**Technical specification** **of the multifunctional (MFMT) measurement train**

# 1. The basic requirements of the vehicle

The self-propelled vehicle shall be equipped with two cabins. The vehicle shall be suitable for

* the installation of the track inspection camera system,
* capable of measuring the overhead catenary,
* GSM-R and ETCS measurement,
* GPS coordinate-based localization, and a connection to central database shall be facilitated.

## 1.1. Main technical parameters

The track gauge 1435 mm

Vehicle construction gauge UIC 505-1, UIC 505-4

Maximum speed 160 km/h with its own prime mover

The minimum horizontal track curvature 100 m

The engine power minimum 6 kW/t specific power of the engine built-in (to be verified by measurements)

The maximum axle load of the axles 18 tons.

**Brake system:**

* indirect brake system of UIC-type,
* gear brake,
* direct brake, gear brake and
* spring-loaded brake.

When the slip protection system is activated the brake control shall change over exclusively to air braking.

**Traction chain:** hydrodynamic gerbox (built-in direction reverser) and gear brake.

**The fuel tank volume:** corresponding to an action radius of 1500 km.

**Energy supply:** The on-board energy supply of the vehicle shall be ensured with the installation of a generator having 3x400 V voltage driven by a diesel engine, whose apparent power shall have minimum 32 kVA.

**The rooms to be built into the vehicle:**

* measurement room,
* minimum 4 sleeping room,
* dining room (with preparation of warm foods),
* conference room,
* bath room,
* closed-type toilet,
* workshop,
* electric power supply room.

The vehicle shall be designed as a railcar in order to accommodate the vehicle crew and the measurement systems to be installed.

**Vehicle radio:**

* The control panel capable of accepting minimum 3 national software and the control devices of the internal communication shall be installed on the control desk of the vehicle. The procurement and the installation of the locomotive radios shall be done by the Tenderer.
* Primarily one piece two-operator vehicle radio shall be installed, if it cannot be realized because of the vehicle design. In this case the Tenderer shall install and put into operation two piece one-operator radios and alter the antenna configuration.
* The locomotive radio shall support the following operational frequency bands: 158,100-158,375-163,100-163,375 MHz duplex; 457,38-458,48/467,38-468,48 MHz duplex and the 873-915/918-960 MHz (160 MHz, UIC 751-3, EGSM-R, GSM-R, GSM900, EGSM900) duplex frequency band and the UIC mainline and local frequency allocation used on the territory of MÁV and GySEV railway undertakings.
* The GSM-R MRM radio module to be installed in the loco radio shall meet – to decrease the disturbations coming from the public networks – the ETSI TS 102 933-1 V2.1.1 (2015-06) Railway Telecommunications (RT) GSM-R improved receiver parameters specifications.

**Traction:**

The vehicle shall be capable of conducting the measurements by being pulled in case of lack of the traction capability of the vehicle.

The vehicle shall operate on electrified mainlines (25 kV, 50 Hz; 15 kV, 16,7 Hz; 3 kV DC systems) without any restrictions.

**Licenses/criteria:**

* The vehicle shall be equipped with Indusi, with EVM having National Safety Authority (NSA) license for 160 km/h on MAV’s tracks or MIREL vigilance system possessing put-into-service license.
* An EC-declaration for the vehicle by an independent Notified Body is not necessary.
* The vehicle shall be delivered with the calculations required by the NSA (brake and clearance calculations), with the filled underframe measurement sheet and with all documents, protocols and additional documents justifing the adequate running safety of the vehicle and the vehicle shall be outfitted with draw and buffer gears operated by MÁV and it shall be designed corresponding to the procurer and with all effective licenses submitted.
* The Tenderer shall procure all necessary Hungarian NSA licenses (included the homologated licenses in case of a used vehicle) required for its operation.

**The documents to be delivered:**

Licenses, protocols (see above), hungarian user’s instructions, technical description, electrical circuit schemes, setting instructions, trouble-shooting guideline, maintenance instructions and maintenance system until the major overhaul of the vehicle.

# 2. The basic requirements of the measurement systems

Only reliable and field-proven measurement systems may be built into the vehicle. They will be checked by the Procurer when being installed.

## 2.1. The general technical requirements of the measurement systems

The MFMT shall be equipped with a network router accepting minimum 2 SIM-cards and supporting local WiFi and mobile network technology for the measurement data uploading, for remote support of the measurement system and for the measurement crew. The network router shall be connected to the Internet via public GSM service network. For that an antenna supporting the public network frequencies and installed on the roof of the vehicle shall be connected to this device. The WiFi coverage shall be ensured, for that a suitable internal antenna system shall be installed into the vehicle. The remote access of the measurement train shall be realized in agreement with MÁV with utilization of the preferably technological SIM-cards.

For the measurement workplaces and the measurements system to be arranged on the vehicle an on-board Ethernet network equipped with shielded cables shall be installed.

### 2.1.1. Hardware requirements

On the vehicle just such hardwares suitable for railway operation shall be employed whose fulfil the requirements of electronic equipment used on the railway vehicles (primarily the the requirements of IEC 60571, EN 50121 and EN 61373 standards).

### 2.1.2. Global positioning system

On the measurement train a global positioning system shall be installed which shall provide the following data associated with the measurement point given by the measurement equipment of the measurement train (including the pictorial files recorded by the video inspection unit)

* track section (required accuracy 0,1 %),
* distance covered with accuracy of three digits (daily and total),
* GPS-coordinate in the EOV and WGS84 coordinate-system,
* the momentarily velocity at measurement in km/h (required accuracy 0,1 %),
* the catenary mast number (if interpreted),
* the local time,
* the external temperature,
* the rail temperature.

The central global positioning system shall be able to accept the space-informatical data (point, line, polygon) from the space-informatical system of the MÁV (for example sectioning, object coordinates, track coordinates).

The technological determination of the physical data exchange and the format of the data exchange are the common object of the Tenderer and the Procurer.

The distance transducer shall be based on the displacement principle in order to eliminate the wheel slip and the faults originating from the wheel wear.

# 3. The main requirements of the video track inspection system

The video inspection system shall be in conformity with the following requirements and prescriptions:

* measurement speed range: 0-160 km/h
* measurement directions: in both directions, forward and backward
* acceleration range: ± 0,5 m/s2
* measurement capability: 500 km/day
* weather conditions: every excluded the heavy rain/snow fall
* operational air temperature: -10 - + 50 °C
* storage air temperature: -20 - + 55 °C
* humidity: up to 95 %
* lighting conditions: bright sunshine

night and tunnel circumstances

dark and artificial lighting.

## 3.1. The general requirements of the video inspection system

1. The video inspection system shall conduct an automatic evaluation.
2. It shall be capable of doing clean pictures with digital, high-speed and low-noise cameras.
3. The system shall be totally resistant to the sunshine and environmental light, due to these reasons a monocromatic light source like a laser combined with highly selective optical interferential filters shall use to correct the proper illumination taking into consideration of the sunshine and other surrounding light sources.
4. In order to analyse the miscellaneous parameters of the railway track the automatic video inspection system shall combine the video inspection with the measurement capability.
5. The MFMT system in conjunction with the other system of the measurement car shall marker the pictures recorded, videos, faults with the data provided by the Central Positioning System.
6. The MFMT system shall have a camera suitable for taking panorama pictures to record the environmental conditions.
7. The MFMT shall have as an accesory of the catenary measurement tool a FullHD resolution digital camera unit consisting of minimum two cameras suitable for recording the interaction between the catenary line and the measurement pantograph and for recording the observation of the electrical track gauge, catenary line components, flora, pantograph respectively. The energy supply of this unit shall be ensured and the data transmission shall make possible by PoE connector.
8. As a part of the MFMT the vehicle shall be equipped with cameras on both sides looking to forward and backward for identifying the track serial number and catenary mast serial number.
9. The MFMT shall have outboard and office (evaluating) system which can evaluate the data collected from the cameras situated on the vehicle.
10. **Outdoor system:** The system shall ensure the execution of the services and lists (lists associated with fault and analysis). There shall be the possibility on the vehicle for archiving, filtering of the measurement data corresponding to the organizational units, generating of several lists and printing them when necessary, writing in file especially.

In case of recognition of a traffic-dangerous fault the system shall send a signal to the onboard operator and via an interface specially designed for this task to the dispatcher system ordering the intervention.

The high-speed data transmission shall be ensured between the measurement car and the office system via the data connection designed for this task (chapter 7.2.).

*The positioning of the measurement unit (front end/rear end and from A to B or from B to A)*

The measurement system shall position the measurement system (measurement car) on the track selected. The vehicle shall have a front and an end position which shall be directed on the track corresponding to the direction of the line.

The setting of the measurement direction shall be made possible: the measurement occur from point “A” to point “B” or from point “B” to point “A” from zone, section position given.

**Office (evaluating) system:**

The playing, evaluation of the inspection data shall be ensured under office circumstances. The fault list, parameters of statistical register, the types of the export data shall be configured on a configuration panel. The data shall be viewed, printed, saved corresponding to these configuration settings.

It shall give the solution for the measurement files to play and evaluate with the original settings and to have the possibility of the evaluation with settings other than the original ones (quality class, change of measurement limit category etc.).

The possibility shall be ensured that if a smaller section for example a section between two stations from a measurement file has to be evaluated than the marking of this small section shall be provided with the starting and final data of zone section (partial evaluation).

The local fault list shall be generated corresponding to the preset configuration and the measurement crew control shall be ensured i.e. the verification of the data gained during which the “no-faults” shall be filtered out before the measurement data are given out.

**Display of the panorama picture**

The proper display of the panorama pictures, interface to the evaluation software shall be ensured in the office system.

## 3.2. The parameters to be inspected by the Video Track Inspection System

**Rail**

* S1\_Rail breakage (Right rail/Left rail)
* S2\_Joint gap (observation, calculation)
* S3\_Rail temperature measurement
* S4\_Air temperature measurement
* S5\_Dip (height, side) observation
* S6\_Running surface fault (Right rail/Left rail), Flaking rail [mm2], UIC 712 fault code: 121, 122, 2221
* S7\_Running surface fault (Right rail/Left rail), Wheel burn [mm2], UIC 712 fault code: 125, 2251, 2252
* S8\_Running surface fault (Right rail/Left rail), shelling [mm2], UIC 712 fault code: 122
* S9\_Periodical depressions\_short pitch corrugation, UIC 712 fault code: 2201
* S10\_Periodical depressions\_long pitch corrugation, UIC 712 fault code: 2202
* S11\_Head check cracks, flaking on the running surface, UIC 712 fault code: 2223
* S12\_Running surface fault (Right rail/Left rail), UIC 712 fault code: 227
* S13\_Flattened rail head
* S14\_Monitoring of welds (AT-welds)
* S15\_Dilatation device monitoring
* S16\_Insulated joint monitoring

**Sleeper**

* A1\_Monitoring of sleeper material type (wood, reinforced concrete, steel)
* A2\_Longitudinal crack
* A3\_Crack in transverse direction
* A4\_Start of crack from vertical fastenings
* A5\_Sleeper distortion
* A6\_Sleeper seizing
* A7\_Greater than average sleeper spacing
* A8\_Chippings, large degree of pitting

**Ballast**

* AG1\_ballast profile surplus
* AG2\_ballast profile deficiency
* AG3\_Recognition of contaminated ballast, muddy ballast
* AG4\_Recognition of contaminated ballast (oily ballast)
* AG5\_Weedy ballast

**Fastenings**

* K1\_Recognition, inspection of fastenings
* K2\_Recognition of mixed fastenings
* K3\_Recognition of missing fastenings
* K4\_Recognition of position and twisting (slewing) of fastenings, their incorrect fitting
* K5\_Fish plate crack recognition (Right/Left and external/internal sides)
* K6\_Single-sided fish plate crack recognition (Right/Left and external/internal sides)
* K7\_Two-sided fish plate crack recognition (Right/Left and external/internal sides)
* K8\_Curved fish plate recognition (Right/Left and external/internal sides)

**Turnouts**

* KIT1\_Automatic recognition of the crossings of turnouts
* KIT2\_Separate handling of switch & crossing areas, saving in separate file
* KIT3\_Recognition of the switches of the turnouts, check of operation dimensions

**Level crossings**

* U1\_Recognition of the level crossing zones, the type of surface
* U2\_Recognition of road crossing surface faults in the track zone
* U3\_Recognition of gaps between road crossing elements in the track zone
* U4\_Soundness of level crossing elements
* U5\_Existence of impact-preventing plates of level crossings

**Other structural elements**

* E1\_Recognition of track section without ballast (with concrete ballast)
* E2\_Size and cleanness of flangeway
* E3\_Recognition of track section with guard rail
* E4\_Recognition of other devices installed in the track (for example signal transmitter, axle counter, sensor, vigilance system, elements of interlocking equipment etc.)
* E5\_Irregular rail joint

## 3.3. Standards to be applied

The Video Track Inspection System shall meet the following standards which shall be confirmed with a document which shall be given over to the Procurer.

* TSI – Technical Specification for Interoperability (Technical Description for Cross-border Capability)
* EN 50121 – Railway, electrical and underground applications, rolling stock – Shock and vibration test
* EN 60825-1 The safety of laser equipment, regulation and guidelines for the users
* UIC 725 3.2. point

# 4. The main technical requiremenets of the Catenary Measurement System

## 4.1. Catenary measurement system

**Fundamental requirements for overhead contact line measurement system** is to provide data regarding the actual condition of the overhead contact line by measuring the geometry of the contact line on electrified lines with respect to the actual limits in accordance with the Central Positioning System.

## 4.2. The requirements of the catenary measurement system services

The measurement system must be able to certify the EC verification procedure carried out on the basis of the 'European Commission Regulation (EU) No 1301/2014 on the technical specification for interoperability relating to the' energy 'subsystem of the European Union rail system' (ENE TSI) for the measured parameters. Regarding the measurement requirements, Regulation 1301/2014/EU and the standards referred to therein must be complied with. Regarding measurement requirements, Regulation 1301/2014/EU and the standards referred to therein must be complied with.

## 4.3. The contactless geometrical measurement of the catenary (static measurement)

The system shall measure continuously and simultaneously the spatial position and the wear of the catenary under neutral zone in case of several lines too. The measurement system shall recognize and measure all types of the catenary found on the railway network of the MÁV Co. (MÁV K 100, K 80, K 65, Sicat SX, MÁV-HÉV)

**Arrangement:** the unit measuring the geometrical position shall be placed on the roof of the vehicle chassis. The unit measuring the geometrical position and the correction unit under the underframe shall be situated in the same cross section of the vehicle.

The measurement system shall be of contactless type, the external units of the MFMT shall be located within the vehicle structure gauge.

**The theoretical measurement velocity of the measurement system:** 0-200 km/h in both direction.

**Light conditions:** The measurement instrument shall provide measurement results corresponding to the accuracy under poor contrast conditions: the measurement of the catenary in tunnel, under the works (flyover, bridge structure with bars), in case of wooden background, by day with change of clouding.

**Measurement frequency:** The geometrical position of the catenary shall be measured at a velocity of 160 km/h in every 0,5 m, the wear of the catenary shall be measured at least in every 0,1 m.

**Fault place location:** The measurement system shall evaluate the measurement results based on the preset but changeable measurement limits and collect the fault location with accuracy of 0,1 m exceeding the limit and it shall record in a separate list with datum and line identification with the designation given.

The limit value of the catenary geometry are the follows:

* maximum zigzag
* maximum height
* minimum height
* minimum height above the level crossing
* descending grade depending of the track velocity (it varies with the distance)
* minimum cross section of the catenary line (changing with the distance, track).

The limit values shall be given in the measurement unit of the values measured.

**Display:** The height of the catenary, the zigzag and the cross section values shall be represented digitally, graphically in connection with the distance included the mast serial number.

a) The measurement of the spatial geometrical position of the catenary

In the ranges mentioned below the following parameters shall be measured:

**Zigzag** measurement: from the middle plane of the track ±600 mm; required accuracy: ±10 mm,

the distance of the catenary from the middle plane in the side direction, the side position

Height measurement: from the running surface of the track: 4800-6500 mm; required accuracy: ±10 mm,

the distance of the catenary from the running surface of the track, the distance measured perpendicular to it.

The measurement unit shall calculate the uncorrigated zigzag and the height, the corrigated zigzag and the height by means of the data from the correction unit. The data measured shall be provided in integer number, in measurement unit of mm. The geometrical data shall be displayed without including the correction values.

**Grade conditions:** the system shall be capable of determining the grade condition of the catenary (change in height [m]/distance [m]) with an accuracy of four decimal or alternatively by providing the extent of the grade (for example 1:250). The extent of the grade mentioned above shall be calculated from the data above simultaneously with the measurement.

The possibility for markering and recording of the side arm position, works and other points, remarks according to the distance shall be ensured.

**The accuracy of the wear measurement of the catenary:** accuracy: ±0,2 mm

## 4.4. The measurement of contact force between the pantograph and catenary with contact

**Position:** The equipment of the MFMT shall be located within the vehicle structure gauge.

The pantograph shall be equipped with induction transducer suitable for contact wire marking of running on horn. This shall be treated as a marker on both sides. The crossing direction of the border point (zigzag increases/decreases) shall be recorded with location identification with an accuracy of metre. The distance of the transducers form the centre of the pantograph shall be ±500 mm.

**The measurement speed:** 0-200 km/h in both directions.

**Fault place location:** The measurement system shall execute the evaluation of the measurement results corresponding to the preset, changeable measurement limits and collect the fault places exceeding the limit values with a fault identification of an accuracy of 0,1 mm and record in a separate list (file) with the given designation, datum and line identification.

**The measurement range of the catenary voltage:** in the range of 17,5…29 kV with measurement after voltage division.

* **Measurement frequency:** 2 kHz

The measurement of the force and acceleration of the pantograph sliding part, measurement range:

0-500 N, required accuracy: ±10 N

* Measurement frequency: force measurement 500 Hz

acceleration measurement 8 kHz

The force and acceleration values shall be measured perpendicular to the plane of the sliding strip of the pantograph. The force values shall be measured on both sides of the pantograph sliding strip, on at least two points. The acceleration of the pantograph part (the whole pallet or one carbon strip) between the catenary line and the force-measuring cells shall be measured to determine the actual contact force. From the measurement results the resultant, the contact force perpendicular to the pantograph sliding strip shall be calculated from the input data above simultaneously with the measurement.

**The measurement of the dynamical catenary height:** required accuracy: ±10 mm

This height shall be measured between the running surface of the rail and the point of the pantograph connecting with the catenary and including the height data of the correction unit.

The detailed requirements of the measurement system can be found in the Cl. 6. and 7. of MSZ EN 50317:2012. The output data above shall be displayed digitally and graphically in function of the distance. The digital displaying shall be made in integer number in case of the acceleration in measurement unit of m/s2, in case of the resultant force in measurement unit of N and in case of the dynamical height in measurement unit of mm.

The contact force of the pantograph shall be set in the range of 40-200 N. The energy supply of the sensors taking into account of the catenary voltage system (25 kV 50 Hz) (for example on the frame of the pantograph or mounted on the isolator) shall be done from the battery. In case of battery supply minimum 12 operational hours shall be taken into consideration. The remaining safe operational time shall be displayed on the central control desk of the measurement system. The battery shall have a battery, a standby unit and it can be changed easily.

The measurement system shall be suitable for safe separation from the high voltage of the measured signals of the sensors mounted on the measurement pantograph contacting with the catenary.

The catenary voltage shall be isolated from the interior of the vehicle! The regulated isolation distances shall be ensured on the roof of the vehicle (MSZ EN 50119:2010 Cl. 5.2.10.).

The measurement of the dynamical zigzag: two-sided, from the force values perpendicular to the plane of the pantograph sliding.

This output values shall be displayed digitally and graphically in function of the distance. The digital displaying shall be made for the catenary voltage in kV with an accuracy of one decimal for dynamic zigzag in mm in integer number for contact wire marking of running on horn with designating of the side concerned.

The measurement of the thermal condition of the catenary: The catenary measurement system shall be equipped with an infracamera, by which the thermal condition of the catenary can be monitored.

Display: The contact wire height, zigzag and the cross esction value shall be displayed digitally and graphically in function of the distance with the mast identification number.

## 4.5. Entering of the temporary orders

Under the measurement the previous recording of the section data of the orders *Pantograph up!, Pantograph down!* shall be made possible about which the system shall give a warning in time.

## 4.6. Calculation of the stiffness of the longitudinal catenary chain

The longitudinal stiffness determined by the quotient of the contact wire height difference based on a geometrical and a dynamical measurement of the line section concerned and the contact force measured in the same point shall be calculated in measurement unit of mm/N. The values calculated shall be collected with a place positioning of 0,1 m accuracy and in a separate file. The values calculated shall be displayed digitally and graphically in function of the distance. The digital display shall be done with integer numbers in measurement inut of mm/N.

In the individual points of the Technical Requirements the following standards shall be met. The procurer consider with respect to the procurement object (the delivery of the complete measurement system suitable for measuring the geometrical and dynamical parameters of the catenary system) the reference to the standards as an equivalent one to the every standards accepted in the European Union.

MSZ EN 15273-1:2013 Railway applications. Gauges. Part 1: General requirements. The general requirements of the infrastructure and the rolling stock

MSZ EN 50119:2010 Railway applications. Fixed installations. Electric traction overhead contact wires

MSZ EN 50317:2012 Railway applications. Pantograph systems. The requirements and validation of the interference measurement between the contact wire and the pantograph

MSZ EN 60529:2015 Degrees of protection of electric equipment provided by enclosures

# 5. The requirements of the onboard devices for ETCS-inspection

**The fundamental requirement for ETCS inspection device** is to provide real-time information regarding the operability and functionality of track-side subsystems ETCS L1 and L2 presently operating and being soon commissioned at MÁV, and document the information electronically, by decoding and processing the balise telegrams /radio signals transmitted by the track-side subsystem ETCS L1/L2 functionally correctly in a verifiable way, without the need of any intervention as for the traction and braking systems of the vehicle. The vehicle during the ETCS-inspection operate under real circumstances on the track suitable for ETCS-operation sometimes at a maximum speed which can mean 160 km/h. ETCS inspection device shall communicate with the track-side subsystem so that the track-side subsystem may not distinguish the vehicle running with active ETCS on-board device (Level SIL 4) and the measuring train carrying the ETCS inspection device.

The ETCS inspection device is composed of the following functional subsystems:

1. real hardware components required for the on-board ETCS L1/L2/STM-EVM unit conforming to the effective UNISIG specifications ([www.era.europa.eu](http://www.era.europa.eu)).

On the vehicle an onboard equipment suitable for the inspection of the ETCS 1 and ETCS 2 track-side system shall be installed. The track-side subsystem operating or being before putting into operation are being installed according to the UNISIG Subset-026 (SRS) 2.3.0d, 3.4.0 and 3.6.0 versions so that an ETCS-inspection onboard device suitable for testing it shall be installed (onboard version: minimum 2.3.0d or 3.4.0/System version 1.0 or 3.6.0/System version 1.0).

1. The ETCS-inspection on-board device do not intervene in the brake system and in the traction control system of the vehicle, it only sends the functionally adequate signals to an evaluation test-computer (OBU inboard intelligence simulation) by which the subsystem inspection can be executed without having to factually intervene in the vehicle operation. Due to this fact the ETCS-inspection on-board device shall not have a safety integrity level of SIL 4.
2. To the functions to be executed the vehicle shall be equipped with the following full-value hardware components:

* the hardware elements necessary for the ETCS L1/L2/STM-EVM on-board system corresponding to the actual UNISIG specifications ([www.era.europa.eu](http://www.era.europa.eu))
  + GSM-R antenna,
  + GSM-R - ETCS data radio,
  + GSM-R - EVC interface,
  + odometer - distance measuring device and Doppler radar;
  + balise antenna,
  + BTM (Balise Transmission Module),
  + JRU (Juridical Recording Unit),
  + required interfaces,
  + ETCS key modul, cables,
* with GSM-R data radio having 2 SIM-card fulfilling the actual UNISIG specifications.

4. The vehicle shall be furnished with the onboard testing computer equipped with a software suitable for interpreting and processing of signals, information provided by the real hardware elements (OBU onboard intelligence simulation) whose functions are:

- the interpretation and processing of the information provided corresponding to SRS given by the real hardware elements,

- the simulation of the OBU system reaction meeting the SRS based on the signals of the track-side subsystem, i.e.

* it shall execute every data processing necessary for continuous speed supervision (input train data, information coming from the track-side subsystem);
* on the display of the test computer it shall display the standard control desk meeting the UNISIG specification and every information to be displayed in real-time;
* it shall generate every information, real output signals especially belonging to the every system reaction whose make possible the real-time test of the system reaction compliance and storing of them by which the additional analysis can be executed (for example the text message, the display of the system text messages, brake commands, displaying associated with the speed supervision, display of ETCS operational modes etc.);
* it shall be suitable for generating and sending (for example sending of real position information, mission permission request and sending, TAF acknowledge etc.) the radio messages – fulfilling the UINISG specifications to be sent for the track-side subsystem;

- the real-time recording of the events, data functionally compliant with real OBU JRU specifications for the additional analysis and documentation.

5. The Deliverer shall confirm the total functional compliance of the system with the UNISIG specifications by a certification issued by an independent certification body.

The BTM antenna shall be installed on the underframe of the vehicle corresponding to the UNISIG Subset-040 (the minimum distance from the buffer shall be 2 metres, the highest distance measured from the centre of the first axle: 12,5 metres is regulated).

The control desk of the simulated ETCS on-board equipment for testing purposes (SIL 0 safety integrity level) shall not be located in the front of the vehicle driver because the vehicle driver has no any intervention task via this so that it can be a portable computer with which only the testing crew works.

The vehicle shall be equipped with an EVM train vigilance system licensed for the maximum velocity (higher speed) of 160 km/h which ensure the full-service train vigilance and which shall make possible the connection of the ETCS on-board equipment only for measurement purposes (STM-EVM module but only for the evaluation executing in the simulated ETCS on-board system in case of measurement purpose of traffic in operational mode NTC). The STM module design to be prioritized is that the receiver coil, the filter, the evaluating unit do not differentiate from that ones used in the conventional EVM system and these are connected via interface to the ETCS measurement system.

The GSM-R antenna shall be installed on the roof of the vehicle, the GSM-R vehicle radio module and control desk shall be placed near by vehicle driver.

# 6. The requirements of the GSM-R measurement installation

The Tenderer shall install the GSM-R measurement system provided by the Procurer.

In the measurement room two RACK units shall be installed, the dimensions of a unit are 423\*265\*896 mm.

The antennas necessary for the GSM-R measurement system shall be placed on the roof of the vehicle and the wiring of the measurement system shall be executed by the Tenderer.

# 7. The requirements of the data collecting, processing and storing unit, data transmission requirements

## 7.1. The requirements in connection with the data storing unit

The storing module of the data collecting unit shall be suitable for storing the measurement data, identified fault places, calculated values of 2500 km taking into account of all measurement unit including the storing of the visual records of cameras installed on the measurement vehicle.

The data storing unit shall be a redundant system with hot swap design. The possibility of the complete exchange of the data storing units due to the data saving shall be ensured.

## 7.2. The requirements for the realization of the data connection

A 10 Gb network connector shall be installed on the exterior part of the vehicle with a protected enclosure (RJ-45 CAT7).

It shall be capable of accepting data originating from the actual space informatical system by means of a technology agreed commonly with the Procurer.

## 7.3. Control, data collector, display and evaluating equipment and programs

A computer system commercially available and compliant with data safety for executing the control of the actual measurement, data collecting and processing shall be applied. To increase the measurement safety the complete measurement system shall contain redundant elements. It shall be suitable for normal railway operational circumstances.

It shall be realized that the displaying information shall be available beside Hungarian language in English language and they shall be printed. For this reason an on-board printer shall be available.

An office system with unrestricted user’s rights shall be ensured for displaying several records and end results by which the end users can look at every existing results which the system can provide.

## 7.4. The requirements in connection with the energy supply

By integrating the uninterruptible power supplies it shall ensure that in case of malfunction the data loss may be maximum 100 m.

## 7.5. The requirements concerning the physical design

The informatical and measurement-processing units shall be placed in a KVM console rack with display by means of an adequate cooling design, it shall be suitable for railway circumstances (for example vibration, electromagnetic disturbation etc.).

# 8. The requirements in connection with the operational safety of the measurement system, the operational support of the measurement system

The complete measurement system

* railway equipment up to 20 years,
* the measurement systems up to 8 years,
* the IT devices up to 5 years,

shall be operational, their availability shall be at least 90 %.

If the Deliverer uses specialized hardwares in the design their basic parts and accessories shall be available in compliance with those mentioned above.

In order to make easy and accelerate the troubleshooting the measurement system shall have fault messages. They shall be sent via Internet to the Seller or the Seller entering into the measurement system shall be able to get information on the possible faults.

The Deliverer shall compile the list of the necessary basic replacement parts during making of its offer. The replacement parts enlisted in the list shall have to be handed over to the Procurer until starting of the technical handover and acceptance process.

When the replacement parts are handed over the list and the prices of the additional replacement and fast-wearing parts shall be handed over including the informatical replacement parts probably to be replaced during the operation.

The requirement is the easy-to-make maintenance, high lifetime and reliability.

The updating of the computer shall be executed by the Customer corresponding to the users instructions without the assistance of the Seller.

The parts of the measurement system shall not be restricted i.e. their useful life or regional applicability shall not be limited.

The Deliverer of the measurement system shall have an ISO quality management system valid for its activity including the installation of the measurement system which shall be confirmed by an ISO-certification issued by an independent certification body.

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