REQUEST FOR PROPOSAL
OF
RF DP3T SMA COAXIAL SWITCHES (SPACE QUALIFIED)

भारत सरकार / GOVERNMENT OF INDIA

अंतरिक्ष उपयोग केंद्र / SPACE APPLICATIONS CENTRE

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भारत / INDIA

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REQUEST FOR PROPOSAL (RFP) – RF SWITCHES

INTRODUCTION

The Indian Space Research Organization (ISRO) requests your company to submit quotation for space qualified RF SWITCHES, as detailed in this document. These will be used in the Flight Models of the Communication / Broadcast Satellite Service Payloads of GEOSAT series operational space-crafts. This document consists of five sections:

ANNEXURE–I A: General background of the Project for which the units are required.

ANNEXURE–I B: Guidelines to vendors.

ANNEXURE–I C: Electrical, mechanical and interface requirements.

ANNEXURE–I D: Details on quantity, delivery schedules and warranty.

ANNEXURE– II: Reliability and Quality Assurance requirements.

BACKGROUND

1.0 Space Applications Centre (SAC) is one of the major research and development Centre of the Indian Space Research Organization (ISRO). It is the lead Centre for satellite payload technology. The primary objective of SAC is to develop and operationalize indigenous satellite payloads and use space technology for socio-economic development of the country.

2.0 GEOSAT is a domestic multipurpose system, using satellites in geo-stationary orbit, for long distance telecommunications, Radio and TV program distribution, meteorological earth-observation, data relay, search and rescue. The Department of Space of the Government of India, which has the responsibility for establishing and maintaining the GEOSAT space segment, has embarked on development and fabrication of GEOSAT series Spacecraft.

3.0 For the fabrication of various satellites hardware, the Department of Space (DOS) of the Government of India, through its Indian Space Research Organization (ISRO), is planning to purchase certain spacecraft components, sub-systems and related services.

4.0 It is very important for our evaluation that your proposal also include sufficient technical data on form, fit and function for in-depth evaluation of your offer. If this technical data is not in public domain, we request that you may apply for appropriate license to your concern department in advance so that relevant technical data can be submitted with your proposal.

GUIDELINES TO VENDORS

1.0 INTRODUCTION

The RF DP3T SMA Coaxial Switches supplied against this RFP should have space heritage or successfully completed qualification program meeting the requirements specified in this document.

FLIGHT MODEL:

Delivery of flight hardware fully tested as per **Annexure-II** requirements and Lot Acceptance tests carried out on samples.

2.0 GUIDELINES FOR PREPARING TECHNICAL DETAILS

2.1 These are very special hardware and ONLY THOSE VENDORS who have adequate experience in

a) Design, development and fabrication of Hi-Rel systems

AND

b) Qualification of such hardware for onboard Communication Satellites should respond and quote against this RFP.

2.2 The vendor is requested to examine the RFP thoroughly and offer **compliance/non-compliance** point by point. In case of non-compliance, the deviation from the specified parameter shall be furnished and for complied parameters, the **vendor specification** (better or same) shall be provided.

2.3 The vendor should provide details regarding **Space flight heritage with name of space program, overall as well as specific to the quoted part, Qualification status, and Qualification report summary along with the quote. Offers without the details of Space flight history, Qualification status and Qualification report summary will not be considered.**

2.4 The vendor should also submit compliance statement consisting of compliance / noncompliance with test philosophy, test plans and other requirements as per **Annexure-II** under “Reliability & Quality Assurance Requirements". Necessary details / documents in support of the compliance stated for each point shall be supplied in the quote. Offers without the compliance statements will not be considered. The vendor may submit the Screening / Lot Acceptance testing programme, which might have been used for supplying similar hardware for other space missions.

2.5 It is necessary for the vendor to furnish complete information as required in **Annexure-IB, IC, ID & Annexure-II** of this RFP for proper evaluation and assessment of his proposal.

2.6 The vendor can attach additional information, if any, which may provide more information on these products.

2.7 The vendor may seek clarifications, if any, in advance before submitting the quotations. However, any clarification thus sent to the vendor will also sent to all other vendors.

3.0 GUIDELINES FOR PREPARING QUOTATIONS

3.1 The quotation shall include, in addition to unit cost, all the prices towards acceptance and lot-acceptance testing etc. The cost break up should include charges for each test to enable SAC in deciding to include / exclude any test depending on the cost and schedule constraints. The breakup of overall cost also need to be indicated.

3.2 This requirement is for flight hardware. Each type of flight hardware shall be subjected to acceptance testing and lot-acceptance units on the representative basis.

3.3 The vendor is requested to acknowledge the receipt of this RFP and his willingness / inability to respond and quote against this RFP.

3.4 The vendor must ensure that his quotation along with all the details reaches SAC/ISRO before the due date.

3.5 The quotation shall consist of two parts:

a) PART-1: Detailed Technical Proposal' giving all details as required in **Annexure – IC & Annexure - II.** This part should not contain any price information. This should also include a copy of 'Cost & Management Proposal' **without price information**, i.e., price column should be left blank.

b) PART-2: Cost & Management Proposal' giving cost, payment terms and other financial details.

Note: Part-2 shall be submitted in a separate sealed envelope. This requirement shall be strictly adhered to. However, both parts shall be submitted together in a sealed envelope.

ANNEXURE – I C

TECHNICAL SPECIFICATIONS

The technical details of the switch are given in this annexure.

TABLE-1: FM DP3T SMA COAXIAL SWITCHES SPECIFICATIONS:

Parameters	Specifications		
1 Frequency Range	DC to 22 GHz		
2 Insertion Loss (max)	**< 4 GHz**	**4-10 GHz**	**>10 GHz**
	0.15 dB	0.2 dB	0.35 dB
3 Return Loss (all ports)	17 dB min.		
4 RF Power handling capability	2 W min. (Max Power Handling capacity can be mentioned at different spectrum bands over entire frequency range, if available)		
5 Isolation (between ports)	65 dB min.		
6 Input / Output Impedance (Nominal)	50 ohms		
7 Shielding Effectiveness	Better than 70 dBi		
8 Dielectric Withstanding Voltage	> 500 VDC		
9 Switching Time	$\leq$ 50 msec		
10 Actuation Voltage	+22 to +29 V		
11 Coil Current	$\leq$ 500 mA		
12 Pulse Duration	Operating from 50 msec to 5 seconds (Switch should not operate below 5ms pulse duration at rated voltage (Noise immunity).		
13 RF Contacts	Break Before Make		
14 Contacts Finishing	Gold plated (as per standard for space use)		
15 Switching Operation	Latching, No power required for holding		
16 Life	1,00,000 operations (Min.)		
17 External Voltage Fed (for Telemetry)	4.5 volts $\pm$ 0.5 volt		
18 Interface circuit (for Telemetry)	CMOS compatible		
19 Reverse voltage break-down of diodes across coil	To be provided by the vendor		
20 TC return, TM return and Chassis Isolation	All three Returns to be isolated from each other		
21 Chassis contact isolated from TC/ TM return	Isolated contact is to be provided		
22 Separate return for each Tele-command	Required		
23 Contact Resistance for Telemetry path	Required with contact resistance values: Closed contact: 1Ω (max.)		

	Open contact: 10MΩ (min)
24 RF Interface	SMA FEMALE for all 5 ports
25 DC Interface	15-pin male D-sub or HD, space qualified for TC TM and Chassis contact.
26 Dimension (Envelope)	100mm x 80mm x 30mm (Max.)
27 Number of Mounting holes (for M3/M4 screws) M3 preferable	4 nos.
28 Casing (Outer Box)	Non-magnetic
29 Venting for space flight	Venting Hole required.
30 Weight	150 grams Max.
31 ICD of the switch	To be provided by vendor

Note:-

1. The switches shall meet all electrical specifications in total bandwidth as given and also under all operating environmental conditions simultaneously as per R&QA Annexure – II.

2. Vendor to provide ICD including detailed DC pin configuration at following stages:
    a. Heritage ICD at technical offer stage, for review by SAC.
    b. Updated ICD (updates only if required) before switch manufacturing, to be approved by SAC for final implementation.

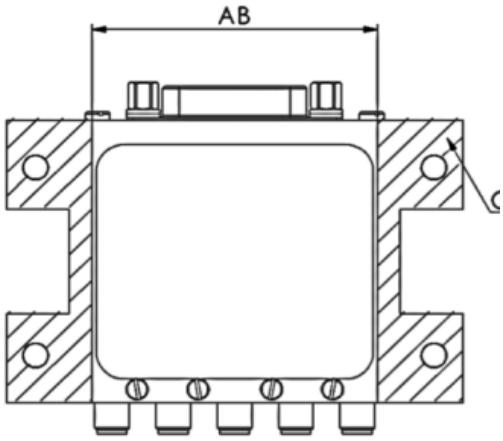


Figure 1: Conceptual drawing of SMA DP3T Switch

QUANTITIES AND SCHEDULE

1 QUANTITIES

The vendor shall quote for the switches as per following quantity slabs.

STEPS OF QUANTITIES

1.1 FLIGHT UNITS 1-10, 11-20, 21-30.
LAT Units (Approx. 5 % qty. of FM)

PLEASE QUOTE IN FOLLOWING FORMAT ONLY

SR NO	ITEM / TEST CHARGES	QTY (SLABS)	EACH COST	TOTAL COST
1	Total flight model (FM) units including screening charges) (Approximate 5% of total FM units will be considered as LAT where quantity is to be rounded off to next higher integer value, for e.g. 6.4 to be rounded off to 7)	1-10, 11-20, 21-30	**XXXX**	**XXXXX**
2	Lot acceptance test charges for first unit (**excluding "LAT unit" cost and Mechanical shock test charges**)	1 Unit	**--------**	**XXXXXXX**
3	Lot acceptance test for additional Unit **excluding "LAT unit" cost and Mechanical shock test charges**)	1 Unit		
4	Mechanical Shock Test Charges	Per unit	**--------**	**XXXXXXX**
5	OTHER CHARGES IF ANY WITH BREAKUP		**XXXX**	**XXXXXX**

2. ORDERING

The order will be placed for total requirement including Lot Acceptance and Flight models.

3 DELIVERY SCHEDULES

Flight Model: Within 8 months after ARO
LAT model: Within 10 months after ARO

1. SAC may allow prior/partial shipment of FM units prior to completion of LAT testing; however, final acceptance of FM is subject to successful completion of LAT. If LAT unit fails during testing, entire FM units should be replaced.

2. Maximum three partial shipments are allowed.

4 WARRANTY

The vendor shall provide Warranty as given below:

1 "The units supplied here upon shall be free from any defects in material or workmanship and in accordance with the applicable specifications and drawings".

2. This warranty shall run for a period of **12 months** from the date of final acceptance by SAC/ISRO and shall be in addition to any other rights available to SAC/ISRO. This warranty shall continue to be valid for corrected or replaced units until **12 months** after the date of final acceptance by SAC/ISRO of the corrected or replaced Switches.

ANNEXURE-II

RELIABILITY AND QUALITY ASSURANCE (R & QA) REQUIREMENTS
SPACE QUALIFIED RF SWITCHES, COAXIAL, LOW POWER

INDEX

RELIABILITY AND QUALITY ASSURANCE REQUIREMENTS

INTRODUCTION

Reliability and Quality are important prerequisites of any Space programme hardware. It is therefore very essential for the vendor to understand and implement the R & QA requirements judiciously. This section provides the details on R & QA requirements, which shall be assured for this programme.

1. Unit Specifications and Configuration

The performance of **Space Qualified Low Power coaxial RF Switches** (referred to as 'unit' throughout this annexure) shall conform to all specifications (electrical and mechanical specifications, interfaces, application mounting configuration(s) etc.) as defined through technical exhibits under specified environmental conditions.

2. Reliability

2.1 On-Board Life

The units shall meet all the design requirements for use onboard spacecraft with a minimum life for **18 years** in environmental conditions as specified.

2.2 Storage and Assembly Life

In addition to on-board life, the units shall be capable of meeting all the functional requirements at various stages of storage and subsystem assembly as follows:

- 5 years in controlled environmental conditions
- 3 years of storage at various levels of subsystem assembly

2.3 Reliability Analysis

Vendor shall provide complete reliability analysis in terms of reliability estimation with stress (derating) analysis. The UNITS shall be designed and fabricated to achieve a failure rate of **better than 0.06x10E-06 per hour.** Vendor shall specify the methodology used in arriving at the failure rate of the units.

3. Environmental Conditions

3.1 Operating and non-operating environment

3.1.1 The design, construction and performance of the units shall be capable of withstanding the environmental conditions specified in **Table 1: Environmental Conditions**.

3.1.2 The temperatures specified are **base plate temperatures**. Temperature rise due to self-heating of unit during operating conditions with full power under thermo-vacuum conditions at this base plate temperature shall be specified by vendor and unit shall be designed to operate in these conditions on-board communication satellite for life as specified.

3.2 Vibration/Shock

The unit shall be designed and fabricated to meet the vibration and mechanical shock requirements as mentioned in this annexure.

3.3 EMI / EMC Shielding

The unit shall be designed for magnetic and EMI shielding to meet the requirements specified herein.

4. Parts, Materials and Processes

4.1 Parts

Parts and materials proposed to be used in units shall be selected from qualified parts and materials list and through a qualified sub-vendor normally associated with long life satellite hardware.

The following quality level of constituent parts (wherever applicable) shall apply:

a) **Qualified RF connectors**, with testing as per MIL-PRF-39012 with group A & B testing OR ESCC3402 with LAT3 testing shall be used. Connectors shall meet the interface dimension requirements of MIL-STD-348.
b) **Discrete Semiconductors** complying to quality requirements of JANS/ESCC Level B3, shall be used.
c) **D connector**, as per MIL-PRF-24308 or ESCC 3401 level B or GSFC specs, shall be used.

The epoxy for coating and adhesion shall not degrade / soften with use of isopropyl alcohol (electronic grade), normally used for cleaning. The electronic parts used should not be of date code older than 5 years, at the time of UNIT manufacturing.

Further, all parts used shall have sufficient space history and shall be inspected before assembly of the units. Nonstandard parts, wherever used, shall also have sufficient space flight history and the quality level equivalent to the above mentioned parts. DPA and Verification of Quality (VoQ) wherever applicable shall be carried out by the manufacturer to gain sufficient confidence in the parts used in the Flight units.

4.2 Materials

Ferrous and non-ferrous materials used shall be corrosion resistance type or suitably treated to resist corrosion caused by atmospheric conditions existent in storage or normal operational conditions. Non-magnetic materials shall be used for all parts except where magnetic materials are essential. Materials which are nutrient for fungus shall not be used.

Organic and inorganic materials shall be stable under atmospheric and high vacuum conditions. These materials shall have Total Mass Loss (TML) less than 1% and Collected Volatile Condensable Material (CVCM) of less than 0.1% when subjected to test condition of 125°C and 10E-6 torr pressure for 24 hours as per ASTM-E-595. Only space qualified epoxies, potting materials, etc. shall be used within their shelf life and cure schedule specified by the manufacturer. However, their use shall be restricted and failures due to these shall be recorded and analysed as and when they are detected.

The selection and use of dissimilar materials shall be avoided, where it is impractical to avoid dissimilar metals in direct contact with each other, suitable protection shall be provided by space proven coating-plating etc.

4.3 Processes

All fabrication processes shall be qualified for space usage. Only qualified processes shall be used for fabrication and assembly of the units. The units shall be built to the standards normally associated with long life communications satellite hardware. Particular attention shall be paid, as a minimum, in respect to the following:

- Neat clean, smooth and fully wetted homogeneous solder joints
- Eliminate bubble entrapment in coatings/epoxies where ever used
- The marking and plating etc. shall be permanent and should not get damaged during normal cleaning process using Isopropyl Alcohol/Freon and other cleaning solvents approved for the fabrication of electronic hardware for space
- All open electrical connections (for TC/TM pins etc) shall be suitable coated to provide electrical isolation

All tolerances not specified shall be consistent with the best engineering practices. Units shall be uniform in quality and free from blemishes and defects.

5. Marking and Identification

5.1 The unit shall be identified by assigning unique serial number on the exterior surface by a suitable process applicable for space use. Marking shall not degrade the performance of the unit. In addition to functional markings like input/output, port markings etc. following marking shall appear on each unit:

- **Part Number** *(mandatory on unit)*
- **Serial Number** *(mandatory on unit)*
- Date Code *(in YYWW format, YY=last two digit of year, WW is week number; eg: 1946 for 46th week in year 2019)*
- Manufacturer's Name/Logo
- **Port marking** *(mandatory on unit)*
- **LAT** unit *(Applicable to units tested to LAT levels only, vendor to specify any suitable marking method to identify LAT units from Flight (FM) units)*

5.2 Vendor to suggest part number and details of other 'on-unit' markings along with technical offer.

5.3 The permanency of the marking shall be sufficient to withstand the specified environmental conditions and normal cleaning operations using Isopropyl alcohol and other cleaning solvents. The test method to demonstrate the same shall be specified by the vendor.

6. Packaging, Storage & Transportation

6.1 Suitable packing shall be provided for the transportation of the units by air, ship or road without any degradation/damage. The transportation package shall protect the unit from rough handling. Wherever required, the transportation container shall have nitrogen-purging facility so that the unit before shipment is purged with dry nitrogen to prevent contamination and corrosion.

6.2 Each unit shall be packaged in individual ESD protective packaging. This package shall protect the unit from environmental conditions encountered during transportation, like heat, humidity & dust.

6.3 All interfaces (connectors/waveguides, as applicable) shall be suitably protected to prevent contamination entering the units, during handling and transportation. The unit

shall be packaged in separate containers to protect against electrical, mechanical and environmental damage. Each individual container shall have a moisture absorbing material inside.

6.4 Units subjected to Lot Acceptance Test shall be clearly marked as “LAT unit” and “NOT FOR FM”.

6.5 This individual container shall then be placed in a transportation container. More than one individual unit may be placed in the transportation container. The transportation container shall protect the units from heat, humidity, dust, mechanical shock & vibrations during transportation. The individual unit package shall be fixed within the shipping package in such a way that they will be resistant to mechanical shock, humidity and dust. The shipping package shall contain all the necessary technical documents as specified and the necessary commercial documents.

6.6 Vendor to provide details of their standard shipping package for space components, for evaluation by SAC (with the technical offer).

6.7 In addition to other mandatory shipping markings, the following additional marking shall appear on the shipping packages in bold letters:

HANDLE WITH CARE
ESD SENSITIVE
TO BE OPENED UNDER CLEAN ENVIRONMENT WITH ESD PROTECTION ONLY
STORE IN A COOL AND DRY PLACE

6.8 The shipping documentation shall be enclosed in the shipping packages.

7. Design Qualification and Space Heritage Requirements

7.1 The unit design shall be a qualified design, i.e. units having similar electrical, mechanical and thermal design are qualified for HI-REL space use. The qualified design shall have similar operating frequency, power levels and mechanical design.

7.2 The following details shall be supplied along with the technical offer:

7.2.1 As a pre-requisite to fabrication, evaluation and testing of space grade units, manufacturer should have adequate capability and experience to supply similar units for space/ Hi-Rel programs. Relevant details shall be supplied with technical offer.

7.2.2 Summary of manufacturer's capability to design, fabricate and testing of similar units

7.2.3 Basic construction details of the proposed design, recommended mounting/assembly procedures and possible failure modes of the units as derived from design/test experience/field data.

7.2.4 Manufacturer's standard qualification and screening test flows for evaluation of same/similar units

7.2.5 Summary **qualification details** of the proposed design clearly indicating the operating frequency, power level and environmental specifications in terms of operating & non-operating temperature range, vibration and shock test conditions, thermovacuum performance, EMI/EMC performance as established through test etc. Vendor should supply specific space flight history of the offered design with name of programme, operating frequency and power level.

7.2.6 Details of the same/similar units supplied to space programs including part number of the units, functionality and name of the space programs

7.2.7 Any **major/minor design changes** (electrical/mechanical/interface etc) anticipated in the vendor's proven design (design for which qualification and space heritage exists), so as to meet current SAC requirement, shall be clearly brought out in the technical proposal.

7.3 After thorough assessment of the supplied technical details of the quoted design from the vendor, the programme will be executed as FM + LAT.

7.4 Only vendors with proven track record of successfully delivering similar units for space shall quote against this requirement. Quotes from vendor with no space heritage and/or qualification for these categories of space products will not be accepted.

8. Test Programme

The programme will be executed as FM + LAT. The details for the two phases are as described below.

8.1 Lot Formation

8.1.1 The term LOT is defined to be consisting of each type of units manufactured together (at the same time) from the same batch of raw materials on the same production and assembly line, having all the provisions for quality assurance. The unit shall satisfy all design, performance and environmental requirements of the specifications.

8.1.2 All the units fabricated as one LOT shall undergo Screening and Lot Acceptance Test (LAT) as per **Table 2: Test Matrix for FM (Screening) and LAT** with the execution flow as per **Figure 2: Flow Chart For Screening And Lot Acceptance Programme** before they are acceptable to SAC.

8.1.3 LAT shall be selected from each fabricated lot, with sample selection as defined.

8.1.4 Vendor may provide details of the number of lots to be fabricated required to meet ordered quantity.

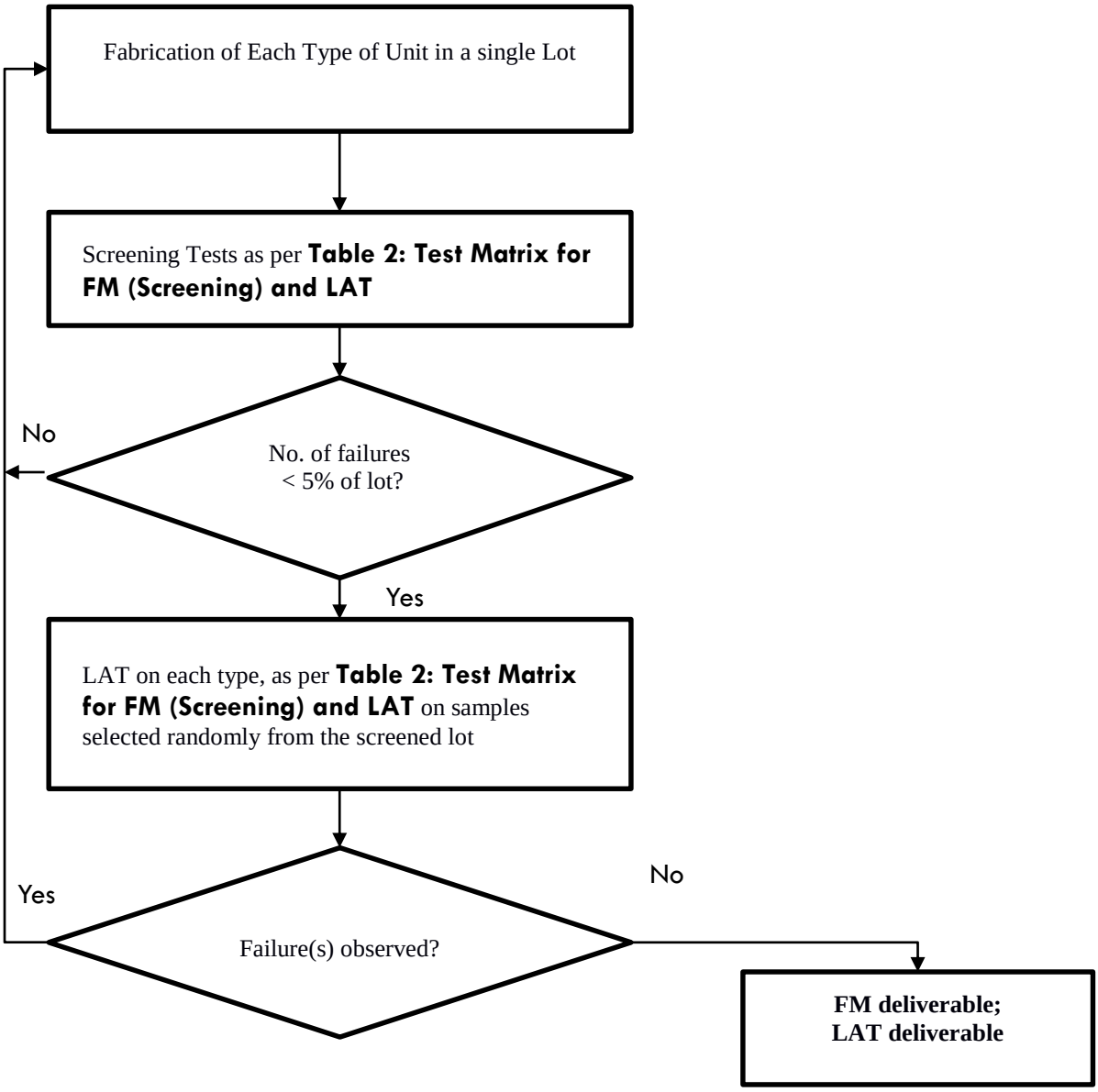
8.1.5 The execution of LAT on one OR more than one OR all ordered types will be decided by SAC at the ordering stage, based on supplied technical details.

8.2 Production Control, Assembly Sequence and In-Process Inspection

8.2.1 Vendor shall specify and provide the details of production control, assembly sequence and in-process inspection stages before the units are finally ready for acceptance (screening) tests. It shall include:

- Pre cap visual inspection and Physical dimension measurements
- 1000 Actuations

Figure 2: Flow Chart For Screening And Lot Acceptance Programme



8.3 Screening and Lot Acceptance Test (LAT)

8.3.1 Screening

All the units fabricated in a single Lot shall undergo Screening (FM) Test as per

A maximum of 5% failures are allowed during screening. Units exceeding the specified limits shall be removed from the lot.

8.3.2 Lot Acceptance Testing

On successful completion of Screening Test, the Lot Acceptance Test (LAT) shall be carried out on 5% samples (minimum one unit of each type), randomly selected from screened lot of each type, as per **Table 2: Test Matrix for FM (Screening) and LAT.**

No failure/ deviation shall be allowed for LAT unit(s).

9. Test Parameters, Procedures and failure Criteria

9.1 Performance measurement stages

The performance of units shall be recorded at performance measurement stages, but not limited to, in the specified formats as per **Table 3: Performance Measurement Stages During Screening** and **Table 4: Performance Measurement Stages During LAT.**

9.2 Test Procedures for Screening and LAT

9.2.1 Vendor shall submit the test plan for the functional and environmental tests to be conducted on the units during the Screening (ATP) and LAT (QTP) test programme. The test plan shall include, but not limited to, the tests and specification as indicated in **Table 2: Test Matrix for FM (Screening) and LAT.**

9.2.2 The test plan shall also include the procedure for conducting each test, the test equipment used and their calibration, total uncertainty for each test set-up and parameter tolerance/limits for the unit under test. Suitable buffer connections shall be provided during testing. Sample test data log format shall be supplied for each test described in **Table 2: Test Matrix for FM (Screening) and LAT.**

9.2.3 It is preferable that test data are logged in electronic form compatible with electronic spreadsheet processing tools.

9.2.4 Only after submission of the test procedures including test data log format (screening and LAT) by vendor and subsequent approval by SAC, testing shall commence.

9.2.5 Units tested through unapproved test procedures are not acceptable.

9.3 Tolerance On Test Conditions

Maximum allowed tolerances on test conditions are as per **Table 5: Tolerance on test conditions.**

9.4 Failure Criteria

The details of the unit fall-out during Screening or LAT shall be informed to SAC. Maximum of 5% of failures are allowed during screening. No failure is allowed during LAT. **Number of failures more than 5% of lot during screening and any failure during LAT shall be a cause for lot rejection.** However, depending on the type of failure and failure mechanism established based on the failure analysis, usability of the Lot will be reviewed. Failure at any stage shall be reported to SAC immediately. This shall be followed by detailed failure analysis. Based on

failure analysis, SAC shall decide for the acceptance of lot, the requirement of corrective actions and retest plan, which shall be decided by SAC and implemented by vendor.

10. Tables

Table 1: Environmental Conditions

The units shall be capable to withstand the following environmental conditions:

S.No.	Parameter	Specifications
1.	**Non-operating temperature range**	-40˚C to +85˚C
2.	**Operating temperature range (FM/Screening)**	-20˚C to +80˚C
3.	**Turn-on temperature (cold turn-on)**	-40°C
4.	**Operating temperature range (LAT)**	-25˚C to +85˚C
5.	**Pressure**	Ambient, vacuum better than 10E-5 torr
6.	**Relative humidity** *(applicable for testing at ground only)*	Upto 95% RH @ 40°C w/o condensation of water

Table 2: Test Matrix for FM (Screening) and LAT

Sr. No.	TEST	Applicability		Test Conditions & Acceptance criteria
		FM	LAT	
1	**External Visual Inspection**	X	X	▪ Units shall be inspected for defects related to material, finish, surface and workmanship. ▪ The visual inspection criteria should necessarily include the inspection of RF and DC connectors, required port markings, any pin bends/damages, if any, subsequent to electrical and environmental tests etc. ▪ Further details shall be specified by the vendor with detailed accept/reject criteria.
2	**Physical Dimensions**	X	-	▪ Mechanical dimensions of the unit **with respect to the SAC approved ICD** shall be measured. ▪ ICD shall specify the surface finish also, and the same shall be verified on sample basis. ▪ Interface dimensions of the connectors (wherever applicable) shall be measured and shall meet the requirements of MIL-STD-348. ▪ Test details to be specified by the manufacturer.
3	**Initial Performance Test**	X	X	▪ Full characterisation (RF and DC) as per electrical specifications, for all applicable paths as per TEST PROCEDURE approved by SAC.
4	**Thermal Shock**	X	X	▪ As per MIL-STD-202, Method 107, Condition 'A', non-operating temperatures as per **Table 1: Environmental Conditions**. Test shall be conducted with cold cycle first. ▪ The test may be performed as fast temperature cycling. ▪ The number of cycles shall be 10 (during Screening) and 25 (during LAT).
5	**Temperature Storage**	X	X	▪ Performance functional test at ambient. ▪ Store units at **lowest non-operating temperature** for 6 hours. ▪ Stabilize the units at ambient and perform functional Test. ▪ Store units at **highest non-operating temperature** for 6 hours. ▪ Stabilize the units at ambient and perform functional Test.
6	**Operational Temperature**	X	X	▪ Record unit performance at specified minimum operating temperatures, maximum operating temperature and ambient (after stabilization).
7	**Sine Vibration**	-	X	▪ The natural resonant frequency of the units shall be higher than 100 Hz. Low level sine (LLS) resonance search shall be carried out before and after each vibration test for all units tested.

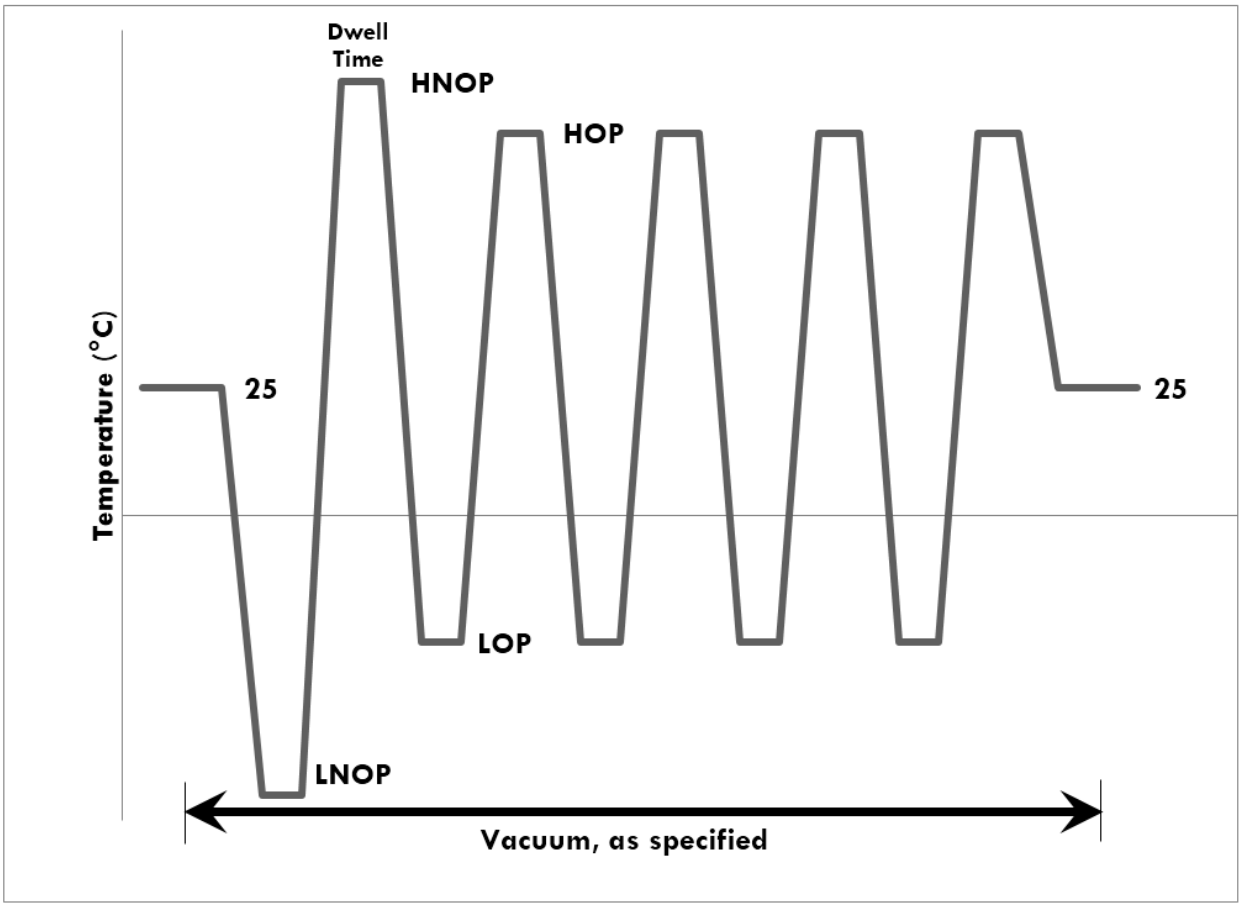
Sr. No.	TEST	Applicability		Test Conditions & Acceptance criteria
		FM	LAT	
				▪ The shift in resonance frequency before and after each vibration test shall not exceed 10%. ▪ Test levels shall be as per **Table 6: Sine Vibration** ▪ Vendor to include detailed accept/reject criteria in test procedure document.
8	**Random Vibration**	X	X	▪ Test levels shall be as per **Table 7: Random Vibration.** ▪ Vendor to include detailed accept/reject criteria in test procedure document.
9	**Mechanical/ Pyro Shock**	-	X	▪ Unit design shall be capable to withstand the defined mechanical/pyro shock test conditions. ▪ Requirement of the compliance demonstration is by analysis and test data. ▪ Test levels shall be as per **Table 8: Mechanical/Pyro Shock Test** ▪ Vendor to include detailed accept/reject criteria in test procedure document.
10	**Thermal Vacuum**	-	X	▪ As per **Figure 3: Thermo-Vacuum Test Profile** ▪ Temperature limits: As per **Table 1: Environmental Conditions** ▪ **Dwell time:** 2 hours each, for all cycles, may be extended for completion of performance measurement tests. ▪ **Monitor:** Performance of each unit under test at each dwell, also record performance during transition from each temperature extreme. ▪ Unit shall be operated within operating temperature limits only.
11	**Actuation Life Test In Vacuum**	-	X	▪ The life test shall be performed on all LAT units. ▪ The units shall be subjected to accumulated actuations (no. of operations) as specified, energizing all applicable paths in all possible switching sequence, in vacuum at extreme coil energization voltages (defined through electrical specifications) under extreme temperature (as per environmental specifications in **Table 1: Environmental Conditions**). ▪ Unless stated otherwise, the accumulated number of actuation cycles shall be 1,00,000 (min). ▪ The accumulated actuations shall be performed in sequence defined in **Table 9: Actuation life test in vacuum**.
12	**EMI / EMC Test**	-	X	▪ RF leakage specifications as per electrical specifications shall be demonstrated through test. ▪ The may be conducted as per MIL-STD-461E or vendor standard EMI/EMC test method as employed

Sr. No.	TEST	Applicability		Test Conditions & Acceptance criteria
		FM	LAT	
				for other space programs. ▪ Vendor to specify the test method with all supporting details.
13	**Humidity (steady state)**	-	X	▪ As per MIL-STD-202, method 103, condition 'A'. ▪ Additionally, units shall also be visually inspected after completion of test. No discolouration, tarnishing, corrosion shall be allowed.
14	**Final Performance Test**	X	X	▪ As per electrical specifications, for all applicable paths as per TEST PROCEDURE approved by SAC.
15	**Resistance to solvents**	-	X	▪ As per MIL-STD-202, method 215 ▪ May be carried out on electrically rejected units/identical test coupons. ▪ To be performed only if applicable for proposed marking method

Note-1*: "X" Mark against the test denotes applicability of test. Test details and conditions are as described.*

Note-1*: At the end of each environmental test electrical performance check shall be performed as per* **Table 3: Performance Measurement Stages During Screening** *and* **Table 4: Performance Measurement Stages During LAT**

Figure 3: Thermo-Vacuum Test Profile



***Legend: LNOP**: Lowest non-operating temperature; **HNOP**: Highest non-operating temperature; **LOP**: Lowest operating temperature; **HOP**: Highest operating temperature; **Dwell time**: 2hours.*

Table 3: Performance Measurement Stages During Screening

PERFORMANCE MEASUREMENTS / TESTS	Visual Inspection	Physical Dimensions	Insertion Loss	I/P AND O/P VSWR	Isolation	Switch Position	Variation over temperature	Switching time, Threshold Voltage, Contact Resistance (TLM), coil current	Transient Suppression, Insulation Resistance, Dielectric Withstanding Voltage	As per defined acceptance criteria
Initial Performance	X	X	X	X	X	X	-	X	X	X
Post Thermal Shock	X	-	X	X	X	X	-	X	-	X
Post Temp. Storage	X	-	X	X	X	X	-	X	-	X
Temperature Operational	-	-	-	-	X	X	X	X	-	X
Post Vibration/ Final Performance	X	-	X	X	X	X	-	X	X	X

Note1: *"X" Mark against the test denotes applicability of performance parameters. Test details and conditions are as described.*

Note2: *Variation over temperature: During transition between max operating temperatures, measurements (RF contact resistance measurements, Insertion Loss and Return Loss) for information only.*

Table 4: Performance Measurement Stages During LAT

PERFORMANCE MEASUREMENTS / TESTS	Visual Inspection	Insertion Loss	I/P AND O/P VSWR	Isolation	Variation over Temperature	Switching time, Threshold Voltage, coil current	Contact Resistance (TLM)	Transient Suppression, Insulation Resistance, Dielectric Withstanding Voltage	Switch Position	MIL 461E/Shielding Effectiveness	RF path monitoring	As per defined acceptance criteria
Initial Performance	X	X	X	X	-	X	X	X	X	-	-	X
Post Thermal Shock	X	X	X	X	-	X	X	-	X	-	-	X
Post Temp. Storage	X	X	X	X	-	X	X	-	X	-	-	X
Temp. Operational	-	-	-	X	X	X	X	-	X	-	-	X
Post Vibration	X	X	X	X	-	X	X	-	X	-	-	X
Post Pyro Shock	X	X	X	X	-	X	X	-	X	-	-	X
Thermo-vacuum	-	-	-	X	X	-	-	-	X	-	-	X
Actuation Life (Vacuum)	-	-	-	-	-	-	X	-	X	-	X	-
Post Humidity (steady state)	X	-	-	-	-	-	-	-	-	-	-	X
EMI / EMC	-	-	-	X	-	-	-	-	-	X	-	X
Final Performance	X	X	X	X	-	X	X	X	X	-	-	X
Post Resistance to Solvent test	X	-	-	-	-	-	-	-	-	-	-	X

Note1: *"X" Mark against the test denotes applicability of performance parameters. Test details and conditions are as described.*

Note2: *Variation over temperature: During transition between max operating temperatures, measurements (RF contact resistance measurements, Insertion Loss and Return Loss) for information only.*

Table 5: Tolerance on test conditions

Temperature	:	± 3°C
Atmospheric Pressure		
Greater than 0.1 torr	:	± 5%
Less than 0.1 torr	:	± 50%
Relative Humidity	:	+0%, -5%
Acceleration	:	± 10%
Vibration		
Frequency	:	± 2% above 20 Hz, 0.5 Hz for f ≤ 20 Hz
Sinusoidal Amplitude	:	± 10%
Random (g-rms)	:	± 10%
Power Spectral Density		
20-300 Hz	:	± 1.5 dB
300-2000 Hz	:	± 3.0 dB

Table 6: Sine Vibration

Sine Vibration test shall be carried out as per MIL-STD-202, Method 204, condition 'E', except the following:

- **10 to 2000 Hz, 30 g peak.**
- **Sweep Rate: 2 Octaves / min.**
- **No. of sweeps: 4 per axis**
- **Axes: All axes**

Table 7: Random Vibration

The test shall be carried out as per MIL-STD-202, Method 214, Condition E. The following conditions shall apply:

Frequency (Hz)	**PSD (g^2/Hz)**	
	Screening	**LAT**
20-50	+ 6 dB/Octave	+ 6 dB/Octave
50-1200	0.20 g^2/Hz	0.45 g^2/Hz
1200-2000	- 6 dB/Octave	- 6 dB/Octave
Overall Level	18.2 g_{rms}	27.2 g_{rms}
Duration	1 minute/axis	2 minute/axis
Axes	All axes	All axes

Table 8: Mechanical/Pyro Shock Test

Frequency (Hz)	SRS Normal to mounting plane	SRS Parallel to mounting plane
100-300	15 dB/octave	15 dB/octave
300-1000	9 dB/octave	9 dB/octave
1000-5000	700 g	400 g
5000-10000	- 6 dB/octave	- 6 dB/octave

The levels are specified for Q=10; No. of shocks=Two shocks per axis

Table 9: Actuation life test in vacuum

Temperature	Coil Energization Voltage	No. of Actuations
High	High	Total no. of accumulated actuations/4
Low	High	Total no. of accumulated actuations/4
High	Low	Total no. of accumulated actuations/4
Low	Low	Total no. of accumulated actuations/4

11. Technical Documents Required Along with The Quote

The following technical details shall accompany the technical quote:

11.1 Detailed Point by point compliance including all relevant technical documents in support of the compliance to each section of this annexure

11.2 Technical documents in support of the compliance to each section of this Request for Proposal

11.3 Qualification report summary giving details regarding the list of tests & test conditions. This report should necessarily contain the operating and non-operating environmental conditions, vibration and shock levels to which the design was successfully tested and typical electrical performance apart from other relevant details.

11.4 Space History/Space Programme to which similar items have been supplied with frequency of operation and RF power level.

11.5 Authorization certificate from original part manufacturer, in case the offer is from an authorized representative.

11.6 Technical compliance to RFP including R&QA requirements shall be endorsed (approved) by original part manufacturer and shall accompany the technical offer.

11.7 List of qualified Parts, Materials and Process proposed to be used for this programme

11.8 Reliability Analysis Summary/Typical failure rate

11.9 Screening/Qualification Plans through which the proposed design is qualified for space use

12. Technical Documents to Be Supplied during Contract

The documents/reports (specified through final purchase order) shall be supplied during contract, at the stages mentioned below. These shall be full reports (not the summary reports):

12.1 DOCUMENTS to be supplied after receipt of purchase Order and before fabrication

12.1.1 List of qualified Parts, Materials and Processes, their quality levels, derating criterion followed, traceability data, procurement history etc. proposed to be used for this programme, for review and subsequent approval by SAC

12.1.2 Details of assembly sequence and Final Production Tests

12.1.3 Thermal Analysis

12.1.4 Structural Analysis

12.1.5 Multipaction Analysis

12.1.6 Configuration change control Plan, for review and subsequent approval by SAC

12.1.7 Non-conformance Control Plan, for review and subsequent approval by SAC

12.2 DOCUMENTS to be supplied before testing (screening and LAT)

12.2.1 Documents containing test procedures (ATP & QTP with test set up details), test and calibration facilities, environmental facilities and relevant operation details. This document shall include Interface Control Drawing (ICD) and clearly address all tests with accept/reject criteria as defined in this annexure, for review and subsequent approval by SAC.

12.2.2 Screening and LAT Test report format, for review and subsequent approval by SAC.

12.2.3 Non-conformance parts and material test reports (if any), for review and subsequent approval by SAC

12.3 DOCUMENTS to be supplied if failures/non-conformances observed

12.3.1 Failures encountered, if any, shall be duly recorded and failure reports (for catastrophic failures), mechanical or handling failures, malfunctioning or operative deviations from the specifications along with corrective actions, for review and subsequent approval by SAC

12.3.2 Non-conformance parts and material reports (if any), for review and subsequent approval by SAC

12.4 DOCUMENTS to be supplied before shipment

12.4.1 Summary sheet of all the tests performed as per SAC approved test plan. This shall have serial numbers of the units over which tests were performed, test conditions for each test and outcome of each test, for review and subsequent approval by SAC (shipment clearance).

12.5 DOCUMENTS to be supplied along with deliverables

12.5.1 Certificate of Conformance (CoC)

12.5.2 Final Test reports of Screening and LAT (as per final purchase order) along with the deliverable units, for review and subsequent approval by SAC.

12.5.3 Any other technical document/report defined through SAC purchase order