Annexure-2

SCOPE OF WORK

A. PRINCIPAL TEST STAND (PTS)

A1 PTS/01: Hardware Preparation (Hot Test):

a. VIKAS main engine valves 2 nos. shifting from engine assembly to PTS 10 m platform. Mounting these valves on the respective feed lines of 6" NB using M8 screws by torquening & wire locking. Positioning these valves along with the feed lines of 6" NB and tightening using M16 bolts (16 Nos.).`The total quantity of work is 6 Nos in two years.

b. Shifting of VIKAS engine from trailer to engine working platform using the crane system available in PTS. Mounting the engine on the engine mounting adapter using 8 nos. of M12 screws. Assembly of S.S. flexible hoses with water valve 2" NB size using 4 nos. of M14 bolts & 6 Nos. of M5 screws with wire locking. The total quantity of work is 36 Nos in two years.

A2 PTS/02: Pre-Test & Post-Test Activities:

a. Scheduled pre-test activities such as all regulators pressure setting, positioning of the manual valves, recordings of the pressure gauge readings, check list entering etc. The total work quantity is 36 Nos in two years.

b. Scheduled post-test activities such as shutting down of all pressure regulators, re-positioning of the manual valves, manual recording of the pressures, venting of the regulator locked up pressures etc. The total quantity of work is 36 Nos in two years.

A3 PTS/03: Servicing Of Fluid Circuits:

a. *Flange Assembly* :

A couple of flanges are to be assembled / disassembled by toquening / loosening the fasteners of the flanges to install / remove the gaskets. The flange size ranges from 15 NB to 150 NB. The total quantity of the flanges to be attended is 730 Nos in two years.

b. S.S. Tube Assembly :

Tubes of sizes ranging from 8mm to 18 mm are to be removed / torquened for the tests. The total quantity of joints is 880 Nos in two years.

c. *Preparation of Teflon gaskets* :

Circular or rectangular required size gaskets are to be cut from the Teflon sheets of variable thickness ranging from 2mm to 6mm. Total quantity of gaskets to be prepared are 160 nos in two years.

d. *Drilling holes*:

Drilling of holes in SS / MS using portable hand machines or bench drilling machines of drill holes ranges from 12mm ϕ to 33 mm ϕ. Total quantity of holes to be drilled is 120 Nos in two years.

e. *Rigid line Segment*:

Certain pipe line segment has to be handed within the PTS yard for cleaning purpose. The sizes of the pipes vary from 50 NB to 150 NB. Total quantity of pipes to be handled is 280 meters in two years.

A4 PTS/04: Mounting / Dismantling Of All Types Of Fluid Circuit Components (Having Weight More Than 10 Kg):

a. *Flanged Manual valves & EP Valves*:

The given valves shall be taken from a place within PTS test facility to the required location and they shall be mounted with the pipe line flange by stud bolts (max 8 nos. and size M20 size) provided over the flanges at both sides. Providing the necessary temporary supports for valves and shall be mounted with proper alignment. After mounting, leak test shall be carried out to ensure leak tightness by snoop. The size of the valves ranges from 15 NB to 150 NB. Total quantity of valves to be serviced is 100 Nos in two years.

b. *Dismantling and Mounting of Pressure Regulator Assembly:*

Pressure regulator assembly (Dome & Spring type) of weight 5 to 12 kg shall be assembled with the rigid pipeline with proper alignment. The assembly shall have approximately, 6 nos. of M20 to M30 threaded swivel nut joints and 6 nos. 'O' rings. The assembly consists of one pressure regulator and one filter. The filter element shall be mounted inside the filter housing. With proper 'O' rings, the pressure regulator and filter shall be interconnected with proper alignment by threaded (swivel nuts) joints. Further, with proper 'O' rings, the regulators assembly shall be mounted with the pipe line and leak test shall be carried out. The sizes of the regulators ranges from 15 NB to 80 NB. Total quantity of regulators to be handled is 120 Nos in two years.

c. *Disassembly and Removal and Mounting of Filter Elements:*

Sintered type filter element provided in the lines shall be removed and replaced by a fresh one. The housing joint may be of flanged / screwed type with 'O' ring / gasket. After mounting the filter element, leak test shall be carried out by snoop solution to ensure leak-tightness. The sizes of the filters range from 15 NB to 150 NB. Total quantity of filters to be handled is 100 Nos in two years.

d. *Ultrasonic Cleaning of Filter Elements / QC Inspection for Visual Inspection:*

The given filter shall be cleaned as stated below:

1. Rinse the element in Iso-Propyl Alcohol (IPA) solution thoroughly.
2. Purge the element with gaseous nitrogen
3. Clean further in Ultrasonic cleaning machine in IPA bath (Duration 45min. to 1 hr).

After cleaning, elements shall be covered with fresh polythene sheets. The sizes and quantity of filter elements to be handled in two years are OD < 25 mm x 80 mm Long (50 Nos.), OD 60 mm x 200 mm Long (30 Nos.) and OD 60 mm and above (20 Nos.).

e. *Disassembly & Assembly of Burst Disc:*

The given burst disc shall be mounted properly in the assembly. The burst disc and the gasket location shall be thoroughly cleaned before assembly. Further, the assembly shall be mounted between the pipe flanges provided by tightening stud bolts with proper alignment. Leak test with snoop solution shall be carried out to ensure leak tightness at the subject joints. The sizes and quantity of burst discs shall be handled in two years are 100 NB (4 Nos.) on Main run tanks (N, U) and 100 NB (4 Nos.) on additional cooling water tank.

f. *Disassembly and Assembly of Safety Relief Valves:*

The valves shall be taken from a place within PTS facility to the required locations providing necessary temporary supports, the flanged end of the valve shall be mounted with proper alignment over the flange in rigid pipeline with proper gasket. After mounting the valve leak

test shall be carried out to ensure the leak tightness. The sizes of the Safety Relief Valves range from 15 NB to 100 NB. Total number of Safety Relief Valves to be handled is 70 Nos in two years.

g. *Disassembly and Assembly of Turbine / Magnetic Type Flow meters:*

The given flow meters shall be mounted / removal for maintenance purpose. The bolt size varies from M16 to M30 bolts. The sizes and quantity of flow meter flange bolt to be handled in two years are 25 NB 1" x 150 (4 Nos.), 40 NB 1½" x 300 (2 No.), 65 NB 2 ½" x 300 (4 Nos.), 65 NB 2½"x 600 (2 No.) and 150 NB 6"x300 (8 Nos.). (Total: 20 Nos.).

h. *Disassembly and Assembly of Flow Control Valves :*

The given flow control valves shall be mounted / removed for maintenance purposes. The bolt size varies from M16 to M30 bolts. The sizes and quantity of f*low control valves* to be handled in two years are 25 NB 1" x 300 (4 Nos.), 65 NB 2½" x 300 (4 Nos.), 80 NB 3" x 300 (4 Nos.), 100 NB 4" x 300 (4 Nos.). (Total: 16 Nos.).

i. *Disassembly and Assembly of Flexible hoses from the Pipe line:*

Hoses shall be taken to the required location within test facility and connection shall be established between required points. The size of flexible hoses may vary from 8 NB (¼") to 100NB (4"). Flanges shall have max. of 8 nos. of stud bolts of M28 size max. The sizes and quantity of f*lexible hoses* flange bolts to be handled in two years are ≤ 25 NB provided with hex swivel nut (20 Nos.) and ≤ 25 NB & 40 NB (20 Nos.). (Total: 40 Nos.).

j. *Hydro testing / Pneumatic Testing of Flexible hoses of Various Size:*

Hydro testing / Pneumatic testing of flexible hoses shall be done for various sizes. Total number of flexible hoses to be tested is 40 Nos in two years..

k. *Removal & Assembly of Pressure Gauges:*

Bourdon type pressure gauge of dial size 150 mm, each weighing approximately 0.25 kg having end connection "NPT (M) thread shall be removed from the line by unscrewing the thread. The open end of the line interface shall be thoroughly cleaned / purged. The given with thread of similar type winding and shall be mounted over the line with proper torque and alignment. Leak test shall be carried out to ensure leak-tightness when checked with the snoop solution. Total number of pressure gauges to be handled is 360 Nos in two years.

A5 PTS/05: Handling / Mobilization of Materials in and around PTS

a. *Providing Temporary Supports & Clamps*

Replacement of old (used) clamps and tightening the support clamp bolts with soft packings of sizes from 15 NB to 150 NB, Total Qty: 1200 Nos. in two years.

b. *Transportation / Movement of materials*:

Small equipments, flow components, instruments etc shall be transported within Mahendragiri (to and fro max. distance 10 km). Maximum weight of the items(s) to be transported will be limited to 30 kg per trip. Department vehicle will be provided at free of cost. The sizes and quantity of materials to be handled in two years shall be Item weighing ≤ 5 kg (60 Nos.), Item weighing > 10 kg ≤ 20 kg (100 Nos.), Item weighing > 20 kg ≤ 30 kg (60 Nos.) and Item weighing > 30 kg (40 Nos.) (Total Qty: 260 Nos.).

c. Handling / Mobilization of Materials:

Preparation and mobilization of slings and 'D' shackles for lifting of various hard wares at facility including engine and tanks & load test blocks. The quantity of materials to be handled in two years shall be 60 MT.

d. Tightening & Torquening of bolts:

Tightening & torquening of bolts of size varying from M12 to M36. The quantity of bolts to be handled in two years shall be 200 Nos.

A6 PTS/06: Work Related To Neutralizers Columns And D.M. Water Plant Regeneration Works):

a. Cleaning of neutralizer columns, solution storage tanks and filling of chemicals:

The scrubber neutralizer column shall be flushed with water (min. three times) and then allowed it to dry for 24 hours. The scrubber column shall be re-circulated with fresh urea solution & Nitric acid solution. Then the scrubber column is allowed for drying. The quantity of chemicals to be handled in two years shall be 4000 Liters.

b. Removal, cleaning of Hydraulic oil:

Removal, cleaning and assembly of hydraulic oil filters for hydraulic jack system and replacing of oil. The quantity of hydraulic oil to be handled in two years shall be 1000 Liters.

c. *Preparation of Chemical for D.M. plant*:

Preparation of chemical for DM water plant regeneration. Regeneration of DM water plant as per standard. Collection of water and checking the quality of water. The quantity of chemical to be handled in two years shall be 400 Liters.

A7 PTS/07: Hydro Testing of Tanks

Propellant is to be drained from Run tanks, over flow tanks and drain tanks. Total system shall be purged with GN2. The system components like pressurization circuit, Burst disc, pressure transmitter tube, Scrubber vent line, Level indicator in the run tanks (UH25 & N_2O_4), overflow tanks (UH25 & N_2O_4) and drain tanks (UH25 & N_2O_4) are to be removed, cleaned and installed after hydro-testing using dummy flanges.(Total quantity of works in two years is 14 Nos.).

A8 PTS/08: High Pressure Cylinders Requalification:

Seven 2.2 m^3 & one 1 m^3 capacity GN2 cylinders shall be dismantled from PTS. Supporting the loading and unloading of cylinders during its requalification programme to be done in GCTF. The total quantity of cylinders to be handled in two years shall be 16 Nos.

A9 PTS/09: Engineering Drawings:

Making of as built drawing, Preparation of P&I (Process & Instrumentation) Diagrams, Preparation of isometric diagrams and list of fluid components , Preparation of structural / fabrication drawings using Auto CAD, Preparation of equipment layout diagrams, Field supervision of erection, commissioning and testing of piping works and maintaining log book. Total number of drawings to be drawn in two years shall be 300 Nos.

B) AUXILIARY TEST STAND (ATS)

B1 ATS/01: Assembly Of Injector(25 Kg)

Assembly of injectors for calibration using 3 nos. of 'O' rings. Moving the injectors from ground floor to 3 m level platform and to assemble in the calibration bed using 48 nos. of M14 size bolts. The total number of Injectors to be assembled in two years shall be 160 Nos.

B2 ATS/02: Disassembly Of Injector(25 Kg)

Disassembly of injectors after calibration by unscrewing 48 nos. of M14 size bolts, moving the injector from 3 m platform to ground floor and finally to remove 3 nos. of 'O' rings. The total number of Injectors to be disassembled in two years shall be 160 Nos.

B3 ATS/03: Assembly Of Central Support Unit (40 Kg) With The Injector

Lifting the unit using chain pulley block to a height of 1 m from the platform level and positioning on the top of the injector cover. Assembly of the unit using 8 nos. of M14 size bolts and to mate with feed line flange using 16 nos. of M20 size bolts. The total quantity of assembly in two years shall be 160 Nos.

B4 ATS/04: Disassembly Of Central Support Unit (40 Kg) From The Injector

Disconnection of feed line flange by loosening 16 nos. of M20 bolts, removal of 8 nos. of M14 bolts and to bring down to platform using chain pulley block. The total quantity of disassembly in two years shall be 160 Nos.

B5 ATS/05: Assembly Of High Regime Calibration Test Set Up(80 Kg)

Assembly of mounting legs using 6 nos. of M12 bolts and 6 nos. of M20 bolts, assembly of the unit with the U torroid using 12 nos. of M12 bolts and assembly of the drain line using 6 nos. of M20 bolts. The total quantity of assembly in two years shall be 16 Nos.

B6 ATS/06: Disassembly Of High Regime Calibration Test Set Up (80 Kg)

Disassembly of the drain line using 6 nos. of M20 bolts, disassembly of the unit from the U torroid using 12 nos. of M12 bolts, disassembly of mounting legs using 6 nos. of M12 bolts and 6 nos. of M20 bolts. The total quantity of disassembly in two years shall be 16 Nos.

B7 ATS/07: Purging Of Injector For Moisture Removal

Purging using the air gun in the internal and external surface of the injector till the moisture gets removed. Packing the injector with air bubble sheet and moving the injector from the assembly table to storage rack. The total quantity of this work in two years shall be 200 Nos.

B8 ATS/08: Assembly Or Disassembly Of Bolted Joints On Per Bolt Basis.

Tightening or loosening of bolts in the bolt joints. The sizes of the bolts range between M20 to M30 (4000 nos.) and above M30 to M40 (2000 nos.). The total quantity of this work in two years shall be 6000 Nos.

B9 ATS/09: Mounting / Dismantling Of All Types Of Flow Components (Having Weight More Than 10 Kg)

Electro Pneumatic / Manual valves, Pressure Regulator, Safety relief valve, Control valves etc. from the pipe lines on per kg basis. The total weight of materials to be handled in two years shall be 4000 Kgs.

B10 ATS/10: Cleaning Of 6" Sintered Filter Elements.

Disassembly of dome portion of the filter from the filter body by removing 20 nos. of M32 bolts, disassembly of 4 nos. of filter elements screwed inside the filter body and ultrasonic cleaning of the 4 filter elements. Assembly of 4 nos. of filter elements back in its position and assembly of dome portion with the filter body using 20 nos. of M32 bolts. The total quantity of this work in two years shall be 20 Nos.

B11 ATS/11: Cleaning Of Underground Water Storage At ATS Of Volume 70000 Litres.

The Storage is having a depth of 2.5 m and length & breadth of 9 m x 3.5 m. Removing all the sediments collected inside the storage, collection pit and the storage walls, cleaning of the wall and floor using the cleaning agents provided by the department, rinsing the sump by filling fresh water and removal of the rinsed water. The total quantity of this work in two years shall be 10 Nos.

B12 ATS/12 : Movement Of Materials On Per Kg Basis Having Weight More Than 10kg

Transportation of materials within ATS or to other facilities inclusive of loading and unloading, the materials will be in the form of pipelines, structural materials, fixtures, spool pieces, valves, actuators, pumps fittings of higher sizes etc. The total weight of materials to be handled in two years shall be 4000 Kgs.

B13 ATS/13 : Transportation Of Ghe Quad (Group Of 54 Nos. Of 50 Litres Cylinders)

Mobile crane loading into the truck at one place and Mobile crane unloading from the truck at another place using the nylon slings. Necessary crane support will be provided by us. The total quantity of this work in two years shall be 40 Nos.

B14 ATS/14 : Transportation Of 50 Litre Ghe Cylinders In Group Containing 5 Nos. Of Cylinders.

Manual Loading into the truck at one place and Manual unloading from the truck at another place 5 nos. of cylinders at a time. Necessary truck support will be provided by us. The total work quantity two years shall be 40 Nos.

B15 ATS/15 : Fitting And Maintenance Works On Per Hour Basis:

Involves material cutting using Hand hacksaw, drilling operation using hand and bench drilling machines and grinding operation using portable grinding machine. The material will be Mild steel, Stainless steel, Teflon. Applying lubrication oil and grease on moving and threaded parts, Oil changing in the compressor. The total number of hours required in two years shall be 2000 hours.

B16 ATS/16 : Pre Test & Post Test Related Activities For Water Calibration:

Pre test Activities:

Opening of high pressure cylinders, Water tank filling, Regulators setting and Manual valves setting

Post test activities:

Manual valves opening, Regulators shall be brought to ambient pressure, All pipe lines venting and Closing of high pressure cylinders.

The total quantity of this work in two years shall be 500 Nos.

B17 ATS/17 : Pre Test & Post Test Related Activities For Umbilical Test:

Pre test Activities:

Opening of high pressure cylinders, Actuator pressure setting and Working Platform (swing type) unfolding

Post test activities:

Working Platform (swing type) folding, Regulators shall be brought to ambient pressure and Closing of high pressure cylinders.

The total quantity of this work in two years shall be 200 Nos.

C) REACTION CONTROL SYSTEM TEST STAND (RCS) / PS4 ENGINE TEST FACILITY (PET)

C1 RCS/PET/01: Test Hardware Related Activities:

Shifting of engine from Engine assembly room to the test bay & test bay to the assembly room. The engine shall be mounted on the engine mounting adaptor using M8 bolts & nuts (4 nos.). Feed line hose shall be connected to the feed line port of engine valve. Engine command line flexible hoses shall be connected to the command pressure port of engine valve. Purge line hose shall be connected to the purge line port of engine valves. Assembly & disassembly of engine bottom cover during leak check (16 nos. of M5 screws) and flexible hose connection to the engine bottom cover. The total quantity of this work in two years shall be 100 Nos.

C2 RCS/PET/02: Pre Test Activities:

Regulators shall be set to required set pressure and the respective Manual valves shall be opened for the test. The total quantity of this work in two years shall be 200 Nos.

C3 RCS/PET/03: Post Test Activities:

Regulators pressure shall be made to ambient pressure, draining of propellant from feed line, purging of feed line and engine and removal of tested hardware from the test bed and shifting the engine to the assembly room. The total quantity of work in two years shall be 200 Nos.

C4 RCS/PET/04: Propellant Related Activities:

The propellant shall be filled from the PTU to the respective run tanks in pressurization mode. Fill line flexible hoses and PTU pressurization flexible hoses shall be connected to the respective ports. Propellant from the propellant tanks shall be transferred to the PTU in pressurization mode after hot test. Fill line flexible hoses shall be connected to the respective ports. The total quantity of this work in two years shall be 48 Nos.

C5 RCS/PET/05: Scrubber Related Activities:

Cleaning of neutralizer columns, solution storage tanks and filling of chemicals:

The scrubber neutralizer column shall be flushed with water (min. three times) and then allowed it to dry for 24 hours.

Re-circulation of chemicals in scrubber columns:

The scrubber column shall be Re-circulated with fresh urea solution & Nitric acid solution. Then the scrubber column is allowed for drying.

The total quantity of this work in two years shall be 24 Nos.

C6 RCS/PET/06: Test Stand Services:

Dismantling, assembly and mounting of different size flange joints:

This refers to aligning of the pipe flanges (2 nos.) and positioning of gasket properly and tightening the flanges with proper torque with the given stud bolts and nuts. The size of the stud bolt may vary from M8 to M18 max. The sizes of propellant service components range from 15 NB to 50 NB. Total number of propellant service components to be handled are 280 in two years. Flanges and gasket shall be thoroughly cleaned with the given cleaning agent before assembly.

Fabrication of Teflon gaskets from Teflon sheet:

Circular or rectangular Teflon gasket to the required dimension shall be cut from the given Teflon sheet. The cut area shall be smoothly filed to bring the required regular shape and size. The sizes of Teflon sheets to be handled in two years are ≤ 2 mm thick Teflon sheet (20 Nos.), > 2 mm and ≤ 4 mm thick Teflon sheet (20 Nos.), > 4 mm and ≤ 6 mm thick Teflon sheet (20 Nos.).

Disassembly and assembly of rigid pipe line segments of various sizes:

The given pipe line segment shall be taken to the required location within test facility and connection (threaded/Flanged) shall be established after thoroughly cleaning them with the cleaning agent. The sizes of pipe line segments range from ≤ 25 NB to 40 NB. Total quantity of pipe line segments in two years are 150 Nos.

Participation in pneumatic leak testing of pipeline circuits:

The pipe line shall be pressurized to required test pressure and the pipe shall be subjected leak test with the snoop solution. The sizes of pipe line circuits range from ≤ 25 NB to 40 NB. Total quantity of pipe line circuits in two years are 150 Nos.

The total quantity of above test stand services in two years shall be 4 Nos.

C7 RCS/PET/07: Assembly & Dismantling Of Fluid Service Components:

Dismantling, assembly and mounting of flanged E/P valves & manual valves:

The EP valves manual valves shall be mounted with the pipe line flange by stud bolts (max 6 nos. and size M18 per side) provided over the flanges at both sides. Providing the necessary temporary supports the valves shall be mounted with proper alignment. After mounting, leak test shall be carried out to ensure leak tightness over snoop. The sizes of fluid service components range from 15 NB to 25 NB. Total quantity of fluid service components to be handled in two years is 36 Nos.

Mounting of clamps:

The hose clamps with the given screws/studs and nuts. The sizes and quantity of clamps to be handled in two years are ≤ 25 NB (100 Nos.), > 25 NB and ≤ 40 NB (100 Nos.).
Total quantity of the above works in two years shall be 24 Nos.

C8 RCS/PET/08: Periodic Maintenance Yearly Twice:

Fresh Neutralizer solution change:

The fresh neutralizer solution shall be changed twice in an year. Total 4 times in two years.

Dismantling and assembly of pressure regulator assembly:

Pressure regulator assembly of weight 2 to 5 kg has to be assembled with the rigid pipeline with proper alignment for replacement/periodical service. The assembly shall have approximately, 6 nos. of M18 to M20 threaded swivel nut joints and 6 nos. 'O' rings. The assembly consists of one pressure regulator and one filter. The filter element has to be mounted properly inside the filter housing. With proper 'O' rings, the pressure regulator and filter have to be interconnected with proper alignment by threaded (swivel nuts) joints. Further, with proper 'O' rings, the regulator assembly shall be mounted with the pipe line and leak test shall be carried-out over on the interconnecting joints. The joints are to be leak tested with snoop solution to ensure the leak tightness. The sizes of pressure regulators range from 15 NB to 25 NB. Total quantity of pressure regulators to be handled in two years is 30 Nos.

Storage & Housekeeping activities of fluid components:

Stock verification of fluid components, pipe lines, stacking of fluid components and pipe lines to respective storage rack.

The quantity for the above periodic maintenance works in two years shall be 4 Nos.

C9 RCS/PET/09: Hydro Testing Of Tanks:

Propellant is to be drained from Run tanks, over flow tanks and drain tanks. Total system are to be purged with GN2. The system components like pressurization circuit, Burst disc, pressure transmitter tube, Scrubber vent line, Level indicator in the run tanks (UH25 & N_2O_4), overflow tanks (UH25 & N_2O_4) and drain tanks (UH25 & N_2O_4) are to be removed, cleaned and installed after hydro-testing using dummy flanges. Filling 1000 L of water to the run tanks, circulating the same water to the corresponding prime and drain tanks and finally draining to the ETP collecting pit. Hydro testing to the required pressure, Purging to the required PPM level and Mounting the components & leak check. The total quantity of hydro testing of tanks to be carried out in two years shall be 12 Nos.

C10 RCS/10: Handling To Transport Small Equipments & Flow Components:

Small equipments, flow components, instruments etc shall be handled within Mahendragiri by loading and unloading for transporting. The total quantity of small equipments and flow components (Item weighing from 1 kg to 10 kg) to be handled in two years are 500 Nos.

C11 RCS/PET/11: Periodic Maintenance Yearly Once:

Dismantling, ultrasonic cleaning and assembling of Propellant filter elements in filter body:

Sintered type filter element from the housing provided in the lines shall be removed and replaced by a fresh one. The housing joint may be of flanged/screwed type with 'O' ring/gasket. After mounting the filter element, leak test shall be carried-out by snoop solution at the subject joint to ensure leak-tightness. The sizes of filter elements range from 15 NB to 25 NB. Total quantity of filter elements to be handled in two years is 16 Nos.

Removal and assembly of flexible hoses after hydro Test:

Hoses shall be taken to the required location within test facility and connection shall be established between required points. The size of flexible hoses may vary from 6 NB (1/4" NB) to 25 NB (1" NB). The sizes and quantity of flexible hoses to be handled in two years are $\leq$ 15 NB (max. length of hose 10 m) (30 Nos.) and $\leq$ 25 NB-provided with hex. Swivel nuts at both ends (max. length of hose 5 m) (16 Nos.)

Removal and assembly of pressure gauges:

Bourdon type pressure gauge of dial size 150 mm, each weighing approximately 0.25 kg having end connection ½"NPT(M) thread shall be removed from the line by unscrewing the thread. The open end of the line interface shall be thoroughly cleaned / purged. The given fresh gauge of similar type shall be provided with thread seal/Teflon tape winding and shall be mounted over the line with proper torque and alignment. Leak test shall be carried-out to ensure leak-tightness when checked with the snoop solution. Total quantity of pressure gauges to be handled in two years is 50 Nos.

Dismantling, ultrasonic cleaning and assembling of GN2 filter elements in filter body:

Sintered type filter element from the housing provided in the lines shall be removed and replaced by a fresh one. The housing joint may be of flanged/screwed type with 'O' ring/gasket. After mounting the filter element, leak test shall be carried-out by snoop solution at the subject joint to ensure leak-tightness. The sizes of filter elements range from 15 NB to 25 NB. Total quantity of filter elements *to be handled* in two years is 16 Nos.

Circulation pump oil changing:

The scrubber solution circulation pump to be serviced and oil to be replaced with new oil.

The total number of the above the periodic maintenance works to be carried out in two years is 2 nos.

D) LIQUID UPPER STAGE-TEST FACILITY (LUS-TF)

D1 LUS-TF/01: PS4 Engine Handling:

This includes shifting of engine from Engine assembly room to the test stand and the engine shall be mounted on the engine mounting fixture using M8 bolts & nuts (8 nos.). After that N_2O_4 & MMH feed line hoses (8 nos.) shall be connected to the feed line ports of engine valve and the feed lines to be subjected to pneumatic leak check at 10 bar pressure. After the completion of test the engine is to be dismantled from the test stand and brought back to Engine assembly room. Total quantity of PS4 engines to be handled in two years is 80 Nos .

D2 LUS-TF/02: Pre Test Activities:

Valve Command pressure shall be set to 8 bar in the pressure regulator. Leak check shall be done in chamber pressure sensor using insitu verification set up for 8 bar. Wire locking the thermocouple connectors, silica cloth winding to cover thrust measurement system, connectors and cables inside vacuum chamber. Loading & unloading the standard dead weights for thrust measurement system calibration. Cleaning of vacuum chamber & view port using isopropyl alcohol solution. Closing of vacuum chamber, Closing of air admittance valves. First switching on the cooling water pump & cooling tower fan, then switching on the two vacuum pumps. Setting of pressure regulators. Opening the feed line manual valves as per the hot test check list. The number of pre test activities in two years shall be 80 nos.

D3 LUS-TF/03: Propellant Handling:

Propellant fill line flexible hoses and PTU pressurization flexible hoses shall be connected to the respective ports. Regulators shall be set and the propellant shall be filled from the PTU to the respective run tanks in pressurization mode. After filling the propellant, system shall be brought back to original position. After the test, drain line flexible hoses shall be connected to the respective ports and propellant from the propellant tanks shall be transferred to the PTU in

pressurization mode. All the activities should be followed as per the document. The number of times the propellant to be handled in two years shall be 40 Nos.

D4 LUS-TF/04: PS4 Engine Hot Test Works:

Switching on the Command Compressor. Setting of the five regulators as per the respective test requirements. Prepressurization of Oxidizer and Fuel tanks to the preset values. Opening of the High pressure system up to the Control valves. Ensuring the open status of the C-top Manual Valve for cooling system and the tanks water level. Opening of the Pc sensor water. Linking Vacuum chamber till the ultimate vacuum is achieved. Final checking of the position of all valves in the test facility shall be done as per the check list. The quantity of PS4 engine hot test works in two years shall be 80 Nos.

D5 LUS-TF/05: PS4 Engine Post Test Works:

Venting of the propellant tanks till 2.5 bar(a) by operating the tank vent valves. Admitting air inside the Vacuum chamber by operating the air admittance valve. Opening the vacuum chamber lid using the test facility overhead crane and keeping the Vacuum chamber lid in the supports. Removal of the silica cloth cover. Flushing of propellants available in the feed lines and removing the flexible hoses, thermo couple wires, Pc connectors etc.

Removing the PS4 engine from the thrust fixture and to keep it in the engine assembly room. Closing of the cooling system Manual valves and high pressure Manual valves. Unloading of all five regulators to ambient and shut down of all Manual valves in the GN2 pressurization system. The number of post test works in two years shall be 80 nos.

D6 LUS-TF/06: Periodic Maintenance Work:

Draining the used vacuum pump lubrication oil from the vacuum pumps and to fill with new oil. Removing, Cleaning and mounting of 5 and 14 micron filters in feed lines. Removal and mounting of safety relief valves for calibration. Cleaning of 40 micron filter in the GN2 line. The scrubber tank shall be flushed with water and then allowed it to dry for 24 hours. Then allow the scrubber column for drying. The scrubber column shall be filled with fresh urea solution& acetic acid solution in MMH &N2O4. Scrubbers respectively. Removing, Cleaning and mounting of 1000 micron filters in cooling system & Cleaning of cooling tower. The quantity of periodic maintenance work to be carried out in two years shall be 48 Nos.

D7 LUS-TF/07: General Replacement Package:

Flexible hoses shall be taken to the required location within test facility and connection shall be established between required points. The size of flexible hoses may vary from 1/4" NB, 1/2" & 1" NB. The burst disc shall be mounted properly in the assembly by 4 nos. of M6 screws and the assembly has to the mounted over the tanks using bolts and nuts. After every assembly Leak test with snoop solution shall be carried-out to ensure leak tightness at the subject joints. The EP valves manual valves shall be mounted with the pipe line flange by stud bolts (size M12/M14) provided over the flanges at both sides. Providing the necessary temporary supports the valves shall be mounted with proper alignment. After mounting, leak test shall be carried out to ensure leak tightness by snoop solution. Bourdon type pressure gauge of dial size 150 mm, each weighing approximately 0.25 kg having end connection ½ " NPT (M) thread shall be removed from the line by unscrewing the thread. The open end of the line interface shall be thoroughly cleaned / purged. The given fresh gauge of similar type shall be provided with thread seal/Teflon tape winding and shall be mounted over the line with

proper torque and alignment. Leak test shall be carried-out to ensure leak-tightness when checked with the snoop solution. The quantity of general replacement package work in two years shall be 48 Nos.

D8 LUS-TF/08 Spares Handling:

Arrangement of spares such as Manual valves, pneumatic valves, filters, flexible hoses, fittings, pressure gauges etc. in the identified racks. Periodic verification and cleaning of the stock properly for record keeping purposes. The total quantity of the above work in two years shall be 24 Nos.

E) SPACECRAFT THRUSTER TEST FACILITY (STTF)

E1 STTF/01: AOCS Engine Mounting:

Handling of AOCS engine from Engine assembly room to the test stand. Mounting the engine in the aluminium fixture which is above the load cell assembly using 4 nos. of M6 bolts & nuts with ablative washers. After mounting the engine, proper alignment should be done. The two feed lines hoses shall be first purged with GN_2 at 3 bar pressure. Then the feed lines are connected to the engine valves. Thermocouples and engine power cables are routed properly in the routing channel. Feed lines are tied by 1 mm SS wire to the engine mounting frame for rigidity. Feed line hoses shall be leak checked at 18 bar pressure using snoop solution. The total quantity of AOCS engine mounting in two years is 200 Nos.

E2 STTF/02: Pre Test Work Package:

Electro pneumatic valves Command pressure shall be supplied by setting the regulator to 8 bar. Leak check shall be done in chamber pressure sensor in insitu verification set up for 8 bar. Wire locking the thermocouple connectors, silica cloth covering of all wires and cables inside vacuum chamber. Loading & unloading the standard dead weights for thrust measurement system calibration. Cleaning of vacuum chamber & view port using isopropyl alcohol solution. Closing of vacuum chamber with four push locks. Closing of air admittance valves. First switching on the cooling water pump & cooling tower fan, then open the water ejector line manual valves for purging of feed lines. Setting of two injection pressure regulator to 16.5 bar. Switching on the two vacuum pumps in the vacuum line. Opening the feed line manual valves as per the hot test check list. The total quantity of work in two years is 200 numbers.

E3 STTF/03: AOCS Hot Test:

Line filling activities in the propellant feed lines. Command pressure shall be given to the high pressure control valve and opening of the high pressure manual valves in the high pressure air bank. Keeping all the Manual valves as per the check list before vacating the test facility. The total quantity of work in two years is 200 numbers.

E4 STTF/04: Post Test Work Package:

Closing of high pressure manual valves and command pressure for control valve in high pressure area. Purging of feed lines with water ejector. Switch off the vacuum pumps, cooling water pump and cooling tower fan. Closing of all feed line manual valves. Opening of air admittance valve in vacuum chamber. Opening of vacuum chamber lid. Removal of SS wire lock and feed line hoses as per the check list sequences. The total quantity of work in two years is 200 numbers.

E5 STTF/05: Dismantling of AOCS Engine

Removal of the engine from the aluminium fixture by loosening four numbers of M6 bolts & nuts and ablative washers. Handling of tested AOCS engine to the cleaning table and cleaning the engine. Carry the engine from the test stand to the Engine assembly room. Cleaning of vacuum chamber with wet cloth. Keeping the engine in the container for transportation. The total quantity of work in two years is 200 numbers.

E6 STTF/06: Regular Maintenance Work

Draining the used vacuum pump lubrication oil from the Vacuum pumps and to fill with new oil. Cleaning and mounting of feed line 10 micron filters from feed lines. Removal and mounting of safety relief valves for calibration. Cleaning of 100 micron filter in the GN_2 line. The scrubber tank shall be flushed with water and then allowed it to dry for 24 hours. Then allow the scrubber tank for drying. The Ox scrubber shall be filled with fresh urea solution & fuel scrubber shall be filled with acetic acid solution. Cleaning of cooling tower with soap powder, after drying fill with required quantity of water. The total quantity of work in two years is 48 numbers.

E7 STTF/07: Propellant Handling:

Connecting PTU and STTF plumbings by tightening the flange joints (4 nos.). Opening of all propellant transfer line Manual valves. The propellant shall be filled from the tanker to the respective run tanks in pressurization mode. At the time of draining, the fill line flexible hoses and tanker pressurization flexible hoses shall be connected to the respective ports by tightening flange joints (4 nos.). Draining off the propellant from STTF tanks to PTU tanks shall be done as per the check list. The total quantity of work in two years is 12 numbers.

E8 STTF/08: Miscellaneous Jobs

Purging of feed lines by water ejector. Removal of four mass flow meters, two turbine flow meters, electro pneumatic valves & Manual valves, feed line pipes & tubes. Providing necessary temporary supports to the valves and they shall be mounted with proper alignment. After mounting, leak test shall be carried out to ensure leak tightness by snoop solution. The total quantity of work in two years is 24 numbers.

E9 STTF/09: Preparation of Fabrication and Isometric Drawings

Preparation of fabrication drawings for vacuum chamber view port flanges, drawings of components and mounting fixtures for TDP trials. Preparation of Isometric drawings for structural components and preparation of fabrication drawings for STTF. The total quantity of work in two years is 100 numbers.

F) SCRAMJET PROPULSION TEST FACILITY (SPTF)

F1 SPTF/01: Test Hardware Related Activities:

This refers to assembling test article based on test conditions. Positioning of the module in the test bed, aligning and bolting (M16- 160 Nos.) & connecting facility interfaces by bolting (M 20 & M 16, 120 Nos.). After assembly of the total Air Heater, it shall be leak tested for 10 bar using GN_2 by closing exit of the module and after leak test the end closure shall be removed & GN_2 circuit shall be isolated. The total quantity of work in two years is 80 numbers.

F2 SPTF/02: Pre test & Post test Related Activities:

Pre test activities: During pre test activities the system shall be pressurized by setting the regulator and opening the respective valves and line priming shall be done for fuel line using vacuum pump and cooling water priming will be done by opening outlet valves. All the chronology operation will be done as per check list, GO2 / Air line priming will be done up to test article valves.

Post test operation: After the Hot test all the feed line circuit is isolated from the source fuel will be back washed to tank.

The total quantity of the above works in two years is 80 numbers.

F3 SPTF/03: Fuel / D.M Water Related Activities:

Ethanol is used as fuel for the Air heater. Connect the diaphragm pump with the run tank and ethanol storage barrel by means of flexible hoses. Set and apply 7 bar command to the diaphragm pump so as to start pumping. Once the required quantity is filled, stop pumping by stopping the Command pressure. Remove the plumbings connected with the pump and container. Remove ethanol container from the test stand to the safe area.

D.M Water is used as the coolant for Air heater. Connect the diaphragm pump suction with the D.M water storage tank fill line and the delivery to the D.M water run tank. Admit 7 bar to the diaphragm pump to start filling. Monitor the quantity of D.M water loaded in the run tank by comparing the DP value. Once the required level is attained stop command pressure. Disconnect inlet and outlet flexible hoses. All the sequence of valves shall be followed as per the check list.

The total quantity of the above works in two years is 80 numbers.

F4 SPTF/04: GO_2 / High Pressure Air filling:

Check initially all the valves in the line connecting LOX pump and GO2 cylinder are in closed condition. Sequence the Manual valve on/off position as per the GO2 filling procedure document. Connect LOX tanker flexible hose flange with the LOX pump inlet flange by tightening 4 nos. of M12 bolts. Monitor the cylinder pressure till it reaches 250 bar. Disconnect LOX tanker flexible hose flanges to the LOX pump inlet flange by removing 4 nos. of M12 bolts. Position all the valves of the GO2 line in the GO2 after filling configuration.

Leak testing of air cylinder fill lines in High Pressure Storage system (80 Nos. of high pressure cylinders with 2.2 m^3 capacity at 300 bar), opening of cylinder valves for air filling in 80 nos. of high pressure cylinders, monitoring of cylinder pressure and closing the fill line valves, line filling by operating air distribution valves. The total quantity of work in two years is 80 numbers.

F5 SPTF/05: Service Work Package:

The EP valves manual valves shall be mounted with the pipe line flange by stud bolts (max 6 nos. and size M18 per side) provided over the flanges at both sides. Providing the necessary temporary supports the valves shall be mounted with proper alignment. After mounting, leak test shall be carried out to ensure leak tightness over snoop. The sizes of E/P valves & manual valves range from 15 NB to 80 NB.

Bourdon type pressure gauge of dial size 150 mm, each weighing approximately 0.25 kg having end connection ½ ” NPT (M) thread shall be removed from the line by unscrewing the thread. The open end of the line interface shall be thoroughly cleaned/ purged. The given fresh gauge of similar type shall be provided with thread seal/Teflon tape winding and shall be mounted over the line with proper torque and alignment. Leak test shall be carried-out to ensure leak-tightness when checked with the snoop solution.

Pressure regulator assembly of weight 2 to 5 kg has to be assembled with the rigid pipeline with proper alignment for replacement/periodical service. The assembly shall have approximately, 6 nos. of M20 to M30 threaded swivel nut joints and 6 nos. ‘O’ rings. The assembly consists of one pressure regulator and one filter. The filter element has to be mounted properly inside the filter housing.

With proper ‘O’ rings, the pressure regulator and filter have to be interconnected with proper alignment by threaded (swivel nuts) joints. Further, with proper ‘O’ rings, the regulator assembly shall be mounted with the pipe line and leak test shall be carried-out over on the interconnecting joints. The joints are to be leak tested with snoop solution to ensure the leak tightness. The sizes of pressure regulator assemblies range from 15 NB to 50 NB.

Sintered, Pleated type filter element from the housing provided in the lines shall be removed and replaced by a fresh one. The housing joint may be of flanged/screwed type with ‘O’ ring/gasket. After mounting the filter element, leak test shall be carried-out by snoop solution at the subject joint to ensure leak-tightness.

The total quantity of above service work package in two years is 80 numbers.

F6 SPTF/06: Periodic Maintenance & Recalibration of fluid components:

The following fluid components and tanks should be qualified based on its functionality/performance. Burst diaphragm replacement (5 Nos.), Flexible hose pneumatic test (2 Nos.), Safety relief valve recalibration (25 Nos.), Bellows (40 Nos.), Pressure gauge recalibration (30 Nos.), Propellant tank hydro test (4 Nos.), GN2 cylinder recalibration (22 Nos.), GN2 buffer bottle hydro test (25 Nos.), Mass & turbine flow meter (10 Nos.) and calibration of sensors (75 Nos.).

The total quantity of periodic maintenance and recalibration of fluid components in two years is 12 nos.

F7 SPTF/07: Hydro testing:

Ethanol / Isrosene / Water is to be drained from the respective Run tanks. Total system are to be purged with GN2. The system components like pressurization circuit, SRV & Burst disc, pressure transmitter tube and Level indicator in the run tanks (Ethanol/Isrosene/Water) are to be removed, cleaned and installed after hydro-testing using dummy flanges. Filling DM water to the run tanks, then to carry out the hydro test to 1.5 times the design pressure of the respective tanks.

The total number of hydro testing in two years is 4 numbers.

F8 SPTF/08: Handling to transport small equipments & flow components:

Small equipments, flow components, instruments etc shall be handled within Mahendragiri by loading and unloading for transporting. The total quantity of equipments and flow components

(Item weighing from 1 kg to 30 kg) to be handled are 1500 MT. The total quantity of this work in two years is 4 numbers.

F9 SPTF/09: Preparation works for Pilot Igniter System:

Transportation of 50 lit cylinders for GH2/GO2 filling, collection of gas samples for purity analysis, leak testing of pilot igniter circuit using GHe and line filling with GH2/GO2.

The total quantity of this work in two years is 24 Nos.

G) LIQUID APOGEE MOTOR-TEST FACILITY (LAM-TF)

G1 LAM-TF/01: LAM Engine Handling:

This includes shifting of engine from Engine assembly room to the test stand and the engine shall be mounted on the engine mounting fixture using M6 bolts & nuts (3 nos.), heat shield assembly with Engine. After that N_2O_4 & MMH feed line hoses (8 nos.) shall be connected to the feed line ports of engine valve and the feed lines to be subjected to pneumatic leak check at 10 bar pressure. After the completion of test the engine is to be dismantled from the test stand and brought back to Engine assembly room. The total quantity of work in two years is 80 Nos.

G2 LAM-TF/02: Pre test Activities:

Valve Command pressure shall be set to 8 bar in the pressure regulator. Leak check shall be done in chamber pressure sensor using insitu verification set up for 8 bar. Wire locking the thermocouple connectors, silica cloth winding to cover thrust measurement system, connectors and cables inside vacuum chamber. Loading & unloading the standard dead weights for thrust measurement system calibration. Cleaning of vacuum chamber & view port using isopropyl alcohol solution. Closing of vacuum chamber, Closing of air admittance valves. First switching on the cooling water pump & cooling tower fan, then switching on the two vacuum pumps. Setting of pressure regulators. Opening the feed line manual valves as per the hot test check list. The total quantity of work in two years is 80 Nos.

G3 LAM-TF/03: Propellant handling:

Propellant fill line flexible hoses and PTU pressurization flexible hoses shall be connected to the respective ports. Regulators shall be set and the propellant shall be filled from the PTU to the respective run tanks in pressurization mode. After filling the propellant, system shall be brought back to original position. After the test, drain line flexible hoses shall be connected to the respective ports and propellant from the propellant tanks shall be transferred to the PTU in pressurization mode. All the activities should be followed as per the document. The total quantity of work in two years is 40 Nos.

G4 LAM-TF/04: LAM Hot Test Works:

Switching on the Command Compressor. Setting of the five regulators as per the respective test requirements. Prepressurization of Oxidizer and Fuel tanks to the preset values. Opening of the High pressure system up to the Control valves. Ensuring the open status of the C-top Manual Valve for cooling system and the tanks water level. Opening of the Pc sensor water. Linking Vacuum chamber till the ultimate vacuum is achieved. Final checking of the position of all valves in the test facility shall be done as per the check list. The total quantity of work in two years is 80 Nos.

G5 LAM-TF/05: LAM Post Test Works:

Venting of the propellant tanks till 2.5 bar(a) by operating the tank vent valves. Admitting air inside the Vacuum chamber by operating the air admittance valve. Opening the vacuum chamber lid using the test facility overhead crane and keeping the Vacuum chamber lid in the supports. Removal of the silica cloth cover. Flushing of propellants available in the feed lines and removing the flexible hoses, thermo couple wires, Pc connectors etc.

Removing the LAM engine from the thrust fixture and to keep it in the engine assembly room. Removing the heat shield from the engine and keep the engine in the engine container for transportation. Closing of the cooling system Manual valves and high pressure Manual valves. Unloading of all five regulators to ambient and shut down of all Manual valves in the GN2 pressurization system.

The total quantity of the above works in two years is 80 Nos.

G6 LAM-TF/06: Periodic maintenance work:

Draining the used vacuum pump lubrication oil from the vacuum pumps and to fill with new oil. Removing, Cleaning and mounting of 5 and 14 micron filters in feed lines. Removal and mounting of safety relief valves for calibration. Cleaning of 40 micron filter in the GN2 line. The scrubber tank shall be flushed with water and then allowed it to dry for 24 hours. Then allow the scrubber column for drying. The scrubber column shall be filled with fresh urea solution& acetic acid solution in MMH &N2O4. Scrubbers respectively. Removing, Cleaning and mounting of 1000 micron filters in cooling system & Cleaning of cooling tower. The total quantity of work in two years is 48 Nos.

G7 LAM-TF/07: General Replacement Package:

Flexible hoses shall be taken to the required location within test facility and connection shall be established between required points. The size of flexible hoses may vary from 1/4" NB & 1/2". The burst disc shall be mounted properly in the assembly by 4 nos. of M6 screws and the assembly has to the mounted over the tanks using bolts and nuts. After every assembly Leak test with snoop solution shall be carried-out to ensure leak tightness at the subject joints. The EP valves manual valves shall be mounted with the pipe line flange by stud bolts (size M12/M14) provided over the flanges at both sides. Providing the necessary temporary supports the valves shall be mounted with proper alignment. After mounting, leak test shall be carried out to ensure leak tightness by snoop solution. Bourdon type pressure gauge of dial size 150 mm, each weighing approximately 0.25 kg having end connection ½ " NPT (M) thread shall be removed from the line by unscrewing the thread. The open end of the line interface shall be thoroughly cleaned / purged. The given fresh gauge of similar type shall be provided with thread seal/Teflon tape winding and shall be mounted over the line with proper torque and alignment. Leak test shall be carried-out to ensure leak-tightness when checked with the snoop solution. The total quantity of work in two years is 48 Nos.

G8 LAM-TF/08 Spares Handling

Arrangement of spares such as Manual valves, pneumatic valves, filters, flexible hoses, fittings, pressure gauges etc. in the identified racks. Periodic verification and cleaning of the stock properly for record keeping purposes. The total quantity of work in two years is 24 Nos.

G9 LAM-TF/09 Preparation of Fabrication & Isometric Drawings

Preparation of fabrication drawings for components and mounting fixtures for TDP trials. Preparation of Isometric drawings for structural components and preparation of fabrication drawings / P&I diagrams for new LAM-TF. The total quantity of work in two years is 296 Nos.

I. DATA ENTRY WORKS

The work description and the quantity of Data Entry Works are given in the following table.

Item Code	Work Description	Quantity in two years
I1 DEW/01	Typing of Technical Checklist	14400 Nos.
I2 DEW/02	Typing of technical specifications	28800 Nos
I3 DEW/03	Typing of Monthly report	1440 Nos.
I4 DEW/04	Typing of Leave / Tour Report	7200 Nos
I5 DEW/05	Typing of Indent documents	12960 Nos.
I6 DEW/06	Typing of Letters / Fax messages / Emails / Logistic request	28800 Nos
I7 DEW/07	Typing of procedure documents and manuals	36000 Nos.
I8 DEW/08	Typing of Minutes of meeting	14400 Nos.
I9 DEW/09	Inward / Outward record entries	44640 Nos
I10 DEW/10	Photocopy of documents and records	187200 Nos.
I11 DEW/11	Scanning of documents and records	77760 Nos.
I12 DEW/12	Filing and organizing of records and documents	44640 Nos.