

SOW for Accelerated Ageing Test of NGARM P1 & P2 motors**1 Introduction**

This document describes scope of work and test plan for Accelerated Ageing Test (AAT) of NGARM Propulsion System and Propellant Cartons at elevated temperature of +60°C. This will provide an estimate of shelf life.

Accelerated ageing would be conducted for six propulsion systems (rocket motors along with cartons). Transportation of rocket motors to and from DRDL is in firm's scope. Ageing chamber (maintenance of chamber + power charges) and all related activities, thermal conditioning and radiography of motors at different ageing times, SSBR testing, propellant cartons casting & curing, mechanical sample preparation and testing are in firm's scope. The firm would collect the rocket motor assemblies (6 nos.) from DRDL as FIM for ageing as per test plan mentioned below.

2 QA Agency: MSQAA**3 Accelerated Ageing Test Plan****3.1 Ageing Test Plan for Propulsion System / Rocket Motor**

Total 6 nos. of Rocket motors assemblies (say, earmarked with Id. No. AAT-1 to AAT-6 for identification purpose) will be required for the AAT. Six Integrated Rocket Motor Assemblies (AAT-1 to AAT-6), including nozzle and igniters, will be kept at +60°C for 6 months with intermittent withdrawal of motors for en-test and static test. Pressure ports and Pyro ports will be closed with suitable blanks during Accelerated ageing. Brief plan for AAT of NGARM Rocket Motors is given below:

- i. Integrated rocket motor assemblies will be provided as FIM. All the cartons as per requirement shall be cast and cured by the firm.
- ii. Load Six Integrated Rocket Motor Assemblies (AAT-1 to AAT-6, RT cleared) and cartons (for TS & TBS) in the conditioning chamber and set the chamber temperature to +60°C (T_0 = starting of conditioning).
- iii. Maintain log book and record the chamber temperatures at 12 hour intervals for complete test duration of 6 months.
- iv. Condition all the motors for 3 months with set temperature of +60°C. Down time to be compensated.

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- v. After 3 months (90 days), switch off the conditioning chamber.
- vi. Leave the motors inside or outside for 24-48 hrs (the objective is that motor casing and propellant should reach ambient temperature). Perform routine RT for all the motors.
- vii. Position all the motors at DRDL/RCI En-test facility for carrying out en-test of motors. DRDL will carry out the En-tests of the motors.
- viii. Post En-test, collect all the motors. Firm shall deliver one en-tested motor to DRDL for carrying out static test.
- ix. Firm shall carry out RT for remaining five motors and keep all the remaining motors in the ageing chamber and switch on the chamber with set temperature of +60°C.
- x. Condition the motors (five nos) for another 3 months with set temperature of +60°C. Down time to be compensated.
- xi. After 6 months (180 days) cumulative ageing, switch off the conditioning chamber.
- xii. Leave the motors inside or outside for 24-48 hrs (the objective is that motor casing and propellant should reach ambient temperature). Perform routine RT for all the five motors.
- xiii. Deliver all the five motors to DRDL.

3.2 Ageing Test of Propellant cartons

The following propellant cartons (preferably cast in two batches) are required to evaluate the mechanical properties after Natural and Accelerated Ageing:

Sl. No.	Carton type	Carton size (mm)	Quantity requirement	
			Pulse 1	Pulse 2
1.	Tensile Strength (TS) carton	150×150×140	10 nos. (Batch 1)	10 nos. (Batch 1)
			10 nos. (Batch 2)	10 nos. (Batch 2)
2.	Tensile Bond Strength (TBS) carton	195×55×200	7 nos. (Batch 1)	7 nos. (Batch 1)
			7 nos. (Batch 2)	7 nos. (Batch 2)

16 nos. TS cartons each and 10 nos. TBS cartons each for pulse 1 propellant and pulse 2 propellant shall be kept inside the conditioning chamber at +60°C. Carton should be wrapped in aluminium foils. Casting batch details to be mentioned on the foils of each block. Record the temperature log, propellant carton batch details and timeline of the samples/cartons. Tensile Test (TS), Hardness & SSBR testing details are given in Table 1. Tensile Bond Strength (TBS) testing details are given in Table 2.

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The following points are to be taken care before sample testing:

- Carry out Radiography of the samples (test specimen). In case any defects like void, pore, crack, inclusion etc. found, the sample should not to be considered for the test.
- Before testing, samples should be kept in desiccator for minimum 12 hrs.
- For tensile test, 68 mm EGL (Effective gauge length) to be used.
- Measured dimensions (width and thickness) before test to be used for cross section area.

Table 1: Details of Tensile, Hardness & SSBR tests to be conducted on accelerated aged samples (Minimum 06 nos. samples for each test of pulse 1 and pulse 2 propellant)

Sl. No.	Timeline	Temperature / Cross Head Speed (mm/min.)	Tensile strength (kgf/cm ²)	% Elongation at break	Initial Modulus (kgf/cm ²)	Hardness (Shore A)	SSBR (mm/s)
1.	After curing	Room Temperature @ 50 mm/min (for Tensile test)					
2.	T ₀ (T ₀ = Time of putting the samples in ageing chamber)						
3.	T ₀ +1 week						
4.	T ₀ +2 weeks						
5.	T ₀ +1 month						
6.	T ₀ +2 months						
7.	T ₀ +3 months						
8.	T ₀ +6 months						

Note: Tensile test specimen shall be prepared as per JANNAF standard.

Table 2: Details of TBS tests to be conducted on accelerated aged samples (Minimum 05 samples, for each test of pulse 1 and pulse 2 propellant)

Sl. No.	Timeline	Temperature/ Cross Head Speed (mm/min.)	TBS (kgf/cm ²)
1.	T ₀	Room Temperature / 250 mm/min	
2.	T ₀ +1 month		
3.	T ₀ +3 months		
4.	T ₀ +6 months		

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4 FIM

Six number of Rocket Motor Assemblies will be issued as FIM.
Total cost of FIM is Rs.4,68,49,080/=.

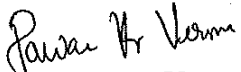
5 List of Deliverables


Six numbers of accelerated aged rocket motor assemblies as per test plan along with following reports need to be given by firm:

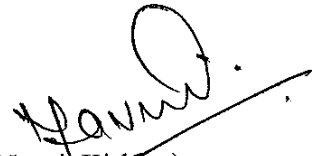
- i. Ageing chamber temperature log data.
- ii. Radiography reports.
- iii. Mechanical test reports, Hardness & SSBR reports.


6 Delivery Schedule

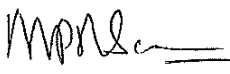
Estimated Delivery period is 7.5 months (from date of SO) in maximum of three lots.


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