

**ERTMS/ETCS**

**Failure Modes and Effects Analysis for DMI-Subsystem  
in Application Level 1**

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| <b>Company</b>   | <b>Technical Approval</b> | <b>Management approval</b> |
|------------------|---------------------------|----------------------------|
| ALSTOM           |                           |                            |
| AZD              |                           |                            |
| CAF              |                           |                            |
| HITACHI RAIL STS |                           |                            |
| MERMEC           |                           |                            |
| SIEMENS          |                           |                            |
| THALES           |                           |                            |

## 1. MODIFICATION HISTORY

| Issue Number<br>Date | Section Number       | Modification / Description  | Author      |
|----------------------|----------------------|---|-------------|
| 0.0.1<br>21-03-01    | All                  | Creation  | HB (Editor) |
| 0.0.2<br>20-02-02    | 4                    | 1.2.6.3.1 in / 1.2.6.3.1 in<br>Operational Mode changed<br>according to mode table in<br>SRS (4.6).   | HB (Editor) |
| 2.0.0.<br>23-02-02   | Section 3 References | Raised in issue for release<br>to the EEIG  | WLH         |
| 2.2.2.<br>21-03-03   |                      | Final release after<br>amendment to reflect the<br>comments in the final report<br>from the ISA's version 1.1<br>dated 07-03-03 as<br>proposed via the Unisig<br>consolidated review<br>comments on the ISA report<br>v 0.0.2 March 03.   | WLH         |
| 2.3.0<br>Feb 2010    | All                  | Update to SRS Baseline<br>2.3.0 d   | IS          |
| 2.3.1<br>Mar 2010    | All                  | Intermediate issue for<br>internal work <ul style="list-style-type: none"> <li>• Comments amended<br/>from MoM RAMS<br/>nr2010:1. Ref.1.9.1.2.<br/>Bullets 2, 3, 4, 5, 6, 7</li> <li>• FMEA Traceability on<br/>MMI-x events.<br/>Alignment to Subset-<br/>088 and LRRs work</li> </ul> | IS          |
| 2.3.2<br>Jun 2010    | All                  | Intermediate issue for<br>internal work<br><br>Some comments amended<br>from BT review file dated on<br>2010-04-12  | IS          |
| 2.3.3<br>Sep 2010    | All                  | All identified "Event-Id"<br>renamed to MMI-x format  | IS          |

|                                    |                          |  |           |
|------------------------------------|--------------------------|--|-----------|
|                                    |                          | Other minor clarifications   |           |
| 2.3.4<br>Sep 2010 (Berlin meeting) | Section 4                | Rows 1.2.7.8.1 in & 1.2.7.8.2 in modified during the meeting                             | IS        |
| 2.3.5                              | All                      | Comments amended from MoM: 2010:5 – Rome 2010-10-25—26                                   | IS        |
| 2.3.6                              | All                      | Minor corrections from RAMS-group review   | IS        |
| 3.0.0                              | All                      | Update to B3 (SRS 3.2.0)   | IS and JP |
| 3.1.0                              | All                      | Update with comments from Karin and Dag  | JP and RB |
| 3.2.0                              | All                      | Update after Monopoli meeting  | JP and RB |
| 3.3.0                              | Section 4 and Annex A    | Update after Brussels meeting  | JP and RB |
| 3.4.0                              | All                      | Update after Berlin meeting  | JP and RB |
| 3.5.0                              | All                      | Update after SG comments   | JP and RB |
| 3.6.0                              | Section 3 and 4.         | Update in20#, in#21 and out#21.<br>New paragraph added at section 3.                     | JP and RB |
| 3.7.0                              | All                      | Update to SRS v3.2.1   | All       |
| 3.8.0                              |                          | Updated during RAMS-meeting  | DR        |
| 3.9.0                              |                          | Baseline 3 release version   | DR        |
| 3.10.0                             | Section 4                | FMEA update taking into account SRS 3.18.3.2.2   | JP        |
| 3.11.0                             |                          | Update to B3 MR1   | NH and JM |
| 3.12.0                             |                          | Administrative changes during RAMS-meeting   | DARI      |
| 3.13.0                             | Section 4<br><br>Annex A | CR1223: LS removed from out#04, out#05. Added LSSMA as out#53.<br>Modification of MMI-2f | NH, DARI  |
| 3.13.1                             | Section 4                | Modifications due to:<br>CR_539, CR_1091<br>CR_1107 and CR_1187<br>(from B3 R2)          | AV        |

|                      |                      |   |         |
|----------------------|----------------------|---|---------|
| 3.13.2               | Section 4            | Modifications due to:<br>CR_1197<br>(from B3 R2)  | AV      |
| 3.13.3               | Section 4            | Modifications due to:<br>CR_1087<br>(from B3 R2) and the review<br>of the assumptions   | AV      |
| 3.13.4               | Section 4 and 5.1.2, | Modifications to align the<br>subset 079 with the analysis<br>done in subset 118 for<br>“Level Crossing not<br>protected” text message<br>(#in16, #out 15 and 5.1.2).<br>Modifications to align the<br>analysis with the<br>consolidated version of<br>table 4.7.2 of subset 026<br>3.5.0 | AV      |
| 3.13.5               | Section 4 and 5.1.2, | Update after UNISIG RAMS<br>group comments; remove<br>“Level Crossing not<br>protected” text message;<br>maintain ref ids in the table.   | AV      |
| 3.13.6               | Section 3            | Update version of SUBSET-<br>026 and 077.   | AV      |
| 3.14.0<br>2016-06-20 | No change            | Baseline 3 2 <sup>nd</sup> release<br>version   | RAMS WP |
| 3.14.1               | Section 4            | Update in#19 related to LS<br>acknowledgement<br>New deletion failure mode<br>for in#35<br>Correction of operational<br>modes in#11, 13, 18, 19,<br>23, 31 and out#01   | AV, TH  |
| 3.14.2               | FMEA, Conclusions    | Update due to TSI 2022<br>release.  | AV, TH  |
| 3.14.3               | FMEA, Conclusions    | Modification after RAMS<br>review and EECT #91, #93   | AV, TH  |
| 3.14.4               | All                  | Editorial fixes.  | AV, TH  |



|                    |                       |  |        |
|--------------------|-----------------------|--|--------|
|                    |                       | Coherency fixes to be aligned with Subsets-077, 088, 080 and 091 (v4.0.0). |        |
| 3.14.5             | Footer, Out#70, 5.1.2 | Application of Quality checks proposed by SG.                              | AV, TH |
| 3.15.0<br>07-05-24 | None                  | Baseline 4 release version   | AV, TH |



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### 3. INTRODUCTION

Scope: Failure Modes and Effects Analysis for UNISIG DMI-Subsystem in Application Level 1

Input documents:

SRS, SUBSET-026

Causal Analysis Process, SUBSET-077

Only mandatory ETCS functions are considered.

In Chapter 4 failure of some functions are shown to be RAM issues and are not developed further.

#### 3.1 Mode transitions with or without acknowledgment

In order to clarify all the possible transitions with or without acknowledgment, it is added a little summary considering the mode after transition. All the other conditions are assumed to be fulfilled and only driver actions are specified:

- OS / LS (further location): Transition after acknowledgment, if not it remains in the current mode that always will be FS.
- OS / LS (current location): Immediate transition. The driver acknowledges to assume more responsibility. If there is no acknowledgment the brakes are applied after a specified time.
- SH selected by the driver: Immediate transition.
- SH ordered by trackside (further location): Transition after acknowledgment, if not it remains in the current mode.
- SH ordered by trackside (current location): Immediate transition. The driver acknowledges assuming more responsibility. If there is no acknowledgment the brakes are applied after a specified time.
- SR from Override: Immediate transition.
- SR from Start of mission and Train Trip: Transition after acknowledgment, if not it remains in the current mode. See CR1050.
- TRIP: Immediate transition.
- POST TRIP: Transition after acknowledgment.
- UN: Transition after acknowledgment.
- RV: Transition after acknowledgment.
- SN: Transition after acknowledgment.
- AD (selected by driver): Immediate transition



## 4. FMEA

Column “Failure Cause”

Driver is noted for the sake of completeness, although driver is considered outside of the ETCS-system in the UNISIG SRS.

Column “Failure Mode”:

Assumption for the FMEA-part of the input functions: Data shown to the driver on the DMI are correct.

Failure modes of the output functions (data shown to the driver on the DMI) are treated in the output-part of the DMI:

|                  | Failure Modes |   |  |
|------------------|---------------|---|--|
|                  |               | DMI   | Driver   |
| Input Functions  | Corruption    | Failure to handle input data within the DMI<br>Failure to transmit correct data to kernel | Wrong driver input   |
|                  | Deletion      | Failure to transmit data or acknowledgement to kernel                                     | No driver input or no driver acknowledgement   |
|                  | Insertion     | Inappropriate acknowledgement not due to driver<br>Untimely data transmission to kernel   | Untimely data input<br>Inappropriate driver acknowledgement (driver presses the button without notice) |
| Output Functions | Corruption    | Incorrect data are shown  | -  |
|                  | Deletion      | No data = not shown, when it should be  | -  |
|                  | Insertion     | Data displayed appear untimely = shown, when not expected                                 | -  |





#### Column “Failure Effects”

Possible failure effects of the failure modes of the output functions (general).

It could lead the driver to take wrong decisions, i.e. no decision, when he should decide.

In case of showing wrong train data to driver, he could assume that the shown train data are valid and he could therefore omit data entry of (the same) valid data.

Column “Ref ID”: Input and Output information have been numerated taking into account SRS 4.7.2. When not included in the table, “in\_extra” indicator has been used, together with its SRS reference. Some output functions which are a direct result of an input function are analyzed together with the corresponding input function. It has been seen that a failure in the output is another potential source of failure of the input (e.g. driver sees an ack of a button that he has not pressed). The failure mode of the output has then been assumed to be such that it affects also the input, e.g. if a button is not enabled, it is not possible for the driver to activate the corresponding input function.

Column “Event-ID” replaces the former one named as “Failure Rate” (originally in FMEA template). This column will be used to provide the link of all failure effects to MMI-x hazardous events in Subset-091 (ETCS Core Hazard coverage).



| Ref ID | Macro Function Data Item    | Failure Mode  | Failure Cause         | Operational Mode   | Failure Effects |                                      |                                      | External Protection / Mitigation / Barriers                | Severity     | Event-ID | Internal Barriers |
|--------|-----------------------------|---|-----------------------|--|-----------------|--------------------------------------|--------------------------------------|--|--------------|----------|-------------------|
|        |                             |   |                       |  | Local           | Intermediate                         | Initial End Effect                   |  |              |          |                   |
| in# 01 | Train Data - train category | <b>Corruption:</b> wrong input for international train category (It also applies to Insertion and Deletion) | driver or DMI failure | in SB, FS, AD, LS, SR, OS, UN, SN available under condition(s) |                 | error in on-board evaluation of SSPs | exceedance of safe speed or distance | operational rules for driver product specific safeguarding | catastrophic | MMI-3    |                   |
| in# 01 | Train Data - train length   | <b>Corruption:</b> wrong input for train length (It also applies to Insertion and Deletion)                 | driver or DMI failure | in SB, FS, AD, LS, SR, OS, UN, SN available under condition(s) |                 | wrong supervision of SSPs and TSRs   | exceedance of safe speed or distance | operational rules for driver product specific safeguarding | catastrophic | MMI-3    |                   |



| Ref ID | Macro Function Data Item               | Failure Mode  | Failure Cause         | Operational Mode   | Failure Effects |   |                                      | External Protection / Mitigation / Barriers                | Severity     | Event-ID | Internal Barriers |
|--------|--|---|-----------------------|--|-----------------|---|--------------------------------------|--|--------------|----------|-------------------|
|        |  |   |                       |  | Local           | Intermediate  | Initial End Effect                   |  |              |          |                   |
| in# 01 | Train Data - traction/brake parameters | <b>Corruption:</b> input for braking parameters higher than real<br>(It also applies to Insertion and Deletion) | driver or DMI failure | in SB, FS, AD, LS, SR, OS, UN, SN available under condition(s) |                 | wrong braking curve calculation   | exceedance of safe speed or distance | operational rules for driver product specific safeguarding | catastrophic | MMI-3    |                   |
| in# 01 | Train Data - maximum train speed       | <b>Corruption:</b> input for maximum train speed too high<br>(It also applies to Insertion and Deletion)        | driver or DMI failure | in SB, FS, AD, LS, SR, OS, UN, SN available under condition(s) |                 | wrong ceiling speed calculation (if vehicle ceiling speed lower than track ceiling speed) | exceedance of safe speed or distance | operational rules for driver product specific safeguarding | catastrophic | MMI-3    |                   |



| Ref ID | Macro Function Data Item        | Failure Mode   | Failure Cause         | Operational Mode   | Failure Effects |  |                              | External Protection / Mitigation / Barriers  | Severity     | Event-ID | Internal Barriers |
|--------|---------------------------------|--|-----------------------|--|-----------------|--|------------------------------|--|--------------|----------|-------------------|
|        |                                 |  |                       |  | Local           | Intermediate                               | Initial End Effect           |  |              |          |                   |
| in# 01 | Train Data - loading gauge      | <b>Corruption:</b> wrong input for loading gauge<br>(It also applies to Insertion and Deletion)      | driver or DMI failure | in SB, FS, AD, LS, SR, OS, UN, SN available under condition(s) |                 | train enters a route although not suitable | collision with side barriers | operational rules for driver<br><br>Lineside indications and driver's route knowledge<br><br>product specific safeguarding | catastrophic | MMI-3    |                   |
| in# 01 | Train Data - axle load category | <b>Corruption:</b> wrong input for axle load category<br>(It also applies to Insertion and Deletion) | driver or DMI failure | in SB, FS, AD, LS, SR, OS, UN, SN available under condition(s) |                 | train enters a route although not suitable | derailment                   | operational rules for driver<br><br>Lineside indications and driver's route knowledge<br><br>product specific safeguarding | catastrophic | MMI-3    |                   |

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| Ref ID | Macro Function Data Item                       | Failure Mode   | Failure Cause         | Operational Mode  | Failure Effects |   |   | External Protection / Mitigation / Barriers  | Severity | Event-ID | Internal Barriers |
|--------|--|--|-----------------------|---|-----------------|---|---|--|----------|----------|-------------------|
|        |  |  |                       |   | Local           | Intermediate  | Initial End Effect  |  |          |          |                   |
| in# 01 | Train Data - train fitted with airtight system | <b>Corruption:</b> wrong input for airtight system available onboard (It also applies to Insertion and Deletion) | driver or DMI failure | in SB, FS, AD, LS, SR, OS, UN, SN available under condition(s)                    |                 | Air conditioning intake is not controlled automatically | Passenger could be affected by sudden change of pressure or noxious air coming inside train | Opening/Closing air conditioning intake can be manually controlled onboard product specific safeguarding | critical |          |                   |
| in# 02 | Selection of language                          | <b>Insertion:</b> inappropriate selection of language  | driver or DMI failure | in SB, SH, FS, AD, LS, SR, OS, NL, UN, TR, PT SN, RV available under condition(s) |                 |   |   | operational rules for driver   | marginal |          |                   |



| Ref ID | Macro Function Data Item | Failure Mode   | Failure Cause         | Operational Mode   | Failure Effects |                   |  | External Protection / Mitigation / Barriers | Severity  | Event-ID | Internal Barriers                        |
|--------|--------------------------|--|-----------------------|--|-----------------|-------------------|--|---|-----------|----------|--|
|        |                          |  |                       |  | Local           | Intermediate      | Initial End Effect                                       |   |           |          |  |
| in# 03 | Driver ID                | <b>Corruption:</b> wrong input of driver identity (It also applies to Insertion and Deletion)      | driver or DMI failure | in SB, SH, FS, AD, LS, SR, OS, NL, UN, SN available under condition(s) |                 | wrong data to JRU | difficulties in taking legal actions in case of accident | operational rules for driver                | RAM issue |          |  |
| in# 04 | Train running number     | <b>Corruption:</b> wrong input of train running number (It also applies to Insertion and Deletion) | driver or DMI failure | in SB, FS, AD, LS, SR, OS, NL, UN, SN available under condition(s)     |                 |                   | confusion for dispatcher                                 | operational rules for driver                | RAM issue |          | not used inside ETCS for safety purposes |



| Ref ID | Macro Function Data Item | Failure Mode  | Failure Cause         | Operational Mode   | Failure Effects |  |                                      | External Protection / Mitigation / Barriers | Severity     | Event-ID | Internal Barriers  |
|--------|--------------------------|---|-----------------------|--|-----------------|--|--------------------------------------|---|--------------|----------|--|
|        |                          |   |                       |  | Local           | Intermediate   | Initial End Effect                   |   |              |          |  |
| in# 05 | ERTMS /ETCS level        | <b>Corruption:</b> wrong input of ETCS-level<br>(It also applies to Insertion and Deletion)             | driver or DMI failure | in SB, FS, AD, LS, SR, OS, NL, UN, SN available under condition(s) | level 2 input   | establishing a communication session to RBC not possible | start of mission not successful      | operational rules for driver                | marginal     |          | kernel allows the driver to change the level only at standstill (SRS 3.18.4.2.4) |
| in# 06 | Track Adhesion factor    | <b>Corruption:</b> wrong input for track adhesion factor<br>(It also applies to Insertion and Deletion) | driver or DMI failure | in SB, FS, AD, LS, SR, OS, UN, SN available under condition(s)     |                 | wrong braking curve calculation                          | exceedance of safe speed or distance | operational rules for driver                | catastrophic | MMI-3    |  |
| in# 07 | Intentionally left empty |   |                       |  |                 |  |                                      |   |              |          |  |



| Ref ID   | Macro Function Data Item     | Failure Mode                             | Failure Cause         | Operational Mode                           | Failure Effects |              |                                      | External Protection / Mitigation / Barriers  | Severity | Event-ID | Internal Barriers |
|----------|------------------------------|--|-----------------------|--|-----------------|--------------|--------------------------------------|--|----------|----------|-------------------|
|          |                              |  |                       |  | Local           | Intermediate | Initial End Effect                   |  |          |          |                   |
| in# 08.1 | RBC Contact information      | level 2 only                             |                       |  |                 |              |                                      |  |          |          |                   |
| In# 08.2 | Radio Network information    | level 2 only                             |                       |  |                 |              |                                      |  |          |          |                   |
| in# 09   | Train integrity confirmation | level 2 only                             |                       |  |                 |              |                                      |  |          |          |                   |
| in# 10   | Start                        | <b>Insertion:</b><br>inappropriate start | driver or DMI failure | in SB, SR, PT available under condition(s) |                 |              | mode-transition to staff responsible | operational rules for driver product specific safeguarding of data entry procedure | critical |          |                   |





| Ref ID | Macro Function Data Item | Failure Mode   | Failure Cause         | Operational Mode   | Failure Effects                              |  |                                       | External Protection / Mitigation / Barriers | Severity     | Event-ID | Internal Barriers   |
|--------|--------------------------|--|-----------------------|--|--|--|---------------------------------------|---|--------------|----------|---|
|        |                          |  |                       |  | Local  | Intermediate                                       | Initial End Effect                    |   |              |          |   |
| in# 11 | Override request         | <b>Insertion:</b><br>Inappropriate override selection not due to driver                                    | DMI failure           | in SB, SH, FS, AD, LS, SR, OS, UN, PT, SN available under condition(s) | mode-transition to SR                        | driver is not prepared to take more responsibility | exceedance of safe speed and distance | operational rules for driver                | catastrophic | MMI-1c   | kernel accepts the ack only when inside the "rectangle" (see conditions in SRS 5.8.2.1) |
| in# 11 | Override request         | <b>Deletion:</b><br>Driver does not select override or DMI fails to transmit override selection to kernel. | Driver or DMI failure | In SB, SH, FS, AD, LS, SR, OS, UN, PT, SN available under condition(s) | override selection not transmitted to kernel |  | override not activated                |   | RAM issue    |          |   |



| Ref ID | Macro Function Data Item                     | Failure Mode   | Failure Cause | Operational Mode   | Failure Effects                              |  |                                       | External Protection / Mitigation / Barriers | Severity     | Event-ID | Internal Barriers  |
|--------|--|--|---------------|--|--|--|---------------------------------------|---|--------------|----------|--|
|        |  |  |               |  | Local  | Intermediate                                       | Initial End Effect                    |   |              |          |  |
| in# 11 | Override request - Enable override selection | <b>Insertion:</b> inappropriate displaying of enabled override selection: shown when not expected    | DMI failure   | in SB, SH, FS, AD, LS, SR, OS, UN, PT, SN available under condition(s) | mode transition to SR after driver input     | driver is not prepared to take more responsibility | exceedance of safe speed and distance | operational rules for driver                | catastrophic | MMI-2f   | kernel accepts the request only when inside the "rectangle"(see conditions in SRS 5.8.2.1) |
| in# 11 | Override request - Enable override selection | <b>Deletion:</b> inappropriate displaying of enabled override selection: not shown when it should be | DMI failure   | In SB, SH, FS, AD, LS, SR, OS, UN, PT, SN available under condition(s) | override selection not transmitted to kernel |  | override not activated                |   | RAM issue    |          |  |



| Ref ID | Macro Function Data Item   | Failure Mode   | Failure Cause         | Operational Mode   | Failure Effects  |   |                                       | External Protection / Mitigation / Barriers                                      | Severity     | Event-ID | Internal Barriers          |
|--------|----------------------------|--|-----------------------|--|--|---|---------------------------------------|--|--------------|----------|----------------------------|
|        |                            |  |                       |  | Local  | Intermediate  | Initial End Effect                    |  |              |          |                            |
| in# 12 | Shunting request (SRS 5.6) | <b>Insertion:</b> shunting initiated by driver at inappropriate location | driver or DMI failure | in SB, FS, AD, LS, SR, OS, UN, PT, SN available under condition(s) | mode transition to SH mode                               | train performs shunting in an area, where it is not permitted | exceedance of safe speed and distance | operational rules for driver product specific safeguarding of SH entry procedure | catastrophic | MMI-1g   | kernel check of standstill |
| in# 12 | Shunting request (SRS 5.6) | <b>Deletion:</b> failure to transmit selection to kernel                 | DMI failure           | in SB, FS, AD, LS, SR, OS, UN, PT, SN available under condition(s) | onboard-equipment remains in performing the current mode |   | no shunting mode possible             |  | RAM issue    |          |                            |



| Ref ID | Macro Function Data Item                    | Failure Mode  | Failure Cause         | Operational Mode                   | Failure Effects                                 |              |                                    | External Protection / Mitigation / Barriers | Severity  | Event-ID | Internal Barriers   |
|--------|---|---|-----------------------|------------------------------------|---|--------------|------------------------------------|---|-----------|----------|---|
|        |   |   |                       |                                    | Local   | Intermediate | Initial End Effect                 |   |           |          |   |
| in# 13 | “Continue Shunting on desk closure” request | <b>Insertion:</b> continue shunting on desk closure at inappropriate location | driver or DMI failure | in SH available under condition(s) | PS mode transition is enabled but not triggered | No effect    | No effect                          | operational rules for driver                | RAM issue |          | Passive input signal from TIU protects against unwanted transition to PS mode |
| in# 13 | “Continue Shunting on desk closure” request | <b>Deletion:</b> failure to transmit selection to kernel                      | DMI failure           | in SH available under condition(s) | PS mode transition not enabled                  |              | Transition to PS mode not possible | operational rules for driver                | RAM issue |          |   |
| in# 14 | “Exit of shunting” request                  | <b>Insertion:</b> inappropriate exit of shunting request                      | driver or DMI failure | In SH available under condition(s) | corresponds to start of mission                 |              | mode transition to SB              | operational rules for driver                | marginal  |          | kernel check of standstill  |



| Ref ID | Macro Function Data Item   | Failure Mode   | Failure Cause         | Operational Mode   | Failure Effects   |   |                                       | External Protection / Mitigation / Barriers                                      | Severity     | Event-ID | Internal Barriers  |
|--------|----------------------------|--|-----------------------|--|---|---|---------------------------------------|--|--------------|----------|--|
|        |                            |  |                       |  | Local   | Intermediate  | Initial End Effect                    |  |              |          |  |
| in# 14 | “Exit of shunting” request | <b>Deletion:</b> failure to transmit request to kernel | DMI failure           | In SH available under condition(s)                         | onboard-equipment remains in performing the current mode          |   | no exit of shunting possible          |  | RAM issue    |          |  |
| in# 15 | Non-leading request        | <b>Insertion:</b> non-leading request at wrong time    | driver or DMI failure | in SB, SH, FS, AD, LS, SR, OS available under condition(s) | unwanted release from supervision (selection of non-leading mode) | non-leading mode: no supervision, driver is fully responsible | exceedance of safe speed and distance | operational rules for driver product specific safeguarding of NL entry procedure | catastrophic | MMI-1b   | kernel check of standstill non leading input signal from the train interface |



| Ref ID | Macro Function Data Item                  | Failure Mode  | Failure Cause         | Operational Mode   | Failure Effects  |              |                              | External Protection / Mitigation / Barriers | Severity  | Event-ID | Internal Barriers   |
|--------|---|---|-----------------------|--|--|--------------|------------------------------|---|-----------|----------|---|
|        |   |   |                       |  | Local  | Intermediate | Initial End Effect           |   |           |          |   |
| in# 15 | Non-leading request                       | <b>Deletion:</b> failure to transmit request to kernel        | DMI failure           | in SB, SH, FS, AD, LS, SR, OS available under condition(s)             | onboard-equipment remains in performing the current mode         |              | no non-leading mode possible |   | RAM issue |          |   |
| in# 16 | Acknowledgement of fixed text information | <b>Deletion:</b> no acknowledgement of fixed text information | driver or DMI failure | in SB, FS, AD, LS, SR, OS, UN, TR, PT, RV available under condition(s) | according to the use of the text messages in operational context |              |                              |   | RAM issue |          | not to be used inside ETCS for safety purposes (refer to 5.1.2) |



| Ref ID | Macro Function Data Item                  | Failure Mode  | Failure Cause         | Operational Mode   | Failure Effects  |              |                    | External Protection / Mitigation / Barriers | Severity  | Event-ID | Internal Barriers   |
|--------|---|---|-----------------------|--|--|--------------|--------------------|---|-----------|----------|---|
|        |   |   |                       |  | Local  | Intermediate | Initial End Effect |   |           |          |   |
| in# 16 | Acknowledgement of fixed text information | <b>Insertion:</b> unintentional acknowledgement of fixed text information | driver or DMI failure | in SB, FS, AD, LS, SR, OS, UN, TR, PT, RV available under condition(s) | according to the use of the text messages in operational context |              |                    |   | RAM issue |          | not to be used inside ETCS for safety purposes (refer to 5.1.2) |
| in# 17 | Acknowledgement of plain text information | <b>Deletion:</b> no acknowledgement of plain text information             | driver or DMI failure | in SB, FS, AD, LS, SR, OS, UN, TR, PT, RV available under condition(s) | according to the use of the text messages in operational context |              |                    |   | RAM issue |          | not to be used inside ETCS for safety purposes                  |



| Ref ID | Macro Function Data Item                  | Failure Mode  | Failure Cause         | Operational Mode   | Failure Effects  |  |  | External Protection / Mitigation / Barriers | Severity     | Event-ID | Internal Barriers                                       |
|--------|---|---|-----------------------|--|--|--|--|---|--------------|----------|---|
|        |   |   |                       |  | Local  | Intermediate                                       | Initial End Effect                               |   |              |          |   |
| in# 17 | Acknowledgement of plain text information | <b>Insertion:</b> unintentional acknowledgement of plain text information | driver or DMI failure | in SB, FS, AD, LS, SR, OS, UN, TR, PT, RV available under condition(s) | according to the use of the text messages in operational context |  |  |   | RAM issue    |          | not to be used inside ETCS for safety purposes          |
| in# 18 | Acknowledgement of level transition       | <b>Deletion:</b> no acknowledgement of level transition                   | driver or DMI failure | in SB, SH, FS, AD, LS, SR, OS, UN, TR, SN available under condition(s) |  | driver is not prepared to take more responsibility | exceedance of safe speed or distance (collision) | operational rules for driver                | catastrophic | MMI-1d   | Service brake is applied after 5 seconds (SRS 5.10.4)   |
| in# 18 | Acknowledgement of level transition       | <b>Insertion:</b> unintentional acknowledgement of level transition       | driver or DMI failure | in SB, SH, FS, AD, LS, SR, OS, UN, TR, SN available under condition(s) | driver not aware of level transition                             | driver is not prepared to take more responsibility | exceedance of safe speed or distance (collision) | operational rules for driver                | catastrophic | MMI-1d   | kernel accepts the ack only when inside the "rectangle" |





| Ref ID | Macro Function Data Item                    | Failure Mode   | Failure Cause         | Operational Mode                                       | Failure Effects            |  |                                       | External Protection / Mitigation / Barriers | Severity     | Event-ID | Internal Barriers   |
|--------|---|--|-----------------------|--|----------------------------|--|---------------------------------------|---|--------------|----------|---|
|        |   |  |                       |  | Local                      | Intermediate                                       | Initial End Effect                    |   |              |          |   |
| in# 19 | Acknowledgement of Limited Supervision mode | <b>Insertion:</b><br>Inappropriate ack not due to driver                               | DMI failure           | in SB, FS, AD, LS, OS, PT available under condition(s) | mode transition to LS mode | driver is not prepared to take more responsibility | exceedance of safe speed or distance  | operational rules for driver                | catastrophic | MMI-1a   | kernel accepts the ack only when it is inside the "rectangle"   |
| in# 19 | Acknowledgement of Limited Supervision mode | <b>Deletion:</b><br>Driver does not acknowledge or DMI fails to transmit ack to kernel | driver or DMI failure | in SB, FS, AD, LS, OS, PT available under condition(s) | no mode transition to LS   | driver is not prepared to take more responsibility | exceedance of safe speed and distance | operational rules for driver                | catastrophic | MMI-1a   | kernel check of LS mode acknowledgement<br>Service Brake is applied after driver acknowledgement time |



| Ref ID | Macro Function Data Item                    | Failure Mode   | Failure Cause | Operational Mode                                       | Failure Effects  |  |  | External Protection / Mitigation / Barriers                   | Severity     | Event-ID | Internal Barriers   |
|--------|---|--|---------------|--|--|--|--|---|--------------|----------|---|
|        |   |  |               |  | Local  | Intermediate   | Initial End Effect   |   |              |          |   |
| in# 19 | Acknowledgement of Limited Supervision mode | <b>Deletion:</b><br>Inappropriate displaying of ack: not shown when it should be | DMI failure   | in SB, FS, AD, LS, OS, PT available under condition(s) |  | driver is not prepared to take more responsibility               | Exceedance of safe speed and distance  | operational rules for driver                                  | catastrophic | MMI-2g   | kernel check of LS mode acknowledgement<br><br>Service Brake is applied after driver acknowledgement time |
| in# 19 | Acknowledgement of Limited Supervision mode | <b>Insertion:</b><br>inappropriate displaying of ack: shown when not expected    | DMI failure   | in SB, FS, AD, LS, OS, PT available under conditions   | driver acknowledges mode change, but kernel does not change mode due to conditions not fulfilled | driver assumes onboard is in LS mode because he has acknowledged | exceedance of safe speed and distance in case current mode provides less supervision than LS | awareness of driver for the current mode displayed on the DMI | critical     |          | kernel monitoring of current mode   |



| Ref ID | Macro Function Data Item   | Failure Mode  | Failure Cause         | Operational Mode                                       | Failure Effects            |  |                                       | External Protection / Mitigation / Barriers | Severity     | Event-ID | Internal Barriers                                       |
|--------|--|---|-----------------------|--|----------------------------|--|---------------------------------------|---|--------------|----------|---|
|        |  |   |                       |  | Local                      | Intermediate                                       | Initial End Effect                    |   |              |          |   |
| in# 20 | Acknowledgement of on sight mode (further and current location ) | <b>Insertion:</b><br>Inappropriate ack not due to driver                                | DMI failure           | in SB, FS, AD, LS, OS, PT available under condition(s) | mode transition to OS mode | driver is not prepared to take more responsibility | exceedance of safe speed and distance | operational rules for driver                | catastrophic | MMI-1a   | kernel accepts the ack only when inside the "rectangle" |
| in# 20 | Acknowledgement of on sight mode (further and current location ) | <b>Deletion:</b><br>Driver does not acknowledge or DMI fails to transmit ack to kernel. | driver or DMI failure | in SB, FS, AD, LS, OS, PT available under condition(s) | no mode transition to OS   | driver is not prepared to take more responsibility | exceedance of safe speed and distance | operational rules for driver                | catastrophic | MMI-1a   | Service Brake is applied after 5 seconds                |



| Ref ID | Macro Function Data Item   | Failure Mode   | Failure Cause | Operational Mode                                       | Failure Effects  |  |  | External Protection / Mitigation / Barriers                   | Severity     | Event-ID | Internal Barriers  |
|--------|--|--|---------------|--|--|--|--|---|--------------|----------|--|
|        |  |  |               |  | Local  | Intermediate   | Initial End Effect   |   |              |          |  |
| in# 20 | Acknowledgement of on sight mode (further and current location ) | <b>Deletion:</b> inappropriate displaying of ack: not shown, when it should be | DMI failure   | in SB, FS, AD, LS, OS, PT available under condition(s) | mode transition to OS independent from driver input  | driver is not prepared to take more responsibility               | exceedance of safe speed and distance  |   | catastrophic | MMI-2g   | kernel check of OS mode acknowledgment (brake if no ack)<br>kernel monitoring of OS mode |
| in# 20 | Acknowledgement of on sight mode (further and current location ) | <b>Insertion:</b> inappropriate displaying of ack: shown, when not expected    | DMI failure   | in SB, FS, AD, LS, OS, PT available under condition(s) | driver acknowledges mode change, but kernel does not change mode due to conditions not fulfilled | driver assumes onboard is in OS mode because he has acknowledged | exceedance of safe speed and distance in case current mode provides less supervision than OS | awareness of driver for the current mode displayed on the DMI | critical     |          | kernel monitoring of current mode  |



| Ref ID | Macro Function Data Item         | Failure Mode  | Failure Cause         | Operational Mode   | Failure Effects                                     |  |                                       | External Protection / Mitigation / Barriers | Severity     | Event-ID | Internal Barriers  |
|--------|----------------------------------|---|-----------------------|--|---|--|---------------------------------------|---|--------------|----------|--|
|        |                                  |   |                       |  | Local   | Intermediate                                       | Initial End Effect                    |   |              |          |  |
| in# 21 | Acknowledgement of shunting mode | <b>Insertion:</b><br>Inappropriate ack not due to driver                                | DMI failure           | in SB, SH, FS, AD, LS, OS, PT available under condition(s) | mode transition to SH                               | driver is not prepared to shunt                    | exceedance of safe speed and distance |   | catastrophic | MMI-1a   | kernel accepts the ack only when inside the "rectangle"                                  |
| in# 21 | Acknowledgement of shunting mode | <b>Deletion:</b><br>Driver does not acknowledge or DMI fails to transmit ack to kernel. | driver or DMI failure | in SB, SH, FS, AD, LS, OS, PT available under condition(s) |   | driver is not prepared to take more responsibility | exceedance of safe speed and distance | operational rules for driver                | catastrophic | MMI-1a   | Service Brake is applied after 5 seconds   |
| in# 21 | Acknowledgement of shunting mode | <b>Deletion:</b><br>inappropriate displaying of ack: not shown when it should be        | DMI failure           | in SB, FS, AD, SH, OS, LS, PT available under condition(s) | mode transition to SH independent from driver input | driver is not prepared to shunt                    | exceedance of safe speed and distance |   | catastrophic | MMI-2g   | kernel check of SH mode acknowledgment (brake if no ack)<br>Kernel monitoring of SH mode |



| Ref ID | Macro Function Data Item                  | Failure Mode   | Failure Cause | Operational Mode   | Failure Effects  |  |                                       | External Protection / Mitigation / Barriers                   | Severity     | Event-ID | Internal Barriers                 |
|--------|---|--|---------------|--|--|--|---------------------------------------|---|--------------|----------|-----------------------------------|
|        |   |  |               |  | Local  | Intermediate   | Initial End Effect                    |   |              |          |                                   |
| in# 21 | Acknowledgement of shunting mode          | <b>Insertion:</b> inappropriate displaying of ack: shown when not expected | DMI failure   | in SB, FS, AD, SH, OS, LS, PT available under condition(s) | driver acknowledges mode change, but kernel does not change mode due to conditions not fulfilled | driver assumes onboard is in SH mode because he has acknowledged | exceedance of safe speed and distance | awareness of driver for the current mode displayed on the DMI | critical     |          | kernel monitoring of current mode |
| in# 22 | Acknowledgement of staff responsible mode | <b>Insertion:</b> Inappropriate ack not due to driver                      | DMI failure   | in SB, PT available under condition(s) (see CR 1050)       | mode transition to SR mode   | driver is not prepared to take more responsibility               | exceedance of safe speed and distance | awareness of driver for the new mode displayed on the DMI     | catastrophic | MMI-1a   |                                   |



| Ref ID | Macro Function Data Item                  | Failure Mode   | Failure Cause         | Operational Mode                                     | Failure Effects                           |  |                                       | External Protection / Mitigation / Barriers                       | Severity     | Event-ID | Internal Barriers  |
|--------|---|--|-----------------------|--|---|--|---------------------------------------|---|--------------|----------|--|
|        |   |  |                       |  | Local                                     | Intermediate                                       | Initial End Effect                    |   |              |          |  |
| in# 22 | Acknowledgement of staff responsible mode | <b>Deletion:</b> Driver does not acknowledge or DMI fails to transmit ack to kernel. | driver or DMI failure | in SB, PT available under condition(s) (see CR 1050) |   | driver is not prepared to take more responsibility | exceedance of safe speed and distance | operational rules for driver                                      | catastrophic | MMI-1a   | kernel check of SR mode acknowledgement (no mode change without ack) |
| in# 23 | Acknowledgement of unfitted mode          | <b>Insertion:</b> Inappropriate ack not due to driver                                | DMI failure           | in SB available under condition(s)                   | Level/mode transition to Level 0/unfitted | driver is not prepared to take more responsibility | exceedance of safe speed and distance | operational rules for driver                                      | catastrophic | MMI-1a   | kernel accepts the ack only when it is inside the "rectangle"        |
| in# 23 | Acknowledgement of unfitted mode          | <b>Deletion:</b> Driver does not acknowledge or DMI fails to transmit ack to kernel. | driver or DMI failure | in SB available under condition(s)                   | No mode transition performed              | ETCS will keep waiting for confirmation of UN mode |                                       | operational rules for driver (e.g. re-start of onboard equipment) | RAM issue    |          |  |

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| Ref ID | Macro Function Data Item         | Failure Mode   | Failure Cause | Operational Mode                    | Failure Effects  |  |  | External Protection / Mitigation / Barriers                         | Severity     | Event-ID | Internal Barriers  |
|--------|----------------------------------|--|---------------|-------------------------------------|--|--|--|---|--------------|----------|--|
|        |                                  |  |               |                                     | Local  | Intermediate   | Initial End Effect   |   |              |          |  |
| in# 23 | Acknowledgement of unfitted mode | <b>Deletion:</b> inappropriate displaying of ack: not shown, when it should be | DMI failure   | in SB, available under condition(s) | mode transition to UN independent of driver input  | driver is not prepared to take more responsibility               | exceedance of safe speed and distance  |   | catastrophic | MMI-2g   | kernel check of UN mode acknowledgment (brake if no ack)<br>kernel monitoring of UN mode |
| in# 23 | Acknowledgement of unfitted mode | <b>Insertion:</b> inappropriate displaying of ack: shown, when not expected    | DMI failure   | in SB, available under condition(s) | driver acknowledges mode change, but kernel does not change mode due to conditions not fulfilled | driver assumes onboard is in UN mode because he has acknowledged | exceedance of safe speed and distance in case current mode provides less supervision than UN | awareness of driver for the current mode/level displayed on the DMI | critical     |          | kernel monitoring of current mode/level  |





| Ref ID | Macro Function Data Item                         | Failure Mode  | Failure Cause         | Operational Mode                               | Failure Effects       |  |                                       | External Protection / Mitigation / Barriers | Severity   | Event-ID | Internal Barriers   |
|--------|--|---|-----------------------|--|-----------------------|--|---------------------------------------|---|--|----------|---|
|        |  |   |                       |  | Local                 | Intermediate                                       | Initial End Effect                    |   |  |          |   |
| in# 24 | Acknowledgement of reversing mode (SRS 5.13.1.5) | <b>Insertion:</b><br>Inappropriate acknowledgement due to driver                        | DMI failure           | in FS, AD, LS, OS available under condition(s) | mode transition to RV | driver is not prepared to take more responsibility | exceedance of safe speed and distance |   | catastrophic   | MMI-1a   | Train must be at standstill and direction controller set to reverse position by the driver<br>Train must be inside a reversing area |
| in# 24 | Acknowledgement of reversing mode (SRS 5.13.1.5) | <b>Deletion:</b><br>Driver does not acknowledge or DMI fails to transmit ack to kernel. | driver or DMI failure | in FS, AD, LS, OS available under condition(s) |                       | driver is not prepared to take more responsibility | exceedance of safe speed and distance | operational rules for driver                | RAM issue<br>Outside ETCS scope, could be catastrophic |          | UDMP will be triggered if driver tries to reverse   |
| in# 25 | Acknowledgement of SN mode                       | <b>Insertion:</b><br>Inappropriate acknowledgement due to driver                        | DMI failure           | in SB available under condition(s)             | mode transition to SN | driver is not prepared to take more responsibility | exceedance of safe speed and distance |   | catastrophic   | MMI-1a   | kernel accepts the ack only when it is inside the "rectangle"   |



| Ref ID | Macro Function Data Item      | Failure Mode   | Failure Cause  | Operational Mode                   | Failure Effects            |  |                                       | External Protection / Mitigation / Barriers | Severity     | Event-ID | Internal Barriers   |
|--------|-------------------------------|--|----------------|------------------------------------|----------------------------|--|---------------------------------------|---|--------------|----------|---|
|        |                               |  |                |                                    | Local                      | Intermediate                                       | Initial End Effect                    |   |              |          |   |
| in# 25 | Acknowledgement of SN mode    | <b>Deletion:</b><br>Driver does not acknowledge          | driver failure | in SB available under condition(s) |                            | driver is not prepared to take more responsibility | exceedance of safe speed and distance | operational rules for driver                | catastrophic | MMI-1a   | kernel check of SN mode acknowledgement<br>Service Brake is applied |
| in# 25 | Acknowledgement of SN mode    | <b>Deletion:</b><br>DMI fails to transmit ack to kernel. | DMI failure    | in SB available under condition(s) | misleads the driver        | mode is not changed                                |                                       | operational rules for driver                | RAM issue    |          | kernel check of SN mode acknowledgement<br>Service Brake is applied |
| in# 26 | Acknowledgement of train trip | <b>Insertion:</b><br>Inappropriate ack not due to driver | DMI failure    | in TR available under condition(s) | mode transition to PT mode | reversing of train by driver in PT mode possible   | exceedance of safe speed and distance | operational rules for driver                | catastrophic | MMI-1e   | kernel check of standstill  |



| Ref ID | Macro Function Data Item      | Failure Mode   | Failure Cause         | Operational Mode                   | Failure Effects          |                           |  | External Protection / Mitigation / Barriers | Severity  | Event-ID | Internal Barriers |
|--------|-------------------------------|--|-----------------------|------------------------------------|--------------------------|---------------------------|--|---|---|----------|-------------------|
|        |                               |  |                       |                                    | Local                    | Intermediate              | Initial End Effect                         |   |   |          |                   |
| in# 26 | Acknowledgement of train trip | <b>Deletion:</b> Driver does not acknowledge or DMI fails to transmit ack to kernel. | Driver or DMI failure | in TR available under condition(s) | Train remains in TR mode | reversing is not possible | not possible to escape out of an emergency | driver may select IS mode to reverse        | Outside ETCS core hazard, could be catastrophic |          |                   |
| in# 26 | Acknowledgement of train trip | <b>Deletion:</b> inappropriate displaying of ack: not shown, when it should be       | DMI failure           | in TR available under condition(s) | Train remains in TR mode | reversing is not possible | not possible to escape out of an emergency | driver may select IS mode to reverse        | Outside ETCS core hazard, could be catastrophic |          |                   |



| Ref ID | Macro Function Data Item      | Failure Mode  | Failure Cause | Operational Mode   | Failure Effects   |  |  | External Protection / Mitigation / Barriers                   | Severity     | Event-ID | Internal Barriers                                       |
|--------|-------------------------------|---|---------------|--|---|--|--|---|--------------|----------|---|
|        |                               |   |               |  | Local   | Intermediate   | Initial End Effect                               |   |              |          |   |
| in# 26 | Acknowledgement of train trip | <b>Insertion:</b> inappropriate displaying of ack: shown, when not expected | DMI failure   | in TR available under condition(s)                             | driver acknowledges Train Trip, but kernel does not change mode due to conditions not fulfilled | driver assumes onboard is in PT mode because he has acknowledged | no train-movement possible because EB is applied | awareness of driver for the current mode displayed on the DMI | RAM issue    |          | kernel monitoring of current mode                       |
| in# 27 | Acknowledgement of RAP        | <b>Insertion:</b> Inappropriate ack not due to driver                       | DMI failure   | in SH, FS, LS, SR, OS, UN, PT, RV available under condition(s) | unintended RAP acknowledgment   | unintended train brakes released                                 | exceedance of safe speed and distance            | operational rules for driver                                  | catastrophic | MMI-1h   | Reinitializing of RAP function using new train position |



| Ref ID | Macro Function Data Item | Failure Mode   | Failure Cause         | Operational Mode   | Failure Effects                |                                  |                                       | External Protection / Mitigation / Barriers | Severity     | Event-ID | Internal Barriers  |
|--------|--------------------------|--|-----------------------|--|--------------------------------|----------------------------------|---------------------------------------|---|--------------|----------|--|
|        |                          |  |                       |  | Local                          | Intermediate                     | Initial End Effect                    |   |              |          |  |
| in# 27 | Acknowledgement of RAP   | <b>Deletion:</b> Driver does not acknowledge or DMI fails to transmit ack to kernel. | Driver or DMI failure | in SH, FS, LS, SR, OS, UN, PT, RV available under condition(s) | RAP not acknowledged           | train brakes remain applied      | no train-movement possible            | operational rules for driver                | RAM issue    |          | kernel check of standstill                               |
| in# 28 | Acknowledgement of UDMP  | <b>Insertion:</b> Inappropriate ack not due to driver                                | DMI failure           | in FS, LS, SR, OS, PT, RV available under condition(s)         | unintended UDMP acknowledgment | unintended train brakes released | exceedance of safe speed and distance | operational rules for driver                | catastrophic | MMI-1h   | Reinitializing of UDMP function using new train position |
| in# 28 | Acknowledgement of UDMP  | <b>Deletion:</b> Driver does not acknowledge or DMI fails to transmit ack to kernel. | Driver or DMI failure | in FS, LS, SR, OS, PT, RV available under condition(s)         | UDMP not acknowledged          | train brakes remain applied      | no train-movement possible            | operational rules for driver                | RAM issue    |          | kernel check of standstill                               |



| Ref ID | Macro Function Data Item                  | Failure Mode  | Failure Cause         | Operational Mode                   | Failure Effects                                  |                                 |                                       | External Protection / Mitigation / Barriers | Severity     | Event-ID | Internal Barriers  |
|--------|---|---|-----------------------|------------------------------------|--|---------------------------------|---------------------------------------|---|--------------|----------|--|
|        |   |   |                       |                                    | Local  | Intermediate                    | Initial End Effect                    |   |              |          |  |
| in# 29 | Acknowledgement of Standstill supervision | <b>Insertion:</b><br>Inappropriate acknowledgement not due to driver                    | DMI failure           | in SB available under condition(s) | unintended SS acknowledgment                     | unintended train brakes release | exceedance of safe speed and distance | operational rules for driver                | catastrophic | MMI-1h   | Reinitializing of Standstill function using new train position   |
| in# 29 | Acknowledgement of Standstill supervision | <b>Deletion:</b><br>Driver does not acknowledge or DMI fails to transmit ack to kernel. | Driver or DMI failure | in SB available under condition(s) | SS not acknowledged                              | train brakes remain applied     | no train-movement possible            | operational rules for driver                | RAM issue    |          | kernel check of standstill                                       |
| in# 30 | Acknowledgement of PT distance exceeded   | <b>Insertion:</b><br>Inappropriate acknowledgement not due to driver                    | DMI failure           | in PT available under condition(s) | unintended PT distance exceedance acknowledgment | unintended train brakes release | exceedance of safe speed and distance | operational rules for driver                | catastrophic | MMI-1h   | system keeps PT mode and supervised distances shall be identical |

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| Ref ID | Macro Function Data Item   | Failure Mode   | Failure Cause         | Operational Mode   | Failure Effects                         |                             |                            | External Protection / Mitigation / Barriers | Severity  | Event-ID | Internal Barriers          |
|--------|--|--|-----------------------|--|---|-----------------------------|----------------------------|---|-----------|----------|----------------------------|
|        |  |  |                       |  | Local                                   | Intermediate                | Initial End Effect         |   |           |          |                            |
| in# 30 | Acknowledgement of PT distance exceeded                                | <b>Deletion:</b> Driver does not acknowledge or DMI fails to transmit ack to kernel. | Driver or DMI failure | in PT available under condition(s)                             | PT distance exceeded not acknowledged   | train brakes remain applied | no train-movement possible | operational rules for driver                | RAM issue |          | kernel check of standstill |
| in# 31 | Acknowledgement of Train Data Change from source different from driver | <b>Deletion:</b> no acknowledgement of train data changed                            | driver or DMI failure | in FS, AD, OS, SR, UN, TR, SN, LS available under condition(s) | Train data change not confirmed onboard | train brakes remain applied | no train movement possible | operational rules for driver                | RAM issue |          |                            |

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|-----------|--|---|-----------------------|--|---|--|--|--|-----------|--|--|
| in#<br>31 | Acknowledgement of Train Data Change from source different from driver | <b>Insertion:</b><br>unintentional acknowledgement of train data change | driver or DMI failure | in FS, AD, OS, SR, UN, TR, SN, LS available under condition(s) | driver is not aware of train data changed onboard |  |  | Traffic planning will not allow a train passing through a non compatible piece of track (e.g. train axle load, loading gauge, etc.)<br><br>Assumption: this failure mode can be 'RAM Issue' only if the 'acknowledgement of train data change from external source' is not claimed as internal barrier | RAM issue |  |  |
|-----------|--|---|-----------------------|--|---|--|--|--|-----------|--|--|

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| Ref ID | Macro Function Data Item                        | Failure Mode  | Failure Cause | Operational Mode                   | Failure Effects                                  |                                 |                                       | External Protection / Mitigation / Barriers   | Severity     | Event-ID | Internal Barriers  |
|--------|---|---|---------------|------------------------------------|--|---------------------------------|---------------------------------------|---|--------------|----------|--|
|        |   |   |               |                                    | Local  | Intermediate                    | Initial End Effect                    |   |              |          |  |
|        |   |   |               |                                    |  |                                 |                                       | against failure mode of on board input leading to train data change from external source. |              |          |  |
| in# 32 | Acknowledgement for reversing distance exceeded | <b>Insertion:</b> Inappropriate ack not due to driver | DMI failure   | in RV available under condition(s) | unintended RV distance exceedance acknowledgment | unintended train brakes release | exceedance of safe speed and distance | operational rules for driver  | catastrophic | MMI-1h   | system keeps RV mode and supervised distances shall be identical |



| Ref ID | Macro Function Data Item                        | Failure Mode  | Failure Cause         | Operational Mode                   | Failure Effects                         |                             |                            | External Protection / Mitigation / Barriers | Severity  | Event-ID | Internal Barriers          |
|--------|---|---|-----------------------|------------------------------------|---|-----------------------------|----------------------------|---|-----------|----------|----------------------------|
|        |   |   |                       |                                    | Local                                   | Intermediate                | Initial End Effect         |   |           |          |                            |
| in# 32 | Acknowledgement for reversing distance exceeded | <b>Deletion:</b><br>Driver does not acknowledge or DMI fails to transmit ack to kernel. | driver or DMI failure | in RV available under condition(s) | RV distance exceedance not acknowledged | train brakes remain applied | no train-movement possible | operational rules for driver                | RAM issue |          | kernel check of standstill |
| in# 33 | Intentionally left empty                        |   |                       |                                    |   |                             |                            |   |           |          |                            |
| in# 34 | Track ahead free                                | level 2 only (SRS 3.15.5)   |                       |                                    |   |                             |                            |   |           |          |                            |



| Ref ID | Macro Function Data Item                            | Failure Mode  | Failure Cause         | Operational Mode                   | Failure Effects |  |                                      | External Protection / Mitigation / Barriers | Severity     | Event-ID | Internal Barriers |
|--------|---|---|-----------------------|------------------------------------|-----------------|--|--------------------------------------|---|--------------|----------|-------------------|
|        |   |   |                       |                                    | Local           | Intermediate   | Initial End Effect                   |   |              |          |                   |
| in# 35 | SR mode speed limit and distance - maximum SR speed | <b>Corruption:</b> too high speed input for Staff Responsible | driver or DMI failure | in SR available under condition(s) |                 | wrong supervision of maximum staff responsible speed | exceedance of safe speed or distance | operational rules for driver                | catastrophic | MMI-4    |                   |
| in# 35 | SR mode speed limit and distance -SR distance       | <b>Corruption:</b> wrong input for staff responsible distance | driver or DMI failure | in SR available under condition(s) |                 | train exceeds staff responsible distance             | exceedance of safe distance          | operational rules for driver                | catastrophic | MMI-4    |                   |



| Ref ID | Macro Function Data Item         | Failure Mode  | Failure Cause         | Operational Mode                   | Failure Effects                                    |  |                                      | External Protection / Mitigation / Barriers  | Severity     | Event-ID | Internal Barriers                            |
|--------|----------------------------------|---|-----------------------|------------------------------------|--|--|--------------------------------------|--|--------------|----------|--|
|        |                                  |   |                       |                                    | Local  | Intermediate                                       | Initial End Effect                   |  |              |          |  |
| in# 35 | SR mode speed limit and distance | <b>Deletion:</b><br>Driver does not input or DMI fails to transmit SR speed or distance to kernel | Driver or DMI failure | in SR available under condition(s) | ETCS kernel uses previous SR speed/distance values | wrong supervision of maximum SR speed and distance | exceedance of safe speed or distance | operational rules for driver   | catastrophic | MMI-4    |  |
| in# 36 | Isolation                        | <b>Insertion:</b><br>Inappropriate input not due to driver  | DMI failure           | All                                | Unwanted transition of ETCS on-board to IS mode    | No train protection available                      | exceedance of safe distance          | operational rules for driver<br><br>External switch is used to enter in Isolation mode | catastrophic | MMI-1a   | Isolation status must be shown to the driver |



| Ref ID | Macro Function Data Item | Failure Mode  | Failure Cause | Operational Mode | Failure Effects                                |   |   | External Protection / Mitigation / Barriers  | Severity  | Event-ID | Internal Barriers                            |
|--------|--------------------------|---|---------------|------------------|--|---|---|--|-----------|----------|--|
|        |                          |   |               |                  | Local  | Intermediate                                    | Initial End Effect  |  |           |          |  |
| in# 36 | Isolation                | <b>Deletion:</b><br>DMI fails to transmit order to kernel | DMI failure   | All              | ETCS does not transit to IS mode when required | Driver does not realize about ETCS not isolated | Current ETCS mode supervision still available on-board<br><br><i>Note: ETCS is intended to be isolated, so that other system (or driver) is meant to control the train. ETCS will conflict with train operation</i> | operational rules for driver<br><br>External switch is used to enter in Isolation mode | RAM issue |          | Isolation status must be shown to the driver |



| Ref ID | Macro Function Data Item | Failure Mode   | Failure Cause         | Operational Mode                   | Failure Effects                            |  |                                      | External Protection / Mitigation / Barriers | Severity     | Event-ID | Internal Barriers  |
|--------|--------------------------|--|-----------------------|------------------------------------|--|--|--------------------------------------|---|--------------|----------|--|
|        |                          |  |                       |                                    | Local                                      | Intermediate   | Initial End Effect                   |   |              |          |  |
| in# 37 | Virtual Balise Cover     | <b>Insertion:</b><br>Unintended input for Virtual Balise Cover         | driver or DMI failure | in SB available under condition(s) | unintended inhibition of BG processing     | safety relevant BG is not processed missing information for train supervision      | exceedance of safe speed or distance | operational rules for driver                | catastrophic | MMI-6    | Trackside may send a new list of Virtual Balise Cover that shall replace the older one<br><br>kernel allows the driver to change VBC only at SoM |
| in# 37 | Virtual Balise Cover     | <b>Deletion:</b><br>Failure to transmit input for Virtual Balise Cover | driver or DMI failure | in SB available under condition(s) | intended inhibition of BG is not performed | Not intended BG is processed providing erroneous information for train supervision | exceedance of safe speed or distance | operational rules for driver                | catastrophic | MMI-6    | Trackside may send a new list of Virtual Balise Cover that shall replace the older one<br><br>product specific safeguarding                      |



| Ref ID | Macro Function Data Item                 | Failure Mode  | Failure Cause         | Operational Mode                   | Failure Effects                          |  |  | External Protection / Mitigation / Barriers | Severity     | Event-ID | Internal Barriers   |
|--------|--|---|-----------------------|------------------------------------|--|--|--|---|--------------|----------|---|
|        |  |   |                       |                                    | Local                                    | Intermediate                             | Initial End Effect                       |   |              |          |   |
| in# 37 | Virtual Balise Cover                     | <b>Corruption:</b> wrong input for Virtual Balise Cover | driver or DMI failure | in SB available under condition(s) | Same as for in#37 insertion and deletion | Same as for in#37 insertion and deletion | Same as for in#37 insertion and deletion | operational rules for driver                | catastrophic | MMI-6    | Trackside may send a new list of Virtual Balise Cover that shall replace the older one<br>product specific safeguarding |
| in# 38 | Supervised Manoeuvrere request           | level 2 only (SRS 4.4.21 & 5.21)                        |                       |                                    |  |  |  |   |              |          |   |
| in# 38 | Supervised Manoeuvrere request           | level 2 only (SRS 4.4.21 & 5.21)                        |                       |                                    |  |  |  |   |              |          |   |
| in# 39 | “Exit of Supervised Manoeuvrere” request | level 2 only (SRS 4.4.21 & 5.21)                        |                       |                                    |  |  |  |   |              |          |   |

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| Ref ID | Macro Function Data Item                           | Failure Mode   | Failure Cause         | Operational Mode                   | Failure Effects                   |                                |                             | External Protection / Mitigation / Barriers | Severity  | Event-ID | Internal Barriers  |
|--------|--|--|-----------------------|------------------------------------|-----------------------------------|--------------------------------|-----------------------------|---|-----------|----------|--|
|        |  |  |                       |                                    | Local                             | Intermediate                   | Initial End Effect          |   |           |          |  |
| in# 39 | “Exit of Supervised Manoeuvre” request             | level 2 only (SRS 4.4.21 & 5.21)   |                       |                                    |                                   |                                |                             |   |           |          |  |
| in# 40 | Acknowledgement of non-leading no longer permitted | <b>Insertion:</b> Unintended input for Acknowledgement of NL no longer permitted | driver or DMI failure | in NL available under condition(s) | DMI indication is shown to Driver | Driver acknowledges exit of NL | On-board remains in NL mode |   | RAM issue |          | NL exit only available at standstill, does not depend on DMI ack |





| Ref ID | Macro Function Data Item                           | Failure Mode  | Failure Cause         | Operational Mode   | Failure Effects  |  |  | External Protection / Mitigation / Barriers     | Severity  | Event-ID | Internal Barriers  |
|--------|--|---|-----------------------|--|--|--|--|---|-----------|----------|--|
|        |  |   |                       |  | Local  | Intermediate                               | Initial End Effect                         |   |           |          |  |
| in# 40 | Acknowledgement of non-leading no longer permitted | <b>Deletion:</b><br>Failure to transmit input for Acknowledgement of NL no longer permitted | driver or DMI failure | in NL available under condition(s)   | Transition to SB mode (if in standstill )<br><br>DMI indication is not shown to driver | Driver may not be aware of exit of NL mode | On-board remains standstill in SB mode     |   | RAM issue |          | NL exit only available at standstill, does not depend on DMI ack |
| in# 41 | ATO selector                                       | <b>Corruption:</b><br>Unintended input for ATO selector- On when it should be Stand-by      | driver or DMI failure | In SB, SH, FS, AD, LS, SR, OS, NL, UN, TR, PT, SN, RV available under condition(s) | Enables automatic driving and display of ATO information                               |  | AD mode is ready to be requested by driver | Driver can switch to Stand-by whenever he wants | RAM issue |          | AD mode has to be activated by driver under certain conditions   |



| Ref ID | Macro Function Data Item | Failure Mode   | Failure Cause         | Operational Mode   | Failure Effects                 |              |                                 | External Protection / Mitigation / Barriers | Severity  | Event-ID | Internal Barriers |
|--------|--------------------------|--|-----------------------|--|---------------------------------|--------------|---------------------------------|---|-----------|----------|-------------------|
|        |                          |  |                       |  | Local                           | Intermediate | Initial End Effect              |   |           |          |                   |
| in# 41 | ATO selector             | <b>Corruption:</b><br>Unintended input for ATO selector- Stand-by when it should be On | driver or DMI failure | In SB, SH, FS, AD, LS, SR, OS, NL, UN, TR, PT, SN, RV available under condition(s) | If in AD, OBU transits to FS    |              | Automatic driving is disengaged |   | RAM issue |          |                   |
| in# 41 | ATO selector             | <b>Deletion:</b><br>Failure to transmit input for ATO selector                         | driver or DMI failure | In SB, SH, FS, AD, LS, SR, OS, NL, UN, TR, PT, SN, RV available under condition(s) | ATO operation remains as it was |              | See corruption Failure modes    |   | RAM issue |          |                   |



| Ref ID | Macro Function Data Item | Failure Mode   | Failure Cause         | Operational Mode                       | Failure Effects                     |  |   | External Protection / Mitigation / Barriers     | Severity  | Event-ID | Internal Barriers   |
|--------|--------------------------|--|-----------------------|--|-------------------------------------|--|---|---|-----------|----------|---|
|        |                          |  |                       |  | Local                               | Intermediate   | Initial End Effect  |   |           |          |   |
| in# 42 | ATO engage               | <b>Insertion:</b><br>Unintended input for ATO engage | driver or DMI failure | In FS, AD available under condition(s) | AD mode is entered, and ATO engaged | Driver not aware of traction being controlled by ATO | Train is moved according to ATO journey profile and train data stored | Driver can brake at any moment and quit AD mode | RAM issue |          | Conditions: AD mode has to be requested by ATO; SSP and gradient have to be known for whole train length; and nor Service brake nor Emergency brake have to be commanded<br><br>ETCS shall remain supervising train movement<br><br>ETCS shall confirm transition to AD mode both to ATO and RS |



| Ref ID | Macro Function Data Item | Failure Mode  | Failure Cause         | Operational Mode                       | Failure Effects                             |   |  | External Protection / Mitigation / Barriers                            | Severity  | Event-ID | Internal Barriers                            |
|--------|--------------------------|---|-----------------------|--|---|---|--|--|-----------|----------|--|
|        |                          |   |                       |  | Local                                       | Intermediate                                  | Initial End Effect   |  |           |          |  |
| in# 42 | ATO engage               | <b>Deletion:</b><br>Failure to transmit input for ATO engage    | driver or DMI failure | In FS, AD available under condition(s) | OBU remains in FS, or in AD but not engaged |   | Train remains at stopping point, or it continues to be manually driven                                     |  | RAM issue |          |  |
| in# 43 | ATO disengage            | <b>Insertion:</b><br>Unintended input for ATO disengage         | driver or DMI failure | In AD available under condition(s)     | Exit AD mode to FS                          |   | Train is manually driven   |  | RAM issue |          |  |
| in# 43 | ATO disengage            | <b>Deletion:</b><br>Failure to transmit input for ATO disengage | driver or DMI failure | In AD available under condition(s)     | OBU remains in AD mode                      | Driver thinks has manual control of the train | Driver not able to control traction<br><br>Train may be stuck in a situation from where it needs to escape | Driver may apply brake or set ATO selector to Stand-by to exit AD mode | RAM issue |          | ETCS shall remain supervising train movement |



| Ref ID | Macro Function Data Item                    | Failure Mode   | Failure Cause         | Operational Mode                       | Failure Effects                |              |                         | External Protection / Mitigation / Barriers   | Severity  | Event-ID | Internal Barriers |
|--------|---|--|-----------------------|--|--------------------------------|--------------|-------------------------|---|-----------|----------|-------------------|
|        |   |  |                       |  | Local                          | Intermediate | Initial End Effect      |   |           |          |                   |
| in# 44 | Skip ATO stopping point request /revocation | <b>Insertion:</b> Unintended input for Skip ATO stopping point request | driver or DMI failure | In FS, AD available under condition(s) | Stopping point will be skipped |              | Operational impact only | Stopping point can only be skipped by driver if the button was previously active. Once requested, driver can revoke it at any time before reaching the stopping point | RAM issue |          |                   |



| Ref ID | Macro Function Data Item                    | Failure Mode  | Failure Cause         | Operational Mode                       | Failure Effects                  |              |                         | External Protection / Mitigation / Barriers   | Severity  | Event-ID | Internal Barriers |
|--------|---|---|-----------------------|--|----------------------------------|--------------|-------------------------|---|-----------|----------|-------------------|
|        |   |   |                       |  | Local                            | Intermediate | Initial End Effect      |   |           |          |                   |
| in# 44 | Skip ATO stopping point request /revocation | <b>Insertion:</b> Unintended input for Skip ATO stopping point revocation | driver or DMI failure | In FS, AD available under condition(s) | Train will stop at planned point |              | Operational impact only | Skip stopping point can only be revoked by driver if it was previously requested by him.<br>Driver can request skip stopping point at any time before reaching it | RAM issue |          |                   |

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| Ref ID | Macro Function Data Item                    | Failure Mode   | Failure Cause         | Operational Mode                       | Failure Effects                      |              |                         | External Protection / Mitigation / Barriers   | Severity  | Event-ID | Internal Barriers |
|--------|---|--|-----------------------|--|--------------------------------------|--------------|-------------------------|---|-----------|----------|-------------------|
|        |   |  |                       |  | Local                                | Intermediate | Initial End Effect      |   |           |          |                   |
| in# 44 | Skip ATO stopping point request /revocation | <b>Deletion:</b><br>Failure to transmit input for Skip Stopping point request/revocation | driver or DMI failure | In FS, AD available under condition(s) | ATO shall stop/skip at planned point |              | Operational impact only | Stopping point can be skipped/revoked at any time.<br>If necessary, driver can apply brake to avoid dangerous situation | RAM issue |          |                   |



| Ref ID | Macro Function Data Item      | Failure Mode  | Failure Cause         | Operational Mode                           | Failure Effects  |  |   | External Protection / Mitigation / Barriers                                   | Severity     | Event-ID | Internal Barriers  |
|--------|-------------------------------|---|-----------------------|--|--|--|---|---|--------------|----------|--|
|        |                               |   |                       |  | Local  | Intermediate   | Initial End Effect  |   |              |          |  |
| in# 45 | BTM alarm reaction Inhibition | <b>Insertion:</b><br>Unintended input for BTM alarm reaction inhibition         | driver or DMI failure | In SB, SH, SR available under condition(s) | Indication is shown in DMI. No reaction is applied when BTM alarm is activated | OBU is allowed to move over BMM without track condition stored | In case of real BTM failure, BG with safety information can be missed | Operational rules for Driver.<br>Driver can revoke inhibition when necessary. | Catastrophic | MMI-1j   | Inhibition can only be performed when train is at standstill<br><br>Inhibition will be automatically revoked when the maximum allowed distance is reached, or if OBU transits to another mode. |
| in# 45 | BTM alarm reaction Inhibition | <b>Deletion:</b><br>failure to transmit input for BTM alarm reaction inhibition | driver or DMI failure | All except SB, SH, SR                      | Inhibition is not activated  |  | In case BTM alarm is activated, a reaction will be applied            | Operational rules for Driver.   | RAM issue    |          |  |





| Ref ID | Macro Function Data Item             | Failure Mode  | Failure Cause         | Operational Mode                           | Failure Effects  |  |   | External Protection / Mitigation / Barriers | Severity     | Event-ID | Internal Barriers   |
|--------|--------------------------------------|---|-----------------------|--|--|--|---|---|--------------|----------|---|
|        |                                      |   |                       |  | Local  | Intermediate   | Initial End Effect  |   |              |          |   |
| in# 45 | BTM alarm reaction Inhibition        | <b>Deletion:</b><br>Failure to transmit input for BTM alarm reaction inhibition       | driver or DMI failure | In SB, SH, SR available under condition(s) | Inhibition is not activated                                      |  | In case BTM alarm is activated, a reaction will be applied            | Operational rules for Driver.               | RAM issue    |          |   |
| in# 46 | Revoke BTM alarm reaction inhibition | <b>Insertion:</b><br>Unintended input to revoke BTM alarm reaction inhibition         | driver or DMI failure | In SB, SH, SR available under condition(s) |  |  | In case BTM alarm is activated, a reaction will be applied            | Operational rules for Driver.               | RAM issue    |          |   |
| in# 46 | Revoke BTM alarm reaction inhibition | <b>Deletion:</b><br>Failure to transmit input to revoke BTM alarm reaction inhibition | driver or DMI failure | In SB, SH, SR available under condition(s) | Indication is shown in DMI. BTM alarm reaction remains inhibited | OBU is allowed to move over BMM without track condition stored | In case of real BTM failure, BG with safety information can be missed |   | Catastrophic | MMI-1j   | Inhibition will be automatically revoked when the maximum allowed distance is reached, or if OBU transits to another mode |

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| Ref ID | Macro Function Data Item                   | Failure Mode | Failure Cause | Operational Mode | Failure Effects |              |                    | External Protection / Mitigation / Barriers | Severity | Event-ID | Internal Barriers |
|--------|--|--------------|---------------|------------------|-----------------|--------------|--------------------|---|----------|----------|-------------------|
|        |  |              |               |                  | Local           | Intermediate | Initial End Effect |   |          |          |                   |
| in# 47 | Perform mission with only one radio system | level 2 only |               |                  |                 |              |                    |   |          |          |                   |



| Ref ID       | Macro Function Data Item   | Failure Mode  | Failure Cause | Operational Mode | Failure Effects  |   |  | External Protection / Mitigation / Barriers                                  | Severity  | Event-ID | Internal Barriers   |
|--------------|--|---|---------------|------------------|--|---|--|--|-----------|----------|---|
|              |  |   |               |                  | Local  | Intermediate  | Initial End Effect                       |  |           |          |   |
| in_extr_a_01 | show permitted speed + target distance request<br><br>Related to SRS 4.4.8.1.10 (SH), 4.4.11.1.7 (SR), and 4.4.12.1.4 (OS) | <b>Deletion:</b><br>DMI do not show permitted speed+target distance on driver request | DMI failure   | SH, SR, OS       | Permitted speed/target distance not shown after driver request | driver does not obtain the information he needs to drive safely | driver cannot start/continue the mission | operational rules for driver driver needs to exceed permitted speed/distance | RAM issue |          | supervision of train speed/target distance by kernel (SH, SR, OS) |

| Ref ID       | Macro Function Data Item   | Failure Mode   | Failure Cause | Operational Mode | Failure Effects                                      |                     |                             | External Protection / Mitigation / Barriers | Severity  | Event-ID | Internal Barriers |
|--------------|--|--|---------------|------------------|--|---------------------|-----------------------------|---|-----------|----------|-------------------|
|              |  |  |               |                  | Local  | Intermediate        | Initial End Effect          |   |           |          |                   |
| in_extr_a_01 | show permitted speed + target distance request<br>Related to SRS 4.4.8.1.10 (SH), 4.4.11.1.7 (SR), and 4.4.12.1.4 (OS) | <b>Insertion:</b><br>permitted speed+target distance shown when not expected | DMI failure   | SH, SR, OS       | Permitted speed/target distance spuriously displayed | misleads the driver | no impact on ETCS-operation |   | RAM issue |          |                   |



| Ref ID  | Macro Function Data Item | Failure Mode  | Failure Cause | Operational Mode   | Failure Effects     |   |  | External Protection / Mitigation / Barriers                                     | Severity     | Event-ID | Internal Barriers                    |
|---------|--------------------------|---|---------------|--|---------------------|---|--|---|--------------|----------|--------------------------------------|
|         |                          |   |               |  | Local               | Intermediate  | Initial End Effect   |   |              |          |                                      |
| out #01 | ERTMS /ETCS-mode         | <b>Deletion, Corruption:</b><br>displaying no or wrong data: FS although actual mode is partial supervision | DMI failure   | SH, AD, LS, SR, OS, NL, UN, PT, SN, RV, IS<br><br>in SB, TR, SF available under condition(s) | misleads the driver | could lead the driver to take inappropriate decisions | exceedance of safe speed or distance                             |   | catastrophic | MMI-2b   | supervision of train speed by kernel |
| out #01 | ERTMS /ETCS-mode         | <b>Deletion, Corruption:</b><br>displaying no or wrong data: partial supervision although actual mode is FS | DMI failure   | FS   | misleads the driver | could lead the driver to take inappropriate decisions | driver could try to take action that could result in train delay | driver-acknowledgment for acceptance of responsibility during level-transitions | RAM issue    |          |                                      |

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| Ref ID  | Macro Function Data Item | Failure Mode  | Failure Cause | Operational Mode   | Failure Effects     |   |                                      | External Protection / Mitigation / Barriers | Severity     | Event-ID | Internal Barriers  |
|---------|--------------------------|---|---------------|--|---------------------|---|--------------------------------------|---|--------------|----------|--|
|         |                          |   |               |  | Local               | Intermediate  | Initial End Effect                   |   |              |          |  |
| out #01 | ERTMS /ETCS-mode         | <b>Corruption:</b><br>displaying wrong SN mode              | DMI failure   | SN   | misleads the driver | could lead the driver to take inappropriate decisions for the current SN mode | exceedance of safe speed or distance | SN specific                                 | catastrophic | MMI-2b   |  |
| out #02 | Current ETCS level       | <b>Deletion, Corruption:</b><br>displaying no or wrong data | DMI failure   | SH, FS, AD, LS, SR, OS, NL, UN, PT, SN, RV<br>in SB, TR available under condition(s) | misleads the driver | could lead the driver to take inappropriate decisions                         | exceedance of safe speed or distance |   | critical     |          | as long as displaying operational mode correctly, there is no problem.<br>(kernel supervision) |
| out #03 | Train speed              | <b>Deletion, Corruption:</b><br>displaying no or wrong data | DMI failure   | SH, FS, AD, LS, SR, OS, NL, UN, PT, RV<br>in SB, TR, SN available under condition(s) | misleads the driver | driver could exceed speed restrictions  | exceedance of safe speed or distance |   | catastrophic | MMI-2a.1 | supervision of train speed by kernel (SH, FS, AD, SR, OS, UN, RV)                              |



| Ref ID  | Macro Function Data Item | Failure Mode   | Failure Cause | Operational Mode                                      | Failure Effects     |   |                                      | External Protection / Mitigation / Barriers | Severity     | Event-ID | Internal Barriers   |
|---------|--------------------------|--|---------------|---|---------------------|---|--------------------------------------|---|--------------|----------|---|
|         |                          |  |               |   | Local               | Intermediate  | Initial End Effect                   |   |              |          |   |
| out #04 | Permitted speed          | <b>Deletion, Corruption:</b> displaying no or wrong data | DMI failure   | FS, AD, RV in SH, SR, OS available under condition(s) | misleads the driver | could lead the driver to take inappropriate decisions | exceedance of safe speed or distance |   | catastrophic | MMI-2a.2 | supervision of train speed by kernel (SH, FS, AD, SR, OS, RV) |
| out #05 | Target speed             | <b>Deletion, Corruption:</b> displaying no or wrong data | DMI failure   | in FS, AD, SR, OS available under condition(s)        | misleads the driver | could lead the driver to take inappropriate decisions | exceedance of safe speed or distance |   | catastrophic | MMI-2a.2 | supervision of train speed by kernel (FS, AD, SR, OS)         |
| out #06 | Target distance          | <b>Deletion, Corruption:</b> displaying no or wrong data | DMI failure   | RV, in FS, AD, SR, OS available under condition(s)    | misleads the driver | could lead the driver to take inappropriate decisions | exceedance of safe speed or distance |   | catastrophic | MMI-2a.2 | supervision of train speed by kernel (FS, AD, SR, OS, RV)     |



| Ref ID  | Macro Function Data Item                         | Failure Mode   | Failure Cause | Operational Mode   | Failure Effects     |   |                                      | External Protection / Mitigation / Barriers | Severity   | Event-ID | Internal Barriers   |
|---------|--|--|---------------|--|---------------------|---|--------------------------------------|---|--|----------|---|
|         |  |  |               |  | Local               | Intermediate  | Initial End Effect                   |   |  |          |   |
| out #07 | Release speed                                    | <b>Deletion, Corruption:</b><br>displaying no or wrong data  | DMI failure   | in FS, AD, LS, OS available under condition(s)                     | misleads the driver | could lead the driver to take inappropriate decisions | exceedance of safe speed or distance |   | catastrophic<br>(2 different cases:<br>depending on the available overlap) | MMI-2a.2 | supervision of train release speed by kernel (FS, AD, OS) |
| out #08 | Speed and distance monitoring supervision status | <b>Deletion, Corruption:</b><br>displaying no or wrong data  | DMI failure   | in SH, FS, AD, LS, SR, OS, UN, PT, RV available under condition(s) | misleads the driver | could lead the driver to take inappropriate decisions | exceedance of safe speed or distance | operational rules for driver                | catastrophic   | MMI-2a.2 | supervision of train speed and distance by kernel         |
| out #09 | Trip reason                                      | <b>Corruption:</b><br>inappropriate triggering of trip alarm | DMI failure   | PT, in TR available under condition(s)                             | misleads the driver |   |                                      |   | marginal   |          |   |





| Ref ID  | Macro Function Data Item               | Failure Mode   | Failure Cause | Operational Mode   | Failure Effects     |   |                                       | External Protection / Mitigation / Barriers           | Severity     | Event-ID | Internal Barriers   |
|---------|--|--|---------------|--|---------------------|---|---------------------------------------|---|--------------|----------|---|
|         |  |  |               |  | Local               | Intermediate  | Initial End Effect                    |   |              |          |   |
| out #10 | Train Data - train category            | <b>Deletion, Corruption:</b> displaying no or wrong data | DMI failure   | in SB, FS, AD, LS, SR, OS, UN, TR, PT, SN, RV available under condition(s) | misleads the driver | could lead the driver to take inappropriate decisions | exceedance of safe speed and distance |   | catastrophic | MMI-2e   | Supervision of train speed by kernel (FS, AD, SR, OS, UN, RV)     |
| out #10 | Train Data - train length              | <b>Deletion, Corruption:</b> displaying no or wrong data | DMI failure   | in SB, FS, AD, LS, SR, OS, UN, TR, PT, SN, RV available under condition(s) | misleads the driver | could lead the driver to take inappropriate decisions | exceedance of safe speed and distance |   | catastrophic | MMI-2e   | supervision of train speed by kernel (FS, AD, SR, OS, UN, RV)     |
| out #10 | Train Data - traction/brake parameters | <b>Deletion, Corruption:</b> displaying no or wrong data | DMI failure   | in SB, FS, AD, LS, SR, OS, UN, TR, PT, SN, RV available under condition(s) | misleads the driver | could lead the driver to take inappropriate decisions | exceedance of safe speed or distance  |   | catastrophic | MMI-2e   | supervision of train speed by kernel (FS, AD, SR, OS, UN, RV)     |
| out #10 | Train Data - Max train speed           | <b>Deletion, Corruption:</b> displaying no or wrong data | DMI failure   | in SB, FS, AD, LS, SR, OS, UN, TR, PT, SN, RV available under condition(s) | misleads the driver | could lead the driver to take inappropriate decisions | exceedance of safe speed and distance | train max speed is normally indicated at train cabins | catastrophic | MMI-2a.2 | supervision of train speed by kernel (SH, FS, AD, SR, OS, UN, RV) |

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| Ref ID  | Macro Function Data Item   | Failure Mode  | Failure Cause | Operational Mode   | Failure Effects     |   |                              | External Protection / Mitigation / Barriers   | Severity     | Event-ID | Internal Barriers                                 |
|---------|----------------------------|---|---------------|--|---------------------|---|------------------------------|---|--------------|----------|---|
|         |                            |   |               |  | Local               | Intermediate  | Initial End Effect           |   |              |          |   |
| out #10 | Train Data - loading gauge | <b>Deletion, Corruption:</b><br>displaying no or wrong data | DMI failure   | in SB, FS, AD, LS, SR, OS, UN, TR, PT, SN, RV available under condition(s) | misleads the driver | could lead the driver to take inappropriate decisions | collision with side barriers | Traffic planning will not allow a train passing through a non compatible piece of track (e.g. train axle load, loading gauge, etc.) | catastrophic | MMI-2e   | Route Suitability may be provided to ETCS onboard |

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| Ref ID  | Macro Function Data Item        | Failure Mode   | Failure Cause | Operational Mode   | Failure Effects     |   |                    | External Protection / Mitigation / Barriers   | Severity     | Event-ID | Internal Barriers                                 |
|---------|---------------------------------|--|---------------|--|---------------------|---|--------------------|---|--------------|----------|---|
|         |                                 |  |               |  | Local               | Intermediate  | Initial End Effect |   |              |          |   |
| out #10 | Train Data - axle load category | <b>Deletion, Corruption:</b> displaying no or wrong data | DMI failure   | in SB, FS, AD, LS, SR, OS, UN, TR, PT, SN, RV available under condition(s) | misleads the driver | could lead the driver to take inappropriate decisions | derailment         | Traffic planning will not allow a train passing through a non compatible piece of track (e.g. train axle load, loading gauge, etc.) | catastrophic | MMI-2e   | Route Suitability may be provided to ETCS onboard |



| Ref ID  | Macro Function Data Item                             | Failure Mode   | Failure Cause | Operational Mode   | Failure Effects     |   |   | External Protection / Mitigation / Barriers   | Severity | Event-ID | Internal Barriers   |
|---------|--|--|---------------|--|---------------------|---|---|---|----------|----------|---|
|         |  |  |               |  | Local               | Intermediate  | Initial End Effect  |   |          |          |   |
| out #10 | Train Data - Traction systems accepted by the engine | <b>Deletion, Corruption:</b> displaying no or wrong data | DMI failure   | in SB, FS, AD, LS, SR, OS, UN, TR, PT, SN, RV available under condition(s) | misleads the driver | could lead the driver to take inappropriate decisions | damage to train   | Traffic planning will not allow a train passing through a non compatible piece of track (e.g. train axle load, loading gauge, etc.) | critical |          | Route Suitability may be provided to ETCS onboard                         |
| out #10 | Train Data - Train fitted with airtight system       | <b>Deletion, Corruption:</b> displaying no or wrong data | DMI failure   | in SB, FS, AD, LS, SR, OS, UN, TR, PT, SN, RV available under condition(s) | misleads the driver | could lead the driver to take inappropriate decisions | Passenger could be affected by sudden change of pressure or noxious air coming inside train | Driver should know if airtight system is available onboard  | critical |          | ETCS onboard controls the air conditioning intakes if system is available |



| Ref ID  | Macro Function Data Item                                 | Failure Mode  | Failure Cause | Operational Mode   | Failure Effects     |   |                    | External Protection / Mitigation / Barriers                      | Severity  | Event-ID | Internal Barriers |
|---------|--|---|---------------|--|---------------------|---|--------------------|--|-----------|----------|-------------------|
|         |  |   |               |  | Local               | Intermediate  | Initial End Effect |  |           |          |                   |
| out #10 | Train Data - List of National Systems available on-board | <b>Deletion, Corruption:</b><br>displaying no or wrong data | DMI failure   | in SB, FS, AD, LS, SR, OS, UN, TR, PT, SN, RV available under condition(s)         | misleads the driver | could lead the driver to take inappropriate decisions |                    | Driver should know which National Systems are available on-board | marginal  |          |                   |
| out #10 | Train Data - Axle number                                 | <b>Deletion, Corruption:</b><br>displaying no or wrong data | DMI failure   | in SB, FS, AD, LS, SR, OS, UN, TR, PT, SN, RV available under condition(s)         | misleads the driver |   |                    |  | RAM issue |          |                   |
| out #11 | Driver identity number                                   | <b>Deletion, Corruption:</b><br>displaying no or wrong data | DMI failure   | in SB, SH, FS, AD, LS, SR, OS, NL, UN, TR, PT, SN, RV available under condition(s) | misleads the driver | could lead the driver to take inappropriate decisions |                    |  | marginal  |          |                   |



| Ref ID    | Macro Function Data Item                       | Failure Mode  | Failure Cause | Operational Mode   | Failure Effects     |   |                    | External Protection / Mitigation / Barriers | Severity | Event-ID                                       | Internal Barriers |
|-----------|--|---|---------------|--|---------------------|---|--------------------|---|----------|--|-------------------|
|           |  |   |               |  | Local               | Intermediate  | Initial End Effect |   |          |  |                   |
| out #12   | Train running number                           | <b>Deletion, Corruption:</b><br>displaying no or wrong data | DMI failure   | in SB, SH, FS, AD, LS, SR, OS, NL, UN, TR, PT, SN, RV available under condition(s) | misleads the driver | could lead the driver to take inappropriate decisions |                    | marginal                                    |          | not to be used inside ETCS for safety purposes |                   |
| out #13.1 | Radio Network information - Radio Network id   | level 2 function  |               |  |                     |   |                    |   |          |  |                   |
| out #13.2 | Radio Network information - Radio Network type | level 2 function  |               |  |                     |   |                    |   |          |  |                   |

| Ref ID    | Macro Function Data Item                | Failure Mode  | Failure Cause | Operational Mode   | Failure Effects     |              |                             | External Protection / Mitigation / Barriers | Severity | Event-ID | Internal Barriers |
|-----------|---|---|---------------|--|---------------------|--------------|-----------------------------|---|----------|----------|-------------------|
|           |   |   |               |  | Local               | Intermediate | Initial End Effect          |   |          |          |                   |
| out #13.3 | RBC contact information-identity number | level 2 only  |               |  |                     |              |                             |   |          |          |                   |
| out #13.4 | RBC contact information-phone number    | level 2 only  |               |  |                     |              |                             |   |          |          |                   |
| out #14   | Brake indication                        | <b>Corruption:</b> inappropriate displaying of brake command indication | DMI failure   | in SB, SH, FS, LS, SR, OS, UN, TR, PT, SN, RV available under condition(s) | misleads the driver |              | no impact on ETCS-operation |   | marginal |          |                   |



| Ref ID  | Macro Function Data Item | Failure Mode   | Failure Cause | Operational Mode   | Failure Effects  |              |                    | External Protection / Mitigation / Barriers   | Severity  | Event-ID | Internal Barriers   |
|---------|--------------------------|--|---------------|--|--|--------------|--------------------|---|-----------|----------|---|
|         |                          |  |               |  | Local  | Intermediate | Initial End Effect |   |           |          |   |
| out #15 | Fixed text information   | <b>Repetition, Deletion, Insertion, Resequencing, Corruption, Delay:</b> inappropriate displaying of fixed text messages | DMI failure   | in SB, FS, AD, LS, SR, OS, UN, TR, PT, RV available under condition(s) | according to the use of the text messages in operational context |              |                    | driver acknowledgment<br>Safety application rule (SAR): not to be used for safety relevant purposes | RAM issue |          | not to be used inside ETCS for safety purposes (refer to 5.1.2) |





| Ref ID  | Macro Function Data Item | Failure Mode  | Failure Cause | Operational Mode   | Failure Effects  |              |                    | External Protection / Mitigation / Barriers   | Severity  | Event-ID | Internal Barriers                              |
|---------|--------------------------|---|---------------|--|--|--------------|--------------------|---|-----------|----------|--|
|         |                          |   |               |  | Local  | Intermediate | Initial End Effect |   |           |          |  |
| out #16 | Plain text information   | <b>Repetition, Deletion, Insertion, Resequencing, Corruption, Delay:</b><br>inappropriate displaying of plain text messages | DMI failure   | in SB, FS, AD, LS, SR, OS, UN, TR, PT, RV available under condition(s) | according to the use of the text messages in operational context |              |                    | driver acknowledgment<br>Safety application rule (SAR): not to be used for safety relevant purposes | RAM issue |          | not to be used inside ETCS for safety purposes |



| Ref ID  | Macro Function Data Item         | Failure Mode   | Failure Cause | Operational Mode                               | Failure Effects                                  |   |  | External Protection / Mitigation / Barriers   | Severity  | Event-ID | Internal Barriers                              |
|---------|----------------------------------|--|---------------|--|--|---|--|---|---|----------|--|
|         |                                  |  |               |  | Local  | Intermediate  | Initial End Effect                                       |   |   |          |  |
| out #17 | Reversing allowed (SRS 5.13.1.3) | <b>Deletion:</b> inappropriate displaying of message: not shown, when it should be | DMI failure   | in FS, AD, LS, OS available under condition(s) | reversing mode allowance not presented to driver | Driver is not aware that train reversing is possible  | Train is at standstill but reversing mode can be entered | Driver should be aware of trackside area where train reversing is allowed Outside ETCS. Emergency procedures for train evacuation | Outside ETCS core hazard, could be catastrophic |          |  |
| out #17 | Reversing allowed (SRS 5.13.1.3) | <b>Insertion:</b> inappropriate displaying of message: shown, when not expected    | DMI failure   | in FS, AD, LS, OS available under condition(s) | misleads the driver                              | could lead the driver to take inappropriate decisions | exceedance of safe speed and distance                    | Driver should be aware of trackside area where train reversing is allowed   | catastrophic                                    | MMI-2j   | UDMP avoids reversing against valid MA onboard |



| Ref ID  | Macro Function Data Item             | Failure Mode   | Failure Cause | Operational Mode   | Failure Effects     |   |   | External Protection / Mitigation / Barriers                    | Severity  | Event-ID | Internal Barriers   |
|---------|--------------------------------------|--|---------------|--|---------------------|---|---|--|-----------|----------|---|
|         |                                      |  |               |  | Local               | Intermediate  | Initial End Effect                                    |  |           |          |   |
| out #18 | Track conditions- Power control      | <b>Deletion, Corruption:</b> displaying no or wrong data | DMI failure   | in FS, AD, LS, OS, NL, TR, PT available under condition(s) | misleads the driver | Wrong power system could be selected by the driver or main switch is not manually activated | damage to train                                       | Train should measure in advance which voltage is available     | RAM issue |          | Power can be automatically controlled onboard (application specific)      |
| out #18 | Track conditions- Pantograph control | <b>Deletion, Corruption:</b> displaying no or wrong data | DMI failure   | in FS, AD, LS, OS, NL, TR, PT available under condition(s) | misleads the driver | Pantograph could be raised at a wrong location  | Train or other external system parts could be damaged | Driver should know where pantograph needs to be raised/lowered | RAM issue |          | Pantograph can be automatically controlled onboard (application specific) |



| Ref ID  | Macro Function Data Item               | Failure Mode   | Failure Cause | Operational Mode   | Failure Effects                               |  |   | External Protection / Mitigation / Barriers              | Severity | Event-ID | Internal Barriers  |
|---------|--|--|---------------|--|---|--|---|--|----------|----------|--|
|         |  |  |               |  | Local   | Intermediate   | Initial End Effect  |  |          |          |  |
| out #18 | Track conditions-Air tightness control | <b>Deletion:</b> inappropriate displaying of air tightness control: not shown, when it should be | DMI failure   | in FS, AD, LS, OS, NL, TR, PT available under condition(s) | air tightness area is not shown to the driver | Driver could fail to close the air conditioning intake     | Passenger could be affected by sudden change of pressure or noxious air coming inside train | Driver should know where air tightness areas are located | critical |          | Opening/Closing air conditioning intake can be automatically controlled onboard (application specific) |
| out #18 | Track conditions-Air tightness control | <b>Corruption:</b> inappropriate displaying of air tightness control                             | DMI failure   | in FS, AD, LS, OS, NL, TR, PT available under condition(s) | misleads the driver                           | Driver could erroneously close the air conditioning intake |   | Driver should know where air tightness areas are located | marginal |          | Opening/Closing air conditioning intake can be automatically controlled onboard (application specific) |



| Ref ID  | Macro Function Data Item             | Failure Mode   | Failure Cause | Operational Mode   | Failure Effects                                  |              |                             | External Protection / Mitigation / Barriers | Severity  | Event-ID | Internal Barriers   |
|---------|--------------------------------------|--|---------------|--|--|--------------|-----------------------------|---|-----------|----------|---|
|         |                                      |  |               |  | Local  | Intermediate | Initial End Effect          |   |           |          |   |
| out #18 | Track conditions- Radio hole control | <b>Insertion:</b> inappropriate displaying of radio hole control                             | DMI failure   | in FS, AD, LS, OS, NL, TR, PT available under condition(s) | misleads the driver (train operating in Level 1) |              | no impact on ETCS-operation |   | RAM issue |          | The track condition could be provided in advance in case of a level transition to level 2 |
| out #18 | Track conditions- Radio hole control | <b>Deletion:</b> inappropriate displaying of radio hole control: not shown when it should be | DMI failure   | in FS, AD, LS, OS, NL, TR, PT available under condition(s) | Radio hole is not shown to the driver            |              | no impact on ETCS-operation |   | RAM issue |          | The track condition could be provided in advance in case of a level transition to level 2 |



| Ref ID  | Macro Function Data Item         | Failure Mode  | Failure Cause | Operational Mode   | Failure Effects  |   |   | External Protection / Mitigation / Barriers                        | Severity | Event-ID | Internal Barriers  |
|---------|----------------------------------|---|---------------|--|--|---|---|--|----------|----------|--|
|         |                                  |   |               |  | Local  | Intermediate  | Initial End Effect                                    |  |          |          |  |
| out #18 | Track conditions- Brakes control | <b>Deletion:</b> inappropriate displaying of brakes control: not shown, when it should be | DMI failure   | in FS, AD, LS, OS, NL, TR, PT available under condition(s) | brake type inhibition area is not shown to the driver (e.g. regenerative, eddy current and magnetic shoes brake) | Driver could fail to inhibit the defined brake type | Train or other external system parts could be damaged | Driver should know where brake type restrictions areas are located | critical |          | Brakes inhibition can be automatically controlled onboard (application specific) |



| Ref ID  | Macro Function Data Item         | Failure Mode   | Failure Cause | Operational Mode   | Failure Effects                            |   |                             | External Protection / Mitigation / Barriers                        | Severity  | Event-ID | Internal Barriers  |
|---------|----------------------------------|--|---------------|--|--|---|-----------------------------|--|-----------|----------|--|
|         |                                  |  |               |  | Local                                      | Intermediate  | Initial End Effect          |  |           |          |  |
| out #18 | Track conditions- Brakes control | <b>Insertion:</b> inappropriate displaying of brakes control: shown, when not expected     | DMI failure   | in FS, AD, LS, OS, NL, TR, PT available under condition(s) | misleads the driver                        | Driver could erroneously inhibit a defined brake type | no impact on ETCS-operation | Driver should know where brake type restrictions areas are located | RAM issue |          | Brakes inhibition can be automatically controlled onboard (application specific) |
| out #19 | Track conditions- Sound horn     | <b>Deletion:</b> inappropriate displaying of sound horn info: not shown, when it should be | DMI failure   | in FS, AD, LS, OS available under condition(s)             | Sound horn area is not shown to the driver | Driver could fail to request the sound horn           | no impact on ETCS-operation | operational rules for the driver                                   | RAM issue |          |  |



| Ref ID  | Macro Function Data Item                                    | Failure Mode  | Failure Cause | Operational Mode                               | Failure Effects  |   |                                       | External Protection / Mitigation / Barriers              | Severity  | Event-ID | Internal Barriers |
|---------|---|---|---------------|--|--|---|---------------------------------------|--|-----------|----------|-------------------|
|         |   |   |               |  | Local  | Intermediate  | Initial End Effect                    |  |           |          |                   |
| out #19 | Track conditions- Sound horn                                | <b>Insertion:</b> inappropriate displaying of sound horn info: shown, when not expected     | DMI failure   | in FS, AD, LS, OS available under condition(s) | misleads the driver                                    | Driver could erroneously request the sound horn                     | no impact on ETCS-operation           | operational rules for the driver                         | RAM issue |          |                   |
| out #19 | Track conditions- non stopping areas, tunnel stopping areas | <b>Deletion:</b> inappropriate displaying of stopping-control: not shown, when it should be | DMI failure   | in FS, AD, LS, OS available under condition(s) | non permitted stopping area is not shown to the driver | Driver could accept a passenger emergency stop in a dangerous area. | Train could stop in a dangerous area. | Driver should know where the dangerous areas are located | critical  |          |                   |



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| Ref ID  | Macro Function Data Item                                    | Failure Mode   | Failure Cause | Operational Mode                               | Failure Effects     |  |  | External Protection / Mitigation / Barriers              | Severity | Event-ID | Internal Barriers |
|---------|---|--|---------------|--|---------------------|--|--|--|----------|----------|-------------------|
|         |   |  |               |  | Local               | Intermediate   | Initial End Effect   |  |          |          |                   |
| out #19 | Track conditions- non stopping areas, tunnel stopping areas | <b>Insertion:</b> inappropriate displaying of non-stopping-control: shown, when not expected | DMI failure   | in FS, AD, LS, OS available under condition(s) | misleads the driver | Driver could not accept a passenger emergency stop although outside a dangerous area | Train could not stop after passenger emergency stop request. | Driver should know where the dangerous areas are located | critical |          |                   |

| Ref ID  | Macro Function Data Item    | Failure Mode   | Failure Cause | Operational Mode   | Failure Effects  |              |                    | External Protection / Mitigation / Barriers   | Severity  | Event-ID | Internal Barriers   |
|---------|-----------------------------|--|---------------|--|--|--------------|--------------------|---|-----------|----------|---|
|         |                             |  |               |  | Local  | Intermediate | Initial End Effect |   |           |          |   |
| out #20 | Geographical train position | <b>Deletion, Corruption:</b> displaying no or wrong data | DMI failure   | in SB, FS, LS, AD, SR, OS, NL, UN, TR, PT available under condition(s) | according to the use of the geographical position in operational context |              |                    | Safety application rule (SAR): not to be used for safety relevant purposes, i.e. awaking of the train<br><br><i>The signaller could provide an inappropriate MA based on the wrong GPI reported by the driver</i> | RAM issue |          | not to be used inside ETCS for safety purposes. See 5.1.1 |



| Ref ID  | Macro Function Data Item | Failure Mode  | Failure Cause | Operational Mode                               | Failure Effects     |   |                                      | External Protection / Mitigation / Barriers              | Severity     | Event-ID | Internal Barriers  |
|---------|--------------------------|---|---------------|--|---------------------|---|--------------------------------------|--|--------------|----------|--|
|         |                          |   |               |  | Local               | Intermediate  | Initial End Effect                   |  |              |          |  |
| out #21 | override status          | <b>Deletion:</b><br>inappropriate displaying of override status: not shown, when it should be | DMI failure   | in SH, SR, UN, SN available under condition(s) | misleads the driver | could lead the driver to take inappropriate decisions                 | exceedance of safe speed or distance | operational rules for driver entry procedure to override | catastrophic | MMI-2f   | Kernel supervision: Override time, distance and balise passage.                            |
| out #21 | override status          | <b>Insertion:</b><br>inappropriate displaying of override status: shown, when not expected    | DMI failure   | in SH, SR, UN, SN available under condition(s) | misleads the driver | could lead the driver to take inappropriate decision to pass a signal | exceedance of safe speed or distance | operational rules for the driver                         | catastrophic | MMI-2f   | Kernel supervision of current mode (Train trip supervision is actually activated on-board) |



| Ref ID  | Macro Function Data Item  | Failure Mode   | Failure Cause | Operational Mode                               | Failure Effects  |   |                                      | External Protection / Mitigation / Barriers | Severity     | Event-ID | Internal Barriers                                       |
|---------|---------------------------|--|---------------|--|--|---|--------------------------------------|---|--------------|----------|---|
|         |                           |  |               |  | Local  | Intermediate                                | Initial End Effect                   |   |              |          |   |
| out #22 | LX status "not protected" | <b>Deletion:</b> inappropriate displaying of message: not shown, when it should be | DMI failure   | in FS, AD, LS, OS available under condition(s) | LX "not protected" information not shown to the driver | Driver could fail to reduce train speed     | exceedance of safe speed or distance | operational rules for the driver            | catastrophic | MMI-2i   | LX "not protected" speed profile is supervised on-board |
| out #22 | LX status "not protected" | <b>Insertion:</b> inappropriate displaying of message: shown, when not expected    | DMI failure   | in FS, AD, LS, OS available under condition(s) | misleads the driver                                    | could lead the driver to reduce train speed | Train speed unnecessarily reduced    |   | RAM issue    |          |   |
| out #23 | Shunting refused by RBC   | level 2 only   |               |  |  |   |                                      |   |              |          |   |



| Ref ID  | Macro Function Data Item             | Failure Mode | Failure Cause | Operational Mode | Failure Effects |              |                    | External Protection / Mitigation / Barriers | Severity | Event-ID | Internal Barriers |
|---------|--------------------------------------|--------------|---------------|------------------|-----------------|--------------|--------------------|---|----------|----------|-------------------|
|         |                                      |              |               |                  | Local           | Intermediate | Initial End Effect |   |          |          |                   |
| out #23 | Shunting refused by RBC              | level 2 only |               |                  |                 |              |                    |   |          |          |                   |
| out #24 | Shunting request not answered by RBC | level 2 only |               |                  |                 |              |                    |   |          |          |                   |
| out #24 | Shunting request not answered by RBC | level 2 only |               |                  |                 |              |                    |   |          |          |                   |
| out #25 | Intentionally deleted.               |              |               |                  |                 |              |                    |   |          |          |                   |
| out #25 | Intentionally deleted.               |              |               |                  |                 |              |                    |   |          |          |                   |

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| Ref ID  | Macro Function Data Item | Failure Mode  | Failure Cause | Operational Mode                   | Failure Effects     |  |                                       | External Protection / Mitigation / Barriers | Severity     | Event-ID | Internal Barriers |
|---------|--------------------------|---|---------------|------------------------------------|---------------------|--|---------------------------------------|---|--------------|----------|-------------------|
|         |                          |   |               |                                    | Local               | Intermediate   | Initial End Effect                    |   |              |          |                   |
| out #26 | Entry in FS              | <b>Deletion:</b><br>inappropriate displaying of message: not shown, when it should be | DMI failure   | in FS available under condition(s) | misleads the driver | driver does not apply manual routines for speed limitation in SR to FS transition (track description not available for whole train length) | exceedance of safe speed and distance | operational rules for driver                | catastrophic | MMI-2d   |                   |
| out #26 | Entry in FS              | <b>Insertion:</b><br>inappropriate displaying of message: shown, when not expected    | DMI failure   | in FS available under condition(s) | misleads the driver |  | no impact on ETCS-operation           |   | RAM issue    |          |                   |



| Ref ID  | Macro Function Data Item      | Failure Mode  | Failure Cause | Operational Mode   | Failure Effects     |   |                                       | External Protection / Mitigation / Barriers                                      | Severity     | Event-ID | Internal Barriers  |
|---------|-------------------------------|---|---------------|--|---------------------|---|---------------------------------------|--|--------------|----------|--|
|         |                               |   |               |  | Local               | Intermediate  | Initial End Effect                    |  |              |          |  |
| out #27 | Level transition announcement | <b>Deletion:</b><br>inappropriate displaying of message: not shown, when it should be | DMI failure   | in FS, AD, LS, SR, OS, NL, UN, TR, PT, SN available under condition(s) | misleads the driver | driver is not prepared to take more responsibility    | exceedance of safe speed and distance | Driver should be aware where level transition is located (e.g. trackside marker) | catastrophic | MMI-2k   | ETCS will require acknowledgment within 5 seconds at level transition point if new level is lower or National System |
| out #27 | Level transition announcement | <b>Insertion:</b><br>inappropriate displaying of message: shown, when not expected    | DMI failure   | in FS, AD, LS, SR, OS, NL, UN, TR, PT, SN available under condition(s) | misleads the driver | could lead the driver to take inappropriate decisions | exceedance of safe speed and distance | Driver should be aware where level transition is located (e.g. trackside marker) | catastrophic | MMI-2k   | kernel monitoring  |
| out #28 | Track ahead free request      | level 2 function  |               |  |                     |   |                                       |  |              |          |  |



| Ref ID  | Macro Function Data Item        | Failure Mode   | Failure Cause | Operational Mode   | Failure Effects                                       |   |  | External Protection / Mitigation / Barriers | Severity     | Event-ID | Internal Barriers  |
|---------|---------------------------------|--|---------------|--|---|---|--|---|--------------|----------|--|
|         |                                 |  |               |  | Local   | Intermediate  | Initial End Effect   |   |              |          |  |
| out #29 | Adhesion factor "slippery rail" | <b>Deletion, Corruption:</b> displaying no or wrong data                           | DMI failure   | in SB, FS, AD, LS, SR, OS, UN, TR, PT, SN, RV available under condition(s)     | misleads the driver                                   | could lead the driver to take inappropriate decisions | driver could try to take action that could result in train delay |   | catastrophic | MMI-2c   | Braking curve calculation by kernel                                      |
| out #35 | Trackside malfunction           | <b>Insertion:</b> inappropriate displaying of message: shown, when not expected    | DMI failure   | in SB, SH, FS, AD, LS, SR, OS, UN, TR, PT, SN, RV available under condition(s) | misleads the driver                                   | could lead the driver to take inappropriate decisions | Train could be stopped unnecessarily                             |   | RAM issue    |          |  |
| out #35 | Trackside malfunction           | <b>Deletion:</b> inappropriate displaying of message: not shown, when it should be | DMI failure   | in SB, SH, FS, AD, LS, SR, OS, UN, TR, PT, SN, RV available under condition(s) | Trackside malfunction information not shown to driver | Driver is not aware about a trackside failure         | no impact on ETCS-operation                                      |   | RAM issue    |          | Supervision of trackside malfunction by on-board (e.g. linking reaction) |





| Ref ID  | Macro Function Data Item  | Failure Mode  | Failure Cause | Operational Mode   | Failure Effects                                 |   |                                       | External Protection / Mitigation / Barriers                   | Severity     | Event-ID | Internal Barriers  |
|---------|---|---|---------------|--|---|---|---------------------------------------|---|--------------|----------|--|
|         |   |   |               |  | Local   | Intermediate  | Initial End Effect                    |   |              |          |  |
| out #36 | Notification of Train Data change from source different from the driver | <b>Deletion:</b> inappropriate displaying of info: not shown, when it should be | DMI failure   | in SB, FS, AD, LS, SR, OS, UN, TR, PT, SN available under condition(s) | train data change is not informed to the driver | driver is not aware of train data changed onboard     | exceedance of safe speed and distance | Product specific safeguarding                                 | catastrophic | MMI-2e   | If Train Data needs to be validated, this shall be requested to Driver<br><br>Train Data validation shall be done with train at standstill |
| out #36 | Notification of Train Data change from source different from the driver | <b>Insertion:</b> inappropriate displaying of info: shown, when not expected    | DMI failure   | In SB, FS, AD, LS, SR, OS, UN, TR, PT, SN available under condition(s) | misleads the driver                             | could lead the driver to take inappropriate decisions | exceedance of safe speed and distance | operational rules for driver<br>Product specific safeguarding | catastrophic | MMI-2e   |  |



| Ref ID  | Macro Function Data Item | Failure Mode   | Failure Cause | Operational Mode   | Failure Effects     |              |                             | External Protection / Mitigation / Barriers | Severity  | Event-ID | Internal Barriers |
|---------|--------------------------|--|---------------|--|---------------------|--------------|-----------------------------|---|-----------|----------|-------------------|
|         |                          |  |               |  | Local               | Intermediate | Initial End Effect          |   |           |          |                   |
| out #37 | Intentionally deleted    |  |               |  |                     |              |                             |   |           |          |                   |
| out #37 | Intentionally deleted    |  |               |  |                     |              |                             |   |           |          |                   |
| out #38 | Operated System Version  | <b>Insertion:</b><br>inappropriate displaying of message: shown, when not expected | DMI failure   | in SB, SH, FS, AD, LS, SR, OS, NL, UN, TR, PT, SN, RV available under condition(s) | misleads the driver |              | no impact on ETCS-operation |   | RAM issue |          |                   |



| Ref ID  | Macro Function Data Item             | Failure Mode  | Failure Cause | Operational Mode   | Failure Effects   |   |                             | External Protection / Mitigation / Barriers | Severity  | Event-ID | Internal Barriers |
|---------|--------------------------------------|---|---------------|--|---|---|-----------------------------|---|-----------|----------|-------------------|
|         |                                      |   |               |  | Local   | Intermediate  | Initial End Effect          |   |           |          |                   |
| out #38 | Operated System Version              | <b>Deletion, corruption</b><br>: displaying no or wrong operated system version | DMI failure   | In SB, SH, FS, AD, LS, SR, OS, NL, UN, TR, PT, SN, RV available under condition(s) | Operated System Version information not shown to driver | Driver is not aware about a different Operated System Version | no impact on ETCS-operation |   | RAM issue |          |                   |
| out #39 | Failed Radio Network registration(s) | level 2 function  |               |  |   |   |                             |   |           |          |                   |
| out #40 | Safe radio connection indication     | level 2 function  |               |  |   |   |                             |   |           |          |                   |



| Ref ID  | Macro Function Data Item | Failure Mode  | Failure Cause | Operational Mode   | Failure Effects                       |  |   | External Protection / Mitigation / Barriers                   | Severity  | Event-ID | Internal Barriers |
|---------|--------------------------|---|---------------|--|---------------------------------------|--|---|---|-----------|----------|-------------------|
|         |                          |   |               |  | Local                                 | Intermediate   | Initial End Effect  |   |           |          |                   |
| out #41 | Local time               | <b>Deletion:</b> inappropriate displaying of local time: not shown, when it should be | DMI failure   | SH, FS, AD, LS, SR, OS, NL, UN, PT, RV<br>in SB, TR, SN available under condition(s) | local time is not shown to the driver | Driver is not aware about the local time through the DMI | no impact on ETCS operation   | Local time provided by other systems located in the dashboard | RAM issue |          |                   |
| out #41 | Local time               | <b>Corruption:</b> wrong local time displayed   | DMI failure   | SH, FS, AD, LS, SR, OS, NL, UN, PT, RV<br>in SB, TR, SN available under condition(s) | misleads the driver                   | could lead the driver to take inappropriate actions      | train could be delayed<br><br><i>Note: only if local time is used to follow the train schedules</i> | Local time provided by other systems located in the dashboard | RAM issue |          |                   |

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| Ref ID  | Macro Function Data Item | Failure Mode  | Failure Cause | Operational Mode                          | Failure Effects     |              |                             | External Protection / Mitigation / Barriers   | Severity  | Event-ID | Internal Barriers |
|---------|--------------------------|---|---------------|---|---------------------|--------------|-----------------------------|---|-----------|----------|-------------------|
|         |                          |   |               |   | Local               | Intermediate | Initial End Effect          |   |           |          |                   |
| out #42 | Gradient                 | <b>Insertion:</b><br>inappropriate displaying of gradient: shown, when not expected | DMI failure   | FS, AD in OS available under condition(s) | misleads the driver |              | no impact on ETCS-operation | Additional information displayed on the DMI (like MRSP, permitted speed...) See 5.1.3 | RAM issue |          |                   |
| out #42 | Gradient                 | <b>Deletion, corruption</b><br>: displaying no or wrong gradient                    | DMI failure   | FS, AD in OS available under condition(s) | misleads the driver |              | no impact on ETCS-operation | Additional information displayed on the DMI (like MRSP, permitted speed...) See 5.1.3 | RAM issue |          |                   |

| Ref ID  | Macro Function Data Item | Failure Mode  | Failure Cause | Operational Mode                            | Failure Effects     |              |                             | External Protection / Mitigation / Barriers   | Severity  | Event-ID | Internal Barriers |
|---------|--------------------------|---|---------------|---|---------------------|--------------|-----------------------------|---|-----------|----------|-------------------|
|         |                          |   |               |   | Local               | Intermediate | Initial End Effect          |   |           |          |                   |
| out #43 | MRSP                     | <b>Insertion:</b><br>inappropriate displaying of MRSP: shown, when not expected | DMI failure   | FS, AD in OS (available under condition(s)) | misleads the driver |              | no impact on ETCS-operation | Additional information displayed on the DMI (like speed profile discontinuity , permitted speed...) See 5.1.3 | RAM issue |          |                   |
| out #43 | MRSP                     | <b>Deletion, corruption</b> : displaying no or wrong MRSP                       | DMI failure   | FS, AD in OS available under condition(s))  | misleads the driver |              | no impact on ETCS-operation | Additional information displayed on the DMI (like speed profile discontinuity , permitted speed...) See 5.1.3 | RAM issue |          |                   |



| Ref ID  | Macro Function Data Item  | Failure Mode  | Failure Cause | Operational Mode                           | Failure Effects     |              |                             | External Protection / Mitigation / Barriers  | Severity  | Event-ID | Internal Barriers |
|---------|---------------------------|---|---------------|--|---------------------|--------------|-----------------------------|--|-----------|----------|-------------------|
|         |                           |   |               |  | Local               | Intermediate | Initial End Effect          |  |           |          |                   |
| out #44 | First Indication location | <b>Insertion:</b> inappropriate displaying of first indication location: shown, when not expected | DMI failure   | in FS, AD, OS available under condition(s) | misleads the driver |              | no impact on ETCS-operation | Additional information displayed on the DMI (like target profile, distance to target...) See 5.1.3 | RAM issue |          |                   |
| out #44 | First Indication location | <b>Deletion, corruption</b> : displaying no or wrong first indication location                    | DMI failure   | in FS, AD, OS available under condition(s) | misleads the driver |              | no impact on ETCS-operation | Additional information displayed on the DMI (like target profile, distance to target...) See 5.1.3 | RAM issue |          |                   |



| Ref ID  | Macro Function Data Item | Failure Mode   | Failure Cause | Operational Mode                           | Failure Effects     |              |                             | External Protection / Mitigation / Barriers  | Severity  | Event-ID | Internal Barriers |
|---------|--------------------------|--|---------------|--|---------------------|--------------|-----------------------------|--|-----------|----------|-------------------|
|         |                          |  |               |  | Local               | Intermediate | Initial End Effect          |  |           |          |                   |
| out #45 | EOA/LOA                  | <b>Insertion:</b><br>inappropriate displaying of EOA/LOA: shown, when not expected | DMI failure   | in FS, AD, OS available under condition(s) | misleads the driver |              | no impact on ETCS-operation | Additional information displayed on the DMI (like MRSP, distance to target...) See 5.1.3 | RAM issue |          |                   |
| out #45 | EOA/LOA                  | <b>Deletion, corruption</b><br>: displaying no or wrong EOA/LOA                    | DMI failure   | in FS, AD, OS available under condition(s) | misleads the driver |              | no impact on ETCS-operation | Additional information displayed on the DMI (like MRSP, distance to target...) See 5.1.3 | RAM issue |          |                   |



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| Ref ID  | Macro Function Data Item | Failure Mode   | Failure Cause | Operational Mode   | Failure Effects     |   |                             | External Protection / Mitigation / Barriers                        | Severity  | Event-ID | Internal Barriers |
|---------|--------------------------|--|---------------|--|---------------------|---|-----------------------------|--|-----------|----------|-------------------|
|         |                          |  |               |  | Local               | Intermediate  | Initial End Effect          |  |           |          |                   |
| out #46 | Brake reason             | <b>Insertion:</b><br>inappropriate displaying of brake reason info: shown, when not expected | DMI failure   | in SB, SH, FS, LS, SR, OS, UN, TR, PT, SN, RV available under condition(s) | misleads the driver |   | no impact on ETCS-operation | Message indicating brake applied is not displayed                  | RAM issue |          |                   |
| out #46 | Brake reason             | <b>Deletion, corruption</b><br>: displaying no or wrong brake reason info                    | DMI failure   | in SB, SH, FS, LS, SR, OS, UN, TR, PT, SN, RV available under condition(s) | misleads the driver | Driver is not aware about the reason for braking or the reason is not correct | no impact on ETCS-operation | Driver is aware of brake applied (message is displayed on the DMI) | RAM issue |          |                   |



| Ref ID  | Macro Function Data Item | Failure Mode   | Failure Cause | Operational Mode   | Failure Effects  |   |                             | External Protection / Mitigation / Barriers | Severity  | Event-ID | Internal Barriers |
|---------|--------------------------|--|---------------|--|--|---|-----------------------------|---|-----------|----------|-------------------|
|         |                          |  |               |  | Local  | Intermediate  | Initial End Effect          |   |           |          |                   |
| out #48 | Trackside not compatible | <b>Insertion:</b> inappropriate displaying of info: shown when not expected    | DMI failure   | in SB, SH, FS, AD, LS, SR, OS, NL, UN, TR, PT, SN, RV available under condition(s) | misleads the driver                                      |   | no impact on ETCS-operation |   | RAM issue |          |                   |
| out #48 | Trackside not compatible | <b>Deletion:</b> inappropriate displaying of info: not shown when it should be | DMI failure   | In SB, SH, FS, AD, LS, SR, OS, NL, UN, TR, PT, SN, RV available under condition(s) | Trackside not compatible information not shown to driver | Driver is not aware about the reason for not establishing communication or train trip | no impact on ETCS-operation |   | RAM issue |          |                   |
| out #49 | Train rejected           | level 2 function   |               |  |  |   |                             |   |           |          |                   |

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| Ref ID  | Macro Function Data Item  | Failure Mode   | Failure Cause | Operational Mode                                | Failure Effects     |   |                                   | External Protection / Mitigation / Barriers   | Severity | Event-ID | Internal Barriers                                 |
|---------|---------------------------|--|---------------|---|---------------------|---|-----------------------------------|---|----------|----------|---|
|         |                           |  |               |   | Local               | Intermediate                                | Initial End Effect                |   |          |          |   |
| out #50 | Route unsuitability (ies) | <b>Insertion:</b> inappropriate displaying of info: shown, when not expected | DMI failure   | in, FS, AD, LS, OS available under condition(s) | misleads the driver | could lead the driver to reduce train speed | train speed unnecessarily reduced | Traffic planning will not allow a train passing through a non compatible piece of track (e.g. train axle load, loading gauge, etc.) | marginal |          | Route Suitability may be provided to ETCS onboard |



| Ref ID  | Macro Function Data Item  | Failure Mode  | Failure Cause | Operational Mode                                | Failure Effects  |   |   | External Protection / Mitigation / Barriers   | Severity     | Event-ID | Internal Barriers                                 |
|---------|---------------------------|---|---------------|---|--|---|---|---|--------------|----------|---|
|         |                           |   |               |   | Local  | Intermediate  | Initial End Effect                                    |   |              |          |   |
| out #50 | Route unsuitability (ies) | <b>Deletion:</b> inappropriate displaying of info: not shown, when it should be | DMI failure   | in, FS, AD, LS, OS available under condition(s) | Route unsuitability message is not shown to the driver | Train could run at a wrong location                   | Train or other external system parts could be damaged | Traffic planning will not allow a train passing through a non compatible piece of track (e.g. train axle load, loading gauge, etc.) | critical     |          | Route Suitability may be provided to ETCS onboard |
| out #51 | SBI Speed                 | <b>Deletion, Corruption:</b> displaying no or wrong data                        | DMI failure   | in FS, AD available under condition(s)          | misleads the driver                                    | could lead the driver to take inappropriate decisions | exceedance of safe speed or distance                  |   | catastrophic | MMI-2a.2 | supervision of train speed by ETCS onboard        |



| Ref ID  | Macro Function Data Item   | Failure Mode  | Failure Cause | Operational Mode  | Failure Effects                           |   |  | External Protection / Mitigation / Barriers      | Severity  | Event-ID | Internal Barriers |
|---------|----------------------------|---|---------------|---|---|---|--|--|-----------|----------|-------------------|
|         |                            |   |               |   | Local                                     | Intermediate                              | Initial End Effect                                   |  |           |          |                   |
| out #52 | Virtual Balise Covers      | <b>Insertion:</b> inappropriate displaying of info: shown, when not expected    | DMI failure   | in SB, SH, FS, AD, LS, SR, OS, NL, UN, TR, PT, SN and RV available under condition(s) | misleads the driver                       |   |  |  | RAM issue |          |                   |
| out #52 | Virtual Balise Covers      | <b>Deletion:</b> inappropriate displaying of info: not shown, when it should be | DMI failure   | in SB, SH, FS, AD, LS, SR, OS, NL, UN, TR, PT, SN and RV available under condition(s) | VBC information not showed to the driver  | Driver is not aware about VBC information | no impact on ETCS-operation                          |  | RAM issue |          |                   |
| out #53 | LSSMA (including LS frame) | <b>Deletion:</b> no LSSMA displayed when it should be                           | DMI failure   | In LS available under condition(s)  | LSSMA information not shown to the driver |   | No impact on ETCS operation (background supervision) | Driver is requested to observe line-side signals | RAM issue |          |                   |



| Ref ID  | Macro Function Data Item | Failure Mode   | Failure Cause | Operational Mode                   | Failure Effects       |              |  | External Protection / Mitigation / Barriers      | Severity  | Event-ID | Internal Barriers |
|---------|--------------------------|--|---------------|------------------------------------|-----------------------|--------------|--|--|-----------|----------|-------------------|
|         |                          |  |               |                                    | Local                 | Intermediate | Initial End Effect                                   |  |           |          |                   |
| out #53 | LSSMA                    | <b>Corruption:</b> wrong value of LSSMA displayed    | DMI failure   | In LS available under condition(s) | Misleading the driver |              | No impact on ETCS operation (background supervision) | Driver is requested to observe line-side signals | RAM issue |          |                   |
| out #53 | LSSMA                    | <b>Insertion:</b> displaying LSSMA when not expected | DMI failure   | In any more                        | Misleading the driver |              | No impact on ETCS operation                          |  | RAM issue |          |                   |

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| Ref ID  | Macro Function Data Item | Failure Mode  | Failure Cause | Operational Mode  | Failure Effects                                 |  |  | External Protection / Mitigation / Barriers | Severity  | Event-ID | Internal Barriers |
|---------|--------------------------|---|---------------|---|---|--|--|---|-----------|----------|-------------------|
|         |                          |   |               |   | Local   | Intermediate   | Initial End Effect   |   |           |          |                   |
| out #54 | Set Speed Indication     | <b>Deletion:</b><br>no Set Speed Indication displayed when it should be | DMI failure   | in SB, SH, FS, AD, LS, SR, OS, NL, UN, TR, PT, SN and RV available under condition(s) | Set Speed Indication is not shown to the driver | Driver is not aware about Set Speed Indication information | No impact on ETCS operation<br>(The set speed input is used by ERTMS/ETCS onboard only for display on the DMI. The onboard is only requested to log this value inside the JRU) |   | RAM issue |          |                   |

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| Ref ID  | Macro Function Data Item | Failure Mode  | Failure Cause | Operational Mode  | Failure Effects                             |                     |  | External Protection / Mitigation / Barriers | Severity  | Event-ID | Internal Barriers |
|---------|--------------------------|---|---------------|---|---|---------------------|--|---|-----------|----------|-------------------|
|         |                          |   |               |   | Local                                       | Intermediate        | Initial End Effect   |   |           |          |                   |
| out #54 | Set Speed Indication     | <b>Insertion:</b> displaying Set Speed Indication when not expected | DMI failure   | in SB, SH, FS, AD, LS, SR, OS, NL, UN, TR, PT, SN and RV available under condition(s) | Set Speed Indication is shown to the driver | Misleads the driver | No impact on ETCS operation<br><br>(The set speed input is used by ERTMS/ETCS onboard only for display on the DMI. The onboard is only requested to log this value inside the JRU) |   | RAM issue |          |                   |





| Ref ID  | Macro Function Data Item | Failure Mode  | Failure Cause | Operational Mode                   | Failure Effects     |  |                                       | External Protection / Mitigation / Barriers | Severity     | Event-ID | Internal Barriers |
|---------|--------------------------|---|---------------|------------------------------------|---------------------|--|---------------------------------------|---|--------------|----------|-------------------|
|         |                          |   |               |                                    | Local               | Intermediate   | Initial End Effect                    |   |              |          |                   |
| out #55 | Entry in OS              | <b>Deletion:</b><br>inappropriate displaying of message: not shown, when it should be | DMI failure   | in OS available under condition(s) | misleads the driver | driver does not apply manual routines for speed limitation in SR to OS transition (track description not available for whole train length) | exceedance of safe speed and distance | operational rules for driver                | catastrophic | MMI-2d   |                   |
| out #55 | Entry in OS              | <b>Insertion:</b><br>inappropriate displaying of message: shown, when not expected    | DMI failure   | in OS available under condition(s) | misleads the driver |  | no impact on ETCS-operation           |   | RAM issue    |          |                   |



| Ref ID  | Macro Function Data Item | Failure Mode  | Failure Cause | Operational Mode                               | Failure Effects                       |   |   | External Protection / Mitigation / Barriers                      | Severity  | Event-ID | Internal Barriers                   |
|---------|--------------------------|---|---------------|--|---------------------------------------|---|---|--|-----------|----------|-------------------------------------|
|         |                          |   |               |  | Local                                 | Intermediate  | Initial End Effect                                |  |           |          |                                     |
| out #56 | NTC not available        | LEVEL NTC only  |               |  |                                       |   |   |  |           |          |                                     |
| out #57 | NTC data needed          | LEVEL NTC only  |               |  |                                       |   |   |  |           |          |                                     |
| out #58 | NTC failed               | LEVEL NTC only  |               |  |                                       |   |   |  |           |          |                                     |
| out #59 | Time to indication       | <b>Deletion:</b> inappropriate displaying of indication: not shown, when it should be | DMI failure   | In FS, AD, OS, SR available under condition(s) | Indication is not shown to the driver | Driver is not aware of coming up indication               | Driver may start braking too close to the target. | It is driver's responsibility to start braking at the right time | RAM issue |          | Braking curve calculation by kernel |
| out #59 | Time to indication       | <b>Corruption:</b> wrong value of time to indication displayed                        | DMI failure   | In FS, AD, OS, SR available under condition(s) | Mislead the driver                    | Driver may think that braking point is further than it is | Driver may start braking too close to the target. | It is driver's responsibility to start braking at the right time | RAM issue |          | Braking curve calculation by kernel |

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| Ref ID  | Macro Function Data Item                         | Failure Mode     | Failure Cause | Operational Mode | Failure Effects |              |                    | External Protection / Mitigation / Barriers | Severity | Event-ID | Internal Barriers |
|---------|--|------------------|---------------|------------------|-----------------|--------------|--------------------|---|----------|----------|-------------------|
|         |  |                  |               |                  | Local           | Intermediate | Initial End Effect |   |          |          |                   |
| out #60 | Supervised Manoeuvre refused by RBC              | level 2 function |               |                  |                 |              |                    |   |          |          |                   |
| out #61 | Supervised Manoeuvre request not answered by RBC | level 2 function |               |                  |                 |              |                    |   |          |          |                   |
| out #62 | Entry in SM                                      | level 2 function |               |                  |                 |              |                    |   |          |          |                   |
| out #63 | Authorised direction                             | level 2 function |               |                  |                 |              |                    |   |          |          |                   |



| Ref ID  | Macro Function Data Item        | Failure Mode  | Failure Cause | Operational Mode                   | Failure Effects                             |  |                             | External Protection / Mitigation / Barriers | Severity  | Event-ID | Internal Barriers   |
|---------|---------------------------------|---|---------------|------------------------------------|---|--|-----------------------------|---|-----------|----------|---|
|         |                                 |   |               |                                    | Local                                       | Intermediate   | Initial End Effect          |   |           |          |   |
| out #64 | Non-leading no longer permitted | <b>Deletion:</b> inappropriate displaying of indication: not shown, when it should be | DMI failure   | In NL available under condition(s) | Driver may think the mode is still NL       | Transition to SB has occurred                              | no impact on ETCS-operation |   | RAM issue |          | Transition to SB shall only occur if train at standstill  |
| out #64 | Non-leading no longer permitted | <b>Insertion:</b> inappropriate displaying of indication: shown, when not expected    | DMI failure   | In NL available under condition(s) | Driver may think the mode has changed to SB | Driver disregards his responsibility with track conditions | no impact on ETCS-operation |   | RAM issue |          | NL mode would still be shown to driver in DMI. Transition to SB shall only occur if train at standstill |



| Ref ID  | Macro Function Data Item | Failure Mode  | Failure Cause | Operational Mode   | Failure Effects  |              |                             | External Protection / Mitigation / Barriers   | Severity  | Event-ID | Internal Barriers   |
|---------|--------------------------|---|---------------|--|--|--------------|-----------------------------|---|-----------|----------|---|
|         |                          |   |               |  | Local  | Intermediate | Initial End Effect          |   |           |          |   |
| out #65 | ATO status               | <b>Deletion:</b> inappropriate displaying of indication: not shown, when it should be | DMI failure   | In SB, SH, FS, AD, LS, SR, OS, NL, UN, TR, PT, SN, RV available under condition(s) | Driver unaware of ATO readiness                                  |              | no impact on ETCS-operation | Driver may apply brake when necessary<br>Driver may quit AD mode by disengaging ATO or setting ATO selector to Stand-by | RAM issue |          | Operating mode (AD or other) shall be indicated to the Driver in DMI<br>ETCS shall supervise train movement |
| out #65 | ATO status               | <b>Corruption:</b> wrong ATO status displayed: other status when ATO is engaged       | DMI failure   | In SB, SH, FS, AD, LS, SR, OS, NL, UN, TR, PT, SN, RV available under condition(s) | Driver unaware of ATO readiness<br>Driver may select ATO engaged |              | no impact on ETCS-operation | Driver may brake when necessary<br>Driver may quit AD mode by disengaging ATO or setting ATO selector to Stand-by       | RAM issue |          | Operating mode (AD or other) shall be indicated to the Driver in DMI<br>ETCS shall supervise train movement |

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| Ref ID  | Macro Function Data Item                                | Failure Mode  | Failure Cause | Operational Mode   | Failure Effects                  |              |                             | External Protection / Mitigation / Barriers   | Severity  | Event-ID | Internal Barriers                                 |
|---------|---|---|---------------|--|----------------------------------|--------------|-----------------------------|---|-----------|----------|---|
|         |   |   |               |  | Local                            | Intermediate | Initial End Effect          |   |           |          |   |
| out #65 | ATO status  | <b>Corruption:</b> wrong ATO status displayed: ATO engaged when it is not | DMI failure   | In SB, SH, FS, AD, LS, SR, OS, NL, UN, TR, PT, SN, RV available under condition(s) | Driver unaware of ATO readiness  |              | no impact on ETCS-operation | Driver may brake when necessary<br>ATO shall only transit to engaged when conditions are accomplished | RAM issue |          | ETCS shall supervise train movement               |
| out #66 | TAS, Coasting advice, next advise change location - TAS | <b>Deletion, Corruption:</b> displaying no or wrong data                  | DMI failure   | In FS available under condition(s)   | Driver not aware of target speed |              | no impact on ETCS-operation |   | RAM issue |          | ETCS shall supervise EB curves are not overpassed |

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| Ref ID  | Macro Function Data Item  | Failure Mode  | Failure Cause | Operational Mode                   | Failure Effects                    |              |                             | External Protection / Mitigation / Barriers | Severity  | Event-ID | Internal Barriers                                 |
|---------|---|---|---------------|------------------------------------|------------------------------------|--------------|-----------------------------|---|-----------|----------|---|
|         |   |   |               |                                    | Local                              | Intermediate | Initial End Effect          |   |           |          |   |
| out #66 | TAS, Coasting advice, next advise change location – Coasting advice | <b>Deletion:</b> inappropriate displaying of indication: not shown, when it should be | DMI failure   | In FS available under condition(s) | Driver not aware of train coasting |              | no impact on ETCS-operation |   | RAM issue |          | ETCS shall supervise EB curves are not overpassed |
| out #66 | TAS, Coasting advice, next advise change location – Coasting advice | <b>Insertion:</b> inappropriate displaying of indication: shown, when not expected    | DMI failure   | In FS available under condition(s) | driver may think train is coasting |              | no impact on ETCS-operation |   | RAM issue |          | ETCS shall supervise EB curves are not overpassed |

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| Ref ID  | Macro Function Data Item   | Failure Mode   | Failure Cause | Operational Mode                   | Failure Effects                               |              |                             | External Protection / Mitigation / Barriers | Severity  | Event-ID | Internal Barriers                                 |
|---------|--|--|---------------|------------------------------------|---|--------------|-----------------------------|---|-----------|----------|---|
|         |  |  |               |                                    | Local   | Intermediate | Initial End Effect          |   |           |          |   |
| out #66 | TAS, Coastin g advice, next advise change location – Next advice change marker | <b>Deletion, Corruption:</b> displaying no or wrong data | DMI failure   | In FS available under condition(s) | Driver not aware of next advice change marker |              | no impact on ETCS-operation |   | RAM issue |          | ETCS shall supervise EB curves are not overpassed |





| Ref ID  | Macro Function Data Item   | Failure Mode   | Failure Cause | Operational Mode                       | Failure Effects                                 |   |   | External Protection / Mitigation / Barriers  | Severity | Event-ID                                  | Internal Barriers |
|---------|--|--|---------------|--|---|---|---|--|----------|---|-------------------|
|         |  |  |               |  | Local   | Intermediate                              | Initial End Effect                            |  |          |   |                   |
| out #67 | Dwell time, next stopping point name and estimated arrival time, stopping points locations, door information, Stopping accuracy, Skip stopping point indicator | <b>Deletion, Corruption:</b><br>displaying no or wrong data - dwell time | DMI failure   | In FS, AD available under condition(s) | Driver not aware of remaining time to departure | Driver may command door closing too early | Passenger hazard, no impact on ETCS operation | Operational procedure for manual door closing<br><br>Visual and audio indication to the passengers when doors are going to be closed | Critical | Safety related (but not ETCS core hazard) |                   |

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| Ref ID  | Macro Function Data Item   | Failure Mode  | Failure Cause | Operational Mode                       | Failure Effects     |              |                             | External Protection / Mitigation / Barriers | Severity  | Event-ID | Internal Barriers |
|---------|--|---|---------------|--|---------------------|--------------|-----------------------------|---|-----------|----------|-------------------|
|         |  |   |               |  | Local               | Intermediate | Initial End Effect          |   |           |          |                   |
| out #67 | Dwell time, next stopping point name and estimated arrival time, stopping points locations, door information, Stopping accuracy, Skip stopping point indicator | <b>Insertion, Corruption:</b><br>displaying wrong data – next stopping point name | DMI failure   | In FS, AD available under condition(s) | Misleads the driver |              | no impact on ETCS operation | Driver has to know line schedule            | RAM issue |          |                   |

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| Ref ID  | Macro Function Data Item   | Failure Mode   | Failure Cause | Operational Mode                       | Failure Effects     |              |                             | External Protection / Mitigation / Barriers | Severity  | Event-ID | Internal Barriers |
|---------|--|--|---------------|--|---------------------|--------------|-----------------------------|---|-----------|----------|-------------------|
|         |  |  |               |  | Local               | Intermediate | Initial End Effect          |   |           |          |                   |
| out #67 | Dwell time, next stopping point name and estimated arrival time, stopping points locations, door information, Stopping accuracy, Skip stopping point indicator | <b>Corruption:</b><br>displaying wrong data – estimated arrival time | DMI failure   | In FS, AD available under condition(s) | Misleads the driver |              | no impact on ETCS operation | Driver has to know line schedule            | RAM issue |          |                   |

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| Ref ID  | Macro Function Data Item   | Failure Mode  | Failure Cause | Operational Mode                       | Failure Effects     |  |                             | External Protection / Mitigation / Barriers | Severity  | Event-ID | Internal Barriers |
|---------|--|---|---------------|--|---------------------|--|-----------------------------|---|-----------|----------|-------------------|
|         |  |   |               |  | Local               | Intermediate   | Initial End Effect          |   |           |          |                   |
| out #67 | Dwell time, next stopping point name and estimated arrival time, stopping points locations, door information, Stopping accuracy, Skip stopping point indicator | <b>Corruption:</b><br>displaying wrong data – stopping point location | DMI failure   | In FS, AD available under condition(s) | Misleads the driver | Driver may apply brake if the thinks the stopping point is closer than it is | no impact on ETCS operation | Driver has to know line schedule            | RAM issue |          |                   |

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|         |  |  |             |  |                     |   |  |  |           |   |  |
|---------|--|--|-------------|--|---------------------|---|--|--|-----------|---|--|
| out #67 | Dwell time, next stopping point name and estimated arrival time, stopping points locations, door information, Stopping accuracy, Skip stopping point indicator | <b>Corruption:</b><br>displaying wrong data – door information | DMI failure | In FS, AD available under condition(s) | Misleads the driver | Driver may open/close incorrect door side | System hazard, no impact on ETCS operation | Driver has to follow operational procedure for door opening.<br><br>Line specific knowledge of the driver<br><br>Note SUBSET-125, clause 6.3.3.1 [Ref 3]:<br><br>The authorisation for the release of the doors will be performed in accordance with the clause 4.2.5.5.6 (TSI LOC&PAS). | Critical  | Safety related (but not ETCS core hazard) |  |
| out #67 | Dwell time, next   | <b>Insertion, Corruption:</b>                                  | DMI failure | In FS, AD available under condition(s) | Misleads the        | Driver may act over direction             | no impact on ETCS                          | Driver has to know line  | RAM issue |   |  |

| Ref ID | Macro Function Data Item  | Failure Mode                              | Failure Cause | Operational Mode | Failure Effects |                              |                    | External Protection / Mitigation / Barriers | Severity | Event-ID | Internal Barriers |
|--------|---|---|---------------|------------------|-----------------|------------------------------|--------------------|---|----------|----------|-------------------|
|        |   |   |               |                  | Local           | Intermediate                 | Initial End Effect |   |          |          |                   |
|        | stopping point name and estimated arrival time, stopping points locations, door information, Stopping accuracy, Skip stopping point indicator | displaying wrong data – stopping accuracy |               |                  | driver          | controller when not required | operation          | schedule                                    |          |          |                   |



| Ref ID  | Macro Function Data Item   | Failure Mode  | Failure Cause | Operational Mode                       | Failure Effects     |              |                             | External Protection / Mitigation / Barriers  | Severity  | Event-ID | Internal Barriers |
|---------|--|---|---------------|--|---------------------|--------------|-----------------------------|--|-----------|----------|-------------------|
|         |  |   |               |  | Local               | Intermediate | Initial End Effect          |  |           |          |                   |
| out #67 | Dwell time, next stopping point name and estimated arrival time, stopping points locations, door information, Stopping g accuracy, Skip stopping point indicator | <b>Deletion, Corruption:</b><br>displaying no or wrong data – skip stopping point indicator | DMI failure   | In FS, AD available under condition(s) | Misleads the driver |              | no impact on ETCS operation | Driver has to know line schedule<br>ATO-TS is informed about stopping points skipped/revoked by driver<br>Driver can only revoke stopping points previously set by himself | RAM issue |          |                   |

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| Ref ID  | Macro Function Data Item | Failure Mode   | Failure Cause | Operational Mode                   | Failure Effects  |                             |                             | External Protection / Mitigation / Barriers                              | Severity                                  | Event-ID | Internal Barriers                   |
|---------|--------------------------|--|---------------|------------------------------------|--|-----------------------------|-----------------------------|--|---|----------|-------------------------------------|
|         |                          |  |               |                                    | Local  | Intermediate                | Initial End Effect          |  |   |          |                                     |
| out #68 | ATO warning              | <b>Deletion:</b><br>No ATO warning sound is produced when needed   | DMI failure   | In AD available under condition(s) | Driver not aware of TBL in wrong position<br>Driver not aware of ATO failure | ATO shall not be engaged    | no impact on ETCS operation |  | RAM issue                                 |          | ETCS shall supervise train movement |
| out #68 | ATO warning              | <b>Insertion:</b><br>ATO warning sound is produced when not needed | DMI failure   | In AD available under condition(s) | Mislead the driver   | Driver shall manipulate TBL | no impact on ETCS operation | Operational procedures for driver to set TBL to neutral when in AD mode. | Safety related (but not ETCS Core hazard) |          |                                     |





| Ref ID  | Macro Function Data Item | Failure Mode   | Failure Cause | Operational Mode   | Failure Effects    |  |                             | External Protection / Mitigation / Barriers | Severity  | Event-ID | Internal Barriers |
|---------|--------------------------|--|---------------|--|--------------------|--|-----------------------------|---|-----------|----------|-------------------|
|         |                          |  |               |  | Local              | Intermediate   | Initial End Effect          |   |           |          |                   |
| out #69 | ATO data need            | <b>Insertion:</b><br>inappropriate displaying of indication: shown, when not expected    | DMI failure   | In FS, AD, LS, SR, OS, UN, TR, PT, SN available under condition(s) | Mislead the driver | could lead the driver to take inappropriate decisions            | no impact on ETCS operation |   | RAM issue |          |                   |
| out #69 | ATO data need            | <b>Deletion:</b><br>inappropriate displaying of indication: not shown, when it should be | DMI failure   | In FS, AD, LS, SR, OS, UN, TR, PT, SN available under condition(s) | Mislead the driver | Driver not aware of ATO data is necessary, ATO cannot be engaged | no impact on ETCS operation |   | RAM issue |          |                   |

| Ref ID  | Macro Function Data Item   | Failure Mode  | Failure Cause | Operational Mode                                   | Failure Effects    |   |                             | External Protection / Mitigation / Barriers                        | Severity  | Event-ID | Internal Barriers |
|---------|--|---|---------------|--|--------------------|---|-----------------------------|--|-----------|----------|-------------------|
|         |  |   |               |  | Local              | Intermediate  | Initial End Effect          |  |           |          |                   |
| out #70 | Impairment due to accumulated underestimation / overestimation in measuring the movement over a defined total distance (SRS 3.6.8.5 and 6) | <b>Insertion:</b><br>inappropriate displaying of indication: shown, when not expected | DMI failure   | In FS, AD, LS, SR, OS available under condition(s) | Mislead the driver | could lead the driver to take inappropriate decisions | no impact on ETCS operation | This situation could be handled by applying operational procedures | RAM issue |          |                   |



| Ref ID  | Macro Function Data Item   | Failure Mode   | Failure Cause | Operational Mode                                   | Failure Effects    |   |   | External Protection / Mitigation / Barriers                           | Severity  | Event-ID | Internal Barriers  |
|---------|--|--|---------------|--|--------------------|---|---|---|-----------|----------|--|
|         |  |  |               |  | Local              | Intermediate                                  | Initial End Effect  |   |           |          |  |
| out #70 | Impairment due to accumulated underestimation / overestimation in measuring the movement over a defined total distance (SRS 3.6.8.5 and 6) | <b>Deletion:</b><br>inappropriate displaying of indication: not shown, when expected | DMI failure   | In FS, AD, LS, SR, OS available under condition(s) | Mislead the driver | Driver not aware of odometry accuracy failure | Planned reaction (such as operational procedures ) may not be put in place by Driver to avoid movement with such odometry error.<br><br>No impact on ETCS operation | The frequency of occurrence of odometry failure is assumed quite low. | RAM issue |          | Once the safety threshold is reached, On-board shall switch to SF (SRS 3.6.8.7). |



| Ref ID  | Macro Function Data Item      | Failure Mode  | Failure Cause | Operational Mode                           | Failure Effects    |   |   | External Protection / Mitigation / Barriers | Severity     | Event-ID | Internal Barriers   |
|---------|-------------------------------|---|---------------|--|--------------------|---|---|---|--------------|----------|---|
|         |                               |   |               |  | Local              | Intermediate                                  | Initial End Effect  |   |              |          |   |
| out #71 | BTM alarm reaction inhibition | <b>Insertion:</b><br>inappropriate displaying of indication: shown, when not expected | DMI failure   | In SB, SH, SR available under condition(s) | Mislead the driver | Driver does not expect reaction to BTM alarm  | In case BTM alarm is activated, reaction will be applied by EVC   |   | RAM issue    |          |   |
| out #71 | BTM alarm reaction inhibition | <b>Deletion:</b><br>inappropriate displaying of indication: not shown, when expected  | DMI failure   | In SB, SH, SR available under condition(s) | Mislead the driver | Driver may think that inhibition has finished | OBU is still allowed to move over BMM without track condition stored<br><br>In case of real BTM failure, BG with safety information can be missed | Operational procedures for driver           | Catastrophic | MMI-2m   | For manual procedure, it only can be inhibited when train is standstill |

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## **5. CONCLUSIONS**

No inconsistencies and open points were found during the analysis. The following assumptions have been considered on the use of ETCS information:

### **5.1.1 Geographical Position**

Geographical position information shall not be used for safety purposes; otherwise wrong geo position information on DMI could derive in a catastrophic event.

### **5.1.2 Text Messages**

Text messages 'track to train' cannot be used for the delivery of safety critical information unless a specific application safety analysis can justify this, e.g. if other information/communications between the two parties concerned is provided so that the recipient's understanding of the message can be verified and safety provisions are taken if driver does not acknowledge the message.

### **5.1.3 Planning Window Objects**

A failure in one of the planning window objects (Gradient, MRSP, Indication location at MRSP speed and EOA/LOA) is considered to be not relevant for safety purposes. The reason behind is that all the planning window objects are related to each other. Additionally, other displayed items (e.g. target speed and distance to target bar) provide similar information. Thus, a failure in one of the planning window objects can be easily identified.



## 6. ANNEX A – LIST OF MMI-X EVENTS IDENTIFIED

| Event Id. | Hazardous Event Description   |
|-----------|---|
| MMI-1a    | False acknowledgement of mode change to less restrictive mode   |
| MMI-1b    | False command to enter NL mode  |
| MMI-1c    | False command of Override request   |
| MMI-1d    | False acknowledgement of Level Transition   |
| MMI-1e    | False acknowledgement of Train Trip   |
| MMI-1g    | False request for SH mode   |
| MMI-1h    | False acknowledgement of undesired train movement (RAM, UDMP, SSS, PT distance, and reversing distance) |
| MMI-1j    | False command to inhibit BTM alarm reaction   |
| MMI-2a.1  | False presentation of train speed   |
| MMI-2a.2  | False presentation of speed (except train speed) or distance, including supervision status              |
| MMI-2b    | False presentation of mode  |
| MMI-2c    | False presentation of track adhesion factor   |
| MMI-2d    | Failure to present Entry in FS/OS information   |
| MMI-2e    | False presentation of train data/additional data  |
| MMI-2f    | Failure to display Override status, including false enabling of override selection                      |
| MMI-2g    | Failure to present acknowledgement message to a less restrictive mode                                   |
| MMI-2i    | Failure to present "LX not protected" information   |
| MMI-2j    | False presentation of reversing allowed   |
| MMI-2k    | False presentation of level transition announcement   |
| MMI-2m    | Failure to indicate BTM alarm reaction inhibition   |
| MMI-3     | Falsification of driver's train data/additional data input stored onboard                               |
| MMI-4     | Falsification of SR speed/distance data   |
| MMI-6     | Falsification of Virtual Balise Cover   |