Request For Proposal
for

Design of QUAD vertical vibration system & magnesium expander

September 2014

Space Environment Test Team
Korea Aerospace Research Institute

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IMPORTANT

1. This RFP should be kept in confidentiality and should neither be copied nor distributed to the third parties.

2. The questions and opinions on this RFP can be asked or suggested to Korea Aerospace Research Institute before submission of the proposal.

3. This RFP should be returned to Korea Aerospace Research Institute with bidder's proposal.

4. This RFP shall be legal bind after the contract is awarded unless the bidder explicitly expresses the differences from the RFP in the compliance sheet.

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I. OVERVIEW

1. Overview of the project

1.1 Korea Aerospace Research Institute (hereinafter referred to as “KARI”) is located at Daeduk Research Complex, 140 km south of Seoul.

1.2 KARI has a satellite assembly, integration and test center (hereinafter referred to as “AITC”) for joint use by corporations and research institutes for the purpose of the effective development of domestic satellites. And basic facilities and equipment for satellite assembly and test have been supplied, installed and used.

1.3 The purposes of this project are ;

- 1.3.1 To design the overall vertical shaker system of 4 shakers to expand load capacity with use of existing shakers and bearing system and predict the system response
- 1.3.2 To design the head expander(H/E) of magnesium and produce the detailed drawings for manufacturing
- 1.3.3 To design the seismic mass(reaction mass) and produce the detailed drawings for fabrication
- 1.3.4 To design the bearing installation and alignment device and produce the detailed drawings for manufacturing
- 1.3.5 To design the static compensation system(load support system) and produce the detailed drawings for manufacturing
- 1.3.6 To design the interface structure between H/E and shakers and produce the detailed drawings for manufacturing
- 1.3.7 To design the pneumatic control cabinet and supply the diagram with part list of pneumatic control cabinet
- 1.3.8 To perform the technical supports at KARI site during the manufacturing the vibration shaker system

1.4 The supplier should submit the agenda of the new vibration shaker system in KARI.

1.5 All the descriptions in this RFP are <u>minimum requirements</u> and the supplier can suggest the better one to improve the overall performance and cost. But in this case, the proposal should clearly indicate the improvements from KARI’s

requirements.

2. Procedures of the project

2.1 The project shall be proceeded with the parts as follows:

1) Overall system design – Head expander and related shaker interface design

- Head expander dimension: 3.25 m x 3.25 m (can have chopped angles)
- Head expander material : Magnesium
- Mass of the expander: less than 2600kg
- Head expander top grid M12 class 12.9 class insert (with grid 100 x 100 mm)
- Frequency of the vertical mode of the system: higher than 170Hz
  at bare table condition
- Maximum overturning moment: 200kNm
  with the use of 16 Team 410-XAP pad bearings or 412 type bearings
- Frequency of the suspension of the reaction mass: ≒ 3Hz
- Maximum displacement: +/- 25mm
- Excitation range: sine 5 Hz ~ 2,000Hz, Random 10Hz ~ 2,000Hz
- Rocking mode ≥ 50Hz
- Crosstalk bare table: 5 ~ 150Hz ≤10%, 150 ~ 400Hz ≤100%
- Homogeneity up to 100Hz ≤15%
- Use of 4 Shakers of LDS V984
-H/E and shaker interface (coupling element) design < 280kg(4x 70kg)

2) Detailed drawing for Manufacturing the subsystems

- Detailed drawing for magnesium head expander
- Detailed drawings for H/E and shaker interface (coupling element)
- Detailed drawings for seismic mass(reaction mass)
- Detailed drawings for hydraulic bearings and installation and alignment devices
- Detailed drawings for static compensation system
- Diagram of the pneumatic control cabinet

3) Technical supports on system manufacturing and acceptance test

2.2 The participants shall submit the detailed work schedule for article 2.1.

2.3 The format of proposal :

1) The participants shall submit 6 copies of a detailed proposal to KARI according to the format and contents satisfying the requirements stipulated

in this RFP.

2) The compliance sheet with the requirement of this RFP shall certainly be included in the proposal.
3) The participants shall make out a proposal with their own writing.
4) The language shall be English or Korean.

2.4 The proposal shall be delivered to KARI before the due date for submission.

2.5 All proposals and documents submitted shall become the property of KARI.

3. Requisites of participants

3.1 The participants shall supply information about themselves including organization, financial standing, major business, experience in manufacturing and delivery performance for five (5) years and technical support.

3.2 The participants shall also have experience of manufacturing, integration, installation and operation for the 3m x 3m (or larger) vibration system equipped with electro dynamic shakers of 4, hydraulic bearing system and magnesium head expander.

4. Scope of the contract

4.1 The proposal shall include the following;

1) Engineering work of overall system
2) Design report and specification on components
3) Detailed drawings and technical support for manufacturing components in KOREA
4) Project management(Technical supports in site) , cooperation with KARI

II. Technical Requirements

1. Total System Configuration

KARI vertical vibration system (Figure 1) is composed of three of vibrators [LDS V984] , Ø3m aluminum head expander, hydraulic bearing for overturning moments support and seismic mass.

Figure 1 Current KARI Vertical Vibration System

To increase the shaker capability and improve the accessibility to test object, new guided expander system with quad shakers shall be designed and built. The head expander should be designed with magnesium material for reducing the weight. Seismic mass should be designed to support dynamic load during the vibration test and also supply the rigid support and load path for the hydraulic bearings. Quad shakers should be used to increase the capability. Top level of H/E is designed to same level of facility floor.

Limitations for design the new vertical shaker system are two points;

- Use of existing shaker system (LDS V984)
- Use of existing hydraulic bearing (16 Team 410-XAP pad bearings)
- Can Use of hydraulic bearing (16 Team 412-XAP pad bearings)

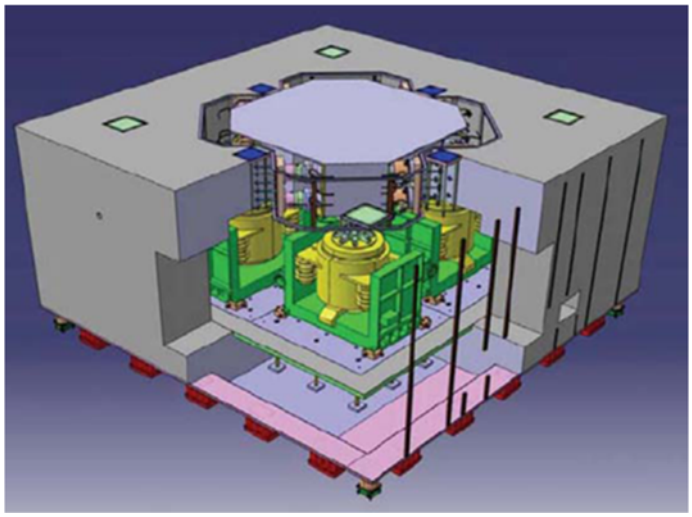

Figure 2 Concept for New Vertical Vibration System

The vertical vibration system consists of:

① **The expander** is the interface structure with the payload. It has a surface of 3.25 m x 3.25 m. For weight saving, this structure is preferably made of light material, like welded magnesium. Its design must be optimized with respect to the following parameters

- Low mass and mass inertia
- High frequency modes
- High overturning moment capacity

② **Sixteen Team hydraulic bearings** are used as they are existing and they are able to work vertically. It is fitted with M12 inserts (class 12-9) on a grid of 100 mm x 100 mm.

③ **The installation and alignment devices**. These parts, placed behind each bearing, are essential for the accurate installation and alignment of the bearings. They have a mechanism to retract the bearings away from the expander, in order to lift and remove the expander for maintenance operation. They allow an accurate re-positioning of the bearings for the expander re-installation.

④ **The reaction mass** is a big concrete mass. To get the best possible stiffness, the bearings and bearings installation and alignment devices are directly interfaced with the reaction mass. The reaction mass is suspended on spring isolators and visco dampers

⑤ **The drive bar** is the interface part between shakers and the expander. They are stiff in tension/compression, but have some flexibility in bending to protect the shakers against excessive lateral displacement

⑥ **The resting pads**. When the vibration test facility is not in use (no activity, installation of the payload,…), the expander is resting on the resting pads. When the facility is in operation (vibrations), the resting pads are lowered in order not to interfere with the displacement of the expander. The resting pads use pneumatic actuators. The position status of the resting (upper or lower position) is detected by position sensors. The information of the position of the resting pads is sent to the control and command panel.

- Static compensation system: this systems consists in several air cushions and air supply. It carries the static weight of the expander and of the payload.
- A control and command panel: located in the control room.

2. Requirements for system design

2.1 The vertical vibration system shall be able to operate all function of vibration shaker of KARI (LDS V984), PCU4 phasing unit and 16 Team 410-XAP pad bearings or 412 pad bearings.

410-10XAP (Self preload configuration)

Preload piston area = 28.27 inch^2

Maximum force (at 3000 psi) = 28.27*3000 = 84,800 lbs.

Spherical bearing angular travel: ± 1.0 Degree

410-10XA Pad Bearing

Static load capacity (with 3000 psi supply) = 100,000 lbs.

Dynamic load capacity (above 5 Hz) = 180,000 lbs.

Spherical bearing angular travel: ± 1.0 Degree

Dynamic stiffness: 70E6 lbs/inch

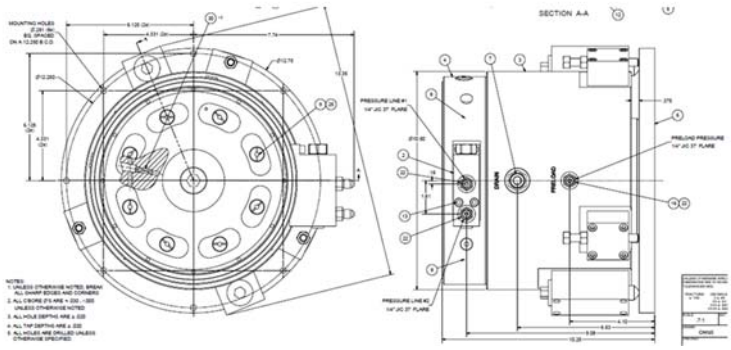

Figure 3 Detailed information on hydraulic bearings

2.2 The supplier shall submit the official records, showing that the designed vibration system shall operate with meeting the technical requirements.

2.3 Requirements for the overall system

- Head expander dimension: 3.25 m x 3.25 m (can have chopped angles)
- Head expander material : Magnesium
- Mass of the expander: less than 2600kg
- Head expander top grid M12 class 12.9 class insert
  (with grid 100 x 100 mm)
- Frequency of the vertical mode of the system: higher than 170Hz
  at bare table condition

- Maximum overturning moment: 200kNm with the use of
  16 Team 410-XAP pad bearings
- Frequency of the suspension of the reaction mass: ≒ 3Hz
- Maximum displacement: +/- 25mm
- Excitation range: sine 5 Hz ~ 2,000Hz, Random 10Hz ~ 2,000Hz
- Rocking mode ≥ 50Hz
- Crosstalk bare table: 5 ~ 150Hz ≤10%, 150 ~ 400Hz ≤100%
- Homogeneity up to 100Hz ≤15%
- Use of 4 Shakers of LDS V984
- H/E and shaker interface (coupling element) design < 280kg(4x 70kg)
- Maximum payload mass: 10 tons

3. Scope for supplied items

3.1 Overall design

- Overall drawings showing the architecture of the vibration shaker system
- Design report and Finite Element Model (FE Model shall include HE, Reaction Mass, Drive Bars, Pad Bearings according to the information provided by KARI. Shaker and Control system are not included in the FEM)
- Specification of the components (i.e. subsystems) of the system

3.2 Head expander

- A design report with qualitative predictions
- Overall drawing
- Detail drawings for fabrication
- Guidelines for going from aluminum welded expander to magnesium welded expander
- Expander LOMC(List of manufacturing and control tasks) and guidelines for magnesium
- Training for Magnesium welding in KOREA (5 days work)

3.3 Interface between H/E & Shaker (Drive bar)

Interface to minimize the horizontal reaction forces that built up at the interface with armature of shaker

- Provide a high axial stiffness(1800Hz) whereas much lower lateral stiffness
- Overall drawings of the drive bars
- Detailed drawings of the drive bars for manufacturing in KOREA

3.4 Resting pads

- Overall design including a functional specification of the resting pads, the reference of the pneumatic actuator and the mechanical detailed drawings

3.5 Hydraulic bearings and installation and alignment devices

- Detailed drawings for fabrication of installation and alignment devices
- Interface drawing of the bearings and of the installation and alignment devices
- Instructions for the alignment of the bearings

3.6 Load support system

- The deliverables for the overall design
- Including the specification of the static compensation system (mass to be

carried, stroke) and the process flow diagram,

- Detailed mechanical drawings and the reference of the air cushion.

3.7 Reaction mass

- the overall design shall include the specification of the reaction mass and the reaction loads under the spring units
- Detailed design shall include the execution drawings of the civil part of reaction mass and the detailed drawings of the mechanical parts of the reaction mass. It shall also include the specification and mechanical drawings of the device between expander in test and reaction mass in order to maintain the cleanliness of the test room.
- Reaction mass fabrication procedure
- The number and position of the spring units and visco dampers shall be defined in the overall design deliverable
- Deliver a specification for the spring units and visco dampers
- Seismic dimension are designed less than 7.5m(L) x 7.5m(D)

3.8 Control panel/electrical cabinet

- The deliverable for the overall design including comment on the logical diagram of the vibration system (shakers, amplifiers and shaker control excluded) prepared by KARI according to the maximum reuse of existing parts.

3.9 Technical Support at KARI

- For inspection of H/E after manufacturing process
- Seismic concrete pouring stage [Check the status of mechanical structure]
- Alignment of bearing interface during seismic mass fabrication
- H/E, shaker & bearing alignment period
- Shaker performance testing after installation of all components
- 5 visits(5 working day basis)

III. Format of Proposal

The proposal shall consist of 10 Work Packages (WP).

WP 1 : Bidder's Qualification Document
WP 2 : Overview and Technical Proposal
WP 3 : Warranty Proposal
WP 4 : Training Proposal
WP 5 : Work Schedule Plan
WP 6 : Acceptance Test Plan Proposal
WP 7 : Documentation
WP 8 : Price Proposal

The bidder shall present 6 copies of the proposal. A4 or letter size paper shall be used. ***The bidder is requested to strictly follow the following illustrated format (tabular form)***. This is very important to compare and evaluate different bidders' proposal. Consequently, disregard for this rule may end up with disqualification. Also, well-prepared and well-organized proposal will be highly appreciated and evaluated. The landscape orientation will be acceptable for tables. The suggested contents in each WP are minimum requirements and works for reminiscences. Ambiguous expression will act adversely to the bidder.

Note : The prices which are used in the proposal to calculate the final total and breakdown prices shall be distinguished from the other prices (e.g. optionally suggested parts by the bidder or KARI, . . .) by marking a.p. (applied price) after the prices. In other words, the sum of a.p. shall be the final total price proposed in the proposal.

(example)

Item	Price	Unit	Subtotal
Item #1	$ 5,000 a.p.	2	$ 10,000
Item #2	$ 4,000 a.p.	1	$ 4,000
Item #3	$ 2,000 a.p.	3	$ 6,000
:	:	:	:
		Total	$ 20,000

WP 1 : Bidder's Qualification Document

The followings shall be included in this WP.

(a) Bidder's last 5 years experience on the prescribed system (“Vibration Control System and Data Acquisition and Processing System”) in this "Request for Proposal" including :

(1) design

(2) manufacturing

(3) installation (specifications, performance, purchaser, supplied year, and price)

(4) training (operation and maintenance) of the facility for foreign countries

(b) Supporting program to maintain high quality of the equipment

(c) ***Bidder’s Qualification Evidence Documents*** to show the Part I Section 3.2 in this RFP. It may be generated by the ON-SITE Users(can be requested by KARI). The documents include personnel's information in charge of the facility, address, FAX number and the others from the world well known satellite testing institutes or companies which are using the facilities installed by the bidder

(d) Other information

1. Total Employees
   - Total number of Employees (Engineer / Technician)
   - Number of Employees for the directly related area
2. Plant Scale
   - Total area of space
   - Factory & Building area
3. General brochure
4. Any documents with which the bidder can show his/her financial and technical abilities (e.g. technical awards, bank balance, etc.)

WP 2 : Overview and Technical Proposal

Concise and clear expression is required. A long sentence should be broken down into several sentences. Detailed block diagrams, figures and photos are recommended for clear illustration.

The bidder should prepare tables for the check list to show the bidder's compliance with the "Request for Proposal". ***The bidder’s compliance list shall be legal bind.*** This table shall be located in the front of Overview part. The article numbers in the "Part I. Overview" and "Part II. Technical Requirements" in the RFP should be completely enumerated in the table. The table format to be

followed is as follows:

Check List for "Part I. OVERVIEW", "Part II. TECHNICAL REQUIREMENTS", “Part Ⅲ. Warranty, Maintenance and other Requirement” and “Part Ⅳ Terms and Conditions”(**COMPLIANCE LIST**)

ANR : Article Number in the Part I and Part II in the RFP

Y/N : Compliance (Yes or No)

CAP : Corresponding Article number in the bidder's Proposal to ANR

AAM : Article number of Added Material in the bidder's proposal which is not mentioned in this RFP

(Exemple)

ANR	Y/N	CAP	Remark	AAM	Remark
I-1.	yes	I-1.1	Ditto		
I-2.	yes	I-2.1.1	Ditto		
I-2.1.	yes	I-2.1.2.	Ditto		
…...	……	……			
II-1.	yes	II-1.1	Ditto		
II-2.	yes	II-2.1.2.	Ditto		
II-2.1.	yes	II-2.1.3.	Ditto		
II-2.1.1.	yes	II-2.1.5.	The specifications look old. We updated them		
N/A	N/A	N/A	N/A	II-2.1.4.	We currently developed a new method.
II-2.1.2.	yes	II-2.2.1.	Ditto		
II-2.1.3.	no	II-2.2.2.	The resolution is high above the necessity. The current technology for the system ..... ……..		
II-2.1.4.	yes	II-2.3.1.	Ditto		
II-2.1.5.	yes	II-2.3.2.	Ditto		
II-2.2.	no	II-2.3.3.	This specification is not Compatible with II-2.2.2 in the Proposal. We suggest other Approach.		
II-2.2.1.	yes	II-2.3.4.	Ditto		
II-2.2.2.	no	II-2.3.5.	Ditto		

WP 3 : Warranty Proposal

3.1. Baseline warranty (2 years)

- plan for the prompt repair

WP 4 : Training Proposal

4.1. The training program

- contents, location, period, etc.

WP 5 : Work Schedule

The work schedule shall be shown as in detail as possible in chronological way. The installation plan shall be detailed enough to figure out daily progress and include the methods and procedures for interface between the equipment and KARI S.I.T.C.(Satellite Integration and Test Center) building (air condition, electricity, treated water, compressed air, etc.). It shall also include visits of KARI AITC site.

- chronological table for work schedule

WP 6 : Acceptance Test Plan Proposal

6.1. General description

6.2. Acceptance test

- schedule
- test list and procedure

6.3. Back-up plan

For the case that the bidder cannot meet the requirements or other contractual binds after the contract is awarded, the bidder shall proposed the back-up plan.
detailed plan and schedule

WP 7 : Documentation

9.1. Documentation

- document list (contents, number of page and figure) to be delivered

WP 8 : Price Proposal

8.1.Total system price :

All the Price Proposal shall be separately submitted being sealed.

Note :

The prices which are used in the proposal to calculate the final total and break-down prices shall be distinguished from the other prices (e.g. optionally suggested parts by the bidder or KARI, . . .) by marking a.p.(applied price) after the prices. In other words, the sum of a.p. shall be the final total price proposed in the proposal.

The total price is the sum of the break down prices hereafter.

APPENDIX

1. General Terms and Conditions