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PRELIMINARY STAFF QUALITATIVE REQUIREMENTS FOR ROCKET MOTOR(RM) AND RM IGNITER OF ARTICLE 'E'

1.	Sponsor	:	Dte of Armament Production and Indigenisation
2.	Reference No.	:	API/3172/MEC_E
3.	Nomenclature	:	Rocket Motor and RM Igniter of Article E
4.	Priority	:	Immediate
5.	Validity of QR	:	Every five years, or as on required basis

INTRODUCTION

1. **Introduction**. The Article E is a supersonic radar guided weapon designed to intercept and destroy airborne targets, such as missiles, aircraft and guided bombs. The article is propelled by a solid propellant rocket motor with reduced smoke. The rocket motor assembly consists of a steel casing which is the structural element of the article. The propellant is contained in the casing which provides the necessary thrust during the article flight. Towards long-term sustenance of the article, replacement of entire energetics including RM and RM igniter is envisaged.

2. **Purpose/ Objective**. The objective of the project is as follows: -

(a) To indigenously develop Rocket Motor of E article with the same form-fit factors.

(b) To indigenously develop Igniter of RM along with hardware for E article with the same form-fit factors.

(c) To involve industry partner during the course of indigenisation and establish the production.

3. **Proposed Service Employment**. The Rocket Motor and Igniter will be assembled onto the E article and will provide functional requirements envisaged from them.

OPERATIONAL & TECHNICAL PARAMETERS

ROCKET MOTOR

4. **Function**. The rocket motor is used for thrusting of article during its trajectory and is located in the middle section of the article. The motor is started by the motor igniter which initiates based on meeting certain conditions. The main functions of the rocket motor are: -

(a) Accelerating the article to its final velocity.

(b) Activating the Safe and Arm unit of the warhead.

(c) Provide steering moment on the article through thrust vectoring using jet vanes of the TVC.

5. **Construction**. The motor has the following main components:

(a) **Casing**. The rocket motor casing is a cylindrical steel tube that contains the article propellant. The article wings are fixed on the circumference of the rocket motor casing.

(b) **Solid-Propellant Charge**. The motor propellant consists of two main materials, Oxidizer and binder.

6. The interior of the motor casing is coated with EPDM rubber in order to prevent overheating of the metallic parts and adjacent components.

IGNITER

7. **Function**. The igniter performs the following functions: -

(a) Ignites rocket motor propellant prior to launch.

(b) Transfers rocket motor gas pressure to Safety & Arming Device for arming during the flight.

8. **Construction**. The igniter is a cylindrical device which is fastened to the front of the rocket motor dome (**Figure 1**). It includes the following components: -

(a) Electrical initiator for igniting the [redacted] pellets in the igniter tune

(b) Motor to S&A adaptor for transferring the gas pressure to S&A device.

(c) Igniter tube containing BPN pellets for igniting the rocket motor.

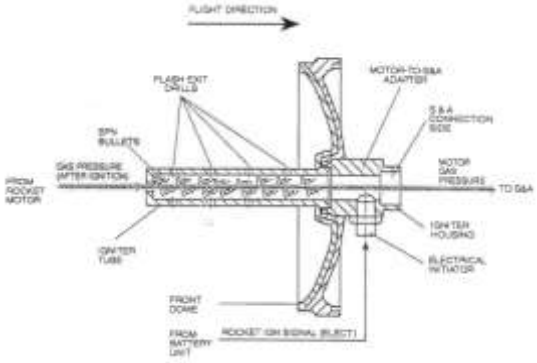

Figure 1

9. **Operation of Rocket Motor Igniter**. The motor igniter is located inside a designated bore in the motor propellant. The igniter is initiated by an electrical signal which in turn ignites the propellant.

10. **Operation of Rocket Motor**. After the propellant is ignited, the rocket motor operation becomes independent and is irreversible. On ignition, the rear section of the propellant becomes the dominant section in the burning process, due to its star shaped geometry. This geometry provides a relatively large burning surface, that intensifies the temperature and pressure inside the rocket motor compartment and allows rapid acceleration of motor thrust. At this stage the article is accelerated vertically out of the canister.

11. When the star-shaped section is burnt out after few seconds, pressure inside the rocket motor compartment decreases by 20%. From this stage, article velocity is accelerated again for rapid flight towards the target. The increased burning surfaces cause the pressure and thrust of the rocket motor to intensify. Article velocity increases until the propellant is completely burnt out. Total burning time of propellant is about 9 seconds.

12. The burning stages are divided into two phases:-

(a) **Star shaped section Burning stage**. Pressure and thrust increase from approximately [redacted] kg/ cm^2 and [redacted] kg to [redacted] kg/ cm^2 and [redacted] kg respectively. The article is vertically launched. Duration of this stage is approximately five seconds. At the end of the stage when propellant star-shaped section is consumed, pressure and thrust decrease to [redacted] kg/cm^2 and [redacted] kg, respectively.

(b) **Centric Burning stage**. Pressure and thrust increase again up to [redacted] kg/ cm2 ad [redacted] kg. The article heads towards the target. Duration of this stage is 2.5 seconds. At the end of this stage the propellant is totally consumed Pressure and thrust decrease to zero over a period of approximately one second.

13. **Technical Specifications**.

(a) **Igniter**

Ser	Characteristic	Value
(i)	Weight	0.16 Kg
(ii)	Operating Current	9A for 10 Sec

(b) **Rocket Motor**

Ser	Characteristic	Value
(i)	Weight	50 ± 0.2 Kg
(ii)	Length (including nozzle)	1826 mm
(iii)	Diameter	170 mm
(iv)	Launch Thrust	800 kg
(v)	Maximum Thrust	1050 kg
(vi)	Effective burning time	8.5 sec
(vii)	Overall burning time	9 sec

MAINTAINABILITY

14. **Shelf Life**. The shelf life of components should be minimum of 10 years with a provision for further life extension.

15. **Manufacturing**. During manufacturing following points to be adhered: -

(a) The components should be maintenance free for the entire shelf life.

(b) All components used for manufacturing are to be submitted for inspection prior to integration.

(c) The date of manufacturing of the components should be less than 01 years on the date of inspection/ acceptance.

(d) All components used in design and manufacturing are to be of MIL grade standards and should be supplied with COC (Certificate of Conformity).

(e) Workmanship and soldering are to be carried out as per IPC 610 and J-STD-001 standards.

(f) Qualification and Acceptance testing of the components are to be undertaken as per JSS 0256/ MIL STD 331/ other relevant specifications and the responsibility to get the qualification and acceptance testing lies with the vendor.

(g) Test jigs required for Qualification and Acceptance testing are required to be generated and manufactured by the firm. Further, the firm should submit the test procedure (along with the parameters being tested) for verification and approval of this office.

(h) The components should function satisfactorily upon integration. The performance efficacy would be gauged during testing at user premises and dynamic trials.

16. **Transportation/ Storage Boxes**. The deliverables should be provided in transportation boxes with airtight arrangement and desiccant.

17. **Documentation**. The developing agency must provide comprehensive documentation on design and manufacturing process covering its functional description, operation, preventive and corrective maintenance, defect identification and repair methodology, part list and drawings in great detail.

QUALITY ASSURANCE/ INSPECTION

18. The development of RM is divided into two phases viz. development and bulk production. QA coverage would be through internal QC by the vendor along with user inspection. Post design finalization, the vendor is to prepare Quality Assurance Plan (QAP) with detailed inspection responsibility matrix.

19. Details of user inspection during each phase are as under: -

(a) **Development Phase**.

(i) Stage inspection of raw materials.

(ii) Inspection during integration of components.

(iii) Qualification trials.

(iv) Issuance of bulk production clearance.

(b) **Bulk Production**.

(i) Stage inspection of raw materials.

(ii) Inspection during integration of components.

(iii) Acceptance trials.

QUALIFICATION/ ACCEPTANCE TESTs

20. Qualification Test / Acceptance Test documents will be prepared by the firm and submitted to NHQ/ DGNAI for vetting and finalization.

21. **Qualification Tests (QTs)**. Prior to accord of bulk production clearance by the user, qualification testing as per the technical specifications would be carried out. Details of QTs are appended below: -

Ser	Test	Qty to be Tested	Levels & Duration	Functional Test on Withdrawn Qty
(a)	**EMPTY Hardware**			
(i)	Fitment trials	01	Fitment onboard article	-
(ii)	Leak Test	02	0.5-gauge pressure or using Helium leak check detector	-
(iii)	Proof Pressure Test	01 – RM Hardware	As per design.	-
(iv)	Burst Test	01 – RM Hardware	As per design.	-
(b)	**Igniter (filled)**			
(i)	Estimation of NFC and AFC	50	As per design.	15 for estimation of AFC & NFC
(ii)	High Temperature (JSS 0256-01, Test No 1)	35	+55°C ± 3°C for 06 hours +65°C ± 3°C for 04 hours +55°C ± 3°C for 06 hours Total 16 hours	02 – CV test at 55°C
(iii)	Low	30	-20°C ± 2°C for 16	02 – CV test at -

Ser	**Test**	**Qty to be Tested**	**Levels & Duration**	**Functional Test on Withdrawn Qty**
	Temperature (JSS 0256-01, Test No 2)		hours.	20°C ± 2°C
(iv)	Tropical Exposure (JSS 0256-01, Test No 4)	25	45°C +2°C with 95% RH for 12 Hrs Settling at 20°C +5°C for 06 hours No. of Cycles - 14	02 – CV test
(v)	Bump Test (JSS 0256-01, Test No 21)	20	4000 bumps (40g) 2-3 bumps/ sec Pulse width – 6 msec	02 – CV test
(vi)	Vibration (JSS 0256-01, Test No 15)	15	Road 05 to 08 Hz: ±6mm constant displacement 08 to 500 Hz: ±15 m/s^2 constant acceleration Duration – 01 hour each in each axis Ship 07 to 300 Hz: ±0.4 mm constant displacement or ±60 mm/s constant velocity, whichever is the lesser. Duration – 01 hour each in each axis Operational 100Hz to 1000Hz: 0.0675 g^2/sec No. of Axis – 03 Duration – 10 min each in each axis	02 – CV test
(vii)	Shock (JSS 0256-01, Test No 18)	10	40g for 11 ms Half sine wave 3 shocks in each axis	02 – CV test
(viii)	Drop Test (JSS 0256-01, Test No 20)	5	Height 120 cm	02 – CV test
(c)	**RM (with igniter)**			
(i)	High	08	High temperature test	Functional test

Ser	**Test**	**Qty to be Tested**	**Levels & Duration**	**Functional Test on Withdrawn Qty**
	Temperature		no. 2 as per MIL STD 331, TEST 112.1, PROC III post pre-conditioning for 16 hrs	post hot conditioning (along with ignition chain)
(ii)	Low Temperature	06	Low temperature test no. 2 as per MIL STD 331, TEST 112, PROC II	Functional test post cold conditioning (along with ignition chain)
(iii)	Thermal Shock test	03	As per MIL STD 810D, MET 503.2 and MIL STD 331 TEST 113	Functional test at ambient conditions (along with ignition chain)
(iv)	Altitude Test	02	Test no. 1 as per MIL STD 810D, MET 500.0 With change rate as 10 m/sec or higher 1 hour in low temp followed by air pressure equivalent of 15,000 ft followed by 40000 ft Test No.2 as per MIL STD 810D, MET 500.0 1 hr of low temp followed by air pressure set to equivalent of 8000ft changed to an equivalent of 40000 ft within 15 sec	NDT
(v)	Temp and Humidity	01	MIL STD 331, TEST 105.1 15 cycles for 48 hours -24 hours at 70°C and RH 95% -24 hours at temperature of -40°C	NDT
(vi)	Salt mist test	01	48 hours as per MIL STD810D, MET 509.2	Visual Inspection
(vii)	Constant Acceleration		MIL STD 810D, MET 513.3	-

Ser	**Test**	**Qty to be Tested**	**Levels & Duration**	**Functional Test on Withdrawn Qty**
	Test			
(viii)	Vibration	04	Road 05 to 08 Hz: ±6mm constant displacement 08 to 500 Hz: ±15 m/s^2 constant acceleration Duration – 01 hour each in each axis Ship 07 to 300 Hz: ±0.4 mm constant displacement or ±60 mm/s constant velocity, whichever is the lesser. Duration – 01 hour each in each axis Operational 100Hz to 1000Hz: 0.0675 g^2/sec No. of Axis – 03 Duration – 10 min each in each axis	NDT and static firing at ambient condition.
(ix)	Shock	04	Operational 50g for 11 ms Half sine wave 6 shocks each along three axis as per MIL STD 810D, MET 516.3 PROC I	Static evaluation in ambient conditioning. (along with ignition chain)
(x)	DROP Test	02	As per MIL STD 331, TEST 103, PROC II And MIL STD 810D, MET 516.3 PROC IV	NDT
(d)	**EMI/ EMC**			
(i)	EMI/ EMC of entire RM	01	MIL 461E	-
(e)	**Entire Rocket motor with igniter**			
(i)	Dynamic Firing/	02	Fitted into article and	-

Ser	**Test**	**Qty to be Tested**	**Levels & Duration**	**Functional Test on Withdrawn Qty**
	Proof		subjected to dynamic firing.	
(ii)	Accelerated Ageing of entire Rocket Motor	05	Equivalent to 10 years in steps of 02 years.	Static evaluation in ambient conditioning. (along with ignition chain)

(a) **Chemical Testing**. In addition to tests above, energetic samples are to be subjected to chemical and mechanical tests.

(b) **Acceptance Tests (ATs)**. Samples from production lot will be subjected to ATs as under: -

Ser	**Test**	**Qty to be Tested**	**Levels & Duration**	**Functional Test on Withdrawn Qty**
(a)	**Igniter**			
(i)	High Temperature (JSS 0256-01, Test No 1)	06	+55°C ± 3°C for 06 hours +65°C ± 3°C for 04 hours +55°C ± 3°C for 06 hours Total 16 hours	02 – CV test at 55°C
(ii)	Low Temperature (JSS 0256-01, Test No 2)	04	-20°C ± 2°C for 16 hours.	02 – CV test at -20°C ± 2°C
(iii)	Tropical Exposure (JSS 0256-01, Test No 4)	02	45°C +2°C with 95% RH for 12 Hrs Settling at 20°C +5°C for 06 hours No. of Cycles - 14	02 – CV test
(b)	**Rocket Motor**			
(i)	High Temperature (JSS 0256-01, Test No 1)	03	+55°C ± 3°C for 06 hours +65°C ± 3°C for 04 hours +55°C ± 3°C for 06 hours	Static evaluation post hot conditioning

Ser	**Test**	**Qty to be Tested**	**Levels & Duration**	**Functional Test on Withdrawn Qty**
			Total 16 hours	
(ii)	Low Temperature (JSS 0256-01, Test No 2)	02	-20°C ± 2°C for 16 hours.	Static evaluation post conditioning at -20°C.
(iii)	Tropical Exposure (JSS 0256-01, Test No 4)	01	45°C +2°C with 95% RH for 12 Hrs Settling at 20°C +5°C for 06 hours No. of Cycles - 14	Static evaluation in ambient conditioning.

(c) The design agency/ vendor may include additional tests to ensure safety/ performance and its compliance to technical specifications.

(d) Fired empties of RM and igniter would be provided for development.