

## ERTMS UNIT

### TEST SEQUENCE VALIDATION AND EVALUATION FOR SUBSET-076

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**EU AGENCY FOR RAILWAYS - ERTMS UNIT**  
**TEST SEQUENCE VALIDATION AND EVALUATION**

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## **Table of contents**

<b>Table of contents.....</b>	<b>4</b>
<b>1. OBJECTIVE .....</b>	<b>6</b>
1.1 Foreword .....	6
1.2 Scope & field of application .....	6
1.3 Document description.....	6
<b>2. REFERENCES AND ABBREVIATIONS.....</b>	<b>7</b>
2.1 Reference documents .....	7
2.2 Abbreviations.....	7
<b>3. TEST SEQUENCE EVALUATION .....</b>	<b>8</b>
3.1 Introduction.....	8
3.2 Type of steps.....	8
3.3 Evaluation of steps.....	9
3.4 Procedure to evaluate the Output steps .....	10
3.4.1 DMI output steps .....	10
3.4.2 RTM output steps.....	10
3.4.3 TIU output steps.....	11
3.4.4 JRU output steps .....	11
3.4.5 ATO output steps .....	11
<b>4. TIME AND DISTANCE VARIABLES ASSESSMENT .....</b>	<b>12</b>
4.1 Introduction.....	12
4.2 Types of validation ranges (time or distance).....	12
4.2.1 Overview .....	12
4.2.2 Validation based on time intervals.....	13

**EU AGENCY FOR RAILWAYS - ERTMS UNIT**  
**TEST SEQUENCE VALIDATION AND EVALUATION**

---

4.2.3	Validation according to distance intervals .....	13
4.2.4	Situations in which distance ranges shall be used .....	14
<b>4.3</b>	<b>Validation ranges at the different interfaces.....</b>	<b>14</b>
4.3.1	BTM/LTM.....	14
4.3.2	RTM .....	14
4.3.3	DMI.....	16
4.3.4	TIU .....	17
4.3.5	JRU.....	18
4.3.6	ODO .....	19
4.3.7	SIM/CMD.....	19
4.3.8	INT .....	20
4.3.9	ATO.....	20
<b>4.4</b>	<b>Validation when the train speed is zero .....</b>	<b>21</b>
4.4.2	RTM Inputs .....	21
4.4.3	DMI Inputs.....	21
4.4.4	Inputs at other interfaces.....	21
<b>4.5</b>	<b>Validation of following steps when steps are classified as non-passed or optional interface .....</b>	<b>22</b>
<b>5.</b>	<b>BRAKING MODEL EVALUATION .....</b>	<b>24</b>
<b>6.</b>	<b>TEST SEQUENCES EXECUTION.....</b>	<b>26</b>
6.1	Principles .....	26
6.2	Failures in the execution .....	26
6.3	Events that depend on the braking model .....	27
6.4	Time Delays.....	28
6.5	Adaptations for Reduced Envelopes.....	28
<b>7.</b>	<b>TEST REPORT .....</b>	<b>29</b>
<b>8.</b>	<b>SUBSET-076 REPORT TEMPLATE.....</b>	<b>31</b>

## **1. OBJECTIVE**

### **1.1 Foreword**

1.1.1.1 Not Applicable

### **1.2 Scope & field of application**

1.2.1.1 The objective of this document is providing a set of rules related to the way in which Test Sequences execution results must be evaluated and to the validation ranges which will be used when testing ERTMS/ETCS on-board equipments according to the SUBSET-076.

1.2.1.2 For the scope of this document, when referring to the compliance with Ss-026 it shall be understood that as the SUBSET-026 v4.0.0

1.2.1.2.1 When applied to the evaluation of Test Sequences for Reduced Envelopes all references to documents shall take into account the exceptions from SUBSET-153 [15] if any.

### **1.3 Document description**

1.3.1.1 Not applicable

## **2. REFERENCES AND ABBREVIATIONS**

### **2.1 Reference documents**

*Table 1 : Reference documents*

<b>Ref. N°</b>	<b>Document Reference</b>	<b>Title</b>
[1]	SUBSET-023	Glossary of Terms and Abbreviations
[2]	SUBSET-026	ERTMS/ETCS – System Requirements Specification
[3]	SUBSET-027	FFFIS Juridical Recorder-Downloading tool
[4]	SUBSET-034	Train Interface FIS
[5]	SUBSET-076-5-2	Test Cases
[6]	SUBSET-076-6-3	Test Sequences
[7]	ERA/ERTMS/015560	ETCS Driver Machine Interface
[8]	ERA-GUI-05	ERA Braking curves tool handbook
[9]	ERA/ERTMS/040092	ETCS Test Plan and Methodology for SUBSET-076
[10]	SUBSET-037	Euroradio FIS
[11]	SUBSET-094	Functional requirements for an on-board reference test facility
[12]	SUBSET-125	ERTMS/ATO – System Requirements Specification
[13]	SUBSET-130	ATO-OB / ETCS-OB FFFIS – Application Layer
[14]	SUBSET-143	Interface Specification – Communication Layer for On-board Communication
[15]	SUBSET-153	Exceptions for on-board reduced envelopes of ETCS system versions

### **2.2 Abbreviations**

*Table 2 : Abbreviations*

<b>Abbreviation</b>	<b>Meaning</b>
CR	Change Request
ERA	European Union Agency for Railways
TC	Test Case
TS	Test Sequence

## **3. TEST SEQUENCE EVALUATION**

### **3.1 Introduction**

- 3.1.1.1** The test sequence evaluation shall be understood as the process where the test sequence results for each step are checked against the reference sequence. In this process the functional behaviour of the steps is checked i.e. the expected result defined in each step of the sequence [\[6\]](#) is compared with the step result of the test.

### **3.2 Type of steps**

- 3.2.1.1** A Test Sequence contains a list of steps with the corresponding description and additional information. The evaluation of the Test Sequence shall be done step by step.
- 3.2.1.2** Every step is normally referred to an interface, where the step check shall be done. According to the interface nature, the steps are classified in the following categories:
- a) Input (BTM, DMI, RTM, LTM, SIM, TIU, ATO, ODO, and CMD). The inputs in the ERTMS/ETCS on-board equipment are, in fact, an output from the lab environment. In this case, the evaluation of the step consists of checking if the lab has produced the corresponding entry within the expected time and distance (i.e, balise telegram delivery, driver action, etc), which will be done every time a TS is executed.
  - b) Output (DMI, RTM, TIU, ATO, JRU). The outputs from the ERTMS/ETCS on-board equipment are the reactions to the programmed entries. For the evaluation, it has to be checked, firstly, if the event has been produced. In second place, it has to be checked at what distance/location and time it happened. In these cases when an inconsistency exists between the SUBSET-026 and the related subsets, the validation of these steps shall be done according to the SUBSET-026 [\[2\]](#).
  - c) Internal interface. Some steps within the Test Sequence have no physical interface specified. They can be classified as follows:
    - a) Expiration of a timer. This may be a timer internal to the OBU or a time span expiring in the test design.
    - b) The steps describe an internal functionality.
- 3.2.1.3** If the classification was not available because of a modification in the sequence (see 6.2) or exceptionally because it was missing in the sequence, the step classification shall be done by the laboratory prior to the execution of a Test Sequence.



- 3.2.1.3.1 Note 1: The evaluation of the input steps is aimed to check the good execution of each TS. The check of the performance of the laboratory tools is out of the scope of this document.
- 3.2.1.3.2 Note 2: The evaluation margins of time and distance for both Input and Output steps are defined in this document.
- 3.2.1.4** The number and the granularity of the entries used as proof of a step validation should depend on the step description. Nevertheless, several entries with different granularity can be used as proof as the step validation if the step description requires it.
- 3.2.1.5** The step description includes the step comments. The comments included in the steps shall be taken into account for the evaluation except for the part behind 'Info:' which is informative and often only relevant for the test sequence design.

### **3.3 Evaluation of steps**

- 3.3.1.1** Once a test sequence has been run, the evaluating laboratory shall classify each step result of this sequence [\[6\]](#) in one of the following categories:
- a) “passed”, this category applies to step that has been reproduced in the laboratory as foreseen in the sequence. If it is an “Input” step it means that the lab and/or the operator behaved correctly according to the test sequence step description. If it is an “Output” step it means that the on-board equipment behaviour is according to the test sequence step description and comment.
  - b) “non-passed”, this category applies to “Output” steps where the on-board equipment behaviour is not in line with the test sequence step description. In addition, to be declared as “non passed”, the step shall be evaluated considering the current state of ERTMS/ETCS On-board equipment by checking that all inputs conditions defined in all relevant previous steps are fulfilled during the TS execution. Otherwise, step shall be declared as “Linked to previous error” or “Not evaluated”. This step evaluation shall refer to the Ss-026 [\[2\]](#) requirement(s) not respected.
- Note : a “non-passed” step means that a deviation or non-conformity to SUBSET-026 requirement(s) has been identified.
- c) “passed with comments”, this category applies to different range of values for ETCS variables to the ones used in the SUBSET-076, optional packets implemented by the supplier, Change Request classified as error in the ERA CR Database or a behaviour of the ETCS on-board which does not contradict requirements defined in SUBSET-026 [\[2\]](#) or the other subsets listed in Chapter 2. This step evaluation shall refer to one of the possibilities aforementioned.

- d) "Optional interface", this category applies to optional interfaces defined in SUBSET-026 [2] and not implemented in the equipment under test (RIU, Euroloop, STM, Train Data acquired from ERTMS/ETCS external sources, Safe consist length information acquired from ERTMS/ETCS external sources).
- e) "Test Sequence error", this category applies for detected errors of a test sequence.
- f) "Linked to previous error", this category applies to steps that cannot be evaluated because a previous error has occurred in the test sequence. This shall deal with linked steps, i.e. a first step triggers one or several steps. With this classification it is possible to distinguish between the source error and the inherited errors.
- g) "Not evaluated" , when the step is in a part of a Test Sequence that has not been reached during execution.

**3.3.1.2** Test case or test sequence errors, preventing the evaluation of the considered requirement in SUBSET-026 [2], shall be shared with ERA and other accredited laboratories, via an IT tool managed by the Agency.

**3.3.1.3** When evaluating the steps in a sequence, other steps not included in the sequence could happen (e.g. JRU data recording), these steps not foreseen by the test sequence shall not be evaluated.

## **3.4 Procedure to evaluate the Output steps**

### **3.4.1 DMI output steps**

**3.4.1.1** The DMI output steps shall be evaluated according to the DMI specifications [7]. The laboratory shall check that the symbols used by the ETCS DMI of the on-board equipment are compliant with the defined form/shape, colour, size, area and remarks (if any) in the DMI specifications.

**3.4.1.2** When a DMI output step is not compliant with 3.4.1.1 it shall be considered as "non-passed".

**3.4.1.3** In any case, the DMI deviation shall not be to any SUBSET-026 requirement of the test sequence under test. If there is a deviation to any SUBSET-026 requirement, section 3.3.1.1 b) applies.

### **3.4.2 RTM output steps**

**3.4.2.1** The RTM output steps shall be evaluated according to the ETCS airgap defined in SUBSET-026 and the Euroradio definitions in SUBSET-037 [10].

**3.4.2.2** The RTM variables used by the RTM outputs can take any of the range values allowed by the SUBSET-026, if it is not fixed by the functionality under test. The

test steps shall be declared as "passed" if they are in the range of values and accurate according to the situation under test.

**3.4.2.3** Example: SUBSET-076 uses Q\_SCALE=1 by default but any other Q\_SCALE value is possible and the step must be considered as "passed" independent from the Q\_SCALE used. Similarly, the value of Q\_DIRTRAIN at standstill is implementation dependent. A difference to the value given in a step of SUBSET-076 does in itself not indicate an error.

**3.4.2.4** If an RTM output step contains a message with optional packets, the step shall be declared as "passed with comments" with the comment "optional packets used" if the use of the optional packets respects the SUBSET-026 requirements.

3.4.2.4.1 Note: In case of Packet 44, no check on national content should be done.

### **3.4.3 TIU output steps**

**3.4.3.1** The TIU output steps shall be evaluated according to the data flow as defined in SUBSET-034. In this case, the data flow from ERTMS/ETCS on-board to vehicle shall be understood as the data flow from the ERTMS/ETCS on-board equipment to the test architecture as defined in SUBSET-094.

**3.4.3.2** When a TIU output step is compliant with the form fit part defined in SUBSET-034 but not compliant with the complementary information at the TIU interface defined in SUBSET-094, the step shall be considered as "passed with comments" with a comment "TIU compliant with SUBSET-034 but not with SUBSET-094".

### **3.4.4 JRU output steps**

**3.4.4.1** The JRU output steps shall be evaluated according to the format and content of the data messages defined in SUBSET-027 [\[3\]](#).

3.4.4.1.1 For JRU messages 5, 6, 7, 8, 9, and 10 it shall be verified that the recorded message matches the content in the corresponding BTM, RTM or LTM step.

**3.4.4.2** When additional information not defined in the SUBSET-027 is recorded in the on-board recording device, the step shall be considered as "passed with comments" with the comment "supplier specific information recorded".

### **3.4.5 ATO output steps**

**3.4.5.1** The ATO output steps shall be evaluated according to the format and content of the data messages defined in SUBSET-130 [\[13\]](#) and SUBSET-143 [\[14\]](#).

## **4. TIME AND DISTANCE VARIABLES ASSESSMENT**

### **4.1 Introduction**

- 4.1.1.1** The test sequence validation shall be understood as the process to evaluate where the ranges in time and distance has been respected by the test results compared to the original test sequence.
- 4.1.1.2** The validation ranges shall be evaluated not only in terms of the distance specified in the steps but also based on previous steps validation entries timestamps, balises emission, radio messages emission or reception, odometry and TIU signals.

### **4.2 Types of validation ranges (time or distance)**

#### **4.2.1 Overview**

- 4.2.1.1** Most of the situations specified in the steps of the Test Sequences shall be validated based on time and distance intervals.
- 4.2.1.2** The specific situations in which distance ranges shall apply are defined in 4.2.4.
- 4.2.1.3** For the steps describing a specific action that happens at a precise time, the following sections apply. Because of their description and comments, some steps will be validated by using other time/distance intervals than the ones defined at points 4.3 and 4.4. In these cases, the time/distance intervals will depend on the step description/comments or, if the step description/comments are not enough detailed, on the Test Sequence context.
- 4.2.1.4** There are several systems recording the events entries (e.g. the test bench, the JRU, the video recording system ...), each recording system can be allocated to the device under test or the test architecture. Each of these recording systems has its clock. During the validation phase, the timestamp of all entries used for the validation coming from all recording system shall be synchronized or an offset interval shall be identified with regards to the reference time selected.
- 4.2.1.5** To ensure the proper reconstruction of the right sequence of events all timestamp offsets shall remain within the tolerances defined in Chapter 4. The tolerances on the time/distances intervals due to time synchronization problems of the different data sources used to retrieve the validation entries, are included in the actual values of those time/distance intervals.
- 4.2.1.6** For validation test sequences are considered to consist of blocks of steps, each block starting with an input step and all following output steps until the next input step. The input step is called trigger.

**4.2.1.7** All steps in a block have the same distance. The trigger defines for all steps in the block to which part of the train – real or virtual – this distance refers to.

4.2.1.7.1 Exception: For RTM Input steps which form part of a radio dialog (see Section 4.3.2) the distance at which the step actually happens defines the distance for all following steps in the block (and this distance can be different from the step distance).

## **4.2.2 Validation based on time intervals**

**4.2.2.1** All the test sequences have the distance at which the step must be checked, specified in each one of the steps. For most steps the distance refers to the distance travelled according to the odometry signal sent by the laboratory. It may refer to other parts of the train – real or virtual – if the trigger is an ODO input step. The validation range is defined in the following way:

4.2.2.1.1 The train gets to the distance specified in the step in time “t” (if there are exceptions, and another “t” must be used as the base of the interval, it will be clearly explained in the following sections).

4.2.2.1.2 The range for the validation shall be within  $[t - t_1, t + t_2]$ .

4.2.2.1.3  $t_1$  and  $t_2$  are defined for each interface.

4.2.2.1.4 Each interface can have different  $t_1$  and  $t_2$  for different situations. For example, in the DMI interface, a different range can be used when the DMI displays an event, or when the driver interacts with the DMI (note that it takes more time for the driver to act on the DMI). The durations  $t_1$  and  $t_2$  are specified in the following sections, taking into account the different situations in each interface.

## **4.2.3 Validation according to distance intervals**

**4.2.3.1** All the test sequences have the distance at which the step must be checked, specified in each one of the steps. The validation range is defined in the following way:

4.2.3.1.1 The distance of the step is the basis of the interval, which will be called distance “d”.

4.2.3.1.2 The range for the validation shall be within  $[d - d_1, d + d_2]$ .

4.2.3.1.3  $d_1$  and  $d_2$  are defined for each interface, if needed.

4.2.3.1.4 Each interface can have different  $d_1$  and  $d_2$  for different situations.

4.2.3.1.5 As the general rule for validation is time intervals, the situations which require distance ranges are specified in section 4.2.4.

#### **4.2.4 Situations in which distance ranges shall be used**

- 4.2.4.1** When the speed of the train is zero (see section 4.4). Note that if mutually dependent events occur at standstill the validation of these shall be based on the distance and the time.

### **4.3 Validation ranges at the different interfaces**

#### **4.3.1 BTM/LTM**

The on-board equipment shall not be validated in steps specified at the BTM/LTM interface as it is not possible to check if the BTM/LTM has received the telegrams/message sent by a balise group/Euroloop (at least in the BTM/LTM steps, although this is checked in the following JRU steps). Therefore these steps shall be used to check if the laboratory has sent each balise telegram in the balise group at the expected position respectively the message in the Euroloop, i. e. the train has been stimulated at the right moment:

*Table 3 : BTM/LTM times*

Definition	Time
t1	1 second
t2	1 second

#### **4.3.2 RTM**

- 4.3.2.1** When a dialog of radio messages is specified between the trackside and the train in a Test Sequence, the following general rules have been applied:
- a) Mostly messages (track to train and train to track) are written in the same distance although the train is moving. The first message at the distance is sent by the laboratory when reaching the position if it is a track to train message and it is expected when reaching the position if it is a train to track message.
  - b) A track to train message may be conditional on a train to track message. A time “delay” can be added to the track to train messages. This means that, when the train sends the triggering message at time t, the message is sent by the laboratory at t + delay. This way, although most of the messages are written in the same step distance, by means of the delay, the time in which they are sent can be fixed. This is the mandatory way of specifying radio dialogs when the train is at standstill. (Note: When the train is moving, it would not be necessary to use the delays, but they are used, so that the radio dialogs are always specified in the same way.)

- c) The messages train to track are also specified at the same distance, no delay is associated to them. If there is a train to track message, and in the sequence of steps appears after a track to train message, this message shall be found after the previous track to train message, and the distance specified in the step shall not be taken into account (if it is the same as the one in the track to train message, as mentioned before).
- d) A “back delay” can also be added to the track to train messages. If it is added, it is also checked that a train to track message was received in the interval which is set by the “back delay”. This interval can be defined as a time or distance. Therefore, it is not necessary to define any range in this document for the “back delays”, apart from the guidelines for the test sequences design given in 6.4 of this document. The back delay itself is the range to be used for the validation, and it has already been written in each sequence.

#### **4.3.2.2 Inputs (messages track to train)**

- 4.3.2.2.1 The on-board equipment shall not be validated in these steps as it is not possible to check if the RTM has received the radio messages (at least in these steps, since this is checked in the following JRU steps). Therefore these steps shall be used to check if the laboratory has sent the radio messages at the expected position i.e. the train has been stimulated in the right moment. The range which must be used for the validation is (supposing an error free transmission)  $[t - t1, t + t2]$ , where  $t$  is the time when the train gets to the distance of the step, plus the sum of delays associated to previous input steps at the same distance and plus the delay associated to the step itself :

*Table 4 : RTM Inputs times*

Definition	Time
t1	2 seconds
t2	2 seconds

#### **4.3.2.3 Outputs (messages train to track)**

- 4.3.2.3.1 As explained in the first section of this chapter, the train to track messages shall be found after the previous track to train message if the distance written in their steps is the same. The range that shall be used is
- 4.3.2.3.2  $[t - t1, t + t2]$ , where  $t$  is the time when the previous track to train message was sent, if they both are at the same distance.
- 4.3.2.3.3 If the train to track message has to be sent after an event, which is different from a track to train message, the time interval shall be  $[t - t1, t + t2]$ , where  $t$  is the time when the event that triggers the transmission of the radio message takes place (this event can be the previous train to track message, a driver’s action on the DMI, an ODO step, etc.).

**EU AGENCY FOR RAILWAYS - ERTMS UNIT**  
**TEST SEQUENCE VALIDATION AND EVALUATION**

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4.3.2.3.3.1 If the message is not part of a dialog and the distance written in the step is different from the one from the previous track to train message, t is the time when the train gets to the distance written in the step.

*Table 5 : RTM Outputs times*

Definition	Time
t1	0 seconds
t2	10 seconds

4.3.2.3.4 Variables validated at the outputs (train to track)

4.3.2.3.4.1 The variables of these messages, which shall be validated, are the ones specified in the Test Sequence. Some variables could depend on the position of the train, such as the distance in the position reports, or are unknown or not defined when the Test Sequence is executed, so the variables shall validated taking into account the sequence execution context and the value range defined in the Ss-026 [\[2\]](#).

### **4.3.3 DMI**

#### **4.3.3.1 Outputs**

4.3.3.1.1 The outputs of the DMI are messages, changes, or enabled/disabled buttons displayed. Therefore these events are displayed by the DMI when the trigger occurs at time t. The following range shall be used to validate this kind of steps:

*Table 6 : DMI Outputs times*

Definition	Time
t1	1.5 seconds
t2	5 seconds

#### **4.3.3.2 Inputs**

4.3.3.2.1 The inputs to the DMI are actions which are performed by the driver. As it takes some time for the driver to read the DMI and perform the action required (see Table 8 in [\[9\]](#)), the range defined for this kind of steps is a wider range.

4.3.3.2.2 The reference time “t” shall be one of the following two options:

- a) the time when the button or message on which the driver must act becomes available for him, such as when an acknowledgment is shown, or a button is enabled.
- b) the time when the train gets to the distance defined on the steps which needs to be validated.



**EU AGENCY FOR RAILWAYS - ERTMS UNIT**  
**TEST SEQUENCE VALIDATION AND EVALUATION**

---

*Table 7 : DMI Inputs times*

Definition	Time
t1	5 seconds
t2	10 seconds

4.3.3.2.3 Note: t2 will be different from 10s (e.g. 5s for most of the required acknowledgements) in the special cases where it is necessary to acknowledge something on the DMI that, if not performed in due time, can make the steps coming afterwards fail.

#### **4.3.4 TIU**

##### **4.3.4.1 Outputs**

4.3.4.1.1 The outputs of the TIU are the signals which are tested in the laboratory. These signals shall be received when the trigger occurs at time t. The following range that shall be used to validate this kind of step:

*Table 8 : TIU Outputs times*

Definition	Time
t1	1.5 seconds
t2	15 seconds

##### **4.3.4.2 Application or release of the brakes due to braking curves or overspeeds (special case)**

4.3.4.2.1 If the train is not running at constant speed due to the nature of the braking curves and to how the Test Sequences are specified, the distance in which the brakes will be applied or released is not well defined. Therefore, a wide range will be used for these specific situations.

*Table 9 : TIU Outputs times - Application or release of the brakes due to braking curves or overspeeds*

Definition	Time
t1	5 seconds
t2	10 seconds

##### **4.3.4.3 Inputs**

**EU AGENCY FOR RAILWAYS - ERTMS UNIT**  
**TEST SEQUENCE VALIDATION AND EVALUATION**

---

- 4.3.4.3.1 The inputs are stimulated by the laboratory. Therefore, in this kind of steps, the on-board equipment is not tested. However the step is validated to ensure that the train was stimulated in the right moment. The laboratory is the one which is tested in these steps. The range defined for this situation is:

*Table 10 : TIU Inputs times*

Definition	Time
t1	2 seconds
t2	2 seconds

#### **4.3.5 JRU**

##### **4.3.5.1 General Range**

- 4.3.5.1.1 The JRU message shall be recorded when the trigger occurs at time t. The general range, which takes into account the average time the JRU needs to record the information which comes from other interfaces. The following range shall apply with the exceptions of records of driver actions, record of radio messages and warnings due to overspeed. However, there are some exceptions which require a wider range (see next section). This is the general range:

*Table 11 : JRU range*

Definition	Time
t1	5 seconds
t2	5 seconds

##### **4.3.5.2 Records of driver actions**

- 4.3.5.2.1 According to Ss-027 [\[3\]](#), the driver actions are stored in a specific message in the JRU. Since it takes some time for the driver to perform the action, and for the JRU to record it, the range shall be the one defined for the actions performed by the driver in the DMI (see Table 8 in [\[9\]](#)) plus the usual time to record something in the JRU (see 4.3.5.1.1). The range for recording driver actions shall be:

*Table 12 : Record of driver actions range*

Definition	Time
t1	5 seconds
t2	15 seconds

##### **4.3.5.3 Records of radio messages**

- 4.3.5.3.1 Records of radio messages shall be traced using the time stamp when they were sent, it shall be taken into account the time delay (see 4.3.2.1 b)). The range shall

be  $[t - t_1, t + t_2]$  where  $t$  is the time when the RTM message was sent or received.

4.3.5.3.2  $t_1$  and  $t_2$  are the values defined in Table 13.

4.3.5.3.3 The RTM messages shall be considered valid in the JRU, if they were previously validated in the RTM interface in order to know the real time when they were sent or received

#### **4.3.5.4 Warnings due to overspeeds**

4.3.5.4.1 If the train is not running at constant speed the range for warnings due to overspeed shall be:

*Table 13 : Record of warnings due to overspeed*

Definition	Time
$t_1$	5 seconds
$t_2$	10 seconds

#### **4.3.6 ODO**

4.3.6.1 All ODO steps are defined as inputs but they may depend on the on-board implementation, in particular the evolution of the confidence interval. If the confidence interval plays a role it has to be determined during the validation. The ranges for ODO steps are:

*Table 14 : ODO Inputs times*

Definition	Time
$t_1$	2 seconds
$t_2$	2 seconds

#### **4.3.7 SIM/CMD**

The inputs on the SIM/CMD interface are used to control functionality of the test bed or the test adapter. The laboratory shall trigger the event at the correct time/distance. The uncertainty of the trigger shall be within the following limits:

*Table 15 : SIM/CMD times*

Definition	Time
$t_1$	2 seconds
$t_2$	2 seconds

#### **4.3.8 INT**

**4.3.8.1** Steps at the INT interface are internal to the OBU. Nevertheless, the laboratory influences this internal behaviour. The times t1 and t2 shall therefore depend on the original cause in the simulation environment.

4.3.8.1.1 For a timer which expires the values of t1 and t2 are given by the values for the step at which the timer started, e.g. for a timer started due to a radio input the values are as given in Table 4.

4.3.8.1.2 For BTM alarm due to big metal masses the following times are used:

*Table 16 : BTM alarm times*

Definition	Time
t1	5 seconds
t2	5 seconds

#### **4.3.9 ATO**

##### **4.3.9.1 Inputs (messages ATO-OB to ETCS-OB)**

4.3.9.1.1 The on-board equipment shall not be validated in these steps. These steps shall be used to check if the laboratory has sent the ATO messages at the expected position i.e. the train has been stimulated in the right moment. The range which must be used for the validation is (supposing an error free transmission)  $[t - t1, t + t2]$ , where t is the time when the train gets to the distance of the step:

*Table 17 : ATO Inputs times*

Definition	Time
t1	2 seconds
t2	2 seconds

##### **4.3.9.2 Outputs (messages ETCS-OB to ATO-OB)**

4.3.9.2.1 If t is the time associated to the trigger for the message then  $[t - t1, t + t2]$  shall be the range for the message from the ETCS On-board to the ATO On-board in the same block of the test sequence, where:

*Table 18 : ATO Outputs times*

Definition	Time
t1	0 seconds
t2	10 seconds

## **4.4 Validation when the train speed is zero**

- 4.4.1.1** This is a special case which needs a different approach. The general rule (see 4.1) cannot be applied, since the train doesn't get to the distance "x" in time "t". The train is at distance "x" at any time (until it starts moving again). Therefore the validation of triggers shall be done using distance, and the order and delays of the steps shall be also checked (a step could appear twice in the sequence of steps - being the train stopped - and if the validation takes only into account distances, both steps would be validated correctly, although only one occurrence were found, since the same occurrence would be found twice in the distance range).
- 4.4.1.2** The range which shall be used for all the cases of steps for which the train speed is zero is  $[d - d1, d + d2]$  where "d" is the distance defined by the step and where the train is at standstill.

*Table 19 : Distances when the train speed is zero*

Definition	Length
d1	30 meters
d2	30 meters

## **4.4.2 RTM Inputs**

- 4.4.2.1** The time interval shall be computed as in 4.3.2.2.1

## **4.4.3 DMI Inputs**

- 4.4.3.1** The inputs to the DMI are actions which are performed by the driver. As it takes some time for the driver to read the DMI and perform the required action and as the train is at standstill, the range defined for these kinds of steps has this into account, and therefore it is a wider range as given in 4.3.3.2.2.
- 4.4.3.2** The time interval for validating the DMI Input steps shall be evaluated by the right events and their delays happening before and after in the sequence of steps at standstill.

## **4.4.4 Inputs at other interfaces**

- 4.4.4.1** The time interval for validating the input steps shall be evaluated by the right events and their delays happening before and after in the sequence of steps at standstill using the following range:

*Table 20 : Input times at standstill*

Definition	Time
t1	2 seconds
t2	2 seconds

## **4.5 Validation of following steps when steps are classified as non-passed or optional interface**

**4.5.1.1** This section applies to situations where some steps are classified as non-passed or optional interface, and how to continue the test sequence validation.

**4.5.1.2** Note: The input steps should always be passed. If it is not the case the TS needs to be re-executed with the required modification until the inputs steps are passed.

**4.5.1.3** Note: In the following cases, a step which is not depending on another step is a step whose the time/distance intervals on which its validation is based is calculated from its distance. It is generally the first step of a steps series at the same distance. When a step is depending on another step, this dependant step cannot occur if the step on which it depends did not occur. (E.g. : the recording of a JRU step depends most of the time on a previous event on another interface, the driver validation of data depends most of the time of a previous step asking the driver to enter data, ...).

**4.5.1.4** The following point describes situations where the step A and the step B are at the same distance in the TS. The validation should be done according to the following table:

*Table 21: Validation for a Step B when Step A is at same distance in the TS*

Step A is validated as	Step B depends on Step A	Step B does not depend on Step A
non-passed because of no entry found	Linked to previous error	Individual validation for Step B without taking into account Step A
non-passed because of no entry found in time/distance	Linked to previous error	Individual validation for Step B without taking into account Step A
Optional interface	Optional interface	Individual validation for Step B without taking into account Step A

**4.5.1.5** Note: In table 16 "non-passed because of no entry found" means that there is no entry at all while "non-passed because of no entry found in time/distance" means

**EU AGENCY FOR RAILWAYS - ERTMS UNIT**  
**TEST SEQUENCE VALIDATION AND EVALUATION**

---

that no entry is found in the time/distance range specified i.e. there is an entry but not at the right time/distance.

## **5. BRAKING MODEL EVALUATION**

- 5.1.1.1** As the SUBSET-076 is a testing based on “black box” principles i.e. no access to the internal processes in the on-board equipment during the testing process, the outputs of the on-board equipment shall be evaluated with a reference. In the case of the braking curve model used by the on-board equipment, the reference is defined in SUBSET-026 but for efficiency reasons the validation will be done against an independent implementation of the model. The reference shall be the applicable version of the Agency Braking Curve Simulation Tool available at the Agency’s website including its handbook [\[8\]](#).
- 5.1.1.2** Each Test Sequence for braking curves provides the outcome calculated by the Agency’s tool that shall be used to compare the on-board behaviour at a given time, speed and distance.
- 5.1.1.2.1** Note: Be aware that each sequence uses a specific train model applicable for the validation.

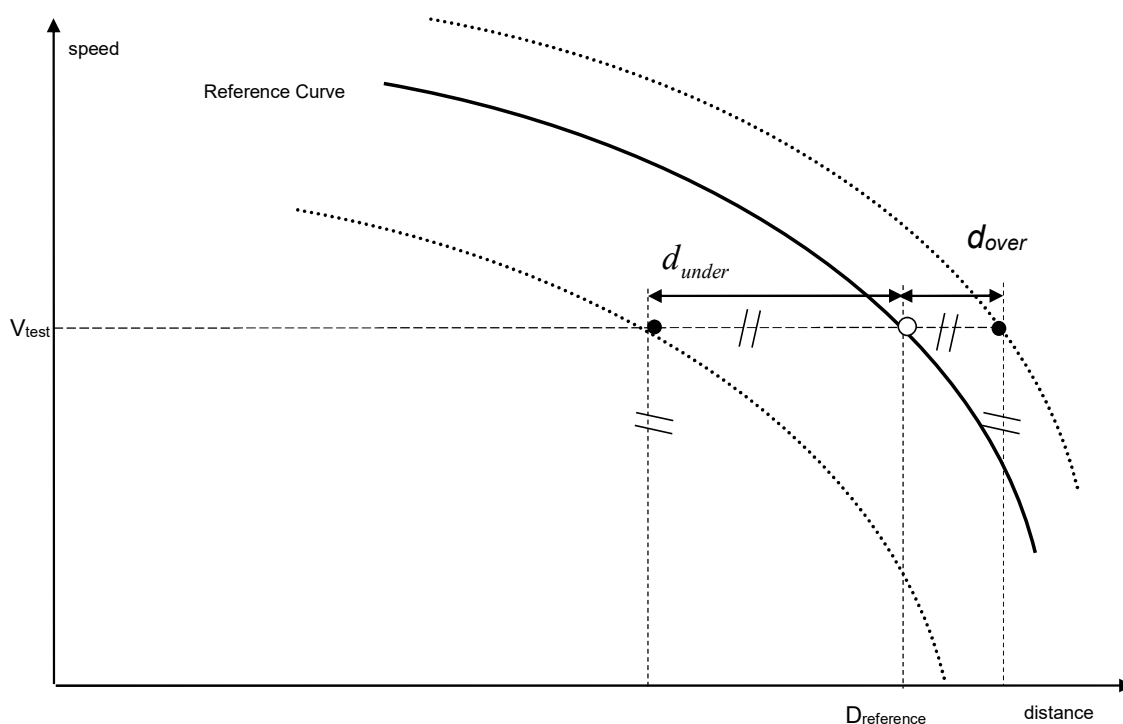


Figure 1: Validation range for a braking curve

- 5.1.1.3** The validation range for the braking curve is defined by :

$$\{D_{\text{reference}} - d_{\text{under}} , D_{\text{reference}} + d_{\text{over}}\}$$



**EU AGENCY FOR RAILWAYS - ERTMS UNIT**  
**TEST SEQUENCE VALIDATION AND EVALUATION**

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Where  $D_{\text{reference}}$  is the distance of the reference point of the curve that will be used to validate the step.

- 5.1.1.4** If a reaction in distance at a given speed is within the validation range the step is passed. The distances  $d_{\text{under}}$  and  $d_{\text{over}}$  are interface and reference curve dependent according to the following table.

*Table 22 : Validation range for DMI and TIU for validation of braking curve test sequences*

Curve	DMI range	TIU range
EBI and SBI	$\{D_{\text{reference}} - d_{\text{under}}, D_{\text{reference}} + 0,5 \cdot d_{\text{over}}\}$ where $d_{\text{under}} = V_{\text{test}} \cdot 1,5\text{s}$ $d_{\text{over}} = V_{\text{test}} \cdot 1,5\text{s}$ and $V_{\text{test}}$ is the speed at $D_{\text{reference}}$ during test execution	$\{D_{\text{reference}} - d_{\text{under}}, D_{\text{reference}} + 0,5 \cdot d_{\text{over}}\}$ where $d_{\text{under}} = V_{\text{test}} \cdot 1\text{s}$ $d_{\text{over}} = V_{\text{test}} \cdot 1\text{s}$ and $V_{\text{test}}$ is the speed at $D_{\text{reference}}$ during test execution
Warning, Permitted, Indication	$\{D_{\text{reference}} - d_{\text{under}}, D_{\text{reference}} + d_{\text{over}}\}$ where $d_{\text{under}} = V_{\text{test}} \cdot 1,5\text{s}$ $d_{\text{over}} = V_{\text{test}} \cdot 1,5\text{s}$ and $V_{\text{test}}$ is the speed at $D_{\text{reference}}$ during test execution	$\{D_{\text{reference}} - d_{\text{under}}, D_{\text{reference}} + d_{\text{over}}\}$ where $d_{\text{under}} = V_{\text{test}} \cdot 1,5\text{s}$ $d_{\text{over}} = V_{\text{test}} \cdot 1,5\text{s}$ and $V_{\text{test}}$ is the speed at $D_{\text{reference}}$ during test execution

- 5.1.1.5** The laboratory shall take into account for the evaluation of braking curve any perturbation (e.g. uncertainty of the accuracy of the speed provided by the test bench) introduced during the execution of the test by the test bench.

## **6. TEST SEQUENCES EXECUTION**

### **6.1 Principles**

**6.1.1.1** The following points describe the situations where a Test Sequence cannot be properly tested at some points. The described changes that are made in those situations shall take into account the aim of the particular Test Cases i.e. with a special attention to the SUBSET-026 requirements that are under test and may be affected by the changes. If this situation arrives, two possibilities can happen:

- a) A requirement affected that has already been tested in another test sequence do not need to be taken into account when the test sequence is modified, though it would be convenient to take them into account
- b) A requirement affected that it is only tested in this testcase, in such a case the modification of the test sequence shall take into account the requirement.

**6.1.1.2** None of the following points of this section means that, if the on-board equipment passes the modified TS(s), the on-board equipment shall be considered to have passed the original TS with all steps in “passed status”, see section 3.3. First, it shall be ensured that all the requirements covered by the original test sequences are covered during the execution of a test campaign.

### **6.2 Failures in the execution**

**6.2.1.1** If an error occurs while executing a Test Sequence, and this error prevents to execute the rest of the sequence, the original TS shall be modified, in order to test as much of the functionality as possible.

**6.2.1.2** The aforementioned error can be an error because of the following reasons:

- a) Error in the Test Sequence or in the test case
- b) Malfunction of the on-board equipment
- c) Not implemented functionality in the on-board equipment
- d) Implementation of optional functionalities

**6.2.1.3** The laboratory shall justify any modification on the test sequence in the report and guarantee compliance of the new test sequence with the SUBSET-026 [\[2\]](#). Nevertheless, the number of modifications in a single test sequence shall be as minimum as possible.

**6.2.1.4** The modifications in the Test Sequence shall not leave untested any functionality from the original test sequence.

**6.2.1.5** The modifications due to optional functions of SRS implemented in the on-board equipment (e.g. allowed choices within ETCS functionality,...) can be solved

modifying it without leaving any other functionality uncovered in the Test Sequence.

**6.2.1.6** The modifications made to a test sequence shall respect the values defined in section 6.4.

**6.2.1.7** In case of the error is caused by the on-board equipment ,the Test Sequence might be modified in different ways: it can be splitted in two different TSs, a balise or radio message can be modified or removed, etc.

6.2.1.7.1 If it is decided to split the Test Sequence in two different TSs, the first one shall be defined from the beginning of the original TS to the location where the error happened, and the second one shall start where the first one finishes and shall finish at the end of the original TS (This could be done more than once for a TS if more than one error of this kind occurs).

6.2.1.7.2 Although the error will occur at a certain step, this does not mean that the second TS will have to start from the following step in the original TS. Eventually, a whole TC will be out of the second TS or even more than one TC might not be possible to be tested in this TS because of the error.

6.2.1.7.3 In the second TS, the Starting Conditions and the first steps (or TCs) shall reach the appropriate state for testing the first TC that is possible to be tested after the step where the error in the original TS occurred. From this TC on, the second TS shall be identical to the original TS.

6.2.1.7.4 Note: adaptation of TC and TS as consequence of the previous clauses is considered being part of the method described by SUBSET-076.

### **6.3 Events that depend on the braking model**

**6.3.1.1** In any TS, after the brakes are applied by the on-board equipment, if an event or a set of events will not happen unless the train has passed a certain location, it shall be ensured that the train passes this location. This might not always be the case when testing a real on-board equipment in the laboratory, due to the braking performance.

**6.3.1.2** There are two general scenarios in the TSs where the aforementioned problem may occur:

- a) While the train is braking, an event (or a set of events) has to be tested (e.g. reading a BG).
- b) The train is at standstill after the brakes application and an event (or a set of events) has to be tested which depends on the stop location (e.g. radio messages from the RBC).

- 6.3.1.3** In those scenarios the TS shall be modified, the laboratory shall avoid any changes in the expected functionality under test, shall respect the step order and shall apply one of the following solutions :
- a) either to modify the speed profile, so the train can run at a different speed before the brakes are applied
  - b) or to delay the triggering event for brake application .
  - c) or to modify the stop location on the basis of the actual location where the on-board equipment under test stops.

## **6.4 Time Delays**

- 6.4.1.1** The radio and the speed profile timings in the Test Sequences [\[6\]](#) are set to the values specified in [\[9\]](#). Nevertheless, if the execution of a Test Sequence is affected by or interrupted due to a particular combination of delays and/or back-delays, those values might be modified in order to make the particular Test Case(s) work properly (as expected). Time values are not considered mandatory for the on-board equipment, they are just the default values used to build the test sequences and are provided for information in [\[9\]](#).

## **6.5 Adaptations for Reduced Envelopes**

- 6.5.1.1** If a test sequence contains the user comment “This test sequence requires tuning by the lab for correct execution for reduced envelope. This tuning shall be done using the available TCs for the reduced envelope.”, the laboratory will have to adjust the test sequence at this point using the version of the TC specific for the tested reduced envelope. The TC needs to be integrated properly into the rest of the test sequence.
- 6.5.1.2** For a test sequence testing braking curves, if the description field contains the text “This TS requires tuning by the lab for correct execution for reduced envelopes. This tuning shall be done by relying on the version 4.3 of the ERA tool for braking curves.”, the adjustments require a calculation with the version of the ERA braking curve tool [\[8\]](#) specific for the tested reduced envelope.
- 6.5.1.3** Any adjustment as per this section shall be shared with ERA and other accredited laboratories, via an IT tool managed by the Agency.

## **7. TEST REPORT**

**7.1.1.1** The SUBSET-076 test report shall contain the following information:

- a)** Reference documents used.
- b)** An identification of each software and hardware component of the on-board equipment under test.
- c)** An identification of each software and hardware component of the laboratory equipment used for the tests.
- d)** The list of test sequence executed (identifying the original ones and the modified during the test campaign).
- e)** A justification of the changes introduced in every modified test sequence.
- f)** A justification for every partially or totally non executed test sequence.
- g)** A justification proving that all the requirements covered by the original test sequences modified are still covered by the test sequences used during the test campaign (i.e. executed at least once).
- h)** A list of SUBSET-026 requirements not implemented or wrongly implemented, linked to non passed steps (see 3.3.1.1), in the on-board equipment in the following format:

*Table 23 : List of requirements not implemented or wrongly implemented*

<b>ID</b>	<b>Ss-026 requirement</b>	<b>Problem description</b>
[01]	[1.1.1.1]	
[02]		
[03]		
...		

- i)** List of non evaluated SRS On-board requirements linked to non evaluated steps (see 3.3.1.1 “non evaluated” steps)
- j)** A list of optional interfaces implemented.
- k)** A summary list of comments for the “passed with comments” steps (i.e. use of different range of values for ETCS variables to the ones used in SUBSET-076, optional packets implemented by the supplier, detected Change Request classified as error in the ERA CR Database or not alignment of the DMI, TIU or JRU implementations by the supplier)
- l)** All the log files (from all available interfaces) from the executed test sequences shall be annexed to the report.



## **8. SUBSET-076 REPORT TEMPLATE**

- 8.1.1.1** This section provides an example of recommended SUBSET-076 test report template to be used as by accredited laboratories.



Test\_sequence\_report  
\_format\_v6.docx