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PRELIMINARY STAFF QUALITATIVE REQUIREMENTS FOR SAFETY AND ACTUATING MECHANISM(SAM) OF ARTICLE E

1.	Sponsor	:	Dte of Armament Production and Indigenisation
2.	Reference No.	:	API/3172/MEC_E
3.	Nomenclature	:	Safety and Actuating Mechanism (SAM) for Article E
4.	Priority	:	Immediate
5.	Validity of QR	:	Every five years, or as on required basis

INTRODUCTION

1. **Introduction**. The E article is a supersonic radar guided weapon designed to intercept and destroy airborne targets, such as missiles, aircraft and guided bombs. The Safety and Actuating Mechanism (SAM) is used for protection of the article warhead from detonation during operation and storage. Towards long-term sustenance of the article, indigenisation/refurbishment of SAM is envisaged.

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

(a) To indigenously develop Safety and Actuating Mechanism (SAM) of E article with the same form-fit factors.

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

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

OPERATIONAL & TECHNICAL PARAMETERS

4. **Function**. The main functions of the article are: -

(a) Transforms an electrical signal into a detonation wave which initializes the warhead, via the warhead booster.

(b) Protects against accidental explosion of warhead (i.e., during transport, testing or launching).

5. **Construction and Operation**. The S&A device is connected to an opening at the dome (fitted to the front end) of the rocket motor and is designed to prevent the E article from being armed throughout assembly, storage, transportation, test, handling and launch. This is obtained by providing a physical interrupt in the explosive chain until following conditions are fulfilled: -

(a) Article has left the canister (steering wings open).

(b) Rocket motor gas pressure has built up and risen above [redacted] atmospheres. This happens after the article has passed the minimum safety range of [redacted] meters from the launching vessel and its flight time has passed the minimum safety period of [redacted] seconds.

(c) An arming signal has been received from the Ship's Fire Control Radar (FCR) via the wireless command channel (communication assembly), via the autopilot and via the battery unit.

6. After motor initiation, some of the motor exhaust gas enters through the opening in the dome, passes through a pneumatic delayer and reaches a pressure tank in the S&A mechanism. The delayer delays the gas pressure rise in order to delay the initiation of the explosive chain until the article reaches a safe distance from the launching vessel. Proper combustion of the rocket motor causes the gas pressure inside the tank to rise. When the pressure exceeds [redacted] atmospheres, it allows movement of the arming slider (which is still locked) in the S&A mechanism.

7. When the article leaves the canister, it unfolds its steering fins which, in turn, release the rear mechanism. This releases the interconnection strip which, as a result, is pulled by the front mechanism operated by its contracted spring. While moving, the strip is disconnected from the rod at the rear mechanism side. The released rod releases the external safety sleeve of the S&A device. The sleeve is then pushed by the force of a contracted spring and so releases the arming pin. This enables the arming pin to move after the ARMING command arrives.

8. When the article enters the FCR guidance beam, the ARMING command signal is received from the battery unit arming circuit. This results in the initiation of two squibs near the arming pin. Detonation of the squibs pushes out the arming pin which thus enables the motion of the arming slider to the armed position. This motion is performed by the gas pressure applied to the slider. At this stage, the detonators are attached to electrical detonation pins and so the warhead explosive chain is completed.

When the article intercepts or hits the target, the detonator in the explosive chain receives the DETONATION signal from the battery unit (originated by the proximity fuze or by the impact switches). This initiates the explosive chain which in turn initiates the warhead.

9. **Safety and Arming Circuits**. The SAM and detonation circuit comprises of two types of sub-circuits. Each type consists of two identical circuits for redundancy. These circuits are: -

(a) **Arming Circuit**. This circuit supplies the energy required to initialize a squib in the S&A device that causes a process which completes the explosive chain. The arming circuit is activated by the ARM1 and ARM2 signals which arrive from the autopilot when the article enters the FCR capture or tracking beam. These signals are [redacted] msec positive pulses functioning in parallel in the two identical circuits. In addition, the arming pulses are supplied to the detonation and arming circuits as described below:-

(i) Each input pulse passes an input voltage threshold circuit which permits input of signals above [redacted] V only. If the pulse level is legitimate, it passes the threshold circuit and operates a current source. The current source charges a detonation capacitor bank in the circuit within less than [redacted] msec (the remaining part of the pulse, until the completion of [redacted] msec, is used by the detonation circuit). When the capacitor voltage rises above a required level, it passes the capacitor voltage threshold circuit and ignites an SCR. The SCR instantaneously transfers the capacitor bank

voltage to the squib in the S&A device causing its initiation. A [redacted] MΩ resistor, parallel to the capacitor bank, is used to discharge the capacitors after test cycles.

(ii) The direct path (via the [redacted] resistors), from the input to the squib, is used for a continuity test during BIT. In this test a low voltage [redacted]V) is received from the [redacted]V BAT circuit and is transferred to the squib. This low voltage does not pass the threshold circuit and therefore cannot initiate the squib (although the voltage drops over the squib. The circuit input impedance, comprising the [redacted] resistor and the squib resistance, reduces the input voltage to approximately [redacted]V. This voltage drop, indicating serviceability of the squib and of the wiring leading to it, and is sensed by the autopilot CPU, via the A/D converter in the 19V BAT circuit.

(b) **Detonation Circuit**. This circuit supplies the energy required to initiate the explosive chain in the S&A device, which in turn initiates the warhead. The circuit operates in two phases: arming phase upon article entrance to the FCR guidance beam, and detonation phase upon interception or hit of the target by the article.

10. **Technical Specifications**.

Ser	Parameter	Value/ Remarks
(i)	Weight	0.56 Kg
(ii)	Length	213 mm
(iii)	S&A Squib Resistance, Ohm	[redacted] ± 0.5
(iv)	S&A Detonator resistance, Ohm	[redacted] ± 0.8

MAINTAINABILITY

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

12. **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 SAM are to be undertaken as per JSS 0256/ MIL STD 331/ relevant specification 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 SAM should function satisfactorily upon integration. The performance efficacy would be gauged during testing at user premises and dynamic trials.

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

14. **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

15. The development of Safety Actuating Mechanism (SAM) 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.

16. 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

17. Qualification Test / Acceptance Test documents will be prepared by the firm and submitted to NHQ/ DGNAI for vetting and finalization. QTs may be modified on approval of NHQ/ DGNAI.

18. **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 SAM Hardware**			
(i)	Fitment trials	01	Fitment onboard article.	-
(ii)	Leak Test	02	0.5-gauge pressure or using Helium leak check detector	-
(b)	**SAM (For squibs and detonators)**			
(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.	01 – for NFC 01 – for AFC 01 – for delay at RFC 02 – CV test at 55°C
(iii)	Low Temperature (JSS 0256-01, Test No 2)	30	-20°C ± 2°C for 16 hours.	01 – for NFC 01 – for AFC 01 – for delay at RFC 02 – CV test at -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	01 – for NFC 01 – for AFC 01 – for delay at RFC 02 – CV test
(v)	Bump Test (JSS 0256-01, Test No 21)	20	4000 bumps (40g) 2-3 bumps/ sec Pulse width – 6 msec	01 – for NFC 01 – for AFC 01 – for delay at RFC

Ser	**Test**	**Qty to be Tested**	**Levels & Duration**	**Functional Test on Withdrawn Qty**
				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	01 – for NFC 01 – for AFC 01 – for delay at RFC 02 – CV test
(vii)	Shock (JSS 0256-01, Test No 18)	10	40g for 11 ms Half sine wave 3 shocks in each axis	01 – for NFC 01 – for AFC 01 – for delay at RFC 02 – CV test
(viii)	Drop Test (JSS 0256-01, Test No 20)	5	Height 120 cm No. of Drops	01 – for NFC 01 – for AFC 01 – for delay at RFC 02 – CV test
EMI/ EMC				
(i)	EMI/ EMC of SAM	01	MIL 461E	-
Entire SAM (with squibs and detonators)				
(i)	High Temperature	06 each	High temperature test no. 2 as per MIL STD 331, TEST 112.1, PROC III post pre-conditioning for 16 hrs	Static evaluation post hot conditioning (along with

Ser	**Test**	**Qty to be Tested**	**Levels & Duration**	**Functional Test on Withdrawn Qty**
				ignition chain)
(ii)	Low Temperature (JSS 0256-01, Test No 2)	06 each	-20°C ± 2°C for 16 hours.	Static evaluation post conditioning at -10°C. (along with ignition chain)
(iii)	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
(iv)	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	Functional test
(v)	Vibration (JSS 0256-01, Test No 15)	04 each	<u>Road</u> 05 to 08 Hz: ±6mm constant displacement 08 to 500 Hz: ±15 m/s^2 constant acceleration Duration – 01 hour each in each axis <u>Ship</u> 07 to 300 Hz: ±0.4 mm constant displacement	NDT and Functional tests

Ser	**Test**	**Qty to be Tested**	**Levels & Duration**	**Functional Test on Withdrawn Qty**
			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	
(vi)	Drop test	03	As per MIL STD 331, TEST 103, PROC II, MIL STD 810D, MET 516.3 PROC IV and MIL STD 331, TEST 111.1 PROC II from altitude of 1.5 m	NDT and Functional tests
(vii)	Shock	02	Operational 50g for 11 ms Half sine wave 6 shocks each along three axis as per MIL STD 810D, MET 516.3 PROC I Maintenance On a 45 mm thick wooden surface simulating maintenance/ handling	NDT and Functional tests
(viii)	Jumble	02	MIL STD 331A TEST 102.1 Turning rate 30 ±2 RPM, for a total of 3600±10 turns	NDT and Functional tests
(ix)	Jolt	02	MIL STD 331A TEST 102.2	NDT and Functional tests
(x)	Tropical Exposure (JSS 0256-01, Test No 4)	02 each	45°C +2°C with 95% RH for 12 Hrs Settling at 20°C +5°C for 06 hours	Functional trial/ Air Blast Trials (along with ignition chain

Ser	Test	Qty to be Tested	Levels & Duration	Functional Test on Withdrawn Qty
			No. of Cycles - 14	and warhead)
(xi)	Accelerated Ageing of entire SAM	05	Equivalent to 10 years in steps of 02 years.	Static evaluation in ambient conditioning. (along with ignition chain)

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

20. **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
SAM (assembled with squibs and detonators)				
(a)	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 – Static evaluation at 55°C
(b)	Low Temperature (JSS 0256-01, Test No 2)	04	-20°C ± 2°C for 16 hours.	02 – Static evaluation at -20°C ± 2°C
(c)	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 – Static evaluation at ambient condition

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

22. Fired empties of SAM would be provided for development