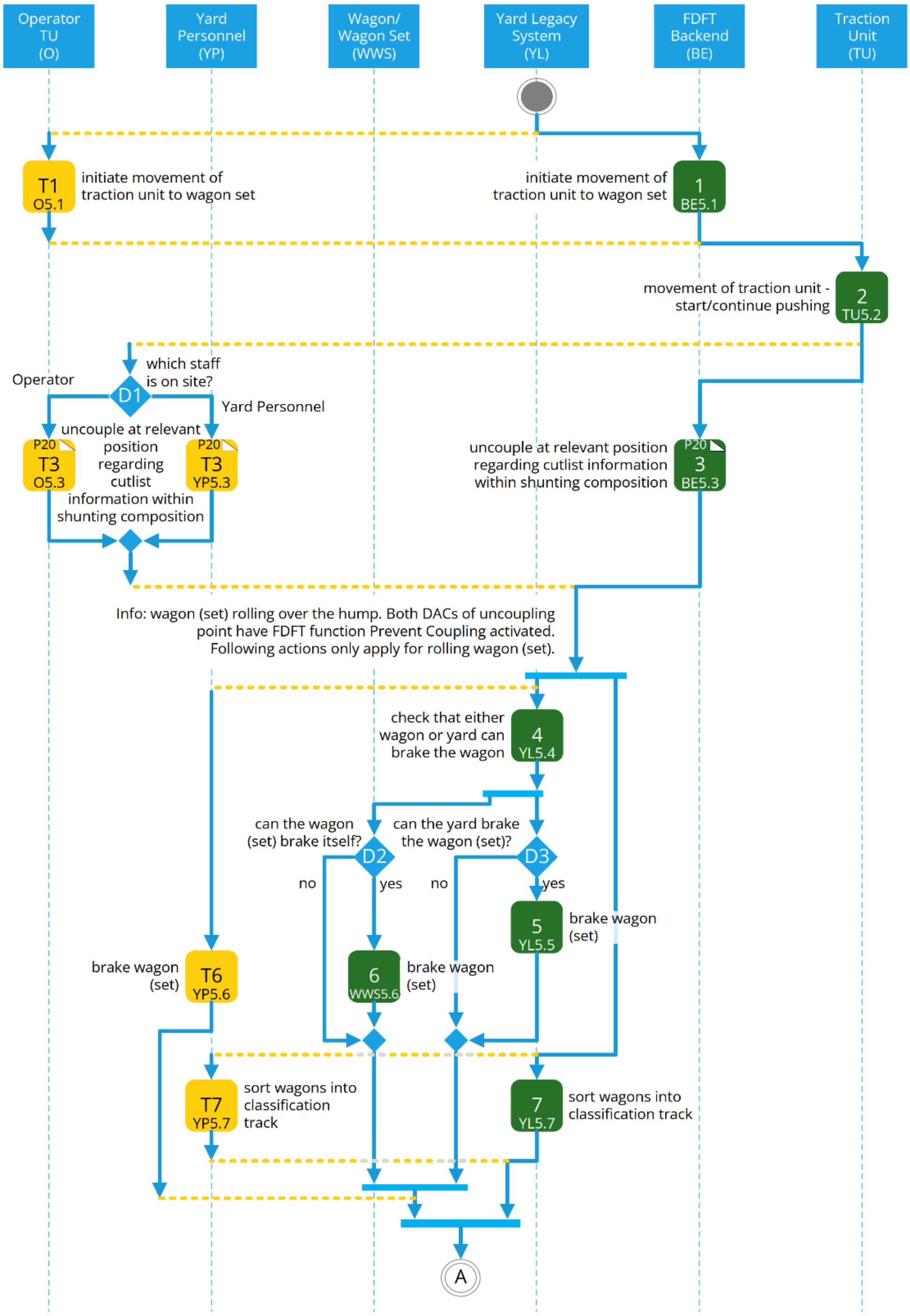


Figure 22: TP05 Hump Shunting - 1 of 2

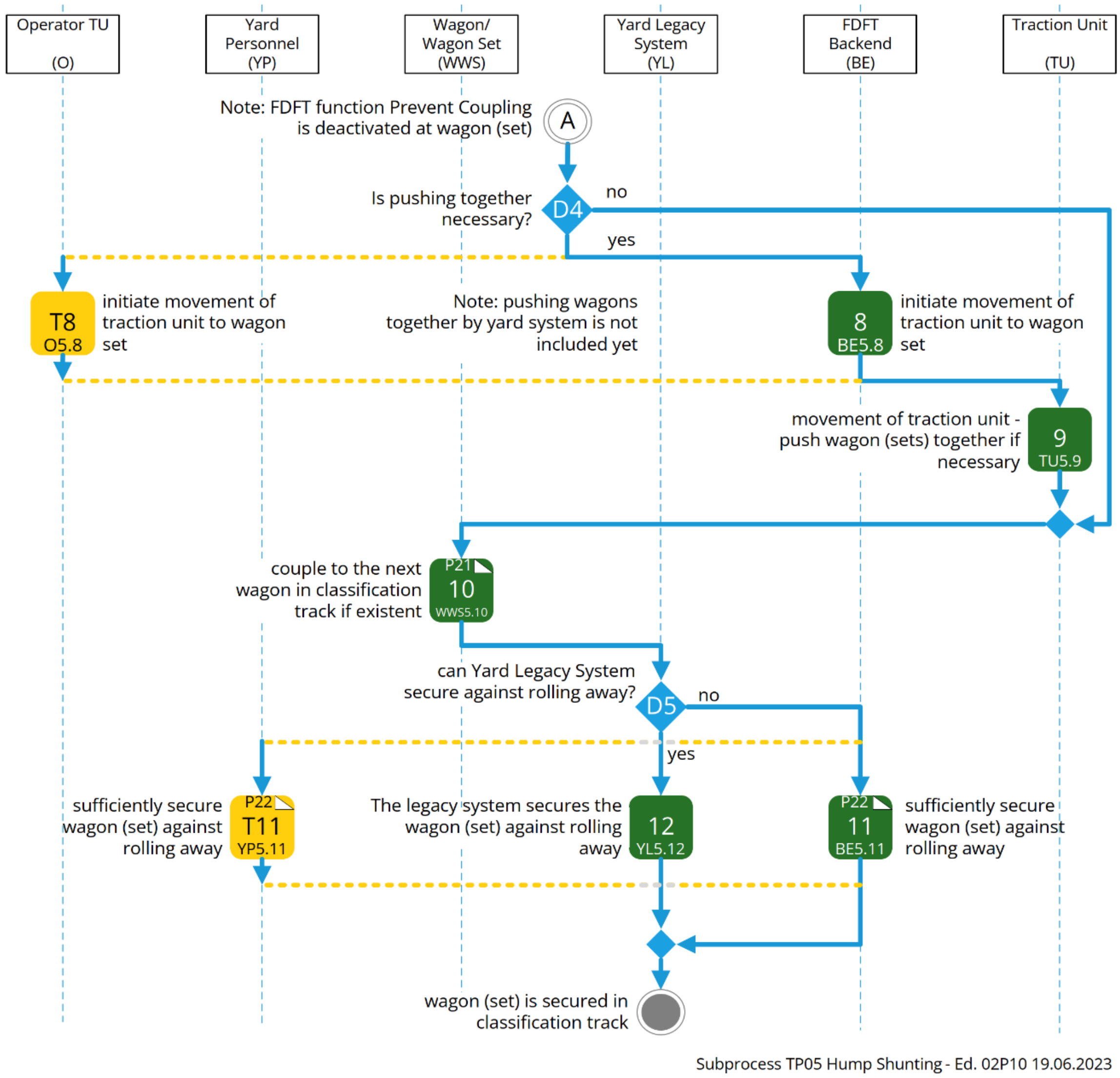


Figure 23: TP05 Hump Shunting - 2 of 2

8.4.6.2 Process-Description

BE5.1	
Activity	Initiate movement of traction unit to wagon set
Precondition	▪ Automated Parking Brake released, Controllable Brake released, traction is allowed and possible.
Conditions	▪ FDFT Backend is available and can initiate movement of wagon set.
Tasks	▪ increase traction force and gain speed up to shunting yard regulatory maximum.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ none ▪ Remark: The FDFT Backend initiates the movement of the Traction Unit by controlling the TU ATO system (legacy) through the landside ATO system (legacy).

O5.1	
Activity	Initiate movement of traction unit to wagon set
Precondition	▪ Automated Parking Brake released, Controllable Brake released, traction is allowed and possible.
Conditions	▪ -
Tasks	▪ increase traction force and gain speed up to shunting yard regulatory maximum.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ none ▪ Remark: The Operator initiates the movement of the Traction Unit by controlling the TU ATO system (legacy) through the local HMI (legacy).

TU5.2	
Activity	Start/continue pushing
Precondition	▪ -
Conditions	▪ -

Tasks	▪ Traction Unit pushes the wagon set up over the hump according to local regulations. ▪ Traction Unit is controlled by FDFT Backend or Yard Legacy System.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ none ▪ Remark: The FDFT Backend controls the movement of the Traction Unit to push the wagon set over the hump by controlling the TU ATO system (legacy) through the landside ATO system (legacy).

BE5.3	
Activity	Subprocess: Uncouple at relevant position regarding cutlist information within shunting composition
Precondition	▪ -
Conditions	▪ FDFT Backend is available, can communicate with the FDFT Wagen Base System and can initiate uncoupling.
Tasks	▪ See subprocess Uncouple 8.4.13
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ See subprocess Uncouple 8.4.13

D1	
Decision	Which staff is on site?
Operator	▪ Operator is on site.
Yard Personnel	▪ Yard Personnel is on site.
Remarks	▪ -
Rationale	▪ -

YP5.3	
Activity	Subprocess: Uncouple at relevant position regarding cutlist information within shunting composition
Precondition	▪ -
Conditions	▪ -
Tasks	▪ See subprocess Uncouple 8.4.13
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ See subprocess Uncouple 8.4.13

O5.3	
Activity	Subprocess: Uncouple at relevant position regarding cutlist information within shunting composition
Precondition	▪ -
Conditions	▪ -
Tasks	▪ See subprocess Uncouple 8.4.13
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ See subprocess Uncouple 8.4.13

YL5.4	
Activity	Check that either wagon or yard can brake the wagon
Precondition	▪ -
Conditions	▪ The wagon has a Controllable Brake or/and the Yard has a brake system, which brakes the wagon (set).

Tasks	▪ Check, if the wagon itself or/and the Yard brake system can brake the wagon (set) after the hump.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ None ▪ Remark: the check has to be performed by the yard legacy system. For the wagon (set) to be braked it has to be equipped with a legacy hand brake.

D2

Decision	Can the wagon (set) brake itself?
yes	▪ The wagon has a Controllable Brake, which brakes the wagon (set).
no	▪ -
Remarks	▪ -
Rationale	▪ -

D3

Decision	Can the Yard brake the wagon (set)?
yes	▪ The Yard has a brake system, which brakes the wagon (set).
no	▪ -
Remarks	▪ -
Rationale	▪ -

YL5.5

Activity	Brake the wagon (set)
Precondition	▪ -
Conditions	▪ -
Tasks	▪ The infrastructure-side system brakes the wagon (set) so that it either comes to a standstill at a certain point in the track or hits the front wagon at a certain speed.
Remarks	▪ -

Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ None ▪ Remark: Activity is performed by a legacy infrastructure-based system.

WWS5.6

Activity	Brake the wagon (set)
Precondition	▪ -
Conditions	▪ -
Tasks	▪ The Controllable Brake brakes the wagon (set) so that it either comes to a standstill at a certain point in the track or hits the front wagon at a certain speed.
Remarks	▪ The brake is controlled via the FDFT Link by the FDFT Backend or Personnel.
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ None ▪ Remark: Activity is performed by a legacy -based system.

YP5.6

Activity	Brake the wagon (set)
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Yard Personnel brakes the wagon (set) according to legacy processes.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ None ▪ Remark: Activity is performed by a legacy infrastructure-based system.

YL5.7

Activity	Sort wagon(s) into classification track
Precondition	▪ -
Conditions	▪ There is a system available that can control the switch stand.
Tasks	▪ The Yard Legacy System ensures that the switches are set so that the wagon(s) run into the planned track.
Remarks	▪ -

Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ None ▪ Remark: Activity is performed by a legacy infrastructure-based system.

YP5.7	
Activity	Sort wagon(s) into classification track
Precondition	▪ -
Conditions	▪ -
Tasks	▪ The Yard Personnel ensures that the switches are set so that the wagon(s) run into the planned track.
Remarks	▪ -
Rationale	▪ -
Postcondition	
Functional system requirements	▪ None ▪ Remark: Activity is performed by yard personnel with legacy infrastructure system.

D4	
Decision	Is pushing together necessary
yes	▪ It is necessary
Remarks	▪ -
Rationale	▪ -

BE5.8	
Activity	Initiate movement of traction unit to wagon set
Precondition	▪ Automated Parking Brake released, Controllable Brake released, traction is allowed and possible.
Conditions	▪ FDFT Backend is available and can initiate movement of Traction Unit.
Tasks	▪ increase traction force and gain speed up to shunting yard regulatory maximum.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ none ▪ Remark: The FDFT Backend initiates the movement of the Traction Unit by controlling the TU ATO system (legacy) through the landside ATO system (legacy).

O5.8

Activity	Initiate movement of traction unit to wagon set
Precondition	▪ Automated Parking Brake released, Controllable Brake released, traction is allowed and possible.
Conditions	▪ -
Tasks	▪ increase traction force and gain speed up to shunting yard regulatory maximum.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ none ▪ Remark: The Operator initiates the movement of the Traction Unit by controlling the TU ATO system (legacy) through the local HMI (legacy).

TU5.9

Activity	Push wagon (sets) together if necessary
Precondition	▪ -
Conditions	▪ -
Tasks	▪ If necessary, a traction unit push the wagon set together so that wagon (set) can couple.
Remarks	▪ Performed only when a planned coupling between wagon(s) has not occurred.
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ none ▪ Remark: The FDFT Backend initiates the movement of the Traction Unit by controlling the TU ATO system (legacy) through the landside ATO system (legacy).

WWS5.10

Activity	Subprocess: Couple to the next wagon in classification track if existent
Precondition	▪ -
Conditions	▪ -
Tasks	▪ See subprocess Couple 8.4.14 ▪ Couple to the next wagon in classification group if existent.

Remarks	▪ Multiple coupling processes can be checked in total at a later step. ▪ This step is not necessary if this is the first wagon for the new wagon set to be formed.
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ See subprocess Couple 8.4.14

D5	
Decision	Can Yard Legacy System secure against rolling away?
Yes	▪ Yard Legacy System can secure the wagon (set) against rolling away?
Remarks	▪ -
Rationale	▪ -

BE5.11	
Activity	Subprocess: sufficiently secure Wagon (Set) against rolling away
Precondition	▪ -
Conditions	▪ FDFT Backend is available and can initiate secure wagon (set) against rolling away.
Tasks	▪ See Subprocess 8.4.15 ▪ Sufficiently secure wagon against rolling away.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ See Subprocess 8.4.15

YP5.11	
Activity	Subprocess: sufficiently secure Wagon (Set) against rolling away
Precondition	▪ -
Conditions	▪ -
Tasks	▪ See Subprocess 8.4.15

	▪ Sufficiently secure wagon against rolling away.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ See Subprocess 8.4.15

YL5.12

Activity	Sufficiently secure Wagon (Set) against rolling away
Precondition	▪ -
Conditions	▪ -
Tasks	▪ The infrastructure has a system that secures the wagon(s) from rolling away. ▪ Yard legacy system initiates securing the wagon (set) against rolling away. ▪ The infrastructure sided system secures the wagon (set) against rolling away and checks, if the wagon (set) is secured. ▪ If available the Yard legacy system sends the securing data to FDFT Backend.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ None ▪ Remark: there are system requirements not affecting the FDFT itself which are not taken into consideration here.

8.4.7 TP06 – Fly Shunting

8.4.7.2 Target Process

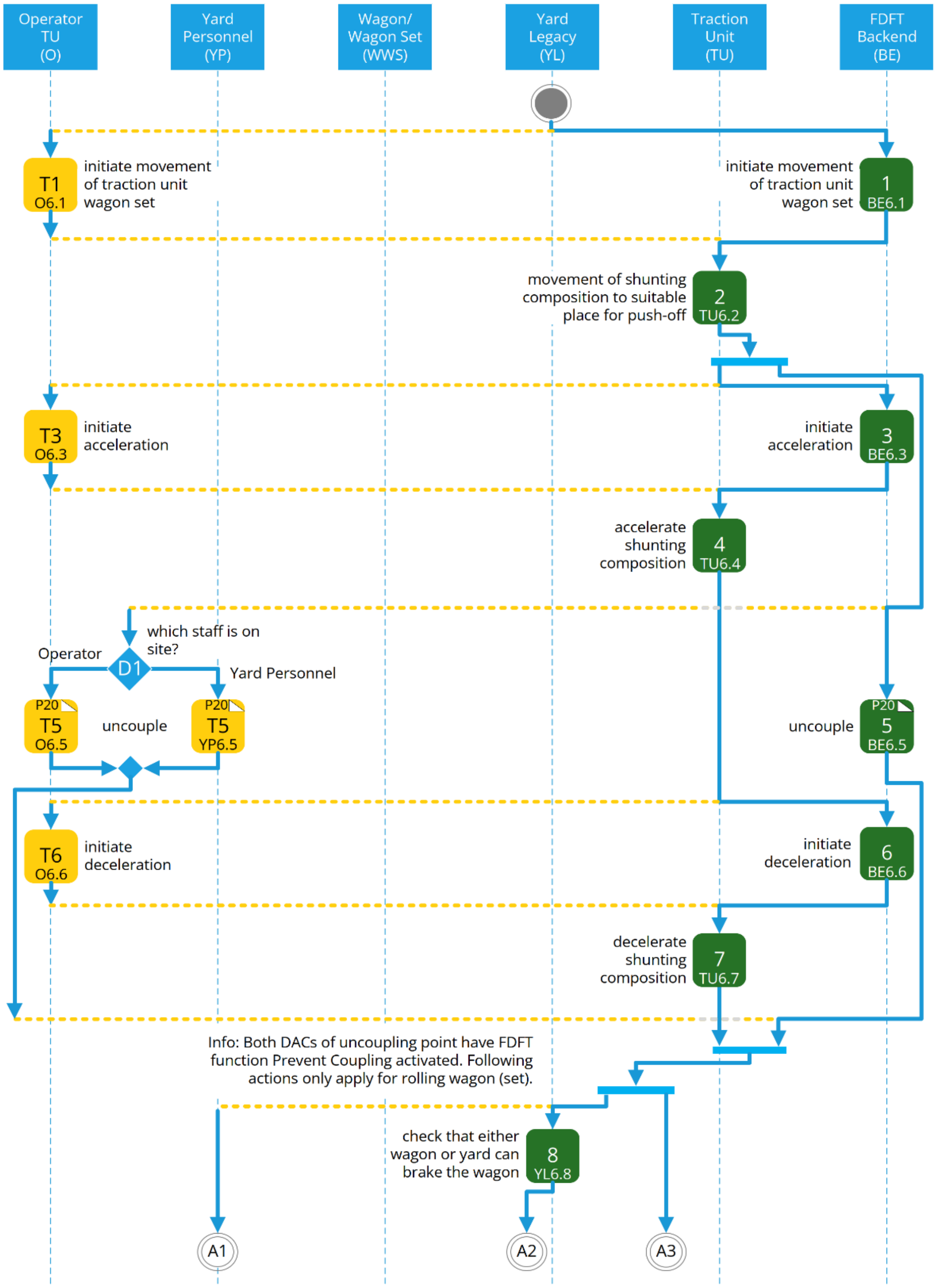


Figure 24: TP06 Fly Shunting - 1 of 2

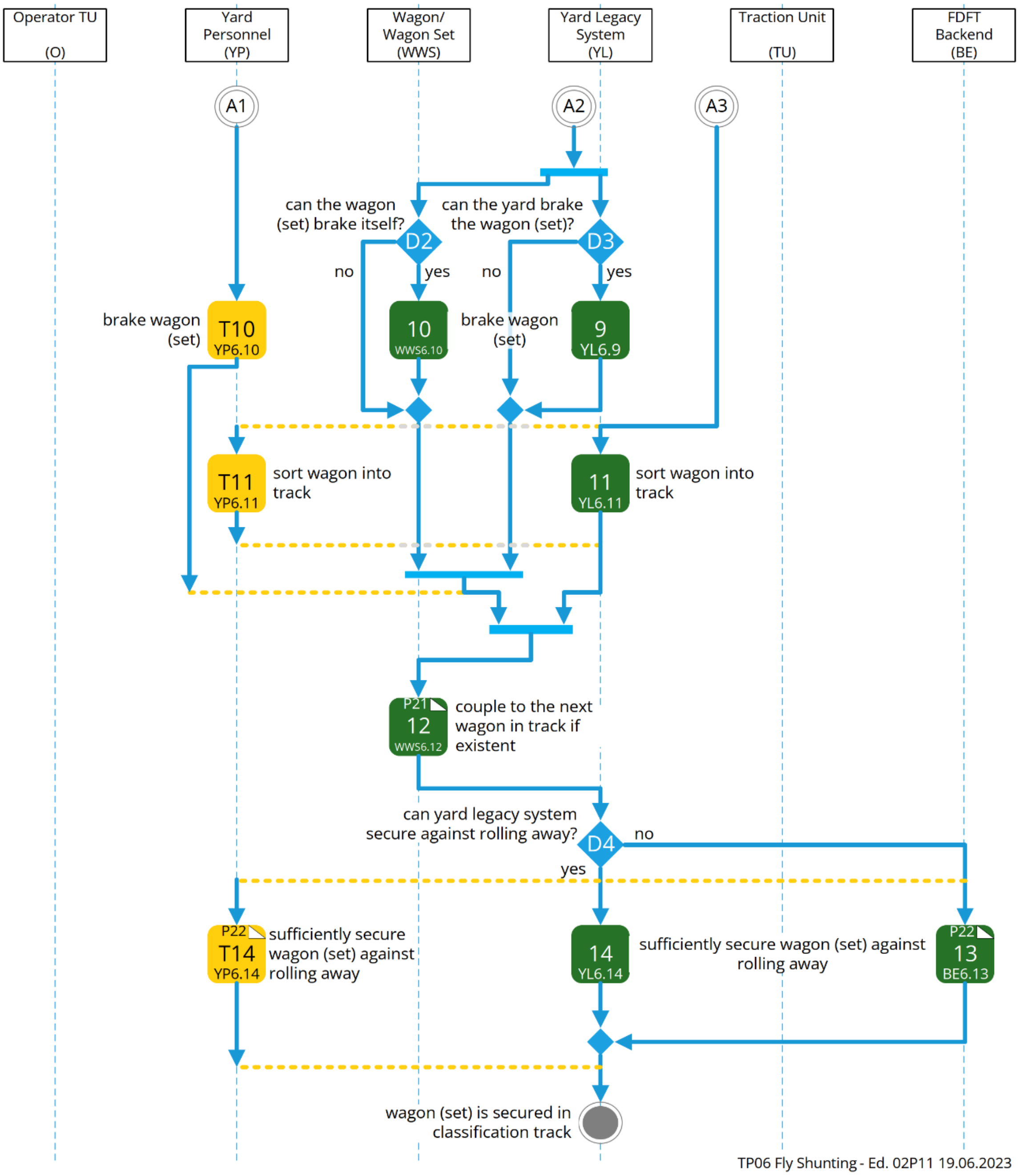


Figure 25: TP06 Fly Shunting - 2 of 2

8.4.7.2 Process-Description

BE6.1	
Activity	Initiate movement of traction unit to wagon set
Precondition	▪ Automated Parking Brake released, Controllable Brake released, traction is allowed and possible.
Conditions	▪ FDFT Backend is available and can initiate movement of Traction Unit.
Tasks	▪ increase traction force and gain speed up to shunting yard regulatory maximum.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ none ▪ Remark: The FDFT Backend initiates the movement of the Traction Unit by controlling the TU ATO system (legacy) through the landside ATO system (legacy).

O6.1	
Activity	Initiate movement of traction unit to wagon set
Precondition	▪ Automated Parking Brake released, Controllable Brake released, traction is allowed and possible.
Conditions	▪ -
Tasks	▪ increase traction force and gain speed up to shunting yard regulatory maximum.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ none ▪ Remark: The Operator initiates the movement of the Traction Unit by controlling the TU through the local HMI (legacy).

TU6.2	
Activity	Move shunting composition to suitable place for push-off

Precondition	▪ -
Conditions	▪ -
Tasks	▪ Movement of Traction Unit to suitable place for push off.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ none ▪ Remark: The Traction Unit moves to a suitable place, being controlled by the TU ATO system (legacy) through the landside ATO system (legacy).

BE6.3	
Activity	Initiate acceleration
Precondition	▪ Automated Parking Brake released, Controllable Brake released, traction is allowed and possible.
Conditions	▪ FDFT Backend is available and can initiate acceleration.
Tasks	▪ Increase traction force and gain speed up to shunting yard regulatory maximum.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ none ▪ Remark: The FDFT Backend initiates the movement of the Traction Unit by controlling the TU ATO system (legacy) through the landside ATO system (legacy).

O6.3	
Activity	Initiate acceleration
Precondition	▪ Automated Parking Brake released, Controllable Brake released, traction is allowed and possible.
Conditions	▪ -
Tasks	▪ Increase traction force and gain speed up to shunting yard regulatory maximum.
Remarks	▪ -
Rationale	▪ -

Postcondition	▪ -
Functional system requirements	▪ none ▪ Remark: The Operator initiates the movement of the Traction Unit by controlling the TU ATO system (legacy) through the local HMI (legacy).

TU6.4	
Activity	Accelerate shunting composition
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Shunting composition accelerates to fly shunting speed.
Remarks	▪ The fly shunting speed depends on the characteristics of the wagon set, the infrastructure, and the point at which the wagon(s) are to stop in the track.
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ none ▪ Remark: The FDFT Backend initiates the movement of the Traction Unit by controlling the TU ATO system (legacy) through the landside ATO system (legacy).

BE6.5	
Activity	Subprocess: Uncouple
Precondition	▪ -
Conditions	▪ FDFT Backend is available and can initiate uncouple.
Tasks	▪ See subprocess uncouple 8.4.13 ▪ Uncouple at uncoupling point.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ See subprocess uncouple 8.4.13 ▪ Uncouple at uncoupling point.

BE6.6	
Activity	Initiate deceleration
Precondition	▪ -
Conditions	▪ FDFT Backend is available and can initiate deceleration.
Tasks	▪ Apply braking force to Shunting composition.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ none ▪ Remark: The FDFT Backend initiates the deceleration of the Traction Unit by controlling the TU ATO system (legacy) through the landside ATO system (legacy).

O6.6	
Activity	Initiate deceleration
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Apply braking force to Shunting composition.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ none ▪ Remark: The Operator initiates the deceleration of the Traction Unit by controlling the TU ATO system (legacy) through local HMI (legacy).

TU6.7	
Activity	Decelerate shunting composition
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Shunting composition decelerates as planned.
Remarks	▪ If there are no wagon(s) left, it could be that only the Traction Unit decelerates.
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ None ▪ The shunting composition shall decelerate as planned.

D1	
Decision	Which staff is on site?
Operator	▪ Operator is on site.
Yard Personnel	▪ Yard Personnel is on site.
Remarks	▪ -
Rationale	▪ -

O6.5	
Activity	Subprocess: Uncouple
Precondition	▪ -
Conditions	▪ -
Tasks	▪ See subprocess uncouple 8.4.13 ▪ Uncouple at uncoupling point
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -

Functional system requirements	▪ See subprocess uncouple 8.4.13 ▪ Uncouple at uncoupling point

YP6.5	
Activity	Subprocess: Uncouple
Precondition	▪ -
Conditions	▪ -
Tasks	▪ See subprocess uncouple 8.4.13 ▪ Uncouple at uncoupling point.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ See subprocess uncouple 8.4.13 ▪ Uncouple at uncoupling point

YL6.8	
Activity	Check that either wagon or yard can brake the wagon
Precondition	▪ -
Conditions	▪ The wagon has a Controllable Brake or/and the Yard has a brake system, which brakes the wagon (set).
Tasks	▪ Check, if the wagon itself or/and the Yard brake system can brake the wagon (set).
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ None ▪ Remark: the check has to be performed by the yard legacy system. For the wagon (set) to be braked it has to be equipped with a legacy hand brake.

D2	
Decision	Can the wagon (set) brake itself?
yes	▪ The wagon has a Controllable Brake, which brakes the wagon (set).

no	▪ -
Remarks	▪ -
Rationale	▪ -

WWS6.10	
Activity	Brake wagon (set)
Precondition	▪ -
Conditions	▪ -
Tasks	▪ The Controllable Brake brakes the wagon (set) so that it either comes to a standstill at a certain point in the track or hits the front wagon at a certain speed.
Remarks	▪ The brake is controlled via the FDFT Link by the FDFT Backend or Personnel.
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ None ▪ Remark: the wagon (set) has to be equipped with a legacy hand brake which can be operated by the personnel. ▪ Question: no involvement of the FDFT backend is shown in the swim lane diagram. Is this really the case?

D3	
Decision	Can the Yard brake the wagon (set)?
yes	▪ The Yard has a brake system, which brakes the wagon (set).
no	▪ -
Remarks	▪ -
Rationale	▪ -

YL6.9	
Activity	Brake wagon (set)
Precondition	▪ -
Conditions	▪ -
Tasks	▪ The infrastructure-side system brakes the wagon (set) so that it either comes to a standstill at a certain point in the track or hits the front wagon at a certain speed.

Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ None ▪ Remark: Activity is performed by infrastructure side system (legacy)

YP6.10	
Activity	Brake wagon (set)
Precondition	-
Conditions	-
Tasks	Yard Personnel brakes the wagon (set) according to legacy processes.
Remarks	-
Rationale	-
Postcondition	-
Functional system requirements	None

YL6.11	
Activity	Sort wagon(s) into track
Precondition	▪ -
Conditions	▪ There is a system available that can control the switch stand.
Tasks	▪ The Yard Legacy System ensures that the switches are set so that the wagon(s) run off into the planned track.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ None ▪ Remark: there are system requirements not affecting the FDFT itself which are not taken into consideration here.

YP6.11	
Activity	Sort wagon(s) into track
Precondition	▪ -
Conditions	▪ -

Tasks	▪ The Yard Personnel ensures that the switches are set so that the wagon run into the planned track.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ none ▪ Remark: Activity is performed by the infrastructure side based system (legacy).

WWS6.12

Activity	Subprocess: Couple to the next wagon in track if existent
Precondition	▪ -
Conditions	▪ -
Tasks	▪ See subprocess Couple 8.4.14 ▪ Couple to the next wagon in track if existent. ▪ Multiple coupling processes can be checked in total at a later step.
Remarks	▪ This step is not necessary if this is the first wagon for the new wagon set to be formed.
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ See subprocess Couple 8.4.14

D4

Decision	Can Yard Legacy System secure against rolling away?
Yes	▪ -
Remarks	▪ If Yard Legacy System
Rationale	▪ -

BE6.13

Activity	Subprocess: sufficiently secure Wagon (Set) against rolling away
Precondition	▪ -
Conditions	▪ FDFT Backend is available and can initiate secure wagon (set) against rolling away.
Tasks	▪ See Subprocess Secure wagon set against rolling away 8.4.15 ▪ Sufficiently secure wagon against rolling away.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ See Subprocess description 8.4.15 ▪ Sufficiently secure wagon against rolling away.

YL6.14

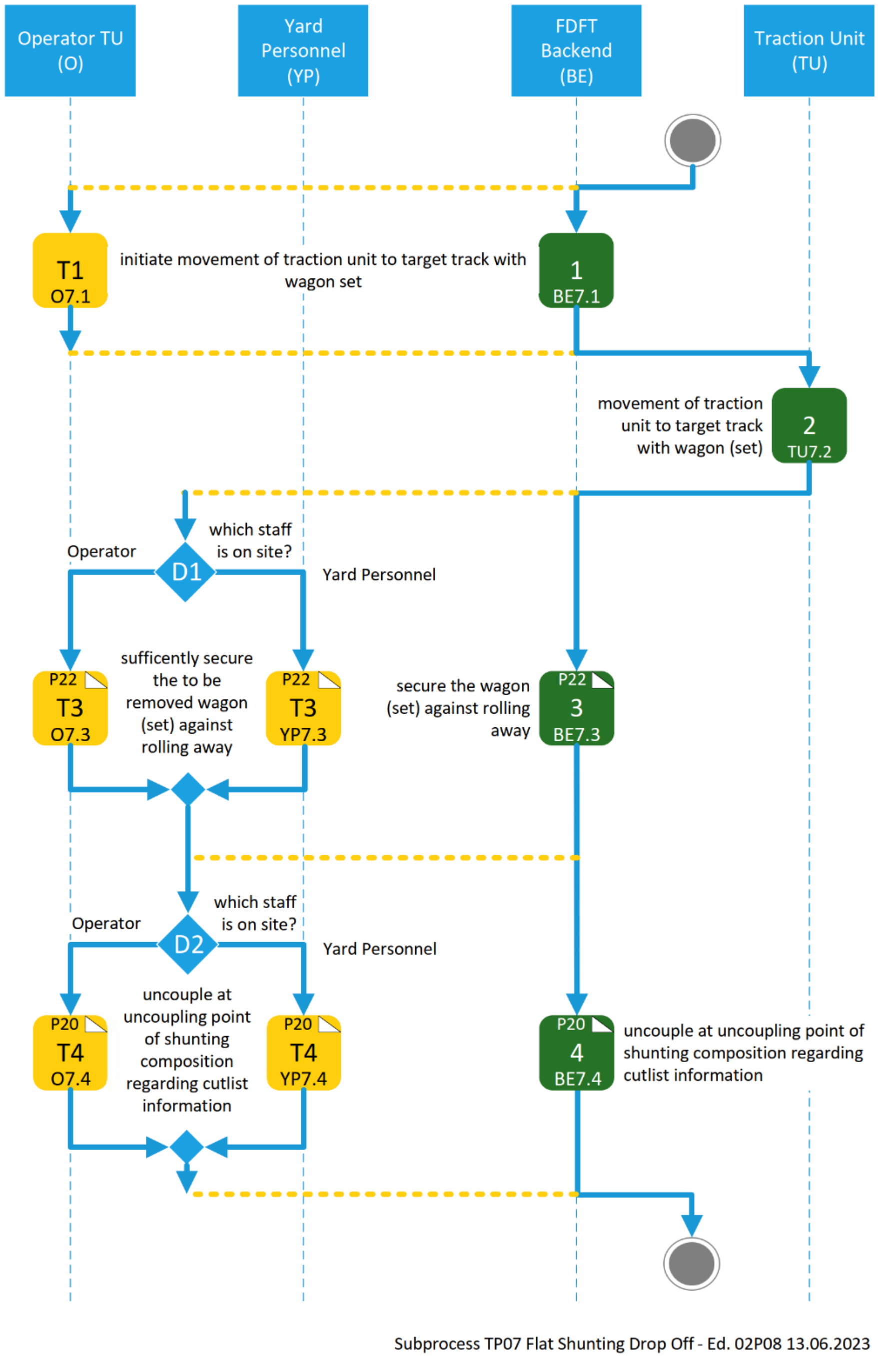
Activity	Sufficiently secure Wagon (Set) against rolling away
Precondition	▪ -
Conditions	▪ -
Tasks	▪ The infrastructure has a system that secures the wagon(s) from rolling away. ▪ Yard legacy system initiates securing the wagon (set) against rolling away. ▪ The infrastructure sided system secures the wagon (set) against rolling away and checks, if the wagon (set) is secured. ▪ If available, the Yard legacy system sends the securing data to FDFT Backend.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ None ▪ Remark: there are system requirements not affecting the FDFT itself which are not taken into consideration here.

YP6.14

Activity	Subprocess: sufficiently secure Wagon (Set) against rolling away
Precondition	▪ -
Conditions	▪ -
Tasks	▪ See Subprocess Secure wagon set against rolling away 8.4.15 ▪ Sufficiently secure wagon against rolling away.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ See Subprocess description 8.4.15 ▪ Sufficiently secure wagon against rolling away.

8.4.8 TP07 - Flat Shunting Drop Off

8.4.8.2 Target Process



Subprocess TP07 Flat Shunting Drop Off - Ed. 02P08 13.06.2023

Figure 26: TP07 Flat Shunting Drop Off - 1-1

8.4.8.2 Process-Description

BE7.1	
Activity	Initiate movement of traction unit to target track with wagon set
Precondition	▪ Automated Parking Brake released, Controllable Brake released, traction is allowed and possible.
Conditions	▪ FDFT Backend available and can initiate movement of Traction Unit.
Tasks	▪ increase traction force and gain speed up to shunting yard regulatory maximum.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ Upon reception of the command from the FDFT backend, the FDFT base system of the traction unit (TU) shall issue a command to the TU ATO system to increase traction force and gain speed up to shunting yard regulatory maximum.

O7.1	
Activity	Initiate movement of traction unit to target track with wagon set
Precondition	▪ Automated Parking Brake released, Controllable Brake released, traction is allowed and possible.
Conditions	▪ -
Tasks	▪ increase traction force and gain speed up to shunting yard regulatory maximum.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ Upon reception of the command from the loco driver, the traction unit (TU) shall increase traction force and gain speed up to shunting yard regulatory maximum.

TU7.2

Activity	Movement to target track with wagon (set)
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Traction Unit moves to target track.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ The TU shall move shunting composition to target track.
Functional system requirements	▪ none ▪ information only

BE7.3

Activity	Subprocess: Secure the wagon (set) against rolling away
Precondition	▪ -
Conditions	▪ FDFT Backend is available. Controllable brake is available and can initiate securing the wagon. FDFT backend is available and can communicate with the FDFT Wagon Base system.
Tasks	▪ See Subprocess Secure wagon set against rolling away 8.4.15 ▪ The wagon set to be removed has to be secured.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ See Subprocess Secure wagon set against rolling away 8.4.15

BE7.4

Activity	Subprocess: Uncouple at uncoupling point of shunting composition regarding cutlist information

Precondition	▪ -
Conditions	▪ FDFT Backend is available, can communicate with FDFT Wagon Base System and can initiate uncoupling.
Tasks	▪ See subprocess description 8.4.13 ▪ Uncouple at uncoupling point of shunting composition.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ See subprocess description 8.4.13

D1	
Decision	Which staff is on site?
Operator	▪ Operator is on site.
Yard Personnel	▪ Yard Personnel is on site.
Remarks	▪ -
Rationale	▪ -

O7.3	
Activity	Subprocess: sufficiently secure the to be removed wagon (set) against rolling away
Precondition	▪ -
Conditions	▪ -
Tasks	▪ See subprocess description 8.4.15 ▪ Secure the wagon (set) to be removed against rolling away.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ See subprocess description 8.4.15 Secure the wagon (set) to be removed against rolling away

YP7.3	
Activity	Subprocess: sufficiently secure the to be removed wagon (set) against rolling away
Precondition	▪ -
Conditions	▪ -
Tasks	▪ See subprocess description 8.4.15 ▪ Secure the wagon (set) to be removed against rolling away.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ See subprocess description 8.4.15 Secure the wagon (set) to be removed against rolling away

D2	
Decision	Which staff is on site?
Operator	▪ Operator is on site.
Yard Personnel	▪ Yard Personnel is on site.
Remarks	▪ -
Rationale	▪ -

O7.4	
Activity	Subprocess: Uncouple at uncoupling point of shunting composition regarding cutlist information
Precondition	▪ -
Conditions	▪ -
Tasks	▪ See subprocess description 8.4.13 ▪ Uncouple at uncoupling point of shunting composition.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ See subprocess description 8.4.13 Uncouple at uncoupling point of shunting composition.

YP7.4

Activity	Subprocess: Uncouple at uncoupling point of shunting composition regarding cutlist information
Precondition	▪ -
Conditions	▪ -
Tasks	▪ See subprocess description 8.4.13 ▪ uncouple at uncoupling point of shunting composition.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -

Functional system requirements,	▪ See subprocess description 8.4.13 uncouple at uncoupling point of shunting composition.

8.4.9 TP08 - Flat Shunting Pick Up

8.4.9.2 Target Process

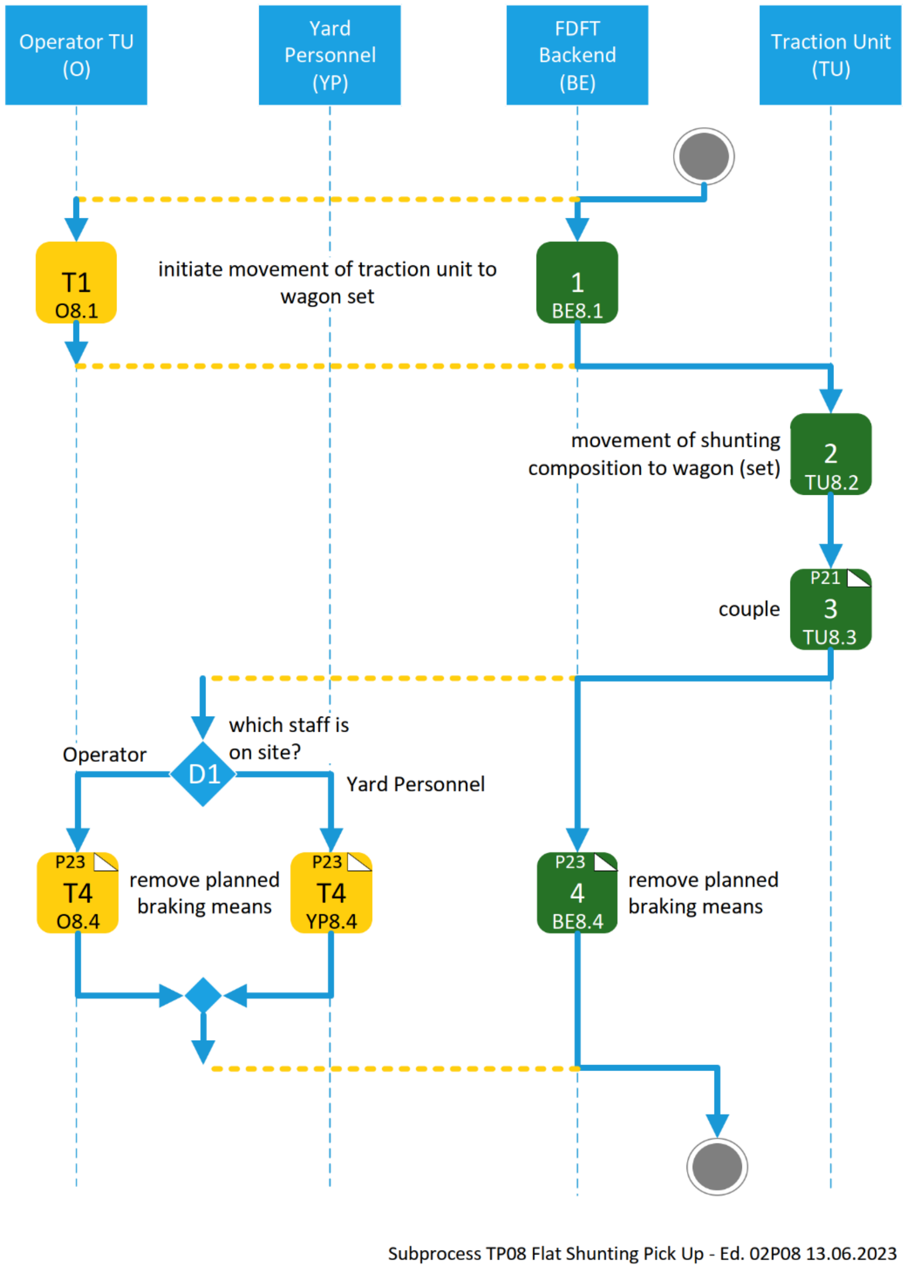


Figure 27: TP08 Flat Shunting Pick Up - 1 of 1

8.4.9.2 Process-Description

BE8.1

Activity	Initiate movement of traction unit to wagon set
Precondition	▪ Automated Parking Brake released, Controllable Brake released, traction is allowed and possible.
Conditions	▪ FDFT Backend is available and can initiate movement of Traction Unit.
Tasks	▪ increase traction force and gain speed up to shunting yard regulatory maximum.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ Upon reception of the command from the FDFT backend, the FDFT base system of the traction unit (TU) shall issue a command to the TU ATO system to increase traction force and gain speed up to shunting yard regulatory maximum.

O8.1

Activity	Initiate movement of traction unit to wagon set
Precondition	▪ Automated Parking Brake released, Controllable Brake released, traction is allowed and possible.
Conditions	▪ -
Tasks	▪ increase traction force and gain speed up to shunting yard regulatory maximum.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ Upon reception of the command from the loco driver, the traction unit (TU) shall increase traction force and gain speed up to shunting yard regulatory maximum.

TU8.2

Activity	Movement of shunting composition to wagon (set)
Precondition	▪ -
Conditions	▪ -

Tasks	▪ Movement of shunting composition to wagon (set) which will be picked up.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ The TU shall move the shunting composition to wagon (set) to be picked up.

TU8.3	
Activity	Subprocess: Couple
Precondition	▪ -
Conditions	▪ -
Tasks	▪ See subprocess description 8.4.14 ▪ Couple shunting composition or traction unit to wagon (set).
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ See subprocess description 8.4.14 Couple shunting composition or traction unit to wagon (set).

BE8.4	
Activity	Subprocess: Remove planned braking means
Precondition	▪ -
Conditions	▪ Controllable brake is available and can initiate securing the wagon. FDFT Backend is available and can communicate with the FDFT Wagon Base system.
Tasks	▪ See subprocess description 8.4.16 ▪
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -

Functional system requirements	▪ See subprocess description 8.4.16

D1	
Decision	Which staff is on site?
Operator	▪ Operator is on site.
Yard Personnel	▪ Yard Personnel is on site.
Remarks	▪ -
Rationale	▪ -

O8.4	
Activity	Subprocess: Remove planned braking means
Precondition	▪ -
Conditions	▪ -
Tasks	▪ See subprocess description 8.4.16
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ See subprocess description 8.4.16

YP8.4	
Activity	Subprocess: Remove planned braking means
Precondition	▪ -
Conditions	▪ -
Tasks	▪ See subprocess description 8.4.16
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ See subprocess description 8.4.16

8.4.10 TP09 - Automated Brake Test

8.4.10.2 Target Process

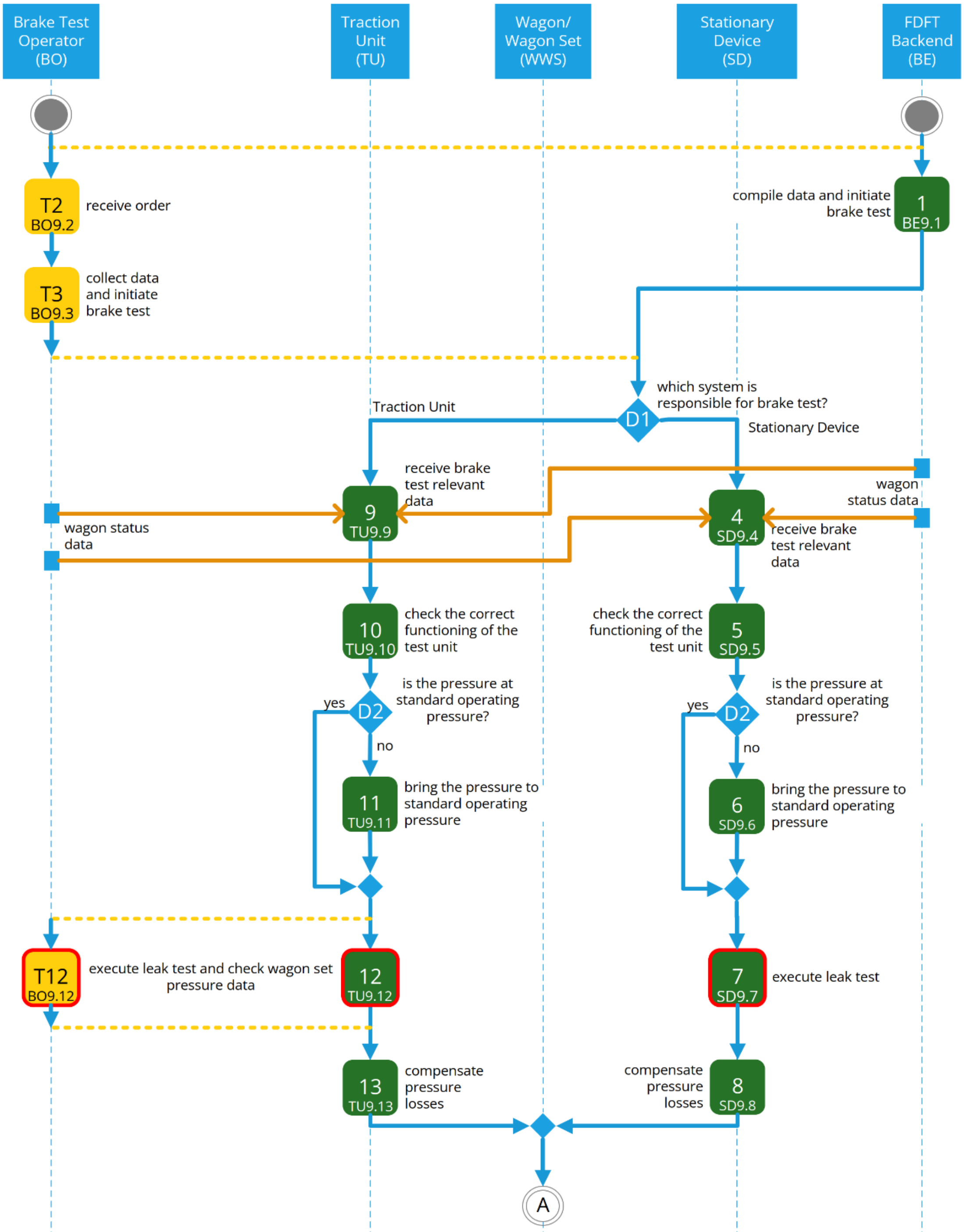


Figure 28: TP09 Automated Brake Test - 1 of 3

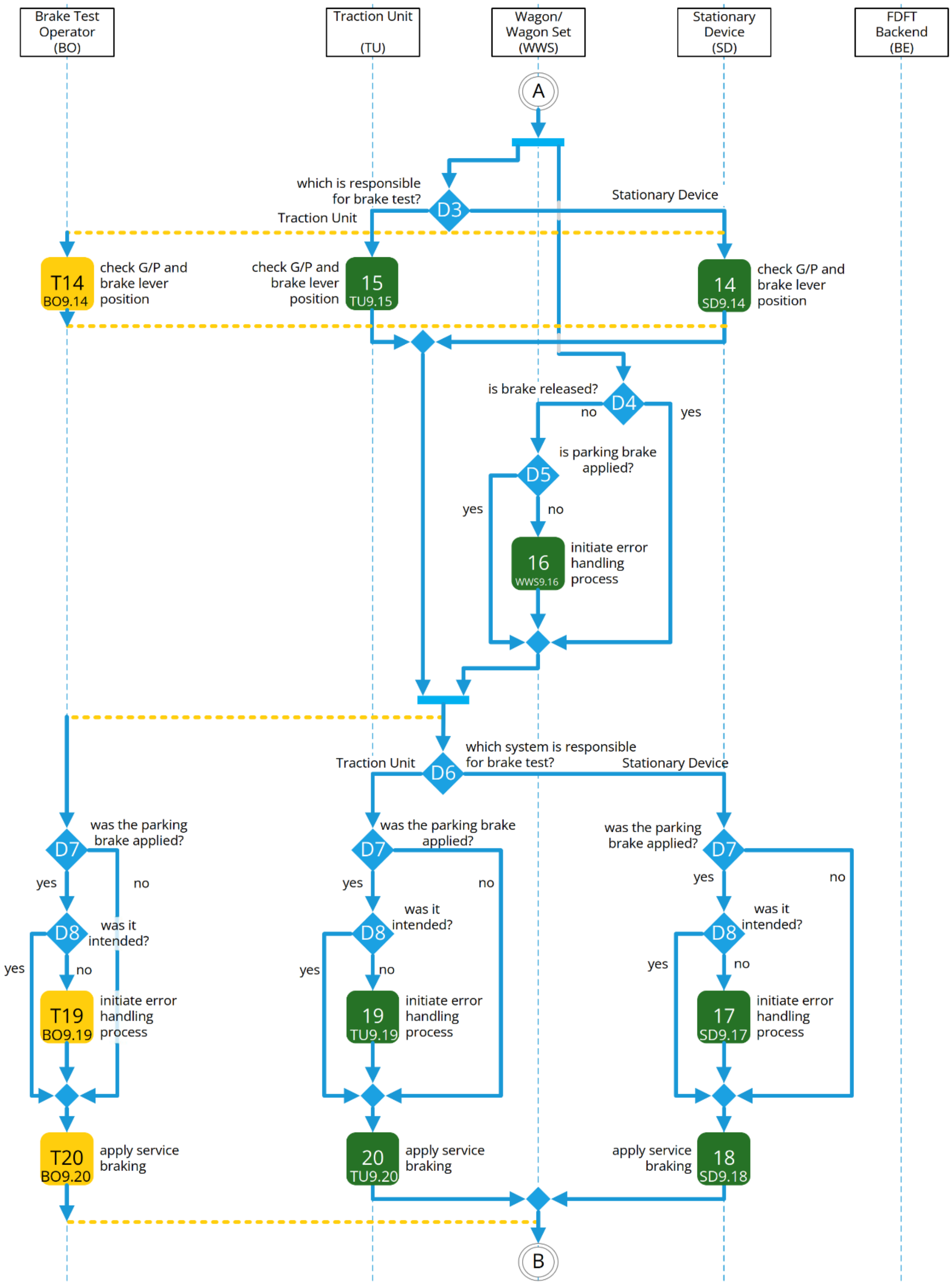


Figure 29: TP09 Automated Brake Test - 2 of 3

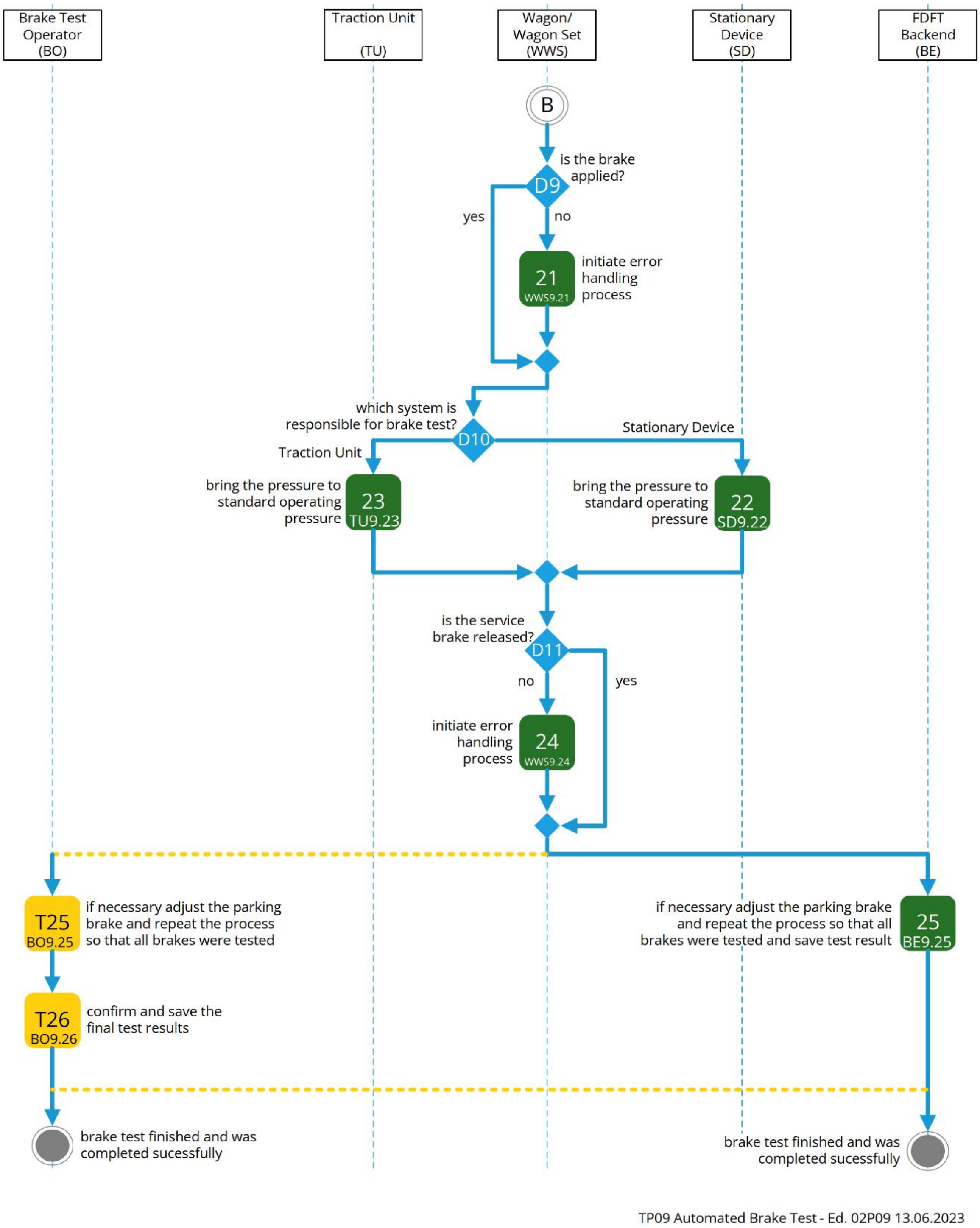


Figure 30: TP09 Automated Brake Test - 3 of 3

8.4.10.2 Process-Description

BE9.1	
Activity	Compile data and initiate brake test
Precondition	▪ -
Conditions	▪ FDFT Backend is available and can initiate brake test.
Tasks	▪ FDFT Backend compiles all necessary data and initiates brake test.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ None ▪ Remark: activity is handled in FDFT Backend

BO9.2	
Activity	Receive order
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Brake Test Operator receives order to perform brake test on wagon set using legacy processes.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ None ▪ Remark: activity is handled by legacy means

BO9.3	
Activity	Collect data and initiate brake test
Precondition	▪ -
Conditions	▪ -

Tasks	▪ Brake Test Operator compiles brake test relevant data and initiates brake test.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ None ▪ Remark: activity is handled by legacy means

D1	
Decision	Which is responsible for brake test?
Traction Unit	▪ -
Stationary Device	▪ -
Remarks	▪ -
Rationale	▪ -

SD9.4	
Activity	Receive brake test relevant data
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Stationary Device receives brake test relevant data.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ None ▪ Remark: Stationary Device not part of this document

SD9.5	
Activity	Check the correct functioning of the test unit
Precondition	▪ -

Conditions	▪ -
Tasks	▪ Correct functioning of test unit on Stationary Device is checked.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ None ▪ Remark: Stationary Device not part of this document

D2	
Decision	Is the pressure at standard operating pressure?
Yes	▪ The pressure is at standard operating pressure.
Remarks	▪ -
Rationale	▪ -

SD9.6	
Activity	Bring the pressure to standard operating pressure
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Stationary Device brings pressure in main brake pipe to standard operating pressure.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ None ▪ Remark: Stationary Device not part of this document

SD9.7	
Activity	Execute leak test
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Stationary Device executes leak test.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ None ▪ Remark: Stationary Device not part of this document

SD9.8	
Activity	Compensate pressure losses
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Stationary Device compensates pressure losses.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ None ▪ Remark: Stationary Device not part of this document

TU9.9	
Activity	Receive brake test relevant data
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Traction Unit receives brake test relevant data.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ The FDFT Base System of the TU shall be able to receive brake test relevant data from the Brake Test Operator. ▪ The FDFT Base System of the TU shall be able to receive brake test relevant data from the FDFT Backend through the FDFT Link Interface. ▪ The brake test relevant data shall be stored in the FDFT Base System of the TU.

TU9.10	
Activity	Check the correct functioning of the test unit
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Correct functioning of test unit on Traction Unit is checked.

Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ The FDFT Base System of the TU shall be able to check that the test unit is working correctly.

D2	
Decision	Is the pressure at standard operating pressure?
Yes	▪ The pressure is at standard operating pressure.
Remarks	▪ -
Rationale	▪ -

TU9.11	
Activity	Bring the pressure to standard operating pressure
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Traction Unit brings pressure in main brake pipe to standard operating pressure.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ The FDFT Base System of the TU shall be able to bring up pressure in the main brake pipe up to the operating pressure using the functional block <Brake Pipe Air Supply Control>

TU9.12	
Activity	Execute leak test and check wagon set pressure data
Precondition	▪ -
Conditions	▪ Traction Unit can receive pressure data for each wagon.
Tasks	▪ Traction Unit executes leak test and checks pressure data for each wagon in set.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ The FDFT Base System of the TU shall be able to query the pressure data for each wagon in composition. ▪ The Base System of the TU shall perform a leak test, using the <ABT Functions>

BO9.12

Activity	Execute leak test and check wagon set pressure data
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Brake Test Operator receives wagon pressure data via the mobile HMI.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ The FDFT Base System of the TU shall be able to trigger the leak test upon reception of the related command from the Mobile HMI. ▪ The FDFT Base System of the TU shall be able to query the pressure data for each wagon in composition. ▪ The Base System of the TU shall perform a leak test, using the <ABT Functions> ▪ The FDFT Base System of the TU shall be able to forward the result of the leak test to the Mobile HMI.

TU9.13

Activity	Compensate pressure losses
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Traction Unit compensates pressure losses.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ The FDFT Base System of the TU shall be able to control the Brake Pipe Air Supply the way that pressure losses are compensated. This shall be done through the <Brake Pipe Air Supply Control>.

D3

Decision	Which is responsible for brake test?
FDFT Backend	▪ -

Stationary Device	▪ -
Remarks	▪ -
Rationale	▪ -

SD9.14	
Activity	Check G/P and brake lever position
Precondition	▪ -
Conditions	▪ The Stationary Device can check the brake lever position.
Tasks	▪ Check planned G/P Brake and lever position.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ None ▪ Remark: The Stationary Device is not part of this document

BO9.14	
Activity	Check G/P and brake lever position
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Break Test operator checks planned G/P Brake and lever position.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ None ▪ Remark: This activity is using legacy means.

TU9.15	
Activity	Check brake lever position
Precondition	▪ -
Conditions	▪ The Traction Unit can check the brake lever position.
Tasks	▪ Check planned G/P Brake and lever position.
Remarks	▪ -

Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ The FDFT Base System of the TU shall be able to request the brake lever position of all wagons in composition via the <F-TCN Interface>. ▪ The FDFT Wagon Base System shall be able to detect the G/P lever position and to send the status to the TU via the <F-TCN Interface>.

D4	
Decision	Is brake released?
Yes	▪ Brake(s) are released.
Remarks	▪ -
Rationale	▪ -

D5	
Decision	Is the parking brake applied?
yes	▪ Parking brake is applied.
Remarks	▪ -
Rationale	▪ -

WWS9.16	
Activity	Initiate error handling process
Precondition	▪ -
Conditions	▪ -
Tasks	▪ FDFT Wagon Base System reports failure in automated brake test. ▪ This information can be used to trigger an error handling process.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ The FDFT Wagon Base System shall be able to detect a failure in automated brake test. ▪ The FDFT Wagon Base System shall be able to send the status of the failed brake to the TU via the <F-TCN Interface>.

D6	
Decision	Which is responsible for brake test?
Conditions	▪ This System used for the brake test can check if the service brake was applied.
FDFT Backend	▪ -
Stationary Device	▪ -
Remarks	▪ if neither the TU nor the system is responsible, the yellow path (partially automated) need to be followed.
Rationale	▪ -

D7	
Decision	Was the parking brake applied?
Yes	▪ -
Remarks	▪ -
Rationale	▪ -

D8	
Decision	Was it intended?
Yes	▪ -
Remarks	▪ -
Rationale	▪ -

SD9.17	
Activity	Initiate error handling process
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Stationary Device reports failure in automated brake test. ▪ This information can be used to trigger an error handling process.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -

Functional system requirements	▪ None ▪ Remark: The Stationary Device is not part of the document.

SD9.18	
Activity	Apply service braking
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Stationary Device applies service braking.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ None ▪ Remark: The Stationary Device is not part of the document.

TU9.19	
Activity	Initiate error handling process
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Traction Unit reports failure in automated brake test. ▪ This information can be used to trigger an error handling process.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ The FDFT Base System shall report failure in automated brake test on the local HMI. ▪ The FDFT Base System shall make use of the <ABT Functions> to trigger an error handling process.

TU9.20	
Activity	Apply service braking

Precondition	▪ -
Conditions	▪ -
Tasks	▪ Traction Unit applies service braking.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ The FDFT Base System of the TU shall be able to control the Brake Pipe Air Supply the way that the service brakes in all wagons in the composition are applied. This shall be done through the <Brake Pipe Air Supply Control>. ▪ The FDFT Base System of the TU shall query from each wagon in the composition the status of its service brake.

BO9.19	
Activity	Initiate error handling process
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Brake Test Operator reports failure in automated brake test. ▪ This information can be used to trigger an error handling process.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ None ▪ Remark: This activity shall be handled by legacy means.

BO9.20	
Activity	Apply service braking
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Brake Test Operator applies service braking.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ None ▪ Remark: This activity shall be handled by legacy means.

D9	
Decision	Is the brake applied?
Yes	▪ -
Remarks	▪ -
Rationale	▪ -

WWS9.21	
Activity	Initiate error handling process
Precondition	▪ -
Conditions	▪ -
Tasks	▪ FDFT Wagon Base System reports failure in automated brake test. ▪ This information can be used to trigger an error handling process.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ The FDFT Wagon Base System shall report failure in automated brake test on the local HMI. ▪ The FDFT Wagon Base System shall make use of the <ABT Functions> to trigger an error handling process.

D10	
Decision	Which is responsible for brake test?
FDFT Backend	▪ -
Stationary Device	▪ -
Remarks	▪ -
Rationale	▪ -

SD9.22	
Activity	Bring the pressure to standard operating pressure
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Stationary Device brings pressure in main brake pipe to standard operating pressure.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ None ▪ Remark: The Stationary Device is not part of this document.

TU9.23	
Activity	Bring the pressure to standard operating pressure
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Traction Unit brings pressure in main brake pipe to standard operating pressure.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ The FDFT Base System of the TU shall be able to control the Brake Pipe Air Supply the way that the pressure in the main brake pipe reaches standard operating pressure. This shall be done through the <Brake Pipe Air Supply Control>.

D11	
Decision	Is the service brake released?
Yes	▪ The service brake is released
Remarks	▪ -
Rationale	▪ -

WWS9.24	
Activity	Initiate error handling process
Precondition	▪ -
Conditions	▪ -
Tasks	▪ FDFT Wagon Base System reports failure in automated brake test. ▪ This information can be used to trigger an error handling process
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ The FDFT Wagon Base System shall be able to detect the status of the service brake.

	▪ The FDFT Wagon Base System shall forward the status of the service brake to the TU and the FDFT Backend in order to allow adjustment of the Parking Brake and to repeat the process. ▪ The FDFT Wagon Base System shall make use of the <ABT Functions>

BE9.25	
Activity	If necessary, adjust the parking brake and repeat the process so that all brakes were tested
Precondition	▪ -
Conditions	▪ FDFT Backend is available and can initiate the brake test.
Tasks	▪ -
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ The FDFT Base System of the TU shall send the result of the Automated Brake Test to the FDFT Backend, where it can be stored.> ▪ The FDFT Base System of the TU shall use the <ABT Functions> to collect and process the results of the performed Automated Brake Test.

BO9.25	
Activity	If necessary, adjust the parking brake and repeat the process so that all brakes were tested
Precondition	▪ -
Conditions	▪ -
Tasks	▪ If a parking brake was required to secure the shunting composition, the functionality of the brake(s) that have not yet been tested must be implemented. For this purpose, the brake test operator adapts the security in such a way that the untested brake is released but the shunting composition is sufficiently secured against always rolling away at all times. ▪ For checking the unbraked brake(s), the process must be started at (A).
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ None ▪ Remark: This activity is to be performed by legacy means.

BO9.26

Activity	Confirm the final results
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Brake test operator conforms the results of brake test to FDFT Backend. ▪ This can also be achieved by using the Mobile HMI.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ None ▪ Remark: This activity is to be performed by legacy means.

8.4.11 TP10 - Confirm Wagon Set

8.4.11.2 Target Process

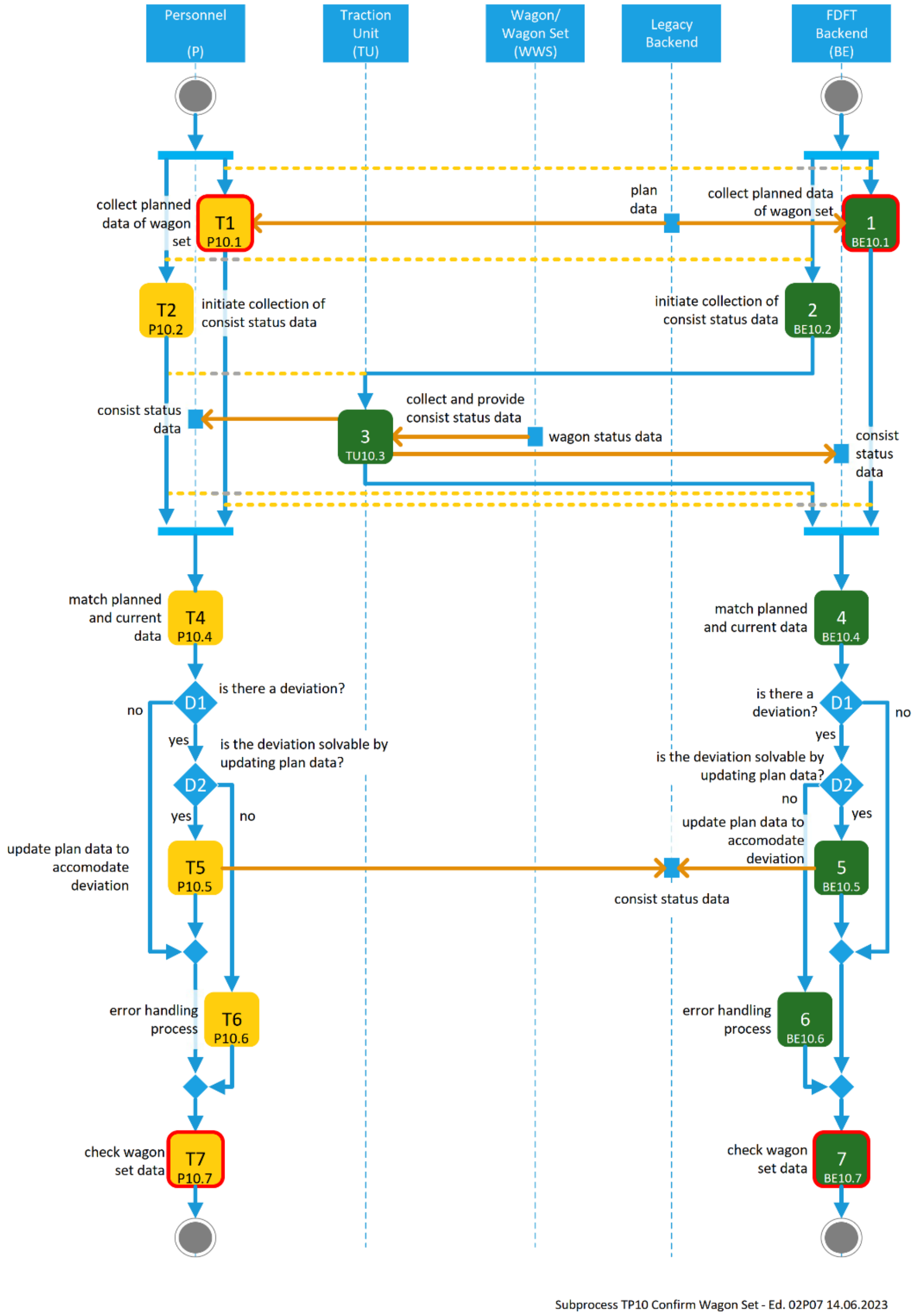


Figure 31: TP10 Confirm Wagon Set - 1 of 1

8.4.11.2 Process-Description

BE10.1

Activity	Collect planned data of wagon set
Precondition	▪ -
Conditions	▪ FDFT Backend is available and can communicate with FDFT Wagon Base System.
Tasks	▪ FDFT Backend collects data on wagon set to be processed. ▪ Information is retrieved from planning systems (e.g. operator specific planning systems)
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ None ▪ Remark: Activity is performed solely in the FDFT Backend.

BE10.2

Activity	Initiate collection of consist status data
Precondition	▪ -
Conditions	▪ FDFT Backend is available and can communicate with FDFT Wagon Base System.
Tasks	▪ FDFT Backend triggers train composition detection function ▪ -
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ The communication system of the traction unit (TU) shall be able to receive commands from FDFT backend system to query the additional wagon data from all FDFT wagon base systems in train.

TU10.3

Activity	Collect and provide consist status data
Precondition	▪ -
Conditions	▪ -
Tasks	▪ FDFT System of Traction Unit collects all composition relevant data of the consist composition, e.g. consist unique id, sequence number, consist orientation, consist length, further static properties of the consists and indicates all data to the Operator
Remarks	▪ TU20.3
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ The communication system of the traction unit (TU) shall be able to receive commands from FDFT backend system to query all composition related data from all FDFT wagon base systems in train. ▪ The FDFT wagon base system of each wagon in shunting composition shall report its wagon data to the TU. ▪ The FDFT base system of the TU shall report the collected wagon data to the FDFT-Backend.

P10.1

Activity	Collect planned data of wagon set
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Personnel collects planned data of wagon set via legacy system
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ None ▪ Remark: Activity is performed by legacy procedures using legacy systems.

P10.2

Activity	Initiate collection of consist status data
Precondition	▪ -

Conditions	▪ -
Tasks	▪ Personnel triggers train composition detection function
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ The system of the traction unit (TU) shall be able to trigger the train composition detection function by using the local HMI.

BE10.4	
Activity	Match planned and current data
Precondition	▪ -
Conditions	▪ FDFT Backend is available and can match planned and current data.
Tasks	▪ FDFT Backend compares planned and current data to identify possible deviations and stores these deviations.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ None ▪ Remark: Activity is performed solely in the FDFT Backend based on information gathered in previous steps.

D1	
Decision	Is there a deviation?
Yes	▪ Deviation between plan data and current data was found.
Remarks	▪ -
Rationale	▪ -

D2	
Decision	Is the deviation solvable by updating plan data?
Yes	▪ A change of plan data is sufficient to correct the deviations.
Remarks	▪ -
Rationale	▪ -

BE10.5

Activity	Update plan data to accommodate deviations
Precondition	▪ -
Conditions	▪ FDFT Backend is available.
Tasks	▪ FDFT Backend changes plan data to reflect found deviations. ▪ The new plan state equals the current state.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ None ▪ Remark: Activity is performed solely in the FDFT Backend based on information gathered in previous steps.

BE10.6

Activity	Error handling process
Precondition	▪ -
Conditions	▪ FDFT Backend is available.
Tasks	▪ FDFT Backend initiates operator specific error handling process to deal with found critical deviations. ▪ The process continues as soon as the error handling process finishes. The result plan state does not deviate to current state.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ None ▪ Remark: Activity is performed solely in the FDFT Backend based on information gathered in previous steps.

BE10.7

Activity	Check wagon set data
Precondition	▪ -
Conditions	▪ FDFT Backend is available.

Tasks	▪ FDFT Backend checks that current wagon set data matches planned data.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ None ▪ Remark: Activity is performed solely in the FDFT Backend based on information gathered in previous steps.

P10.4	
Activity	Match planned and current data
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Personnel compares planned and current data to identify possible deviations.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ None ▪ Remark: Activity is performed solely by Personnel using legacy means.

P10.5	
Activity	Update plan data to accommodate deviations
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Personnel changes plan data to reflect found deviations. ▪ The new plan state equals the current state.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -

Functional system requirements	▪ None ▪ Remark: Activity is performed solely by Personnel using legacy means.

P10.6

Activity	Error handling process
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Personnel initiates operator specific error handling process to deal with found critical deviations. ▪ The process continues as soon as the error handling process finishes. The result plan state does not deviate to current state.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ None ▪ Remark: Activity is performed solely by Personnel using legacy means.

P10.7

Activity	Check wagon set data
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Personnel checks that current wagon set data matches planned data
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ None ▪ Remark: Activity is performed solely by Personnel using legacy means.

8.4.12 TP11 - Technical Wagon Inspection

8.4.12.2 Target Process

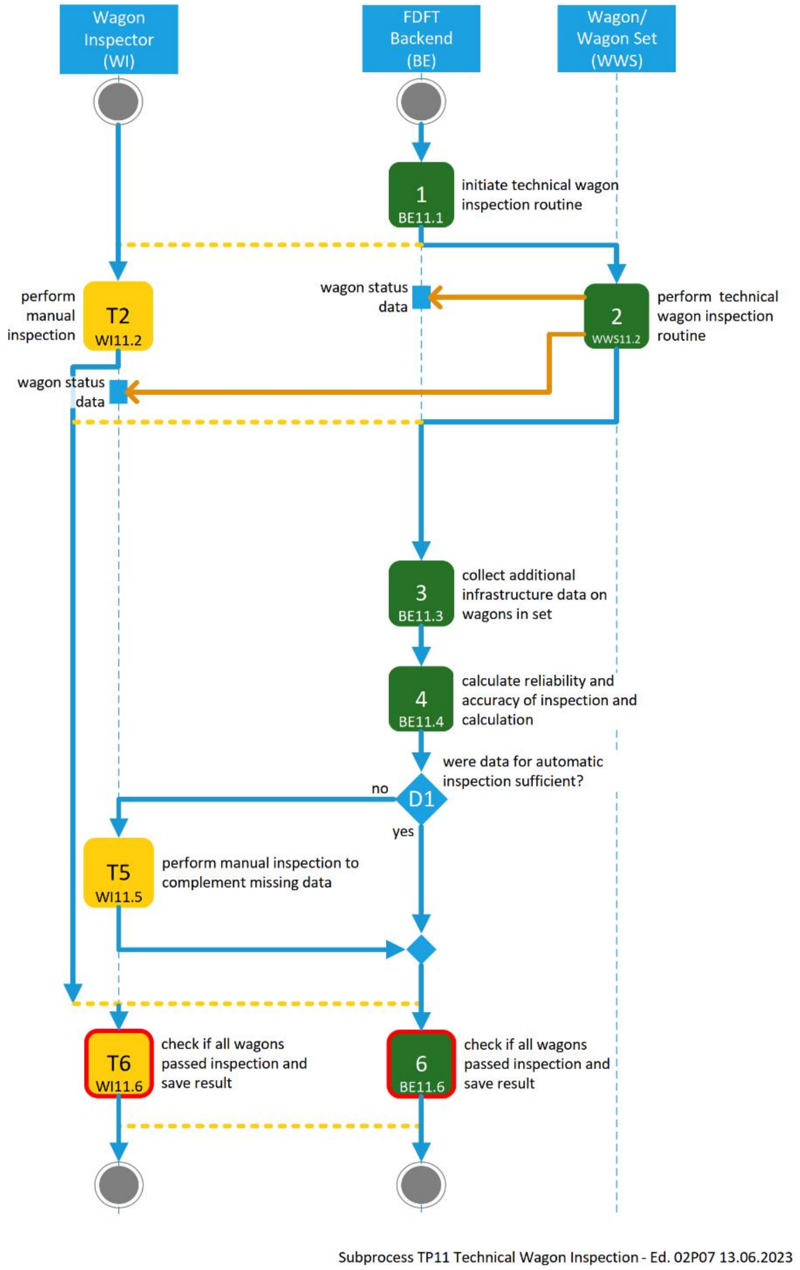


Figure 32: TP11 Technical Wagon Inspection - 1 of 1

8.4.12.2 Process-Description

BE11.1

Activity	Initiate technical wagon inspection routine
Precondition	▪ -
Conditions	▪ - FDFT Backend is available.
Tasks	▪ FDFT Backend initiates wagon inspection routine in FDFT Wagon Base System for all wagon(s) in set.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ None ▪ Remark: It isn't yet clear what are the requirements, expected results, sensor principles to be applied, to perform a technical wagon inspection.

WWS11.2

Activity	Perform technical wagon inspection routine
Precondition	▪ -
Conditions	▪ FDFTE Backend is available and can communicate with all wagon(s) in set.
Tasks	▪ FDFT Wagon Base System receives command to perform wagon inspection routine and starts the routine. ▪ FDFT Wagon Base System send results of inspection to FDFT Backend.
Remarks	▪ Inspection is supported by the usage of Sensors and other available wagon data.
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ The FDFT wagon base system shall perform the wagon inspection routine. ▪ Remark: It isn't yet clear what are the requirements, expected results, sensor principles to be applied, to perform a technical wagon inspection

WI11.2

Activity	Perform manual wagon inspection routine
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Wagon Inspector performs wagon inspection including report using legacy processes. ▪ Wagon Inspector inputs results to FDFT Backend if available.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ None ▪ Remark: Activity is performed by using legacy processes.

BE11.3

Activity	Collect additional infrastructure data on wagon(s) in set
Precondition	▪ -
Conditions	▪ FDFT Backend is available.
Tasks	▪ FDFT Backend collects additional data from infrastructure systems (e.g. video gate, hot box detector) on each wagon if available.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ None ▪ Remark: Activity is performed solely by the FDFT Backend collecting additional data from infrastructure systems.

BE11.4

Activity	Calculate reliability and accuracy of inspection and calculation
Precondition	▪ -
Conditions	▪ FDFT Backend is available.
Tasks	▪ FDFT Backend uses all available data on each wagon to calculate the reliability and accuracy of data as basis for further checks.

Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ None ▪ Remark: Activity is performed solely by the FDFT Backend collecting additional data from infrastructure systems.

D1	
Decision	Were data for automatic inspection sufficient?
Yes	▪ -
Remarks	▪ -
Rationale	▪ -

WI11.5	
Activity	Perform manual inspection to complement missing data
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Wagon Inspector performs additional manual inspections on wagon(s) where available data is not sufficient. ▪ Wagon Inspector reports results to FDFT Backend.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ None ▪ Remark: Activity is performed solely by the Wagon Inspector using manual means. The Wagon Inspector reports the results directly to the FDFT Backend by external means.

BE11.6	
Activity	Check if all wagon(s) passed inspection and save results
Precondition	▪ -
Conditions	▪ FDFT Backend is available and has sufficient current data for technical wagon inspection check.
Tasks	▪ FDFT Backend uses wagon status data (sensors on wagon), wagon data provided by infrastructure (e.g. video gate) to verify that wagon(s) are operationally safe for planned subsequent movement. ▪ FDFT Backend stores the results of the technical wagon inspection (according to regulations) in a tamper safe way and provides this data to other systems. ▪ FDFT Backend initiates a separate process for deviations (damaged wagon(s) prohibiting subsequent movement).
Remarks	▪ See regulations: General Contract of Use for Wagon(s) (GCU), Appendix 9

Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ None ▪ Remark: Activity is performed solely in the FDFT Backend based on information gathered in previous steps.

WI11.6

Activity	Check if all wagon(s) passed inspection and save results
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Use legacy processes for technical wagon inspection check.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ None ▪ Remark: Activity is performed by using legacy processes.

8.4.13 TP20 – Uncouple

8.4.13.2 Target Process

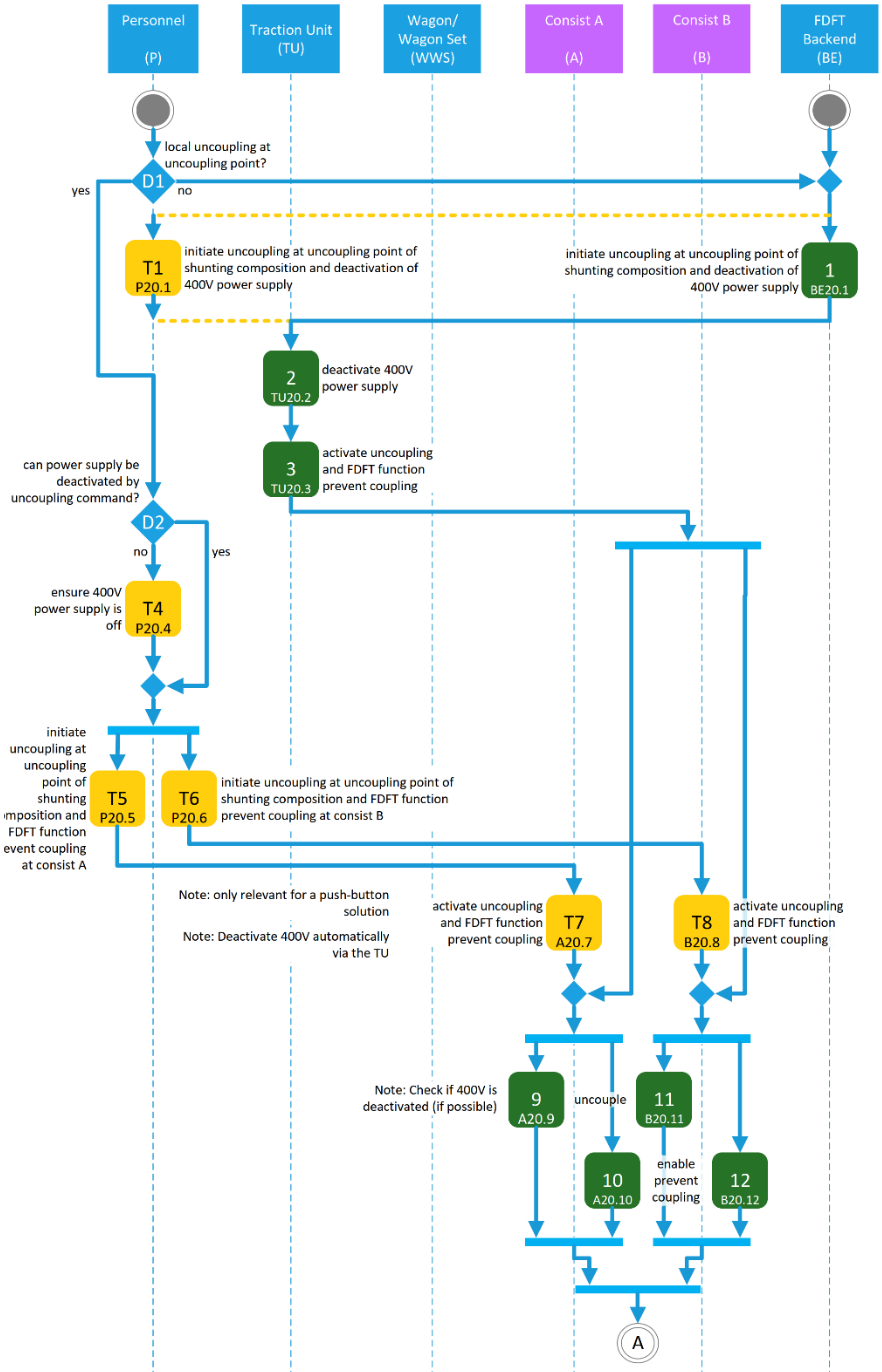


Figure 33 TP20 Uncouple - 1 of 2:

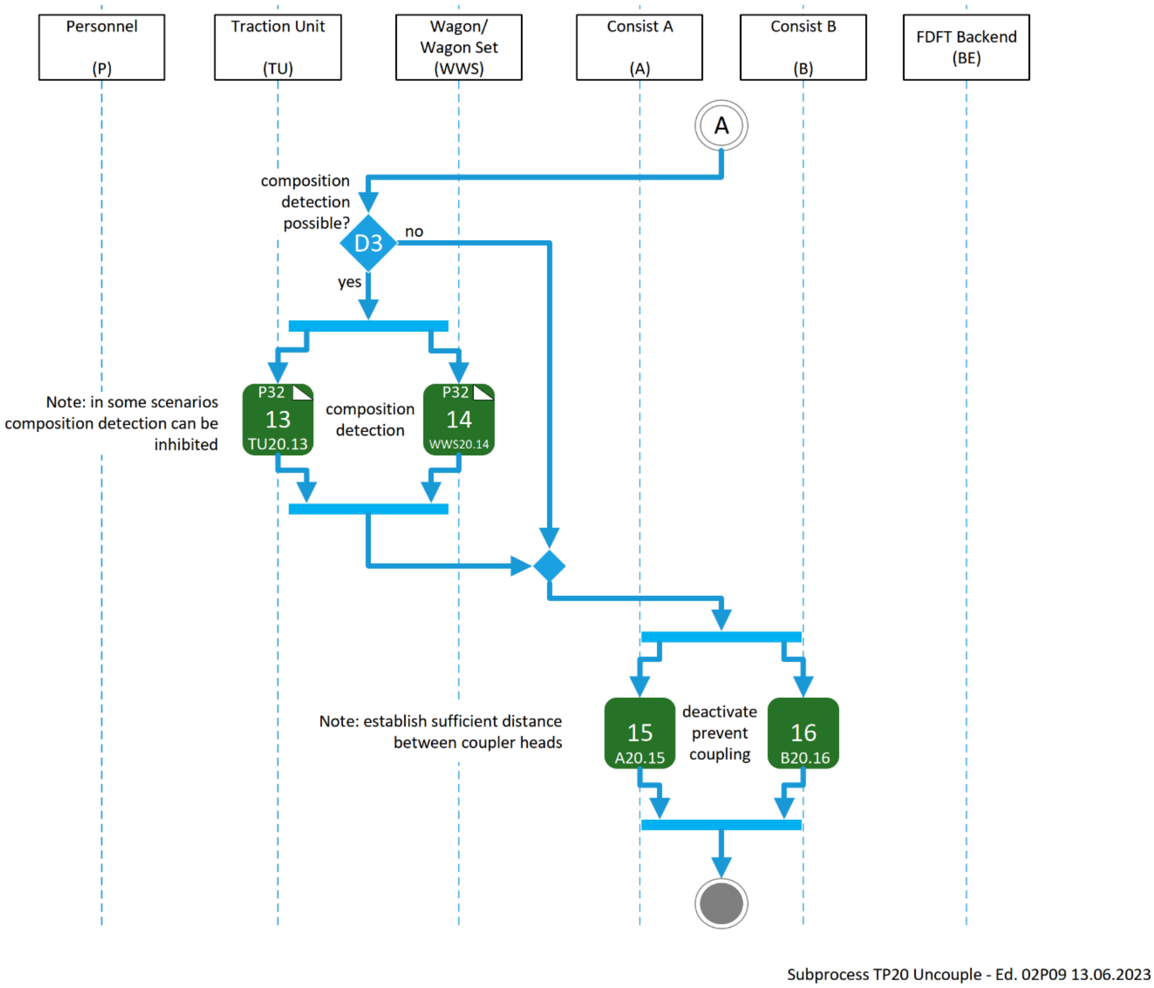


Figure xx: TP20 Uncouple - 2 of 2

8.4.13.2 Process-Description

D1	
Decision	Local uncoupling at uncoupling point?
Yes	▪ -
No	▪ -
Remarks	▪ -
Rationale	▪ -

BE20.1	
Activity	Initiate uncoupling at uncoupling point of shunting composition and deactivation of 400V power supply
Precondition	▪ -
Conditions	▪ FDFT Backend is available and can initiate uncoupling incl. deactivation power supply.
Tasks	▪ FDFT Backend initiates uncoupling at Uncoupling Point at relevant FDFT Wagon Base Systems and deactivation of 400V power supply.
Remarks	▪ Data from FDFT Backend to FDFT Wagon Base System is transferred through FDFT Link(s).
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ The communication system of the traction unit (TU) shall be able to receive commands from FDFT backend system. ▪ The communication system of the TU shall accept only commands, which are validated, authenticated, and authorized. ▪ The traction unit shall be able to send commands to dedicated wagons after the acceptance of the relevant commands of the FDFT backend system.

P20.1	
Activity	Initiate uncoupling at uncoupling point of shunting composition
Precondition	▪ -
Conditions	▪ -

Tasks	▪ Personnel initiates uncoupling by using Traction Unit or Mobile HMI.
Remarks	▪ Manual emergency lever is not considered as feasible means for uncoupling.
Rationale	▪ -
Postcondition	▪ -
Functional System requirements	Personnel shall be able to deactivate the 400 V power supply by using the HMI of the TU. Personnel shall be able to send an uncoupling command to the relevant wagons by using the HMI of the TU. The wagons shall be able to receive commands from the TU via the F-TCN.

TU20.2	
Activity	Deactivate 400V power supply
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Traction Unit deactivates 400V power supply.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional System requirements	The onboard system of the TU shall be able to deactivate the power supply to the power distribution line upon command.

TU20.3	
Activity	Activate uncoupling and FDFT function prevent coupling
Precondition	▪ -
Conditions	▪ -
Tasks	▪ FDFT System activates consist A coupler and consist B coupler prevent coupling function until it will be deactivated.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -

Functional System requirements	▪ The onboard system of the TU shall be able to send the activate uncoupling command to the CCU of consist A to enable uncoupling of the related coupler. ▪ The onboard system of the TU shall be able to send the activate uncoupling command to the CCU of consist B to enable uncoupling of the related coupler. ▪ The CCU's of both consists shall be able to receive the activate uncoupling command to enable uncoupling of the related couplers. ▪ The onboard system of the TU shall be able to send the prevent coupling command to the CCU of consist A to enable the prevent coupling FDFT function at the related coupler. ▪ The onboard system of the TU shall be able to send the prevent coupling command to the CCU of consist B to enable the prevent coupling FDFT function at the related coupler. ▪ The CCU's of both consists shall be able to receive the prevent coupling command to enable the prevent coupling FDFT function of the related couplers. ▪ Remark: If prevent coupling function shall be activated, the related command be sent together with the uncoupling command, to allow correct handling in the coupler.

D2	
Decision	Can power supply be deactivated by uncoupling command?
Yes	▪ -
No	▪ -
Remarks	▪ -
Rationale	▪ -

P20.4	
Activity	Ensure 400V power supply is off
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Personnel makes sure that the 400V power supply is turned off.
Remarks	▪ -
Rationale	▪ If uncoupled with power supply on, this could result in harmful electric arc

Postcondition	▪ -
Functional System requirements	▪ Personnel shall be able to ensure that the 400V power line is dead by observing an indicator situated on both sides of the wagon near the wagon end or by using the Mobile HMI connected with the wagon CCU indicating that the 400V power supply of the wagon is dead.

P20.5	
Activity	Initiate uncoupling at uncoupling point of shunting composition and FDFT function prevent coupling at consist A
Precondition	▪ -
Conditions	▪ -
Tasks	▪ User triggers uncoupling at uncoupling point of shunting composition at consist A.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ Personnel shall be able to trigger uncoupling at uncoupling point. ▪ Personnel shall send an uncoupling command to consist A and B and a command to trigger the FDFT function prevent coupling for the relevant couplers e.g.: by using a Mobile HMI connected with the wagon CCU.

P20.6	
Activity	Initiate uncoupling at uncoupling point of shunting composition and FDFT function prevent coupling at consist B
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Personnel triggers uncoupling at uncoupling point of shunting composition at consist B
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional System requirements	▪ Personnel shall be able to trigger uncoupling at uncoupling point. ▪ Personnel shall send an uncoupling command to consist A and B and a command to trigger the FDFT function prevent coupling for the relevant couplers e.g.: by using a Mobile HMI connected with the wagon CCU.

A20.7	
Activity	Activate uncoupling and FDFT function prevent coupling
Precondition	
Conditions	▪ -
Tasks	▪ FDFT System activates consist A coupler uncoupling function until it will be deactivated. ▪
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional System requirements	▪ The CCU of consist A shall be able to monitor the 400 V power line of the consist. ▪ The CCU of the consist A shall be able to initiate uncoupling at uncoupling point of consist A after receiving the respective command, the positive check that both consists are is in FDFT mode Shunting and the positive check that the 400 V power line is dead (i.e. no 400 V voltage). ▪ The CCU of consist A shall be able to initiate FDFT function prevent coupling.

B20.8	
Activity	Activate uncoupling and FDFT function prevent coupling
Precondition	▪ -
Conditions	▪ -
Tasks	▪ FDFT System activates consist B coupler uncoupling function until it will be deactivated
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional System requirements	▪ The CCU of consist B shall be able to monitor the 400 V power line of the consist. ▪ The CCU of the consist B shall be able to initiate uncoupling at uncoupling point of consist B after receiving the respective command, the positive check that both consists are in FDFT mode Shunting and the positive check that the 400 V power line is dead (i.e. no 400 V voltage). ▪ The CCU of consist B shall be able to initiate FDFT function prevent coupling.

A20.9

Activity	Uncouple
Precondition	▪ No or sufficiently low tensile forces
Conditions	▪ -
Tasks	▪ Activate function uncouple on selected coupler
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional System requirements	▪ The precondition is checked and ensured by external means (yard automation systems) and thus don't imply a requirement to the FDFT Wagon Base System. ▪ The CCU shall activate the uncoupling function of the selected coupler. ▪ The coupler shall uncouple upon command from the CCU. ▪ The CCU shall capture and send the outcome of the requested action to the requesting actor.

A20.10

Activity	Enable prevent coupling
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Activate function prevent coupling
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ The CCU shall check that the selected coupler is uncoupled. ▪ The CCU shall activate the prevent coupling function for the selected coupler. ▪ The CCU shall be able to monitor the coupler regarding the FDFT function Prevent coupling.

B20.11

Activity	Uncouple

Precondition	▪ No or sufficiently low tensile forces
Conditions	▪ -
Tasks	▪ Activate function uncouple on selected coupler
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional System requirements	▪ The CCU shall be able to check that sufficiently low tensile forces for uncoupling are present at the selected coupler. ▪ The CCU shall activate the uncoupling function of the selected coupler. ▪ The coupler shall uncouple upon command from the CCU.

B20.12

Activity	Enable prevent coupling
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Activate function prevent coupling
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional System requirements	▪ The CCU shall check that the selected coupler is uncoupled. ▪ The CCU shall activate the prevent coupling function for the selected coupler. ▪ The CCU shall be able to monitor the coupler regarding the FDFT function Prevent coupling.

D3

Decision	Composition detection Possible?
Yes	▪ -
No	▪ -
Remarks	▪ -
Rationale	▪ -

TU20.13

Activity	Subprocess Composition Detection
Precondition	▪ -
Conditions	▪ -
Tasks	▪ See subprocess description 8.4.21
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ See subprocess description 8.4.21

WWS20.14

Activity	Subprocess Composition Detection
Precondition	▪ -
Conditions	▪ -
Tasks	▪ See subprocess description 8.4.21
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ See subprocess description 8.4.21

A20.15

Activity	Deactivate prevent coupling
Precondition	▪ -
Conditions	▪ -

Tasks	▪ The function prevent coupling is deactivated
Remarks	▪ If this function cannot be deactivated by the coupler itself (e.g. actuator), then it must be ensured on the infrastructure side with a device in case of hump shunting.
Rationale	▪ -
Postcondition	▪ Coupler is in ready to couple position.
Functional System requirements	▪ The CCU shall be able to monitor the coupler that has sufficient distance to the other coupler involved in the uncoupling process. ▪ The CCU shall deactivate the prevent coupling function for the selected coupler by a criterion (e.g., time based, location based, ...) to ensure that sufficient distance has been reached between both involved couplers being involved in the uncoupling process.

B20.16	
Activity	Deactivate prevent coupling
Precondition	▪ -
Conditions	▪ -
Tasks	▪ The function prevent coupling is deactivated
Remarks	▪ If this function cannot be deactivated by the coupler itself (e.g. actuator), then it must be ensured on the infrastructure side with a device in case of hump shunting.
Rationale	▪ -
Postcondition	▪ Coupler is in ready to couple position.
Functional system requirements	▪ The CCU shall be able to monitor the coupler that has sufficient distance to the other coupler involved in the uncoupling process. ▪ The CCU shall deactivate the prevent coupling function for the selected coupler after the successful check that there is a sufficient distance to the other coupler involved in the uncoupling process.

In principle there is nothing described about behaviour of brake air. Decouple with released brike pipe or brake pipe under 5bar pressure with the risk of pressure drop during decoupling and closing of valve.

8.4.14 TP21 – Couple

8.4.14.2 Target Process

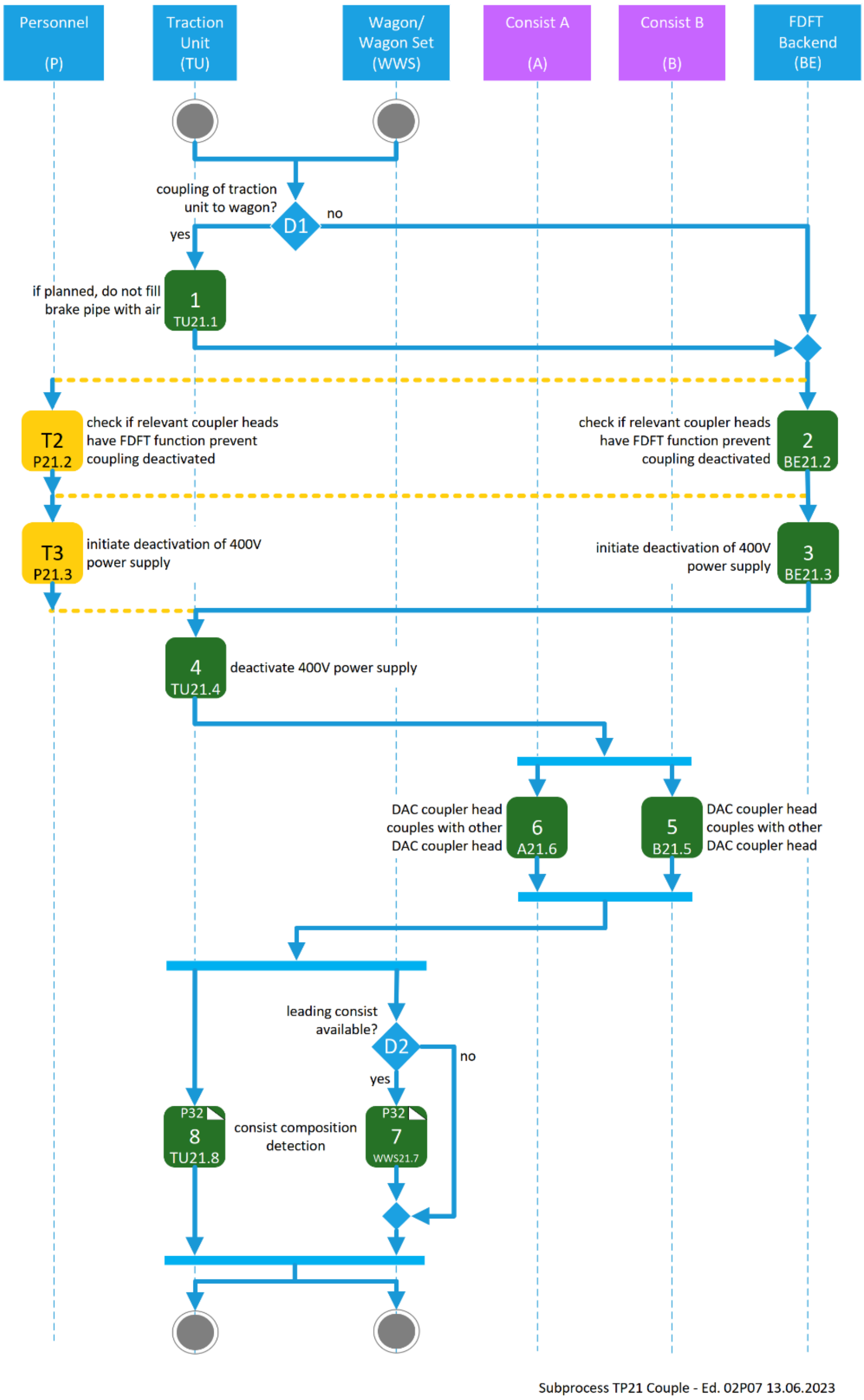


Figure xx: TP21 Couple - 1 of 1

8.4.14.2 Process-Description

This subprocess describes the coupling of two DAC coupler heads mounted on wagon(s)/traction unit(s). The coupling of Stationary Device or other DAC coupler head compatible devices is out of scope of this process.[4]

D1	
Decision	Coupling of Traction Unit to Wagon?
Yes	▪ -
No	▪ -
Remarks	▪ -
Rationale	▪ -

TU21.1	
Activity	If planned do not fill main brake pipe with air
Precondition	▪ -
Conditions	▪ -
Tasks	▪ If planned, ensure that the main brake does not fill with air
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ The communication system of the traction unit (TU) shall be able to receive commands from FDFT backend system or the local HMI ▪ The communication system of the TU shall accept only commands, which are validated, authenticated, and authorized. ▪ The TU shall disable filling the brake pipe with air upon command by the FDFT backend or the local HMI.

BE21.2

[4] Description amended vs. /WP2_D2.1/

Activity	Check if relevant coupling points have FDFT function Prevent Coupling deactivated
Precondition	▪ -
Conditions	▪ FDFT Backend is available and can communicate with relevant FDFT Wagon Base Systems.
Tasks	▪ FDFT Backend checks that the two relevant DAC coupler heads have FDFT function Prevent Coupling deactivated.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -

Functional system requirements	The CCUs of both wagons which are supposed to be coupled shall be able to receive commands from FDFT backend system. This requires having a wireless interface between FDFT Backend and the wagon (e.g.: Mobile Device Interface). This will be detailed in /WP3_D3.2/ and /WP3_D3.3/. The CCUs of the wagons shall be able to address the couplers at the coupling point and to command them that FDFT function Prevent Coupling shall be deactivated. The CCUs of both wagons shall be able to transmit the status message on the deactivated FDFT function Prevent Coupling of the couplers at the coupling point to the FDFT backend system. Remark: From functional perspective it is assumed that the prevent coupling function is deactivated after (e.g.: time out, location, …).

P21.2

Activity	Check if relevant coupling points have FDFT function Prevent Coupling deactivated
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Operator checks that the two relevant DAC coupler heads have FDFT function Prevent Coupling deactivated. ▪ This can also be achieved by using the Mobile HMI.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -

Functional system requirements	▪ The yard personnel shall use a Mobile HMI connected with the wagon CCU to be able to check if the FDFT function Prevent Coupling of the couplers at the coupling point is deactivated. ▪ The CCUs of the wagons shall be able to address the couplers at the coupling point and to command them that FDFT function Prevent Coupling shall be deactivated. ▪ The couplers of the wagon shall be able to deactivate the FDFT function Prevent Coupling and to send a status message on the FDFT function Prevent Coupling to the CCU. ▪ The CCUs of both wagons shall send a status message on the deactivated FDFT function Prevent Coupling of the couplers at the coupling point to a Mobile HMI. ▪ The coupler or the CCU of the wagon shall use an indicator showing if the FDFT function Prevent Coupling of the of the coupler is deactivated.

BE21.3

Activity	Initiate deactivation of 400V power supply
Precondition	▪ -
Conditions	▪ FDFT Backend is available and can initiate power supply.
Tasks	▪ FDFT Backend triggers deactivation of the power supply.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ The communication system of the traction unit (TU) shall be able to receive commands from FDFT backend system. ▪ The communication system of the TU shall accept only commands, which are validated, authenticated, and authorized.

P21.3

Activity	Initiate deactivation of 400V power supply
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Personnel triggers deactivation of the power supply.

Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ Personnel shall be able to initiate disabling of 400V power supply by performing an appropriate switching action (on the driver's desk) and to ensure that the 400V power supply is turned off by observing the HMI of the TU.

TU21.4	
Activity	Deactivate 400V power supply
Precondition	▪ -
Conditions	▪ -
Tasks	▪ 400V power supply will be deactivated in the Traction Unit.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirement	▪ The onboard system of the TU shall be able to deactivate the power supply to the power line upon command. ▪ The new status of the power supply to the power distribution line shall be displayed by the TU HMI and sent to the FDFT-Backend.

B21.5	
Activity	DAC coupler head couples with other DAC coupler head
Precondition	▪ -
Conditions	▪ -
Tasks	▪ DAC coupler head couples with other DAC coupler head
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -

Functional system requirements	▪ DAC coupler head shall be able to couple with other DAC coupler head. ▪ DACs shall connect the brake pipes of the coupled wagons. ▪ DACs shall connect the electric couplers. ▪ CCU shall be able to check the state of coupling of the coupler.

A21.6	
Activity	DAC coupler head couples with other DAC coupler head
Precondition	▪ -
Conditions	▪ -
Tasks	▪ DAC coupler head couples with other DAC coupler head
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ DAC coupler head shall be able to couple with other DAC coupler head. ▪ DACs shall connect the brake pipes of the coupled wagons. ▪ DACs shall connect the electric couplers. ▪ CCU shall be able to check the state of coupling of the coupler

D2	
Decision	Leading consist available?
Yes	▪ -
No	▪ -
Remarks	▪ -
Rationale	▪ -

WWS21.7	
Activity	Subprocess Consist composition detection
Precondition	▪ -
Conditions	▪ -

Tasks	▪ See subprocess description 8.4.21
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ See subprocess description 8.4.21

TU21.8	
Activity	Subprocess Consist composition detection
Precondition	▪ -
Conditions	▪ -
Tasks	▪ See subprocess description 8.4.21
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ See subprocess description 8.4.21

8.4.15 TP22 - Secure Wagon (Set) Against Rolling Away

8.4.15.2 Target Process

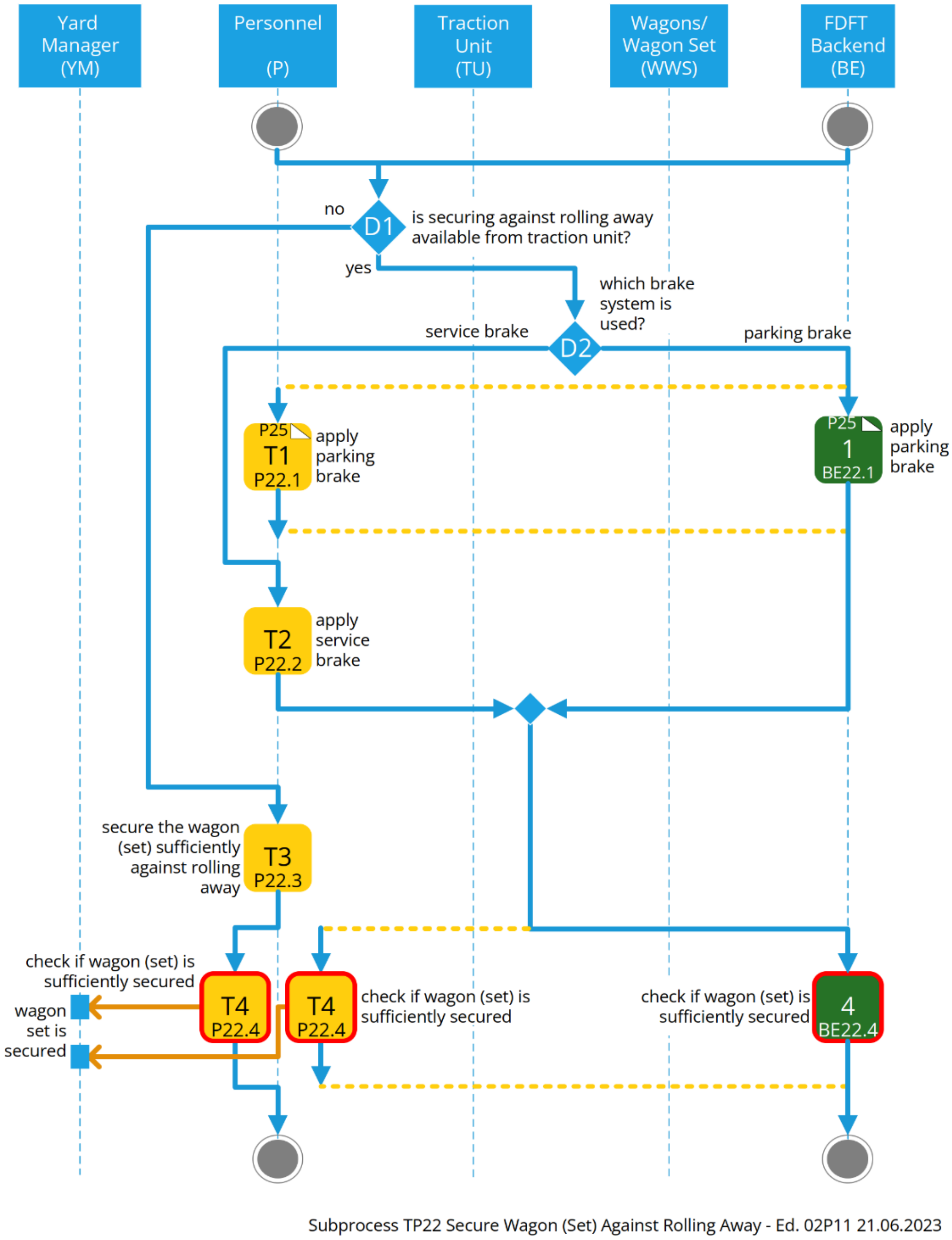


Figure xx: TP22 Secure Wagon (Set) Against Rolling Away - 1 of 1

8.4.15.2 Process-Description

D1	
Decision	Is securing against rolling away available from traction unit?
Yes	▪ -
No	▪ -
Remarks	▪ -
Rationale	▪ -

D2	
Decision	Which brake system is used?
Service brake	▪ -
Parking brake	▪ -
Remarks	▪ -
Rationale	▪ -

BE22.1	
Activity	Subprocess: Apply parking brake
Precondition	▪ -
Conditions	▪ FDFT Backend is available, can communicate with FDFT Wagon Base System and can initiate parking brake
Tasks	▪ See subprocess description 8.4.17
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ The communication system of the traction unit (TU) shall be able to receive commands from FDFT backend system. ▪ The communication system of the TU shall accept only commands, which are validated, authenticated, and authorized. ▪ The communication system of the TU shall be able to send commands to

	the wagon set. ▪ Other functional system requirements see subprocess description 8.4.17

P22.1	
Activity	Subprocess: Apply parking brake
Precondition	▪ -
Conditions	▪ -
Tasks	▪ See subprocess description 8.4.17
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ See subprocess description 8.4.17

P22.2	
Activity	Subprocess: Apply service brake
Precondition	▪ -
Conditions	▪ -
Tasks	▪ See subprocess description 8.4.17
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ See subprocess description 8.4.17

P22.3

Activity	Secure wagon (set) sufficient against rolling away
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Secure wagon (set) against rolling away as legacy process
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ none ▪ The yard personnel shall be able to secure the wagon (set) against rolling away by legacy means (e.g.: existing hand brakes, anti-drift shoes, ...)

BE22.4

Activity	Check if wagon (set) is sufficiently secured
Precondition	▪ -
Conditions	▪ FDFT Backend is available and communicate with FDFT Wagon Base System.
Tasks	▪ FDFT backend checks if the brakes are activated as planned. ▪ The Wagon Status Data for each wagon is stored tamper safe.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ The CCU of the wagon shall be able to communicate with the FDFT backend system. ▪ The CCU of the wagon shall be able to send a status message regarding the brake status to the FDFT backend upon request. ▪ The FDFT backend system shall store the brake status of each wagon together with the wagon list/wagon set.

P22.4

Activity	Check if wagon (set) is sufficiently secured
Precondition	▪ -

Conditions	▪ -
Tasks	▪ Personnel checks the braking status and sends data to Yard Manager
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ If this activity follows activity BE22.1/P22.1 or P22.2, the personnel shall be able to check the braking status of the wagon (set) either by receiving a status message sent by the wagon to a mobile device (legacy) of the personnel or by observing the relevant indicator situated on the wagon. ▪ In both cases the personnel shall be able to report the status to the Yard Manager.

8.4.16 TP23 – Remove, Release Braking Means

8.4.16.2 Target Process

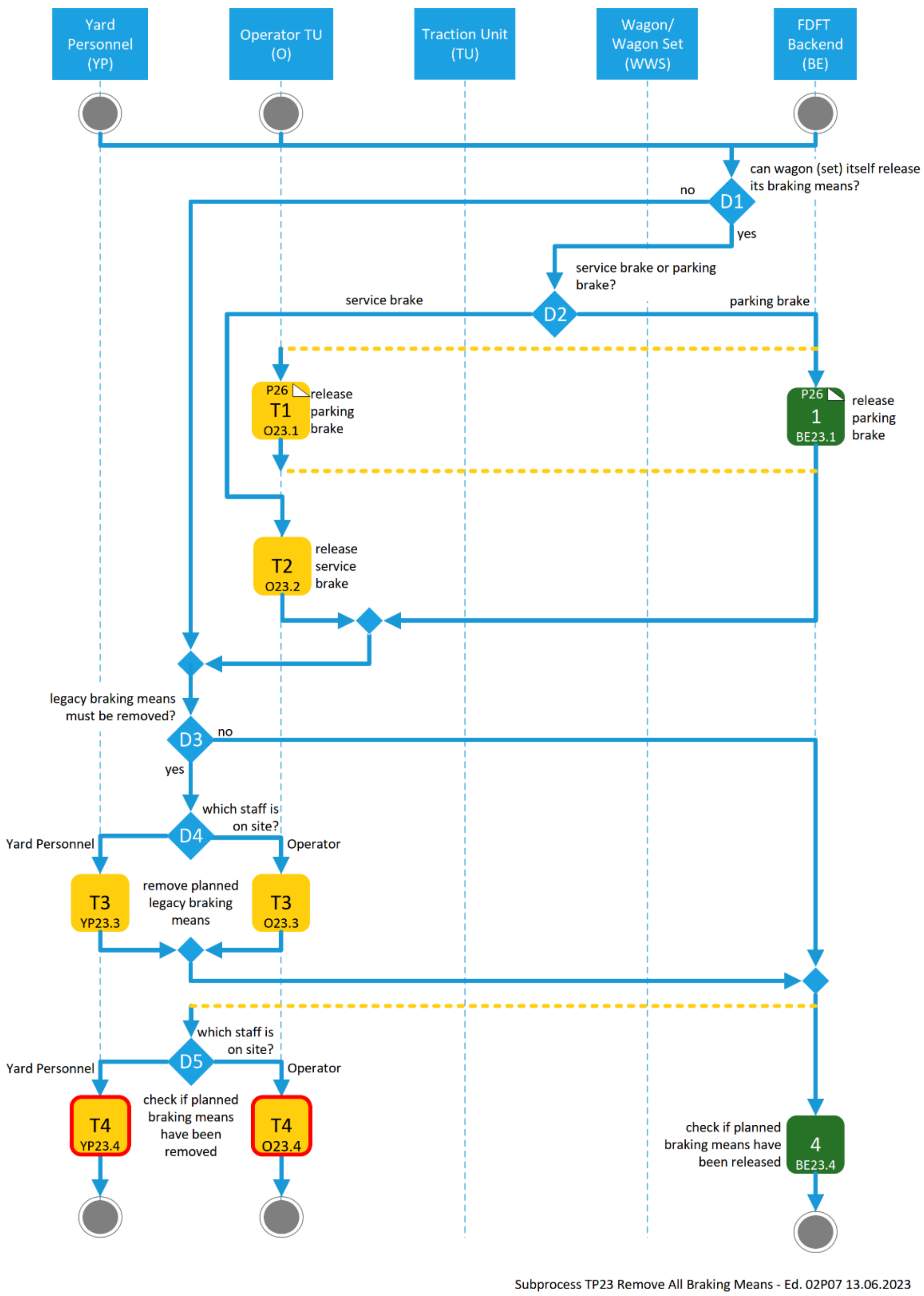


Figure 34: TP23 Remove, Release Braking Means - 1 of 1

8.4.16.2 Process-Description

•

D1	
Decision	Wagon (set) itself can release braking means?
Yes	▪ FDFT Wagon Base System can control all its braking means.
No	▪ -
Remarks	▪ -
Rationale	▪ -

D2	
Decision	Service brake or parking brake to be released?
service brake	▪ -
parking brake	▪ -
Remarks	▪ -
Rationale	▪ -

BE23.1	
Activity	Subprocess: Release parking brake
Precondition	▪ -
Conditions	▪ FDFT Backend is available, can communicate with FDFT Base System and can initiate-parking brake
Tasks	▪ See subprocess description 8.4.18
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ See subprocess description 8.4.18

O23.1	
Activity	Subprocess: Release parking brake
Precondition	▪ -
Conditions	▪
Tasks	▪ See subprocess description 8.4.18
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ See subprocess description 8.4.18

O23.2	
Activity	Release service brake
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Operator releases service brake
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ none ▪ Remark: the service brake is released by legacy means.

D3	
Decision	Legacy braking means must be removed?
Yes	▪ -

No	▪ -
Remarks	▪ -
Rationale	▪ -

D4

Decision	Which staff is on site?
Operator	▪ Operator is on site.
Yard Personnel	▪ Yard Personnel is on site.
Remarks	▪ -
Rationale	▪ -

O23.3

Activity	Remove planned legacy braking means
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Operator removes or releases planned legacy braking means. ▪ Report that planned braking means have been removed or released to FDFT Backend if available.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ none

YP23.3

Activity	Remove planned legacy braking means
Precondition	▪ -

Conditions	▪ -
Tasks	▪ Yard Personnel removes or releases planned legacy braking means. ▪ Report that planned braking means have been removed or released to FDFT Backend if available.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ The yard personnel shall be able to remove or release legacy braking means. ▪ The personnel shall be able to transmit a message to the FDFT backend that the legacy braking means have been removed by using a mobile device (legacy).

BE23.4

Activity	Check if planned braking means have been released
Precondition	▪ -
Conditions	▪ FDFT Backend is available and can communicate with FDFT Wagon Base System
Tasks	▪ FDFT backend checks if the brakes are deactivated as planned. ▪ The Wagon Status Data for each wagon is stored tamper safe.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ The CCU of the wagon shall be able to communicate with the FDFT backend system. ▪ The CCU of the wagon shall be able to detect the status of the brakes. ▪ The CCU of the wagon shall be able to send a status message regarding the brake status to the FDFT backend upon request.

Open point	To be clarified if there are two ways to communicate for the wagon with the backend, either remotely or (preferably using F-TCN and the TU). Will be clarified in /WP3_D3.2/ and /WP3_D3.3/.

D5

Decision	Which staff is on site?
Operator	▪ Operator is on site.
Yard Personnel	▪ Yard Personnel is on site.
Remarks	▪ -
Rationale	▪ -

O23.4

Activity	Check if planned braking means have been removed
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Operator checks that planned braking means have been removed. ▪ Operator reports that planned braking means have been removed (Legacy process) ▪ Operator reports that planned braking means have been removed to FDFT Backend if available.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ None

YP23.4

Activity	Check if planned braking means have been removed
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Yard Personnel checks that planned braking means have been removed. ▪ Yard Personnel reports that planned braking means have been removed (Legacy process) ▪ Yard Personnel reports that planned braking means have been removed to FDFT Backend if available.

Remarks	-
Rationale	-
Postcondition	-
Functional system requirements	▪ None ▪ Remark: Yard personnel checks that the legacy braking means have been removed and transmits a message to the FDFT backend that the legacy braking means have been removed by using a legacy system.

8.4.17 TP25 – Apply Parking Brake

8.4.17.2 Target Process

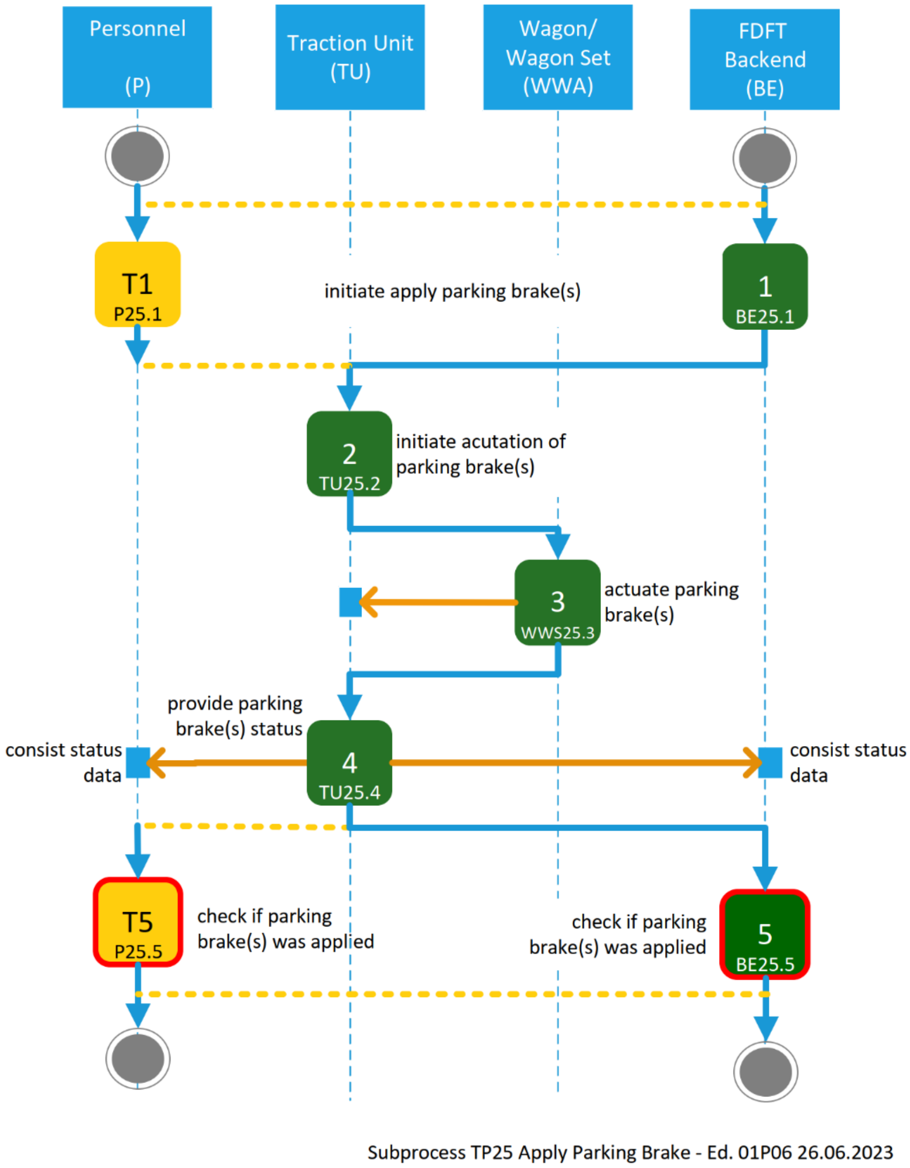


Figure xx: TP25 Apply Parking Brake - 1 of 1

8.4.17.2 Process Description

BE25.1	
Activity	Initiate apply parking brake
Precondition	▪ -
Conditions	▪ FDFT Backend is available, can communicate with FDFT Wagon Base System and can initiate parking brake
Tasks	▪ FDFT Backend selects the parking brake(s) to be applied in a consist composition and triggers the application
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ The communication system of the traction unit (TU) shall be able to receive commands from FDFT backend system. ▪ The communication system of the TU shall accept only commands, which are validated, authenticated, and authorized.

P25.1	
Activity	Initiate apply parking brake
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Personnel selects the parking brake(s) to be applied in a consist composition and triggers the application
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ Personnel shall be able to send a command based on the availability of the parking brakes. ▪ It shall be possible to select wagons to apply the parking brake by using the HMI of the TU. ▪ The wagons shall be able to receive commands from the TU via the F-TCN. ▪ Remark: If this is a transformational activity because the wagon doesn't yet have a remote controllable parking brake, the personnel can still apply the parking brake as legacy procedure (hand wheel) on the

	selected wagons.

TU25.2

Activity	Initiate actuation of parking brake(s)
Precondition	▪ Train composition is valid
Conditions	▪ -
Tasks	▪ FDFT System commands each selected parking brake to be applied, if available.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ The HMI of the TU shall display the availability of the parking brake of each wagon. ▪ The onboard system of the TU shall be able to send a command to the CCUs of the selected wagons to apply the parking brake. ▪ The result of the performed activity shall be displayed on the HMI of the TU.

WWS25.3

Activity	Actuate parking brake(s)
Precondition	▪ t is ensured that wagons are secured against rolling away.
Conditions	▪ -
Tasks	▪ Each consist receiving the apply parking brake command will actuate the parking brake application locally.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ Each wagon shall be able to apply the parking brake upon command. ▪ The status of the parking brake of the wagon shall be indicated at each side of the wagon.

TU25.4

Activity	Provide parking brake(s) status data
Precondition	▪ Train composition is valid
Conditions	▪ -
Tasks	▪ FDFT System collects the status of all parking brakes in the wagon(s) and indicates it to Personnel.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ Each wagon shall be able to detect the status of parking brake applied. ▪ The status is shown to the personnel on the HMI and stored in the so long as the train composition is valid. ▪ The TU shall be able to transmit the status to the FDFT backend.

BE25.5

Activity	Check if parking brake(s) was applied
Precondition	▪ -
Conditions	▪ FDFT Backend is available. FDFT Base System is available and can communicate with FDFT Base System-
Tasks	▪ FDFT Backend checks the status of all parking brakes.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ none

P25.5

Activity	Check if parking brake(s) was applied
Precondition	▪ -

Conditions	▪ -
Tasks	▪ Personnel shall check the status of all parking brakes.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ The personnel shall be able to check the status of all parking brakes of the train on the HMI of the TU. ▪ The personnel shall be able to check the status of the parking brake of a wagon by using the Mobile HMI connected with the wagon CCU or by observing the relevant indicator at the wagon side.

8.4.18 TP26 – Release Parking Brake

8.4.18.2 Target Process

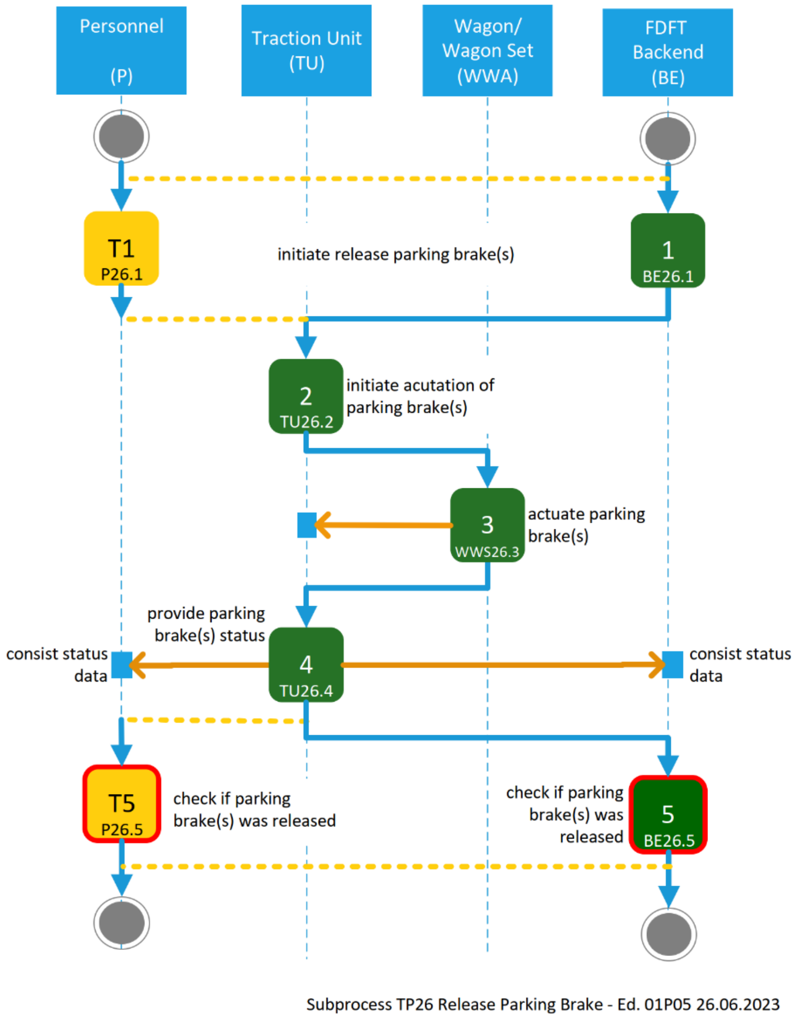


Figure xx: TP26 Release Parking Brake - 1 of 1

8.4.18.2 Process Description

BE26.1	
Activity	Initiate release parking brake
Precondition	▪ -
Conditions	▪ FDFT Backend is available, can communicate with FDFT Wagon Base System and can initiate parking brake
Tasks	▪ FDFT Backend selects the parking brake(s) to be released in a consist composition and triggers the release.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ The communication system of the traction unit (TU) shall be able to receive commands from FDFT backend system. ▪ The communication system of the TU shall accept only commands, which are validated, authenticated, and authorized. ▪ The traction unit shall be able to send commands to dedicated wagons after the acceptance of the relevant commands of the FDFT backend system.

P26.1	
Activity	Initiate release parking brake
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Personnel selects the parking brake(s) to be released in a consist composition and triggers the release.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ Personnel shall be able to send a command to selected wagons to release the parking brake by using the HMI of the TU. ▪ The wagons shall be able to receive commands from the TU via the F-TCN. ▪ Remark: If this is a transformational activity because the wagon doesn’t yet have a remote controllable parking brake, the personnel can still

	release the parking brake as legacy procedure (hand wheel) on the selected wagons.

TU26.2	
Activity	Initiate actuation of parking brake(s)
Precondition	▪ Train composition is valid
Conditions	▪ -
Tasks	▪ FDFT System commands each selected parking brake to be released, if available.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ The onboard system of the TU shall be able to check if the train composition is valid. ▪ The onboard system of the TU shall be able to send a command to the CCUs of the selected wagons to release the parking brake after the positive check by the TU that the train composition is valid and the positive check that the service brake is applied.

WWS26.3	
Activity	Actuate parking brake(s)
Precondition	It is ensured that wagons are secured against rolling away
Conditions	▪ -
Tasks	▪ Each consist receiving the release parking brake command will actuate the parking brake release locally
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ The CCU of the wagon shall be able to check if the service brake is applied. ▪ The CCU of the wagon shall be able to command that its parking brake shall be released after the positive check that the service brake is applied. ▪ The CCU of the wagon shall send a status message of the parking brake to

	the TU upon request.

TU26.4

Activity	Provide parking brake(s) status data
Precondition	▪ Train composition is valid
Conditions	▪ -
Tasks	▪ FDFT System collects the status of all parking brakes of the wagon(s) and indicates it to Personnel
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ The TU will request a status message of all wagons int the train regarding their parking brake application upon command by the FDFT backend or the driver after the positive check that the train composition is valid. ▪ The TU shall be able to display the status on the HMI for the driver and transmit it to the FDT backend.

BE26.5

Activity	Check if parking brake(s) was released
Precondition	▪ -
Conditions	▪ FDFT Backend is available and can communicate with FDFT Wagon Base System
Tasks	▪ FDFT Backend checks the status of all parking brakes.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ The TU shall be able to transmit the status of all parking brakes to the FDFT backend upon request.

P26.5

Activity	Check if parking brake(s) was released
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Personnel shall check the status of all parking brakes.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ none

8.4.19 TP30 – Switch to FDFT mode Shunting

8.4.19.2 Target Process

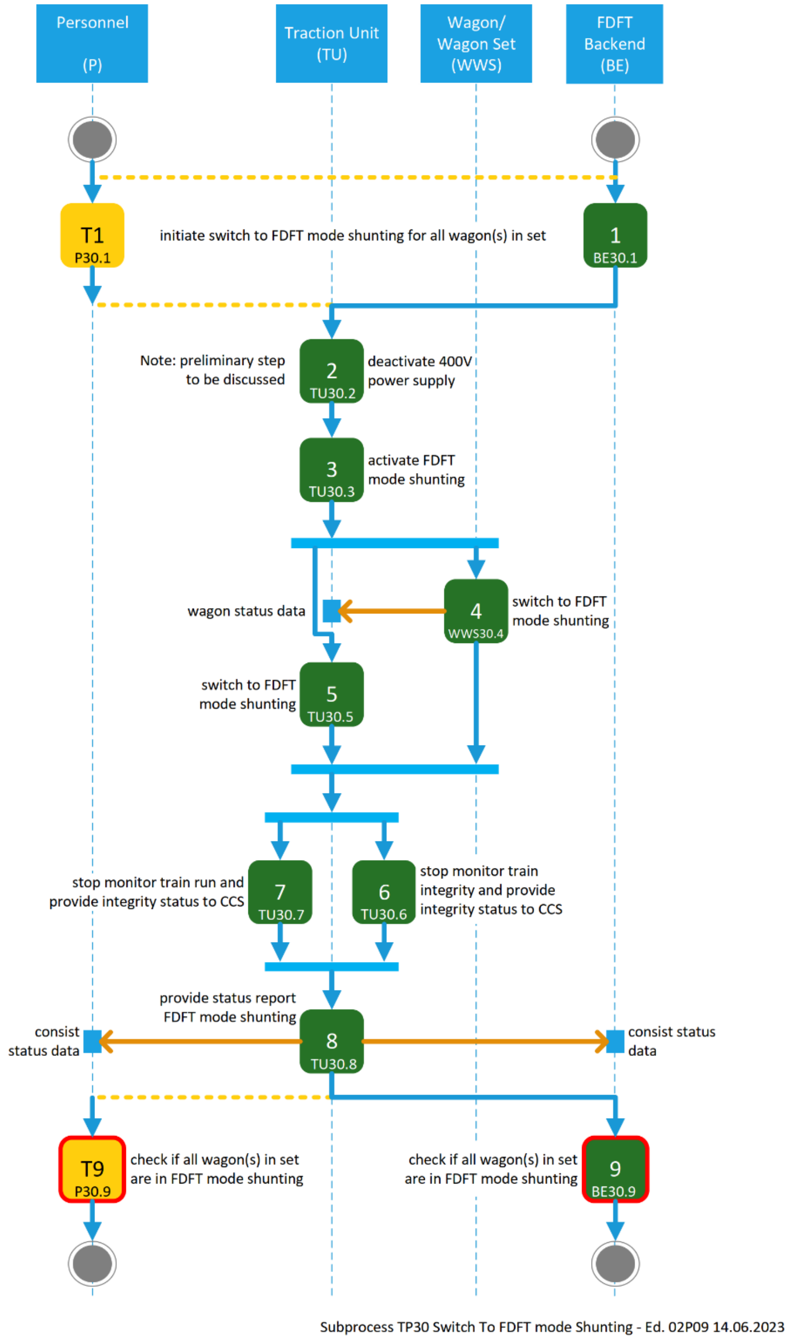


Figure xx: TP30 Switch wagon(s) of set to FDFT mode Shunting - 1 of 1

8.4.19.2 Process-Description

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BE30.1	
Activity	Initiate switch to FDFT mode shunting for all wagon(s) in set
Precondition	▪ -
Conditions	▪ FDFT Backend is available, can communicate with FDFT Wagon Base System for each wagon in set and can initiate Switch to FDTF mode shunting.
Tasks	▪ FDFT Backend initiates activation of FDFT mode Shunting for all wagon(s) in set and traction unit.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ The communication system of the traction unit (TU) shall be able to receive commands from FDFT backend system. ▪ The communication system of the TU shall accept only commands, which are validated, authenticated, and authorized. ▪ The TU shall be able to switch itself to FDFT mode Shunting upon command from the FDFT backend. ▪ The TU unit shall be able to send commands to the wagons after the acceptance of the relevant commands of the FDFT backend system.

P30.1	
Activity	Initiate switch to FDFT mode Shunting for all wagon(s) in set
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Personnel initiates the activation of the FDFT mode Shunting for all wagon(s) in set and traction unit. ▪ This can also be achieved by using the Mobile HMI.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -

Functional system requirements	▪ Personnel shall command the TU to switch to FDFT mode Shunting by using the HMI of the TU. ▪ Personnel shall be able to send a command to switch to FDFT mode Shunting to all wagons by using the HMI of the TU. ▪ The wagons shall be able to receive commands from the TU via the F-TCN. ▪ The wagons shall **not** accept (i.e., reject) a command to switch to FDFT mode Shunting by the yard personnel using a Mobile HMI.

TU30.2	
Activity	Deactivate 400V power supply
Precondition	▪ -
Conditions	▪ -
Tasks	▪ FDFT System deactivates the 400V power supply
Remarks	▪ This activity is included preliminarily.
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ The onboard system of the TU shall be able to deactivate the power supply to the power line upon command from the FDFT backend. ▪ Personnel shall be able to send a command to deactivate the power supply to the power line by using the HMI of the TU.

TU30.3	
Activity	Activate FDFT mode Shunting
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Traction Unit commands activation of FDFT Shunting mode to all consist in the consist composition.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -

Functional system requirements	▪ The TU shall be able to send a command to activate the FDFT mode Shunting to all wagons via F-TCN.

WWS30.4	
Activity	Switch to FDFT mode Shunting
Precondition	▪ -
Conditions	▪ -
Tasks	▪ FDFT Wagon Base System switches to FDFT mode Shunting. ▪ If FDFT Backend is available, the FDFT Wagon Base System sends Wagon Status Data to FDFT Backend.
Remarks	▪ E.g. after switch to FDFT mode Shunting, uncoupling and activation of FDFT function Prevent Coupling is allowed.
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ The CCU's of the wagons shall be able to receive commands from the TU via F-TCN. ▪ Each CCU shall send a message to the TU that command for switching to FDFT mode Shunting was received and the FDFT mode Shunting is on.

TU30.5	
Activity	Switch to FDFT mode Shunting
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Traction Unit switches to FDFT mode Shunting. ▪ If FDFT Backend is available, the Traction Unit sends Wagon Status Data to FDFT Backend.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ The onboard system of the TU shall be able to switch on the "FDFT mode Shunting" upon command from the FDFT backend. ▪ The TU shall send the command switch to "FDFT mode shunting" of data

	regarding the "FDFT mode Shunting" to all wagons. ▪ The TU shall collect the FDFT mode of all wagons in composition and send it to the FDFT Backend.

TU30.6	
Activity	Stop monitor train integrity
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Monitoring of train integrity will be deactivated.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ The TU shall deactivate monitoring of train integrity.

TU30.7	
Activity	Stop monitor train run and provide integrity status to CCS[5]
Precondition	▪ -
Conditions	▪ -
Tasks	▪ The sensor data relevant for the train run are no longer available to the CCS. ▪ The last valid status of the train must be saved.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ The TU shall be able to transmit the integrity status to the CCS via the ETCS on-board device interface

[5] CCS (command control & signalling), not to be confused with "CCU", which was just a typo in /WP2_D2.1/

TU30.8

Activity	Provide status report FDFT mode shunting
Precondition	▪ -
Conditions	▪ -
Tasks	▪ FDFT System of the Traction Unit detects FDFT mode of all consists in consist composition and indicates it to Personnel.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ The FDFT Base System of the traction unit shall query the FDFT mode of itself and all consist in consist composition. ▪ The FDFT Base System of the traction unit shall be able to display the collection of data regarding the FDFT shunting mode of TU and all consists on the HMI of the TU.

BE30.9

Activity	Check if all wagon(s) in set are in FDFT mode Shunting
Precondition	▪ -
Conditions	▪ FDFT Backend is available and can communicate with the FDFT Wagon Base System.
Tasks	▪ FDFT Backend checks if every wagon in set and traction unit is in FDFT mode Shunting.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ The communication system of the traction unit (TU) shall be able to send messages to the FDFT backend. ▪ The TU shall send the collection of data regarding the FDFT shunting mode of TU and all wagons to the FDFT backend.

P30.9

Activity	Check if all wagon(s) in set are in FDFT mode Shunting
Precondition	▪ -
Conditions	▪ Personnel must be able to see the status of all wagons on an HMI.
Tasks	▪ Personnel checks if every wagon in set and traction unit is in FDFT mode Shunting. ▪ This can also be achieved by using the Mobile HMI.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ The HMI of the TU shall be able to display the collection of data regarding the FDFT shunting mode of TU and all wagons. ▪ Each wagon shall provide a message regarding the activation of the FDFT mode Shunting to the Mobile HMI connected with the wagon CCU. ▪ Personnel shall be able to check if every wagon in set and TU is in FDFT mode Shunting by using the HMI of the TU or by using the Mobile Device or by local means of the wagon.

8.4.20 TP31 – Switch to FDFT mode Train Run

8.4.20.2 Target Process

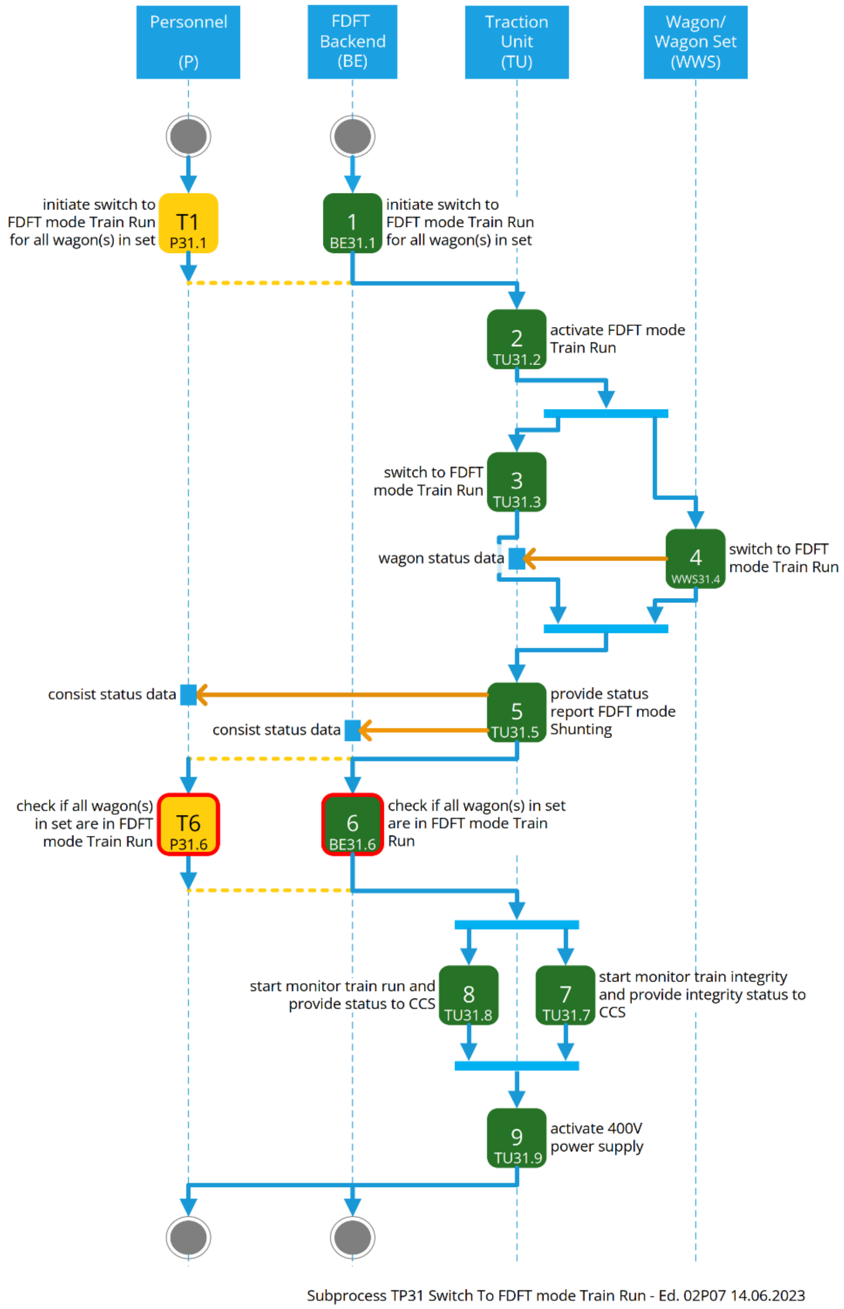

Figure 35: TP31 Switch to FDFT mode Train Run - 1 of 1

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8.4.20.2 Process-Description

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BE31.1	
Activity	Initiate switch to FDFT mode Train Run for all wagon(s) in set
Precondition	▪ -
Conditions	▪ FDFT Backend is available, can communicate with FDFT Wagon Base System for each wagon in set and can initiate switch to FDFT mode Train Run.
Tasks	▪ FDFT Backend initiates switch to FDFT mode Train Run for all wagon(s) in set and traction unit.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ The communication system of the traction unit (TU) shall be able to receive commands from FDFT backend system. ▪ The TU shall be able to switch to FDFT mode Train Run upon command from the FDFT backend. ▪ The TU unit shall be able to send commands to the wagons after the acceptance of the relevant commands of the FDFT backend system.

P31.1	
Activity	Initiate switch to FDFT mode Train Run for all wagon(s) in set
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Personnel initiates the activation of the FDFT mode Train Run for all wagon(s) in set and traction unit. ▪ This can also be achieved by using the Mobile HMI.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ Personnel shall be able to send a command to switch to FDFT mode Train Run to all wagons by using the HMI of the TU. ▪ The wagons shall be able to receive commands from the TU via the F-TCN. ▪ The wagons shall **not** accept (i.e., shall reject) the activation of the FDFT

	function Train Run by the yard personnel using a Mobile HMI.

TU31.2

Activity	Activate FDFT mode train run
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Traction Unit commands activation of FDFT mode Train Run to all consist in the consist composition.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ The TU shall be able to send a command to activate the FDFT mode Train Run to all wagons via F-TCN.

TU31.3

Activity	Switch to FDFT mode Train Run
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Traction Unit switches to FDFT mode Train Run.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ The onboard system of the TU shall be able to switch to FDFT mode Train Run upon command from the FDFT backend or upon command from HMI in TU

WWS31.4

Activity	Switch to FDFT mode Train Run
Precondition	▪ -
Conditions	▪ -
Tasks	▪ FDFT Wagon Base System switches to FDFT mode Train Run. ▪ If FDFT Backend is available, the FDFT Wagon Base System sends Wagon Status Data to FDFT Backend.
Remarks	▪ E.g., after switch to FDFT mode Train Run, Uncoupling and activation of FDFT function Prevent Coupling is not allowed.
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ The CCU's of the wagons shall be able to receive commands from the TU via F-TCN. ▪ Each CCU shall send a message to the TU that switching to FDFT mode Train Run was received and successfully switched into FDFT mode "Train Run"

TU31.5

Activity	Provide status report FDFT mode Shunting / Train Run
Precondition	▪ -
Conditions	▪ -
Tasks	▪ FDFT System of the Traction Unit detects FDFT mode of all consists in consist composition and indicates it to Personnel.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ The TU shall be able to display the collection of data regarding the FDFT mode "Shunting" or "Train Run" of TU and all wagons in composition on the HMI of the TU.

BE31.6

Activity	Check if all wagon(s) in set are in FDFT mode Train Run
Precondition	▪ -

Conditions	▪ FDFT Backend is available and can communicate with FDFT Wagon Base System.
Tasks	▪ FDFT Backend checks if every wagon in set and traction unit is in FDFT mode Train Run.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ The TU shall send the collection of data regarding the FDFT mode Train Run of TU and all wagons to the FDFT backend. ▪ Remark: A joint message shall be considered, saying that train is completely in FDFT Mode Train Run. This message shall include all wagons in composition. This requirement will be detailed in /WP3_D3.3/

P31.6

Activity	Check if all wagon(s) in set are in FDFT mode Train Run
Precondition	▪ -
Conditions	▪ Personnel must be able to see the status of all wagons on an HMI.
Tasks	▪ Personnel checks if every wagon in set and traction unit is in FDFT mode Train Run. ▪ This can also be achieved by using the Mobile HMI.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ The HMI of the TU shall be able to display the collection of data regarding the FDFT mode Train Run of TU and all wagons. ▪ Each wagon shall transmit a message regarding the activation of the FDFT mode Train Run to the Mobile HMI connected with the wagon CCU. ▪ Personnel shall be able to check if every wagon in set and TU is in FDFT mode Train Run by using the local HMI of the TU.

TU31.7

Activity	Start monitor train integrity and provide integrity status to CCS
Precondition	▪ -

Conditions	▪ -
Tasks	▪ Monitoring of train integrity will be activated and reported to the CCS on the Traction Unit.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ Missing

TU31.8

Activity	Start monitor train run and provide status to ~~CCU~~ CCS
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Sensor data relevant for the train run are made available to the ~~CCU~~ CCS in order to be able to record and monitor the condition of the train.
Remarks	▪ E.g. goods monitoring, tracking, ...
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ Missing

TU31.9

Activity	Activate 400V power supply
Precondition	▪ Train composition is valid
Conditions	▪ -
Tasks	▪ FDFT System activates the 400V power supply
Remarks	▪ -
Rationale	▪ -

Postcondition	▪ -
Functional system requirements	▪ The onboard system of the TU shall be able to activate the power supply to the power line upon command from the FDFT backend.

8.4.21 TP32 – Composition Detection –

8.4.21.2 Target Process

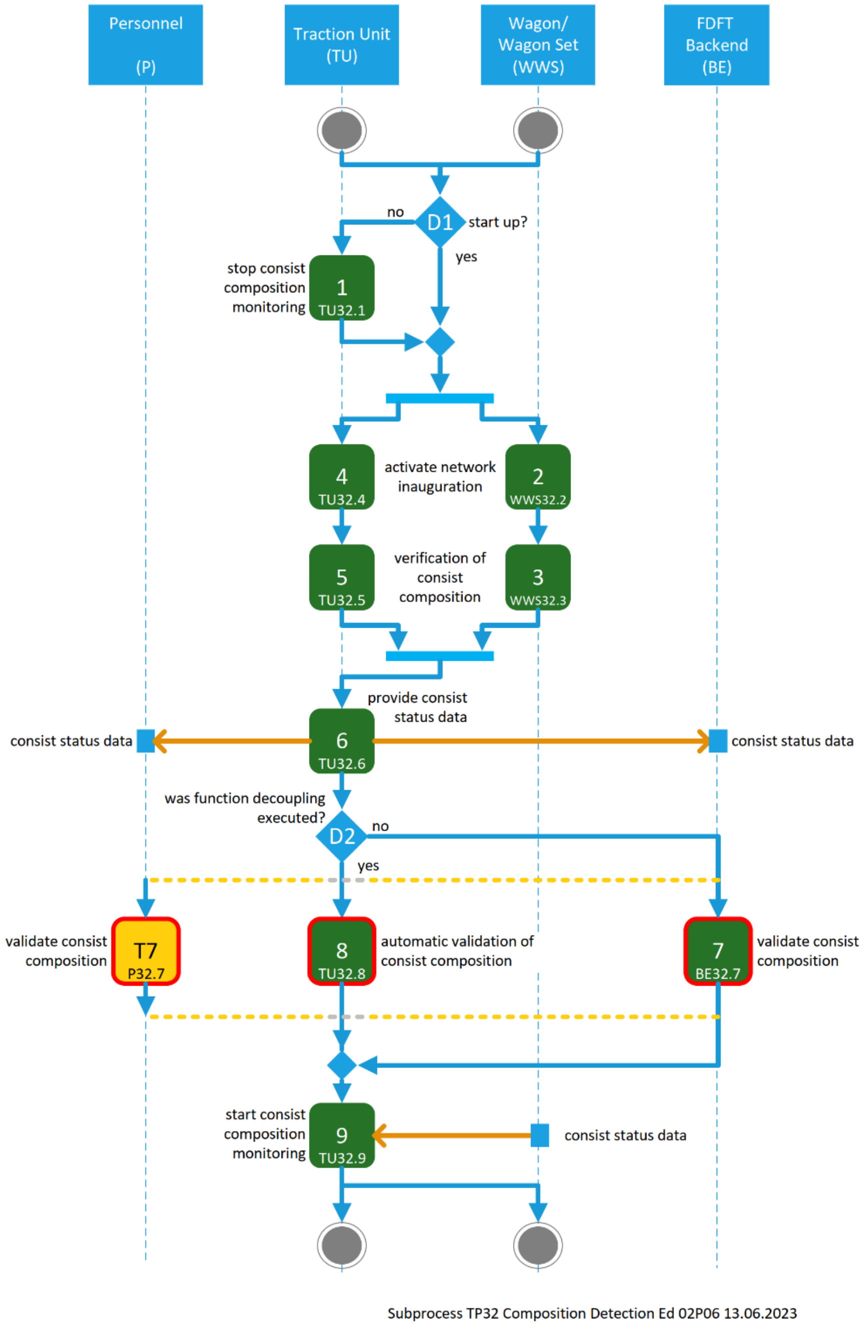

Figure 36: TP32 Composition Detection - 1 of 1

8.4.21.2 Process Description

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D1	
Decision	Start up?
Yes	▪ FDFT System powers up from power off status
No	▪ -
Remarks	▪
Rationale	▪

TU32.1	
Activity	Stop consist composition monitoring
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Traction Unit stops monitoring of the current consist composition
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	The FDFT base system of the traction unit shall be able to stop monitoring of the current consist composition upon request.

WWS32.2	
Activity	Activate network inauguration
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Network inauguration is executed by FDFT System in all consists to compile a network node list
Remarks	▪ -
Rationale	▪ -

Postcondition	▪ -
Functional system requirements	▪ The FDFT base system of the consists of the wagon (set) shall be able to support the network inauguration upon request from the FDFT base system of the traction unit.

WWS32.3	
Activity	Verification of consist composition
Precondition	▪ -
Conditions	▪ -
Tasks	▪ FDFT System verifies the network node list detects further consist which are either unpowered or which leaking a network node and build a composition list (consist status data)
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ The FDFT base system of the consists of the wagon (set) shall be able to support the verification of the network node list and the compilation of the composition list upon request from the FDFT base system of the traction unit.

TU32.4	
Activity	Activate network inauguration
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Network inauguration is executed by FDFT System in all consists to compile a network node list
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -

Functional system requirements	▪ The FDFT base System of the traction unit shall be able to start the network inauguration to compile the network node list

TU32.5

Activity	Verification of consist composition
Precondition	▪ -
Conditions	▪ -
Tasks	▪ FDFT System verifies the network node list detects further consist which are either unpowered or which leaking a network node and build a composition list (consist status data)
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ The FDFT base system of the traction unit shall be able to verify the network node list and to build the consist composition list

TU32.6

Activity	Provide consist composition
Precondition	▪ -
Conditions	▪ -
Tasks	▪ FDFT System indicates the detected composition list to Personnel or FDFT Backend
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -

Functional system requirements	▪ The FDFT base system of the traction unit shall be able to provide the detected composition list to FDFT Backend upon request from the FDFT backend. ▪ The FDFT base system of the traction unit shall be able to display the detected composition list on the HMI of the TU to Personnel upon request.

D2

Decision	Was function uncoupling executed?
Yes	▪ If FDFT System detects based on the detected composition only a shortening of the last valid composition, a validation by Personnel or FDFT Backend is not necessary
No	▪ -
Remarks	▪ In case of uncoupling without the train function being activated by Personnel/Backend, the train driver/backend system should receive a status message.
Rationale	▪ -

BE32.7

Activity	Validate consist composition
Precondition	▪ -
Conditions	▪ FDFT Backend is available.
Tasks	▪ Validate consist composition
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ None ▪ Remark: The validation is done in FDFT backend.

P32.7

Activity	Validate consist composition
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Personnel shall validate the indicated consist composition - indicated consist composition shall fit to the real consist composition
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ None ▪ Personnel shall be able to validate the indicated consist composition comparing the indicated consist composition with the real consist composition.

TU32.8

Activity	Automatic validation of consist composition
Precondition	▪ Uncoupling is activated
Conditions	▪ -
Tasks	▪ Consist composition is set to automatically valid if it fits to the last valid composition minus uncoupled consists
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ The FDFT base system of the traction unit shall set Consist composition to valid automatically, if it fits to the last valid composition minus uncoupled consists

TU32.9

Activity	Start consist composition monitoring

Precondition	▪ -
Conditions	▪ -
Tasks	▪ Traction Unit starts monitoring of the current consist composition
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ The FDFT base system of the traction unit shall be able to start monitoring of the current consist composition upon request

8.4.22 TP41 – Addition, Removal of Wagon (Set)

8.4.22.2 Target Process

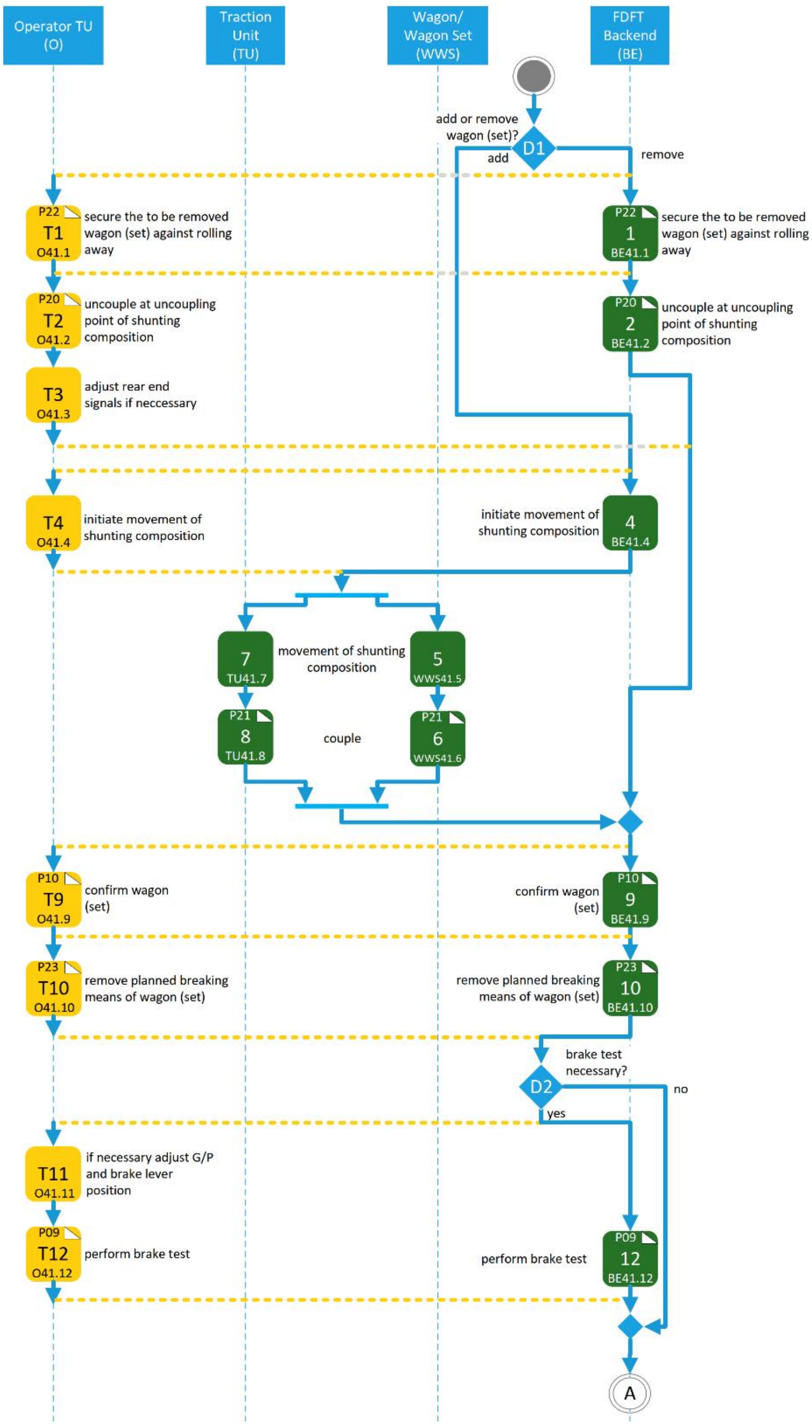

Figure 37: TP41 Addition, Removal of Wagon (Set) - 1 of 2

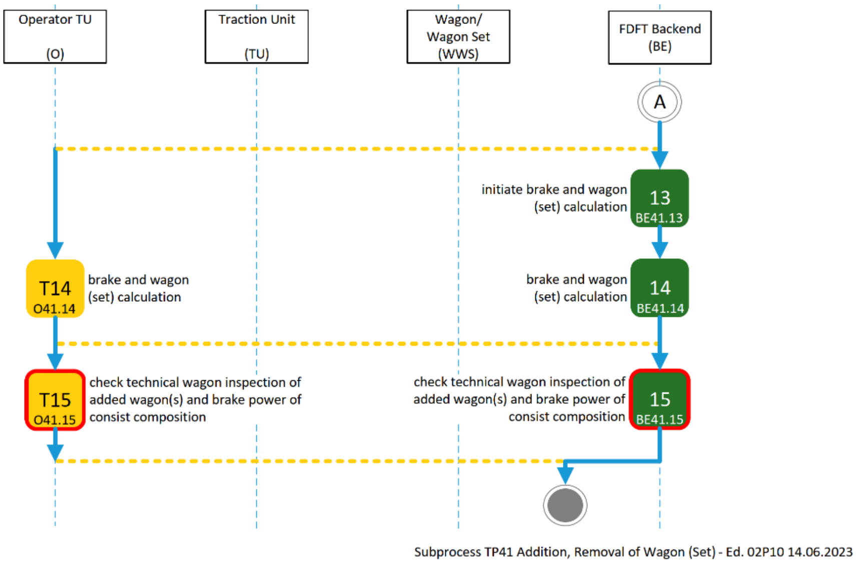

Figure 38: TP41 Addition, Removal of Wagon (Set) - 2 of 2

8.4.22.2 Process-Description

D1	
Decision	Add or remove wagon (set)?
Add	▪ -
Remove	▪ -
Remarks	▪ -
Rationale	▪ -

BE41.1	
Activity	Subprocess: Secure to be removed wagon (set) against rolling away
Precondition	▪ -
Conditions	▪ FDFT Backend is available and, can communicate with FDFT Base System and can initiate secure against rolling away.
Tasks	▪ See subprocess description 8.4.15
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ See subprocess description 8.4.15

O41.1	
Activity	Subprocess: Secure to be removed wagon (set) against rolling away
Precondition	▪ -
Conditions	▪ -
Tasks	▪ See subprocess description 8.4.15
Remarks	▪ -
Rationale	▪ -

Postcondition	▪ -
Functional system requirements	▪ See subprocess description 8.4.15

BE41.2

Activity	Subprocess: uncouple at uncoupling point of shunting composition
Precondition	▪ -
Conditions	▪ FDFT Backend is available and, can communicate with FDFT Base System and can initiate uncouple.
Tasks	▪ See subprocess description 8.4.13
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ See subprocess description 8.4.13

O41.2

Activity	Subprocess: uncouple at uncoupling point of shunting composition
Precondition	▪ -
Conditions	▪ -
Tasks	▪ See subprocess description 8.4.13
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ See subprocess description 8.4.13

O41.3	
Activity	Adjust rear end signals if necessary
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Operator adjusts rear end signals.
Remarks	▪ This step can be skipped if not necessary according to regulations. ▪ E.g., train integrity monitoring makes rear end signal obsolete.
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ Operator shall adjust rear end signals if necessary, according to regulations.

BE41.4	
Activity	Initiate movement of shunting composition
Precondition	▪ Automated Parking Brake released, Controllable Brake released, traction is allowed and possible.
Conditions	▪ FDFT Backend is available.
Tasks	▪ Increase traction force and gain speed up to shunting yard regulatory maximum.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ The communication system of the traction unit (TU) shall be able to receive commands from FDFT backend system. ▪ The communication system of the TU shall accept only commands, which are validated, authenticated, and authorized. ▪ The TU shall be able to check if the service brake of the train and the parking brakes of all consists of the train are released. ▪ The control system of the TU shall be able to apply tractive effort to gain speed and shall be able to control speed up to shunting yard regulatory maximum upon command of the FDFT backend.

O41.4	
Activity	Initiate movement of shunting composition
Precondition	▪ Automated Parking Brake released, Controllable Brake released, traction is allowed and possible.
Conditions	▪ -
Tasks	▪ Increase traction force and gain speed up to shunting yard regulatory maximum.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ The operator shall be able to check if the service brake of the train and the parking brakes of all consists of the train are released. ▪ The operator shall command the TU to apply tractive effort to gain speed and shall be able to control speed up to shunting yard regulatory maximum by using appropriate operating actions.

TU41.7	
Activity	Movement of shunting composition
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Movement of shunting composition to wagon (set)
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ The TU shall move the shunting composition to the wagon (set) to be added based on the application of tractive effort whilst controlling the speed up to shunting yard regulatory maximum. ▪ The TU shall be able to reduce speed to an appropriate value for coupling whilst approaching the wagon (set) to be added.

TU41.8	
Activity	Subprocess: Couple
Precondition	▪ -
Conditions	▪ -
Tasks	▪ See subprocess description 8.4.14
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ See subprocess description 8.4.14

WWS41.5	
Activity	Movement of shunting composition
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Movement of shunting composition to wagon (set)
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ The wagon (set) of the shunting composition shall be moved from the TU to the wagon (set) to be added.

WWS41.6	
Activity	Subprocess: Couple
Precondition	▪ -

Conditions	▪ -
Tasks	▪ See subprocess description 8.4.14
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ See subprocess description 8.4.14

BE41.9	
Activity	Subprocess: Confirm wagon set
Precondition	▪ -
Conditions	▪ FDFT Backend is available and can communicate with FDFT Wagon Base System.
Tasks	▪ See subprocess description 8.4.11
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ See subprocess description 8.4.11

O41.9	Add or remove wagon (set)
Activity	Subprocess: Confirm wagon set
Precondition	▪ -
Conditions	▪ -
Tasks	▪ See subprocess description 8.4.11

Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ See subprocess description 8.4.11

BE41.10	
Activity	Subprocess: Remove planned braking means of wagon set
Precondition	▪ -
Conditions	▪ FDFT Backend is available, can communicate with FDFT Wagon Base System and can initiate remove braking means.
Tasks	▪ See subprocess description 8.4.16
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ See subprocess description 8.4.16

O41.10	
Activity	Subprocess: Remove braking means of wagon set
Precondition	▪ -
Conditions	▪ -
Tasks	▪ See subprocess description 8.4.16
Remarks	▪ -
Rationale	▪ -

Postcondition	▪ -
Functional system requirements	▪ See subprocess description 8.4.16

D2	
Decision	Brake test necessary?
Yes	▪ -
No	▪ -
Remarks	▪ For example, a brake test must be made when a wagon will be added.
Rationale	▪ -

BE41.12	
Activity	Subprocess: Perform brake test
Precondition	▪ -
Conditions	▪ FDFT Backend is available, can communicate with FDFT Wagon Base System and can initiate brake test.
Tasks	▪ See subprocess description 8.4.10
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ See subprocess description 8.4.10

O41.11

Activity	If necessary, adjust brake lever position
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Operator adjusts brake lever position if necessary.
Remarks	▪ This step can be skipped if wagon is equipped with a brake system not needing manual lever changes.
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ None

O41.12

Activity	Subprocess: Perform brake test
Precondition	▪ -
Conditions	▪ -
Tasks	▪ See subprocess description 8.4.10
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ See subprocess description 8.4.10

BE41.13

Activity	Initiate brake and Wagon (Set) calculation
Precondition	▪ -
Conditions	▪ FDFT Backend is available, can communicate with FDFT Wagon Base System and can initiate brake calculation.
Tasks	▪ Compile all information needed to calculate brake power. ▪ This may include getting data from other systems (not part of FDFT

	System environment)
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ None ▪ Remark: The brake calculation is done in FDFT backend or FDFT systems or legacy systems being interfaced to the FDFT Backend.

BE41.14

Activity	Brake and Wagon (Set) calculation
Precondition	▪ -
Conditions	▪ -
Tasks	▪ FDFT Backend uses compiled data on wagon(s) of set and load and calculates available brake power.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ None ▪ Remark: The brake calculation is done in FDFT backend or FDFT systems or legacy systems being interfaced to the FDFT Backend.

O41.14

Activity	Brake and Wagon (Set) calculation
Precondition	▪ -
Conditions	▪ FDFT Backend is available.
Tasks	▪ Legacy processes for calculation of available brake power.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -

Functional system requirements	▪ None ▪ The operator triggers the legacy processes for calculation of available brake power and receives the result via legacy means.

BE41.15

Activity	Check technical wagon inspection of added wagon(s) and brake power of consist composition
Precondition	▪ -
Conditions	▪ FDFT Backend is available
Tasks	▪ FDFT Backend checks that added wagon(s) passed technical wagon inspection and stores that information tamper safe. ▪ FDFT Backend checks that brake power is sufficient.
Remarks	▪ Technical wagon inspection for added wagon(s) is done beforehand and not part of this process.
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ The TU shall be able to receive clearance by the FDFT backend that the added wagon(s) passed technical wagon inspection.

O41.15

Activity	Check technical wagon inspection of added wagon(s) and brake power of consist composition
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Operator checks that available brake power is sufficient for planned track. ▪ Operator checks technical wagon inspection data. ▪ Operator checks restrictions due to requirements. E.g. wagon clearance, exceptional consignments.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -

Functional system requirements	▪ The operator shall be able to check that available brake power is sufficient for planned train run by observing the information given at the HMI of the TU. ▪ The operator shall be able to access technical wagon inspection data or other restrictions relevant for the planned train run by observing the information given at the HMI of the TU.

8.4.23 TP42 – Addition, Removal of Traction Unit

8.4.23.2 Target Process

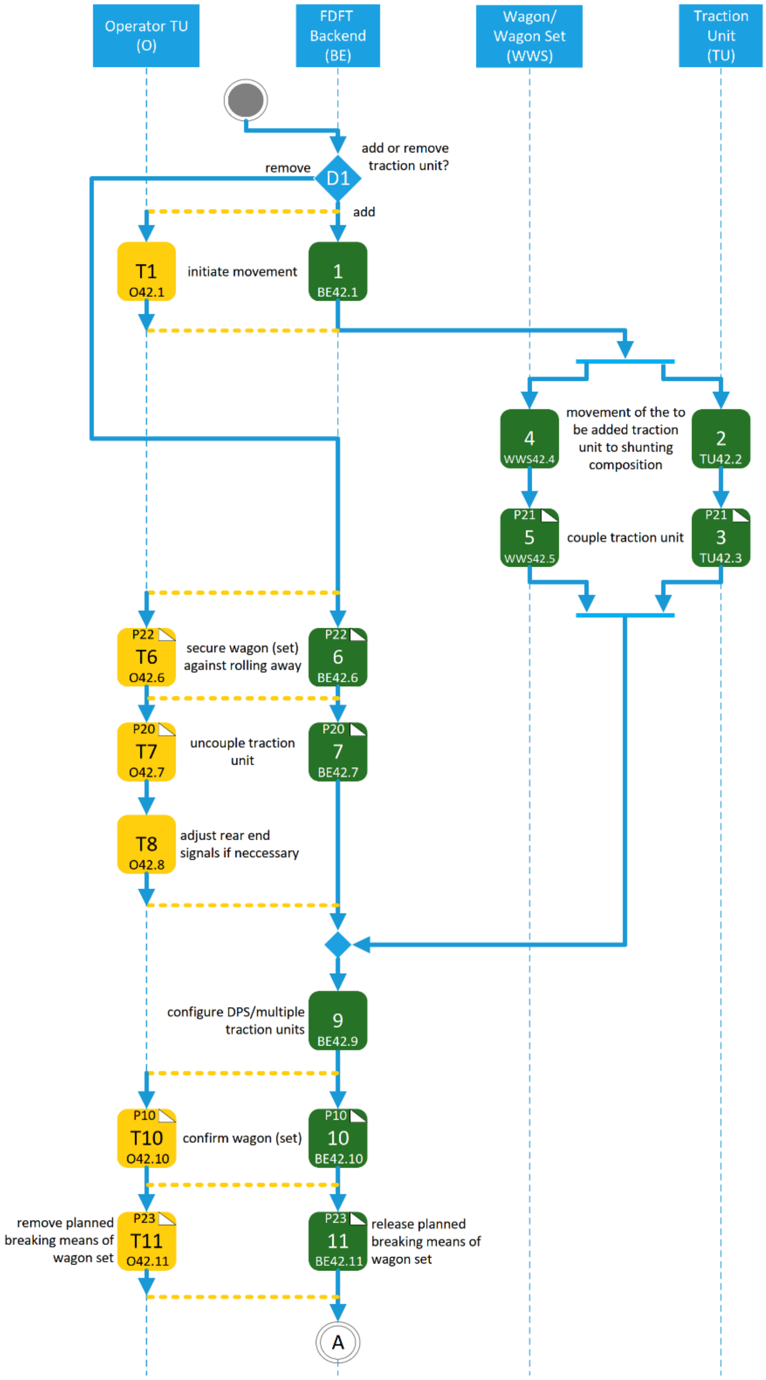

Figure xx: TP42 Addition, Removal of Traction Unit - 1 of 2

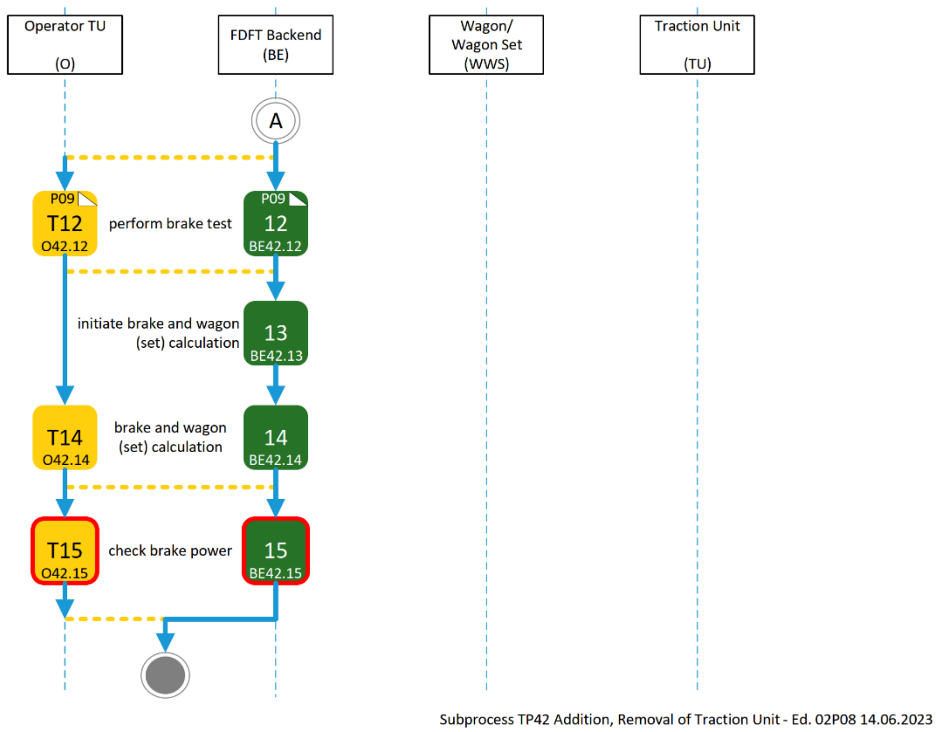

Figure xx: TP42 Addition Removal of Traction Unit - 2 of 2

8.4.23.2 Process-Description

D1	
Decision	Add or remove traction unit?
Add	▪ -
Remove	▪ -
Remarks	▪ -
Rationale	▪ -

BE42.1	
Activity	Initiate movement
Precondition	▪ Automated Parking Brake released, Controllable Brake released, traction is allowed and possible.
Conditions	▪ FDFT Backend is available and can initiate movement of Traction Unit
Tasks	▪ Increase traction force and gain speed up to shunting yard regulatory maximum.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ The communication system of the traction unit (TU) shall be able to receive commands from FDFT backend system. ▪ The communication system of the TU shall accept only commands, which are validated, authenticated, and authorized. ▪ The TU shall be able to check if the service brake and the parking brake of the TU are released. ▪ The control system of the TU shall be able to apply tractive effort to gain speed and shall be able to control speed up to shunting yard regulatory maximum upon command of the FDFT backend.

O42.1	
Activity	Initiate movement
Precondition	▪ Automated Parking Brake released, Controllable Brake released, traction is allowed and possible.

Conditions	▪ -
Tasks	▪ Increase traction force and gain speed up to shunting yard regulatory maximum.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ The operator shall be able to check if the service brake and the parking brake of the TU are released. ▪ The operator shall command the TU to apply tractive effort to gain speed and shall be able to control speed up to shunting yard regulatory maximum by using appropriate operating actions.

TU42.2

Activity	Movement of the to be added Traction Unit to shunting composition
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Traction Unit moves to the shunting composition.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ none ▪ Remark: Movement of the traction unit to be added to the shunting composition. This is done by legacy systems TU ATO / landside ATO.

TU42.3

Activity	Subprocess: Couple Traction Unit
Precondition	▪ -
Conditions	▪ -
Tasks	▪ See subprocess description Couple 8.4.14
Remarks	▪ -

Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ See subprocess description 8.4.14

WWS42.4

Activity	Movement of the to be added Traction Unit to shunting composition
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Traction Unit moves to the shunting composition.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ none

WWS42.5

Activity	Subprocess: Couple Traction Unit
Precondition	▪ -
Conditions	▪ -
Tasks	▪ See subprocess description Couple 8.4.14
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ See subprocess description Couple 8.4.14

BE42.6

Activity	Subprocess: Secure Wagon (Set) against rolling away
Precondition	▪ -
Conditions	▪ FDFT Backend is available, can communicate with the FDFT Wagon Base System and can initiate securing against rolling away
Tasks	▪ See subprocess description 8.4.15
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ The communication system of the traction unit (TU) shall be able to receive commands from FDFT backend system. ▪ The communication system of the TU shall accept only commands, which are validated, authenticated, and authorized. ▪ The communication system of the TU shall be able to send commands to the wagon set. ▪ Other functional system requirements see subprocess description 8.4.15

O42.6

Activity	Subprocess: Secure the Wagon (Set) against rolling away
Precondition	▪ -
Conditions	▪ -
Tasks	▪ See subprocess description 8.4.15
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ See subprocess description 8.4.15

BE42.7

Activity	Subprocess: Uncouple traction unit
Precondition	▪ -
Conditions	▪ FDFT Backend is available, can communicate with the FDFT Wagon Base System and can initiate uncoupling of traction unit
Tasks	▪ See subprocess description 8.4.13
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ See subprocess description 8.4.13

O42.7

Activity	Subprocess: Uncouple traction unit
Precondition	▪ -
Conditions	▪ -
Tasks	▪ See subprocess description 8.4.13
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ See subprocess description 8.4.13

O42.8

Activity	Adjust rear end signals if necessary
Precondition	▪ -
Conditions	▪ -

Tasks	▪ Operator adjusts rear end signals.
Remarks	▪ This step can be skipped if not necessary according to regulations. ▪ E.g. train integrity monitoring makes rear end signal obsolete.
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ Operator shall adjust rear end signals if necessary, according to regulations.

BE42.9

Activity	Configure DPS/multiple traction units
Precondition	▪ -
Conditions	▪ FDFT Backend is available.
Tasks	▪ This step is a placeholder for processes needed to reflect the changed train configuration.
Remarks	▪ E.g. assign new master traction unit.
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ Functional system requirements to be clarified upon clarification of tasks.

BE42.10

Activity	Subprocess: Confirm wagon set
Precondition	▪ -
Conditions	▪ FDFT Backend is available and can communicate with FDFT Wagon Base System.
Tasks	▪ See subprocess description 8.4.11
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -

Functional system requirements	▪ See subprocess description 8.4.11

O42.10	
Activity	Subprocess: Confirm wagon set
Precondition	▪ -
Conditions	▪ -
Tasks	▪ See subprocess description 8.4.11
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ See subprocess description 8.4.11

BE42.11	
Activity	Subprocess: Release planned braking means of wagon set
Precondition	▪ -
Conditions	▪ FDFT Backend is available, can communicate with the FDFT Base System and can initiate releasing of braking means.
Tasks	▪ See subprocess description 8.4.16
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ See subprocess description 8.4.16

O42.11

Activity	Subprocess: Remove planned braking means of wagon set
Precondition	▪ -
Conditions	▪ -
Tasks	▪ See subprocess description 8.4.16
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ See subprocess description 8.4.16

BE42.12

Activity	Subprocess: Perform brake test
Precondition	▪ -
Conditions	▪ FDFT Backend is available, can communicate with the FDFT Base System and can initiate brake test.
Tasks	▪ See subprocess description 8.4.10
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ See subprocess description 8.4.10

O42.12

Activity	Subprocess: Perform brake test
Precondition	▪ -
Conditions	▪ -

Tasks	▪ See subprocess description 8.4.10
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ See subprocess description 8.4.10

BE42.13

Activity	Initiate brake and wagon (set) calculation
Precondition	▪ -
Conditions	▪ FDFT Backend is available and can initiate brake calculation
Tasks	▪ FDFT Backend triggers calculation of brake and wagon (set) values
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ none

BE42.14

Activity	brake and wagon (set) calculation
Precondition	▪ -
Conditions	▪ FDFT Backend is available.
Tasks	▪ FDFT Backend calculates brake and wagon (set) valuest
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -

Functional system requirements	▪ none

O42.14	
Activity	Brake and wagon (set) calculation
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Carry out brake and wagon set calculation.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ None ▪ Remark: The operator performs the (legacy) process for brake calculation.

BE42.15	Add or remove traction unit
Activity	Check brake power
Precondition	▪ -
Conditions	▪ FDFT Backend is available.
Tasks	▪ Calculated brake power is compared to the required main line minimum brake power at the given speed.
Remarks	▪ If brake power is insufficient for intended speed, then select appropriate lower speed for that mainline track.
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ none

O42.15

Activity	Check brake power
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Calculated brake power is compared to the required main line minimum brake power at the given speed.
Remarks	▪ If brake power is insufficient for intended speed, then select appropriate lower speed for that mainline track.
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ None ▪ Remark: Check is to be done by legacy means.

8.4.24 TP43 - Change of Operator

8.4.24.2 Target Process

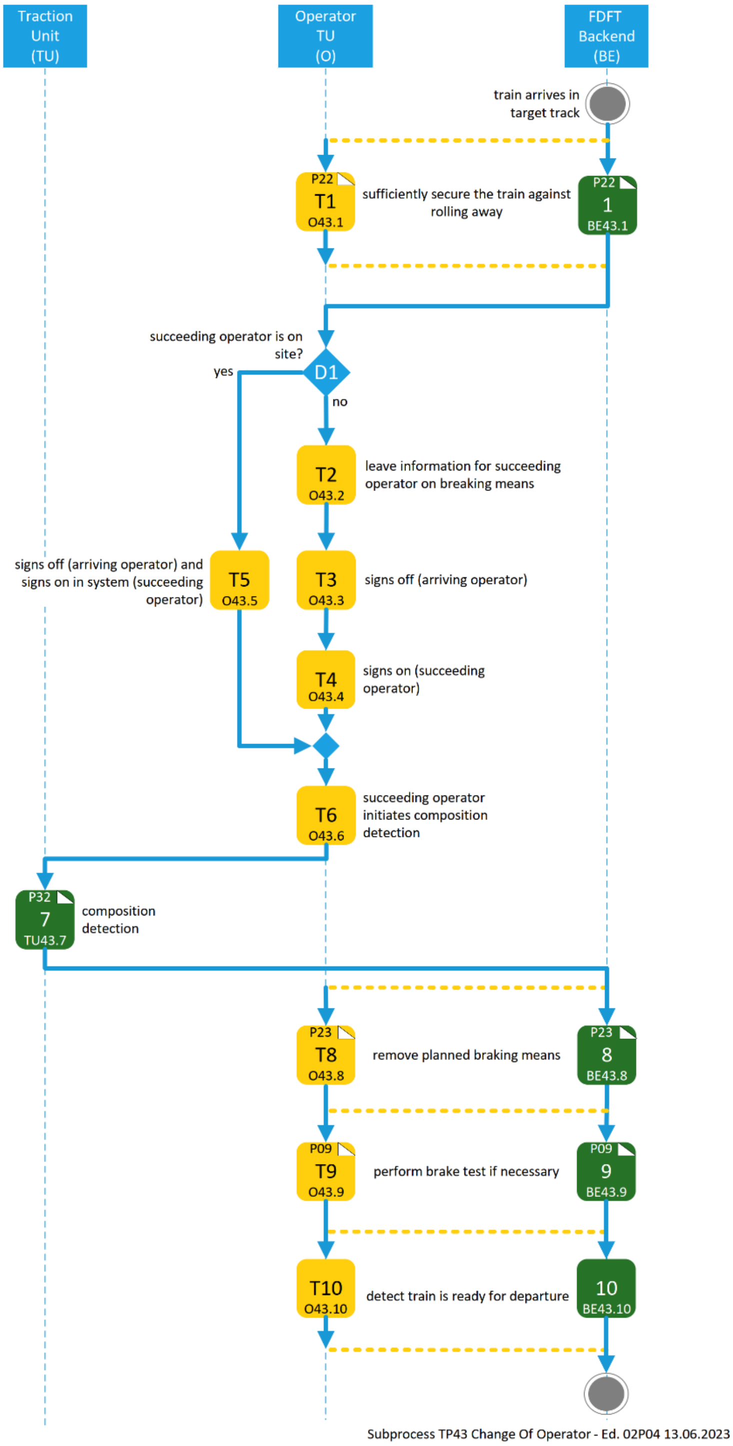

Figure xx: TP43 Change of Operator - 1 of 1

8.4.24.2 Process-Description

BE43.1	
Activity	Subprocess: Sufficiently secure the train against rolling away
Precondition	▪ -
Conditions	▪ FDFT Backend is available, can communicate with relevant FDFT Wagon Base Systems and can initiate secure Wagon against rolling away.
Tasks	▪ See subprocess description 8.4.15
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ See subprocess description 8.4.15

O43.1	
Activity	Subprocess: Sufficiently secure the train against rolling away
Precondition	▪ -
Conditions	▪ -
Tasks	▪ See subprocess description 8.4.15
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ See subprocess description 8.4.15

D1	
Decision	Succeeding operator is on site?

Yes	▪ Operators can change directly.
No	▪
Remarks	▪ -
Rationale	▪ -

O43.2

Activity	Leave information for succeeding Operator on braking means
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Operator leaves information how the securing was done for the succeeding Operator (legacy process) ▪ If FDFT Backend is available, the information can be retrieved from FDFT Backend
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ Operator shall be able to leave information by means of a legacy process how the securing was done for the succeeding Operator.

O43.3

Activity	Signs off (arriving Operator)
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Arriving Operator signs off on Traction Unit (legacy process)
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -

Functional system requirements	▪ Arriving operator shall be able to sign off by means of a legacy process.

O43.4	
Activity	Signs on (succeeding Operator)
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Succeeding Operator signs on and takes further steps according to Legacy process.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ Operator shall be able to get information by means of a legacy process how the securing was done by the arriving Operator. ▪ Succeeding operator shall be able to sign on by means of a legacy process.

O43.5	
Activity	Signs off (arriving Operator) and signs on in System (succeeding Operator)
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Arriving Operator signs off (legacy process) ▪ Succeeding Operator signs on (legacy process)
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ Arriving operator shall be able to sign off by means of a legacy process. ▪ Succeeding operator shall be able to sign on by means of a legacy process.

O43.6

Activity	Succeeding operator initiates composition detection
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Trigger composition detection on HMI.
Remarks	▪
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ Operator shall be able to trigger composition detection by using the HMI of the TU.

TU43.7

Activity	Subprocess: Composition detection
Precondition	▪ -
Conditions	▪ -
Tasks	▪ See subprocess description 8.4.21
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ See subprocess description 8.4.21

BE43.8

Activity	Subprocess: Release planned braking means
Precondition	▪ -
Conditions	▪ FDFT Backend is available, can communicate with the FDFT Wagon Base System and can initiate release braking means.

Tasks	▪ See subprocess description 8.4.16
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ See subprocess description 8.4.16

O43.8	
Activity	Subprocess: Remove planned braking means
Precondition	▪ -
Conditions	▪ -
Tasks	▪ See subprocess description 8.4.16
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ See subprocess description 8.4.16

BE43.9	
Activity	Subprocess: perform brake test if necessary
Precondition	▪ -
Conditions	▪ FDFT Backend is available, can communicate with the FDFT Wagon Base System and can initiate brake test.
Tasks	▪ See subprocess description 8.4.10
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -

Functional system requirements	▪ See subprocess description 8.4.10

O43.9	
Activity	Subprocess: perform brake test if necessary
Precondition	▪ -
Conditions	▪ -
Tasks	▪ See subprocess description 8.4.10
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ See subprocess description 8.4.10

BE43.10	
Activity	Detect train is ready for departure
Precondition	▪ -
Conditions	▪ FDFT Backend is available and can automatically detect that train is ready for departure.
Tasks	▪ FDFT Backend automatically detects that train is ready for departure and triggers following processes.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ none

O43.10	
Activity	Detect train is ready for departure
Precondition	▪ -
Conditions	▪ -
Tasks	▪ Operator detects that train is ready for departure and triggers following processes.
Remarks	▪ -
Rationale	▪ -
Postcondition	▪ -
Functional system requirements	▪ none

9 Reference system architecture FDFT

This chapter describes the elements building the functional system architecture FDFT, based on the functional system requirements from operational procedures, see chapter 8.

The physical and data related system architecture will be part of /WP3_D3.2/ and /WP3_D3.3/ and will be described there.

9.1 FDFT functional communication system architecture

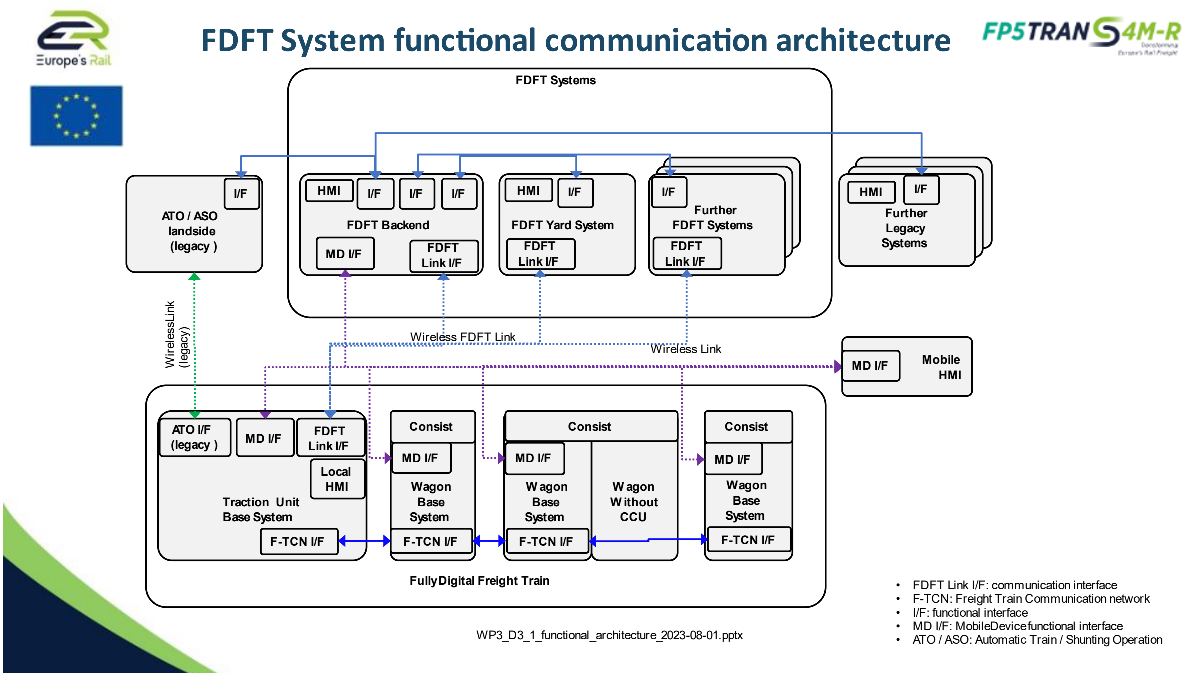

Figure 39: FDFT System functional communication architecture

The FDFT System functional communication architecture gives an overview on the interfaces, relevant for the communication between involved FDFT systems, legacy systems, Mobile HMI and the FDF train. As this document describes the pure functional view, all physical and data aspects aren't covered. They will be covered through the planned deliverables /WP3_3.2/ and /WP3_D3.3/.

9.2 FDFT Traction unit Base System functional architecture

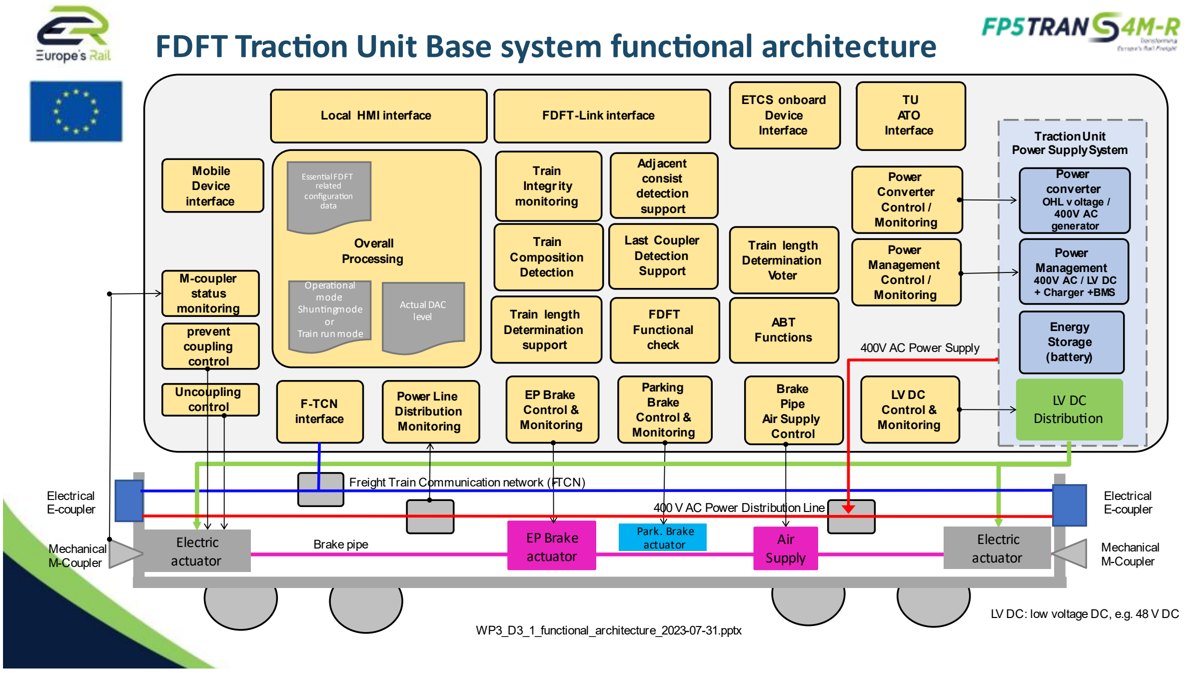

Figure 40: FDFT Traction Unit Base System functional architecture

The FDFT Traction Unit Base system functional architecture, gives an overview on the functional blocks and relevant interfaces, to cover the functional systems requirements as derived from the Target Operational Procedures in chapter 8.4. The connections shown in Figure 40: FDFT Traction Unit Base System functional architecture are shown to highlight the functional aspects only. As this document describes the pure functional view, all physical and data aspects of those connections aren't covered here. They will be covered through the planned deliverables /WP3_3.2/ and /WP3_D3.3/.

9.2.1 Communication system F-TCN interface in traction unit

The FDFT base system shall have an Interface to the F-TCN, allowing the onboard devices to communicate with other network participants using the F-TCN.

Details on physical and data access will be described in /WP3_D3.2/ and /WP3_D3.3/

9.2.2 Power Distribution line in traction unit

The power distribution line is planned to be based on 400 V AC.

Details on physical access will be described in /WP3_D3.2/ and /WP3_D3.3/

9.2.3 Brake Pipe in traction unit

The <Brake Pipe> is a legacy system, well known and not further specified.

Details on physical access will be described in /WP3_D3.2/ and /WP3_D3.3/

9.2.4 Traction Unit power supply system (producer)

- Power supply from the loco: regular operation
- The power supply system feeds the Power distribution line with power allowing all coupled wagons / consists with 400 V AC (as defined in EDDP SG2).
- The traction unit is able to supply electrical power to the power distribution line, of at least 3 kW (as defined in EDDP SG2).

9.2.5 Traction Unit related functional blocks

9.2.5.2 Uncoupling control

The function <M-Coupler uncoupling control> allows to engage the electric actuator of the M-Coupler, resulting in uncoupling the traction unit from the adjacent wagon / consist or traction unit. The uncoupling function shall be performed on both M-Couplers simultaneously in order to reduce mechanical wear of the coupler.

All physical and data related details will be defined in /WP3_D3.2/ and /WP3_D3.3/.

9.2.5.2 Prevent coupling control

The function <prevent coupling control> allows to engage the electric actuator of the M-Coupler, resulting in preventing automatic coupling with the adjacent wagon's coupler. With the traction unit, this is used for shunting. The prevent coupling function shall be performed upon command and shall be released, if certain conditions are met (conditions not yet specified). The prevent coupling function shall be performed on both M-Couplers in such a way that mechanical wear of the couplers is minimized.

All physical and data related details will be defined in /WP3_D3.2/ and /WP3_D3.3/.

9.2.5.2 M-Coupler status monitoring system

The <M-Coupler status monitoring system> allows to capture the M-Coupler status and to make it available to the traction unit base system.

All physical and data related details will be defined in /WP3_D3.2/ and /WP3_D3.3/.

9.2.6 Traction unit power supply system (consumer)

The <traction unit power supply system> provides the traction unit base system with energy to perform the required functions. When traction unit is active, the traction power supply system is powered thru the traction unit itself. When the traction unit is "offline" the overhead line, it is able to get energy from the power distribution line, convert it into an adequate battery voltage to charge the on-board battery. It provides energy to the traction unit base system, even if the power distribution line is powered off.

The power supply to the base system is a so-called low voltage DC power supply.

All physical and data related details will be defined in /WP3_D3.2/ and /WP3_D3.3/.

9.2.7 Traction unit local HMI device interface

The traction unit local HMI device interface allows access to the functionality of the traction unit base system via a local HMI. This allows e.g.: TU operator to make use of the functionality provided by the traction unit base system.

The local HMI device and the related interface requirements will be specified in /WP3_D3.2/ and /WP3_D3.3/.

9.2.8 FDFT-Link interface

The traction unit <FDFT-Link interface> allows access to the functionality of the traction unit base system via the FDFT-Link. This allows any FDFT-System to initiate all activities as given by the operational procedures. In addition, the FDFT-Link interface allows the FDFT Base System of the TU to send the process & status data as captured by the traction unit base system itself or captured by the wagon / consist base systems and transferred via the F-TCN to the traction unit.

It will be ensured that only one acting FDFT system or user at a time, is able to get access.

The FDFT-Link interface and the related interface requirements will be specified in /WP3_D3.2/ and /WP3_D3.3/.

9.2.9 Train integrity monitoring

The traction unit <train integrity monitoring> collects information from all wagons / consists in train, foremost from the last wagon / consist in train, to perform the train integrity detection function.

The train integrity detection support and the related interface requirements will be specified in /WP3_D3.2/ and /WP3_D3.3/.

9.2.10 Train composition detection support

The traction unit based <train composition detection> function collects information from all wagons / consists in the train to derive the actual train composition.

The train composition detection and the related interface requirements will be specified in /WP3_D3.2/ and /WP3_D3.3/.

9.2.11 Train length determination support

The traction unit based <train length determination support> provides the length of the TU and forwards this information to the requesting function (e.g., Train length determination voter).

The train length determination support and the related interface requirements will be specified in /WP3_D3.2/ and /WP3_D3.3/.

9.2.12 Train length determination voter

The traction unit based <train length determination voter> collects wagon length information from all wagons / consists & own TU in train and either determines the train length by own means or using the ETCS on-board device. In addition to this, the train length determination voter. In addition to this, the voter requires additional input from independent sources (e.g.: TU operator, FDFT Backend, …)

As the determination of length is highly safety related, any technical approach needs to be based on input from the RAMS team.

The train length determination voter and the related interface requirements will be specified in /WP3_D3.2/ and /WP3_D3.3/.

9.2.13 Last coupler detection support

The traction unit based <last coupler detection support> provides information to the traction unit base system, if and which coupler of the train is the so called "last coupler" in a train. This function requires distinct means (e.g.: sensors) to determine the last coupler.

Additionally the TU has also to monitor their second coupler which is called "front end coupler". From functional point of view is the "front end coupler" equal to the last coupler and has to be monitored.

The traction unit last coupler detection support and the related interface requirements will be specified in /WP3_D3.2/ and /WP3_D3.3/.

9.2.14 Adjacent wagon detection support

The <adjacent wagon detection support> provides information to the traction unit base system, if there exists an adjacent wagon / consist.

The adjacent wagon detection support and the related interface requirements will be specified in /WP3_D3.2/ and /WP3_D3.3/.

9.2.15 FDFT functional check

The traction unit < FDFT functional check> provides information to the traction unit base system about the functional health state of the traction unit. This function requires a set of sensors allowing to derive the functional state of the traction unit, not yet specified. This functional becomes relevant only, if the traction unit is part of a train in a passive way (i.e.: behaving like a wagon).

The traction unit FDFT functional check required sensors and the related interface requirements will be specified in /WP3_D3.2/ and /WP3_D3.3/.

9.2.16 ABT functions

The traction unit ABT (automated brake test) functions, trigger ABT functions on all wagons / consists in the train, collects resulting information and performs the necessary

ABT procedure. It provides information about the actual working state of the on-board braking systems of all wagons / consists in the train.

The wagon-based sensors required for ABT functional check and the related interface requirements will be specified in /WP3_D3.2/ and /WP3_D3.3/.

9.2.17 Power Management Control / Monitoring

The traction unit-based <Power Management Control & Monitoring> function allows to control and monitor the traction unit power supply system, to allow operations as well as charging the Energy Storage (battery).

The details for performing the functional control of the traction unit power supply system and the related interface requirements will be specified in /WP3_D3.2/ and /WP3_D3.3/.

9.2.18 LV DC Control & Monitoring

The traction unit-based <LV DC Control & Monitoring> allows to control the low voltage DC output to the TU base system as well as to the M-Coupler actuator.

The details for performing the functional control of high-power switch and the related interface requirements will be specified in /WP3_D3.2/ and /WP3_D3.3/.

9.2.19 Brake Pipe Monitoring

The traction unit-based <Brake Pipe Monitoring> allows to monitor pressure in the brake pipe.

The details for performing the functional monitoring of the brake pipe pressure and the related interface requirements will be specified in /WP3_D3.2/ and /WP3_D3.3/.

9.2.20 Parking Brake Control & Monitoring

The traction unit-based <Brake Parking Brake Control & Monitoring> functional block allows to engage or release the on-board parking brake actuator and to monitor its status. This if applicable only, when the TU acts as a wagon (it is a "loco" but not involved in any haulage or active power supply functions).

The details for engaging or releasing the parking brake and the related interface requirements will be specified in /WP3_D3.2/ and /WP3_D3.3/.

9.2.21 EP Brake Control & Monitoring

The traction unit-based <EP Parking Brake Control & Monitoring> functional block allows to engage or release the on-board EP brake actuator and to monitor its status.

This if applicable only, when the TU acts as a wagon (it is a "loco" but not involved in any haulage or active power supply functions).

The details for engaging or releasing the EP brake and the related interface requirements will be specified in /WP3_D3.2/ and /WP3_D3.3/.

9.2.22 Brake Pipe Air Supply Control & Monitoring

The traction unit-based <Brake Pipe Air Supply Control & Monitoring> functional block allows to raise or lower pressure in the brake pipe (legacy means) and to monitor its status.

The details for controlling the Brake Pipe Air Supply and the related interface requirements will be specified in /WP3_D3.2/ and /WP3_D3.3/.

9.2.23 Power Distribution Line Monitoring

The traction unit-based <Power Distribution Line Monitoring> functional block allows to monitor the status of the Power Distribution Line, to derive actions from or inhibit functions depending on the status of the Power Distribution Line (e.g.: wake-up, uncouple, ...).

The details for monitoring the Power Distribution Line and the related interface requirements will be specified in /WP3_D3.2/ and /WP3_D3.3/.

9.2.24 ETCS on-board device interface

The traction unit-based <ETCS on-board device interface > functional block allows communication with the ETCS device. This is used for deriving a high safety level information on train length, by sending the aggregated information from all wagons / consists in the train in an accepted way to the ETCS device. The ETCS device will derive the overall train length in a safe way.

The details for interfacing the ETCS device from a functional point of view and the related interface requirements will be specified in /WP3_D3.2/ and /WP3_D3.3/.

9.3 FDFT Wagon Base System functional architecture

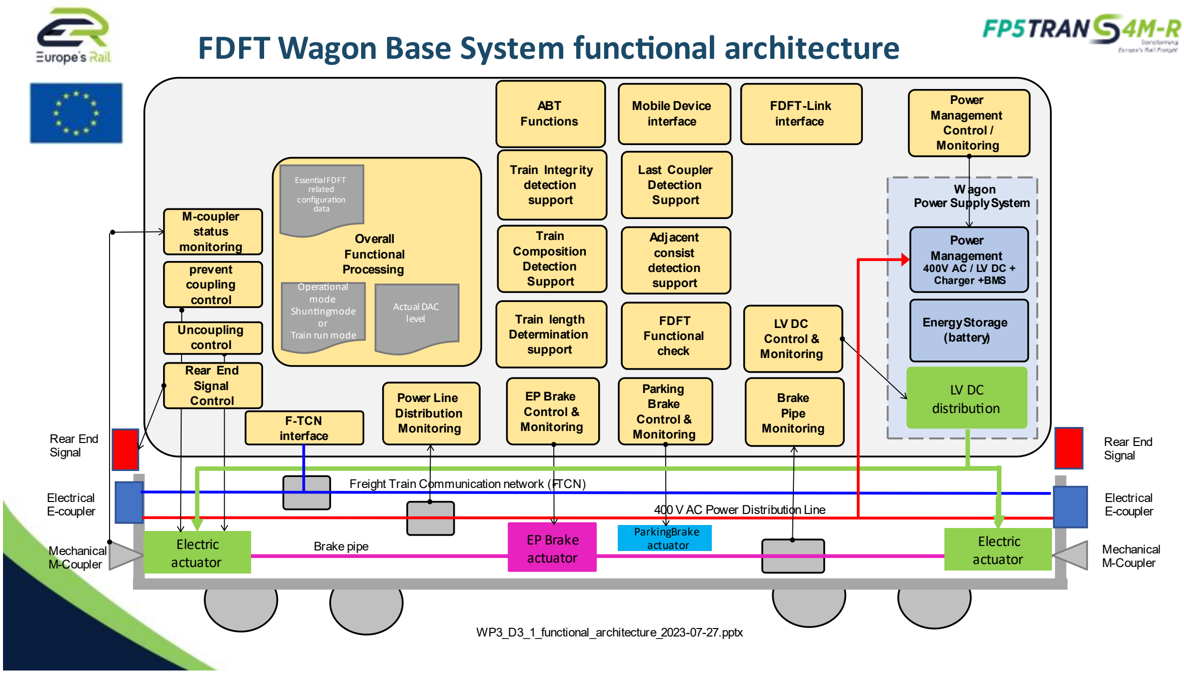

Figure 41: FDFT Wagon Base System functional architecture

The FDFT Wagon Base system functional architecture gives an overview on the functional blocks and relevant interfaces, to cover the functional systems requirements as derived from the Target Operational Procedures in chapter 8.4. The connections shown in Figure 41: FDFT Wagon Base System functional architecture are shown to highlight the functional aspects only. As this document describes the pure functional view, all physical and data aspects of those connections aren't covered here. They will be covered through the planned deliverables /WP3_3.2/ and /WP3_D3.3/.

9.3.1 Communication system freight wagon / consist

The FDFT base system shall have an Interface to the F-TCN, allowing the onboard devices to communicate with other network participants using the F-TCN.

Details on physical and data access will be described in /WP3_D3.2/ and /WP3_D3.3/

9.3.2 Power Distribution line wagon / consist

The power distribution line is planned to be based on 400 V AC.

Details on physical access will be described in /WP3_D3.2/ and /WP3_D3.3/

9.3.3 Brake Pipe in wagon / consist

The <Brake Pipe> is a legacy system, well known and not further specified.

Details on physical access will be described in /WP3_D3.2/ and /WP3_D3.3/

9.3.4 Wagon related functional blocks

9.3.4.2 Uncoupling control

The function <M-Coupler uncoupling control> allows to engage the electric actuator of the M-Coupler, resulting in uncoupling the wagon from the adjacent wagon. The uncoupling function shall be performed on both M-Couplers simultaneously in order to reduce mechanical wear of the coupler.

All physical and data related details will be defined in /WP3_D3.2/ and /WP3_D3.3/.

9.3.4.2 Prevent coupling control

The function <prevent coupling control> allows to engage the electric actuator of the M-Coupler, resulting in preventing automatic coupling with the adjacent wagon's coupler. The prevent coupling function shall be performed upon command and shall be released, if certain conditions are met (e.g.: after time out, when target location is reached, ...).

All physical and data related details will be defined in /WP3_D3.2/ and /WP3_D3.3/.

9.3.4.2 M-Coupler status monitoring system

The <M-Coupler status monitoring system> allows to capture the M-Coupler status and to make it available to the wagon base system.

All physical and data related details will be defined in /WP3_D3.2/ and /WP3_D3.3/.

9.3.5 Wagon power supply system (consumer)

The <wagon power supply system> provides the wagon base system with energy to perform the required functions. It is able to get energy from the power distribution line, convert it into an adequate battery voltage to charge the on-board Energy Storage (battery). It provides energy to the wagon base system, even if the power distribution line is powered off.

The wagon power supply system is able to shut down, when certain conditions are met (e.g.: low energy situation in battery, upon command…).

All physical and data related details will be defined in /WP3_D3.2/ and /WP3_D3.3/.

9.3.6 Wagon Mobile Device interface

The wagon Mobile Device interface allows access to the functionality of the wagon base system by the Mobile HMI. This allows e.g.: yard personnel to make use of the functionality provided by the wagon base system.

Remark: Details on Accessibility (Cyber security & safety) needs to be analysed from a RAMSS perspective.

The mobile device interface and the related interface requirements will be specified in /WP3_D3.2/ and /WP3_D3.3/.

9.3.7 Wagon FDFT-Backend interface

The <wagon FDFT-Backend interface> allows access to the functionality of the wagon base system by the FDFT-Backend. This allows the FDFT-Backend to initiate all activities as given by the operational procedures. In addition, the FDFT-Backend interface allows sending the process & status data as captured by the wagon base system.

The FDFT-Backend interface and the related interface requirements will be specified in /WP3_D3.2/ and /WP3_D3.3/.

9.3.8 Wagon train integrity detection support

The <wagon train integrity detection support> provides information to the train integrity detection function, located in the TU.

The wagon train integrity detection support and the related interface requirements will be specified in /WP3_D3.2/ and /WP3_D3.3/.

9.3.9 Train composition detection support

The wagon based <train composition detection support> provides information to the train composition detection function, located in the TU.

The wagon train composition detection support and the related interface requirements will be specified in /WP3_D3.2/ and /WP3_D3.3/.

9.3.10 Train length determination support

The wagon based <train length determination support> provides information to the train length determination support function, located in the TU.

The wagon train length determination support and the related interface requirements will be specified in /WP3_D3.2/ and /WP3_D3.3/.

9.3.11 Wagon last coupler detection support

The wagon based <last coupler detection support> provides information to the wagon base system, if and which coupler of the wagon is the so called "last coupler" in a train. This function requires distinct means (e.g.: sensors) to determine the last coupler.

The wagon last coupler detection support and the related interface requirements will be specified in /WP3_D3.2/ and /WP3_D3.3/.

9.3.12 Adjacent consist detection support

The <adjacent consist detection support> provides information to the wagon base system if there exists an adjacent wagon / consist.

The adjacent wagon detection support and the related interface requirements will be specified in /WP3_D3.2/ and /WP3_D3.3/.

9.3.13 Wagon FDFT functional check

The <wagon FDFT functional check> provides information to the wagon base system about the functional health state of the wagon. This function requires a set of sensors allowing to derive the functional state of the wagon, not yet specified.

The wagon FDFT functional check required sensors and the related interface requirements will be specified in /WP3_D3.2/ and /WP3_D3.3/.

9.3.14 Wagon ABT functions

The wagon ABT (automated brake test) functions, provide information about the actual working state of the on-board braking system.

The wagon sensors required for ABT functional check and the related interface requirements will be specified in /WP3_D3.2/ and /WP3_D3.3/.

9.3.15 Power Management Control / Monitoring

The wagon-based "Power Management Control & Monitoring> function allows to control and monitor the wagon power supply system, to allow operations as well as charging of battery.

The details for performing the functional control of the wagon power supply system and the related interface requirements will be specified in /WP3_D3.2/ and /WP3_D3.3/.

9.3.16 LV DC Control & Monitoring

The wagon-based <LV DC Control & Monitoring> allows to control the low voltage DC output.

The details for performing the functional control of LV DC control and the related interface requirements will be specified in /WP3_D3.2/ and /WP3_D3.3/.

9.3.17 Brake Pipe Monitoring

The wagon-based <Brake Pipe Monitoring> allows to monitor pressure in the main brake pipe.

The details for performing the functional monitoring of the main brake pipe pressure and the related interface requirements will be specified in /WP3_D3.2/ and /WP3_D3.3/.

9.3.18 Parking Brake Control & Monitoring

The wagon-based <Brake Parking Brake Control & Monitoring> functional block allows to engage or release the on-board parking brake actuator and to monitor its status.

The details for engaging or releasing the parking brake and the related interface requirements will be specified in /WP3_D3.2/ and /WP3_D3.3/.

9.3.19 EP Brake Control & Monitoring

The wagon-based <EP Brake Control & Monitoring> functional block allows to engage or release the on-board EP brake actuator and to monitor its status.

The details for engaging or releasing the EP brake and the related interface requirements will be specified in /WP3_D3.2/ and /WP3_D3.3/.

9.3.20 Power Distribution Line Monitoring

The wagon-based <Power Distribution Line Monitoring> functional block allows to monitor the status of the Power Distribution Line, to derive actions from or inhibit functions depending on the status of the Power Distribution Line (e.g.: wake-up, uncouple, …).

The details for monitoring the Power Distribution Line and the related interface requirements will be specified in /WP3_D3.2/ and /WP3_D3.3/.

10 Conclusions

This document constitutes Deliverable 3.1 System Requirements Specification FDFT for Development of ER JU Flagship Area 5 project FP5-TRANS4M-R. The project aims to boost innovation for the European rail freight sector, concretely by developing, validating, and demonstrating FP5-TRANS4M-R technical enablers.

The objective of this document is to provide the functional system requirements to develop an FDFT (Full Digital Freight Train) i.e., FDFT traction units and freight wagons. The functional system requirements define the basis for the development of the innovations for WP5 - WP12. It describes the requirements to archive the target of full automation of the freight sector. A subset based on the agreed technical enablers in FP5-TRANS4M-R needs to be implemented first.

The content of this WP3 document is aligned with the various input of experts from other WPs.

While designing the functional system architecture for a FDFT, the so-called target processes from /WP2_D2.1/ have been the base to include all features necessary to cover the vision of a fully automated European freight railway system. Not everything mentioned within the so-called target processes is covered in the contract of the first ER JU Call. These gaps need to be discussed for the upcoming calls of ER JU, since it will be crucial that some of these gaps are overcome for operational usage, as well as for digitalization.

These gaps will become more visible, when the physical and data systems requirements specifications are being developed and described in /WP3_D3.2/ and /WP3_D3.3/.

With this document the groundwork has been done for a common development of the FDFT base systems. This document shall serve as foundation for other work packages. Based on the continuous development in FP5-TRANS4M-R, the feedback from the freight sector, new concepts, the document will be succeeded by further documents, to cover the physical system architecture requirements and the data architecture requirements.

11 References

Reference	*Publication date*	*Description*
WP2_D2.1	2023-06-30	WP2 D2.1: Preliminary Operational Procedures_v1.0 D2.1 was submitted to the ERJU on the 30th of June and is currently under evaluation.
WP3_D3.2	planned	WP3 D3.2: Physical reference system architecture FDFT
WP3_D3.3	planned	WP3 D3.3: Data reference system architecture FDFT