

Annex 1 - Organisational and technical specifications (OTS)

1. General

a) Supply object

This technical document defines the technical, functional, and qualitative requirements, as well as the documents to be provided during the design phase and the tests for the verification of compliance. The compliance parameters will be defined according to the requirements defined in this document, for the in-quality assurance, to the Customer, about the telematics monitoring system (TMS) for intermodal wagons. The TMS are intended for wagons performing services within the national and the international network, with the mission profile and characteristics described below.

b) Acronyms

AMIS/APM	Autorization to place on the market
CE/CEE	European community
CEN	European Committee for Standardization
CF	Brake cilinder
CG	Brake pipe
EN	European Norm
ERRI	European Rail Research Institute (ex ORE)
FS	Ferrovie dello Stato
FSI	Ferrovie dello Stato Italiane S.p.A
ORE	Office de Recherches et d'Essais de l'UIC
MIR	Mercitalia Rail S.r.l
NEV/EVN	European Vehicle Number
PA	Warranty Assistance Plan
PFC	Manufacturing and Control Plan
PDA	Procurement plan
p.d.f.	Rail level
PdM	Maintenance plan
PdP	Design plan
PdProve	Type and series test plan
RIN/NVR	National Vehicle Register
RO	Major overhaul
RU	Railway undertaking
RR	Minor overhaul
MSE	Rolling Stock Management System (SAP application)
RTB/ HABD	Hot Axle Box Detection
RTI	Temporary Grouping of Companies
TMS	Telematic Monitoring System
r.v.	Current release
STI/TSI	Tecnica Specification of Interoperability
UIC	Union International des Chemins de Fer

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UNEL	Ente Nazionale Italiano di Unificazione Elettrica
UNI	Ente Nazionale Italiano di Unificazione.
UNI EN	En Standard Italian Edition
VHB	Vehicle History Book
Vhom	Max speed per hour (running order)
VIS /ISA	Valutatore indipendente di sicurezza /Independent Safety Assessor
VOM	Vehicle in running order

c) Upgrade of existing project

In the case of a project developed before the entry into force of the reference legislation cited in this Technical Specification, the supplier must highlight in the first design review the list of the tests performed and the available reports highlighting the deviations with the existing legislation and the any necessary additions that must not affect the obtaining of APM.

d) Development of the project

The technical drawings related to the project should preferably be developed in computer graphics (CAD) The supplier shall provide a general assembly of the TMS in the wagon complete with all the components designed through solid 3D modeling in editable vector format exported or exportable in ACIS SAT standard without loss of functionality invalidating the readability of the solid models contained.

2. Telematic monitoring system prescriptions

a) TMS general characteristics

- The TMS should be totally integrated in the wagon structure;
- The installation phase of the serial devices could be done in the wagon construction phase for new wagons;
- The installation of the TMS should be guaranteed also for wagons already in service;
- The modification introduced into the wagons for the installation and operation of the TMS should not affect the certification of the wagon (e.g. TSI);
- The TMS should not reduce the functional characteristics of the wagon;
- The TMS should be able to send and receive information from in-land server;
- The TMS should minimize impact on the availability of the wagon, and maintenance activities scheduled in the life cycle of the wagon;
- The TMS should include a GPS system with an accuracy higher than 2 m in normal open sky in field;
- The system should be equipped with a battery /energy supply system able to send the GPS information in a regular way with intervals lower than 15 minutes for 24 hours of continuous mission, or using pushing notification driven by events;
- The system should be able to remain in stand-by mode when the wagon is parked with full and new battery in the yard at least 10 days without dry completely the battery and be able to wake up at any change of the status (impact, movements, etc) and send info related to the cause of wake up;

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- The GPS information should provide also the geocode information and identify zone of interest defined by the users;
- The TMS should include an acceleration measurement system able to measure impacts following EN 12663 and the ride characteristics of the vehicle following EN 14363;
- The acceleration measurements of the TMS should be able to acquire data with a sampling frequency higher than 1 kHz and with the possibility of implement a real time monitoring of the acceleration;
- The sensor of the TMS should be able to communicate with other sensor or systems through CAN bus base protocols;
- The TMS should include pressure sensors to measure the pressure of the different brake pipes. Algorithm to determine the pneumatic brake health to avoid damage to the wheelset due the failure / misuse of the pneumatic brake components is to be developed jointly;
- All the data have to be pre-elaborated on board in order to avoid large amount of raw data transmission;
- All the TMS information should be provided in real time in a web portal and it should be reachable for Mercitalia Intermodal IT systems through API or provided a direct connection from the TMS to Mercitalia Intremodal IT system. Precondition is the availability of GMS and the time is depending on the set triggers;
- The TMS installation should be done in a way to minimize constraint on the possibility of disassembling the components of the wagon (wheelset / bogie / other) or determine a greater complexity (conceptual / time employed) in carrying out these operations;
- For pocket wagons, the TMS must also include a system able to detect if a semitrailer is carried on the wagon and if its king-pin is correctly locked into the hitch;-
- The TMS must be conceived in order to make it possible to transfer it from a wagon to another one, in few hours and without the necessity to buy new parts.

b) Maintenance criteria

All parts of the TMS that requires regular replacement should be designed to be replaced during the major overhaul of the wagon that is normally scheduled in intervals of 600,000 km or 6 years from the previous major maintenance activity. The components that do not require regular replacement must have a longer technical life, and in any case, not less than the one indicated in the maintenance manuals.

c) Use and operation conditions

i. Prevalent use and mission profile

The TMS will be installed in wagons that must be able to be used, without particular subjection and within the scope of the services overall interoperable European network. The prevalent use consists in carrying out freight trains both nationally and internationally following the mission profile describe above:

<i>Yearly average mileage</i>	<i>100000 km</i>
<i>Daily average mileage</i>	<i>1500 km</i>
<i>Weekly average mileage</i>	<i>3000 km</i>
<i>Single mission duration</i>	<i>24 h</i>
<i>Maximum Speed</i>	<i>120 km/h</i>
<i>Stand by time</i>	<i>10 days</i>

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d) Environmental service conditions

The TMS must be able to operate correctly in the presence of snow, ice formation and normal size hail.
Class of outdoor air temperature: TX (-40 ° C to +50 ° C).

e) Performance

i. Performance requirements in availability of the GPS system

The TMS must be able to guarantee the transmission of the GPS positions with intervals lower than 20 minutes up to 24 hours of continuous trip. The TMS should be able to send the GPS position on occurrences of safety alarm or dangerous behaviour of the wagon. GPS information is requested complete of GPS coordinates (latitude, longitude height and velocity) and the geocoded position of the wagon (country, city and closest address). All GPS information should be provided in real time (Depending on time defined triggers and if GSM is available) it should be reachable for Mercitalia Intermodal IT systems through API (following the scheme provide by MII after the signature of the contract) or provided directly from the TMS to the Customer's IT system.

ii. Performance requirements of the acceleration monitoring system

The TMS should be able to provide during the mission a ride index according to UNI EN 14363 standard, moreover the TMS should be able to provide the impact information in the stand still phase according to EN 12663. The acceleration monitoring should allow the communication with other systems trough an interface base in CAN bus protocols. The impact and ride index should be provided in real time upon defined triggers and if GSM is available to a web portal and should be reachable for MII IT systems through API (following the scheme provide by MII after the signature of the contract) or provided directly from the TMS to MII IT system.

The acceleration monitoring should:

- use MEMS or capacitive accelerometers in order to limit the problems related to a possible saturation of the sensors;
- measure vertical acceleration around 16 g max value (before the low-pass filtering);
- The accelerometric signals must be acquired with a sampling frequency 8000Hz internal and filtered to 1000Hz usable / filtered to different application requirements;
- Implement the following logic monitoring logic:
 - The logic acquires continuously the acceleration measurements;
 - The logic involves monitoring the following quantities:
 - the instantaneous vertical acceleration of carbody;
 - the RMS value (root mean square) of the vertical acceleration of carbody. The RMS value is calculated on a moving window, having a length of 1 s.
 - When the amplitude of the instantaneous value of the vertical acceleration of carbody (low-pass filtered at 100 Hz, as previously stated) exceeds a threshold value $A = 4.5$ [g], a trigger is activated and the monitoring of the RMS value of the carbody acceleration begins;
 - If the RMS value of the acceleration of carbody remains higher than the threshold $a = 1$ [g] for the duration of 1 s from the activation of the trigger, the logic identifies the condition of derailment, and send the information to the Web portal. Otherwise, the condition of derailment is not identified.

iii. Performance requirements of the brake status monitoring system

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The TMS must be able to provide a health index, which needs to be defined together with the brake systems at least one time during the mission and one time during the stand still time if defined criteria are fulfilled. The system shall monitor relevant pressures in order to warn in case of malfunction during un-breaking operation that lead to an unwanted broken wheelset. Any modification introduced in the wagon by the installation and operation of the brake status monitoring system should not modify the TSI certification of the wagon. The health index should be provided based upon defined triggers and if GSM is available in real time in a web portal and it should be reachable for MII IT systems through API (following the scheme provided by MII after the signature of the contract) or provided directly from the TMS to MII IT system.

The brake monitoring systems uses the:

- diagnosis of the pneumatic system, able to detect a potential malfunction of the system or a single component;
- predictive algorithms to identify the state of degradation of the system and/or its components to be developed and implemented together in the months after installation
- verification of the correct use of the braking system by railway operators (loco drivers).

Parameter, limits and details requirements for the above mentioned algorithms are provided by Mercitalia.

The identification in advance of the degradation of the braking system, allows to reduce/mitigate the failure consequences (ex. Flat Wheelset, wheel overheating and wheelset damage).

The pressure transducer should be an absolute pressure transducer with at least 6 bar). The sensor should be able to acquire the pressure signal continuously with 1 Hz sampling frequency (each sample as the result of 4 samples mediated on-board over a 1 second time-window)

The TMS should be available to identify the conditions:

- $T=0$ bar and $HL>0$ to identify weight valve, sensor or T-piece fault;
- HL change with a gradient higher than 0,1 bar/s the C pressure should change;
- C pressure compliant with the expected value C as function of T and HL. The C pressure has a tolerance of + 0,2 bar and - 0,15 bar, to consider the T tolerance of $\pm 0,2$ bar and measure the HL value in steady state (gradient lower than 0,005 bar/s during 6 s);
- C pressure not compliant in two circuits to identify brake valve fault (Flat wheelset / overheat wheelset);
- C pressure not compliant in just one circuit to identify Relè fault (Flat wheelset / overheat wheelset);
- $T> 3,1$ bar and emergency braking and $HL=0$ (remain gradient lower than 0,005 bar/s by 6 s) the C pressure should be higher than 3,42 bar in a time between 3s and 6s. (P position);
- $T> 3,1$ bar and emergency braking and $HL=0$ (remain gradient lower than 0,005 bar/s by 30 s) the C pressure should be higher than 3,42 bar in a time between 18s and 30s. (G position);
- $T> 3,1$ bar and brake release $HL>5$ bar (remain gradient lower than 0,005 bar/s by 20 s) the C pressure should be lower than 0,4 bar in (Overheat wheelset) (P position);
- $T> 3,1$ bar and brake release $HL>5$ bar (remain gradient lower than 0,005 bar/s by 60 s) the C pressure should be lower than 0,4 bar in (Overheat wheelset) (G position);
- Verification of brake monitoring status.

iv. Performance requirements of hitch monitoring system

The TMS must be able to supply the status of the trestle/hitch. The status should be provided based upon defined triggers and if GSM is available in real time in a web portal and it should be reachable for MII IT systems through API (following the scheme provided by MII after the signature of the contract) or provided directly from the TMS to MII IT system.

The TMS should guarantee:

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- no negative interference with the hitch mechanics (e.g. king pin locking or the height adjustment) and other indications/signals during operation;
- Full resistance against all operational conditions (snow, rain, hail, dirt, ...);
- possibility to easily check the correct function of the system in the webportal;
- Fail Safe: in case of defects (e.g. broken cable, short circuit, reverse polarity) no positive signaling is given to the operation;
- Give a clear indication of the right king pin position in the webportal;
- Give a clear indication of the king pin locking in the webportal;
- Provide a time stamp of the transferred information / status change history;
- Upgrade to include indication and temporary manual activation of the wagons needs to be possible;
- Transport is allowed when both criteria, the right king pin position and the king pin locking, are indicated as fulfilled, therefore the TMS should notify when the wagon is moving without the condition fulfilled;
- The system should send the time stamp and GPS information when a wagons move with the wrong position of lift or locking mechanism;
- The system will send any change of the position of the lift or locking mechanism after a defined number of seconds of constant open or closed signal.

3. General and functional requirements

a) Environmental impact

The use of materials containing asbestos is prohibited.

b) Prevention measures against the risk of fire

The rubber components must ensure the fire resistance requirements (i.e. according to UL94-β or UNI EN 45545-2).

c) Interchangeability

The TMS must be equal to each other. All components must be mechanically and functionally interchangeable with each other.

d) Handling

Each component subject to disassembly for replacement in the event of failures or scheduled maintenance must have a weight not exceeding 25 kg, if to be handled by hands by a single person. This maximum value can be doubled if the accessibility conditions allow working simultaneously with two workers. In the case of objects to be moved with mechanical lifting and transport means, suitable measures must be provided for allowing hooking, anchoring and positioning operations.

4. Tests

a) General

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The Supplier shall provide the execution of all the tests and checks on complete wagon installed with TMS, sub assembly and elementary component necessary for the demonstration of conformity and the achievement of the APM of the wagon. The Supplier must therefore perform the tests at its own expense by using their own means, or through its subcontractors or through qualified Bodies proposed by the Supplier itself and accepted by the Customer. The Customer reserves the right to request, in agreement with the Supplier, the repetition and / or additional tests if deemed necessary for the verification of the full achievement of the requirements.

b) Tests on installation workshop

Together with the functional test of the brake system must be performed on all the wagons the test of the braking system sensor, Moreover, the trestle / hitch monitoring system should be tested using equipment capable. The test conditions must be reported by PJM in the quality assurance document.

c) Type tests

The supplier must provide an appropriate test plan together with the relative conduction specifications, necessary for the preparation of the technical dossier for the compliance assessment for the monitoring system. Tests and verifications of any type made on the individual components and systems are under the responsibility of the Supplier who, therefore, must perform the test and verification at his own expense, by using with his own means, through his Sub-suppliers or through qualified Bodies proposed by the Supplier and accepted by the Customer. The Customer reserves the right to request the repetition and / or additional tests if deemed necessary for the verification of the full achievement of the requirements. These tests have to be agreed with the Supplier. For the TMS the existing typetests of the Waggontracker and Generator are seen as sufficient and no extra typt test will be performed.

d) Test report

The Supplier must draw up the relative "test reports" on which the values actually measured during the tests must be noted. It must be reported in a clear and legible form:

- Type of test (standard or type);
- The methods for carrying out the various tests;
- The units of measurement and the theoretical values with the relative tolerances of the parameters to be tested (even if these theoretical values are not specified by this technical specification);
- Diagrams and recordings.

Each test report, completed in its entirety, must be signed on behalf of the Supplier by a legally responsible technician. The test report must therefore be forwarded to MII, which reserves the right to communicate any observations.

5. General requirements

a) General prescriptions

Drawing and technical documentation that certify the accuracy and performance of each functionality of the TMS are required. All the TMS information should be provided in real time if GSM availability ist given and based on defined triggers in a web portal and it should be reachable for MII IT systems through API or provided directly from the TMS to MII IT system. The TMS data should be recoverable up to 10

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years. The supplier should provide the documentation for the maintenance of the mechanical and electronic part of the systems. The supplier should provide any special software/hardware for the trouble shooting of the TMS. The supplier should provide the training and certification need for the maintenance of the TMS. The Supplier should provide a list of components to be change in every major overhaul (600000 km or 6 years).

b) General manufacturing requirements

The following are the technical requirements that the supplier must follow during the design phase:

- All equipment mounting weathering must guarantee correct operation with normal environmental operating conditions;
- The hardware and software used must be conform to EN standards. Any non-compliance must be previously submitted to Customer's approval.

c) Interface devices

i. Bolt and nut fastening

For fastening only 8.8 and 8 class (or higher) nuts must be used, complying with the UNI EN ISO 898-1 and UNI EN ISO 898-2 standards. The nuts used must be of the entirely metallic self-braking type. The fastening of safety-relevant parts must be sized with the loads required by the UNI EN 13749 standards.

Fastening must be secured against loosening according to the provisions of UIC 802-72 leaflet. In particular, in bolted joints in which the length of the section between the head of the screw and the nut is reduced, conical spring washers conforming to the UNI 8836 standard must be provided to ensure the maintenance of the preload. All screw joints must be easily accessible and clamped with both common tools and standard torque wrenches. The tightening must be performed without the use of lubricants.

In the coupling of the parts by fastening, all the necessary measures must be adopted to guarantee the maintenance of the prescribed tightening torque (definition of flatness tolerances and roughness of the contact surfaces, etc.). The stiffness of the parts of the connection must be such as not to allow deflections that may cause loss of preload. Where possible, fastening must be made by a through hole. For all joints, the tightening torque must be indicated on the drawings.

6. Cited documents

About TMS supply, the requirements contained in all documents referred to in the text of this technical specification must be respected, in the updated status in force at the time of contract signature. For the rules divided into various parts, if the part referred to is not expressly indicated, reference must be made to all parts of the standard. If the requirements are lacking, inapplicable or in contradiction, the manufacturer must ask for clarification from the competent Mercitalia Intermodal offices before starting the design or construction of the equipment. On a non-exhaustive basis, the list of the main technical standards and specifications referred to is shown.

Requirements	EXPRESSION OF CONFORMITY
<i>Electromagnetic Compatibility</i>	<i>Compliant with EN 50121</i>
<i>Insulation coordination</i>	<i>Compliant with EN 50155 chapter 12.2.6</i>
<i>Electronic Equipment</i>	<i>Compliant with EN 50155, CLC/TS 50238-3</i>
<i>Axle box generator</i>	<i>Compliant with CLC/TS 50238-3, EN13749, EN 15437-1, EN 12081,</i>
<i>Shock and vibration</i>	<i>Compliant with EN 61373</i>

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<i>Environmental resistance</i>	<i>Compliant with EN 50155</i>
<i>GPS accuracy</i>	<i>2 m, Normal open sky in field</i>
<i>Brake system sensors</i>	<i>The systems should respect the certification of the wagon</i>
<i>Maximum weight</i>	<i>200 kg</i>

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