**ISRO-LEOS-PSA-3DLIDAR-RFP**

# Request for Proposal (RFP) for

# 3D LIDAR

**July-2023**

**LABORATORY FOR ELECTRO-OPTICS SYSTEM (LEOS)**
**INDIAN SPACE RESEARCH ORGANISATION**
**DEPARTMENT OF SPACE**
**BENGALURU**

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**Director, LEOS**

**(On behalf of President of India)**

# List of Abbreviations

| | | |
|---|---|---|
| CVCM | - | Collective Volatile Condensed Material/matter. |
| FDIR | - | Fault Detection Isolation & Recovery |
| FOV | - | Field Of View |
| FIT | - | Failure in time |
| rms | - | root mean square |
| Grms | - | g root mean square |
| ICD | - | Interface Control Document |
| km | - | kilometer |
| LASER | - | Light Amplification by Stimulated Emission of Radiation |
| LOS | - | Line Of Sight |
| m | - | Meter |
| MIL | - | Military |
| mm | - | Millimeter |
| PCB | - | Printed Circuit Board |
| RDN | - | Reliability Discrepancy Note |
| TBC | - | To Be Confirmed |
| TBD | - | To Be Decided |
| TBF | - | To Be Finalised |
| TBU | - | To Be Updated |
| TC | - | Telecommand |
| TM | - | Telemetry |
| TML | - | Total Mass Loss |
| DOF | - | Degree Of Freedom |

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# 1 INTRODUCTION

Indian Space Research Organization (ISRO), Department of Space, Government of India, has embarked on the development of 3D LIDAR based Autonomous Navigation for various satellite missions.

This RFP document provides necessary specifications / requirements to be met by the Vendor for the deliverables including various qualification / acceptance tests, schedules etc. Vendor shall provide his response to this RFP.

**This is a Global Open tender under Two-part basis. Only online tenders will be accepted. No manual/Postal/e-mail/Fax Offers will be entertained.**

**Technical Bid shall contain point to point compliance in RFP mentioned along with supporting documents in NEW EGPS mode.**

**The Proposer shall provide Commercial Bid with cost break up inclusive of taxes for the total contract in NEW EGPS mode.**

**Please do no attach price details with technical details in pdf or any format. If so, your offer shall be rejected.**

**This RFP is to procure the following :**

i. 3D LIDAR: Engineering Model along with Data Acquisition system and Ground Support Equipment – 01 No.

ii. 3D LIDAR : Flight Model – 01 No

The proposal submitted in response to this RFP should be in conformity with the requirements / specification laid down in this document. The Vendor should provide a compliance chart with respect to specification of this RFP. In case the Vendor is unable to meet the specifications / requirement, the deviations from the specifications should be highlighted in the proposal. Additionally, whenever the realization of the qualification / acceptance tests has significant technical and/or cost impact, if any, the same should be indicated. Qualification by similarity is also acceptable. Proposals which have closer match to the requested 3D LIDAR and which have a proven flight history is preferable.

The proposal should include detailed information on the space heritage and previous qualification data on similar models. LEOS reserves the right to witness the qualification / acceptance tests and to review the progress of work at various milestones of the programme. The Vendor shall suggest the review scheme along with the proposal. If any test is to be carried out at a place other than the Vendor's place, the Vendor shall make appropriate arrangements for the participation of LEOS/ISRO nominees. The specifications in this document may be modified on any ground before the finalization of the contract. After the award of contract, any deviation/non-conformance / modifications shall be mutually agreed upon by both parties.

# 2 SCOPE

This request for proposal (RFP) provides the requirements for design, development, testing, performance evaluation and delivery of 3D LIDAR capable of estimating Pose (Relative Attitude and Relative Position) of the target. This RFP also provides information about the commercial terms and conditions applicable to the supplier of 3D LIDAR.

# 3 REFERENCE DOCUMENTS

1. MIL-B-5087B: Bonding Electrical, and lightening protection for Aero Space Systems.
2. MIL-P-55110F: General specifications for printed wiring boards - Rigid.
3. MIL-C-26482G: Specifications for miniature circular and general purpose connectors.
4. BELL CORE/TELECORDIA specifications for fibre optics components.
5. MIL-STD-275E: Printed wiring for electronic equipment.
6. MIL-STD-461C/D: Requirements for the equipment towards Electromagnetic emission and susceptibility requirement/interface characteristics.
7. MIL-STD-1541A: Electromagnetic compatibility requirements for space systems.
8. MIL-SD-462 C/D: Measurement of Electromagnetic Interference Characteristics.
9. MIL-E-6051D: System Electro-Magnetic compatibility requirements.
10. MIL-STD-1553B - Aircraft internal time division command multiplexed data bus.
11. MIL-STD-675C: Quality standards for coating of Glass optical elements.
12. NHB-5300-4 (3A-1): Requirements for soldered electrical connections.
13. MIL-STD-19500P: Performance specifications; General specifications of semiconductors devices.
14. MIL-STD-38510J: General specifications for microcircuits.
15. MIL-M-13508C: Mirrors, Glass, front surfaces aluminized for Optical elements.
16. MIL-M-13830: General specifications for manufacture, assembly and inspection of optical components.
17. MIL-O-16898: Optical elements packaging.
18. MIL-STD-750E: Test Methods for semi-conductor devices.
19. MIL-STD-883F: Test methods for microelectronic components.
20. MIL-STD-202H: Test methods for electronic and electrical components.
21. MIL-HDBK-217D: Reliability Prediction of Electronic equipment.
22. RADC-TR-75-210, AD A016347: Laser Reliability Prediction.
23. RADC-TR-80-322, AD A092315: Failure Rates for Fibre Optic Assemblies.
24. MIL-HDBK-978-B (NASA): NASA Parts Application Handbook.
25. NSWC-94/L07: Handbook of Reliability Prediction Procedures for Mechanical Equipment.



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# 4 3D LIDAR CONFIGURATION

3D LIDAR generates three-dimensional "point-cloud" images by either scanning the laser beam in two dimensions or using a pixilated "FLASH" LIDAR camera. The Point cloud images of the Target will be processed to estimate the POSE (Relative Position and Relative Attitude).

3D LIDAR shall have an Optical assembly and associated processing electronics. Minimum weight, power and volume are of prime importance. Functional performance specifications shall be met over the operating temperature range.



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# 5 3D LIDAR SPECIFICATIONS

## 5.1 Specification Table

| | | |
|---|---|---|
| **I** | **Performance Specifications** | |
| 1. | Maximum Range of Operation | ≥ 200 m |
| 2 | Minimum Range of Operation | ≤ 1 m |
| 3 | Target Type | Non Cooperative |
| 4 | Target Size | 5± 1 m X 15± 2m Typical |
| 5 | Data Output | 6 Degree of freedom<br>Relative Position and Orientation |
| 6 | Attitude Accuracy (3σ Noise + Bias ) | < 1 Degree (Range: 200m to 10 m)<br>< 0.5 Degree (Range: < 10 m)<br>Finer accuracy is preferred throughout the Range. |
| 7 | Position Accuracy (3σ Noise + Bias ) | < 2 m (Range > 25 m)<br>< 0.25 m (Range: 25m to 2m)<br>< 0.01 m (Range < 2m ) |
| 8 | Maximum operating Angular Rate | 5 Deg/sec |
| 9 | Maximum operating Acceleration | Linear: 0.1 m/sec$^2$<br>Angular : 1.5 Deg/ sec$^2$ |
| 10 | Output Data Format | MIL-STD-1553 B (TBD) |
| 11 | Update Rate | ≥ 1 Hz |
| 12 | LIDAR Technology | Scanning / Flash |
| 13 | ON Board Storage | Option to Upload the Target 3D Model |
| **II** | **High Speed Interface** | |
| 1 | Target 3D Point Cloud images | ON-Board Storage<br>Memory requirements and High |



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| | | |
|---|---|---|
| | | speed LVDS Data rate for transfer to be discussed (TBD) |
| **III** | **Electrical – Power** | |
| 1 | Power Dissipation<br>Average Power | < 50 W |
| 2 | Peak Power | 80W (Typical) |
| 3 | Input Supply Voltage | 28 to 42.5 V |
| **IV** | **Mechanical** | |
| 1 | Weight | < 15 Kg |
| 2 | Dimension | As compact as possible |
| **V** | **Environmental** | |
| 1 | Operating Temperature | -10 ◦C to +50 ◦C (TBD ) |
| 2 | Storage Temperature | -30 ◦C to +70 ◦C (TBD ) |
| 3 | Total Ionization Dose | 50 Krad (TYP) |
| 4 | SEL and SEU Mitigations | Hardened / Mitigated |
| 5 | Vibration Levels | Refer to Annexure-I |
| 6 | Shock Levels | Refer to Annexure-I |
| **VI** | **LIDAR quoted should have space heritage** | |

- **The Vendor shall provide a detailed error budget in order to meet the** accuracies mentioned in the performance specification.
- The above specifications and accuracies shall be met under all environmental conditions as given in the test matrix under qualification programme chapter 7.
- The Vendor shall mention the various test and validation methods employed to demonstrate the performance specifications.
- The Vendor shall provide Note on the handling, safety and storage conditions.
- The Vendor shall specify the Space heritage of the model being offered. Also, space heritage of the components that have gone into the design may also be brought out to



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highlight the reliability of the system, life of the components and radiation related performance.

- Qualification status and heritage of the components used shall also be indicated.

## 5.2 3D LIDAR POWER ,TELECOMMAND AND TELEMETRY INTERFACE

3D LIDAR will have interfaces to Power subsystem, AOCE subsystem, Telemetry and Tele command subsystem.

Electrical Interface Definition of 3D LIDAR shall be defined in the ICD. MIL-STD-1553 address setting details with pull up, Buffer IC's etc., shall be defined in the ICD. The Vendor should mention the ON/OFF sequence.

### 5.2.1 3D LIDAR ON/OFF interface:

ON/OFF command will be used for switching of Raw Bus Power to 3D LIDAR. The interface between the 3D LIDAR and Tele-command (TC) subsystem shall be as per the ICD. CMOS 0 - 5V, 64 ms Pulse will be issued for switching the package. ON/OFF command of this nature is preferable or as mutually agreed upon.

The 3D LIDAR shall provide a status bit which shall indicate the status of the 3D LIDAR ON/OFF status. The electrical interface of ON/OFF status shall be provided in the proposal.

### 5.2.2 3D LIDAR DATA COMMAND INTERFACE

3D LIDAR Data command Interface is through MIL-STD-1553 B interface. Data command (in terms of Data format and timing) shall be indicated clearly in the proposal.

### 5.2.3 3D LIDAR OUTPUT DATA & TELEMETRY INTERFACE:

- 3D LIDAR Output Data interface is through standard MIL-STD-1553B interface.
- Handshake (Sync Command) requirement for initiation of Pose measurement shall be specified.
- Electrical ICD with timing details shall be provided in the proposal.

The Vendor shall mention output data format for all parameters. The format of the data shall contain timing diagrams, protocols, bit allocations, total number of words etc. For all



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data parameters, the appropriate conversion factors shall be provided. The typical parameters:

a) 6DOF (Relative Attitude and Relative Position)
b) Measurement Time stamp
c) Health and status information
d) Any other parameter

- The Vendor shall provide the Data Validity information and mention all the possible cases under which Data will be designated as Valid and Invalid.
- Fault Detection, Isolation and Recovery (FDIR) aspect of 3D LIDAR shall be clearly mentioned in the proposal.

### 5.2.4 Point cloud Data Interface:

Point cloud image of the Target shall be transferred to On-board storage. High speed LVDS interface shall be preferable. The Vendor shall clearly indicate Data format and timing in the proposal.

## 5.3 Electrical &Mechanical Interface

The Vendor shall provide all Electrical and Mechanical interfaces in detail. The electrical grounding scheme of the sensor shall be provided. Electrical Interface Definition (EID) shall be defined in the ICD.

### 5.3.1 Alignment reference

3D LIDAR shall be provided with an optical cube, which will be used as reference for aligning the Optical axis of sensor head. At least three orthogonal surfaces of cube shall be available for viewing in the fully assembled condition. Measured misalignment values between measurement axes and cube axes shall be provided to an accuracy of less than 10 arc sec. The alignment data shall be displayed in a direction angle transformation matrix, which is a table (in degree) giving the angles between +X, +Y, +Z (sensor axis) and +X, +Y, +Z (cube axis) as per mechanical ICD.

### 5.3.2 Polarity Details

The Vendor shall provide the polarity of relative attitude and position in each axis. This information shall be in the form of a table and shall be explained with the help of a diagram.



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# 6 PRODUCT ASSURANCE PLAN

The Vendor shall ensure the flight worthiness of the supplied items after adequate testing, qualification and verification in accordance with the quality assurance and reliability plans.

Product assurance plan shall cover the following aspects:

- Design Reviews
- Reliability Engineering
- Parts, Materials and Process control
    - Test & Evaluation methods and Procedures
    - Non-Conformance Control
    - Failure Analysis and Corrective Action mechanism
    - Life Test / Demonstration

## 6.1 Design Reviews

Design Review to validate the initial design in terms of adequacy, and to consolidate the system specification and interfaces. This review shall be part of the schedule planning and shall be intimated to LEOS at least one month in advance along with the relevant documents.

End Item Data Pack (EIDP) of 3D LIDAR to be provided by Vendor before delivery of the package after completing all the tests. EIDP will be reviewed by LEOS and shall provide the clearance for shipment.

## 6.2 Reliability Engineering

Following reliability exercises shall be carried out.

- **Derating**: Derating of the components with respect to the device parameters shall be as per MIL-STD-975.
- **Non-Conformances** arising from the above exercises generated by a RDN (Reliability Discrepancy Note) shall be disposed with the consent of LEOS.
- **Prediction**: Vendor shall provide the parts failure rates in FITS per $10^9$ hours as per MIL-STD-217 (latest version).
- **Failure Mode Effects and Criticality Analysis (FMECA)** shall be carried out as per MIL-STD-1629 for functional failures to identify the single point failures and critical failure points. A list of the single point failures and critical failure points and its failure effects shall be provided.



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## 6.3 Parts, Materials and Process control

### 6.3.1 Component Selection / Quality

#### 6.3.1.1 Electronic / Electro-Optical Components

- The electronic components selected shall be of Class 883B for the Engineering Model and Class 'S'/QMLV for the flight Model. Any deviation shall be mutually agreed upon.
- All electro-optic components shall be screened and qualified as per MIL-STD-883B test methods for space use.
- Any other non-standard parts shall be screened and qualified as per MIL883B test methods for space use. List of such parts shall be provided.
- Bill of Materials (components, mechanical parts) shall be provided.

#### 6.3.1.2 Radiation Tolerance

The radiation tolerance of the individual optical and electronic components used, in terms of total dosage and single event upsets shall be

TID : >= 50K rads (Si)

Single event upset : >= 40 Mev-cm$^2$/mg

Single event latches up: >= 80 Mev-cm$^2$/mg

Any deviation from the above specification shall be indicated and mutually agreed upon.

### 6.3.2 Materials

All materials like adhesives, environmental protective coating and other consumables used in the fabrication of 3D LIDAR shall have flight heritage meeting out gassing specification for space use TML<1% CVCM <0.1%. The Vendor shall provide a Declared Materials List.

## 6.4 Test and Evaluation Methods and Procedures

The Vendor shall submit a detailed test and evaluation plan giving the test specifications & their tolerances and test procedures, acceptance and retest criteria, test facilities and instruments proposed to be used during qualification and acceptance tests. The Vendor shall also provide the list of parameters being tested during each and every test stage. Also, the detailed test matrix for each model shall be submitted. The demonstration plan of each parameter (table 5.1) to its full range shall be provided by Vendor. LEOS reserves the right to participate during demonstration.

The test procedures shall contain the following:



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- All activities description in steps, right from the start to the end of the test including handling, inspection, pre and post functional tests, along with the time schedule.
- Description of the test procedures, test facility, environmental conditions, calibration and operational details.
- Format of test results required during testing, giving specified values and tolerance.
- Failure criteria, test termination, re-test and start of test sequence and damage limits.
- Handling and Safety precautions.
- Details of the instruments including their calibration history used for testing 3D LIDAR.
- List of equipment needed for functional tests and full performance test.
- Details of the Test Bed used for full performance test in the Lab environment shall be provided.
- Details of the Test Bed used for full performance test performed during field test shall be provided.
- Details of the Stimuli and performance matrix verified used during Environmental testing shall be provided.
- Handling and Safety aspects with respect to the operator.
- Details of Protective covers for optical and alignment components.

## 6.5 Non-Conformance Control

All Non-Conformances/deviations shall be reviewed and their effects on the system as a whole shall be analyzed. The Non-Conformance along with the closeout reports and reworks shall be submitted by the Vendor to LEOS as and when they occur. All Close-outs/Corrective actions shall be with the approval of LEOS.

## 6.6 Failure Reporting and Corrective Action Mechanism

Any failure during the course of realization & testing shall be reported to LEOS. The Failure Analysis and Corrective Action along with the closeout reports and reworks shall be submitted by the Vendor to LEOS as and when they occur. All Close-outs/Corrective actions shall be with the approval of LEOS.

## 6.7 Life Test / Demonstration:

Any life limiting components if exist shall be demonstrated for useful life of 6 years either in the normal operating mode or at an accelerated mode. Details of any such tests carried out on



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similar components shall be provided. Any theoretical analysis carried out on the life aspects of the equipment shall also be provided. Any deviation shall be mutually agreed upon.

List of Life limiting components shall be listed and provided to LEOS.

# 7 QUALIFICATION PROGRAMME

The qualification programme is applicable to new configuration or new designs. In case, the proposed 3D LIDAR has already undergone a qualification programme, qualification by similarity is acceptable to save time and cost. Only new configurations and designs shall be subjected to full qualification sequence. The Vendor shall provide the history of previous qualification programmes and tests.

## 7.1 Qualification / Acceptance Tests

The Engineering and Flight models shall be subjected to the following tests as per the test matrix given in Table-7.1 after having passed all the screening tests at the component / subassembly levels. The parameters to be monitored and measured are as per the table 7.2. The Environmental tests are as detailed below:

**Table 7.1 Test Matrix**

| TEST | Engineering Model | Flight Model |
|---|---|---|
| Functional test | ✓ | ✓ |
| EMI/EMC | ✓ | ✓ |
| Sine Vibration# | ✓ | ✓ |
| Random Vibration# | ✓ | ✓ |
| Thermal Vacuum Cycling$ | ✓ | ✓ |
| Final Bench Test @ ambient | ✓ | ✓ |
| ESD Test | ✓ | X |
| Mechanical Shock test | ✓ | X |

**Alignment reading shall be recorded Pre & Post thermal vacuum test and pre& post vibration test.**

**$:** As per Fig.7.1

**#:** Levels TBD



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**Table 7.2: Test Matrix (Parameter Measurements during Test & Evaluation)**

**List of parameters are indicative only.**

| Test Parameters | Initial Functional test at lab | EMI/EMC | Pre &Post Vibration at Lab | Thermal Vacuum Cycling | Final performance test at lab |
|---|---|---|---|---|---|
| 1. Electrical Isolation check | √ | √ | √ | √ | √ |
| 2. Input Current at different Bus Voltages | √ | √ | √ | √ | √ |
| 3. Various Health Telemetry | √ | √ | √ | √ | √ |
| 4. Laser source Power | √ | √ | √ | √ | √ |
| 5. 6DOF Data (Target with selectable translation and orientation) | √ | √ | √ | √ | √ |
| 6. 6DOF Data (Mounting Target on a Motion Simulator) | √ | X | √ | X | √ |
| 7. Any Other parameter available from 3D LIDAR | √ | √ | √ | √ | √ |

### 7.1.1 EMI / EMC

The unit shall meet the EMI/EMC standard as per MIL-STD-461C & MIL-STD- 462D.

### 7.1.2 ESD:

The equipment / component susceptibility to ESD shall be demonstrated using a standardized ESD susceptibility test as specified in DOD-1686/DOD-HDBK-263 and MIL-STD 883 method 3015.The sensitivity of the equipment shall also be classified as per the above standards. Test details & levels shall be mutually agreed upon.



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### 7.1.3 Thermal Vacuum Temperature Cycles

The 3D LIDAR unit shall be subjected to temperature cycles with a rate of change of $2.5^0$C per minute (Refer Fig.7.1) in vacuum of at least $10^{-6}$Torr. The 3D LIDAR unit shall be cycled for temperature levels as per mutually agreed upon. Performance of the 3D LIDAR shall be evaluated at various stages of cycling as shown in profile#1 fig. 7.1.

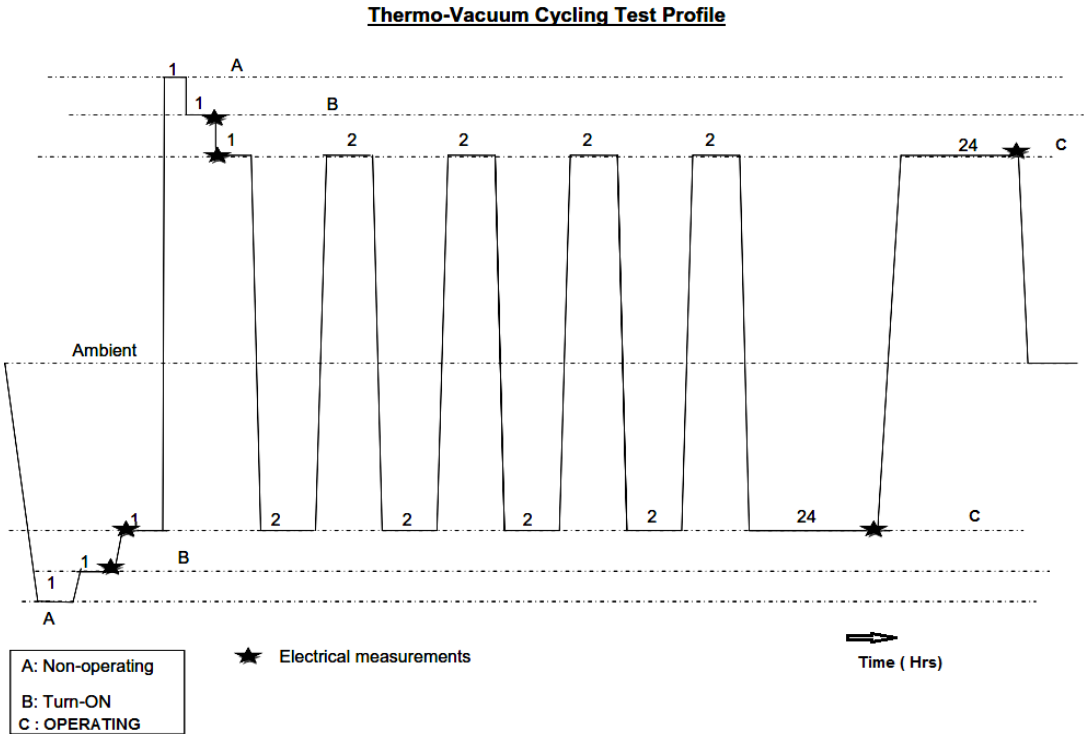


**Fig 7.1 THERMAL VACUUM CYCLING PROFILE**

### 7.1.4 Sine Vibration

3D LIDAR shall undergo passive vibration test. The vibration testing shall involve frequency swept vibration levels, mechanically induced from 5 Hz to 100 Hz at sweep rates 4octaves/minute for Flight model along all the 3 axes. The details of typical levels are mentioned below or as mutually agreed upon.



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**Axis: Normal to Mounting Plane**

| Frequency (Hz) | Amplitude | |
|---|---|---|
| | Qualification Level | Acceptance Level |
| 5 – 20 | 12.4 mm (0 – P) | 8.3 mm (0 – P) |
| 20 – 70 | 20 g | 13.3 g |
| 70 – 100 | 15 g | 10 g |
| Sweep Rate | 2 Octave/min | 4 Octave/min |

**Axis: Parallel to Mounting Plane**

| Frequency (Hz) | Amplitude | |
|---|---|---|
| | Qualification Level | Acceptance Level |
| 5 – 18 | 11.5 mm (0 – P) | 7.7 mm (0 – P) |
| 18 – 70 | 15 g | 10 g |
| 70 – 100 | 8 g | 5.3 g |
| Sweep Rate | 2 Octave/min | 4 Octave/min |

### 7.1.5 Random Vibration

3D LIDAR shall be subjected to random vibration over frequencies of 20-2000 Hz. The levels specified are generic and hence these can be reviewed if there is any concern. The details of typical levels are mentioned below and the levels specified are generic. The detailed test profile for the dynamic tests shall be submitted by the Vendor for approval by LEOS.



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**4kg < Mass ≤ 10kg**

**Axis: Normal to Mounting Plane**

| Frequency (Hz) | PSD ($g^2$/Hz) | |
|---|---|---|
| | Qualification Level | Acceptance Level |
| 20 – 100 | + 3 dB/Octave | + 3 dB/Octave |
| 100 – 700 | 0.22 | 0.10 |
| 700 – 2000 | - 6 dB/Octave | - 6 dB/Octave |
| Overall RMS | 15.6 g | 10.4 g |
| Duration | 120 s | 60 s |

**Mass > 10kg**

**Axis: Normal to Mounting Plane**

| Frequency (Hz) | PSD ($g^2$/Hz) | |
|---|---|---|
| | Qualification Level | Acceptance Level |
| 20 – 100 | + 3 dB/Octave | + 3 dB/Octave |
| 100 – 700 | 0.10 | 0.044 |
| 700 – 2000 | - 3 dB/Octave | - 3 dB/Octave |
| Overall RMS | 11.8 g | 7.8 g |
| Duration | 120 s | 60 s |

**Axis: Parallel to Mounting Plane**

| Frequency (Hz) | PSD ($g^2$/Hz) | |
|---|---|---|
| | Qualification Level | Acceptance Level |
| 20 – 100 | + 3 dB/Octave | + 3 dB/Octave |
| 100 – 700 | 0.10 | 0.044 |
| 700 – 2000 | - 3 dB/Octave | - 3 dB/Octave |
| Overall RMS | 11.8 g | 7.8 g |
| Duration | 120 s | 60 s |



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### 7.1.6 Mechanical Shock:

Two shocks per axis are recommended. The shock tests need not be carried out on the flight model. Instead it may be carried out on the qualification model. The levels specified are generic and hence these can be reviewed if there is any concern and mutually agreed upon.

**Axis: Normal to Mounting Plane**

| Frequency (Hz) | Qualification SRS |
|---|---|
| 100 – 600 | 15 dB/Octave |
| 600 – 5000 | 1000 g |
| No. of Pulses | 2 |

**Axis: Parallel to Mounting Plane**

| Frequency (Hz) | Qualification SRS |
|---|---|
| 100 – 600 | 15 dB/Octave |
| 600 – 5000 | 1000 g |
| No. of Pulses | 2 |



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### 7.1.7 Certificates

The Vendor shall provide the following certificates:

- Process Qualification Certificate.
- Parts Compliance Certificate.
- Calibration Certificates of the test systems/equipment used for testing the unit.
- Special Parts/ In-house screened and Materials Quality Control Certificate.
- 3D LIDAR Specification Conformance Certificate.



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# 8 QUALITY ASSURANCE PROVISIONS

## 8.1 Quality Assurance Provisions

3D LIDAR shall meet all quality assurance and reliability requirements. The environmental conditions and test matrices are given in Table 7.1.

The Vendor shall ensure flight worthiness of the supplied items through adequate test, qualification and verification in accordance with reliability and quality assurance plan compliance certificates, process qualification reports and incoming parts and material quality control certificates shall be supplied.

The Vendor shall be responsible for 3D LIDAR Compliance with all the requirements detailed under specifications accomplished by the following methods applicable in each case.

1. Analysis
2. Demonstration
3. Inspection
4. Test

LEOS, ISRO may witness or conduct any specified tests.

## 8.2 Reliability

Reliability of operation shall be considered of prime importance in the design and manufacturing of the 3D LIDAR. The Vendor shall carry out a reliability analysis which will include parts stress derating analysis, FMECA and FTA. The Vendor shall use MIL-HDBK-217 failure rate models for reliability assessments. FMECA shall be performed at all levels from part failures through functional failures to assure timely identification of single point failures and critical failure areas. Fault trees providing visibility of failure effects of single point failure blocks, functional blocks and summarizing of the subsystem top effects shall be carried out. Any discrepancy observed during the analysis shall be reported as a reliability discrepancy note (RDN)

### 8.2.1 Probability of Success (Ps) Requirements:

The unit shall meet the requirements of this specification for 6 years of operation with a Ps of 0.9 or better.

### 8.2.2 Life requirements:

**Mission Life:** The mission life for 3D LIDAR operation shall be 6 years.

**Vendor to specify an assured performance useful life considering ground storage in suitable environment for 2 years.**

### 8.2.3 Failure Safety / Isolation:

The failure or effects of failure to 3D LIDAR elements upon other elements shall be minimized. Every possible means shall be used to prevent the cascading of failures.



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# 9DATA ACQUISITION SYSTEM

- Ground support equipment necessary for testing & evaluation of 3D LIDAR to be provided by the Vendor. This shall include power sources, necessary test systems, software, harness, fixtures etc.
- User manual for operating above system shall be provided.

# 10 GROUND CHECKOUT SIMULATOR

Vendor shall provide Ground Checkout simulator for functional performance verification of 3D LIDAR at unit level, thermal vacuum test and spacecraft level tests. Simulator shall be mountable on 3D LIDAR unit. Operating manual and interface details shall be provided along with the Simulator.

# 11 PROJECT MANAGEMENT PLAN

The Vendor shall submit along with the proposal a detailed project management plan for carrying out the contract (in the case of the contract being awarded). The Vendor shall provide the following:

- Identification of a Project Manager, their address for contact,
- Phone number, FAX number and e-mail address.
- Weekly/Monthly progress reports.
- Anomaly reports and review board reports.

# 12 DELIVERABLES AND DOCUMENTATION

## 12.1 Deliverables before qualification tests

Following shall be the delivered

i. Preliminary Design and Detailed Design documents
ii. Part stress de-rating document.
iii. Reliability prediction/Assessment report.
iv. Screening and qualification plan for Nonstandard/ fiber optic/ Electro-optical components.
v. Project Management plan with detailed delivery schedule.



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vi. Failure Mechanism and Criticality Analysis (FMECA) documents indicating the critical failures list and single point failures list.

vii. Structure ,Thermal design and analysis.

viii. Test Procedures - The procedures prepared shall be subjected for approval by LEOS before the tests are performed.

## 12.2 Deliverables along with the 3D LIDAR – ENGINEERING MODEL

**Hardware Deliverables**

1. 3D LIDAR : Engineering Model – 01 No
2. 3D LIDAR Data acquisition system (Ground support equipment & accessories, software, harness, fixtures) : 01 No.
3. Ground Checkout Simulator- 01 No.
4. All mating connectors and accessories wherever applicable.

**Deliverable Documents**

Following shall be the delivered

5. Critical Design Document for Flight model clearance
6. Test Reports - EM - A final report indicating the functional performance of 3D LIDAR - EM before and after each qualification test and calibration data.
7. EMI/EMC Report
8. ESD Report.
9. Failure Reports - EM : Failure Reports for malfunction, deviations in operation from the specifications along with the corrective actions taken to meet the specifications for the EM model
10. Log Traveller - EM : Logbooks containing all the functional performance evaluation tests .
11. User manuals for both the EM and FM models that give details of Operating, transport, handling and storage instructions.
12. Mechanical, thermal, electrical and other interface details.
13. Safety precautions and considerations.
14. Configuration and data management plan.
15. Evaluation & Data acquisition system documents with complete design, interface and operational details with interpretation, diagnostics etc.
16. 3D LIDAR EM operating instructions with warnings, Do’s and Don’ts, Contingency Recovery Procedures etc.



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17. NCR's and close-outs - EM
18. Conformance Certificates. – EM
19. All mating connectors and accessories wherever applicable.

### 12.3 Deliverables along with the 3D LIDAR FLIGHT MODEL

**Hardware Deliverables**

i. 3D LIDAR: Flight Model – 01 No
ii. All mating connectors and accessories wherever applicable.

Following shall be the delivered along with the FM Models

i. Test Reports – FM - A final report indicating the functional performance of 3D LIDAR before and after each test and calibration data.
ii. Failure Reports –FM:-Failure Reports for malfunction, deviations in operation from the specifications along with the corrective actions taken to meet the specifications for the flight model.
iii. Log Traveller - FM : Logbooks containing all activities of qualification test results, fabrication history, assembly reports, waivers etc. – FM
iv. User manuals for FM models that give details of Operating, transport, handling and storage instructions.
v. Mechanical, thermal, electrical and other interface details.
vi. Safety precautions and considerations.
vii. Configuration and data management plan.
viii. 3D LIDAR FM operating instructions with warnings, Do's and Don'ts, Contingency Recovery Procedures etc.
ix. NCR's and close-outs - FM
x. Conformance Certificates. – FM

## 13 DELIVERY SCHEDULE

The following shall be the delivery schedule requirements for the various models.

1. Engineering model of the 3D LIDAR conforming to the requirements specified in this document along with Evaluation &Data Acquisition system and Hardware Simulator shall be delivered to LEOS within **22 months** from the date of release of purchase order.



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2. Flight model of the 3D LIDAR conforming to the requirements specified in this document shall be delivered along with hardware simulator (if opted) within **24 months** from the date of release of purchase order

## 14 DELIVERY TERMS:

a) In case of indigenous supply – FOR, LEOS/ISRO, Bengaluru

b) In case of Import supply – Ex-works as per INCO terms.

## 15 PACKING

The Supplier shall strictly conform to the packing specifications.

a) The Supplier wherever applicable shall pack and crate the Products for Air worthy packing as applicable in a manner suitable for export to a tropical humid climate, in accordance with internationally accepted export practices and in such a manner so as to protect it from damage and deterioration in transit by Road, Rail or Air for Space Qualified Products. The Supplier shall be held responsible for all damages due to improper packing.

b) The Supplier shall ensure that each box/unit of shipment is legibly and properly marked for correct identification. Failure to comply with this requirement shall make the Supplier liable for additional expenses involved.

c) The Supplier shall notify the LEOS, ISRO of the date of shipment from the port of embarkation as well as the expected date of arrival of such shipment at the designated port of arrival.

d) The Supplier shall give complete shipment information concerning the weight, size, content of each package etc.

e) Transshipment of Products shall not be permitted except with written permission of the LEOS, ISRO.

f) The following documents shall be Air-mailed/couriered to the LEOS, ISRO within 05 days from the date of shipment.

1) Air Way Bill (3 copies)
2) Invoice (3 copies)
3) Packing List (3 copies)
4) Test Certificates (3 copies)
5) Warranty / Guarantee Certificate
6) Certificate of Origin



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The Supplier shall also ensure that one copy of the packing list is enclosed in each package.

# 16 WARRANTY

a) Supplier shall provide the warranty for a period One year from the date of acceptance of 3D LIDAR Units (EM & FM) at LEOS.

b) Supplier warrants that the Products sold to the LEOS, ISRO under this Purchase Order shall be of the best quality and workmanship and shall be strictly in accordance with the specifications and particulars mentioned in the Purchase Order. The Supplier also guarantees that the said Products would continue to conform to the description and quality aforesaid during the period of guarantee and that notwithstanding the facts that the LEOS, ISRO (Inspector) may have inspected and/or approved the Products. If during the aforesaid period of Warranty, the Products be discovered not to conform to the description and quality aforesaid or have deteriorated, the LEOS, ISRO will be entitled to reject the Products such portion thereof as may be discovered not to conform to the said description and quality. On such rejection the Products will be at the Supplier's risk and all the provisions herein contained relating to rejection of Products shall apply. The Supplier if called upon to do so, shall repair / replace in consultation with the LEOS, ISRO within a reasonable period of time, on an application made thereof by the Supplier, the products or such portion thereof as is rejected by LEOS, ISRO and in such an event the period of warranty shall be 12 months from the date of acceptance at LEOS or shall be extended by the period of unavailability in case the Products are repaired.

The above warranty does not apply if the Products:

a) Have been altered, except by the Supplier,

b) Have not been installed, operated, maintained, repaired or reset in accordance with instruction supplied by the contact in writing.

c) Have been subject to abnormal physical stress, misuse, negligence or accident,

d) Are used in ultra-hazardous activities, or

e) Are defective resulting from incidents related to fortuitous are Force Majeure.



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# 17 PAYMENT TERMS AND MILESTONE PAYMENT

**Mile Stone Payment:**

a. 30 % Advance payment against bank guarantee will be held at LEOS up to all the hardware delivery and acceptance at LEOS.
b. 25 % after delivery of EM Model, Data Acquisition system and Ground check out simulator and specification performance test & acceptance at LEOS.
c. 25 % after delivery of FM-1 Model and specification performance test & acceptance at LEOS.
d. 20 % after acceptance of all Hardware and performance evaluation at LOES premises.

## IMPORT AND EXPORT LICENCE

This import is being covered under Free Importability under Para 2.01 of Chapter 2 of Export - Import Policy 2022 of Govt. of India and time to time amendments / modifications / extensions, if any. No separate Import License is required. If it is required subsequently, the LEOS, ISRO shall obtain necessary import license.

The Supplier shall obtain and maintain the Export License as may be required in the Country of Origin at its expenses.

## 17.2 MODE OF DESPATCH

Products unless otherwise agreed to by the LEOS, shall be dispatched preferably by Air on Freight to Collect basis. A copy of the Invoice and Packaging list shall invariably be kept attached to each of the packages and a copy of the same shall be sent by fax or E-mail together with a copy of Invoice Air Way Bill to LEOS. PORT OF ENTRY shall be BANGALORE-INDIA



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