

## SCOPE OF WORK

### Supply of RTRS Rocket Motors (RRM-1)

#### 1 Introduction

This document covers the Scope of Work for Supply of RTRS Rocket Motor (RRM-1) on turnkey basis.

**Net Quantity of Final Assembled RRM-1 to be delivered to TBRL: 33 Sets in one lot.**

***Delivery period: 09 Months from Supply Order***

*Note: (1) Casings / Hardwares to be fabricated: 35 sets out of which 01 set will be subjected to Burst Pressure Test for casing qualification.*

*(2) Insulation lining and propellant filling in 34 sets out of which 01 set will be subjected to qualification test firing.*

#### 2. Scope of Work for Casings & Forgings

General Information:

- i. The manufacturer shall undertake manufacture of necessary testing or assembly fixtures / set-ups, including those required for checking of geometrical features, with the approval of Inspection Agency and provide facilities for such testing / checking along with these fixtures /set-ups.
- ii. The Manufacturer shall notify the QA Officer when he is in a position to start work and shall inform him of all sub-orders placed in connection with this orders at the same time as they are placed.
- iii. The QA Officer shall have access at all times to all departments of manufacturing plants which are concerned with production and storages of material or components under order, at the works either of the manufacturer or of the sub manufacturer and shall arrange for inspection to be carried out by him or his representative as he considers necessary.
- iv. Where QAP for any component / assembly calls for stage inspection or in-process inspection, the processing / manufacturing of such items shall be carried out in the presence of representative of Inspection Agency to facilitate monitoring of in-process parameters or clearing the items for further processing / manufacture.
- v. The manufacturer shall provide and maintain an effective quality assurance system acceptable to the QA Officer covering the samples against the order. The written description of the system will be considered acceptable when as a minimum it provides the quality assurance required by this specification and the related documents and also provides 100% examination of product for each listed critical defect. Results of all exams and test pre-formed under this quality assurance system shall be made available to the QA Officer of and obtain approval for any change to the written procedure that affects the degree of assurance required by this specification or other documents referred to therein.
- vi. All tests and hardness check of components shall be undertaken by the manufacturer in the presence of the representative of Inspection Agency as per QAP.
- vii. If any component / assembly involve more than one process of manufacture such as forging followed by machining, Heat treatment, machining & flow forming etc. the manufacturer shall submit the manufacturing process plan to inspecting agency well in advance to enable planning for in-process and stage inspection.

- viii. All monitoring and measuring devices (M & MD), used for quality control activities shall have valid calibration and copies of certificates of calibration for M & MDs shall be made available to QA Officer along with the inspection report.
- ix. All thread ring gauges are required to be calibrated.
- x. The material used for the Fabrication of motor Casings & Forgings is SAE 4130 Steel. The manufacturer is required to go through all QAP Documents and send a confirmation for it to TBRL. Following activities are part of work:

**Preparation and Submission of document comprising of:**

- a) Process /fabrication details (like Flow Forming & Machining, Development and Process Parameters Setting, Flow Forming of Casing, Retainer Ring, Nozzle/Head End Cover, Igniter, Nozzle Casing etc.)
- b) Raw materials details with their specifications (like Hardness Test, Mechanical Properties, Chemical Analysis Tests etc.)
- c) Toolings details being designed/used (like Preforms for Flow forming, Toolings Mandrel, Rollers Fixtures etc.)
- d) Inspection details as carried out by the vendor, defining NDT to be used (like Inspection of Flow Formed Motor Casing by Ultra Sonic Method, 3D- Co-ordinate measuring of other assembly items etc.) and furnishing the details of inspection equipments.
  - i. SAE 4130 Steel in the form of forged bars & flow formed required for fabrication of Rocket motors components as given in QA plan to be procured as per QA plan for materials.
  - ii. Rough machining. Heat treatment, mechanical testing of samples, final machining and proof pressure testing of total hardware should be as per the QA plan.
  - iii. The strain gauge locations during Proof Pressure Test (PPT)/ Burst Pressure Test of motor hardware are as per section VI.
  - iv. The necessary 'O' rings required for Leak, PPT & burst test will be procured by the firm.
  - v. Procurement of Raw Materials (for Complete casing hardware and associated toolings).
  - vi. Fabrication of tooling required for flow forming of the tubes and fixtures for machining.
  - vii. Procurement/Fabrication of Mandrels and Rollers bore gauges, OD Gauges, Verniers, Ovality Inspection Tools & associated Hardware required for Fabrication & Metrology.
- viii. Fabrication of Casing Hardware, Retainer Ring, Nozzle/Head End Cover, Igniter, Nozzle Casing, O – Rings etc.
- ix. Inspection (on 3D Co- Ordinate Measurement Machine as per TBRL drawing), NDT and proof pressure testing (With Instrumentation to estimate the Burst Pressure).
- x. Drying of casing hardware and Painting.

The following are the parts of Rocket motor Hardware assembly, applicable drawings and quantity required **PER SET** (major assembly drawings are enclosed with this document, complete set of drawings will be provided with the detailed document)

S.No.	NOMENCLATURE	DRAWING No.	Material	Qty.
1	Motor Casing ( Final M/C Stage)	ASL/SLEDGE/TBRL/0.0/01.01.01	SAE 4130 Steel	01
2	Motor Casing ( Flow Form Tube )	ASL/SLEDGE/TBRL/0.0/01.01.02		
3	Retainer Ring Head End	ASL/SLEDGE/TBRL/0.0/00.00.01	SAE 4130 Steel	01
4	Retainer Ring Nozzle End	ASL/SLEDGE/TBRL/0.0/00.00.01A	SAE 4130 Steel	01
5	'O' Rings	ASL/SLEDGE/TBRL/0.0/00.00.02	Viton/ Silicon Rubber	04
6	Nozzle Closure	ASL/SLEDGE/TBRL/0.0/00.00.03	Aluminum	01
7	Head End Cover	ASL/SLEDGE/TBRL/0.0/02.01.01	SAE 4130 Steel	01
8	Igniter Canister	ASL/SLEDGE/TBRL/0.0/02.02.01	SAE 4130 Steel	01
9	Nozzle Casing	ASL/SLEDGE/TBRL/0.0/03.00.01	SAE 4130 Steel	01
10	Thrust frame	ASL/SLEDGE/TBRL/0.0/03.00.02	MS	01

**Note:**

- (a) Any change in design of the Motor will be accepted after mutual discussion with the firm and Rep assigned by Director, TBRL.

- (b) The Firm has to abide by the QA/QC Plan provided by TBRL.
- (c) Inspection will be made in stages i.e. during the fabrication by the Committee/Reps assigned by the Director TBRL.
- (d) The complete document along with test certificates (for raw material, NDT, inspection etc) of development and supply of casing of rocket motor to be submitted with delivery of products.
- (e) All critical Joints must be overlapped as per the functional requirements.
- (f) All geometrical tolerances, surface finish, concentricity to be as per TBRL requirement.
- (g) All sharp edges and burrs to be removed.
- (h) The casing hardware shall be made ready for further processing i.e. Liner bonding & propellant casting & Igniter filling etc.

#### **Hydro Static Pressure Tests**

- Every Rocket Motor assembly after completion and clearance in all respects such as heat treatment and final machining, shall be assembled, with 'O' Rings placed in position, and subjected to Hydraulic Leak and Proof Pressure test. Burst Pressure test shall be conducted on 01 rocket motor.
- Motor assembly shall be pressurized by suitably closing the nozzle exit end.
- The pressuring media (fluid) used for the leak, proof and burst tests of Rocket Motor shall be 'SERVO SYSTEM 68' proprietary to M/s Indian Oil Corporation or equivalent, and shall be free from any contamination.
- Proof test shall be done on all the motors. Strain gauges shall be mounted on 02 nos. of randomly selected motors or as decided based on requirement, by TBRL.
- The testing method shall follow IS 7285 standard. In case of deviation in testing methodology, approval from TBRL is mandatory.

## **2 Scope of Work for Bonding of Liners**

The Scope of Work for Bonding & Curing of Liners on various parts of RTRS Rocket Motor (RRM) is as follows:

The Following Parts of RRM will be needed as 01 set for further processing:

- Flowformed Casing
- Head End Cover
- Nozzle
- Igniter Canister
- Retainer Ring

**Quantity of Liners to be Bonded: 34 Sets.** (01 set will be subjected to qualification test firing).

The manufacturer is required to go through all QAP Documents and send a confirmation for it to TBRL. Following activities are part of the work:

**Preparation and Submission of document:**

- i. Process /fabrication details (like Vacuum Bagging, Curing Cycle to be followed, Machining, Bonding etc.). The process sheets and each activity of fabrication process shall also be recorded for each component. It shall be supplied to TBRL with Inspection Report & Hardware.
- ii. Raw materials details with their specifications (like Hardness Test, Mechanical Properties, and Chemical Analysis Tests etc.)
- iii. Toolings details being designed/used (like Final Machining tool etc.)
- iv. Inspection details as carried out by the vendor, defining NDT to be used (like Inspection of Liner Bonding by Ultra Sonic Method, Radiography, measuring of assembly etc.) and furnishing the details of inspection equipments.

Motors and related components as set shall be delivered for further processing as per following Scope of Work:

Motor and components should be thoroughly cleaned with trichloro-ethylene (TCE) followed by vapor decreasing.

The surface to be lined should be sand blasted followed by thorough cleaning with TCE.

The following Components to be insulated with proper materials as given below:

- Motor Casing - Rocasin Rubber Insulation
- Nozzle Convergent - Carbon-Phenolic
- Nozzle Divergent - Carbon-Phenolic
- Nozzle Throat - Graphite (IG15 Grade/equivalent as per standards)
- Throat Metal Back up Liner - Silica-Phenolic
- Igniter Canister - Carbon-Phenolic

The Summary of work per set is as follows (*major assembly drawings are enclosed with this document, complete set of drawings will be provided with the detailed document*):

S. No.	NOMENCLATURE	DRAWING No.	Material	Qty.
a.	Motor Casing Assembly (With Lining)	ASL/SLEDGE/TBRL/0.0/01.01.00	Rocasin	01
b.	Casing Assembly	ASL/SLEDGE/TBRL/0.0/01.00.00	Assembly View	
c.	Head End Cover With Lining	ASL/SLEDGE/TBRL/0.0/02.01.00	Carbon-Phenolic	01
d.	Igniter Canister With Lining	ASL/SLEDGE/TBRL/0.0/02.02.00	Carbon-Phenolic	01
e.	Head End Cover Assembly with Igniter	ASL/SLEDGE/TBRL/0.0/02.00.00	Assembly View	
f.	Nozzle Insulator Assembly	ASL/SLEDGE/TBRL/0.0/03.00.00	Convergent - CP	01
			Divergent - CP	
			Throat Backup - SiP	
			Throat - Graphite	

Preparation of carbon Phenolic prepregs for laying on components.

Laying of Rocasin Rubber and Carbon Phenolic prepregs liners and then curing.

Preparation of Rocasin rubber samples & Carbon-Phenolic samples and testing for mechanical properties.

UT inspection for any de-bonding and delamination of the liner.

Machining of motor ID and other dimension as per the drawings enclosed. Nozzle convergent nozzle divergent and head end dish are to be machined as per the dimensions & tolerances given in the drawings.

PACKING: Lined motors along with components should be packed in wooden crates with appropriate packing material to avoid any damage to the liner as well as to the motor and components.

INSPECTION AGENCY: TBRL Rep.

### 3 Scope of Work for Propellant

Scope of Work (SOW) for **Filling of Composite Propellant, Final Assembly & Supply** of RTRS Rocket Motor (RRM-1) with required parts.

The Following Parts of RRM will be needed as 01 set for further processing:

■	Flowformed Casing Lined with Rocasin Rubber	01 No.
■	Head End Cover Lined with C-P	01 No.
■	Nozzle Lined with C-P, Si-P & Graphite	01 No.
■	Igniter Canister Lined With C-P	01 No.
■	Retainer Rings	02 Nos.
■	Nozzle Closure	01 No.
■	Thrust Frame	01 No.

**Total Assembled Quantity to be prepared with Composite Propellant & Required parts: 34 Sets**  
**No. of RRM to be utilized for qualification Static Firing: 01 set (firing to be arranged by the firm)**

**Net Assembled Quantity to be delivered to TBRL: 33 Sets in one lot.**

The manufacturer is required to go through all QAP Documents and send a confirmation for it to TBRL. Following activities are part of work:

#### Preparation and Submission of Document

Process /fabrication details for Achieving Physical, Ballistic & Mechanical Properties (like AP Sieving & processing, Strand Burn Test, BEM Hardware & Test details, Casting Conditions & Curing Cycle to be followed etc.). The process sheets and each activity of fabrication process shall also be recorded for each component. It shall be supplied to TBRL with Inspection Report & Hardware.

Raw materials details with their specifications (like Hardness Test, Mechanical Properties, and Chemical Analysis Tests etc.)

Toolings details being designed/used (like Mandrel etc.).

Inspection details as carried out by the vendor, defining NDT to be used (like Inspection of propellant using Radiography to determine defects, measurement of assembly etc.) and furnishing the details of inspection equipment's.

**Activities:**

The manufacturer shall procure necessary raw material ingredients for manufacturing the required propellant as mentioned in enclosed QA plan.

The required ballistic, mechanical and physical properties as mentioned in QA plan are to be achieved in samples testing and to be shown to user before casting the full scale propellant grain.

Towards achieving the required properties, the firm has to carry out *at least 03 Nos.* of Ballistics Evaluation Motor Firings per batch of propellant. In addition, BEM firings (03 nos.) shall be carried out by conditioning the motors to three different temperatures as specified by TBRL. The BEM testing (no. of tests and test conditions) shall be planned in consultation with TBRL.

All necessary tests mentioned in QA plan shall be carried out by manufacturer as per standard relevant methods of testing (International standards). The test report should contain the test method for each test and relevant standards.

The required mandrels for propellant casting in full-scale motors should be manufactured by firm itself to cast the propellant. The mandrels should be designed to suit the propellant shape. The design & fabrication drawings should be reviewed by TBRL.

The necessary propellant casting fixtures should be made by the firm itself. The relevant drawings also to be made by firm itself to suit the facilities/machinery of the firm.

The fixtures required for handling, transportation, curing, core extraction, end trimming, NDT fixtures, liner abrasion and ped coat spraying should be designed to suit their equipment and fabricated by the firm itself.

All motor propellants will be cleared only after NDT testing and acceptance criteria as per QA plan.

The dimensional inspection has to be carried out on full-scale propellant and report the values. The necessary metrology tools should be made available by firm itself for dimensional inspection.

The burn surfaces of the propellant should be thoroughly cleaned with appropriate solvents from any greasy materials used during casting.

The Lined Igniter Canister shall be filled with 91g B/KNO<sub>3</sub> pallets. The Pressure generation requirement from the Igniter is 21.3 ksc. The Firm is required to do the Closed Vessel Test for the Igniter Charge and result for the same shall be presented to TBRL before filling of it.

The Nozzle Closure Shall be bonded with Lined Nozzle Assembly with the help of Araldite with Hardener Mixed in the Ratio of 90:10. The mixture is applied on Nozzle closure and left overnight at room temperature for set.

Finally, the propellant shall be peeled to match the dimensions as per drawing No. ASL/SLEDGE/TBRL/0.0/01.00.00 and Thrust Frame, Head, Igniter Canister & Nozzle End in Position, tightened with Retainer Ring with a Torque of 240 Nm to make the Final Assembly as per drawing No. ASL/SLEDGE/TBRL/0.0/00.00.00.

The Summary of work per set is as follows (major assembly drawings are enclosed with this document, complete set of drawings will be provided with the detailed document):

Sr. No.	NOMENCLATURE	DRAWING No.	Work Required	Specs/Qty.
1	Casing Assembly with Lining & Propellant	ASL/SLEDGE/TBRL/0.0/01.00.00	Filling of Propellant	Aluminized Composite 67kg
2	Igniter Canister With Lining	ASL/SLEDGE/TBRL/0.0/02.02.00	Filling of Igniter Charge Pallets in Canister	B/KNO3 91gm
3	Nozzle Closure	ASL/SLEDGE/TBRL/0.0/00.00.03	Bonding of Nozzle Closure with Nozzle Assembly	Araldite + Hardener 90:10, overnight curing
4	Nozzle Insulator Assembly	ASL/SLEDGE/TBRL/0.0/03.00.00	-	-
5	Retainer Ring Tool	ASL/SLEDGE/TBRL/0.0/00.00.06	Tightening of Retainer Ring with Head/Nozzle Ends	240 Nm Torque
6	Thrust Frame	ASL/SLEDGE/TBRL/0.0/03.00.01	Assembly with RRM	

**PACKING:** Propellant Filled & Assembled RRM should be packed in wooden boxes with appropriate packing material to avoid any damage to the propellant as well as other components of Motors.

Also, for each motor, 03 Nos. of Pyro cartridges PC50DQ, 03 nos. of squibs, shorting caps for pyro cartridges, good quality connectors with cables, Copper washers for pyro cartridges and pressure port blanks (of appropriate thread length) class 10.9 shall be provided.

■ **INSPECTION AGENCY:** TBRL Rep.

■ **DELIVERY POINT:** The Propellant Filled & Assembled RRM as a set duly packed shall be dispatched in an Explosive Van to **TBRL Ranges, Ramgarh**. The necessary arrangements shall be managed by the Firm.

**DELIVERY SCHEDULE:** *within 09 months from placement of Supply Order*

**General Terms:**

- Any change in Design/ Fabrication Methodologies will be accepted only after mutual acceptance with the firm and Rep assigned by Director, TBRL.
- The Firm has to abide by the QA/QC Plan provided by TBRL.
- Inspection will be made in stages i.e. during the fabrication by the Committee/Reps assigned by the Director, TBRL.
- The complete document along with test certificates (for raw material, NDT, inspection etc. as mentioned in following sections) of liners of rocket motor to be submitted with delivery of products.
- All critical Joints must be overlapped as per the functional requirements.
- All geometrical tolerances, surface finish, concentricity to be as per TBRL requirement.
- The product shall be prepared for shipment in accordance with commercial practice and in accordance with applicable rules and regulations pertaining to the handling, packaging, and transportation of the product to ensure carrier acceptance and safe delivery.

#### **4 Replacement by Manufacturer**

Formal acceptance of material or components by the QA Officer shall not relieve the manufacturer of his responsibility for any parts, which may subsequently prove to be defective. If material or components from batches accepted after sampling inspection proves to be subsequently defective during examination or assembly, the manufacturer will be required to replace the material or components free of cost.

If the materials are finished or partly finished stores are expended or damaged in this specification or elsewhere as a condition of acceptance, the manufacturer will be required to replace or repair, free of charge the number so expended or damaged, which becomes the property of Government.

Where finished stores are expended in proof or reproof as stipulated in this specification or elsewhere as a condition of acceptance, the cost of the sample so expended will be borne by the consignee if the samples representing the lot have OOD passed satisfactorily. Where the manufacturer request for such proof/special proof a written request should be obtained from the manufacturer including his willingness to bear the entire cost of such proof including that of all proof stores. In the case of rejected lots, cost of all samples sent in all proofs should be borne by the manufacturer.

#### **5.1 ADDITIONAL TERMS AND CONDITIONS**

- *Supply Order will be placed on turnkey basis for all the items / processes in the scope. Quotations for partial scope / supply of items / processes will not be considered.*
- *TBRL may depute representatives for inspection at any stage. Inspection by TBRL rep., wherever needed, may be carried out either at firm's premises or through Video Conferencing mode, at the discretion of TBRL. The firm shall make arrangements for the same.*
- *Vendor has to mark "RRM-1 or as specified by TBRL" with "Double red color band on circumference" on each rocket motor.*