DESCRIPTION OF THE RELEVANT PROCUREMENT CONDITIONS
APPENDIX 2

Tender PIAP/KZP/15/09

UGV Navigation System Requirements

Short spec

Table of Contents

1. SCOPE

1.1. IDENTIFICATION

This document establishes the requirements for the Unmanned Ground Vehicle (UGV) navigation system for TALOS demonstrator.

1.2. System purpose

The purpose of the UGV navigation system ("system" hereafter) is to provide vehicle position and attitude data to the UGV computers enabling them to perform the UGV mission.

The system is intended to be installed on the 4 wheels skid track vehicle. The vehicle maximum speed is 30 km/h, while the regular speed will be up to 22 km/h.

2. APPLICABLE DOCUMENTS

The following documents, of the exact issue shown, form part of the specification to the extent specified herein. In the event of a conflict of documents referenced herein, the detail contents of Sections 2 and 3 shall be considered superseding documents.

2.1. Specifications

MIL-C-38999	Connectors
MIL-STD-461E	Electromagnetic Emission And Susceptibility Requirements For The Control And Electromagnetic
MIL-STD-810F	Environmental Test Methods And Engineering Guidelines
MIL-STD-1275B	Characteristics Of 28vdc For Electrical Systems In Military Vehicles

3. REQUIREMENTS

3.1. General requirements

The system shall be of Differential DGPS aided INS type.

The system, installed on a wheels skid track vehicle, shall be able to provide in real time the following data :

- Attitude
- Azimuth
- Velocities in three axes
- Acceleration in three axes
- Angular rates in three axes
- Latitude, Longitude and altitude
- Data validity
- Status and performance
- Control data
- GPS time
- INS raw data (even when operated in hybrid mode)
    - Attitude
    - Azimuth
    - Velocities in three axes
    - Acceleration in three axes
    - Angular rates in three axes
- DGPS raw data (even when operated in hybrid mode)
    - Latitude, Longitude and altitude

All data shall have a time tag.

An "off the self" system is required. Software adaptations are permitted.

The system shall include four main elements:

- INS

- Differential GPS (including antenna)
- Fusion processor
- Power supply and electronic cards

The vendor shall perform the fusion between the INS and the Deferential GPS.

3.2. Capabilities

The system shall provide the following capabilities:

3.2.1. Modes of operation

The system shall implement its own state machine and have at least the following modes of operation:

- Initialization mode
- Operational mode
- Maintenance mode

The system shall have the following sub modes of operation:

- Power up
- Slow Alignment
- Init/ Fast alignment
- Operation/ Fast alignment
- Hybrid navigation
- Inertial only

3.2.2. Fusion

Loosely coupling is the minimum requirement (Fusion of DGPS information into the KALMAN filter).

The system shall provide an RTK and Omnistar HP- capable receiver and/or use odometer aided to the INS

The desired combined INS/DGPS system shall feature tightly or deeply combined architecture.

For tightly or deeply combined architecture, the DGPS receiver provides aiding information for the INS, and shall be reciprocally aided by feedback from the INS, as follows:

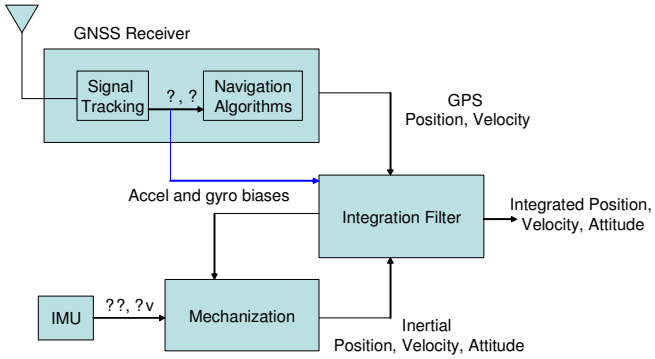

Figure 1: Tightly combined architecture

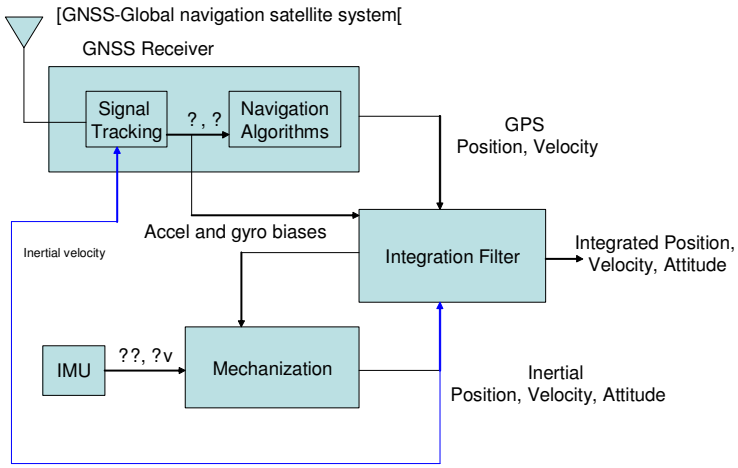

Figure 2: Deeply combined architecture

3.2.3. **System performance**

3.2.3.1. System Accuracies

The system output accuracies shall be at least as follows:

Parameter (RMS)	Accuracies (RMS)
Position and height (m)	Omnistar HP and RTK-2 (1Cm+1ppm)
Velocity (m/s)	0.015
Roll / pitch (Deg):	0.03
Azimuth (Deg)	0.2
60s, free inertial/unaided 3D position Error (m)	0.12 without odometers correction
60s, free inertial/unaided, Velocity Error (m/s)	0.07
60s free inertial/unaided yaw Error (deg)	0.2

Note1: Free inertial , and/or unaided performances are defined, 30 minutes after the completion of the initialization,while the vehicle velocity is at least 20 km/h,

Note 2: The azimuth accuracy before the first vehicle movement, but after the completion of the initialization, shall be better than 0.3 deg up to 65 deg latitude

This 0.3 deg accuracy shall be achieved even if:

a) The vehicle azimuth was changed between the previous system turn off and the present initialization

b) The present azimuth was not received from the vehicle computer during, or before, the initialization.

The parameters resolutions shall be at least twice better than the accuracies parameters.

3.2.3.2. System dynamic range

The system shall have the following minimum dynamic range:

Parameter	Accuracies (RMS)
Velocity (m/sec)	30
Altitude (m)	-450-5000
Angular rate (deg/sec)	± 400
Angular Acceleration (deg/sec^2)	± 10000
Pitch & Rol (deg)	± 90

Azimuth (deg)	± 180

3.2.3.3. System Refresh Rate

The minimum refresh rate shall be 50 Hz

3.2.3.4. INS performances

The INS performances are driven from the system accuracies as defined in paragraph 3.2.3.1, and shall be as follows:

- Min Refresh rate : 50 Hz
- Max data latency : 5 msec

3.2.3.5. Differential GPS performance

The system shall be based on the Omnistar HP and RTK-2 (1Cm+1ppm) technology. The performances shall be equal or better than:

- Data rate: 20 Hz
- Typical time to first fix:
  - Cold start: 60 sec
  - Hot start: 35 sec
- Typical Reacquisition time:
  - L1: 0.5 sec
  - L2: 1.0 sec
- Time accuracy: 20 ns RMS
- For Omnistar HP mode the initialization time ver. position accuracy shall be better than:
  - After 2 min=0.8 meters RMS
  - After 3 min=0.5 m RMS
  - After 30 min=0.2 m RMS
  - After 40 min=0.1 m RMS

For faster initial convergence and higher level of accuracy it is desired to use the FW V3.400 OEMV receiver.

As a default the system shall use the RTK mode . The system shall use the Omnistar HP when the RTK corrections are not received or not valid

The antenna, zero offset active type, shall receive L1 and L2 frequencies from the GPS and GLONASS satellites as well as the L-band frequencies used by the OmniSTAR differential correction services.

The antenna performances shall be as follows:

- 3 db band pass for GPS option:
    - L1: 1575+/- 20 Mhz
    - L2: 1228+/- 20 Mhz
    - L-band: 1543+/- 20 Mhz
- Noise figure (typical): <2.5 db
- VSWR (typical):,20:1
- 3 db band pass for GLAONASS option:
    - L1: 1588.5+/- 23.0 Mhz
    - L2: 1236.0+/- 18.3 Mhz

The DGPS shall output the power for the antenna circuits via the receiver coax. The system shall support the coax min cable length of 10m.

3.3. System External Interfaces

3.3.1. Interface diagram

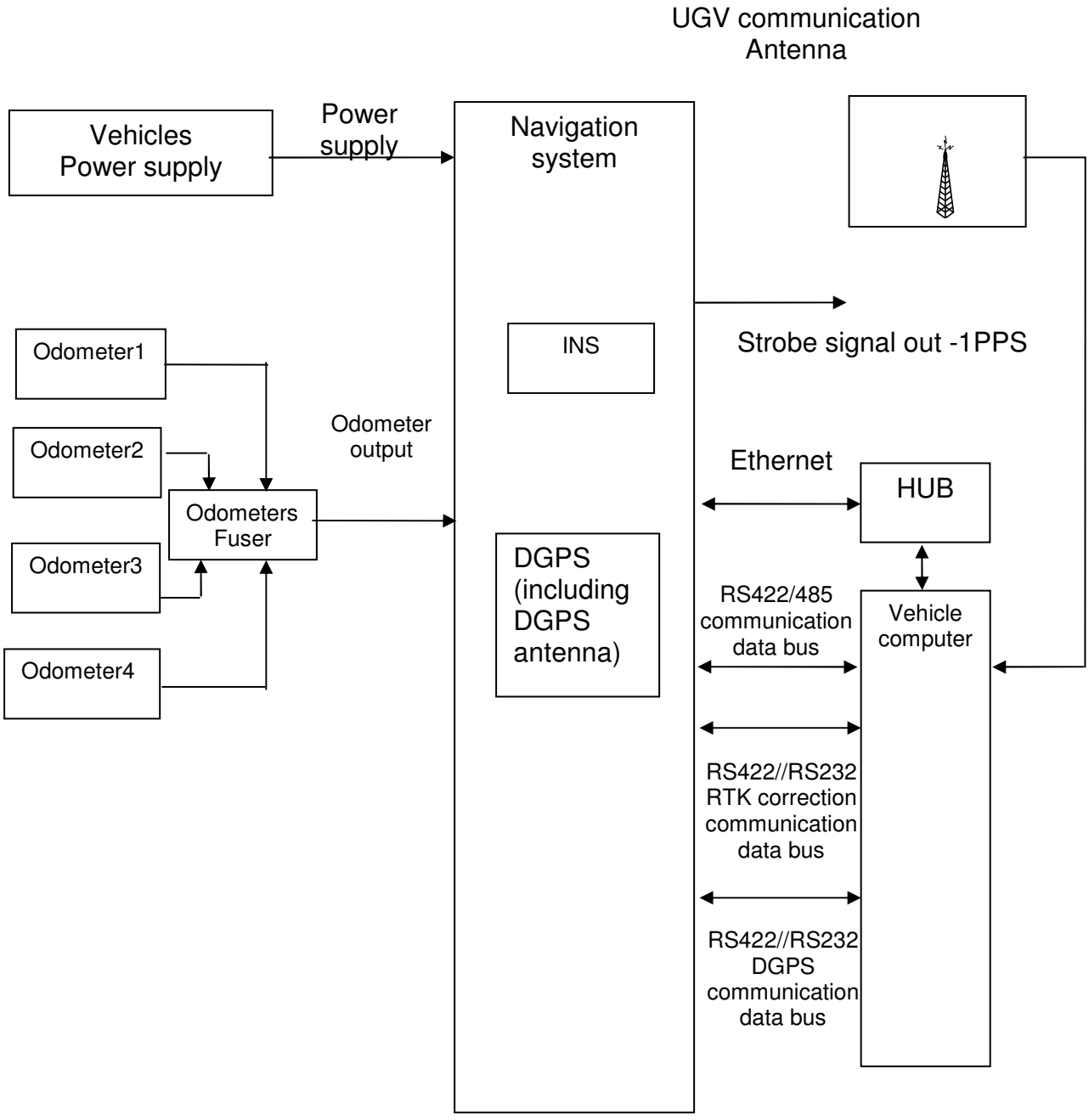

Figure 3: System Interface Diagram

3.3.2. Interface definition

The navigation system will contain the following interface:

3.3.2.1. Power supply

The INS shall accept 18V to 34V DC steady state according to MIL-STD-1275B,

The DGPS shall accept 9.5v to 18 v steady state regulated power supply

.Desired power supply range: 18V to 34V DC steady state according to MIL-STD-1275B for "one box" system.

3.3.2.2. RS422/RS485 or Ethernet Data Bus

The system shall communicate with the other vehicle's systems through RS422/485.or Ethernet data bus.

it is desired that the data bus shall include all the data described in para 3.1, and the RTK data correction, otherwise part of the data shall be transferred thought RS422//RS232 RTK correction communication data bus and the RS422//RS232 DGPS communication data bus.

3.3.2.3. RS422//RS232 RTK correction communication data bus

The differential GPS may receive RTK corrections through this data bus. It is desired that the RTK corrections will be transmitted through the RS422/RS485 or Ethernet Data Bus –See para 3.3.2.2

3.3.2.4. RS422//RS232 Differential GPS communication data bus

This communication data bus shall be used for DGPS raw data transfer.

3.3.2.5. 1 PPS (strobe signal out)

This para shall be updated by the supplier. This output shall be received even when the deferential GPS is not working or while outage .

3.3.2.6. Odometer output

The system shall have at least one odometer input. Data received from this input shall be used in localization algorithm. The supplier shall specify the exact interface.

3.4. Safety Requirements

This para shall be updated by the supplier.

3.5. Security and Privacy requirements

N/A

3.6. System environment requirements

The system is intended to be installed on the tracked vehicle with off-road moving capability. As such, it shall be capable of delivering all performances as defined in this specification, when subjected to any applicable combination of environmental condition as defined in MIL-STD-810F, or alternative standard, except as modified herein.

The DGPS unit may be supplied in COTS enclosure.

3.6.1. INS and "one box system" requirements

3.6.1.1. Temperature

Temperature conditions, which the system shall be capable of enduring (operated and non-operated), shall be as follows:

- Operation: -30°C to +60°C according to method 501.4 procedure II, method 502.4 procedure II, and table 501.4-II
- Storage : -40°C to +71°C according to method 501.4 procedure I, method 502.4 procedure II

3.6.1.2. Altitude (pressure)

Altitude conditions, which the system shall be capable of enduring (operated and non-operated), shall be defined as follows:

- Operation: From -450m till 5000 m, according to method 500.4 procedure II.
- Storage: From -450 m till 12000 m, according to method 500.4 procedure I.

3.6.1.3. Rain

Rain (including hail) conditions, which the system shall be capable of enduring (operated and non-operated), shall be as defined in method 506.4 procedure I, and the following parameters:

- Rain rate ; 100 mm/h
- Wind velocity : 65 km/h
- Drops dimensions : D = 4.5 mm

3.6.1.4. Humidity

Humidity conditions, which the system shall be capable of enduring (operated and non-operated), shall be as defined in method 507.4 (while exposed to 10 test cycles).

3.6.1.5. Fog and Salt Atmosphere

The system and the system performances shall not be harmed after 2 cycles, 24 h each, of continuous exposure to fog and salt conditions (5% salt) as defined in procedure 509.4

3.6.1.6. Sand and Dust

3.6.1.6.1. Blowing Dust

Dust blowing conditions, which the system shall be capable of enduring (operated and non-operated), shall be as defined in method 510.4 procedure I and the following parameters:

- Wind velocity: 5m/sec-10m/sec
- Temp: 50 deg c
- Relative humidity: 25-30%
- Dust definition: according to method 510.4 para a,2.3.2.5 and a,2.3.2.6
- Exposure duration for each axis : 6 hours at 23 deg c and another 6 hours at 50 deg c

3.6.1.6.2. Blowing Sand

Sand blowing conditions, which the system shall be, capable of enduring (operated and non-operated) shall be as defined in method 510.4 procedure II and the following parameters:

- Wind velocity: 20m/sec-30m/sec
- Temp: 50 deg c
- Relative humidity: 25-30%
- Sand definition: according to method 510.4 para b,2.3.2.5
- Sand concentration : 0.5 g/m3
- Exposure duration for each axis : 2 hours

3.6.1.7. Vibration

Vibration conditions which the system shall be capable of enduring (operated and non-operated) shall be as defined in method 514.5 procedure I, category 20 , and as follows:

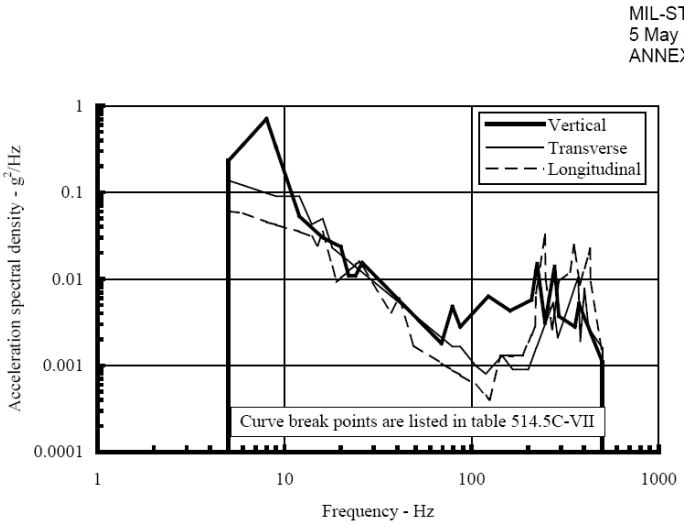

FIGURE 514.5C-3. Composite wheeled vehicle vibration exposure.

During land and air transportation or by shipping (loose cargo), while the system is in a package(s), the vibration condition is according to method 514.5 procedure II, category 5.

3.6.1.8. Shocks

Shocks conditions, which the system shall be capable of enduring, shall be as defined in method 516.5, and as follows:

- Operational condition:

  Procedure I is applicable, when apply 40g for 9 msec for each one of the 3 axis.

- Transit drop

  Procedure IV is applicable

- Fragility

  Procedure III and table 516.5-IV are applicable

- Drop with the package :

Procedure II and table 516.IV are applicable

- Maintainability drop

  Procedure VI is applicable

3.6.2. **DGPS Requirements**

The DGPS unit may be supplied in COTS enclosure

3.6.3. **Computer resource requirements**

N/A

3.7. System quality factors

3.7.1. Reliability

3.7.1.1. MTBF

System Field MTBF shall be not less than 5000 hours at 55 deg C , with confidence level of 90%.

3.7.1.2. Operational Service Life

This para shall be updated by the supplier.

3.7.1.3. Useful Life

This para shall be updated by the supplier.

3.7.1.4. Storage Life

This para shall be updated by the supplier.

3.7.2. Maintainability

3.7.2.1. Definitions for Maintainability Terms

This para shall be updated by the supplier.

3.7.2.2. Quantitative Maintainability Requirements

This para shall be updated by the supplier.

3.7.2.3. Maintenance concept

This para shall be updated by the supplier.

The maintenance policy for the navigation system shall consist of one level of maintenance, which is an Organizational Level.

The organizational level maintenance shall be based on BIT (Built In Test) provisions and rapid accessibility to all LRUs (Line Replaceable Units). The LRUs shall be designed for fast removal and replacement.

3.7.2.4. Equipment Handling

This para shall be updated by the supplier.

3.7.2.5. Adjustments

Adjustment alignment or calibration shall not be permitted for the system. Any adjustments, alignment or calibration that may be required shall be carried out only at the system manufacture.

3.7.2.6. Reversibility Restrictions

The system design shall incorporate features so that it is impossible to incorrectly install, attach cables, electrical plugs, or any other items to, mechanically and electrically, in an improper manner. Mechanical keyed mating, different size connectors, etc. shall be incorporated to eliminate all such possibilities.

3.7.2.7. Preventive Maintenance

There shall be no Preventive Maintenance (including maintenance inspections and forced replacement).

3.7.3. **Testability**

The system shall provide BIT data and identify malfunctions in all LRUs.

3.7.3.1. BIT general description

Adequate initial and continuous BIT should be incorporated with appropriate failure annunciations.

The system shall include built-in test feature for failure detection and fault isolation. BIT shall be designed as internal part of the system. BIT shall require no external stimuli or measurement equipment to perform its function.

Reliability or BIT circuitry and devices shall be an allocated portion of the electronic system.

Any fault detected by the system BIT, shall be transmitted to the vehicle systems via the communication bus.

3.7.3.2. BIT Modes

The system shall have three BIT modes:

- Power-up bit
- Periodic/Continuous BIT
- Initiated BIT

3.7.3.2.1. Power-up BIT:

During the system initialization an automatic BIT shall be performed. At the end of the BIT process, the system shall analyze the results and transmit the BIT results to the vehicle's mission computer.

3.7.3.2.2. Periodic/Continuous BIT

The Periodic BIT shall be performed automatically and simultaneously on a non-interference basis alongside the normal system operation.

The Periodic Bit monitor and/or test all the functions and/or signals on a sequential basis, except for signals and/or functions, which can not be tested during the operation due to safety or other constraints.

3.7.3.2.3. Initiated BIT:

Maintenance BIT shall be performed by when requested by operator. Upon maintenance BIT command VCS shall interrupt normal operation, activate self-test programs, and make appropriate measurements to detect and isolate failures.

3.7.3.3. False Alarm

This para shall be updated by the supplier

3.7.3.4. BIT Timing

This para shall be updated by the supplier

3.7.4. **Transportability**

This para shall be updated by the supplier

3.7.5. **Interchangeability**

This para shall be updated by the supplier

3.7.6. **Design and construction constraints**

3.7.6.1. Physical characteristics

3.7.6.1.1. Dimensions and weight

As an "off the self" item this requirement is not relevant.

It is desired to be as small as possible.

The system manufacturer shall submit the proposed system outline drawing(s)

3.7.6.1.2. System package

The navigation system may be "one box" type (the systems elements are cards that installed in one box) or "multi box" type (the system elements are installed in separated boxes).

3.7.6.2. Cooling

No specialized cooling system should be required for the navigation systems.

3.7.6.3. Connectors

The system connectors shall be circular sealed types.

Desired connectors: MIL-C-38999-III type.

3.7.6.4. DGPS antenna

The proposed antenna shall be suitable for outdoor use.

3.7.6.5. Electrical Power Requirements

3.7.6.5.1. Power Input

The system shall accept steady state inputs as defined in 3.3.2.1 . The INS and "one box system" the system shall meet the requirements for spikes, ripples and surges as defined in MIL-STD-1275B, or equivalent standard.

3.7.6.5.2. Power consumption

As an "off the self" item this requirement is not relevant.

It is desired to be as small as possible.

The system manufacturer shall submit the proposed system outline drawing(s)

3.7.6.5.3. Overload protection

This para shall be updated by the supplier

3.7.6.5.4. Input Circuits

Input circuits shall not suffer damage when equipment that interfaces with the system is not installed or is in a power "OFF" condition.

3.7.6.5.5. Power on Removal and Replacement

Removal and replacement of the system with the power applied shall not damage the system.

3.7.6.6. Materials Process and Parts

3.7.6.6.1. Material, Selection Limitations

This para shall be updated by the supplier

3.7.6.6.2. Dissimilar Metals

This para shall be updated by the supplier

3.7.6.6.3. Corrosion Prevention

This para shall be updated by the supplier

3.7.6.6.4. Finish

This para shall be updated by the supplier

3.7.6.6.5. Parts

This para shall be updated by the supplier

3.7.6.6.6. Wiring

Wiring insulated with fluorocarbon/polyamide material shall not be used.

3.7.7. **Electromagnetic Interference and Compatibility**

The INS and "one box system" shall meet MIL-STD-461E, or alternative standard, as follows:

CE102	Conducted Emissions, Power Leads, 10 kHz to 10 MHz;
CS101	Conducted Susceptibility, Power Leads, 30 Hz to 150 kHz;
CS114	Conducted Susceptibility, Bulk Cable Injection, 10 kHz to 200 MHz, Curve #4;
CS115	Conducted Susceptibility, Bulk Cable Injection, Impulse Excitation;
CS116	Conducted Susceptibility, Damped Sinusoidal Transients, Cables and Power Leads, 10 kHz to 100 MHz , Imax= 10A ;
RE102	Radiated Emissions, Electric Field, 2 MHz to 18 GHz, Navy mobile & Army
RS103	Radiated Susceptibility, Electric Field, 2 MHz to 18 GHz, Radiated Electric Field - 50 V/m for equipment installed in ground platform.

The DGPS shall meet the TBD standard/ requirements.

3.7.8. **Mechanical installation requirements**

This paragraph shall be updated by the supplier

The system shall provide the possibility to enter its distance from the vehicle center of gravity (lever arm).