SUPPLY, INSTALLATION, TESTING, & COMMISSIONING OF 6000 kgf ELECTRO DYNAMIC VIBRATION SHAKER SYSTEM

Version 0.3

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Tender Preamble

The Indian Institute of Astrophysics(IIA) is a premier institute devoted to research in astronomy, astrophysics and related physics. IIA is funded by the Department of Science and Technology, the Institute ranks as a premier institution devoted to research and education of astronomy and physics in the country. The main observing facilities of the Institute are located at Kodaikanal, Kavalur,Gauribidanur and Hanle. Institute is also involved in space astronomy and engaged in building space instruments/telescopes in collaboration with ISRO units. As a part of this IIA is engaged in design, development and realization of various subsystems and delivery of payloads for Indian space program. Theses space instruments and its subsystems are subjected to various environmental tests such as vibration tests, thermo vacuum tests and acoustic tests etc. as part of design validation, qualification and flight acceptance requirements. Vibration testing is one of the important environmental tests being carried out on space instruments and subsystems.

Vibration tests are being conducted using vibration shaker systems comprising electrodynamics shaker, slip-table, load bearing platform (LBP), power amplifier, field power supply, cooling units, hydraulic supply units, control system and data acquisition system and associated instrumentation elements.

The electro dynamic shaker systems used for testing space instruments and its subsystems have to meet stringent aerospace test requirements. The shaker system should be highly reliable and of high precision. The system has to function uninterruptedly, with minimum time lost in maintenance.

The essential requirements for electro dynamic shaker systems for testing space instruments and its subsystems are:

- Low Distortion
- Low Cross axial Response
- Low noise
- High over turning moment restraint
- Large Dynamic Range.
- Precise alignment between shaker and slip table.
- High pressure hydro static journal or 'T' film bearing guidance for shaker and slip-table.

- Modular design of power amplifiers for ease and quick maintenance.
- Safety interlocks considering machine and the specimen under test.

Offers are invited from the suppliers who have supplied the system, conforming with this tender specifications, which have established heritage for testing aerospace systems.

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SECTION-A

1 Specifications

(*Note: All the Parameters with numerical values should be supported with necessary test plots and results for the quoted system*)

Sl. No.	Description
1	***Specific requirements***
1.1.	**Supplier's experience** The supplier should have at least 5 years of experience in supplying electro-dynamic shakers of ≥4000 kgf (typical) force rating capacity with ~600mm (nominal) armature diameter to aerospace industries. Details like purchase order copy, date of installation etc., of such systems should be given along with the quote. The offers/quote without this information will be rejected without any further reference.
1.2.	**Heritage of the offered system** The supplier should have supplied at least one number of shaker system in the preceding 5 years with same configuration as detailed in the specifications to the aerospace industries in India. Test results and performance plots of such systems are to be provided with the technical bid. The supplied shaker system should have completed at least 12 months of satisfactory performance. The supplier should provide the details of the shaker system supplied with contract / purchase order copies, model number, year of supply and copy of installation /acceptance report along with the details of the such customers including name of the organization, end user division/group and contact details of the end user. It should be noted that this will be one of the criteria for evaluation of the quoted system for technical suitability. The offers/quote without this information will be summarily rejected.
1.3.	**Local service support** Supplier should have service centre or authorized service centre with trained service engineers in Bangalore. Service centre address, contact person details, phone/fax numbers, email should be provided along with the offer.

1.4.	**Original manufacturer** Supplier should be original manufacturer of the system. Offers from original manufacturer or their authorized representative only will be accepted. Representative should submit authorization certificate along with the offer.	
1.5.	**Certificate of origin** Certificate of origin should be supplied. Details should be provided along with the offer.	
1.6.	**Duty Cycle** The Shaker system should be rated for ONE-hour continuous operation at full rated output force.	
2.	***SHAKER***	
2.1.	Electro-dynamic Shaker and slip table on a common base with air isolation configuration.	
2.2.	Type	Air cooled
2.3.	Sine Force Rating (Peak)	≥ 6,000 kgf
2.4.	Random Force Rating (Rms)	≥ 6,000 Kgf
2.5.	Maximum Half sine bump force	≥ 12000 kgf
2.6.	Static Load capacity	≥ 550 kg
2.7.	Useful frequency range	5 to 2200 Hz or better
2.8.	**Body resonance frequency**	**< 2.5 Hz**
2.9.	Bare Table Sine Acceleration	≥ 100g (peak) with multi-point maximal control
2.10.	Bare table Random Acceleration	≥ 70 g(rms) with multi-point maximal control

2.11.	Velocity (Sine, continuous)	≥ 1.8 m/sec
2.12.	Displacement (Sine, continuous)	≥ 50 mm
2.13.	Axial stiffness	≤50 N/mm
2.14.	Cross axial Stiffness	≥2.5 kN/mm
2.15.	Rotational Stiffness	≥65 kN m/rad
2.16.	Offset Moment	≥400 Nm
2.17.	Bare table acceleration noise on armature tabletop with the rated power amplifier. (Power amplifier at 100% gain and input shorted)	0.2g
2.18.	Minimum possible test level	≤ 0.3 g peak swept sine test from 5 Hz to 2000 Hz with control channel in Broad Band RMS (BBRMS) measurement mode with 2 kHz bandwidth with power amplifier 100% gain.
2.19.	Armature Diameter	440 ±5 mm
2.20.	Armature mass	< 60 kg
2.21.	Fundamental Armature Resonance	>2000Hz
2.22.	Armature cross axis response	5 Hz – 1000 Hz : < 10%
2.23.	Armature Suspension	Armature should be supported with suitable flexures. The flexure type and configuration drawing should be provided along with technical quote.

2.24.	Armature guidance	Armature should be internally guided with suitable linear bearings. The armature and bearing guidance configuration drawing should be provided along with technical quote.
2.25.	Auto centering of armature	Auto-centering of the armature for the rated static load should be provided. This should be achieved with non-contact type optical sensing.
2.26.	Armature over travel interlock	Armature over travel should be sensed using non-contact type optical sensor/scale. Armature over travel should be interlocked with power amplifier.
2.27.	Inserts for armature table	M10 type, Replaceable stainless steel inserts
2.28.	Geared shaker rotation	a. Easy rotation of the shaker to 90^0 using **manual** rotation with gear and chain drive so as to connect to the slip table as and when required. b. Electrical cables, flexible hoses and Hydraulic hoses are to be properly guided and secured during shaker rotation.
2.29.	Shaker vertical / horizontal tilt switch	Shaker vertical / horizontal tilt switch interlocked with slip table hydraulic supply and power amplifier should be provided.
2.30.	Trunnion guidance	The shaker unit should be provided with a trunnion and guidance system with Pneumatic isolation.

2.31.	Shaker Cooling unit.	The shaker should be provided with air blower **with silencer** of suitable capacity. The acoustic noise during the cooling unit operation should not exceed 80 dBA at a distance of 1 meter. Rating and technical details of the blower and silencer should be provided along with technical quote.
2.32.	Operating Environment	a. Temperature: 15°C to 40°C b. Relative Humidity: 20% to 90%
3.	***SLIP-TABLE***	
3.1.	Type (**Combo Base Horizontal Slip Table)** **3.1.1.** Common base type: Shaker trunnion and guiding system and slip table, mounted on a common steel structure providing permanent alignment with shaker and slip table. **3.1.2.** Common base Isolation: The shaker unit along with common base should be isolated from floor by the use of air mounts of appropriate capacity with common pneumatic supply circuit. **3.1.3.** Slip plate should be supported by granite base/bearing blocks. Bearings may be of high-pressure hydrostatic journal bearings or T-film type bearings.	
3.2.	Slip plate usable dimensions(Nominal)	800 mm (L) x 800(W)
3.3.	Slip plate thickness	~50mm
3.4.	Slip plate material	Magnesium Alloy (Tool grade)
3.5.	Flatness:	< 0.1mm per meter
3.6.	Surface finish:	3-triangle finish or better (Roughness average < 1.6micron)
3.7.	Parallelism:	0.2mm per meter or better

3.8.	Overturning Moment (Supplier to provide the bearing configuration as part of technical offer)	Pitch: ≥ 45 kN-m Roll: ≥45 kN-m Yaw: ≥30 kN-m
3.9.	Number of high pressure hydrostatic journal bearings or low pressure 'T' film bearings (Supplier to provide the bearing configuration as part of technical offer)	2 numbers (Minimum)
3.10.	**Bare table resonance frequency**	**≥1000Hz (nominal)**
3.11.	Cross axis responses	5Hz – 200Hz < 10%; 200Hz – 500Hz < 15%;
3.12.	Combined useful frequency range of shaker with slip table	5 to 2000Hz.
3.13.	Displacement	≥40 mm peak to peak (bare table)
3.14.	Maximum testing payload capacity	≥500 Kg
3.15.	Accelerometer mounting provision	Provision for M5 tapped holes with 1.5D Helicoil at THREE locations viz. one at center and other two about 50mm from the right and left edge of the slip table shall be provided
3.16.	Mounting hole pattern (Drawing and insert pattern need to be approved by IIA before fabrication)	M10 sized SS inserts are provided for all tapped holes at 100mm matrix
3.17.	Driver bar	**3.17.1.** Type: Tension bolt type **3.17.2.** Material: Magnesium Alloy

3.18.	Hydraulic power supply unit	A suitable Hydraulic power supply unit with oil pressure interlock, required oil hoses and electrical cables are to be provided. Electrical Mains Supply: 3 phase, 415V AC ±5%,50 Hz
3.19.	Slip plate over travel switch	Slip plate over travel switch interlock should be interlocked with power amplifier.
3.20.	Slip plate surface temperature	Maximum stabilized slip plate temperature should not exceed $45^{O}C$ under the laboratory ambient of $25^{O}C$.
3.21.	Operating Environment	a. Temperature: 15°C to 40°C b. Relative Humidity: 20% to 90%
4.	***HEAD EXPANDER***	
4.1	Shape:	Circular
4.2	Size	800 mm Diameter
4.3	Material	Magnesium alloy (Tool grade plate)
4.4	Construction	Webbed structure and ribs throughout
4.5	Frequency range	5 to 2000 Hz
4.6	Item Mounting	M10 sized SS inserts to be provided for all tapped holes at 100mm matrix and **Matrix drawing to be approved by IIA before integration.**
5.	***POWER AMPLIFIER, DIGITAL VIBRATION CONTROLLER and ACCELEROMETERS.***	

5 a	***POWER AMPLIFIER***	
5.1.	Type:	Pulse Width Modulated (PWM) switching type, class-D amplifier (Digitally modulated power amplifier). Modular in construction Scalable architecture 7 inch Touch Screen TFT Display, 32-bit Microcontroller based control unit for operation, monitoring, and diagnostics with display of Voltage Current, Temperature, Operating Hours, Operations and Shaker Axis (H/V), and Interlocks
5.2.	Amplifier Capacity	a. Total capacity shall be suitable to the rated capacity of the shaker. b. Number of power modules required for rated capacity to be specified.
5.3.	Individual power module capacity	a. Maximum sine current rating to be specified. b. Maximum voltage rating to be specified.
5.4.	Frequency Response	Full power: 20Hz to 2000 Hz Half power (-3dB): 3 kHz
5.5.	Efficiency	≥90%
5.6.	Switching Frequency	≥ 100 kHz
5.7.	Total Harmonic Distortion (THD) when connected with shaker	With an acceleration of 1g on armature bare table top between 5 Hz to 100 Hz and with 2kHz measurement bandwidth, the THD should be ≤10%. THD shall be computed as per ISO 5344 standard.

5.8.	Amplifier output noise	≤0.05 V rms. With input shorted and maximum gain.
5.9.	Peak current handling	Approximately three times or more than the continuous sine current rating for a period of 100 ms.
5.10.	Connections provision	Heavy- duty terminal blocks for connecting vibrator armature cables.
5.11.	Cable length between amplifier and shaker	15 meters
5.12.	Line Filter (Power)	Line filter (RFI filter) to be incorporated to meet the emission levels specified by European Union (EU) directive 2004/108/CE (previously 89/336/EEC) or equivalent standard. The total system should comply with EU directive 2004/108/CE or equivalent standard.
5.13.	Signal Inputs (Nominal)	Differential input compatible with standard controller 1 vrms for 80 vrms to 100 vrms nominal (inclusive) output
5.14.	Output Voltage	Should be compatible with shaker.
5.15.	Input Impedance(Nominal)	≥ 10 kΩ
5.16.	Power amplifier acoustic noise level	≤ 80 dBA at 1 m distance.

5.17.	Power module protection for mains power failure	The power devices / modules should be protected during abrupt mains power failure during operation.
5.18.	Electrical Mains Supply	3 Phase, 415 Volts AC $\pm$ 5% 50 Hz
5.19.	Control and Protection Circuits	Microprocessor based system
5.20.	Controls to be provided:	ON/OFF controls from amplifier local and remote panels for the following: **5.20.1.** Field power supply **5.20.2.** Cooling unit **5.20.3.** Amplifier Gain
5.21.	Interlocks to be provided (Typical)	

	5.21.1. Shaker over travel **5.21.2.** Armature coil over temperature **5.21.3.** Field coil over temperature **5.21.4.** Shaker vertical/Horizontal interlock **5.21.5.** Low voltage supplies fault **5.21.6.** HT Under voltage/Over voltage **5.21.7.** Module over current / Fault **5.21.8.** Power amplifier over load **5.21.9.** Field failure **5.21.10.** Cooling unit fault **5.21.11.** Hydraulic oil pressure fault **5.21.12.** Slip Table over travel **5.21.13.** Emergency abort **5.21.14.** External trip
	Monitoring for recording purpose Scaled down outputs for recording purpose **5.21.15.** Scaled down output voltage for armature voltage **5.21.16.** Scaled down output voltage for armature current
	Displays **5.21.17.** Amplifier output voltage **5.21.18.** Amplifier output current
5.22.	**Indications (Typical)** Amplifier Interlocks and status display at local and remote panels

	5.22.1. Auxiliary power supplies ON **5.22.2.** Mains supply Low/ High voltage **5.22.3.** Low voltage supplies fault **5.22.4.** HT Under voltage/Over voltage **5.22.5.** Output over current **5.22.6.** Output over voltage **5.22.7.** Vibrator cooling fault **5.22.8.** Vibrator over travel **5.22.9.** Field failure **5.22.10.** External trip	
	Remote Control Panel(Cable length 20 Meters) **5.22.11.** Auxiliary ON/OFF control **5.22.12.** Amplifier ON/OFF control **5.22.13.** Gain control **5.22.14.** All Indications **5.22.15.** Display of output voltage **5.22.16.** Display of output current	
	5.22.17. Cooling : Self cooled (Integral instrument fans inside)	
5.23.	Event Log	Provision to log the important events such as alarms, interlock status, etc. and retrieval later for analysis. Any required hardware and software.

5.24.	Construction	Construction should be such that physical addition or removal of power modules should be easily carried out and whole amplifier system should be mounted on integrated 19" racks with wheels and jacks. Opening will be sealed to make it rodent free. The total system will comply with EU directive 2004/108/EC or equivalent standard.
5.25.	Electrical Wiring	Wiring suitable for 415 Volts AC + 10%, 50 Hz, 3 Phase
5.26.	Operating environment	a. Temperature: 15°C to 40°C b. Relative Humidity: 20% to 90%
5 b	**DIGITAL VIBRATION CONTROLLER**	
	MAKE	CRYSTAL USA, LMS like standard controllers which fulfils the heritage criteria described in section 1.2
	Analog channels	16 input channels
	Resolution	24-bit ADC, built in signal conditioner
	Software packages	*Sine* *Resonance Search Track and Dwell* *Random* *Shock* *Sine-on-Random* *Random-on-Random* *Re-calibration*
	PC	Latest PC Branded, Min. 19" TFT monitor, DVD R/W Drive, 4 GB RAM, 1 TB HDD, Operating System Windows 10,
5 c	**ACCELAROMETERS (Piezoelectric)**	

	Make	PCB
	Type	ICP type
	Nominal sensitivity	10 mV/g
	Connecting cable	10-32 type microdots-BNC connector coaxial cable with Teflon jacket, 10 m length.
6.	**FIELD POWER SUPPLY (FPS)**	
6.1.	Power Rating: Should be suitable to deliver the full rated supply.	
6.2.	Stray Magnetic field	≤ 2.5 mT at 150mm above armature table
6.3.	Field protection	The field power supply should be protected against short circuit and should be provided with freewheeling diodes.
6.4.	Control and Interlocks	Should be provided with suitable interlock to amplifier for field power ON and field failure indication.
6.5.	Electrical Mains Supply	3 Phase, 415 Volts AC ± 5% 50 Hz {Tapping on input of transformer required: 380V, 400V, 415V, 440V, 460V}
6.6.	Line Filter (Power)	Line filter (RFI filter) to be incorporated to meet the emission levels specified by European Union (EU) directive 2004/108/CE (previously 89/336/EEC) or equivalent standard. The system should comply with EU directive 2004/108/CE or equivalent standard.
6.7.	Display for:	a. Field current b. Field voltage

6.8.	Cable length between FPS and shaker	15 meters
6.9.	Cooling	Forced air cooled
6.10.	Construction	Standard 19" racks with wheels and jacks.
6.11.	Operating environment	a. Temperature: 15°C to 40°C b. Relative Humidity: 20% to 90%
7	***SPARES*** **The cost break up for the following spares should be given separately in the price offer (Part 2 of offer).** NOTE: Spares for maintenance of shakers and amplifier may be quoted separately as optional with cost breakup for each of the items. It may be noted that this optional spares will not be considered for arriving at lowest offer.	
7.1	**Shaker** 7.1.1 Shaker bearings-1set 7.1.2 Current leads-3sets 7.1.3 Over travel switch assembly-2 sets 7.1.4 Shaker seals-3sets 7.1.5 Armature auto centring PCB- 1No 7.1.6 Vacuum switch(Air blower suction sensor) -2No's 7.1.7 Armature load support bellows - 1set 7.1.8 Freewheeling diode - 1 set	

7.2	**7.2 Slip table** 7.2.1 Bearings – 1 set 7.2.2 Over travel switch assembly-1set 7.2.3 Hydraulic supply interlock switch -1No
7.3	**7.3 Power amplifier** 7.3.1 Power modules -2No's 7.3.2 Control & interlock PCB-1No **Note: One set is equal to the total quantity that is assembled in the respective system.**
8.	***Alignment and maintenance tool kit*** Tool kit comprising of the necessary tools is to be supplied for alignment and maintenance of the shaker system Detailed list of tools of the tool kit should be given.
9.	***OTHER REQUIREMENTS***

9.1 Quality of surfaces:	All equipments should have good finish with anti-corrosive protection & PU based paint only to be used.
9.2 Installation	The supplier or their representative should take full responsibility for unloading, unpacking, installation, commissioning, carrying out acceptance tests and handing over the system to IIA-CREST Hoskote, Bangalore.

	9.3 Training at IIA	Supplier should provide mandatory training on operation and routine maintenance of the system to IIA Bangalore personnel as part of installation and commissioning.
	9.4 Documentation (Two sets in English)	9.4.1 Operation manual 9.4.2 Service manual 9.4.3 Electrical wiring and mechanical schematics, dimensioned drawings, Parts list. 9.4.4 System specifications including subsystems, subsystem data sheets, interface requirements, calibration requirements and procedures. 9.4.5 Factory test results.
	9.5 Warranty and support	9.5.1 Two year comprehensive On-site Warranty from the date of Acceptance of the system. 9.5.2 Extended 3 year comprehensive on-site warranty (after completion of standard two years warranty)
	9.6 List of deliverables	List of deliverables to meet the functional requirements should be given along with the Techno commercial quote **(Part-I of the offer).**
	9.7 Utility requirements	Supplier should provide details of the utilities required for operation of the shaker system like power requirements, compressed air requirements, place requirement, etc
	9.8 Shaker system should be fully tested (As per Section-C) prior to dispatch and these test results shall be made available to IIA-CREST, Hoskote,Bangalore for perusal. IIA Bangalore may inspect and witness the pre-shipment factory tests at our discretion.	
	9.9 Acceptance tests (As per Section-D) to be carried out at IIA-CREST,Hoskote, Bangalore will be the basis for acceptance of the system.	

10	***Scope of supply***
10.1	Supply of complete system as per specifications
10.2	Handling at IIA-CREST, Hoskote
10.3	Installation at IIA-CREST, Hoskote IIA Bangalore
10.4	Electrical wiring from mains power panel to power amplifier, filed power supply, cooling unit and hydraulic connections should be taken care by the vendor. (15 metres approximately for each unit)
10.5	Spares
10.6	Alignment and maintenance tool kit
10.7	Carrying out acceptance tests at factory As per Section-C
10.8	Carrying out acceptance test at IIA-CREST, Hoskote, Bangalore as per Section-D
10.9	Training
10.10	Two sets of Documentation
10.11	The warranty certificate
10.12	Certificate of origin. Details should be provided along with the offer.

SECTION-B

2 TERMS &CONDITIONS

11.0 Offer should be submitted in two parts. **Part-I is the "Techno commercial part"** and **Part-II is the "Price part".** Both parts to be submitted simultaneously in separate sealed covers.

11.1 PART–I (Techno Commercial part)

Techno commercial part should consist of following two sections:

11.1.1 Technical

- Detailed technical specifications of the items quoted.
- Catalogues with model no, technical manuals, and related literature, test results/plots, etc.
- Foot print dimensions for installations
- Standard accessories for the quoted systems.
- Standard options for quoted systems.
- Options to meet IIA Bangalore requirement with detailed description.
- Technical compliance statement as per **annexure-5.**
- List of deliverables.
- **unpriced commercial bid to be enclosed with technical bid with all line items and terms and conditions**

11.1.2 Commercial

All the following commercial terms (other than price) should be specified in this section in the following format.

Sl No.	Description	Confirm /Specify
1.	Individual break up costs provided for Shaker, Power amplifier, Slip table, cooling units, hydraulic units, etc.	Yes/No
2.	Break-up cost of spares as per the specification Sl. No.7.	Yes/No
3.	Alignment and maintenance tool kit as per the specification Sl. No.8. (List with break up cost)	Yes/No

4.	Extended warranty **(Optional)** Extended 3 year comprehensive onsite warranty (after completion of standard 2 year warranty)	Yes/No
5.	Annual Maintenance Contract.(AMC) **(Optional)**	Yes/No
6.	Delivery period	3 to 4 months
7.	**Validity period**: Both the technical and commercial offers should be valid for a minimum period of 120 days from the due date of opening of the price bid.	Yes/No
8.	Payment terms	Conform compliance with IIA Bangalore terms
9.	Approximate system weight	To be specified

Note: Part- 1 should not contain any price details, but unpriced commercial bid to be enclosed with technical bid

11.2 PART-II (Price offer)

Price part should provided in the following format.

Sl No.	Description	Price
1.	Individual break up costs provided for Shaker, Power amplifier, Slip table, cooling units, hydraulic units, etc.	
2.	Break-up cost of critical spares as per the specification Sl. No.6.	
3.	Alignment and maintenance tool kit as per the specification Sl. No.7. (List with break up cost)	
4.	Break-up cost of optional spares as per the specification Sl. No.8.**(Optional)**	
5.	Extended warranty **(Optional)** Extended 3 year comprehensive onsite warranty (after completion of standard 2 year warranty).	
6.	Annual Maintenance Contract.(AMC) **(Optional)** Non-comprehensive AMC for 3 years after completion of standard 1 year warranty with break up for 1st year, 2nd year and 3rd year should be quoted separately.AMC should include two mandatory visits in a year as part of preventive maintenance and unlimited break down calls.	

11.2.1 Complete details as per specific requirement giving suppliers experience, heritage of the quoted system, customer list for ≥4000 kgf (typical) force rating capacity with ~600 mm (nominal) armature diameter with contact details, local service support, certificate of origin are to be provided as part of techno commercial offer (Part-1 of offer). **Offers without this information or offers with incomplete or inaccurate or false information will be rejected without any further reference.**

11.2.2 Offers from traders / resellers will not be considered.

11.2.3 Table of compliance statement (as per the format given in annexure-5) giving exact numerical values with tolerances or range of values should be supplied along with the quote without which the quote will not be considered. Merely stating, “comply” does not constitute sufficient technical data. **In case of insufficient technical data the quote will be summarily rejected without seeking any clarifications.**

11.2.4 Specified technical data should be supported by product catalogues, manuals and test plots or results.

11.2.5 Specified **options** will be exercised at the time of order and hence should be **quoted separately.**

11.2.6 **All optional items** should be quoted separately.

11.2.7 Utilities: The supplier to specify the various requirements of operation & installation of the shaker system.

11.2.7.1 Electrical Power requirements.

11.2.7.2 Civil requirements like footprint of various systems, minimum area required for entire system like field power supply etc.

11.2.7.3 Cooling system requirements

11.2.7.4 AC requirements like heat dissipation factor for each subsystem

11.2.7.5 Foundation requirement for installation, trench requirement, etc.

11.2.7.6 Floor plan with foot prints for installations.

11.2.8 Additional features if any may be indicated separately and quoted as optional.

11.2.9 Supplier shall be ready to give technical presentation/demonstrations if required by IIA.

11.2.10 Minor modifications that are necessary to meet IIA Bangalore interface requirements should be accommodated while executing the order. All the items need to be supplied to IIA-CREST, Hoskote and Installation of Shaker also need to be done at this site. The logistic facilities needed in this regard to be arranged by vendor himself.

SECTION-C

Factory Acceptance Test(FAT) Plan at factory prior to dispatch

SHAKER
BARE TABLE TESTS
1. Resonance test (Pre signature) 1g Constant control. Frequency 5 Hz to 2000 Hz at 2Oct/min. Control at center of armature. 1.1. Plot response accelerations for all three axes at locations shown in fig.1. 1.2. Plot Drive, O/P current, and O/P voltage.
2. Sine Capability test Maximum Displacement, Maximum Velocity and Maximum Acceleration of the quoted system. With frequency 5 Hz to 2000 Hz at sweep rate of 2Oct/min. Multi point maximal Control at armature top 2.1. Plot response accelerations for all three axes at locations shown in fig.1. 2.2. Plot Drive, O/P current, and O/P voltage.
3. Resonance test (Post signature) 1g Constant control. Frequency 5 Hz to 2000 Hz at 2Oct/min. Control at center of armature. 3.1. Plot response accelerations for all three axes at locations shown in fig.1. 3.2. Plot Drive, O/P current, and O/P voltage.
4. Diaphragming and Cross axis response test 5g Constant control from 5 to 2000 Hz with required slopes for Displacement and velocity, with sweep rate of 2Oct/min. Control at center of armature. 4.1. Plot response accelerations for all three axes at locations shown in fig.1. 4.2. Plot Drive, O/P current, and O/P voltage.
5. Noise measurement on armature top With amplifier Set to 100% gain and zero input signal 5.1. Measure accelerometer output at the armature top for 5 Hz to 20 kHz analysis range.

6. Low g sine test

Constant input acceleration level of 0.3g
Frequency 5 Hz to 2000 Hz at 2Oct/min.
Control at center of armature.

6.1. Plot response accelerations for all three axes at locations shown in fig.1.
6.2. Plot Drive, O/P current, and O/P voltage.

7. Random Capability test

(20-100Hz:6dB/Oct, 100-2000Hz:flat PSD to obtain the max rms acceleration of the quoted system)
Multi point maximal Control at armature top

7.1. Plot response accelerations for all three axes at locations shown in fig.1.
7.2. Plot Drive, O/P current, and O/P voltage.

8. Low g -rms random test

Flat PSD from 20 Hz to 2000 Hz 0.3grms test level.
Control at armature center.

8.1. Plot response accelerations for all three axes at locations shown in fig.1.
8.2. Plot Drive, O/P current, and O/P voltage.

9. Resonance test (Post signature)

1g Constant control.
Frequency 5 Hz to 2000 Hz at 2Oct/min.
Control at center of armature.

9.1. Plot response accelerations for all three axes at locations shown in fig.1.
9.2. Plot Drive, O/P current, and O/P voltage.

10. Wave form distortion tests

With input of 1G between 5 Hz to 100 Hz
Control at center of armature.
The THD should be ≤10% between 5Hz – 100Hz
THD computation should be carried as per ISO 5344

LOAD TESTS

11. Resonance test (Pre signature without load)

1g Constant control.
Frequency 5 Hz to 2000 Hz at 2Oct/min.
Control at center of armature.

11.1. Plot response accelerations for all three axes at locations shown in fig.1.
11.2. Plot Drive, O/P current, and O/P voltage.

12. Sine Capability test

With 2 times weight of armature(supplier should provide the mass)
Maximum Displacement , Maximum Velocity and Maximum Acceleration of the quoted system.
Multi point maximal Control on mass top as shown in fig.1.
Frequency 5 Hz to 2000 Hz at 2Oct/min.
Plot Drive, O/P current, and O/P voltage.
Check waveform distortion of accelerometer output and Amplifier output using Digital data acquisition system.
Acceleration limited to maximum force rating of shaker.

13. Random Capability test

With mass 2 times weight of armature
20-100Hz:6dB/Oct, 100-2000Hz: flat PSD for maximum random force rating of the quoted system.
Multi point maximal Control on mass top as shown in fig.1.
13.1. Plot acceleration, Drive, O/P current and O/P voltage.
13.2. Plot response accelerations for all three axes at locations shown in fig.1.

14. Endurance test

Shaker should run continuously for 1 hour with the following specification.
With mass 2 times weight of armature
Maximum Displacement, Maximum Velocity and Maximum Acceleration of the quoted system.
Multi point maximal Control on mass top
Frequency 5Hz to 2000 Hz at 1Oct/min.
14.1. Plot acceleration, Drive, O/P current and O/P voltage.

15. Resonance test (Post signature without load)

1g Constant control.
Frequency 5 Hz to 2000 Hz at 2Oct/min.
Control at center of armature
15.1. Plot response accelerations for all three axes at locations shown in fig.1.
15.2. Plot Drive, O/P current, and O/P voltage.

SLIP-TABLE TESTS

16. Resonance test (Pre signature)

1g Constant control.
Frequency 5 Hz to 2000 Hz at 2Oct/min.
Control at slip table end along shaker axis
16.1. Plot response accelerations for all three axes at locations shown in fig.2.
16.2. Plot Drive, O/P current, and O/P voltage.

17. Sine Capability test

Maximum Displacement, Maximum Velocity and Maximum Acceleration of the quoted shaker system.

With Frequency 5 Hz to 2000 Hz at 2Oct/min sweep rate.

Control at slip table end along shaker axis

17.1. Plot response accelerations for all three axes at locations shown in fig.2.

17.2. Plot Drive, O/P current and O/P voltage.

18. Cross axis response test

5g Constant control from 5 to 2000 Hz with required slopes for Displacement and velocity with sweep rate of 2Oct/min.

Control at slip table end along shaker axis.

18.1. Plot response accelerations for all three axes at locations shown in fig.2.

19. Resonance test (Post signature)

1g Constant control.

Frequency 5 Hz to 2000 Hz at 2Oct/min.

Control at slip table end along shaker axis

19.1. Plot response accelerations for all three axes at locations shown in fig.2.

19.2. Plot Drive, O/P current, and O/P voltage.

POWER AMPLIFIER

20. Noise measurement

Bare table

With amplifier Set to 100% gain and zero input signal

Measurement of output voltage and current with input shorted and amplifier set to 100% gain

21. Shaker system interlocks

Over travel limit by test

Cooling unit flow switch

Temperature switch

Field power supply

Emergency Abort switches

SECTION-D

Site Acceptance Test(SAT) Plan at IIA-CREST, Hoskote, Bangalore after installation

SHAKER
BARE TABLE TESTS
1. Resonance test (Pre signature) 1g Constant control. Frequency 5 Hz to 2000 Hz at 2Oct/min. Control at center of armature. 1.1. Plot response accelerations for all three axes at locations shown in fig.1. 1.2. Plot Drive, O/P current, and O/P voltage.
2. Sine Capability test Maximum Displacement , Maximum Velocity and Maximum Acceleration of the quoted system With frequency 5 Hz to 2000 Hz at sweep rate of 2Oct/min. Multi point maximal Control at armature top 2.1. Plot response accelerations for all three axes at locations shown in fig.1. 2.2. Plot Drive, O/P current, and O/P voltage.
3. Resonance test (Post signature) 1g Constant control. Frequency 5 Hz to 2000 Hz at 2Oct/min. Control at center of armature. 3.1. Plot response accelerations for all three axes at locations shown in fig.1. 3.2. Plot Drive, O/P current, and O/P voltage.
4. Diaphragming and Cross axis response test 5g Constant control from 5 to 2000 Hz with required slopes for Displacement and velocity, with sweep rate of 2Oct/min. Control at center of armature. 4.1. Plot response accelerations for all three axes at locations shown in fig.1. 4.2. Plot Drive, O/P current, and O/P voltage.
5. Noise measurement on armature top With amplifier Set to 100% gain and zero input signal 5.1. Measure accelerometer output at the armature top for 5 Hz to 20 kHz analysis range.

6. Low g sine test

Constant input acceleration level of 0.3g
Frequency 5 Hz to 2000 Hz at 2Oct/min.
Control at center of armature.

6.1. Plot response accelerations for all three axes at locations shown in fig.1.
6.2. Plot Drive, O/P current, and O/P voltage.

7. Random Capability test

(20-100Hz:6dB/Oct, 100-2000Hz:flat PSD to obtain the max rms acceleration of the quoted system)
Multi point maximal Control at armature top

7.1. Plot response accelerations for all three axes at locations shown in fig.1.
7.2. Plot Drive, O/P current, and O/P voltage.

8. Low g -rms random test

Flat PSD from 20 Hz to 2000 Hz 0.3grms test level.
Control at armature center.

8.1. Plot response accelerations for all three axes at locations shown in fig.1.
8.2. Plot Drive, O/P current, and O/P voltage.

9. Resonance test (Post signature)

1g Constant control.
Frequency 5 Hz to 2000 Hz at 2Oct/min.
Control at center of armature.

9.1. Plot response accelerations for all three axes at locations shown in fig.1.
9.2. Plot Drive, O/P current, and O/P voltage.

10. Wave form distortion tests

With input of 1G between 5 Hz to 100 Hz
Control at center of armature.
The THD should be ≤10% between 5Hz – 100Hz
THD computation should be carried as per ISO 5344

LOAD TESTS

11. Resonance test (Pre signature without load)

1g Constant control.
Frequency 5 Hz to 2000 Hz at 2Oct/min.
Control at center of armature.

11.1. Plot response accelerations for all three axes at locations shown in fig.1.
11.2. Plot Drive, O/P current, and O/P voltage.

12. Sine Capability test

With ≤2 times weight of armature
Maximum Displacement , Maximum Velocity and Maximum Acceleration of the quoted system
Multi point maximal Control on mass top as shown in fig.1.
Frequency 5 Hz to 2000 Hz at 2Oct/min.
Plot Drive, O/P current, and O/P voltage.
Check waveform distortion of accelerometer output and Amplifier output using Digital data acquisition system.
Acceleration limited to maximum force rating of shaker.

13. Random Capability test

With ≤2 times weight of armature
20-100Hz:6dB/Oct, 100-2000Hz: flat PSD for maximum random force rating of the quoted system.
Multi point maximal Control on mass top as shown in fig.1.
13.1. Plot acceleration, Drive, O/P current and O/P voltage.
13.2. Plot response accelerations for all three axes at locations shown in fig.1.

14. Endurance test

Shaker should run continuously for 1 hour with the following specification.
With ≤2 times weight of armature
Maximum Displacement , Maximum Velocity and Maximum Acceleration of the quoted system
Multi point maximal Control on mass top
Frequency 5Hz to 2000 Hz at 1Oct/min.
14.1. Plot acceleration, Drive, O/P current and O/P voltage.

15. Resonance test (Post signature without load)

1g Constant control.
Frequency 5 Hz to 2000 Hz at 2Oct/min.
Control at center of armature
15.1. Plot response accelerations for all three axes at locations shown in fig.1.
15.2. Plot Drive, O/P current, and O/P voltage.

SLIP-TABLE TESTS

16. Resonance test (Pre signature)

1g Constant control.
Frequency 5 Hz to 2000 Hz at 2Oct/min.
Control at slip table end along shaker axis
16.1. Plot response accelerations for all three axes at locations shown in fig.2.
16.2. Plot Drive, O/P current, and O/P voltage.

17. Sine Capability test

Maximum Displacement , Maximum Velocity and Maximum Acceleration of the quoted shaker system

With Frequency 5 Hz to 2000 Hz at 2Oct/min sweep rate.

Control at slip table end along shaker axis

17.1. Plot response accelerations for all three axes at locations shown in fig.2.

17.2. Plot Drive, O/P current and O/P voltage.

18. Cross axis response test

5g Constant control from 5 to 2000 Hz with required slopes for Displacement and velocity with sweep rate of 2Oct/min.

Control at slip table end along shaker axis.

18.1. Plot response accelerations for all three axes at locations shown in fig.2.

19. Resonance test (Post signature)

1g Constant control.

Frequency 5 Hz to 2000 Hz at 2Oct/min.

Control at slip table end along shaker axis

19.1. Plot response accelerations for all three axes at locations shown in fig.2.

19.2. Plot Drive, O/P current, and O/P voltage.

POWER AMPLIFIER

20. Noise measurement

Bare table

With amplifier Set to 100% gain and zero input signal

Measurement of output voltage and current with input shorted and amplifier set to 100% gain

21. Shaker system interlocks

Over travel limit by test

Cooling unit flow switch

Temperature switch

Field power supply

Emergency Abort switches

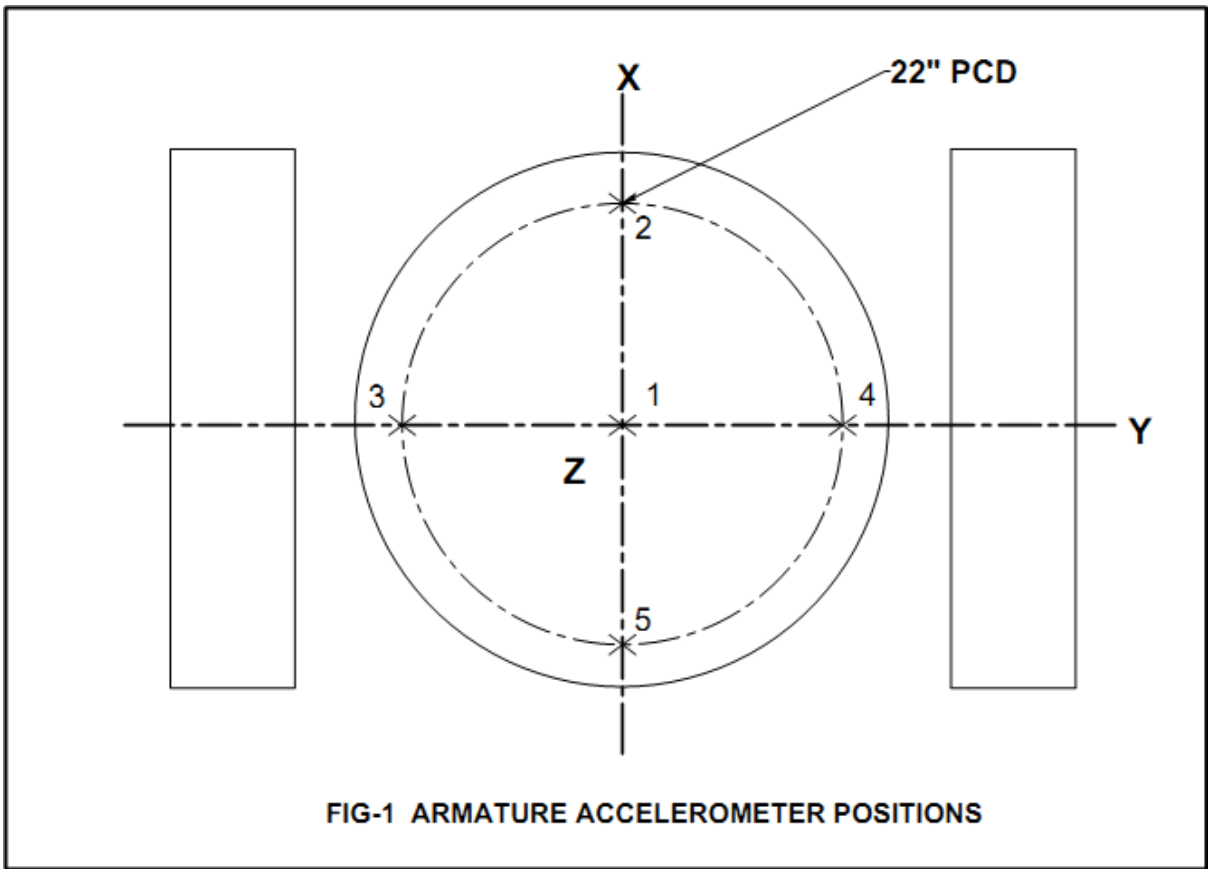

FIG-1 ARMATURE ACCELEROMETER POSITIONS

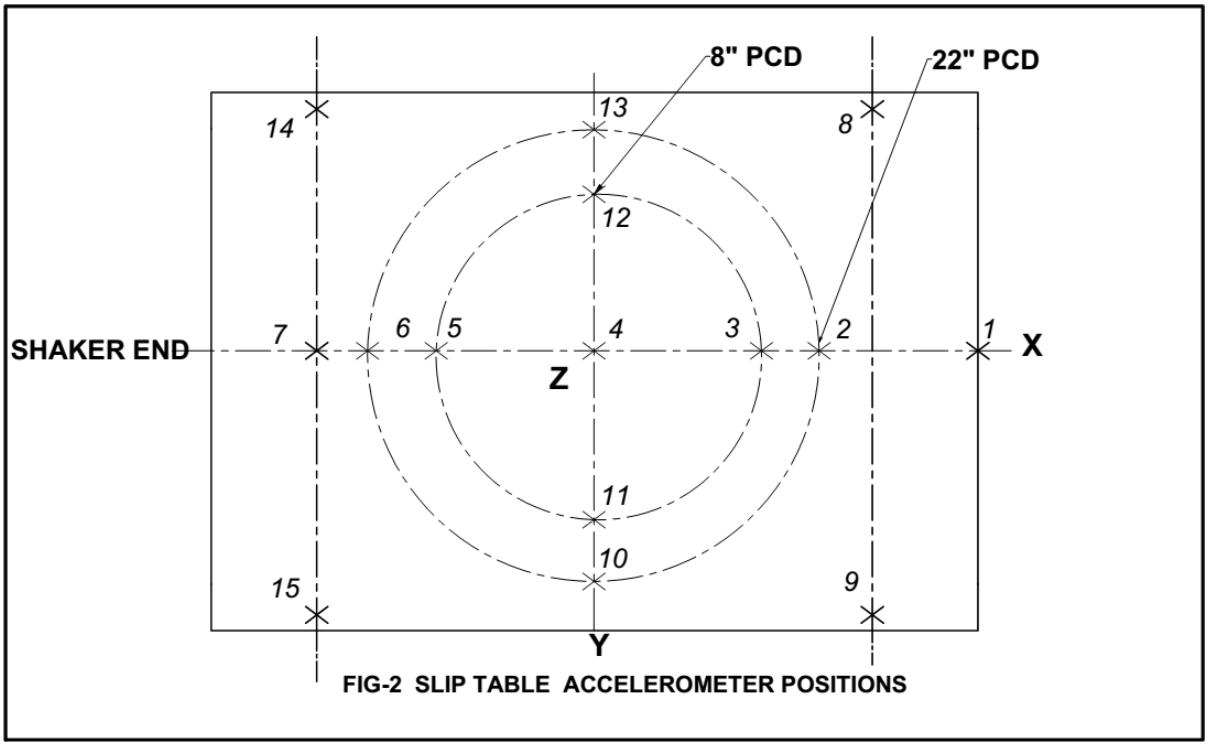

FIG-2 SLIP TABLE ACCELEROMETER POSITIONS