Government of India
Department of Space
HUMAN SPACE FLIGHT CENTRE
Bengaluru – 560 094
Phone: +91-080-2217 2655/71

Ref No: HSFC/PUR/Eol/04

March 11, 2020

Invitation for “Expression of Interest for Development, Realisation & Qualification Testing of Crew Seat Assembly”


This Expression of interest is “for Development, Realisation & Qualification Testing of Crew Seat Assembly”. The Crew seat is the place where crew will be sitting in comfortable semi supine posture during ascent, descent phases of missions. The Crew seat is attached to the Crew module (CM) through a set of Impact attenuators to mitigate the impact loads while soft landing in sea water with parachute. The impact attenuators have to be designed to minimise the impact loads experienced by the crew during landing so that they are kept within human tolerable limits during nominal and off nominal conditions of touch down in sea.

The scope of work involves: The Scope of work for Crew Seat Assembly involves ergonomic and structural design, design realization and testing of impact attenuation system, raw material and standard items procurement, configuration, assembly and integration, testing of the overall crew seat assembly, its realization and delivery. The design and realization process shall take care of human rating and other aerospace grade quality requirements. The entire crew seat and impact attenuation system shall be dynamically tested in a drop test.

For accomplishing the above scope of work, Expression of Interest is sought from National vendors having capabilities of taking up the job and also having prior experience of realising and supplying similar hardware to other industries.

Along with “Expression of Interest” please furnish the following information also in detail:

1. Registered address with Phone, Fax, 8 Email, Web etc.
2. Company Status (Proprietary / 9 Partnership / Private Ltd. Etc.) with Name and Address of Proprietor, Partners, Board of Directors etc.
3. Associates : (a) Indian (b) Foreign
4. List of Major Customers with full address and their Contact Persons
5. Details of other Contracts, if any now in hand
6. Details of Infrastructure Facilities owned/ available
7. Capital and Turnover for last Three years with copy of latest Annual Report

Financial Capacity/Credit facilities available
Establishment/Goods Service Tax Registration Number, PAN, TIN etc.
Trade Association to which you belong to
Name and Address of the Bankers
Nature of Business
Any other information you consider relevant

“Expression of Interest” with all the above information shall reach Sr. Head, Purchase & Stores, Human Space Flight Centre, ISRO HQ Campus, New BEL Road, Anathariksha Bhavan, Bengaluru – 560 094. Quoting above Reference Number on or before March 25, 2020 at 14.00 Hours IST. HSFC reserves the right to accept or reject all or any such “Expression of Interest”; without assigning any reasons what so ever.
Eol received without signature and seal will be treated as unsolicited offer and the same will not be considered for evaluation.

Sd/-
Sr Head, Purchase & Stores
Expression of Interest for
Development, Realisation & Qualification
Testing of Crew Seat Assembly

Human Space Flight Centre
Indian Space Research Organisation
Feb 2020
1. Introduction

The Crew seat is the place where crew will be sitting in comfortable semi supine posture during ascent, descent phases of missions. The Crew seat is attached to the Crew module (CM) through a set of impact attenuators to mitigate the impact loads while soft landing in sea water with parachute. The impact attenuators have to be designed to minimise the impact loads experienced by the crew during landing so that they are kept within human tolerable limits during nominal and off nominal conditions of touch down in sea.

This report is intended to provide brief description and requirements of Crew seat and Impact attenuators for the crew module.

2. Description about the Hardware:

The brief description about the configuration of Crew Seat assembly with Impact Attenuation System is described in this section.

2.1. Crew Seat Assembly

The crew seat assembly consists of following elements, Refer figure-1

a) Crew Seat frame palette
b) Crew bucket & Liner
c) Impact Attenuators

![Attenuator Diagram]

Figure 1: Crew Seat and impact attenuation system assembly refers to crew seat frame palette, 3 Nos of Crew bucket with liner, leg pan, head rest & 08 Nos of attenuators

2.1.1 Crew Seat Frame Palette

The crew seat frame palette provides the structural rigidity to the crew seat assembly
Configuration: Integrated frame structure option is favoured over individual seat configuration since it reduces crowding inside the module and is found mass efficient. As shown in Fig 1 it has got a palette where crew buckets with liner can be mechanically fastened. The interface between seat assembly and crew module is provided by crew seat frame palette through attenuators.

![Figure 2: Crew Seat Frame Palette](image)

2.1.2 Crew Bucket & Liner

The crew bucket interfaces with the crew seat structural frame and provides support to the crew during various phases of the mission. It is proposed to realize the crew bucket with CFRP-Al honeycomb sandwich. Each bucket shall be provided with a strain hardening open cell polymeric liner to eliminate hot spots (local pressure points) for the crew under various dynamic mission conditions.

![Figure 3: Crew Seat Bucket and Liner](image)

2.1.3 Impact Attenuators

Impact attenuators offer two functions: providing interface to the frame structure and impact load attenuation/ absorption. Impact attenuators attach the crew seat assembly to crew module and attenuate the load during impact. The attenuators reduce the loads transferred to the crew during water impact so that the loads remain within human tolerable limits.

Configuration of attachment system:
The overall configuration of the Crew Seat Assembly (1 set) with Attenuator System is shown in Figure-1.

3. Scope of Work
The Scope of work for Crew Seat Assembly involves ergonomic and structural design, design realization and testing of impact attenuation system, raw material and standard items procurement, configuration, assembly and integration, testing of the overall crew seat assembly, its realization and delivery. The design and realization process shall take care of human rating and other aerospace grade quality requirements.

1. Systems engineering of the crew seat assembly
2. Configuration of the crew bucket and liner as per standard crew size (5pc to 95 pc) considering ergonomic design requirements
3. Configuration and structural design of a lightweight crew seat frame pallet
4. Configuration, structural design, kinematic design and optimization of efficient lightweight impact attenuator which meet design requirement spelt out in Section 4.3
5. Realization of all individual items as per Section 2.1
6. Preparation of detailed drawings, showing the configuration of individual elements. The drawings, sketches, 3D models etc shall clearly represent the configuration and construction details of all elements individually.
7. Preliminary design review and presentation of design and 2D CAD drawings to HSFC
8. Identify, procure and characterise all the raw materials required for individual element of crew seat
9. Realisation of necessary systems for testing evaluation of individual components.
10. Final assembly and integration of Crew seat.
11. Inspection, testing and qualification of individual elements as per test matrix vetted by design review team of HSFC, in the presence of HSFC engineers.
12. Review of test results and design modifications if any to a team constituted by HSFC
13. Critical design review: presentation of final design, tests data, 3D CAD model and 2D CAD drawings to HSFC
14. Flightworthy hardware realization specified in section 9 and acceptance testing.
15. All technical support, tooling, fixtures and test equipment and test setup required for testing of the crew seat shall be provided by the supplier.
16. All technical support and equipment required for inspection and of the crew seat shall be provided by the supplier.
17. Prepare detailed log book for assembly and integration, testing and inspection indicating identification number, acceptance details of components and process steps / methods used to integrate the elements to realise the entire crew seat assembly. Generation of process document mentioning each step of process adopted. (This shall be submitted to HSFC).
18. Packing and transportation of the unit to HSFC, Bangalore.

4. Requirements

4.1 General requirements

The following are the general system requirements for the Crew seat and Impact Attenuation (IA) system.

i. The raw materials used in realization of crew seat assembly shall be biocompatible and fire resistant. The system shall have no adverse effect in case of cabin depressurization.

ii. System and subsystems should have a shelf life of minimum 5 years.

iii. All components of the seat design shall take care of the ergonomic aspects for direct human interaction.

iv. The overall crew seat assembly mass shall be within 120kg.

4.2 Functional Requirements

1. The inside of crew seat should have a soft liner that shall be custom-made to suit the shape of the body portion (crew with IVA suit; suit will be made available by HSFC/ISRO) that is in contact with the crew seat. There shall not be any local hotspots in the crew seat and all the loads shall be uniformly distributed.

2. Seat liner design must take into account the increase in astronaut height a maximum of 30mm.

3. As far as possible modular design shall be done.

4. The impact attenuators shall be provided with pyro actuated pin pullers so that attenuators can be made active on command (pyros interfaces will be provided by HSFC/ISRO).

5. Multi point restraint system should contain a minimum of five-point support which include torso restraint, pelvic restraints and an anti-submarining restraint at minimum.

6. The Multi point restraint shall be designed to hold the crew even under an acceleration of 10 g (crew mass with IVA suit 90kg).

4.3 Design Requirements

1. The crew seat impact attenuation must be designed such that during landing event the Brinkley’s Dynamic Response Index (DRI) does not cross a value of 1.0 for a 0.5% risk of serious injury.

2. Design loads: The crew seat shall withstand maximum acceleration load of 40 g for a duration of 10ms under emergency conditions.

3. The crew seat, restraint harness and impact attenuation system design must satisfy all other specific injury criteria requirements like HIC-15, Head acceleration limits, Neck protection criteria, transient force application limits and restrained body movements and deflection as provided in NASA CxP 70024.

4. The crew seat design must prevent hyperextension and flail injury to restrained crew during any dynamic mission phases

5. The seat assembly with attenuator attachment shall have a frequency greater than 15Hz in all directions
6. The seat assembly shall be contained within 1.95mx0.9mx0.3m envelope. Space occupied by head rest, leg-pan and impact attenuation system are additional.
7. Approximate stroke available* in different directions is as-
   a. Normal to chest : 300 mm
   b. Along spine : 215 mm
   c. Across chest : 150 mm
* The stroke availability depends on the configuration being proposed. It shall be verified in consultation with Department by integrating the proposed configuration with Crew Module assembly.

4.4 Anthropometric Requirements
1. The crew seat hardware should be designed to accommodate a range of Indian male population (preferred value 5pc to 95 pc). Subsequently, the liner design shall ensure that the seat suits to the individual crew. The liner shall be removable and should be based on the anthropometric dimensions of particular crew.
2. The seat shall be designed to accommodate Indian population with maximum mass of 90kg per crew with IVA suit.

5. Qualification and Acceptance Test plan:
The party shall realize & integrate the crew seat assembly and attenuation system to carry out following test:
1. Quasi-static testing of attenuator unit.
2. Unit level dynamic drop test of attenuator
3. Static structural testing of crew seat assembly
4. Dynamic drop testing of integrated crew seat assembly.
5. Raw material characterization (materials shall be suggested by HSFC)

Note: Any minor modifications and suggestions found necessary during integration shall also be incorporated by the supplier. Tests need to be repeated in case DRI requirement is not met.

6. Facilities required
1. CAD/CAM facility with skilled man power for generating models of crew seat components and assembly required for fabrication.
2. Facility for structural test, dynamic drop test, environmental test.
3. Quality control and inspection facility with all calibrated instruments

7. Vendor Qualification Criteria
1. Core competence, previous experience and heritage in realization and supply of similar systems like impact attenuation systems, energy absorbers, dampers, ergonomic designs, composite structures etc.
2. In-house CAD/CAM facility for generating Crew seat assembly and sub-assembly models.
3. In house design team with qualified manpower in CAD/CAE softwares (such as solidworks, ADAMS, Ansys, NASTRAN etc.) (Mandatory)

4. Party should be ISO certified or equivalent.

5. Vendor should have previous experience working for Aerospace sector (preferred).

6. Experience in carrying out the qualification, acceptance and functional tests as per section 5 SI 1 to SI 5 of this document. (Mandatory)

7. Ability to procure/source raw materials and bought-out items as per international standards.

8. Partial Delivery/solution is not acceptable. (Mandatory)

9. Minimum average annual financial turnover of the bidder during last three years: 2 Cr. INR. (Mandatory)

10. In-house quality control and inspection facility as per national and international standards with all calibrated instruments. (preferred)

8. Vendor Selection Criteria

1. Initial shortlisting shall be done based on qualification criteria described in EoI. Participating vendors shall satisfy the qualification norms.

2. Final selection shall be done subject to completion of compliance matrix. Party shall provide necessary documentation against the compliance matrix queries.

3. Vendors shall provide evidence for substantiating their claim and if needed facility visit shall be carried out by HSFC engineers.

9. Hardware delivery Schedule

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Hardware Requirement for HSFC (No of Sets)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Development tests</td>
<td>1</td>
</tr>
<tr>
<td>Flight and standby</td>
<td>4</td>
</tr>
<tr>
<td><strong>Total Nos of sets required</strong></td>
<td><strong>5</strong></td>
</tr>
</tbody>
</table>

In house development of hardware shall be in addition to this

Schedule

1. Design Completion - T + 1 month
2. Development test hardware - T + 5 month
3. Testing & Qualification - T + 7 months
4. 1st flight hardware Delivery - T + 8 months
5. Remaining sets should be supplied within 1 months (T-Date of signing of contract)

The delivery schedule projected above is inclusive of all time required for the Party to get all export related clearances.

Gaganyaan is driven by schedule constraints therefore delivery schedule shall be given topmost priority.
<table>
<thead>
<tr>
<th>SI No</th>
<th>Criteria</th>
<th>Mandatory/Preferred</th>
<th>Expected Response from party</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Core competence, previous experience and heritage in realization and supply of similar systems like impact attenuation systems, energy absorbers, dampers, ergonomic designs, composite structures etc. (preferred)</td>
<td>Mandatory</td>
<td>Party has to furnish previous purchase orders &amp; project completion certificate</td>
</tr>
<tr>
<td>2</td>
<td>Any tie up with national/international agencies for technology development/acquisitions. If so details to be furnished.</td>
<td>Mandatory</td>
<td>Party has to provide in detail the areas where tie-up is planned to acquire or develop the technology and also furnish the details of the parties and type of collaboration.</td>
</tr>
<tr>
<td>3</td>
<td>ISO Certification or equivalent</td>
<td>Mandatory</td>
<td>Party shall provide the certificates.</td>
</tr>
</tbody>
</table>
| 4     | In-house CAE design capability                                            | Mandatory           | 1. Details of qualified manpower (3D modelling, design and analysis) in bidders’ payroll shall be provided  
2. Ownership of license for software tools for carrying out the analysis shall be provided |
| 5     | Partial solution is not acceptable. End to end solution to be provided. No splitting of order is permitted. | Mandatory           | Party has to be comply with department requirements                                             |
| 6     | List of the major facilities available with the party                     | Mandatory           | Details with proof of ownership / Partnership of facilities shall be provided                   |
| 7a    | Ability to procure materials as per applicable standards                   | Mandatory           | Previous purchase order details                                                                |
| 7b    | List the prospective suppliers of raw materials                           | Mandatory           | Name of the parties                                                                            |
| 8     | Qualification Testing facilities  
1.Unit and system level dynamic drop testing facility  
2.Static Structural testing facility | Mandatory           | 1. Details with proof of ownership / Partnership of facilities/ details of outsourcing shall be provided.  
2. If testing is outsourced in India, it shall be done only in NABL accredited labs or ISRO approved facility and if outsourced to foreign countries, it shall be done in the nationally recognized facilities of that country. |
<table>
<thead>
<tr>
<th></th>
<th>9a List the sub-contracting activities</th>
<th>Details of such jobs shall be provided.</th>
</tr>
</thead>
</table>
| 9b | List the sub-contractors and their accreditations | 1. Details of the Sub-contractor with name, address and their expertise area. Sub-contractor shall be an approved vendor of ISRO.  
2. If ISRO approved vendors are not available, selected vendors shall have prior experience in executing the jobs of aerospace quality and vendor shall be approved by HSFC. |
|   | 10 Annual turn-over with proof for last three years. (Minimum average annual financial turnover of the bidder during last three years: 2.0 Cr. INR.) | Mandatory | 1. Income tax return of last three years shall be provided.  
2. Audited statement of annual turnover, Balance sheet and profit & loss account of the party to whom PO is to be placed) for the last 3 years duly authenticated by a Chartered Accountant / Cost Accountant shall be provided  
3. Bidder firm should not have suffered any financial loss for more than one year during last three years.  
4. Solvency certificate of current financial year |

**Note:**

1. Ownership of the facilities shall be in the name of registered company/owner/partner with whom PO is placed  
2. Assembly & integration activities and testing facilities must be carried out in India for mandatory participation / verification by HSFC  
3. All proofs/ documents, details, information provided by party in the bid are liable to verification by HSFC
4. If the party is not able to submit the proofs required for addressing the evaluation parameters which are mentioned as mandatory in compliance matrix, the bid will not be considered for further processing.

5. If any discrepancy is found between the information provided in technical bid and verification carried out by HSFC during review/ facility visit, the bid shall not be considered for further evaluation.
<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Specification</th>
<th>Complied (Yes/No)</th>
<th>Offered Specification / Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Core competence, previous experience and heritage in realization and supply of similar systems like impact attenuation systems, energy absorbers, dampers, ergonomic designs, composite structures etc.</td>
<td></td>
<td>Party has to furnish previous purchase orders</td>
</tr>
<tr>
<td>2.</td>
<td>Any tie up with national/international agencies for technology development/acquisitions. If so details to be furnished.</td>
<td></td>
<td>Party has to provide in detail the areas where tie-up is planned to acquire or develop the technology and also furnish the details of the parties and type of collaboration.</td>
</tr>
<tr>
<td>3.</td>
<td>ISO Certification or equivalent</td>
<td></td>
<td>Party shall provide the certificates.</td>
</tr>
</tbody>
</table>
| 4.    | In-house CAD/CAM facility                                                      |                   | 1. Details of qualified manpower (3D modelling, design and analysis) in bidders’ payroll shall be provided  
2. Ownership of license for software tools for carrying out the analysis shall be provided  |
<p>| 5.    | Partial solution is not acceptable. End to end solution to be provided.        |                   | Party has to be comply with department requirements                                                |
| 6.    | List of the major facilities available with the party                          |                   | Details with proof of ownership / Partnership of facilities shall be provided.                    |
| 7.    | Ability to procure materials as per applicable standards                       |                   | Previous purchase order details                                                                  |
| 8.    | List the prospective suppliers of raw materials                                |                   | Name of the parties                                                                               |
| 9.    | Qualification Testing facilities                                               |                   | 1. Details with proof of ownership / Partnership of facilities/ details of                          |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Unit and system level dynamic drop testing facility</td>
<td>outsourcing shall be provided.</td>
</tr>
<tr>
<td>2.</td>
<td>Static Structural testing facility</td>
<td>2. If testing is outsourced in India, it shall be done only in NABL accredited labs or ISRO approved facility and if outsourced to foreign countries, it shall be done in the nationally recognized facilities of that country.</td>
</tr>
<tr>
<td>10.</td>
<td>List the sub-contracting activities</td>
<td>Details of such jobs shall be provided.</td>
</tr>
</tbody>
</table>
| 11. | List the sub-contractors and their accreditations | 1. Details of the Sub-contractor with name, address and their expertise area. Sub-contractor shall be an approved vendor of ISRO.  
2. If ISRO approved vendors are not available, selected vendors shall have prior experience in executing the jobs of aerospace quality and vendor shall be approved by HSFC. |
| 12. | In-house assembly and integration facility | 1. Details with proof of ownership / Partnership of facilities shall be provided. |
| 13. | Ability to procure materials as per international standards | Previous purchase order details |
| 14. | List the prospective suppliers of raw materials | Name of the parties |
| 15. | In-House Qualification Testing facilities (Environmental test facilities) | 1. Details with proof of ownership / Partnership of facilities/ details of outsourcing shall be provided.  
2. If testing is outsourced in India, it shall be done only in NABL accredited labs or ISRO approved facility and if outsourced to foreign countries, it shall be done in the nationally recognized facilities of that country. |
| 16. | Delivery Schedule (Staggered delivery-first off hardware within 7-8) | Party has to assess its capability based on the above requirements and give a |
| 17. | Annual turn-over with proof for last three years. (Minimum average annual financial turnover of the bidder during last three years: 2.0 Cr. INR.) | 1. Income tax return of last three years shall be provided.  
2. Audited statement of annual turnover, Balance sheet and profit & loss account of the party to whom PO is to be placed) for the last 3 years duly authenticated by a Chartered Accountant / Cost Accountant shall be provided  
3. Bidder firm should not have suffered any financial loss for more than one year during last three years.  
4. Solvency certificate of current financial year |