Design of Lightning Protection System for Third Launch Pad Project

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Contents

Abbreviations:

EMI: Electromagnetic Interferences

FRP: Fiber Reinforced Plastic

GRP: Glass Fiber Reinforced Plastic

GPR: Ground Potential Rise

LPS: Lightning Protection System

LPT: Lightning Protection Towers

ST-1: Tiltable structure (Approx. 85m tall)

ST-2: Tower structure (Approx. 120m tall)

ST-3: Pedestal structure (Approx. 8m tall)

TLP: Third Launch Pad

Section – A

Scope of Contract

1.0 TITLE OF THE CONTRACT:

Design of Lightning Protection system for Third Launch Pad Project at SDSC SHAR.

2.0 INTRODUCTION:

This is a consultancy service contract for study, design, theoretical analysis, simulation of models and experimental evaluation of lightning protection system for Third Launch Pad Project for future Missions of ISRO. The outcome of this work includes optimal location of air terminal /insulated mast, sizing of mast, sizing of interconnecting catenary wires, connections of catenary wires with distant earthing station, down conductors, grounding system based on the ground potential rise limit, lightning data acquisition system and total system validation. The approximate launch Pad area is around 785000 Sqm.

3.0 DETAILS OF SITE:

Location of Plant	: Sriharikota, AP State
Elevation	: approx.3.0 m
Access to Site	: Road-from North of Chennai is approx. 100 km.From East of Sullurpeta in Tirupati dist is approx 30km.Rail- Chennai -Vijayawada rail track line

Environmental Conditions

a) Temperature

Mean of daily max	:	42.2 °C
Mean of daily min.	:	11.8 °C
Maximum Temperature	:	44.6 °C

b) Humidity

Mean of daily max	:	75%
Mean of daily min.	:	67%
Maximum	:	99%

c) Lightning Activity

Activities per year	:	47 Days

d) Soil Resistivity

Maximum Value	:	200 -250 Ohm-m

e) Atmosphere type

Seashore	:	Saline

f) Hazardous area

Explosive -Ex	:	IIC, Zone 1

Section – B
Technical Specification

4.0 SCOPE OF WORK:

The total work is decided to be carried out in four phases.

Phase -1:

a. Study, design, investigation and assessment of direct lightning strokes interception efficacy of lightning protection system for the Launch Pad area which includes Launch vehicle, ST-1, ST-2, ST-3 structures and process facilities etc, equipped with electrical and high end space electronic systems-avionics, pipelines with hazardous chemicals.

b. Literature survey shall be carried out for Rocket launch pad lightning protection system at various launch pads in the world.

c. Finding out latest methodology specific to the Rocket launch pads which should be followed as per standards & norms with latest amendments of BIS, NBC, IEC, IEEE, NFPA, OSHA, NASA, ESA etc or peer reviewed research.

d. INTEGRAL (NON-ISOLATED) type LPS: All the studies are to be carried out considering catenary wires with steel mast and insulated (GRP/FRP) mast with lattice steel structure and Mono structure and considering ST-1, ST-2, ST-3 structures and launch Vehicle.

e. The INTEGRAL type LPS studies & design includes the placement of mast on ST-2 or ST-1 or near to ST-1 etc.

f. ISOLATED type LPS: All the studies are to be carried out considering catenary wires with steel mast and insulated (GRP/FRP) mast with lattice steel structure and Mono structure and considering ST-1, ST-2, ST-3 structures and Launch vehicle.

g. The ISOLATED type LPS studies & design includes the placement of mast considering various cases - 60mx60m area, 90mx90marea and 90mx108.5m (minor changes as per site requirements will be intimated prior to commencement of studies) Launch pad area with multiple catenary wires interconnections on the above of the tower.

h. Theoretical analysis, calculation and simulation shall be carried out and lightning surge response of the system for sneaking strokes and strokes intercepted/side flashes and direct lightning strikes.

i. Results are to be furnished in different cases which includes probability and minimum prospective lightning stroke current in the event of direct lightning to the vehicle and structures in Launch pad area.

j. 3D software model of the proposed LPS and Launchpad shall be provided along with penetration analysis using latest methods specifically applicable to launch pads.

k. The submission of detailed design document consists of sizing & location of LPT, sizing and fixing of catenary, sizing and fixing of FRP/GRP, Bill of quantities, specifications for all components and materials used nearer sea shore / saline atmosphere, drawings etc. shall be submitted for field execution.

Phase- 2:

a) In continuation with Phase-1 work, the phase-2 work shall be carried out which involves extensive computer simulation incorporating the latest modelling aspect for the lightning surge analysis -physical phenomena.

b) The models required for conducting risk assessment, electromagnetic transients & electromagnetic interferences and ground potential rise for various systems in the launch Pad area shall be developed during the simulations with latest software. Detailed risk assessment shall be carried out for the LPS.

c) The probability of lightning strikes for each point on the structure must be determined and the overall interception efficiency of the LPS based on the electro-geometrical model must be calculated. The probability of lightning strikes to various parts of the LPS, Launchpad and Launch vehicle shall be calculated.

d) Electrical models of the LPS, electrical, instrumentation, pipelines, structures and any other associated systems at the launch pad shall be prepared and simulations shall be carried out to assess the effect of transients and electromagnetic interferences (EMI) using dedicated software and electromagnetic transient programs such as XGS Lab, MATLAB, CDEGS, EMTP or other similar software.

e) Determination of voltage developed across GRP mast and tower under lightning conditions.

f) Determination of magnetic field intensity (H) levels in Launchpad area under lightning conditions.

g) Determination of induced voltages in electrical lines, signal lines and pipelines.

h) Determination of maximum developed GPR at launcher area in event of lightning strikes.

i) Determination of probable induced currents in electrical lines, signal lines and pipelines during all possible cases of lightning activity.

j) The efficacy of the grounding system and possible safety considerations (step & touch potential levels etc) shall be verified using multilayer soil modelling using software such as XGS Lab, CDEGS etc or other software.

k) Ascertain the lightning surge response of the system for the voltage rise and currents and gross field level in launch pad which includes LPTs, ST-3, ST-2, Launch vehicle, ST-1 and its associated equipment.

l) Studies related to phases of discharge mechanism which includes Corona inception, steamer inception, steamer to leader transition, inception of upward leader from the structures, propagation of upward leader and final jumps.

m) The theoretical studies should provide data with regard to GPR, EMI in the power cables and umbilical's (both pneumatic and checkout /signal cables), developed surge voltages & currents in various sections and components for entire scope of work and necessary feasible solutions for improvements to be provided based on the above data.

Phase-3:

A. In continuation with Phase-2 work, the phase-3 experiments work shall be carried out through extensive lab with sub scale models.

B. The Laboratory should have capability for conducting lightning impulse tests in accordance with applicable international standards (IEC, CIGRE, NFPA, IEEE etc.) in various case studies for direct and indirect strokes.

C. Lightning Interception study of LPS using high voltage generator.

D. Impulse current testing and validation of LPS components under simulated lightning condition.

E. Impulse voltage testing of insulated mast under dry and wet conditions.

F. After completion of the experiments, the data obtained shall be compared with the simulation results and shall be validated by experts from national / international institutions engaged in the field of lightning protection research.

G. Maintenance procedures for LPS to be submitted.

H. Submission of detailed design report for realization of lightning activity measurement at Launchpad area consisting of the following details:

a) Generation of different configurations to measure the parameters of lightning like lightning currents, voltages etc. and their remote monitoring and logging.

b) High reliable hardware and software architecture and data acquisition system.

c) Schemes which includes sensors /coils etc.

d) Detailed Technical Specifications of sensors and data acquisition system.

e) Bill of Quantities.

Phase-4: Commences after realization of LPS systems at Launchpad OR Three years from the date of completion of Phase-3 activities.

I. Validation of the realized LPS and submission of the results of validation.

Section- C
Terms and Conditions

1.0 BIDDER QUALIFICATION CRITERIA:

a (i). Bidder shall be IISc/IITs/NITs/State Universities with experience in the area of lightning protection system study and design for high raised (minimum 70m tall with isolated LPS type) industrial facilities / launch Pad facilities / launch vehicle stage test facilities.

(OR)

(ii). Bidder shall be consultant or OEM or OEM authorized agency with experience in the area of lightning protection system study and design for high raised (equal or above 70m tall with isolated LPS type) industrial facilities / launch Pad facilities / launch vehicle stage test facilities.

b. Bidder shall have executed similar or relevant type of projects for hazardous area containing highly flammable items for Government of India/National/ International / PSU/Private agencies.

c. Bidder shall have resources like design expert team, software with main frame computer and own/hired laboratory setup for analysis of lightning protection system. Work /experience profiles of the technical /expert staff available with the party shall be furnished.

d. The following documents shall be submitted along with the bid.

i. **Details of the analysis lab with associated hardware &software.**

ii. **License copies of the analysis software's proposed to be used for above work.**

iii. **MoU or Tie-up with reputed laboratories having accreditation certificate**.

e. If Bidder is not an academic institution, then bidder shall submit proof for having executed project involving study and design of lightning protection system in any firm against a single purchase order of value Rs 36 Lakh or more and two purchase orders of value Rs 27 Lakh.

f. If Bidder is not an academic institution, then the average annual turnover of the bidder in the last three financial years ending with FY 2023-2024 shall be Rs 54Lakh or more.

2.0 REPEAT ANALYSIS:

Based on the site conditions as part of erection and commissioning of LPS, a repeat analysis needed to be carried out and updated document shall also be included even after completion of entire work for up to two iterations.

3.0 DELIVERY SCHEDULE

The detailed design reports shall be submitted within the specified period from the date of receipt of the P.O.

The major milestones and the date of completion shall be as per schedule given below:

Sl No.	**Activity**	**Completion date following project Commencement**
Phase- 1		
1	Date of release of Purchase Order	T0
2	Site visits / online meetings /Inputs by SDSC SHAR, ISRO DOS	T0 + 7 Days

3	Preparation of action plan	T0+ 10 Days
4	Development of a sophisticated model and submission of Detailed Design Report with BOQ, Sizing of LPS etc	T0 + 100 Days
Phase- 2		
5	Simulation Studies & Reporting of main findings	T0 + 150 Days
6	Generate and Review of Simulation results and modifications in software.	T0 + 210 Days
Phase -3		
7	Experimental set up and Practical tests	T0 + 240 Days
8	Review and compare the simulation and practical results	T0 + 270 Days
9	Submission of Results and Report to SDSC (T1)	T0 + 300 Days
Phase -4		
10	Validation of LPS to be carried out after realization	T1+ 1095 Days

4.0 TERMS OF PAYMENTS

Our payment terms will be as given below, Payments will be made on pro-rata basis as per the Bill certified by engineer, SDSC SHAR

i. 30% Payment of PO value will be paid in advance to the Bidder after receipt of PO.
ii. 20% payment of PO value will be paid for after completion of phase -1 work.
iii. 20% payment of PO value will be paid for after completion of phase-2 work.
iv. 25% payment of PO value will be paid for after completion of phase-3 work.
v. 5% payment of PO value will be paid for after completion of phase-4 work.

5.0 SUMMARY OF RESPONSIBILITIES
SDSC SHAR and Academic Institution / Bidder:

1. SDSC SHAR, ISRO, DOS is responsible for the supply of all necessary inputs and requirements for carrying out the work.
2. Bidder shall bring out a preliminary report on methodology and present to Technical Review Team of SDSC SHAR, ISRO, DOS at each phase of the activity (Phase-1 to Phase-3).
3. Bidder shall undertake to develop models required for the study.
4. Bidder shall arrange for all the software and analysis tools required and modelling of systems under study.

5. Bidder shall make the required test set up, including instruments and oscilloscopes, etc., for the intended experimental part of the study.

6. Bidder shall provide a copy of the raw data acquired during the analysis, tests and to be submitted to SDSC SHAR ISRO, DOS.

7. Bidder shall carry out detailed analysis and evaluate the test data.

8. Bidder shall prepare a detailed document on the analysis & test results and present the same to SDSC SHAR, ISRO, DOS within the schedule as per the contract.

9. Bidder shall be responsible for supply and fabrication of scale down model for complete launch pad area which includes ST-1, ST-2, ST-3, Launch vehicle, LPT system with and without FRP/GRP mast for carrying out experimental studies in HV Lab. (Note: Scale down model with FRP/GRP mast in the scope of the bidder only)

10. The Technical specifications of FRP/GRP mast shall be submitted by bidder based on detailed studies conducted.

11. Bidder shall be responsible for conducting the additional HV laboratory tests on the samples of FRP/GRP mast of finalized FRP/GRP material for LPS and submit the report for further usage in actual system. SDSC SHAR, ISRO will provide samples of GRP/FRP mast to the bidder for conducting tests at bidder's laboratory.

12. Bidder shall guarantee that the technical information and data exchanged with SDSC shall be treated as confidential and should not be disclosed without prior written permission from SDSC.

13. All technical data generated in this project will be property of SDSC SHAR, ISRO.

14. Bidder shall furnish the lab details where subscale model tests are to be conducted.

15. SDSC, SHAR, Department reserves the right for the evaluation of the prospective bidders and their facilities which includes their capabilities, resources, expertise and laboratories etc.

16. The technical data generated under the programme may be used by Bidder or any publications made only with the **prior permission** from SDSC SHAR.

6.0 ADDITIONAL INSTRUCTIONS TO THE ACADEMIC INSTITUTIONS / BIDDER

a) All the hard copies and soft copies of the test reports and documents to be supplied under this contract.

b) The supplier shall indicate any assumption made in respect of specification, data of any other details that have not been mentioned in this order but considered necessary for system design to meet the specified application requirements. All such assumptions will not be binding on ISRO unless expressly agreed upon. The supplier, under these conditions, shall supply all results based on the data accepted to ISRO without any commercial implication.

c) As all the tendered items are inter-related, the cost comparison will be done on the total cost of all items put together including repeat analysis during site conditions (minimum two iterations) and overall, technically qualified L1 will be considered.

d) All necessary facilities including tools, testing equipment, instruments, accessories, manpower assistance etc. shall be in the scope of the bidder.

e) Filled in bidder compliance statement with all certificates/reports/proofs as asked shall be submitted along with technical bid. All points shall be specifically complied by the bidder. Declaration in any other form will be considered as incomplete offer and will be rejected.

f) The agency shall ensure that all the personnel engaged by them are adequately experienced in the type of work

g) Technical team from SDSC SHAR will witness the activities during software simulations and Lab tests etc.

h) The bid cost shall include all costs towards transportation up to site, accommodation, food for the manpower deployed by the supplier.

7.0 DELIVERABLES:

Detailed study report to be submitted on the studies detailed in the scope of work above for the entire launch pad and newer vehicle for Mission with the Lightning Protection Scheme. The study and design shall also discuss on the grounding aspects of Launch Pad.

The combined design report with all outcomes, recommendations and solutions for ensuring effective lightning protection system for space programme shall be submitted.

The bidder should strictly follow the schedules and outcomes of Phase-I, II, III & IV. The schedule time may be varied based on the inputs provided by the departmental and site clearances.

a. **Phase-1**: The detailed report consisting of activities mentioned in this phase along with the configuration of LPS, sizing, GPR, schematic, BOQ and optimal placement of mast/air terminal etc.

b. **Phase-2**: The detailed report consisting of results of simulation, modelling, rise of potential & interference for various equipment with shielding and grounding solutions.

c. **Phase-3**: The detailed report consisting of experimental results with each iteration shall be provided validating the design and simulation results, the configurations of hardware & software architecture, schemes, specifications and BOQ etc for realization of Lightning data acquisition system.

d. **Phase-4**: Validation of the realized LPS and submission of the results of validation.

8.0 REVIEW AND REPORT:

SDSC SHAR, ISRO, DOS will be responsible for organizing reviews, as per mutually agreed schedule. Institutions/ Bidder shall participate in the reviews and present the necessary documents; study results etc whenever required. Institutions/ Bidder shall also send the status of the project to SDSC SHAR, ISRO, DOS for Review.

9.0 EFFECTIVE DATE OF THIS CONTRACT:

This contract shall be effective from the date of release of the Purchase Order.

Section – D
Bidder Compliance Statement

Bidder Compliance Statement
"Submit along with Technical bid"

Study and Design of Lightning Protection system for Third Launch Pad Project at SDSC SHAR. Bidders have to confirm all the specifications, terms and conditions and requirements as mentioned above and as applicable. **Any deviation shall be clearly brought out separately**. Any unfurnished data or details or documents considered as non-compliance and the offer will be rejected as incomplete bid.

Sl. No	Particulars	Requirement	Quoted by the Bidder	Confirm if conforming to tender specs
1.	Scope of the contract put to tender as detailed in Section- A and all terms and conditions in the Tender.	Bidder shall confirm if the complete scope of the contract is fully understood.		
2.	The scope of work involved in the Phase-1 activity as detailed in Section-B	Please submit and confirm.		
3.	The scope of work involved in the Phase-2 activity as detailed in Section-B	Please submit and confirm.		
4.	The scope of work involved in the Phase-3 activity as detailed in Section-B	Please submit and confirm.		
5.	The scope of work involved in the Phase-4 activity as detailed in Section-B	Please submit and confirm.		
6.	i) Bidder shall be IISc / IITs / NITs / State Universities with experience in the area of lightning protection system study and design for high raised (minimum 70m tall with isolated LPS type) industrial facilities / launch Pad facilities / launch vehicle stage test facilities. **(OR)** ii) Bidder shall be Consultant or OEM or OEM authorized agency with experience in the area of lightning protection system study and design for high raised (equal or above 70m tall	Please confirm and submit relevant documents as roof of the claims including completion reports		

	with isolated LPS type) industrial facilities / launch Pad facilities / launch vehicle stage test facilities.			
7.	Bidder shall have executed similar or relevant type of projects carried out for hazardous area containing highly flammable items for Government of India/National/International/PSU/Private agencies.	Please confirm and submit relevant documents as proof of the claims including completion reports		
8.	Bidder shall have resources like design expert team, software with main frame computer and own/hired laboratory setup for analysis of lightning protection system. Work /experience profiles of the technical /expert staff available with the party shall be furnished.	Please confirm and submit relevant documents as proof of the claims		
9.	The following documents shall be submitted along with the bid. i. Details of the analysis lab with associated hardware &software. ii. License copies of the analysis software's proposed to be used for above work. iii. MoU or Tie-up with reputed laboratories having accreditation certificate.	Please confirm and submit relevant documents as proof of the claims		
10.	If Bidder is not an academic institution, then bidder shall submit proof for having executed project involving study and design of lightning protection system in any firm against a single purchase order of value Rs 36 Lakh or more and two purchase orders of value Rs 27 Lakh.	Please confirm and submit relevant documents as proof of the claims including completion reports		
11.	If Bidder is not an academic institution, then the average annual turnover of the bidder in the last three financial years ending with FY 2023-2024 shall be Rs 54Lakh or more.	Please confirm and submit relevant documents as proof of the claims including		

		completion reports		
12.	**Deliverables** Section C:7.0 are complied	Please note and confirm		
	Phase-1			
	Date of release of Purchase order	T0		
	Site visits / online meetings /Inputs by SDSC SHAR, ISRO, DOS	T0 + 7 Days		
	Preparation of action plan	T0 + 10 Days		
	Development of a sophisticated model and submission of DDR	T0+ 100 Days		
	Phase-2			
	Simulation studies & reporting of main findings	T0+ 150 Days		
	Generate and Review of simulation results and modifications in software	T0+ 210 Days		
	Phase-3			
	Experimental set up and practical tests	T0+ 240 Days		
	Review and compare the simulation and practical results	T0+ 270 Days		
	Submission of the results and reports **(T1)**	T0+ 300 Days		
	Phase-4			
	Validation of LPS to be carried out after realization	T1+ 1095 Days		
13.	a) One set of tender documents duly signed and stamped shall be submitted along with technical bid as token of acceptance. Scanned copy shall be uploaded in the e-procurement portal. b) Latest income tax clearance certificate.	**Please submit**		
14.	The bid cost shall include all costs towards transportation up to site, accommodation, food for the manpower deployed by the Bidder.	Please note and confirm		
15.	Bidder shall submit any additional information that will be asked further, to confirm the authenticity of above compliances/ facts / statements made in technical bid.	Please note and confirm		
16.	All details, relevant documents, test certificates as asked to be attached with technical bid shall be submitted as sought. Claim for submission after	Please note		

	placement of PO or at a later stage will be considered as reason for rejection.			
17.	Bidder may please confirm if terms detailed in Section C:2.0 are complied	Please confirm		
18.	Bidder may please confirm if payment terms detailed in Section C:4.0 are complied	Please confirm		
19.	**Any bids/offers with price details in Techno-Commercial Offer (Part) shall be rejected. Freight charges shall not be mentioned in the Techno Commercial Part of the Bid.**	Please note		