

# Request For Proposal

The logo of the Korea Aerospace Research Institute (KARI) is a circular emblem. It features a globe in the center with a stylized aircraft or rocket shape overlaid. The globe is surrounded by Korean text at the top and bottom. Below the globe, there is a banner with the Latin phrase "AERIUS SPATIUM" and the year "1989".

***Shaker Power  
Amplifier System  
for V964***

August, 2010

Space Environment Test Dept.  
Korea Aerospace Research Institute

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**Request For Proposal  
For  
Shaker Power Amplifier System  
for V964**

**IMPORTANT**

1. This RFP shall be kept in confidentiality and shall neither be copied nor distributed to the third parties.
2. The questions on this RFP can be asked to the Space Test Department before submission of the proposal.
3. This RFP shall 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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## II. 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 purpose of this project is to change the power amplifier system, remote control panel, relating signal cable lines and cooling unit/Field power supply in the electro-magnetic shaker system (LDS, V964) in order to maintain the shaker performance and to reinforce the interchange with other existing vibration system(V984 & V994 system).
- 1.4 The power amplifier system should be combined with the existing shaker components of V964 (e.g. Body of shaker) without modification of existing system. If any modification needed, the supplier should supply all of components and additional facility without any request of cost.
- 1.5 Remote control panel should control the all the shaker components safely and exactly as the same function of current system.
- 1.6 Power amplifier system should accommodate the existing power modules (LDS power amplifier module, Model : LDS DPA-K ).
- 1.7 The main undertakings of the project are to perform factory and site acceptance tests, install, guarantee quality and training, etc.
- 1.8 The supply should submit the business showings of the installing the power amplifier & control system for LDS V964.
- 1.9 All the descriptions in this RFP are minimum requirements 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 five parts as follows:
- 1) Organization of power amplifier cabin, remote control panel, cooling unit, field power supply
  - 2) Factory acceptance test & safety plan verification (e.g. General power shut down case) with V964 shaker body
  - 3) Transportation
  - 4) Installation at KARI
  - 5) Final acceptance test at KARI according to supplied test procedure & previous test results
- 2.2 The participants shall submit the detailed work schedule for article 2.1. Specially, the work schedule at KARI shall be confirmed by KARI for avoiding overlap with KARI's other test schedules.
- 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 price of the system shall be broken down.
  - 4) The participants shall make out a proposal with their own writing.
  - 5) 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 according to the form in Part V of this RFP.
- 3.2 The participants shall also have experience of installation, operation, arranging, integrating and wiring the water-cooling shaker system.
- 3.3 The supply should submit the business showings of the installing the power amplifier & control system for LDS V964.

### **4. Scope of the contract**

- 4.1 The project is on turnkey base and the proposal shall include the following;
  - 1) Engineering work of the equipment
  - 2) Manufacture, assembly and turnkey delivery of the equipment
  - 3) Parts and particular instruments necessary to operate the equipment
  - 4) Installation work and acceptance test at factory & KARI site
  - 5) Project management, site operation, cooperation with KARI
  - 6) Basic principle, operation, warranty, maintenance, repair, safety and training for the equipment
  - 7) Relevant books and manuals
  - 8) Other necessary matters required for acquiring and installing the equipment (including checking of AITC building interface and construction)
  - 9) Changing of signal & power cables from power amp. system to shaker body
  - 10) Overall V964 system check for shaker body, cooling units and filed power supply

### III. Technical Requirements

#### 1. Total System Configuration

Space environmental test dept. is operating the three shaker systems of 480kN, 280kN, 80kN. One of these shaker systems, the 80kN shaker system was installed in 1994 and now is in the operation. The purpose of project is to change all power amplifier system except the shaker body in order to maintain the shaker performance and safety.

- **Vibration Test for small satellite & component**
- **Single electro-dynamic vibrator with slip table**
  - Max. sine force : 80 kN
  - Half sine bump : 267 kN
  - Displacement : 50.8 mm (pk-pk)
  - Mounting surface : 1 m
  - Armature resonance : 2200 Hz
  - Max. mass of test object : 1 ton

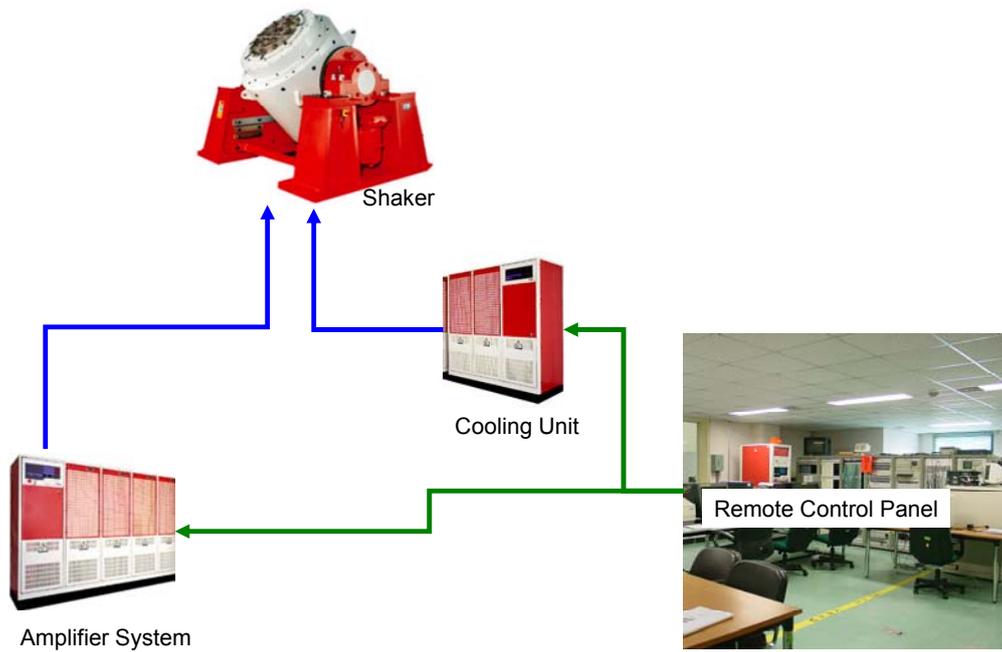


**Figure 1 Specifications of V964 (80 kN)**

The currently installed and operated shaker system is composed of shaker and power amplifier system. Power amplifier system is composed of power amplifier, cooling units & field power supply, remote controller.

- Shaker : mechanical system of moving the test objects
- Power Amplifier System
  - Power Amplifier : determination of thrust force in the shaker system, modular type system included control cabinet

- Cooling units and Field power supply : water-cooling units for shaker system
- Remote Controller



**Figure 2 Main components of shaker system**

## 2. General requirements

- 2.1 The supplied amplifier & cooling units system shall be able to operate in the previous shaker configuration (LDS V964).
- 2.2 The supplier shall have successful experience in installation of water-cooling shaker system.
- 2.3 The supplier shall have successful experience of replacement with power amplifier, control system, cooling system and field power supply, which are products of participant, for LDS V964 (80KN system).
- 2.4 The power of the amplifiers will be chosen to enable the maximum thrust to be reached in sine mode and random mode
- 2.5 The supplier should provide the all the accessories, interface components and cable lines needed to satisfy the best-performance of LDS V964 shaker system.
- 2.6 By using the power amplifier module sets supplied by KARI, supplier should verify the specification of shaker system (Refer to specification of V964). Amplifier system should accommodate some of LDS DPA-K(8KVA module type) and operated without any problems.
- 2.7 Cable set & data link package should be supplied.
- 2.8 Remote control panel and related system should be supplied.(Only optical connection type is allowed)
- 2.9 Interface cable between shaker body & power amplifier module system.
- 2.10 Supplier should check and solve the noise problem
- 2.11 Supplier should provide the KARI with the maintenance manual.
- 2.12 The amplifier system shall act as the system control and monitoring center for the vibrators, the vibrator cooling equipment, the field power supply and the

external interlocks. All of interlocks should be checked & monitored as same of previously system.

- 2.13 Protection unit accommodate the current shaker errors
- 2.14 Complete control of existing shaker system from control room using amplifier remote control
- 2.15 Supply the remote control panel system with optical modulate
- 2.16 A length of cables of 30 m  $\pm$  2 m (can be more) will be provided between the shaker(s) and the amplifier(s).
- 2.17 Built-in safety feature shuts down the amplifier in the event that communication between the amplifier and Remote Panel is interrupted and general power problem. The Emergency Stop switch remains active on both the local and remote panels during shaker operation. This Emergency Stop switch is a button on the front panel of the RCP9 unit, and a separate hardware unit to be located near the PC for the software option.

### 3. Requirements for Power Amplifier

- 3.1 Signal to Noise > 65dB.
- 3.2 Supply voltage : three-phased 380 V - 60 Hz (ground).
- 3.3 The input voltage for full output power will not exceed 5 V peak.
- 3.4 The input impedance should be 10 k $\Omega$  nominal.
- 3.5 Total harmonic distortion should be less 0.5% at full load with current LDS V964 system.
- 3.6 Input sensitivity should be 1 V rms input for 100V rms output (Compatible with all standard controllers).
- 3.7 Switching frequency is 150,000 Hz
- 3.8 Modulator range is DC to 3,000 HZ
- 3.9 Rated output voltage is 100 V rms (Sine option)
- 3.10 Continuous output current is 80 A rms(sine and random) per 8kVA module
- 3.11 Transient output current is 240A for 100ms per 8KVA module
- 3.12 Full power bandwidth is 20 ~ 3,000Hz
- 3.13 Shock impulse by switching ON-OFF :

*The maximum allowed peak value of a shock impulse, induced by switching ON-OFF the amplifiers shall be less than 0.2g measured at the empty shaker armature.*

Power loss protection :

*A protection facility has to be implemented in the amplifier(s) to activate immediately a safe shutdown when power fails.*

3.14 Maximum D.C. offset voltage : +/- 20 mV DC.

3.15 Electrical safety :

*The amplifiers, auxiliary equipment, terminal boxes and cable installation shall be compliant with the European safety regulations regarding electrical installations "European low voltage directive 73/23/EEC".*

*Verification of the correct application of the rules shall be part of the "works acceptance", for the manufactured components, and of the "final acceptance", for the electrical installation on site.*

3.16 Choice of components with low equivalent series inductance and resistance

3.17 Optical coupling of logic signals

3.18 Safety devices and interlocks :

Any malfunctions of the overall system, which requires a test run abort, shall result in a soft shut down of the test run. A soft shut down is a controlled decrease of the acceleration down to zero, whereby the accelerations at the payload interface do not exceed the specified accelerations. In particular the test run abort triggered by mains disturbances or interruption shall be controlled. The following internal and external interlocks shall be incorporated in the amplifier as a minimum.

#### Internal interlocks on

- Supply over-current and excessive ripple
- Excessive current in individual power modules
- Adjustable limits for output current and voltage
- Monitoring of D.C supply output voltages and fuses.
- Monitoring of D.C offset of output current
- Amplifier excessive air temperature

#### External interlocks on

- Master gain switch position (Amplifier ON only possible when Master Gain on zero)

- Over-travel or over-limit detection
- Vibrator armature status
- Head Expander status
- Vibrator cooling
- External amplifier water cooling (if applicable)
- Field power supply
- Amplifier balance (amplitude/phase)
- Field coil temperature
- Armature temperature
- Oil pressure of Head Expander
- Vibrator mercury switches
- Manual abort (red push button)
- Auxiliary supplies.

### 3.19 Amplifier Local Control

The amplifier local control shall comprise the following items :

- Indicators for output voltage and current
- Illuminated push-buttons for amplifier ON/OFF, auxiliary ON/OFF
- Illuminated key switch for local/ remote control
- Adjustable trip levels for output over voltage and over current
- Re-settable alarms for output over voltage and current, supply over current, auxiliary voltages, vibrator over travel, vibrator cooling, field power supply, fuses and external trip signal
- Amplifier gain control
- Emergency stop
- Auxiliary oscillator input if applicable (BNC)

### 3.20 Amplifier – Vibrator interface

If the present amplifier-vibrator interface is a transformer configuration of identical double wound transformers with electrical tap changing on the primary windings, the transformers have to be located in one enclosure.

#### 4. Requirements for Cooling units/Filed power supply

- 4.1 Cooling units and field power supply system accommodate voltage range 380, 400, 415, 440V 50/60Hz, 480, 500, 520V 60Hz.
- 4.2 Supply input power at full level FPS(field power supply) should less than 70 kW.
- 4.3 Supply input power at economy FPS(field power supply) should less than 40 kW.
- 4.4 FPS full level setting value should be below

FPS Full Level Setting		
Nominal Load	ohms	0.363
DC Rated Output	Volts	145
DC Rated Output	Amps	400
DC Rated Output	kVA	58
Supply Input Power	kW	60.56
Supply Input kVA	kVA	63.6
Heat Rejected to Air	kW	2.55
Initial Switch on DC overload current (amps) Decaying to rated current within 5 minutes		480

- 4.5 FPS economy level setting value should be below

FPS Economy Level Setting		
Nominal Load	ohms	0.363
DC Rated Output	Volts	101.5
DC Rated Output	Amps	280
DC Rated Output	kVA	29
Supply Input Power	kW	29.85
Supply Input kVA	kVA	31.34
Heat Rejected to Air	kW	1.72

- 4.6 Degauss supply value should be below

Degauss Supply		
Nominal Load	ohms	19.1
DC Rated Output (Adjustable Volts)		0 - 145
DC Rated Output (Adjustable Amps)		0 - 7.6
DC Rated Output	kVA max	1.102
Supply Input Power	kW max	1.174
Supply Input kVA	kVA max	1.23
Heat Rejected to Air	kW max	0.072

## 5. Remote Controller

The existing control-command system has to be modified or replaced. The interfaces with the new equipment will be under the contractor's responsibility. The equipment should be installed into the existing 19" cabinets.

### 5.1 Amplifier remote control

The amplifier remote control shall interface with the KARI - SITC vibration control console, composed of LMS equipment. The remote control shall be located in the control room on the first floor, and shall have the control and monitoring of the vibrator. And the remote control shall therefore be equipped per amplifier with the control and monitoring devices as described under "Amplifier Local Control" and additionally with:

- Phase control equipment
- Transformer tap changing device if applicable
- Master gain control and input attenuator for low level testing
- Control of existing vibrator(s) switch cabinet, if applicable, including shaker cooling unit(s) and field power supply(ies).
- Additional set of voltage and current measuring converters incl. suitable signal conditioning (for additional measurement interface)
- External trips equipment.

### 5.2 Remote control configuration

The amplifier remote control shall have a control and monitoring module subdivided into:

### 5.3 Gain control unit

The gain control unit shall be able to handle. The customers vibration signal of 10 volt peak to peak, a frequency range between 5 Hz and 2500 Hz, a signal to noise ratio better than 90 dB. The output voltage level and impedance to be specified by the supplier. The unit shall therefore be equipped with:

- An insulating pre-amplifier.
- A low pass filter with a corner frequency of 2500 Hz with a roll-off of 80 dB/decade.
- A front panel mounted selector switch to bypass the filter.

#### 5.4 Vibrator performance display unit :

The vibrator performance display unit comprising front panel mounted individual analogue voltage and current measuring devices (logically grouped per vibrator, voltmeter above current meters and adequately labeled or engraved) and voltage and current measuring converters to facilitate additional measuring outputs. The unit shall be equipped with :

- Vibrators voltage indicators with scale 0-100% with respect to the RMS.
- Vibrators current indicators with scale 0-100% with respect to the RMS vibrator current.
- Vibrators voltage converters with single ended buffered output, providing an output of 50 mV/Vvibr.
- Vibrators current converters with single ended buffered output, provided with the following front panel labeled selectable outputs: 66.66 mV/Avibr, 20 mV/Avibr, 6.66 mV/Avibr and 2 mV/Avibr.
- The front panel selector must be lockable.
- All converters shall have BNC outputs both on the panel front and rear side.
- The shaker body position and shaker moving coil position information have to be reported in the control and command system.

## 6. Mechanical Interface requirements

- 6.1 The amplifier system should be installed in the previously installed site of amplifier.
- 6.2 The amplifier cabinets shall have free-standing self-supporting frames, which will rest on a flat concrete floor. Shims or adjustable feet or rollers shall be incorporated if necessary. The bottom part of the amplifier casing should be at 20 cm from the floor. In case the assembled equipment consists of more than one cabinet, the frames shall be aligned and bolted together firmly after positioning on site.
- 6.3 Enclosures :
- The amplifier cabinets shall have metal enclosures which shall meet the protection class IP-44 as described in EN 60529/ IEC529, or better, as well as the requirements specified by the “European Electromagnetic Immunity Standards” as far as applicable for this purpose.
  - Removable panel sections and doors shall have suitable (lift-out) hinges for easy removal.
  - Removable panels and doors shall be positioned in such a way that easy access to vital components is guaranteed.
  - Hinges should allow for a door opening of 100° minimum.
  - All doors in a row should open in the same direction.
- 6.4 Panel Internal Wiring and Termination :
- Equipment internal wiring shall run in metal or plastic cable conduit with removable covers.
  - Cables and wires attached to front door mounted equipment or swing-out racks shall be protected by flexible hoses to prevent damage.
  - Only stranded wire and multi-core cables are allowed.
  - Soldering of stranded wire is not allowed.
  - A wiring identification system shall be provided for all circuit with non-loosening terminal and wire markers.

## 6.5 External and Interface Cabling :

- Interface cabling between equipment and external interfaces shall enter the enclosures from the bottom for power cables and from the top for other cables.
- Cables should either enter the cabinet through properly sized compression type cable glands or clamped to a metal bar for stress relief.
- Cables between interfaces shall run in one length. Joints are not permitted.
- Spare wires of multi-core interface cables shall be put on terminals
- Cable conductors in excess of 16 mm<sup>2</sup> may directly be connected to the components concerned if convenient (e.g.. main switches).
- Power cables and cables carrying large currents should be kept separate from control cables.
- Power cables and cables carrying dangerous voltage levels shall be connected to clearly marked terminals and be separated from other terminals by separator plates and labeled covers.

## 6.6 Noise restriction :

*The acoustic noise levels inside the building during amplifier operation shall not exceed:*

- 100 dBA in the amplifier room
- 75 dBA in the control room area on the first floor
- 90 dBA in the test and hall preparation area.

## 6.7 Temperature :

*The maximum temperature of the external surfaces of the amplifiers shall be lower than 30 degrees °C.*

## 7. Auxiliary requirements

### 7.1 Building accommodation :

7.2 The amplifiers shall be installed in the machine room at basement level.

7.3 The doors on ceiling of basement (2400 x 6000 mm) provide entrance for large equipment to this room.

- 7.4 Two side doors of the machine room are available for equipments entrance, The larger one is 2300 x 2300 mm(height x width) and the smaller one is 1500 x 2000 mm(height x width)
- 7.5 Inside the machine room, the free area for maneuvering the equipment is limited by existing equipment, such as vibrator cooling units and field power supplies
- 7.6 The room has no gantry crane or other installed lifting equipment.

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## VI. Warranty, Maintenance and Other Requirements

### 1. Warranty

- The system shall be warranted for duration of 2 years from the date of definitive acceptance on the site against any operational faults. The date of acceptance is the date when the whole system is completely installed and its function is approved perfect in a written format by KARI or its representative.
- The warranty covers the replacement of faulty parts, the labor required for repair, traveling cost, and all necessary costs.
- The contractor or A/S teams in a foreign country shall submit the written plan for repair within 3 days while the contractor or A/S teams in Korea shall do it within 2 days after the reception of the notification of fault. The contractor or A/S teams in a foreign country shall completely finish the repair within 2 weeks after the reception of the notification of fault while the contractor or A/S teams in Korea shall do it within 1 week.
- To meet these requirements, the contractor shall propose a detailed plan for the prompt repair in the proposal. The detailed information (location, number of crews, resume, phone and FAX numbers, etc.) of the A/S teams (in Korea and foreign countries) shall be shown in the proposal and shall be approved by KARI.

### 2. Maintenance

#### 2.1 General Rules

All parts requiring reconditioning or maintenance must be easily accessible. Their installation and removal must be easy : i.e.

- ✓ the installation and removal shall be possible with standard tooling or provided specific handling tooling,
- ✓ visual checks must not be obstructed (lighting shall be provided if required),
- ✓ Removal must be performed in perfect safety (electric shocks, high voltage, water pressure, compressed air, etc.)

All the parts shall be visibly identified.

Unless there is a particular reason, the part used in the subassemblies shall be standard and available at the various manufacturers for a duration of 10 years.

A maintenance note shall be included in the documentation by using the friendly explanation with reference to schematic diagrams, drawings or photographs :

- 1) A maintenance schedule and guide providing detailed instructions of disassembly, adjustment and calibration of the units, with a list of the tools necessary for carrying out these operations.
- 2) A trouble shooting guide listing the main failures for the various systems and units.

## 2.2 Spare parts

The contractor shall have responsibility to provide the spare parts required to maintain the whole system for a period of 10 years. The contractor shall update the list of spare parts in the event of modifications.

The contractor shall draw up a list of mandatory spare parts (due to long lead time, redundancy, safety, etc.) and a list of optional spare parts with their failure frequency records.

In the case of optional spare parts, the contractor shall categorize the spare parts from 1st to 3rd groups depending on their frequencies of malfunction over last 10 years. The proposal shall include current purchase prices of the parts and on-site labor charge to replace them after the warranty period expires.

## 2.3 Service conditions

Maintenance services shall be provided by the contractor during the equipment lifetime at minimum expense. For 5 years after the basic and extended warranties expire, two kinds of maintenance service are requested. One is for the regular maintenance and the other is for the urgent maintenance during a test period of KARI.

For the regular maintenance, the deadline for action is 2 weeks (for A/S team in Korea, 1 week) from the reception of the notification of service. For the urgent maintenance, the deadline for action is 5 days (for A/S team in Korea, 24 hrs) from the reception of the

notification of service. To meet the deadline of the urgent maintenance service, KARI will notify the contractor of the test starting date and the period 2 weeks before the test date. According to this, the contractor shall stand by the maintenance crews at the contractor's convenient place during the test period(usually 2 weeks). The number of the urgent maintenance service requests is limited to 5 during the entire 5 year maintenance period.

The contractor shall include a plan for these requirements in the proposal. The proposal shall also include the detailed and total maintenance charges for two kind of maintenance.

The contractor has the responsibility to immediately answer the operational and maintenance questions which KARI brings in by FAX or telephone calls until the system is dismantled by KARI. General description

### 3. Acceptance

#### 3.1 General description

The main purpose of the various acceptance tests is to check that the systems and sub-systems satisfy all the requirements of the present document. Consequently, the contractor shall conduct the tests and show the fulfillment of any technical requirements of the present document through acceptance tests. To check the fulfillment of the specific requirements, KARI can ask the corresponding acceptance tests during the acceptance test period.

An acceptance shall also be conducted by the contractor before the delivery for each individual piece of equipment in order to check that it meets all its specifications.

All the acceptance procedures shall be written in English,

- Partial check of various elements by the manufacturer,
- Temporary check by the contractor,
- Definitive check by the contractor on the test site in KARI

The contractor shall provide the test procedures in English to KARI or his representative for a critical review and approval at least one month before each of the above-mentioned acceptance tests.

The final acceptance shall be approved in a written format by KARI or the personnel designated by KARI after the contractor successfully carry out the acceptance tests and KARI reconfirm them by themselves.

The contractor shall provide all the necessary works, equipment for the installation and acceptance test without any additional costs.

Model	V964 – DPA-K	
	<b>Metric</b>	<b>American</b>
Armature diameter	432 mm	17 in
Peak sine force	89.0 kN	20000 lbf
Random force rms (ISO 5344)	89.0 kN	20000 lbf
Half sine peak bump force	267 kN	60000 lbf
Armature resonance (m)	2250 Hz	2250 Hz
Useful frequency range	5-2500 Hz	5-2500 Hz
Effective mass of moving element	59 Kg	130 lb
Velocity peak sine	2.0 m/s	78.7 in/s
Acceleration sine peak	981 m/s <sup>2</sup>	100 gn
Acceleration random rms	686 m/s <sup>2</sup>	70 gn
Degauss*		
Stray magnetic field:	<1 mT	<10 gauss
Total heat dissipation		
Shaker:	12 kW	12 kW
Amplifier:	13.8 kW	13.8 kW
CUFPS:	2.8 kW	2.8 kW
LDS amplifier	DPA130/140K	DPA130/140K
Amplifier rating	130 kVA	130 kVA
Suspension cross-axial stiffness	21000 N/mm	120000 lbf/in
Suspension axial stiffness	61.3 N/mm	350 lbf/in
Displacement (continuous) pk-pk	38 mm	1.5 in
Body mass	2820 kg	6217 lb
Displacement pk-pk half sine bump	50.8 mm	2.0 in
Body suspension resonance	<2.5 Hz	<2.5 Hz
Internal load support capability	907 kg	2000 lb
Cooling air flow		
Amplifier:	3.3 m <sup>3</sup> /s	6990 ft <sup>3</sup> /m
CUFPS:	0.66 m <sup>3</sup> /s	1400 ft <sup>3</sup> /m
Heat rejected to raw water		
CUFPS:	100 kW	100 kW
Raw water flow		
CUFPS:	90 l/min	23.8 US G/min
Raw water max. inlet temperature		
CUFPS:	32°C	90°F
Raw water pressure drop		
CUFPS:	0.44 bar	6.38 lbf/in <sup>2</sup>
Compressed air supply	6.9 bar	100 lbf/in <sup>2</sup>
Total electrical requirements		
Shaker:	0.12 kVA	0.12 kVA
Amplifier:	123 kVA	123 kVA
CUFPS:	72 kVA	72 kVA
Working ambient temperature range		
Shaker:	+4.5°C to 66°C	+40°F to 150°F
Amplifier:	+5°C to 40°C	+41°F to 104°F
CUFPS:	+5°C to 40°C	+41°F to 104°F
Acoustic noise at 2m**		
Shaker:	105 dBA	105 dBA
Amplifier:	85 dBA	85 dBA
CUFPS:	68 dBA	68 dBA

#### DPA-K series power amplifier characteristics

Power range	5 - 280 kVA in 5 kVA increments
Total harmonic distortion	Typically 0.15 % when measured into resistive load
Input impedance	10K ohm nominal
Input sensitivity	1 V rms for 100 V rms output. Differential Input compatible with all standard controllers
Signal to noise ratio	>68 dB
Amplifier efficiency	>90 %
Switching frequency	150 kHz
Modulation range	dc to 10 kHz
Rated output voltage	100 V rms (sine)
Continuous output current	50 A rms (sine and random) per 5 kVA increment
Transient output current	150 A for 100 ms per 5 kVA increment
Full power bandwidth	10 Hz to 5 kHz
Module efficiency	93 %
Protection	Integral protection to prevent the MOSFET output devices working outside their specification limits
Safety	Complies with the Essential Health and Safety Requirements of the Machinery Directive 89/392 EEC and the Low Voltage Directive 73/23/EEC
EMC	EN50081-1 Emissions, EN50082-2 Immunity

## 3.2 Acceptance test

### 3.2.1 Partial check by the manufacturer

- Amplifier system shall be tested by the manufacturer and certificate before delivery with LDS shaker & water cooling system under charge of KARI persons.
- For the acceptance, the manufacturer should prepare the test procedure and relating the detailed configuration & system drawings.
- Amplifier Characteristics & Harmonic distortion to checked at factory with loading conditions.
- The acceptance material above mentioned should be supplied to KARI

### 3.2.2 Definitive test by the contractor on the test site in KARI

This test shall be conducted in two steps:

- hard configuration & connection check
- Overall performance test.

#### a) Hard configuration

Electrical continuity test on the system

Amplifier output check

#### b) Overall performance test

Scope : - verify the complete excitation and measurement system.

For the verification of the overall performance test, KARI will supply the previous test results for shaker system (V964). The supply should show that the performance of new power amplifier system better than that of previous one.

After the overall performance test, the contractor shall submit the test results in a written paper and take the Kari's approval.

## 6.0 PRELIMINARY CHECKS AND PROCEDURES

VIBRATOR SERIAL NO. 1008103/1

PRELIMINARY CHECKS		LIMIT	RESULT
6.3	Field diode polarity correct		✓
6.4	Insulation resistance to frame at 500V:		
6.4.1	Vibrator field coils.	> 10 Megohms	✓
6.4.2	Degauss coils.	> 10 Megohms	✓
6.5	Vibrator levelled.		✓
6.6	Supply voltage settings checked.		✓
6.7	Calibrate control room monitor settings. 100 Volts            1000 Amps		✓
6.8	Mercury tilt switch checked for operation.		✓
6.9	CU/FPS water and oil hoses connected to vibrator. CU/FPS filled with water and oil.		✓
6.10	CU/FPS connected to 3 phase mains supply and rotation of water and oil pumps checked.		✓
6.11	CU/FPS to Vibrator water and oil hoses flushed out, cooling system re-filled with distilled water, and oil topped up as necessary.		✓
6.12	Remaining equipment, cables, hoses and interlocks connected.		✓
6.13	Set: Oil pressure to 2500 lbf/in <sup>2</sup> .		✓
	Water pressure to 160 lbf/in <sup>2</sup> .		✓
	Water aeration level.		✓
6.14	Water flow interlocks checked.		✓
6.15	Water leak detection checked.		✓
6.16	Oil pressure interlocks checked.		✓
6.17	Raw water supply flow checked.		✓
6.18	Set and record field power supply levels:		
6.18.1	FPS current (hot) set to 480 amps.		480A
6.18.2	FPS voltage (hot): Record.		257V

PRELIMINARY CHECKS		LIMIT	RESULT
6.19	Overtemperature interlocks checked.	< 0.2g	✓
6.20	All other interlocks checked.		✓
6.21	CU/FPS time delay set to 12 mins.		✓
6.22	Adjust electronic overtravel switch position for mid-position of armature travel. Armature positional datum - top plate to armature table: 255.0mm.		✓
	PIC2 Sensor head set to mean position.		✓
6.23	Fit triaxial accelerometers to positions 1,2 and 3Z. Fit single axis accelerometers to positions 4 and 5.		✓
6.24	Record system noise level at 1Z.		0.04 g
6.25	Vibrator Overtravel switch checked for operation.		✓
6.26	Oil and Water systems checked for leaks and correct working pressures.	✓	

BARE TABLE TESTS		LIMIT	RESULT
7.1	Control at 1Z.	1260 - 1390Hz	✓
	Displacement 20mm p-p.		✓
	Acceleration level 2g (peak).		✓
	Frequency range 5 to 2500Hz.		✓
	Plot drive signal.		✓
	Plot acceleration at 1,2,3,4 & 5Z.		✓
	Check Accelerometer 1Z waveform		✓
	7.2		Armature fundamental resonance:
7.3	Set Bare table Random Test programme for running in test with 5 channel extremal control using accelerometers at 1,2,3,4 & 5Z.	VIB	✓
	Acceleration level 30g (rms).		✓
7.4	Run 10 minutes Random Endurance.		✓
7.5	Plot drive PSD at 0, 5 & 10 minutes. Plot and record voltage V rms at :		AMP
	0 minutes	37.2V	23.25V
	5 minutes	37.4V	23.25V
	10 minutes	37.3V	23.3V
	Record current A rms at :		✓
	0 minutes	422. 2A	743. 5A

	5 minutes	<i>422. 2A</i>	<i>749. 5A</i>
	10 minutes	<i>421. 7A</i>	<i>746. 5A</i>
7.6	Set programme, for Bare Table Sine System Capability Check, as stated in System Performance Data Sheet for one sweep only with 5 channel extremal control using accelerometers at 1,2,3,4 & 5Z.		✓
7.7	Plot distortion at 1Z.		✓
	Plot drive signal.		
	Plot acceleration at 1,2,3,4,5Z and 1,2,3X & Y.		✓
	Plot voltage V rms and current A rms.		✓
	Check plots against standards.		✓

**7.0 TESTING**VIBRATOR SERIAL NO. 1008103/1

LOADED RANDOM TESTS		LIMIT	<i>RESULT</i>
7.8	Body suspension and load support systems and pipework checked for leaks.		
7.9	PIC 2 Armature position controller set up.		
7.10	Fit LDS test load as stated below. (If system includes a Head Expander, this can be used in place of the test load. Mass and part No. to be recorded.)  Test load - V994 Part No.350550:- 613 Kg (1351.4 lb) including adaptor plate Part No. 380100.		
7.11	Shut down aeration.		
7.12	Set programme for Loaded Random Proving Test with 5 channel external control using accelerometers at 1,2,3,4 & 5Z.  Maximum Thrust (rms): See system performance data sheet. Record value used.  Maximum Acceleration level (rms): See system performance data sheet. Record value used.		
7.13	Plot drive PSD at 0, 5 & 10 minutes. Record voltage V rms at :  0 minutes  5 minutes  10 minutes  Record current A rms at :  0 minutes  5 minutes  10 minutes		
7.14	Remove test load.		

VIBRATOR SERIAL NO. 1008103/1

FINAL BARE TABLE SINE TESTS		LIMIT	<i>RESULT</i>
7.15	Repeat 7.1 with vibrator vertical: Control at 1Z.  Displacement 20mm p-p. Acceleration level 2g (peak). Frequency range 5 to 2500Hz. Plot drive signal.  Plot acceleration at 1,2,3,4 & 5Z. Check Accelerometer 1Z waveform		
7.16	Armature fundamental resonance:	1260 - 1390Hz	
7.17	No action.		
7.18	Measure and record:  Vibrator cooling water pressure.  Vibrator oil pressure.		
7.19	Vibrator stray field measurements at 150mm above Armature table using full field setting at operating temperature.  Position 1 - 28" PCD Position 2 - 16" PCD Position 3 - Centre Position 4 - 16" PCD Position 5 - 28" PCD	< 2.0 mT < 2.0 mT < 2.0 mT < 2.0 mT < 2.0 mT	
7.20	Project Engineering signature for Special feature design validation.		-
7.21	Check input supply voltage settings and apply label.		
END OF TESTS			

## Documentations

The complete system operating and maintenance manuals, including instructions, technical specifications, construction drawings and schematics shall be provided with the system upon delivery.

Prior to delivery the contractor shall provide complete installation requirements.

All documents shall be written in English or Korean and provided by the contractor in 3 copies and electrical file(CD form) on delivery time or at least 1 month before the final acceptance test.

## VII. Terms and Conditions

### Payment Condition

The payment condition is shown by Table 1. This can be changed by rule of KARI's purchasing office.

Table 1 Payment condition

Payment Stage	Payment Times	% of Total
Initial Payment	Within EDC + 1 month	15
Intermediate Payment	After hardware delivery is completed. <u>(LDS site acceptance test is previously completed under KARI persons)</u>	45
Final Payment	After KARI site acceptance	40

## VIII. 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 : Maintenance Proposal
- WP 5 : Training Proposal
- WP 6 : Transport - Handling - Storage Proposal
- WP 7 : Work Schedule and Installation Plan
- WP 8 : Acceptance Test Plan Proposal
- WP 9 : Documentation
- WP 10 : 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 and 3.3 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
- information on A/S team

## **WP 4 : Maintenance Proposal**

### 4.1. General description

### 4.2. Spare parts

## **WP 5 : Training Proposal**

### 5.1. The training program

- contents, location, period, etc.

## **WP 6 : Transport-Handling-Storage Proposal (baseline price)**

- plan for packaging
- list of special parts and their treatment plan
- storage plan of products for final integration
- price tables

Note : The abbreviation a.p. shall be marked after the appropriate prices in the tables.

## **WP 7 : Work Schedule and Installation Plan (baseline price)**

The work schedule and installation plan 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 and installation plan

- price tables for installation

## **WP 8 : Acceptance Test Plan Proposal**

### 8.1. General description

### 8.2. Acceptance test

- schedule
- test list and procedure

### 8.3. Back-up plan

For the case that the bidder can not 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 9 : Documentation**

### 9.1. Documentation

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

## **WP 10 : Price Proposal**

### 10.1.Total system price :

**All the Price Proposal shall be separately submitted being sealed.**

All amounts should be given in U.S. dollars only.

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.