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AIRWORTHINESS CERTIFICATION PLAN for Air Launched Weapon for Missile

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Disclaimer:

This document is a guidance document. Applicable section / table rows may be considered. Any additional details may be added. Any not applicable section/ table rows may be deleted. The template is very general and vary with process to process followed by Development Agency. The document may be fine-tuned with the TAA for finalization.

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Revision Sheet

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1 Introduction

Brief introduction of the project to be given along with platform of integration.

1.1 Scope of the document

Scope of the document to be mentioned here.

1.2 Reference documents

1.2.1 Project Documents

S. No.	Document Number/Date	Document Name

1.2.2 Standards/Guidelines

S.No.	Document Number/ Date	Document Name

1.3 List of Abbreviations

Abbreviation	Expansion

1.4 Organizations Involved

Mention the details of Nodal agency for the project development and role and responsibility of various agencies involved shall be provided.

SI. No.	Organization/ Team	Responsibilities

2 Project Definition

2.1 Scope of the Project:

Scope of the project to be brought out here. The details about the development of missile/ launcher/ other platform related LRU'S etc., to be described here.

2.2 System Requirements

PSQR reference, project requirements and their means of compliance shall be elaborated as per the table below.

S. No	PSQR Para	Performance Parameters	PSQR Statement	Testing Method/Remarks

2.3 Operational Envelope

The operational envelope of missile shall be brought out as described below:

Carriage conditions: The carriage conditions of the missile w.r.t altitude, G limits, Max. speed etc., shall be brought out here.

Release Conditions: The release conditions of the missile w.r.t altitude, G limits, Max. speed, Bank limits, pitch limits etc., shall be brought out here.

3 Specification of Missile

The brief specifications of missile to be listed as shown below. The list is not exclusive; you can bring out all the other specifications.

SI. No.	Parameter	Value
a)	Length	
b)	Diameter	
c)	weight	
d)	Type of propulsion	
	system	
e)	Modes of Operations	
f)	Type of guidance	
g)	Range	
h)	Altitude of operation	
i)	Launch platform	
j)	Launcher	
k)	Time of Flight	
I)	Type of Warhead	
m)	Kill Probability	
n)	Other parameters	

3.1 Missile Operation

Missile operation sequence to be explained with figure

The sequence should contain the information like Pre-Launch Phase, Auto-Launch sequence, Release, Boost Phase, Mid-course Phase, Target search & selection, Terminal Phase etc., as per relevance of mission sequence.

It shall also bring out the activities listed below:

- a. Activities in the hanger before integration to Aircraft
- b. Missile preparation on the ground prior to mission
- c. Integration of missile with launcher on aircraft on the ground
- d. NOGO Requirement
- e. Realignment Requirements

4 Design and Development

Configuration of the missile (section wise) to be explained with Figure

4.1 Development of Hardware

The development of new technologies for Project and adaptation of existing systems from other projects to be tabulated below as per configuration of missile/launcher/platform LRUs.

S. No.	Sub-systems	New Development/ Adaptation/Bol	Remarks
i.	Missile Sub-s	ystems	
ii.	Launcher Sub	o-systems	
iii.	Platform LRU	S	

4.2 Development of Software

The development of software for Project and adaptation of existing software from other projects to be tabulated below as per configuration of missile/launcher/platform software intensive sub-systems.

S. No.	Sub-systems	New Development/ Adaptation/Bol	Remarks
iv.	Missile Sub-s	ystems	
۷.	Launcher Sub	o-systems	
vi.	Platform LRU	S	

4.3 System/sub-system Criticality Classification:

The criticality of systems/subsystems/LRUs and material of Weapon System has to be categorised based on the Failure Mode Effect and Criticality Analysis (FMECA) / Failure Tree Analysis (FTA) studies. The classification shall be as Safety Critical (C1), Mission Critical (C2) and Non Critical (C3).

4.4 Integration of Missile Sections

Missile is to be realized as per the approved drawings and to be integrated as per the approved Mechanical & Electrical Integration documents with the integration of subsystems and assembly of sections. The relevant phase checks shall be carried at section and integrated missile level as per the approved Checkout document. The routing of wires and cables shall be carried out as per the approved drawings.

5 Instrumentation of Missile

A suitable telemetry system free from electromagnetic interference, hazards to be used for recording, transmitting the instrumented data during flight trials. The instrumentation plan will be approved by RCMA (Missiles). Project shall release analysis report after each trials.

6 Missile Integration to Platform

Platform integration details to be explained and clearance activities and the readiness details to be provided. The amount of testing and checks to be carried before integration to the platform has to be elaborated.

The prerequisite for the integration clearance/SEO are provided below:

- vii. Stress analysis w.r.t structural integration
- viii. Store Separation Studies (Theoretical and CFD studies)
- ix. Functional check document (Ground and Flight)
- x. EMI/EMC Qualitative Test Plan Document
- xi. Electrical load analysis

7 Certification

7.1 Certification process

The certification process shall be as per ALM Subpart-B3 of IMAP 23 shall be elaborated in detail.



The airworthiness certification process of different domain of weapon system is enumerated below for compliance:

7.1.1 Material

Material certification to be followed as per the following format:

Proje Nam	Project : Material Grade : Name of Inspection Agency : Size (mm) :								
SI.	Component	Classification	S	tress Conditi	ons	Environmental	Temperature	Weld ability	Any other
NO.			Primary	Secondary	Static/ Dynamic loading conditions	Conditions	Conditions	requirements	Information
			Eg: <u>Fatigue,</u> YS, UTS	Eg: <u>Fatigue,</u> YS, UTS				 Type of welding No. of joints Component details which are to be welded Material type WPS & PQR Status- approved or not? Vendor details 	
Enclosures: Signature 1. Brief write-up about the Project Name of Organization (with Seal) 2. End use of the Components along with justification for classification Drawings/Photographs of components 3. Drawings/Photographs of components Application for Type Approval									

Application for Type Approval
 Details of Supplier, if already identified

7.1.2 Airframe Structure

The certification procedure for airframe structure is as shown in below Fig.



7.1.3 Aerodynamics

The certification procedure for aerodynamics is as shown in below Fig.



7.1.4 Avionics System:

The certification procedure for avionics is as shown in below Fig.



Figure 1 Figure Avionics System Certification

7.1.5 Software Certification

Phases of Clearances and Certification Plan for each phase:

Phase	Activities to be carried out			
CFT and Dummy drop trials	 Preparation of certification plan Approval of SRD, ICD Approval of High level test cases Requirement Based testing (LRU-wise) Baselining of the software with version description document IV&V recommendation Missile integration tests Aircraft integration Tests xii. 			
Mission launch without warhead	Preparation of certification plan Approval of SRD, ICD Requirement Review Design Review Code Walkthrough			

	 Approval of the test rigs and software Approval of Test plan and High level test cases Requirement Based testing (LRU-wise) Baselining of the software with version description document IV&V recommendation Missile integration tests Aircraft integration Tests Change management with SCR and SCN forms
Mission launch with warhead	 Preparation of certification plan Approval of SRD, ICD Requirement Review Design Review Code Walkthrough Static and Dynamic analysis Algorithm validation Approval of the test rigs and software Approval of Test plan and High level test cases Requirement Based testing (LRU-wise) Software Verification report consisting of results from all the analyses and testing. Baselining of the software with version description document IV&V recommendation Missile integration tests Aircraft integration Tests Change management with SCR and SCN forms
Production	 Consolidation of all the changes and incorporation into corresponding artefacts Reconciliation of the limitations and known issues Closure of defect investigations and Request for Actions. Conformance to standards User acceptance trial reports Final configuration of the software User documentation (User manual, installation manual, troubleshooting / diagnostics manual etc)

7.1.6 Cooling System

The certification procedure for cooling system is as shown in below Fig.



7.1.7 Propulsion system

The certification procedure for propulsion is as shown in below Fig.



7.1.8 Warhead

The certification procedure for warhead is as shown in below Fig.



7.1.9 Bought out Item

The Bought out Item (BOI) Performa as per Form 40A of IMAP 23 to be submitted for imported equipment for issue of clearance by RCMA.

7.1.10 Human Machine Interface

HMI design development details, their integration aspects, simulation details, test rig details and means of compliance to be explained.

7.2 Test and Validation

Acceptable means of compliance of the weapon w.r.t testing (QT/SOFT/LQT/AT), analysis and review shall be described here. Test report generation and their acceptance criteria to be defined.

7.2.1 Ground Tests

The following weapon/section level tests shall be carried out successfully before commencement of developmental flight trials as per the approved test procedure document.

- a) Ground Resonance Test (GRT)
- b) Structural (Missile sections & Full Missile), Vibration & Shock Tests
- c) Pit Drop Test
- d) Aircraft Electrical System compliance i.a.w. Mil-Std 704-F
- e) Booster Separation Test
- f) Rocket Motor (Booster & Sustainer) Ground Tests
- g) Warhead Performance Evaluation
- h) Integration of Missile & Fire Control System with Helicopter
- i) Altimeter Performance Evaluation
- j) Seeker Performance Evaluation (Sorties during different weather Conditions)
- k) Phase Checks of Missile
- I) Hardware In-Loop Simulation (HILS) Tests
- m) RCS Measurement of Missile
- n) Counter Measures test (RF/IR)
- o) Missile Handling equipment
- p) Operational and Service Life Testing
- q) Training aids development and assessment

The above mentioned tests and test conditions to be elaborated, the list is not exclusive. Add all the other applicable tests as well.

7.2.2 Dummy Drop

Static Firing on Ground:

The trial plan is given below:

Test No.	Mission Objective	Config.	Flight Profile (Alt,Speed, etc.)	Remarks

Table 1 Dummy drop trial Plan

7.2.3 Carriage Flight Trials / Captive Flight Trials (CFT)

Bring out the reason to carry out Carriage/Captive flight trials

S. No.	Flight No.	Mission Objective	Config.	Flight Profile (Alt, Speed, etc.)	Remarks
Carria	ge Trials				

7.2.4 Release Flight Trials

Objectives for RFT to be brought out.

S/ N	Mission Objective	Configuration of Missile and LH/RH	Release Conditions(H/c, Alt, Speed, sideslip etc)	Target Type (Fixed/Simulated /Moving)	Remarks

Note: The parameters listed in the table are not exclusive, you can include other parameters as per PSQR

7.2.5 Integration on **Platform**

The aspects of integration on platform and its clearance aspects can be described.

7.3 Documents to be generated:

The documents to be generated at Missile level and subsystem level are listed in following Tables:

Missile Level:

SI. No	Documents required	Remarks
а.	Technical Specification	Docs to be
b.	List of equipment and their hardware/software versions	approved by RCMA
С.	List of drawings	
d.	Wire harness document	
e.	Mechanical & Electrical Integration document	
f.	Phase Check/Checkout Test document	

g. ;	Qualification Test Procedure (QTP)	
h.	Daily Inspection (DI) Procedure	
i.	ENTEST Specification Document	
j.	System safety analysis	For review,
k.	HILS test Plan and Report	scrutiny, and
Ι.	Mission Studies	reference for issue
m.	Safe Separation, Emergency	of clearance.
	Jettison	
n.	Failure Mode Studies	
0.	Qualification test report	Test reports to be
р.	Phase Checks report	coordinated by
		MSQAA/RDAQA

Subsystem Level:

SI. No	Document required	Remarks
	Technical specification	Docs to be approved
	BOM	by RCMA
	MDI/Drawings	
	Integration Processes Document	
	SOFT/LQT/Qualification test schedule along with Functional Test Procedure	Docs to be approved by RCMA.
	Design Analysis i. PDR/CDR ii. Mechanical Stress Analysis iii. Electronic Packaging (Dynamic & Thermal Analysis) iv. De-rating v. FMECA / FTA vi. Reliability analysis	For review, scrutiny, and reference for issue of clearance.
	ESS report COTS screening report Qualification test report	Test reports to be coordinated by MSQAA/RDAQA

7.4 Design Modifications

During qualification test/flight evaluation if any Defect/Snag is observed a detailed investigation has to be carried out as described in the IMAP 23 involving RCMA, R&QA, MSQAA and Designer. For any design modification or software modification Engineering Change Notice (ECN) or Software Change Notice (SCN) to be issued.

8 Project Time Line

The brief timeline of project is to be given.

9 Challenges

- i. Store Separation & Carriage Flight Trial (CFT) Likely Issues:
- ii. MFCS Integration with Sea King Helicopter Likely Issues:
- iii. Control Flight Trial Likely Issues:
- iv. Development of Float Body for Targets Likely Issues:
- v. Control & Guidance Flight Trial (w/o Warhead) Likely Issues:
- vi. Full Configuration Flight Trial (with Warhead) Likely Issues
- vii. Additional Tests/ Mil-Std Compliance:

10 Clearance

After completion of development, flight evaluation and Qualification, project to finalize the Compliance Document with respect to PSQR. RCMA (Missiles) accords the operational clearance for service use.