TENDER ENQUIRY

Appendix-I (1/8)

1. Specification of 150 V, 320 kWh Indigenous Lithium-ion Battery with Tray and BMS:

Sl. No.	Parameters	Specifications
1.	**Electrical Characteristic of Indigenous Lithium-ion Battery**	
1.1	Cell Type	Indigenous Li-ion cells of LFP-MCMB chemistry in prismatic configuration based on TOT from NSTL, Visakhapatnam
1.2	Battery Maximum Voltage (OCV)	164.5 V
1.3	Battery Nominal Voltage	150.4 V
1.4	Battery Minimum Voltage	131.6 V
1.5	Nominal capacity at 90% DOD	2135 Ah (minimum)
1.6	Nominal capacity at 100% DOD	2376 Ah (minimum)
1.7	Total capacity with design margin (Considering self discharge , calendar life, etc)	2724 Ah (minimum)
1.8	Total energy at 90% DOD	320 kWh (minimum)
1.9	Total energy at 100% DOD	356 kWh (minimum)
1.10	Total energy with design margin (Considering self discharge , calendar life, etc)	408 kWh (minimum)
1.11	Continuous discharge current	5.84 A
1.12	Pulse discharge current	30A (max) for 60 min (Approx)
1.13	Peak discharge current	150A (max) for 1 min
1.14	Maximum DoD	90%
1.15	No of parallel modules	12 modules
1.16	Discharge duration	Not less than 15 days
1.17	Terminals	Plug-in Anderson connector or better
2.	**Characteristics of Indigenous Single Cell**	
2.1	Minimum capacity	178Ah @ C/5 rate discharge at 90% DoD
2.2	Cell type	Li-ion cells of LFP-MCMB chemistry in prismatic configuration
2.3	Cell case cover and cell lid	Aluminum/ Polypropylene
2.4	Single cell self-discharge of capacity	< 3% per month
2.5	Discharge cut off voltage	2.8V at 100% DoD
2.6	Nominal voltage	3.2V
2.7	Charge acceptance of single cell	The cell should accept the charge at C/5, C/10 & C/20 rate without any loss in capacity. Charge acceptance at C/2 rate may be explored during development.
2.8	Charge cut off voltage	3.6V at 100% SoC
3.	**Weight and dimensions of battery**	
3.1	Diameter	900 mm (± 0.5 mm)
3.2	Length	4600 mm (± 5 mm) with terminals and BMS
3.3	Weight (without shell)	3425 ± 25 kg
4.	**Operational requirements of battery**	

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4.1	Calendar life	3 years at 25^0C
4.2	No. of cycles at 90% DoD	Not less than 200 cycles
4.3	Charge stand period	25 days (without any load on battery)
4.4	State of charge (SoC) during storage	40%
4.5	Discharge stand period	50 days at 40% SoC
4.6	Operating Temperature	Charge: $+15^0$C to $+50^0$C Discharge: $+10^0$C to $+50^0$C
4.7	Storage Temperature	0^0C to $+30^0$C
5.	**Battery Management system**	
5.1	Built in BMS features:	a) Short circuit protection b) Over charge protection c) Over discharge protection d) Over load protection e) Thermal overload protection f) Reverse polarity protection g) Cell balancing during charging and communication with the charger and data display unit h) 1553 communication to Mission Computer System(MCS) by messages: SOC, SOH, Voltage, Discharge current, Battery temp, Error codes, etc with 1553 Interface connector i) Touch screen display device for control and data downloading with USB port & Ethernet connection
5.2	Characteristics of BMS	➢ In-Built BMS with requisite Electronics hardware & programmable Software. ➢ Software shall be upgradable. ➢ Secondary memory storage: Parameters like voltage, current, capacity, temperature during charge, discharge and stand-by periods to be monitored and recorded internally for 15 days period. Should have onboard secondary memory storage. ➢ During battery charging, discharging and stand-by periods, battery conditions (SOC, cell voltages etc.) shall be displayed by in data display unit through communication cable. ➢ Touch screen display device is required to display the parameters like battery voltage, SOC, cell temperature, voltage, battery module conditions, etc.). This display device should be fitted with the battery. The selection of battery banks for discharge & charge and downloading of recorded data should be done via this device.

		➢ Should have communication link to MCS for command. ➢ Less than 20Ah capacity loss due to power consumption by protective components during charge stand period. ➢ BMS should have the provision to be powered by external power supply during discharge stand period or incase the main battery is unable to power the BMS.
5.3	Battery bank selection by BMS for mission duration	BMS will be configured in such a way that it enables exploitation of battery optimally based on mission duration of vehicle. The BMS will load only the required number of battery banks in parallel and these battery banks will be discharged during operation of vehicle. Remaining battery banks will be idle.
5.4	Battery bank selection by BMS during charging	BMS will have feature to charge a particular bank or group of banks in parallel. Remaining battery banks will be idle during charging of other banks.
6.	**Battery charging and charger characteristics**	
6.1	Charging and charger type	CC & CV mode charging through BMS with active balancing. Chargers should charge the cells by in *situ* charging
6.2	Charge Capability	C/20 , C/10 and C/5 rate Option of charging at C/2 rate may be explored.
6.3	Chargers capability and no. of chargers	Single charger should have the capability to charge minimum 2 nos. of battery modules. Hence 6 nos. of chargers for full battery to be used.
6.4	No of charging port in battery tray	Maximum 6 nos. of charging ports are required with MIL grade connectors for charging

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7	**Battery Tray:** The battery tray is meant for assembling the cells by interconnecting the cells and interconnecting 12 nos. of battery modules of 150V and 178Ah with battery management system. The cells and modules are to be arranged and connected in such a way that all the terminals are brought to one side of the bulkhead.	➢ The tray design should withstand shock and vibration specifications and also to be light in weight. ➢ The tray is to be painted with corrosion resistant coating. The trays are to be engineered for better heat transfer and mechanical strength. Polymeric separators/ insulators are to be provided in between cells, modules, tray partitions and inter rows. ➢ Cells are to be rigidly assembled with suitable tie rods etc. ➢ The tray is required to be designed for holding the cells & modules together strongly. End to end tightness through the rods and separators are to be ensured. Provision to be made for integrating the tray to shell by bolting on both sides. ➢ For loading and unloading of tray into the battery shell, suitable rail assembly to be provided in the battery tray.
8.	**Battery Storage**	The batteries are to be stored in inert gas filled metallic shipping container at the prescribed storage condition.
9.	**Battery Storage Container**	Each battery should be supplied along with Nitrogen filled, sealed container with RH indicator & NRV.
10.	**Battery Loading Trolley**	Battery loading trolley is required. It is should have following features: ✓ It should have the hydraulic provision for lifting the battery. ✓ It should have robust nylon wheels for movement. ✓ Battery loading and unloading provision should be there for integration with the shell.

2. 150V, 178Ah indigenous lithium-ion battery module and BMS

Sl. No.	Parameters	Specifications
1.	**Electrical Characteristic of battery**	
1.1	Cell Type	Indigenous Li-ion cells of LFP-MCMB chemistry in prismatic configuration based on TOT from NSTL, Visakhapatnam
1.2	Battery Maximum Voltage (OCV)	164.5 V

1.3	Battery Nominal Voltage	150.4 V
1.4	Battery Minimum Voltage	131.6 V
1.5	Nominal capacity at 90% DOD	178 Ah
1.6	Nominal capacity at 100% DOD	198 Ah
1.7	Total capacity with design margin (Considering self discharge , calendar life, etc)	227 Ah (minimum)
1.8	Total energy at 90% DOD	26.67 kWh
1.9	Total energy at 100% DOD	29.63 kWh
1.10	Total energy with design margin (Considering self discharge , calendar life, etc)	34 kWh (minimum)
1.11	Continuous discharge current	4.315A
1.12	Pulse current	30A (max) for 60 min (Approx)
1.13	Peak current	150A (max) for 1 min
1.14	Maximum DoD	90%
1.16	Discharge duration	1.25 days
1.17	Terminals	Plug-in Anderson connector or better
2.	**Single Cell characteristics**	
2.1	Minimum capacity	178Ah @ C/5 rate discharge at 90% DoD
2.2	Cell type	Li-ion cells of LFP-MCMB chemistry in prismatic configuration
2.3	Cell case cover and cell lid	Aluminum/ Polypropylene
2.4	Single cell self-discharge of capacity	< 3% per month
2.5	Discharge cut off voltage	2.8V at 100% DoD
2.6	Nominal voltage	3.2V
2.6	Charge cut off voltage	3.6V at 100% SoC
3.	**Weight and dimensions of battery**	
3.1	Diameter	Compatible with full battery
3.2	Length	
3.3	Weight (without shell)	
4.	**Operational requirements of battery**	
4.1	Calendar life	3 years at 25^0C
4.2	No. of cycles at 90% DoD	Not less than 200 cycles
4.3	Charge stand period	25 days (without any load on battery)
4.4	State of charge (SoC) during storage	40%
4.5	Discharge stand period	50 days at 40% SoC
4.6	Operating Temperature	Charge: $+15^0$C to $+50^0$C Discharge: $+10^0$C to $+50^0$C
4.7	Storage Temperature	0^0C to $+30^0$C
4.8	BMS	For operation of the single module also BMS is required as per the features listed in Sl.No.5. (Battery management system)

TENDER ENQUIRY

Appendix-II

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List of Deliverables:

List of items:

S.No	Item	Quantity
1.	150V, 320 kWh lithium-ion battery with BMS, Tray , Hardware and storage container	3 nos.
2.	150V, 178 Ah lithium-ion battery module with BMS Tray, Hardware and storage container	2 nos.
3.	Battery charger for full battery (Should be capable of charging individual modules)	2 nos.
4.	Discharge load banks for full battery (Should be capable of discharging individual modules)	2 nos.
5.	Data display unit, handling system and software for full battery (compatible for single module also)	2 nos.
6.	Battery loading trolley with hydraulic lift and loading & unloading provision	1 nos.

List of documents:

S.No	Item	Quantity
1.	Operating manual for 150V, 320 kWh lithium-ion battery with BMS	2 nos.
2.	Operating manual for 150V, 178 Ah lithium-ion battery module with BMS	2 nos.
3.	Design document for 150V, 178 Ah lithium-ion battery module with BMS, 150V, 320 kWh lithium-ion battery with BMS, Tray, Chargers, Electronic load banks, data handling system and battery loading trolley.	2 nos.
4.	Operating manual for Chargers, Electronic load banks, data handling system and battery loading trolley	2 nos.
5.	MQAP document and drawings	2 nos.
6.	Test reports on cell, environmental test reports on battery modules and test reports on full battery	2 nos.

TENDER ENQUIRY

Appendix-IV (1/2)

STAGES OF BATTERY MANUFACTURE AND SUPPLY:

Design & evaluation Schedule: Tentative design schedule involving various activities are given in the table. The firm has to provide a detailed break up of various design activities and time schedule of these activities within a total period of 32 months. Firms may give their delivery schedule keeping in view the overall time frame of NSTL and stages of development/delivery. **Responsibility of design lies with firm not withstanding approval of the documents by NSTL.**

No	Description	No of months
1.	Receipt of Order (T_o)	#
2.	Design of battery mudule, Full Battery, BMS, Tray, Chargers, Electronic load banks, data handling system and battery loading trolley & submission of design documents to NSTL	
3.	Creation of test facility for testing of modules and full battery for 15 days at Firm	
4.	Fabrication & electrical evaluation of 2 nos. of prototype module (150V, 178Ah) with BMS and submission of test reports to NSTL	
5.	Design & proving of BMS components for full battery and submission of test reports to NSTL	
6.	Environmental test on modules (150V, 178Ah) with BMS and tray and submission of test reports to NSTL	
7.	MQAP Preparation & finalization	
8.	Fabrication of 1st battery as per MQAP along with accessories for initial checks and static discharge test for 15 days at firm's premises and submission of test reports to NSTL.	
9.	Manufacture of 2 nos. of full battery as per MQAP, static discharge test for 15 days on these 2 nos. of batteries at firm's premises, submission of test reports to NSTL and supply of these batteries along with common utilities to NSTL.	

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
#																															

Performance tests on battery are to be carried out by the firm to validate the design. Tests are to prove and confirm the design and quality of the product as per specification. NSTL will participate in all tests. Failure to any test, the firm has to repeat the test at its own cost before proceeding to next. Approval of NSTL has to be obtained to proceed to next stage.

S.No	Stages	Milestones	Duration	Total duration
1.	I	Development of prototype module and static discharge test	10 months	10 months
2.	II	Environmental test on modules and submission of test reports to NSTL **Deliverables :** (i) 150 V, 178 Ah lithium-ion battery module with BMS – 2 nos. (ii) Full Battery charger – 1 no. (iii) Electronic load bank for full battery – 1 no. (iv) Data display unit, handling system and software for full battery –1 no. (v) Battery loading trolley for full battery – 1 No	6 months	16 months
3.	III	Manufacture of 1st battery along with accessories for initial checks and static discharge test for 15 days at firm's premises and submission of test reports to NSTL. **Deliverables :** (i) 150 V, 320 kWh lithium-ion battery with BMS, Tray S.No.001 – 1 No Completion of environmental test and developmental activities	8 months	24 months
4.	IV	Manufacture of 2 nos. of full battery, static discharge test for 15 days on these 2 nos. of batteries at firm's premises, submission of test reports to NSTL and supply of these batteries along with common utilities to NSTL. **Deliverables :** (i) 150 V, 320 kWh lithium-ion battery with BMS – 2 No (S.No.002 & 003) (ii) Full battery charger – 1 no. (iii) Electronic load bank for full battery – 1 no. (iv) Data display unit, handling system and software for full battery –1 no.	8 months	32 months