TECHNICAL REQUIREMENTS

to GPS Vehicle Monitoring System

(AVL system)

Version 4.0

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Contents

Terms and Definitions

Vehicle Monitoring System (AVL system) – a system composed of onboard equipment and software, which allows to monitor vehicle's (or other object's) position by GPS/GLONASS technology, vehicle's operational parameters and allows to compose analytical reports to support decision-making process in a customer's company, which owns monitored vehicles.

Customer – vehicle owner or vehicle operator.

Vehicle (object) – any movable (stationary) unit, which is subject to monitoring and where onboard equipment is installed.

Onboard equipment – a set of devices, which measure or otherwise monitors performance of vehicle's components and systems.

Onboard unit (telematics unit, GPS tracker) – a device, which has inbuilt GPS module for position tracking and serves as a gateway for sending data or information from Onboard equipment to a web server.

Web server – a computer system, which obtains data or information from Onboard unit and displays it in software (telematics service) for analysis by vehicle operator/owner.

Software (telematics service) – a part of computer system, which provides vehicle owner/operator with information on vehicle operation; software is intended to help vehicle owner/operator to make decision on increasing efficiency of vehicle in operation.

Onboard equipment manufacturer (Manufacturer) – a manufacturing company, which produces equipment installed on vehicles (objects).

Vehicle Monitoring System integrator (Integrator) – a company, who performs installation of onboard equipment and provides technical support for users.

Users – employees of Customer, who are responsible for vehicles' operation and are allowed to use Software.

1 General requirements to Vehicle Monitoring System

1.1 Goals of Vehicle Monitoring System implementation

1) Monitoring of location, direction and speed of vehicle in real time.

2) Monitoring of trip distance and time.

3) Monitoring of places and time of parking.

4) Monitoring of fuel consumption during trip and/or time interval: split according to fuel consumption modes – idle, regular, overload.

5) Monitoring of unrealistic high volume of fuel consumption, defined for the vehicle (tampering consumption by third party).

6) Monitoring of interference time into AVL system.

7) Monitoring of places and volumes of fuel refilling and draining from fuel tank (tanks).

8) Monitoring of load per axle.

9) Monitoring of main parameters of engine operation: RPM, temperature, working time.

1.2 GPS Vehicle Monitoring System architecture

GPS Vehicle Monitoring System should consist of:

1. Set of onboard equipment:
    - sensors,
    - tracking unit (GPS tracker).
2. Web server, where specialized vehicle monitoring Software (telematics service) is hosted.

1.3 Communication channels

To ensure data transfer to the server, standard data channels of GSM network should be used.

2 Requirements to set of onboard equipment

2.1 Onboard equipment architecture

1) Sensors with CAN (J1939) interface.

2) Temperature sensors and axle load sensors with analog output.

3) Tracking unit, which could be power supplied from onboard electrical network of a vehicle and equipped with in-built battery.

2.2 General requirements to set of onboard equipment

Onboard units and sensors should be able to integrate with onboard systems of vehicle according to CAN (J1939) automotive interface.

Set of onboard equipment can include, but is not limited with the following combination of devices:

1) Onboard unit with functionality of obtaining location coordinates using GPS/GLONASS technology, functionality of transferring data via GSM network and functionality of its remote diagnostics and configuration, it should be equipped with inbuilt GPS/GLONASS antenna and full set of installation parts.

2) Fuel flow meter with CAN (J1939) interface for data transfer to onboard unit, able to be power supplied from vehicle's onboard electrical network and from inbuilt battery, with full set of installation pats.

3) Fuel level sensor with CAN (J1939) interface for data transfer to onboard unit or with GSM modem for direct data transfer to vehicle monitoring Software (telematics service), able to be power supplied from vehicle's onboard electrical network, with full set of installation pats.

4) Axle load sensor with analog output.

5) Adapter for reading signals from CAN (J1939) bus.

6) Adapter for reading signals from J1708 bus.

7) Contactless FMS-gateway.

8) J1939 i/o module (digital-to-analog converter) for transforming analog signals to CAN (J1939) interface.

Detailed set of equipment is defined depending on specific goals of monitoring of particular vehicle.

In case of using two and more pieces of onboard equipment, it should be connected through one signal cable (bus). Power supply should also be done though the signal cable (bus).

Vehicle Monitoring System should allow configuration of all onboard equipment without disconnecting it from signal cable (bus).

In case of connecting standard automotive CAN (J1939) bus or/and J1708 bus, the adapter should be connected in a contactless way avoiding electrical contact with CAN-High and CAN-Low and/or A and B wires of bus. During vehicle maintenance, a responsible person should have a possibility of visual control of adapter's operability.

Onboard equipment should have functionality for automatic monitoring of its operability (self-diagnostics of malfunctions) and in event of malfunction it should send a special message containing a code of malfunction, which could be used for further diagnostics and decision-making on troubleshooting.

Onboard unit should have functionality of flexible configuration of operation modes for data traffic saving – when vehicle is out of home GSM network (i.e. in roaming), up to turning data transfer off and recording all data in internal memory with further data transfer to web server when vehicle returns to home GSM network.

Equipment for fuel consumption monitoring (e.g. fuel flow meter) should have functionality of recording data in its internal memory in case of intentional or accidental disconnection of the equipment from vehicle's onboard electrical network or signal cable breakage.

Fuel monitoring equipment should have functionality of adjusting measurement data according to fuel temperature.

In case vehicle has two or more fuel tanks, fuel level sensors should transfer data on fuel volume in each fuel tank to onboard unit via one signal cable. Calibration table for each fuel tank (table of correspondence between fuel level and liters/m^3) should be stored in internal memory of corresponding fuel level sensor.

2.3 Requirements to the functionality of vehicle monitoring system

Onboard equipment should ensure solution of the following tasks:

1) Movement monitoring:
- Recording vehicle's geoposition linked to timestamps, recording route, calculating mileage, detecting speed and direction of movement;
- Detecting signs of starting/stopping movement, registering time of trip, number of trips and stops, average and maximum speed in trip.

2) Fuel tank monitoring:
- Current fuel volume in fuel tank/tanks (in liters, millimeters, percentage from total fuel tank volume)
- Fuel refiling and draining volumes;
- Temperature of fuel in tank;
- Detecting water in fuel tank – notification through a special message sent to onboard unit or directly to web server.

3) Fuel consumption monitoring (configurable boundaries of consumption modes for particular vehicle):
- in idle mode;
- in optimal consumption mode;
- in maximum engine load mode.

4) Potential fuel misuse:
- Artificial increase of fuel consumption (overstating and/or tampering of fuel consumption data);
- Attempts to influence or stop normal operation of fuel flow meter by using magnetic field.

5) Engine operation time monitoring:
- in idle mode;
- in optimal consumption mode (for particular vehicle);
- in maximum engine load mode.

6) Monitoring current axle load and/or cargo weight.

7) Monitoring operational parameters of vehicle's components and units via CAN bus data:
- Engine speed;
- Fuel consumption by engine: instant and total;
- Time of stops and total idling time;
- Axle weight;

- Engine coolant temperature;
- Engine fuel temperature;
- Engine oil temperature;
- Tambient air temperature;
- Engine oil pressure;
- Current gear of transmission;
- Alternator speed;
- Lock status of doors;
- Notification on low level of aftertreatment selective catalytic;
- Bellow pressure;
- Movement/stop signs;
- Parking break switch status;
- Driver beltlock status.

In case of detecting fuel misuse attempt, fuel level sensor and fuel flow meter should send a special message to onboard unit or directly to web server. The message should contain the time of event, type and duration of misuse, degree of impact in quantitative terms (e.g. volume of fuel drained, duration of influence on fuel flowmeter, etc.)

2.4 Requirements to onboard equipment design

1) Onboard equipment should be manufactured from materials, which ensure lifetime of at least 3 years.

2) Fuel level sensor should be of capacitive principle of operation, weight is max. 1kg in order not to deform fuel tank.

3) Fuel level sensor should be protected from dirt and short circuiting of tubes by water.

4) Fuel level sensor should have firm fixation in fuel tank from the top and from the bottom, which will not allow sensor to order fluctuate in mounting hole.

5) Fuel flow meter should be made of ZAMAK alloy.

6) Fuel flow meter should be equipped with inbuilt mud filter, which could be cleaned/replaced without disassembling the device.

7) Fuel level sensor and fuel flow meter should be compatible by signal type and should be connected to onboard unit through one signal cable.

8) Equipment and its installation parts should be provided with special holes for sealing in order to detect unauthorized disconnection or unmounting.

3 Requirements to vehicle monitoring Software (telematics service)

3.1 General requirements to the Software

1) Software architecture should be scalable – it should provide possibility to connect up to 5000 onboard units without making major changes in developed and configured features of the Software and its analytical reports.

2) Software should provide access to authorized users from any PC connected to the Internet.

3) Access should be provided through web-based interface, authentication is done by login and password.

4) Access to information in the Software should have an option to be divided by levels in accordance with rights of access regulated by internal rules of customer.

5) Possibility to create route checkpoints and geozones (areas, where vehicles are allowed to operate).

6) Data storage for previous 365 days.

3.2 Requirements to Software interface

1) User-friendly and convenient interface, intuitive for users who are not experts in information technologies.

2) Ability to customize filters and report templates for selected parameters of vehicle operation.

3) Vehicle list should be available in real-time mode, according to provide access level of user. Vehicles should be also displayed as icons on a map.

4) When hovering over icon, status of vehicle should be displayed.

5) The interface should provide possibility to group vehicles according to criteria defined by user.

6) The interface should provide possibility to configure notifications and alarms, which are displayed as pop-up windows, sent by SMS and e-mail.

7) When viewing charts, the interface should allow user to:

- Change scale by selecting necessary area of chart;
- Scroll chart left and right;
- Export reports and charts to combined PDF-files.
- Export reports in format of tables.

3.3 Requirements to functionality of the Software

1) The Software should provide vehicle monitoring in real-time mode:

- Current location, stop/movement sign, direction and speed of movement;
- Parameters of fuel status and fuel consumption: current volume, instan consumption, trip consumption, temperature, consumption mode, etc.;
- Places of stops and parking;
- Current axle load;
- Other parameters obtained by set of onboard equipment.

2) The Software should provide possibility of simultaneous route playback of several vehicles, according to selected time frame and displaying the following information for each vehicle:

- coordinates;
- Total trip distance;
- Number of satellites, which signal was received by onboard equipment, and accuracy of vehicle positioning;
- Ignition switch status;
- Sign of stop/movement;
- Vehicle speed;
- Onboard electrical network voltage
- Fuel volume in tank;
- Instant and trip fuel consumption;
- Fuel temperature;
- Engine load mode;
- Engine hours.

Depending on vehicle speed, each part of route should be colored differently.

3) The software should provide possibility for after-trip analysis and reports generation:

- General statistics:
  - number of trips,
  - mileage,
  - engine hours for trip,
  - total engine hours of vehicle,
  - average speed,
  - maximum speed,
  - initial fuel level,
  - final fuel level,
  - total volume of tank refueling per trip,
  - number of tank refuelings,
  - volume of fuel drainings per trip,
  - number of fuel drainings,
  - total fuel consumption,
  - average fuel consumption per hour,
  - maximum RPM,
  - average RPM,
  - number of stops per trip,
  - durations of stops per trip.
- Travel journal:
  - date and time of beginning movement,
  - starting position,
  - date and time of finishing movement,
  - final position,
  - duration of trips,
  - mileage per trip,
  - mileage inside cities,
  - mileage outside cities,
  - average speed,
  - maximum speed.

- Mileage summary:
  - average speed,
  - maximum speed,
  - trip duration,
  - stops duration,
  - initial fuel level,
  - final fuel level,
  - total fuel consumption from tank,
  - average fuel consumption from tank per 100km,
  - number of tank refuelings,
  - volume of reguelings,
  - number of fuel drainings,
  - volume of fuel drainings,
  - total fuel consumption according to fuel flow meter,
  - average fuel consumption according to fuel flow meter per 100km.
- Refuellings:
  - time and place of refuelling,
  - initial volume of fuel in tank,
  - final volume of fuel in tank,
  - refilled volume of fuel.
- Fuel drainings:
  - time and place of draining,
  - initial volume of fuel in tank,
  - final volume of fuel in tank,
  - drained volume of fuel.
- Chart of fuel volume in tank change.
- Chart of fuel temperature in tank change.
- Combined chart of change of fuel volume and temperature in tank.
- Combined chart of change of fuel volume in tank and vehicle’s movement speed.
- Combined chart of change of fuel volume in tank and vehicle’s engine speed.
- Chart of instant fuel consumption change.
- Combined chart of change of fuel consumption and vehicle’s movement speed.
- Combined chart of change of fuel consumption and vehicle’s engine speed.
- Combined chart of change of fuel consumption, vehicle’s engine speed and vehicle’s movement speed.
- Chart of onboard network voltage change.
- Chart of vehicle’s movement speed change.

- Chart of axle weight (load) change.
- Combined chart of change of vehicle's movement speed and axle weight (load).
- Chart of signal strength in GSM network.

4) The Software should provide possibilities of configuring real-time notifications on:

- start/stop of vehicle movement;
- passing check points;
- excessing speed limit;
- fuel refilings/drainings;
- excessing allowed axle weight (laod);
- exiting geozone.

4 Requirements to related services: warranty, installation, after-warranty service, user training, technical support

1) Fuel level sensors and fuel flow meters should have at least 3-year warranty, while other devices from set of onboard equipment – at least 2-year warranty.

2) Official warranty services (authorized by manufacturer of onboard equipment) in the region of Vehicle Monitoring System operation or in other regions, where delivery of the equipment for servicing would take reasonable time.

3) Set of onboard equipment (except onboard unit/GPS tracker) should be carried out by specialists, certified for this by the equipment manufacturer.

4) In case of using onboard equipment of different manufacturers, provide configuration recommendations issued by one of the manufacturers.

5) Possibility of running training for customer's specialists, who will be responsible for system operation. Training should be carried out by specialists, who were officially certified by the equipment manufacturers.

6) Technical support from Vehicle System Monitoring integrator or onboard equipment manufacturer should be available for assistance at least 16 hours 5 days per week.

5 Requirements for onboard equipment manufacturer and Vehicle Monitoring System integrator

1) Manufacturer's experience in fuel level sensor and fuel flow meter manufacturing – at least 10 years.

2) Manufacturer's experience in other electronic devices used in Vehicle Monitoring System – at least 5 years.

3) Integrator's experience in installation of onboard equipment – at least 3 years.

4) Absence of legal procedures of debt recovering or bankruptcy in relation to onboard equipment manufacturer or Vehicle Monitoring System integrator

5) Confirmation from onboard equipment manufacturer/software developer, that onboard equipment and/or software was officially and directly purchased by integrator from respective onboard equipment manufacturer/software developer.

6 Certification requirements

1) In case of installing onboard equipment from different manufacturers, there should be a certificate signed by at least one of the manufacturers, that onboard equipment is compatible between each other.