RESTRICTED **DRDO-RDEE-SRVLU-TSP-003-2020**

Technical Specification Of

VLU

for Project VL SRSAM

R&DE(E)

Government of India, Ministry of Defence

Defence R&D Organization

Research & Development Establishment (Engineers)

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TECHNICAL SPECIFICATION OF VLU FOR PROJECT VL SRSAM

SPECIFICATION NO: **DRDO- RDEE- SRVLU-TSP-003-2020**

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SECTION I

GENERAL AND SCOPE OF WORK

1.1 GENERAL

It is intended to design and develop Vertical Launch Unit (VLU) assembly (Qty: 2 No.) along with canister and its subsystems for VL SRSAM Missile which will be used for supporting and launching of eight (8) Canisterised Missiles (CMs) from a naval ship platform. The VL SRSAM VLU is mounted over the naval ship deck. The VLU houses the eight (8) Canisterised Missiles (CMs), top and bottom plate, VLU structure, Plume Deflector, Plenum uptake chamber, Launcher electronics and other necessary equipment described hereafter. The General Assembly of VLU structure along with Canister assembly is shown in Drawing. No. VLU 11 1110 00 00.

1.1.1. Brief Specifications: This specification covers the brief description, material specification, fabrication, manufacture, workmanship, quality control, inspection, integration of Vertical Launch Unit along with the canister assembly for VL SRSAM Missile.

General scope and brief specifications for VLU are same as for the canister.

1.2 SCOPE OF WORK

1.2.1. Brief of Scope of Work

a. **Preparation and Submission of final detailed drawings, manufacturing process plans and QAP for approval as per R&DE(E)'s format/drawing template (soft and hard copy)**
b. **Manufacture, integration, testing and supply of VLU along with canister assembly as per approved drawings and specifications**
c. **Procurement of raw materials, bought out items etc.**
d. **Physical and Chemical testing of the procured material from NABL accredited lab**
e. **Qualification of welders and submission of the welder's qualification report**
f. **Physical testing of weld joints (for weld joint strength) from NABL accredited lab and submission of the report**
g. **Component, sub-assembly and assembly level testing as per test plan**
h. **Performance trial within the factory as per approved ATP/QAP document**

i. **Loading/unloading trials of canisterised dummy missile inside VLU at site or at location stated by R&DE(E). Dummy Missile shall be provided by R&DE(E). Actual canister is to be used for trials.**
j. **Acceptance Trials at site designated by DRDO**
k. **Assembly, integration, handling and lifting (with dummy missile payload) trials within factory. Material handling units/devices /crane etc to be arranged by vendor.**
l. **Delivery of VLU assembly at R&DE(E) or DRDL Hyderabad or any location in India.**
m. **Supply of special tools (if any) for operation of canister mechanism, VLU and for integration of them**
n. **Submission of Documents (soft editable & hard copy format - 3 copies each)**
    i. **Technical Manual**
    ii. **User Manual**
    iii. **Maintenance Manual**
    iv. **All drawings and solid models**
    v. **Manufacturing Process Plans**
    vi. **Inspection Reports**
    vii. **Material Test Certificate**
    viii. **Welder Qualification Report**

1.2.2. This specification covers the work involved in VLU Structure fabrication, Jet/Plume deflector, plume uptake chamber, hatch door and its mechanism, etc. For Plume Deflector liner/coating, all steps/stages in manufacturing, inspection etc. followed for Project Pralay shall be followed in this case also (any deviation, if any, shall be brought out in writing for further necessary action, and approval thereof).

1.2.3. Preparation of manufacturing drawings, preparation of drawings of assemblies, sub-assemblies, components & drawings related to site testing/ working including integration of canister. Drawings need to be approved by R&DE (E) before starting the manufacturing.

1.2.4. The contractor should prepare the process plan and bill of materials for manufacturing of the VLU and submit to R&DE (E) for approval.

1.2.5. Incorporation of improvements/ changes/ additions/ alterations as required in the system during manufacturing process and after testing at site.

1.2.6. Procurement of entire raw materials and bought out items for VLU as specified in the relevant drawings.

1.2.7. Preparation of layout and submission of two sets of drawings to the inspecting authority for approval of the same before commencing the manufacturing. One set of drawings dully approved will be sent to the manufacturer.

1.2.8. Manufacturing/ Fabrication / Press Work / Bending Work of complete VLU structure assembly as per specifications and approved manufacturing drawings.

1.2.9. The contractor shall design and develop the suitable fixtures during press working, fabrication/welding of sheet metal, bending of sheets to avoid distortions and shrinkages. Also the contractor shall follow proper welding sequence and press working practices. Any failure like thinning of sheets, development of the cracks on sheet and welding distortion will not be acceptable and the contractor will be responsible for the job.

1.2.10. Fabrication, manufacturing, assembly and testing of complete VLU structure along with its subassemblies.

1.2.11. The contractor shall inspect all the weld joints using ultrasonic/dye penetrant tests which will be witnessed by R&DE (E) representative nominated by R&DE (E).

1.2.12. Integration of mechanisms in plenum chamber doors with reference to approved drawings by R&DE(E) to meet the geometrical and dimensional tolerances shall be done and R&DE(E) or any site specified by R&DE(E). Vendor has to give necessary and required assistance to carry out Integration of mechanisms in canister.

1.2.13. The contractor shall use good quality stainless steel helicoils for screwing of Aluminum components for entire assembly.

1.2.14. The first unit of mechanisms for VLU structure as well as for canister shall be manufactured and tested and integrated with electronics and electrical items by the contractor. After successful manufacturing, testing and acceptance of first unit, the other mechanisms set for second unit to be manufactured with incorporating any changes/modifications in design/drawing as specified by R&DE (E).

1.2.15. The contractor firm shall prepare and forward detailed QAP and Acceptance Test Plan document based on the guide line QAP and FAT documents for review and approval by R&DE (E). The system shall be tested as per above approved documents. Formats for the same shall be provided by RDE.

1.2.16. Inspection and testing of raw material, component, assembly/module and subsystem levels for various structural, mechanical subsystems as per approved QA plan.

1.2.17. The contractor shall submit the material test reports (physical as well as chemical), inspection reports, heat treatment reports to Director R&DE (E). The Material Test certificate shall mention yield strength, % elongation, impact strength at -30˚ C, chemical composition, etc.

1.2.18. The contractor shall check the weld strength (yield strength of weld joint- lap/fillet and butt joint) of the material as per standard procedures.

1.2.19. Performance and Acceptance testing as per approved ATP

1.2.20. The drawings given along with Tender Document are Engineering Design Drawings. The contractor shall be responsible for preparing manufacturing / fabrication drawings along with Process Plan in consultation with R&DE (E) and forward these drawings for approval of R&DE (E).

1.2.21. Surface treatment and painting of fabricated assemblies, sub-assemblies and components at manufacturer's premises as per specifications laid down in "Manufacture, Workmanship and Finish".

1.2.22. The contractor shall provide corrosion resistant protection to required components of the VLU assembly. Also where ever there are dissimilar materials are in contact, the contractor shall provide suitable means to prevent the galvanic corrosion. Paint Scheme explained hereafter in this document.

1.2.23. Mechanical and electrical assembly, integration, mounting, interfacing and cable harnessing of mechanisms are to be carried out at contractor's premises or at any other site specified by R&DE (E).

1.2.24. Functional testing of assembly structure and all mechanisms as per test plan is to be done at manufacturer's premises before dispatch to the R&DE (E).

1.2.25. The contractor shall ensure proper sealing of the Top flange, plenum uptake chamber, VLU structure at the deck, bottom flange. The seals shall withstand high temperature up to temperature range of 80 to 90 degree Celsius and should have shelf life of 5years or more.

1.2.26. The contractor shall provide valid calibration certificates for all the machines & instruments used for fabrication, testing, inspection etc. related to this job.

1.2.27. Final painting and finishing of the entire integrated equipment after completion of all functional trials is to be carried out. .

1.2.28. Transportation of entire structure assembly to the R&DE (E) or DRDL Hyderabad (or anywhere as per requirement). Packaging for transportation will be mutually decided between vendor and R&DE(E).

1.2.29. The contractor shall provide on-site (site specified by R&DE(E)) skilled manpower support even after completion of the job during launcher track trials, missile firing trials or any other technical activities.

1.2.30. Engraved metallic/brass name plates shall be affixed for identification of the components/systems. Display of 'Ministry of Defense' emblem in the form of radium stickers as per details given.

1.2.31. The contractor shall provide all spares as specified in the relevant section in this document, consumables and a set of tools required for normal operation, maintenance and upkeep of this system. The maintenance tools accessories, consumables and spares list shall be finalized in consultation with R&DE (E).

1.2.32. Weight of all the components shall be recorded in weight register. The Weight shall be punched / marked on major assemblies with handling instructions. Also the center of gravity symbol with missile and without missile shall be marked on the canister.

1.2.33. The tender enquiry document does not include the cost of the spares. However, the contractor shall work out detailed list of spares based on the following:

a. Field maintenance
b. Depot/ base level maintenance
c. Long term supply of spares

This list shall be submitted by the Contractor to the Purchaser. The Purchaser, if so desires shall place a separate order for spares after reviewing the list of spares submitted by the contractor.

1.2.34. The contractor shall provide nameplate on the canister and VLU as per the drawing provided by R&DE (E).

1.2.35. Submission of one set of hard copies along with the soft copy on compact disc of all approved documents as per list enclosed, 3D solid model (in *.stp or *.x_t format) and drawings in AutoCAD format with R&DE(E) template, other documents in word and pdf format.

1.2.36. Deliverables

As per approved drawings based on reference drawings and scope of work, following are the deliverables of VLU assembly (per VLU). The list of drawings is mentioned in section 1.2.48.1. **The Industry partner has to deliver VLU Assembly – Qty 02 Nos.**

VLU Assembly (1 No) Consists of following sub-systems		**Qty**
1	Top Mounting Plate/flange	01
2	VLU structure	01
3	Bottom Plate/flange	01
4	Collars assembly	08
5	Plume Deflector Structure (plate with thermal coating)	01
6	Plenum Uptake Chamber (plate with thermal coating)	01
7	Top hatch door for plenum uptake chamber	01
8	Door opening mechanism – EM actuators along with linkages, motors, brake and clutches	02
9	EM actuators for Door locking	02
10	Interface mounting structure with ship deck	01
11	System interconnection cables and harness	01 set
12	Firefighting equipment	02
13	Weatherproof non-controlled shelter for tools and spares	01
14	Launcher Electronics & Control System (Specifications provided separately)	-
15	Dummy covers for canister openings to be placed on VLU	09
16	Lifting beam for VLU	01
17	Slings for lifting of VLU	04 nos. or as reqd.
18	Turnbuckles for side support with end brackets	04 no.
19	Ladders	04 no.

1.2.36.1. List of Drawings

List of drawings is as mentioned below:

Sr. No.	Drawing No.	Description
1.	VLU 11 1110 00 00	VLU STRUCTURE ASSEMBLY-GENERAL ARRANGEMENT
2.	VLU 11 1111 00 00	VLU STRUCTURE ASSEMBLY
3.	VLU 11 1112 00 00	TOP MOUNTING FRAME
4.	VLU 11 1113 00 00	BOTTOM MOUNTING PLATE
5.	VLU 11 1114 00 00	INTERFACE MOUNTING STRUCTURE WELDMENT
6.	VLU 11 1115 00 00	JET DEFLECTOR ASSEMBLY

1.2.37. System Requirements and Performance Specifications

Sr. No.	Parameters	Requirements / Specifications	
1.	Type of Structure	VLU structure assembly	
2.	Payload	Canisterised VL SRSAM articles (08 Nos)	
3.	Capability	Capability of storing, transporting, holding and launch of 8 no. VL SRSAM Articles along with Plume deflector and uptake chamber structure	
4.	Overall Dimension (approx.)	Height = 4960 mm Length = 3020 mm Width = 2210 mm	
5.	Mechanisms / Sub-assemblies	Top plate	As per drawing
		VLU structure	As per drawing
		Bottom plate	As per drawing
		Plume Deflector	As per drawing
		Plenum uptake chamber	As per drawing
		Interface mounting structure	As per drawing
		Pair of turnbuckles	As per drawing
6.	Mounting Arrangement	Welding for interface structure with ship deck and bolting arrangement for VLU top deck with interface	

		structure	
7.	Electromechanical actuator	EM actuator for plenum uptake chamber door opening /closing EM actuator for PUC door lock/unlock	Qty. 2 No. As per specification Qty. 2 No. As per specification
8.	Sensors	Limit Switches for door open / close position Limit Switches for door lock/unlock	Qty. 2 Nos. As per specification Qty. 2 Nos. As per specification
9.	Cable Duct	On sides; as specified	
10.	Operating Panel	Switch Type; As per specification	
11.	Launcher Electronics & Control System	Technical Specification Provided separately	
12.	Plume Management	Provision of a Jet/ Plume Deflector Assembly and plenum uptake chamber to divert the plume up into the atmosphere. Plume Deflector shall be capable of withstanding without damage 48 normal firing based on: two consecutive launches of 8 missiles each (16 launches) + 32 single launches. Plume deflector shall also able to withstand one hang fire event	

N.B. – RDE has provided GA drawings and basic technical specifications for VLU and Canisters. The vendor shall contact RDE through PD for any clarification, additional data/drawings etc. especially electronic/electrical data like BOIs, connectors, cables, harnessing details etc. This is also applicable to Canister Assy.

SECTION II

APPLICABLE DOCUMENTS

2.1 Applicable documents:

The following documents (of the exact revision mentioned or the latest approved issue where a specific issue is not cited) form a part of this specification to the extent specified herein.

2.1.1 Customer's documents:

The applicable documents in this paragraph are binding when pertinent. Tailoring of military standards is permitted, pending formal approval.

2.1.2 Reference documents :

A. Military standards :

SR. No.	Standard	Description
(a)	MIL-Q-9858A	Quality Assurance Program Requirements
(b)	MIL-STD-202	Test methods for Electronics and Electrical Component Parts
(c)	MIL-STD-242	Electronic Equipment Parts
(d)	MIL-STD-454Cs(Ch2)	Standard General Requirements for Electronic Equipment
(e)	MIL-STD-470	Maintainability Program Requirements
(f)	MIL-STD-756A	Reliability Prediction
(g)	IEEE 12207	Software Standard, Configuration Management
(h)	MIL STD 810G	Environmental Tests for High Temperature, Low Temperature, Humidity, Driving Rain, Salt, Fog, Mould Growth, Shock Standards, Vibration, Immersion, Sealing and Wind Velocity
(i)	MIL STD 2164A/344A	Environmental Stress Screening
(j)	MIL STD 1686C	Electrostatic Discharge Control Programme
(k)	MIL STD 331B	Environmental and Performance Tests for Fuse Components
(l)	MIL STD 882C	Standard Practice for System Safety
(m)	MIL STD 1316	Fuse Design Safety Criteria

(n)	MIL STD 2105C	Hazard Assessment Tests for Non-Nuclear Munitions
(o)	MIL DTL 23659	Initiators, Electric, General Design Specifications.
(p)	MIL STD 1751(A)	Safety and Performance Tests for Qualification of Explosives(HE, Propellants and pyrotechnics)
(q)	NAVY MIL M-8856B(1)	Missiles Structural Integrity and General Specification
€	STANAG 4439	Insensitive Munitions Test
(s)	MIL STD 1629A	Failure Mode and Effect Analysis(FMEA)
(t)	MIL STD 1901A	Safety Criteria for Munition Rocket and Missile Motor Ignition System Design
(u)	JSS-0256-01:1992	Environmental Test Methods for Missile System
(v)	MIL STD 1385	Preclusion of Electromagnetic Hazards on Ordnance
(w)	MIL-STD 462 and 449D	RADHAZ
(x)	MIL-STD 882E	System Safety Program Requirements
(y)	JSG 0270	EMI/ EMC Specification for Missile System
(z)	MIL STD 901D	Shock Test
(aa)	MIL STD 461E/F MIL 464A	EMI/ EMC
(bb)	MIL – C – 5541	Chemical conversion coating on aluminum and aluminum alloys
(cc)	MIL – A – 8625	Anodic coatings for aluminum and aluminum alloys
(dd)	FED – STD – 595	Federal standard Colors
(ee)	MIL – STD – 1472F	Human Engineering Design Criteria for Military Systems, Equipment and Facility
(ff)	Llyod's Register	Code for Lifting Appliances for Marine Environment

B. Other standards :

i. JSS 55555 – 2000 – Environmental Test Methods for Electronic and Electrical Equipment

ii. IEC 529, DIN 40050 – Protection classes

iii. ISO 9001:2015 – Quality Management System Requirements

C. Standards for software products:

The following standards shall be followed for the development of software products.

Process: The IEEE12207 Software Development shall be followed for the software development of this project.

Coding: The 'C/C++' language coding standard for implementation of the code.

Documentation: The documentation shall be in accordance with the guidelines in IEEE 12207 standards and the Data Item Description (DID) of MIL-STD-498

D. Handbooks

a. MIL – HDBK – 217F – Reliability prediction of electronic equipment

b. MIL – HDBK – 759 – Human Engineering Design Guidelines

2.1.3 Order of Precedence

In the event of conflict between the documents referenced herein the contents of this document, the order of precedence shall be:

i. The contents of this Technical specification document

ii. The contents of the referenced documents

SECTION III

ENVIRNMENTAL CONDITIONS

The VLU assembly shall maintain its specified performance when exposed to all environmental conditions specified herein:

3.1 Natural (climatic) Environmental Conditions

3.1.1 Low Temperature

a. Operating temperature: -10°C +/- 3˚C

b. Storage temperature: -20°C +/- 3˚C

3.1.2 High Temperature (Not exposed directly to solar radiation (Indoor))

a. Operating temperature: +55°C +/- 3˚C

b. Storage temperature: +65°C +/- 3˚C

3.1.3 High Temperature (Exposed directly to solar radiation (Outdoor))

a. Operating temperature: +55°C +/- 3˚C

b. Storage temperature: +85°C +/- 3˚C

3.1.4 Humidity

All VLSRSAM VLU equipment shall maintain the specified performance when exposed to relative humidity of 95% ± 5 % at +45°C ± 2 ˚ C for both continuous and intermittent periods, including conditions wherein water condensation takes place in and on the equipment. The humidity test shall meet the requirements specified in MIL-STD-810F or other equivalent standard.

3.2 Corrosion (Salt Fog)

All VLSRSAM VLU equipment shall withstand the effects of corrosion environment as encountered in sea area. The corrosion test shall meet the requirements, specified in MIL-STD-810F or other equivalent standard.

3.3 Solar Radiation (For Actinic Effects Only)

All exposed VLSRSAM VLU equipment shall withstand the effects of solar radiation in its operating and non-operating state and maintain its specified performance when exposed to

1120W/m^2. Actinic effect is covered by MIL-STD-810F Method 505.4 Procedure II- steady state for constant energy of 1120 W/m^2 and constant Temperature of 39 °C, 44°C or 49°C.

3.5 Rain

The rain test shall meet the requirements specified in MIL-STD-810F, Method 505.4

6.1 Operating

All exposed VLSRSAM VLU equipment shall withstand the effects of 10mm/Hr rain at 18m/s wind.

2) Non-operating

All exposed VLSRSAM VLU equipment shall withstand the effects of 36mm/Hr rain at 18m/s wind.

3.6 Degree of Enclosure

a. Ground equipment exposed to weather (unsheltered)

All VLSRSAM VLU equipment exposed to weather condition (unsheltered) will withstand degree of enclosure of IP 67.

b. Ground equipment un-exposed to weather (Sheltered)

The degree of enclosure specified for sheltered equipment (all consoles and cabinets that require air circulation) should withstand degree of enclosure according to IP 67.

3.7 Fungus

The equipment shall be resistant to fungus and maintain its specified performance, in both operating and non-operating conditions, when exposed to fungus growth. The fungus proof shall be done by using analysis or similarity.

3.8 Wind Velocity

A wind static resistance analysis shall be performed to check that the equipment meets the following requirement.

1) Operating

The exposed VLSRSAM VLU equipment shall withstand and maintain its specified performance when exposed to relative wind velocity up to 90 km/hr.

2) Non-operating

The VLSRSAM VLU shall withstand without damage, winds having a relative velocity up to 120 km/hr (survival).

3.9 Induced Environmental Conditions

3.9.1 Vibration

a. Operating

1) The vibration test for Operating Mode shall meet the requirements specified in MIL-STD-810F Method 514.5, Cat.4 or other equivalent standard (no packaging) as follows
2) VLSRSAM VLU – will withstand the vibration established during missiles firing, and due to winds per 2.2.1.8 as well as any other vibration established by the VLSRSAM VLU such as generator, EF Motors etc.

b. Non-Operating

The VLSRSAM VLU shall not suffer damage or be unable to meet the specified performance after it is subjected to vibration environment expected during transportation in its original form (non-operational) by:

1) Wheeled vehicles / Trailers (MIL-STD-810F Method 514.5, Cat 4)
2) Air (MIL-STD-810F Method 514.5, Cat 7)
3) Sea-Onboard ship (MIL-STD-810F Method 514.5, Cat 10)
4) Railroad – ((MIL-STD-810F Method 514.5, Cat 11)

3.9.2 Acceleration

The acceleration test shall meet the requirements specified in MIL-STD-810F Method 513.5.

1) Operating

N/A

2) Non-Operating

The VLSRSAM VLU shall not suffer damage or subsequently fail to meet the specified performance when subjected to the acceleration during Non-active state of

During road/air/rail transportation:

Longitudinal X	+/-3g
Transversal Y	+/-1.5g
Vertical Z	+/- 2g

Due to ship motions:

	Sea State 7 (survival)	**Sea State 5 (operational)**
Longitudinal X	0.6 g	0.5 g
Transversal Y	1.3 g	0.9 g
Vertical Z	2.5 g	2.2g

(Note: a load factor of 1.25 is to be taken over the 'g' values due to ship motion)

3.9.3 Acoustic Noise

The VLSRSAM VLU equipment shall not suffer damage or subsequently fail to meet the specified performance when subjected to the Acoustic Noise of 150dB. Workspace noise shall be reduced to level that permit necessary direct (person to person) and telephone Communication and established an acceptable acoustical work environment shall not exceed 65dBA.

3.9.4 Contamination

All ground equipment exposed to weather (unsheltered) shall withstand pollutant material such as fuel gas, oil condition that BTP/LPI Systems (Generator vehicle) comply with the contamination requirements defined for it.

3.9.5 Painting scheme

Please refer Annex B of the technical specifications for Canister for details.

SECTION IV

SYSTEM ELEMENTS AND SUBSYTEMS

4.1 Introduction:

The Main Role of the VL SRSAM Vertical Launch Unit (VLU) is supporting and launching of eight (8) Canisterised Missiles (CMs) from a floating platform. The VL SRSAM VLU is mounted over the ship deck. The VLU houses the eight (8) Canisterised Missiles (CMs), Plume Deflector, Plenum Uptake Chamber (PUC), Door Opening / Closing Mechanism, Door Lock/Unlock Mechanism, Missile & Launcher Electronics and other necessary equipment described hereafter.

The VLU is composed of main subsystems as shown in the *Figure 4-1*

I. VLU structure assembly, which include a top flange plate, VLU structure, bottom plate, plume deflector structure, plenum uptake chamber, door opening mechanism for opening/closing of the door of the plenum uptake chamber, interface mounting structure and turn buckles for side support.

II. Canister, which holds, supports, guides and smoothly launches missiles

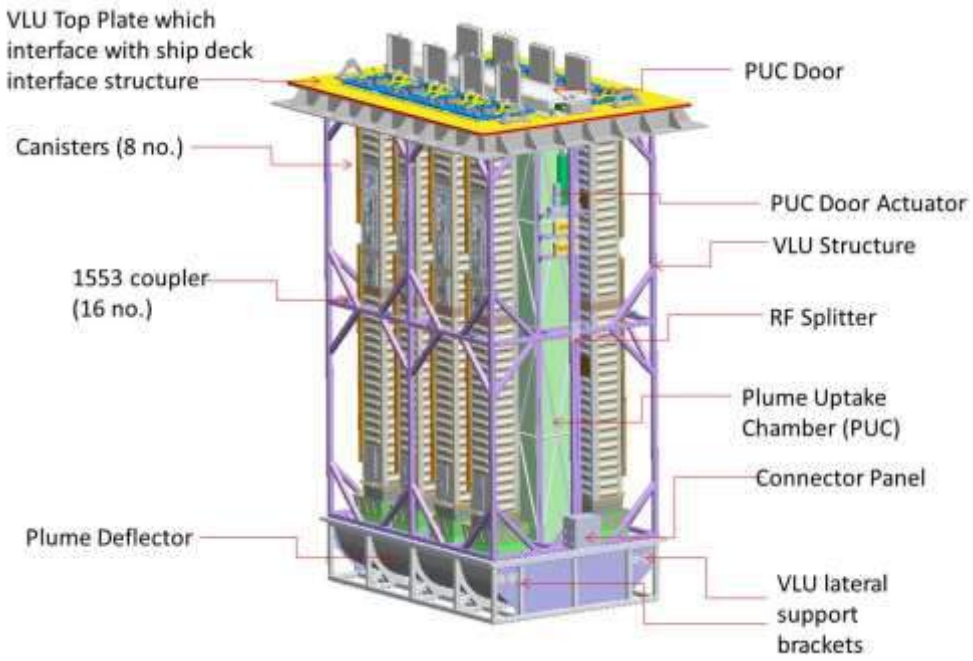

Figure 4-1: VLU Configuration

4.2 System Tree diagram:

As a part of the Technical specifications, the main elements and subsystems of the VLU required for carrying out the various functions and tasks have been identified and shown in system family tree diagram form at *Figure 4.2*

1. VL SRSAM Missiles (8 nos.)
2. Canisters (8 nos.)
3. VLU Structure Assembly:
    a. Top Mounting Plate (1 no.)
    b. VLU Structure (1 no.)
    c. Bottom Plate (1 no.)
    d. Collars (8 Nos.)
    e. Plume Deflector Structure (1 no.)
        i. Deflector Plate
        ii. Thermal Coating
    f. Plenum Uptake Chamber (1 no.)
        i. Plenum chamber structure
        ii. Thermal Coating
        iii. Top Hatch Door
        iv. Door Opening Mechanism:
            - EM Actuator and assembly (brakes, motors, clutch) (2 Nos)
            - Linkage Mechanism (2 Nos)
            - Limit switches (04 Nos)
        v. Door Locking / Unlocking Mechanism
            - EM Actuator (2 Nos)
            - Limit switches (04 Nos)
4. Interface Mounting Structure with ship deck
5. System interconnection cables and harness
6. Pair of turnbuckles (2 pairs – one pair on each side of VLU)
7. Fire Fighting Equipment – 6 nos
8. Weatherproof Non-Controlled Shelter for Tools and Spares
9. Ladders and stool tables – 4 nos each
10. Launcher Electronics & Control system (Scope of work separately attached)

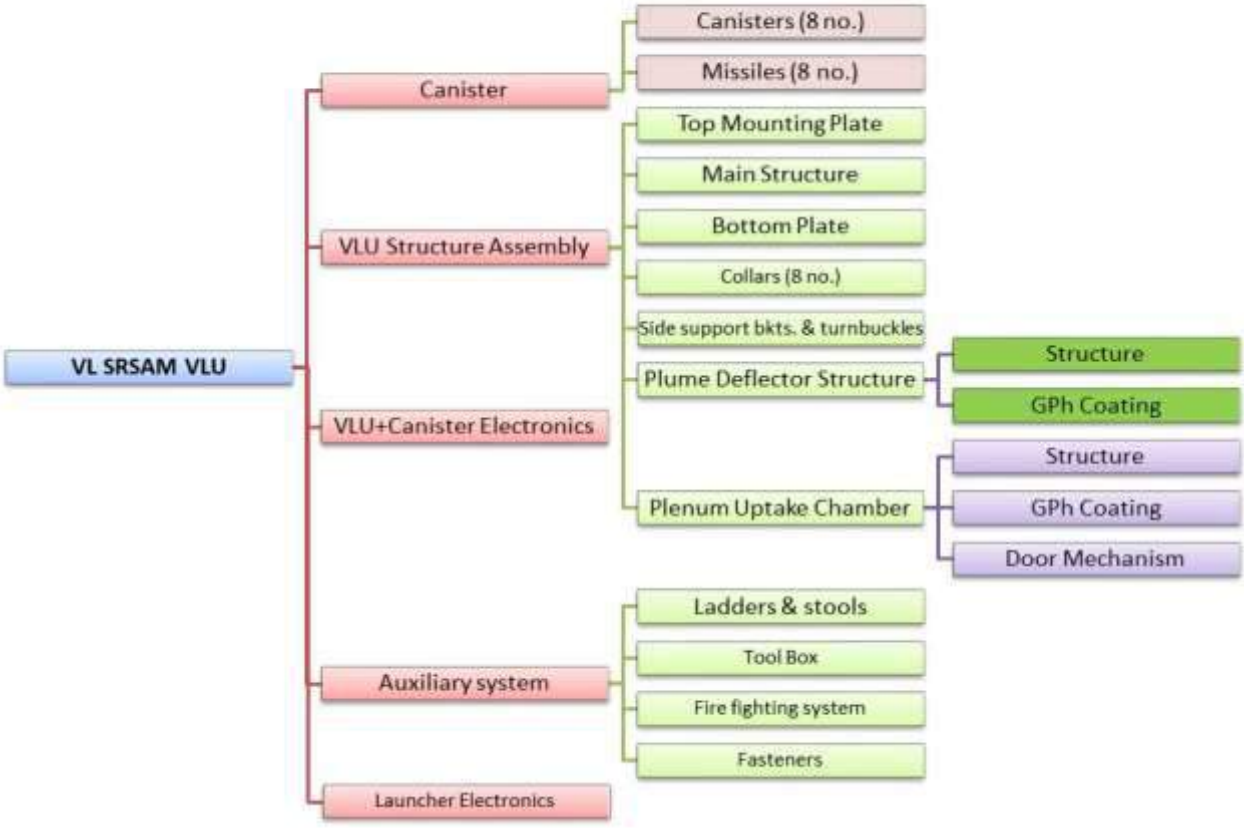

Figure 4.2 System Tree diagram

SECTION V

VLU SUBSYTEMS

5.1 VLU Main Structure Assembly

The Main Structure functions as an outer frame which gives the launcher its rigidity. It should support and holds the canisterised missiles in firm position. The top mounting plate of the Main structure enables mounting of the VLU under the ship deck. It also provides interface for the common plenum uptake chamber for all eight canisters. The plume deflector structure is mounted at the bottom of the VLU main structure.

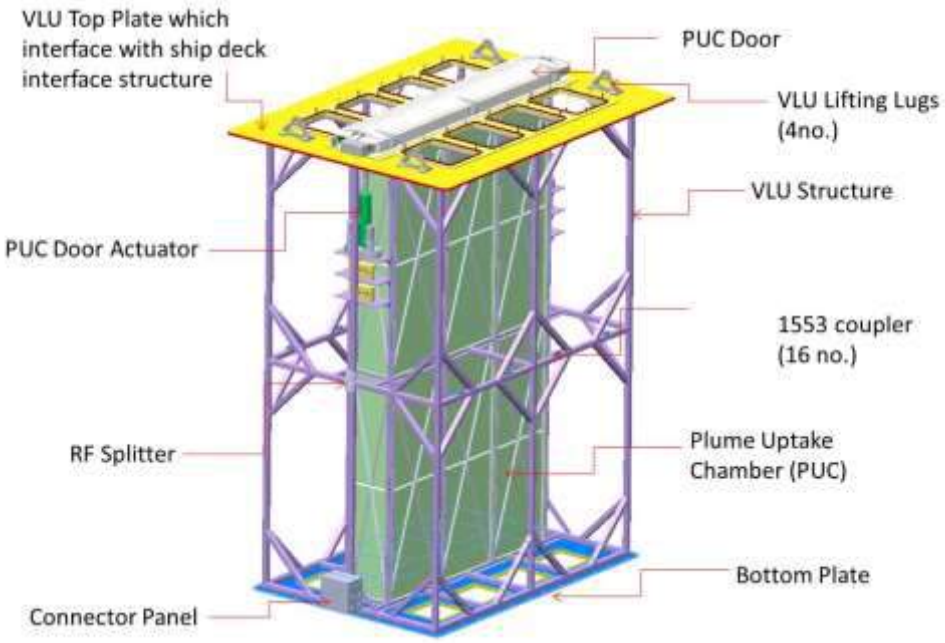

Figure 5.1 VLU Main Structure Assembly

The VLU Main Structure is shown in figure 5.1. The subsystem elements of the Main structure are shown in the tree diagram as follows:

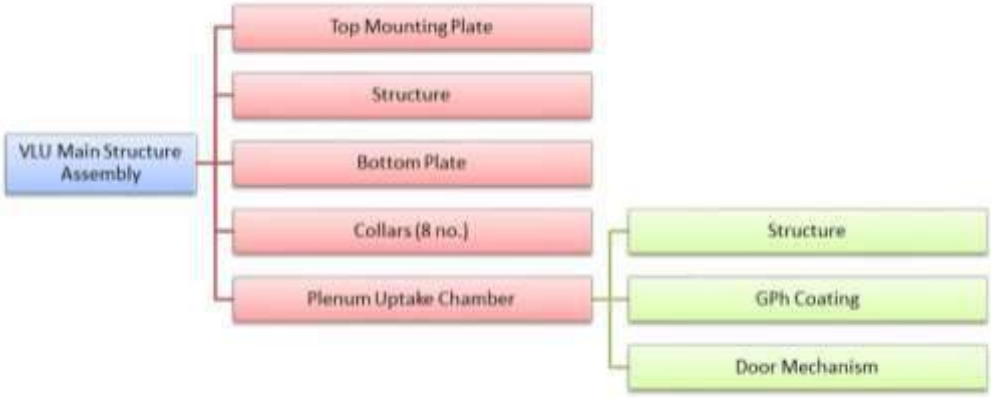

Figure 5.2 VLU Main Structure Assembly Tree Diagram

5.1.2 Structure

The Main Structure shall provide sufficient space for mounting of the associated sub systems and equipment. The Main Structure serves as a support and enclosure to the canisterised missiles. Also, it houses the common plenum chamber for all eight CMs. It is formed using a 3D space structure using standard box sections of size 50x50x4 mm. It is made up of AA 6061 T6 / AA5083 H111 or equivalent material. At the top of the structure, top mounting plate is welded while at the base of the structure bottom plate is welded. The plenum uptake chamber is the integral part of the structure. The dimensions of the main structure assembly have been evolved considering the need for accommodating the CMs as well as provide a strong interface between the CMs and the ship deck.

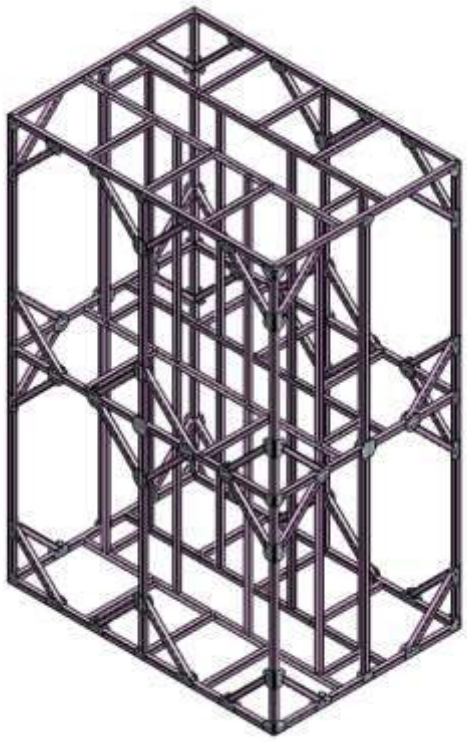

Figure 5.3 Structure

Table 5.1 Technical Specifications for Structure	
Configuration	3 D space structure
Construction	• Welded 3D space structure constructed out of hollow box sections of size 50 x 50 x 4 mm and C channels of size 50 x 50 x 4 mm • Trays of 4mm thickness with thermal coating (e glass phenolic)
Quantity	1 No
Material	AA 6061 T6 / AA5083 H111 or equi.
Overall Dimensions(mm)	4132 (H) x 2720 (L) x 1905 (W) mm
Overall Weight	Not to exceed than 750 kg (including PUC structure, trays with coating)
Mounting & Interface Provisions	• Welded interface for top mounting plate • Welded interface for bottom plate • Common plenum uptake chamber

	• Mounting interfaces for launcher and missile electronics • Cable Routing • Mounting arrangement for ladders

Note: Vendor to provide (in discussion with R&DE (E) anchoring arrangement for ladders on the structure

5.1.3 Top Mounting Plate

The top mounting plate is made of AA 6061 T6 / AA5083 H111 or equivalent material and its thickness is 25 mm. The top flange of canister is mounted over the top mounting plate. The top mounting plate is welded to the structural members. The top mounting plate forms the interface of the VLU with the ship deck through an interface structure. There are four no. of lifting lugs provided to lift the VLU during loading / unloading into the ship. The door assembly of the uptake chamber is also mounted over the top mounting plate

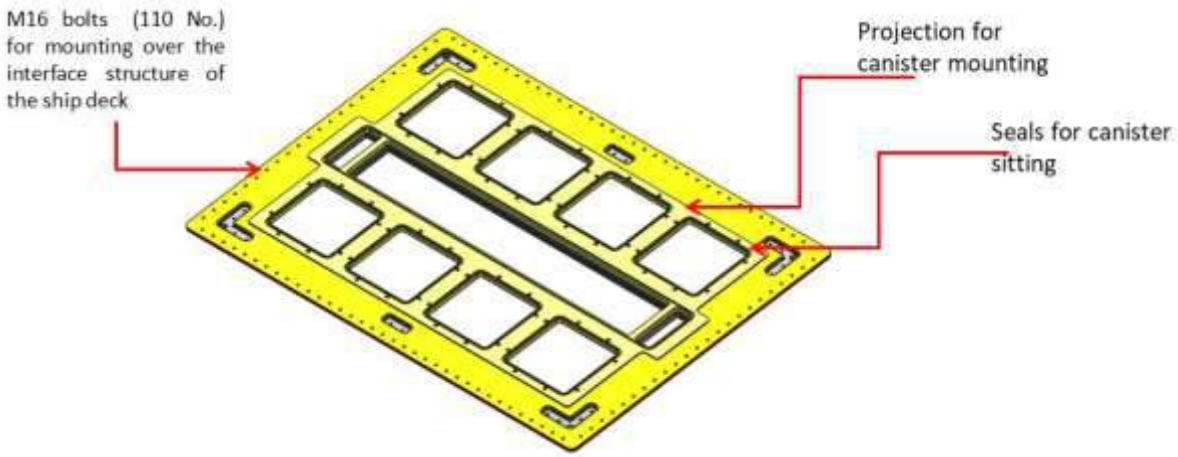

Figure 5.4 Top Mounting Plate

The interface of the canister with the top mounting structure is shown in the figure 5.5 and figure 5.6 below,

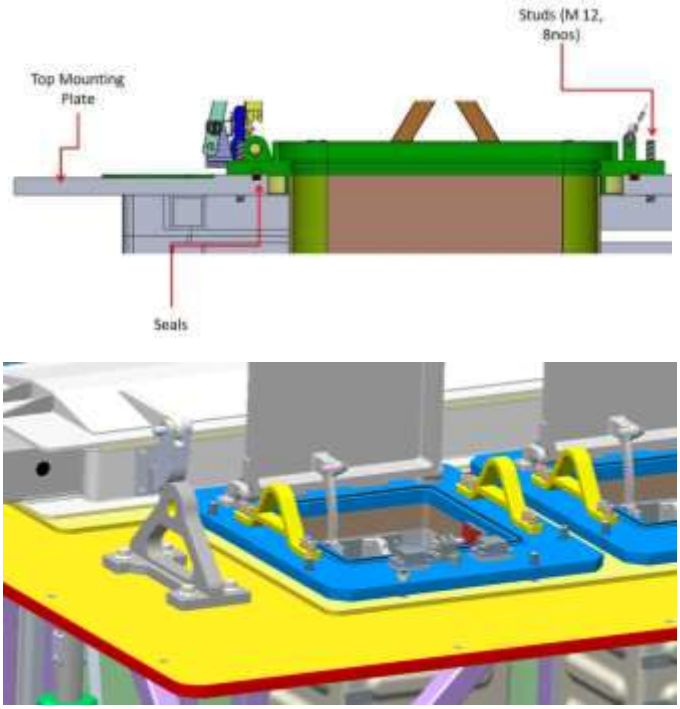

Figure 5.5 Canister flange interface with top mounting plate

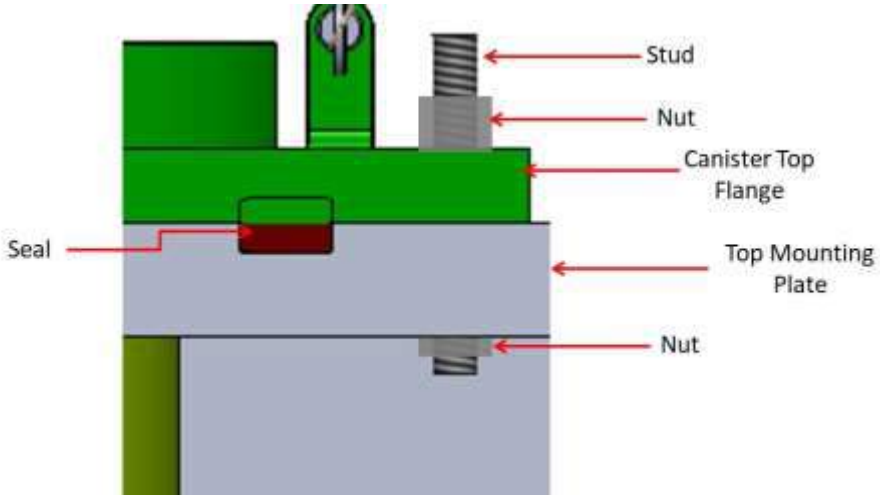

Figure 5.6 Canister flange interface with top mounting plate (close up view)

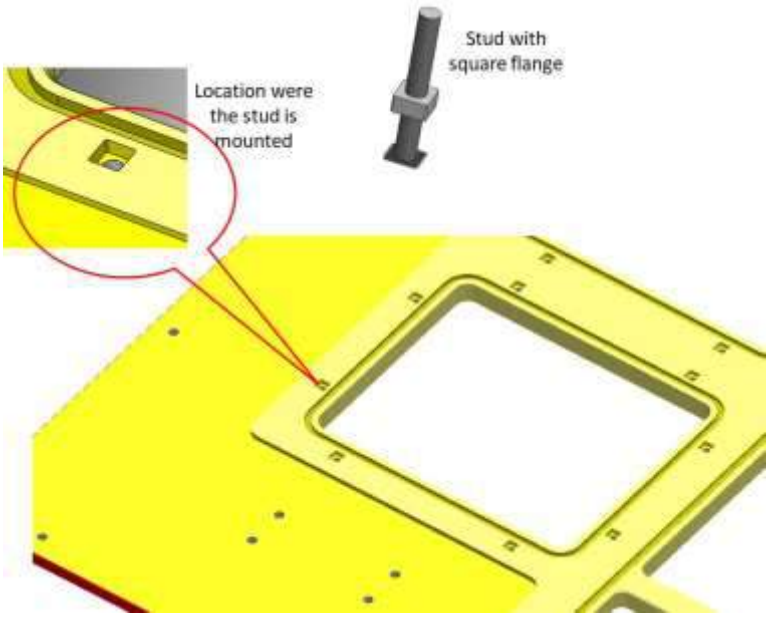

Figure 5.7 Stud position over the Top Mounting(mtg) Plate

The canister flange sits over the raised machined surface of the top mounting plate. There are diagonal dowel pins provided for location of the canister over the top mtg plate. On the top mtg plate studs of size M12, 8 nos are provided. These studs are fastened to the top mtg plate using the nuts below the top mtg plate and once the canisters are placed over the top mtg plate, the studs holding the canister top flange are fastened by the nuts from above plate. This type of arrangement is provided to prevent use of helicoils in the top mtg plate. The stud location over the top mounting plate is shown in figure 5.7. The canister top flange sits over the seals provided over the top mtg plate as shown in the figure 5.6 above.

The interface between cover for the plenum uptake chamber with top mounting plate is shown in the figure below,

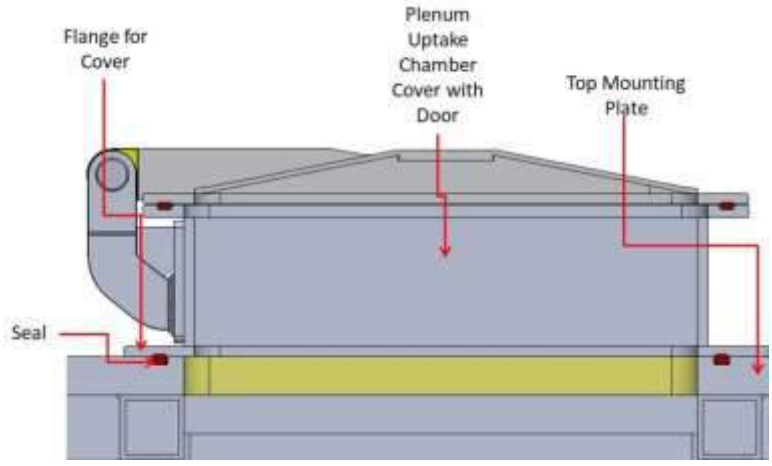

Figure 5.8 Interface between plenum uptake chamber cover and top mounting plate

The uptake chamber is an integral part of the upper and lower structure of the VLU. But the cover for uptake chamber is provided externally which is mounted over the top mounting plate. For this cover, a flange is being provided which sits over the raised machined surface of the top mounting plate. For fastening, similar arrangement as for canister is being provided. There are studs which are fastened to top mounting plate by nuts below the plate. Once the flange of the cover is placed over the plate, the nuts from the top side are tightened. This arranegement elimates use of helicoils.

Table 5.2 Technical Specifications for Top Mounting Plate	
Configuration	Plate
Quantity	1 No
Material	AA 6061 T6 / AA5083 H111 or equivalent
Overall Dimensions(mm)	3228(L) x 2413 (W) x 25 (H) mm
Overall Weight	Not to exceed than 420 kg.
No. of Support Points	• Supported on ship deck over the ship interface structure
Mounting & Interface Provisions	• Machined surfaces for mounting of CMs- 8 No. • Cover (with door) for plenum uptake chamber • Top mtg. plate is welded with structure • Lifting Lugs (4 no.)

5.1.4 Bottom Plate

At the bottom of the structure, there is a bottom plate of 25 mm thick welded to the structure. The bottom plate is made of AA 6061 T6 / AA5083 H111 or equivalent material. The bottom plate forms an interface between VLU structure and the plume deflector structure. It also provides bottom support to the canister bottom flange. There are eight collars mounted over the bottom plate. These collars have a draft angle on the inner side to guide the canisters and enable resting of the canister bottom flange. The inner surface of the collar has 30eflon sheets to reduce any friction between canister bottom flange and collar while lowering the canisters. There are disc springs provided at the four corners of the collar. These disc springs enable resting of the bottom flange of the canister. The plume deflector structure is fastened to the bottom plate.

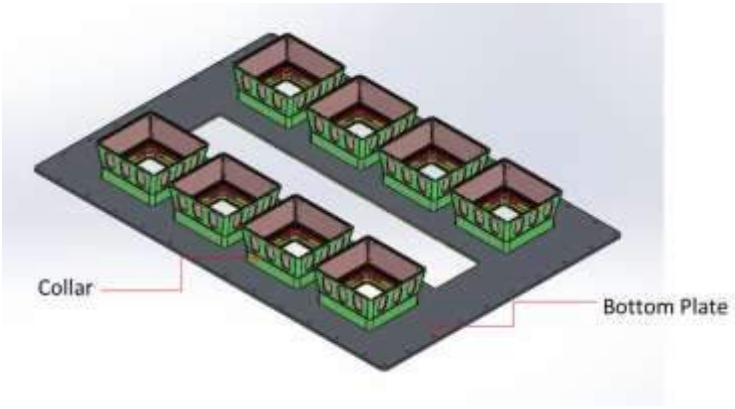

Figure 5.9 Bottom Plate (View from top)

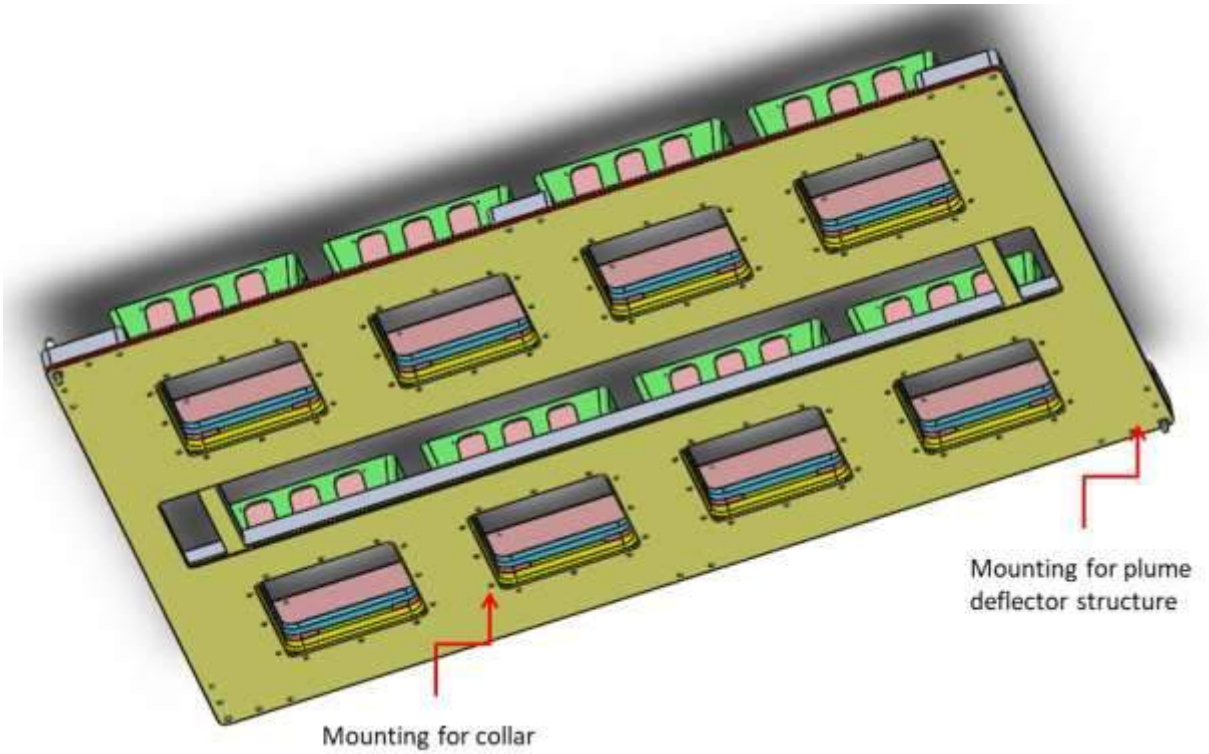

Figure 5.10 Bottom Plate (Bottom view)

Table 5.3 Technical Specifications for Bottom Plate	
Configuration	Plate
Quantity	1 No
Material	AA 6061 T6 / AA5083 H111 or equivalent
Overall Dimensions(mm)	2840(L) x 2025 (W) x 16 (H) mm
Overall Weight	Not to exceed than 175 kg.

Mounting & Interface Provisions	• Mounting of Collars- 8No. • Mounting interface for the plume deflector structure • Bottom plate is welded with structure

5.1.5 Collar Assembly

There are eight collars mounted over the bottom plate. These collars have a draft angle of 10 degree with the vertical on the inner side to guide the canisters and enable resting of the canister bottom flange. The inner surface of the collar has turcite sheets to reduce any friction between canister bottom flange and collar while lowering the canisters. Turcite is an internally lubricated acetal based material. It reduces friction. There are disc spring assembly to maintain a positive pressure between the seals and the canister flange. The collar assembly is shown in the figure below

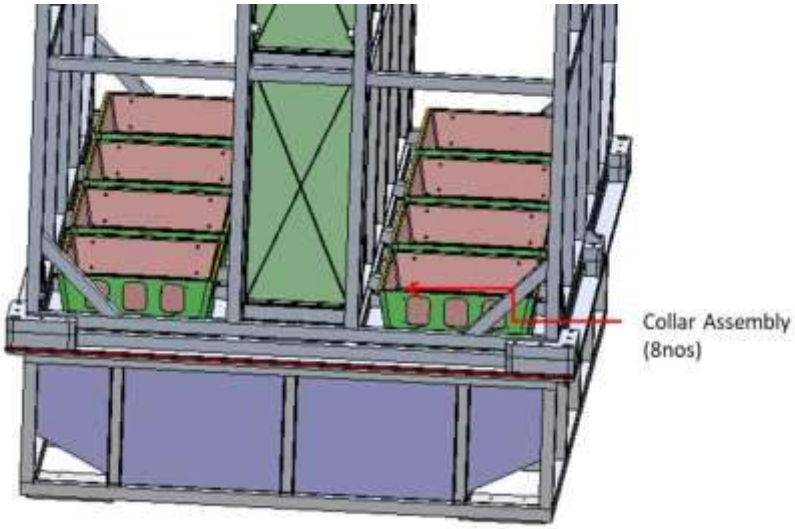

Figure 5.11 Collar Assembly within VLU

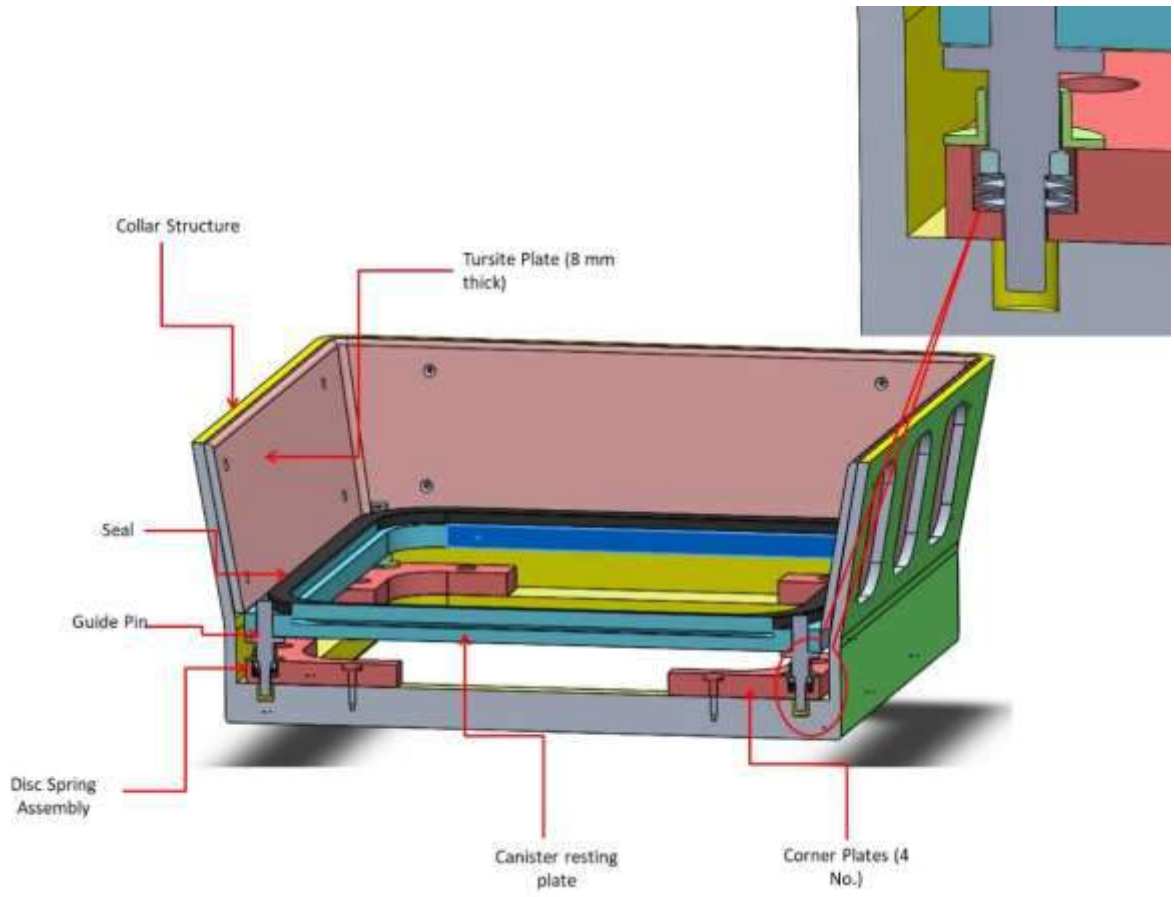

Figure 5.12 Collar Assembly (sectional view)

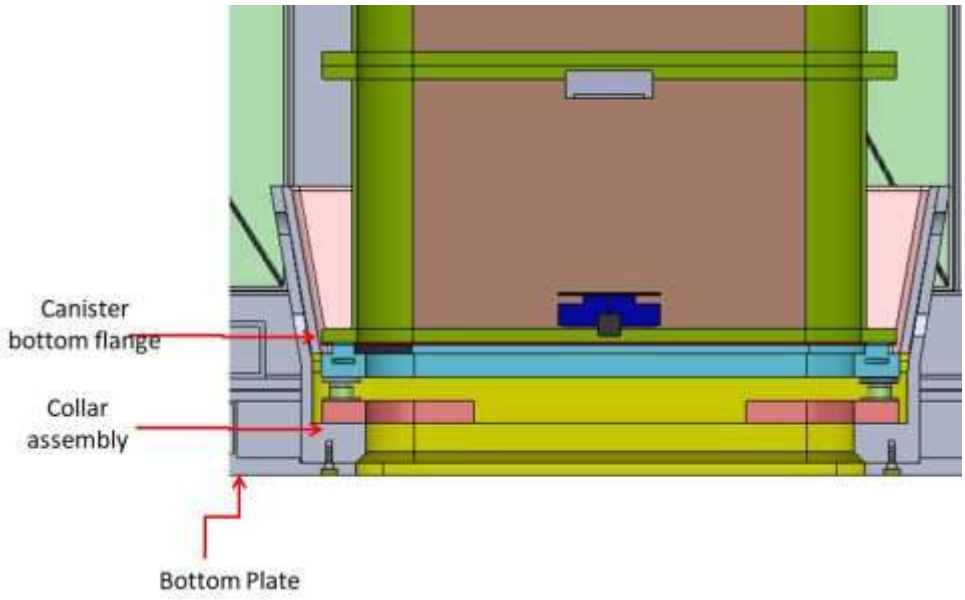

Figure 5.13 Interface between Collar assembly and Bottom Plate

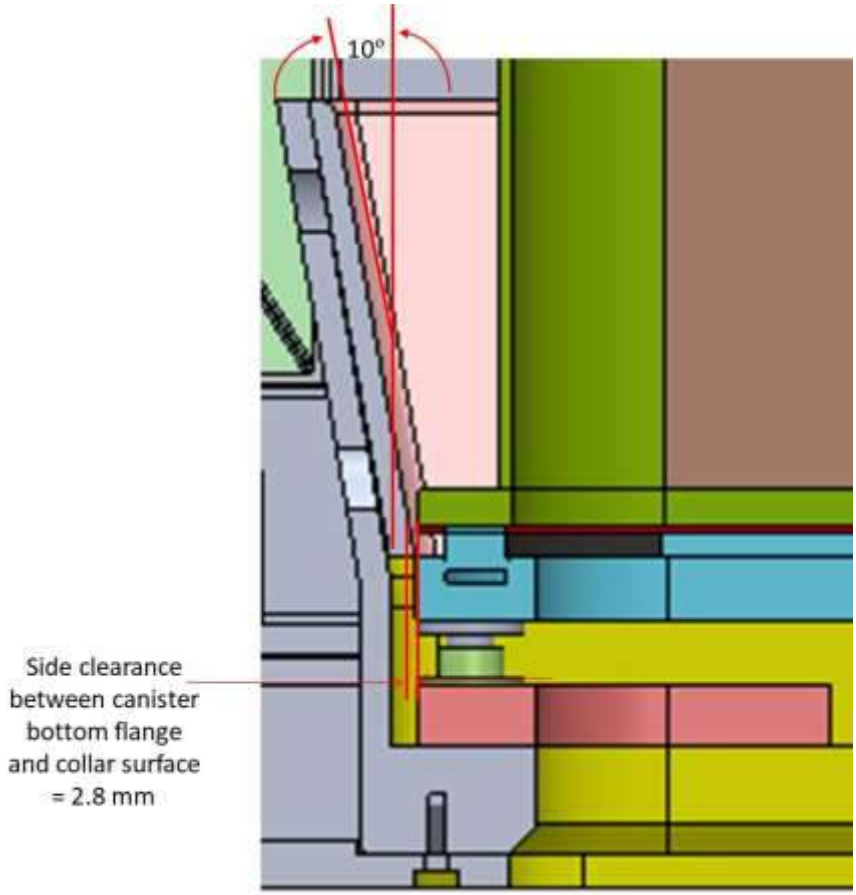

Figure 5.14 Interface between Collar assembly and Bottom Plate (enlarged view)

The collar assembly is screwed to the bottom plate. For this stainless steel helicoils have been provide within collar assembly. The interface of collar assembly and the bottom plate is shown in the figure above.

The sectional view of the collar assembly is shown in the figure above. When the canister rests onto the top mounting plate, it may happen that the lower flange of the canister may not rest due to manufacturing inaccuracies, resulting into canister remaining in hanging position. Also there will not be any positive pressure on the seal between bottom canister flange and bottom resting surface. The present collar configuration will ensure proper resting of the canister at the bottom surface. Also it will help in maintaining a positive pressure on the seal. The spring force of the disc spring is kept slightly less than the weight of the canisterised missile. When the canister touches the resting plate the springs will get compressed. Further providing tightening torque to the stud of the canister top flange, the canister bottom flange will further deflect the resting pad. This will ensure positive pressure maintaining over the seal.

Table 5.4 Technical Specifications for Collar Assembly	
Quantity	8 No
Material	AA 6061 T6 / AA5083 H111 or equivalent: main structure plates, Thickness: 10 mm Tursite plate coating: 6 mm thick
Overall Dimensions(mm)	490 (L) x 490 (W) x 240 (H) mm
Overall Weight	Not to exceed than 30 kg
Mounting & Interface Provisions	• Mounting interface with the bottom plate • Interface resting plate with canister bottom flange

Table 5.5 Technical Specifications for Disc Spring(TBR)	
Quantity	256 No
As per Standard	IS 12511 (Part2) : 2004 (C Series)
Spring Material	Steel Grade 50Cr4V2 conforming to IS 2507 (suitable coating to prevent galvanic corrosion)
Overall Dimensions(mm)	• Outside Dia : 22.5 mm • Inside Dia : 11.2 mm • Thickness of the Disc Springs :0.6 mm • Free Overall Length in Initial Positio : 1.4 mm • Deflection of Single Disc : 0.6 mm

5.1.6 Plenum Uptake Chamber

The plenum uptake chamber is an integral structure of the VLU structure. The uptake chamber is common for all eight canisters. The PUC is formed by welding standard C channels (size 50 x 50 x 4 mm) to box section of VLU structure. The plenum uptake chamber is then covered by AA6061 T6/ AA5083 H111 or equivalent material sheets of 4 mm thickness. These sheets are formed in tray shape form which will enable easy removal and installation of the sheets. Such a

modular arrangement will enable selective removal and installation of the trays. Only the damaged trays because of missile plume can be removed and replaced. The trays of the plenum uptake chamber are coated with the e- glass phenolic coating of 6 mm thickness.

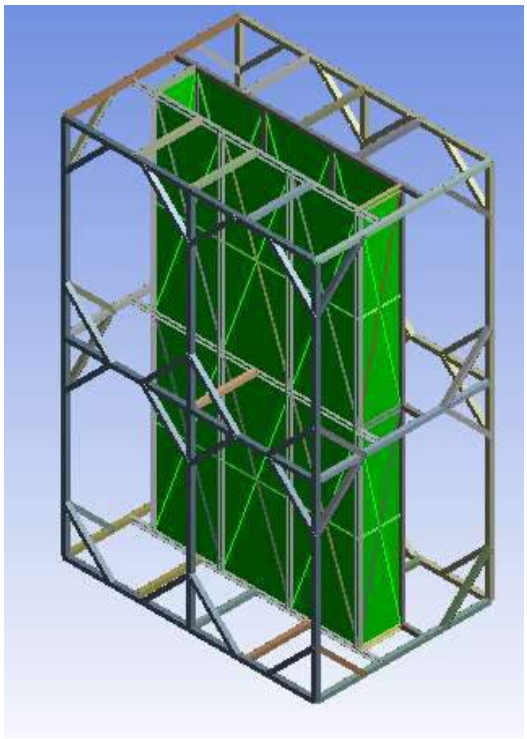

Figure 5.15 Plenum Uptake Chamber

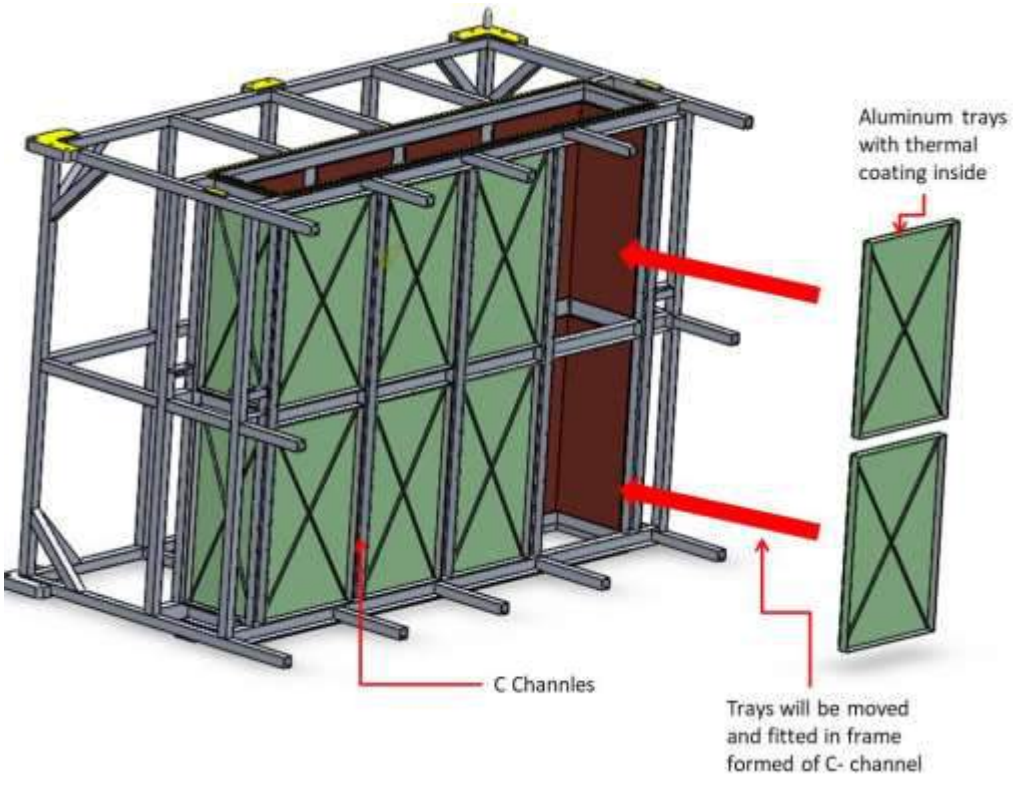

Figure 5.16 Plenum Uptake Chamber : Tray Replacment Arrangement

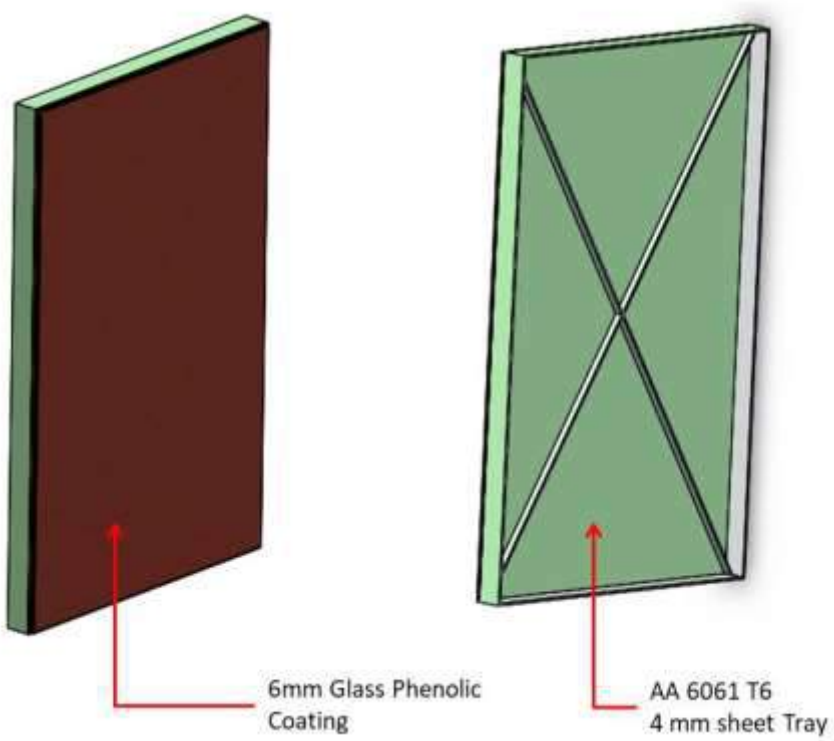

Figure 5.17 Tray Arrangement for Plenum Uptake Arrangement

The above shown trays are bolted to C-Channels of the upper and bottom structure which can enable easy replacement of the tray panels.

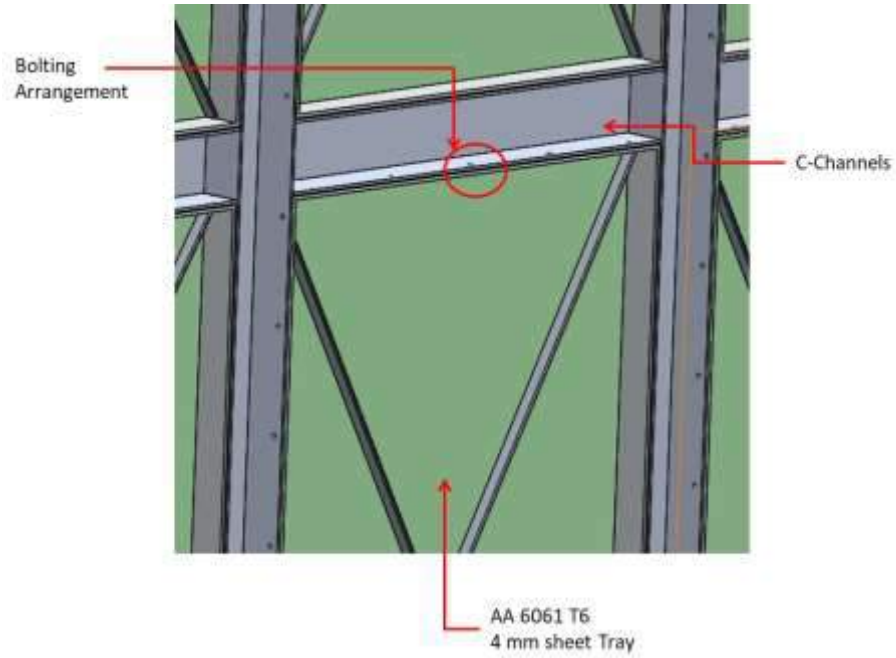

Figure 5.18 Fastening arrangement of the tray panels with the C Channels of the structure

Note: The trays are shown plane in above figures, but in actual these trays will have corrugations

5.2 Plume Deflector Structure

A Plume Deflector Structure is provided with the VLU as a Plume Management Unit. The Plume Deflector is required to divert missile booster exhaust plumes smoothly away from Canister towards the common plenum uptake chamber in order to avoid any damage to the CM and other subsystems of the VLU. The plume deflector is coated with Glass Phenolic Coating. The configuration and layout of the Plume Deflector has been evolved with a view to meet the various functional and operational requirements of the Launcher. The location of the Plume Deflector Structure is shown in *figure 6.30.*

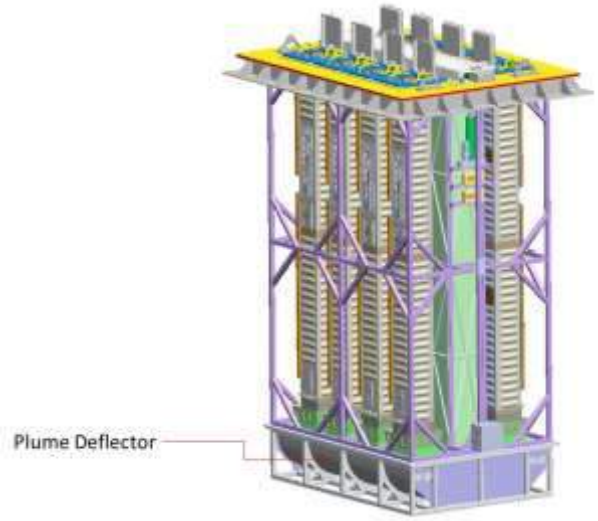

Figure 5.19 Plume Deflector Structure Location

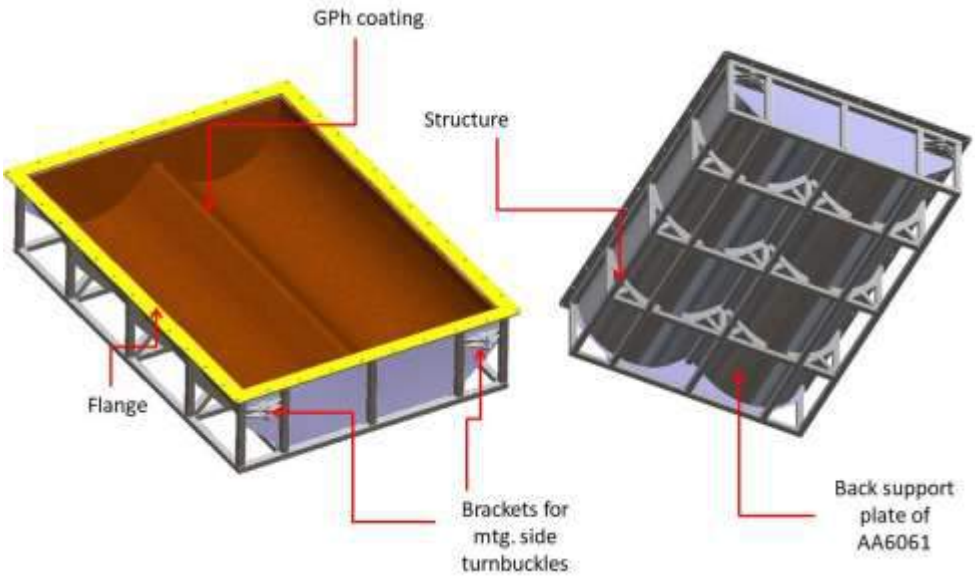

Figure 5.20Plume Deflector structure

Table 5.6 Technical Specifications for Plume Deflector Structure	
Overall size, mm	2025 W x 2840 L x 587 H mm
Material of structure (Tube)	AA 6061 T6 / AA5083 H111 or equivalent Size of tubes: 50 x 50x 4mm Size of C Channels: 50 x50 x4 mm
Material of plate	6 mm thick AA 6061 T6 / AA5083 H111 or equivalent
Weight of structure & plates	Less than 275 kg (excluding coating)
Coating	20 mm coating of e-Glass phenolic
Weight of coating	Less than 205 kg

5.3 PUC Door Opening / Closing Mechanism

The common plenum uptake chamber is closed by a door to avoid water incoming into the launcher (Splash proof sealing). The top door is opened / closed before / after missile launch, upon receiving an electrical signal from WCS. The configuration and layout of the mechanism has been evolved with a view to meet the various functional and operational requirements of the Launcher. The location of the mechanism is shown in figure below,

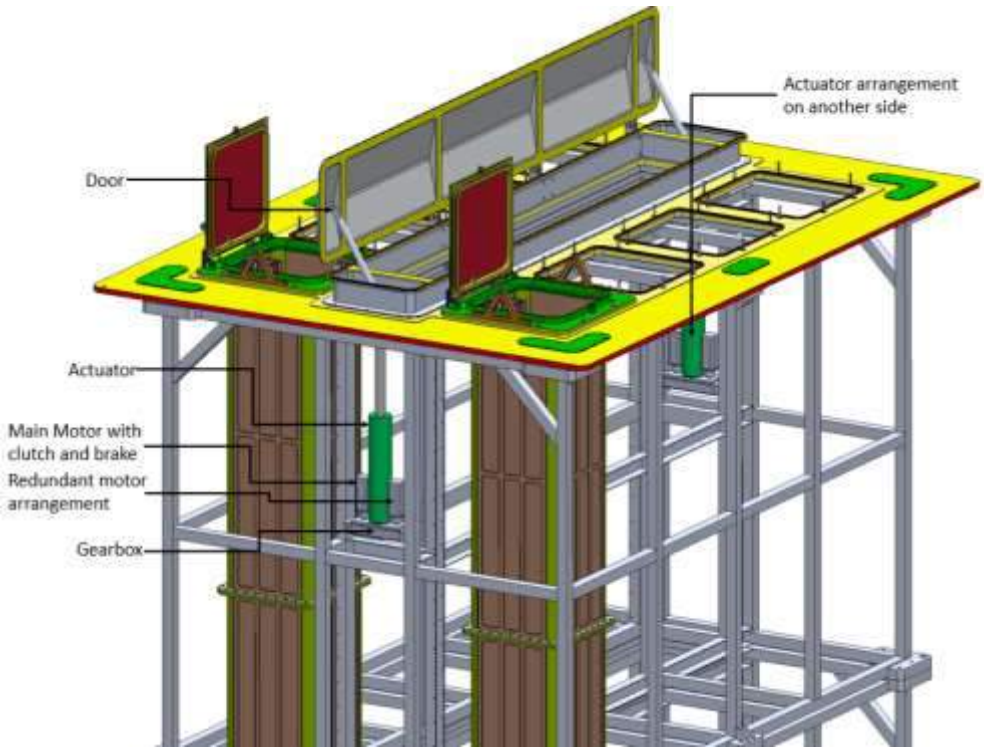

Figure 5.21 PUC Door Mechanism

The major sub systems of the hatch door opening mechanism is shown in the figure 8-2 below.

Figure 5.22 Hatch Door Opening Mechanism- Major Subsystems

The hatch door is opened and closed using an electromechanical actuator. The connecting link is kept between door and actuator out-put link to transmit the motion to door while opening and closing. The door is mounted at the top of the structure. The components of hatch door opening mechanism is shown in the figure 5.23 below.

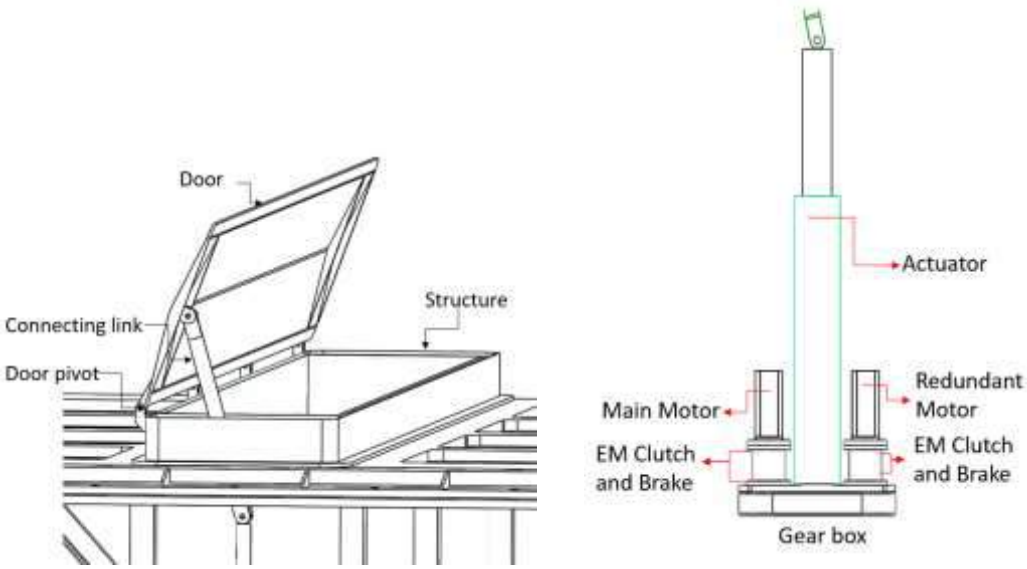

Figure 5.23 Hatch Door Opening Mechanism

Modes of Operation-

1) **In static/hold condition** – Main motor is in connection with the actuator through gear pair of stage 1 and 2. The EM clutch is in disengaged position while EM brake is in engaged condition to hold the gear shaft stationary.

2) **Operation through Main motor**– Brake is released on both sides. Now, EM clutch on main motor side is in engaged condition. So the power will be transmitted from the main motor to actuator through the gear box. At this condition, the gear pair on redundant motor side will rotate ideally.

3) **Failure mode** – In case of failure of main motor the clutch on main motor side is in released condition so that the shaft of gear on main motor side will rotate ideally.

4) **Redundant motor operation** – For redundant motor operation, the clutch on redundant motor side is in engaged condition so that the power will be transmitted to actuator from redundant motor through gear box. At this condition, the gear pair on main motor side will rotate ideally.

Table 5.7 Technical Specifications for EM Actuator

for PUC door Opening/Closing		
Open Length	709.89	mm
Close Length	434	mm
Stroke	275.89	mm
Max Act Force	627.2	N
Max Linear Speed	242.02	mm/sec

Table 5.8 Technical Specifications of Plenum Chamber Door Mechanism		
S. No.	**Item**	**Technical Specification**
1	Hatch Door	Material: AA 6061 Cond T6 / AA5083 H111 or equivalent Weight ≤ 40kg Door Opening Time < 2 seconds Opening Angle : 90˚ Dimensions: 2500 mm x 438 mm Mountings/Brackets/Attachments: 1. Pivoted at one end (4 no.) 2. Connecting link to connect door and actuator (2 no.) 3. Groove for sealing Door Pivot – *a. Material – En 19* b. Pivot pin – Material En 19, Dia. – 16mm Quantity – 1 No.
2	Connecting link	Material: AA 6061 Cond T6 / AA5083 H111 or equivalent Weight < 1.5kg Dimensions: ø 32 mm , 450 mm (L) Mountings/Brackets/Attachments:

		1. Both end pivoted (2 no.). 2. Provision for pivot mounting to the door and actuator Quantity -2 no.
3	Electromechanical Actuator	1. Actuator Specifications: a. Electromechanical actuator b. Make and Model – Rollvis- Type RV – Ground screws c. Stroke: 275.89 d. Static load rating = 76.9 kN e. Dynamic load rating = 67.2 kN 2. Actuator Top Pivot Bracket *c. Material – En 19* d. Pivot pin – Material En 19, Dia. – 12mm e. Connected to connecting link of mechanism. 3. Actuator Bottom a. Flange mounted to Canister structure Quantity – 2 no.
4	Electromechanical Clutch and brake	Clutch and brake specification: Vortex – Design 101 or equivalent Size- 0.45 Torque capacity -3.6 Nm Quantity – 2 no. EM Brake and 2 no. EM Clutch
5	Motor	Make: ABB or equivalent Model: MotiFlex e180 10 Amp @230 VAC

5.4 PUC Door Locking/Unlocking Mechanism

The door after closing is required to be locked. For this a locking mechanism is being provided as shown in the figure below,

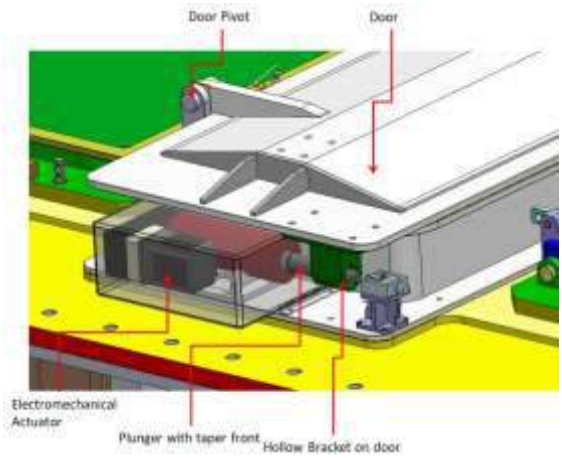

Figure 5.24 Door Locking/ Unlocking Mechanism

As shown in the above figure, the door locking mechanism consists of an electromechanical actuator, with a plunger. The plunger has taper at the tip to enable entry into the hollow bracket. This hollow bracket is mounted on the door. Prior to launch the lock is opened and the door is opened using the mechanism explained in the previous section. This locking mechanism maintains pressure on the seals preventing water ingress into the VLU through the door. This locking mechanism is provided both sides of the door**.** The actuator is covered by an enclosure.

Note: The EM actuator for locking / unlocking mechanism will be mutually selected by vendor and R&DE€ (Reqd Qty. 2 no.)

5.5 Interface Structure of VLU with ship Deck (To be decided)

The interface structure forms an interface between VLU top mounting plate and ship deck. This structure will be welded to the ship deck girders. On the top surface of the interface structure, proper seals will be provided between the VLU top mounting plate and interface top surface.

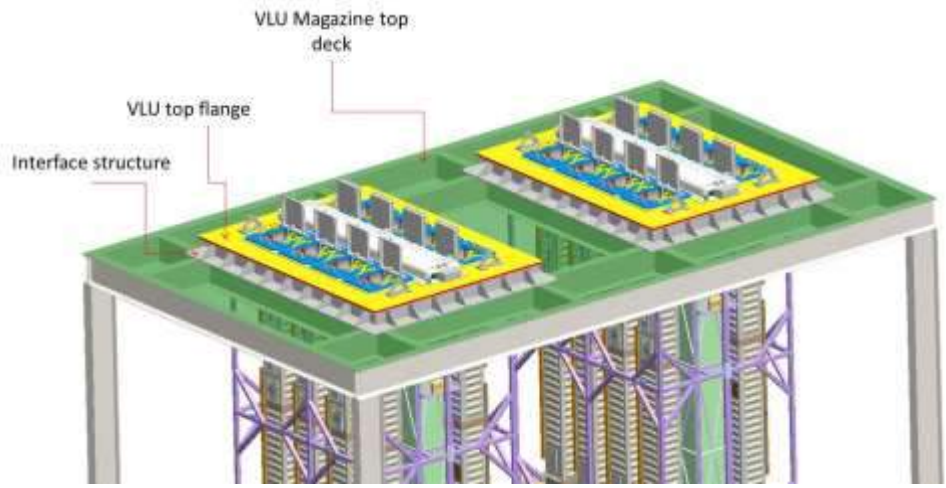

Figure 5.25 Interface Structure on ship

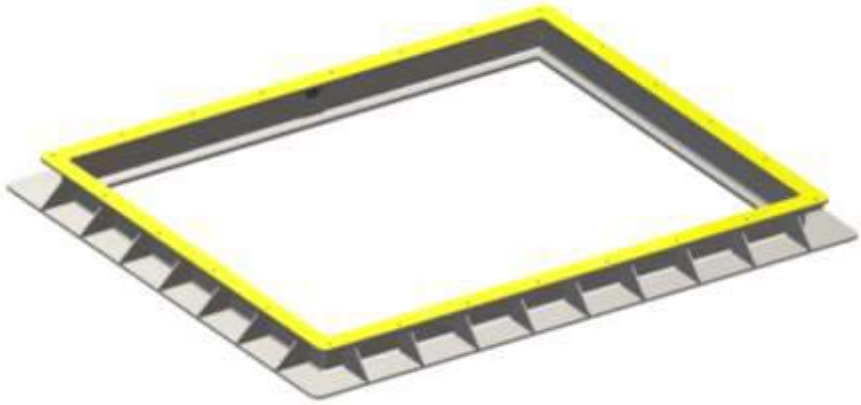

Figure 5.26 Interface Structure

Table 5.9 Technical Specifications for Interface Structure	
Overall size, mm	2641 W x 3456 L x 200 H mm
Material of plate	GOST 5521-76 10XCH 16 mm thick
Weight	Less than 900 kg
Qty.	1 no.

5.6 Pair of Turnbuckles

A pair of turnbuckles are hinged to the both the lateral sides of the VLU assembly as shown in figure below. One end of the turnbuckle is anchored to the VLU structure while the other end is

mounted to the ship wall. There are spherical joints at each end of the turn buckle. The turnbuckles will restrict the lateral and longitudinal movement of the complete assembly.

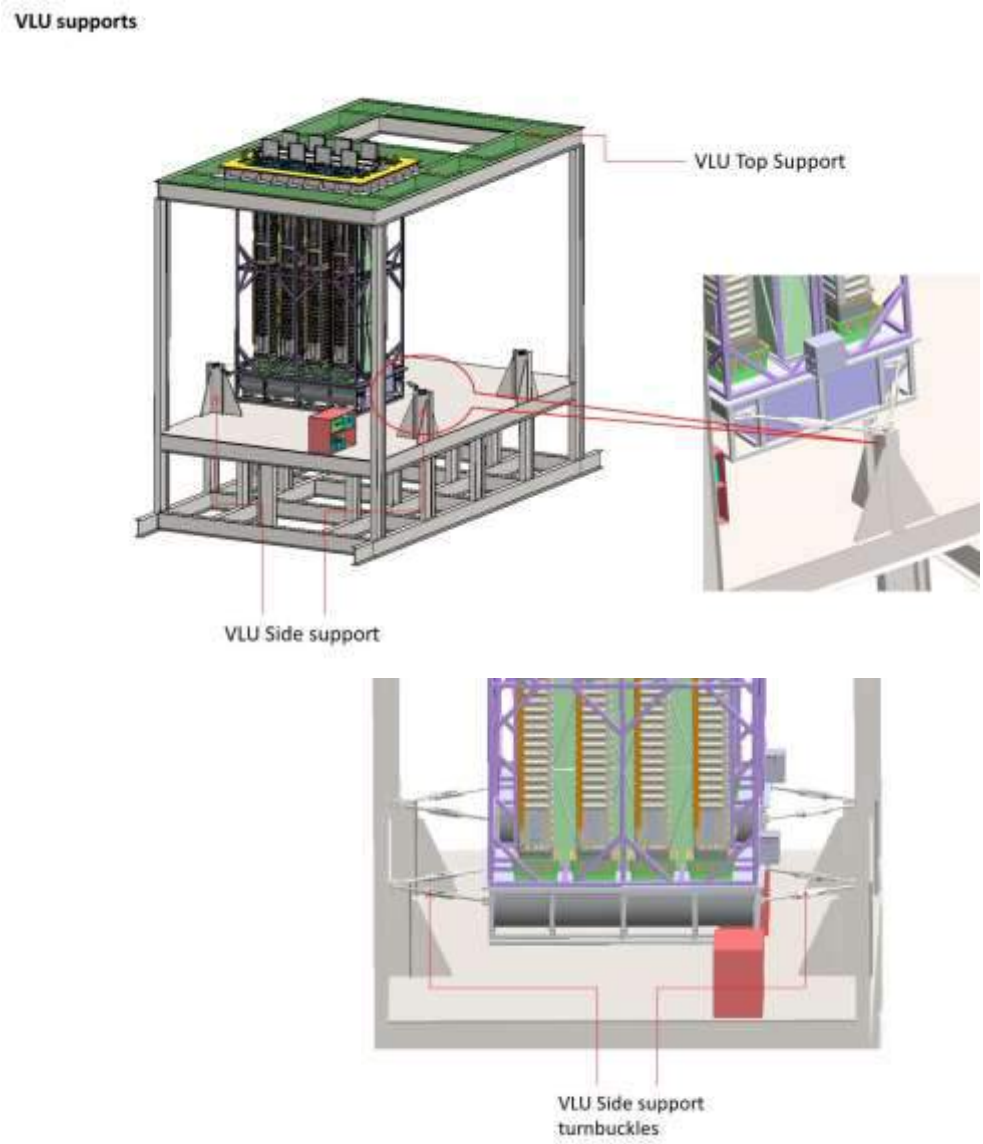

Figure 5.27 Side Support Turnbuckle

Table 5.9 Technical Specifications for Side Support Turnbuckle	
Diameter	50 mm
Material	En 24 Cond T
Qty.	4 no. per VLU

SECTION VI

LIST OF DELIVERABLES

3.11 List of Deliverables

The scope of work is for Manufacturing, Integration, Testing and Supply of VLU Assembly (2 nos.) as per drawing no**.** VLU 11 1110 00 00 consisting of following items:

Sr. No.	**Deliverable Items (per VLU)**	**Quantity per set**	**Remarks**
1	Top Mounting plate	01 Nos	
2	VLU structure	01 Nos	
3	Bottom mounting plate along with collar (08 nos.) assembly	01 Nos	
4	Plume Deflector structure	01 Nos.	
5	Plenum uptake chamber and Hatch door assembly(2 EM actuators, 2 Motors, 2 clutches, GB and 2 brakes)	01 Nos.	
6	Pair of turnbuckles with end brackets	02 Nos.	
7	Ladders	04 Nos.	
8	Slings for lifting	01 set	4 slings with end connectors
9	Interface mounting structure	01 Nos	
10	Dummy canister covers	08 Nos	

6.2 List of Deliverable Documents

(Documents be supplied along with the System)

Sr. No.	**Description of Document**	**Quantity**		**Remark**
		Hard Copy	**Compact Disc's**	
1.	Manufacturing Drawings of all sub- systems	1 Set	1 Set	On AutoCAD with R&DE(E) template

2	All layouts prepared at all stages & As Built Drawings	1Set	1 Set	On AutoCAD
3	3D Solid Model in Step or Parasolid format	-	1 Set	Compatible with Solid works
4	All inspection reports pertaining to stage and final inspection with all internal inspection reports, manufacturer's certificates wherever applicable, including material test certificate/ reports in the form of document, heat treatment reports, glass phenolic temperature test, welding inspection reports, emboss thinning reports, dye penetrate reports for emboss and bends in sheet	1 Set	-	
5	Test Certificates of all Bought Out Materials , including all Consumables:- welding electrodes/ wires, shielding gases, paints, FOL etc.	1 Set	-	
6	Process sheets & Process Plan	1 Set	1 Set	
7	Quality Assurance Plan	1 Set	1 Set	
8	Calibration reports of all equipment & instruments used	1 Set	-	
9	Welder Qualification Records including WPS,PQR, WPQ/ WPQR, Weld test reports,(Destructive & Non-destructive)	1 Set	-	
10	Acceptance Test Plan & Report	1 Set	1 Set	

SECTION VII

MANUFACTURE, WORKMANSHIP AND PAINTING

3.12 Laying Out, Marking, Identification and Preparatory Operations:

3.12.5 All steel, aluminum plates & other sections shall be cleaned by using wire brush or by sand blasting to remove rust, paint, chalk, graphite and other contaminants used for marking before welding. For identification & verification of the material, the contractor shall put the transfer of stamps once the marking on material is done for cutting or machining. Stamps shall be marked such way that they are available & visible on each component or part. All the material used for particular component / subassembly shall be traceable to the material certificate. Stamp transfer shall be carried out & the record of the same shall be kept in the form of cutting diagrams. The transfer of stamping activity shall be carried out in presence of "Inspecting Authority"

3.12.6 Straightening

3.12.6.1 All cleaned and prepared plates shall be welded using proper jigs and fixtures and proper welding sequence to avoid warping. While using welding rods for welding the plates and other sections, both the electrodes and the plates and other sections would be preheated as per the recommendations of the electrode manufacturer.

3.12.6.2 All material used in fabrication shall be straight, unless required to be in curvilinear form. Any further straightening including correction of distortion arising from cutting or machining shall be done as per engineering standard processes / practices & manner so as not to cause any injury and the resulting member shall be free from twist, sharp kinks or bends.

3.12.7 Cutting

3.12.7.1 Cutting shall be done by machining, shearing or sawing. Band saws and circular saws as per procedure laid down in IS: 800. Shearing or cutting of any part of the material shall be done neatly and accurately. Lubricants of soluble oil types are recommended. Flame cutting and plasma cutting, preferably by mechanically controlled torch, shall be permitted subject to the approval of inspecting authority. The sharp edges shall be clean, square and free from any distortion. All sharp edges, burs & corners likely to cause injury during handling should

be removed & suitably rounded off. Sheared edges should normally be subsequently machined to remove edge cracks and shall be filed and finished smooth.

3.13 Fabrication

3.13.5 The manufacture of the VLU assembly shall be in strict accordance with the drawings supplied and no deviation is permitted without prior approval of the Inspection.

3.13.6 All workmanship on structure shall be of the order and in accordance with the engineering production standards and practices for ensuring quality of product. Prior approval of inspecting authority shall be obtained, if Non-standard / special process is to be employed by the firm, during die punching/ bending/fabrication. Fabrication of structural and mechanical systems shall be in accordance with the standards referred in this specification.

3.13.7 No dimensions shall be scaled from the drawings. All components shall conform to shape and dimensions shown on the drawings. All sharp edges, burs & corners likely to cause injury during handling should be removed & suitably rounded off. Contractor shall prepare a detailed process planning report indicating the various processes used, time, characters to be checked, method(s) of checking, quantum check, acceptance standard, related records, inspection & witness etc. The same shall be submitted to R&DE (E) for approval before starting the fabrication.

3.13.8 Interchangeability of the components, sub-assemblies/assemblies is the highest priority, which is to be ensured by the manufacturer.

3.13.9 The contractor shall maintain a register showing details of various types of raw material received, raw material expended and balance raw material available.

3.13.10 The contractor shall prepare schedule of materials/cutting schedules of raw materials for various components. Whenever welding is involved, the dimensional details of edge preparation shall be got approved from the inspecting authority.

3.13.11 While handling raw material or embossed panels or fabricated components, care shall be taken to prevent scratching and damage. Wherever required, pieces of wood or other soft material shall be inserted between the contacting surfaces

3.13.12 If raw material is stored in damp conditions where condensation can take place superficial corrosion may cause staining. Since such staining is not desirable, as far as possible all material shall be stored in a dry place, clear off the ground. When temperature and moisture

conditions are such that condensation may occur, as far as possible, efforts should be made to store the material in heated and ventilated storage area.

3.13.13 Contact with other metals and materials like cement and damp timber shall be avoided. Plates and sheets shall be stored on edge and not in direct contact with each other.

3.14 Welding

3.14.5 Welding process incorporated for welding of plates and frames shall be as per Boiler pressure vessel code ASME section VIII, mandatory Appendix 17 for dimpled or embossed assemblies (TBD). The welding control shall also be as per given appendix of BPVC ASME section VIII, and shall include proof testing for procedure and process qualification and workmanship samples.

3.14.6 All aluminum components/parts shall be welded by Tungsten Inert gas (TIG) welding process. Welding should be done in dust and draft free enclosure.

The Contractor shall employ qualified & experienced welders with strict and reliable regime of supervision. Welders and work areas shall be protected from wind, rain etc. Weld consumable shall be subjected to proper calcinations cycle and level of diffusible Hydrogen should be within the permissible limit, as specified in the relevant documents.

3.14.7 Welding Electrodes/ wire:

3.14.7.1 Visual Examination: The filler wires for the TIG welding processes shall have a smooth finish and shall be free from surface imperfections, corrosion product, grease, oxide or other foreign matter which would adversely affect the properties of the weld.

3.14.7.2 Chemical Composition: The filler wire shall also be subjected to analysis for chemical composition. In the chemical composition analysis particular attention shall be given for the proper content of elements and low hydrogen contain. All other elements also shall be as per the specifications within limits. Normal sampling and sealing procedure shall be adopted while drawing the samples for testing and sealing the bulk.

3.14.7.3 Suitable filler rod as per ASTM standard to be used. Weld testing to be done to verify the weld strength, accordingly the welding current to be adjusted.

3.14.8 Approval of welders: Any welder, who is engaged in the welding of aluminum, is required to be approved by the Inspecting Authority based on results of the welders approval tests described in the succeeding paragraphs. Only the approved welders by the Inspecting authorities should be employed on the welding jobs. For the purpose of approval, the welders shall have to qualify the prescribed tests.

3.14.9 Welding Procedure & Qualification Record: The Contractor shall prepare welding procedure specification (WPS) & maintain all procedure qualification records (PQR's) and qualify each welding procedure. These records shall be submitted to the Customer for approval. The Contractor shall carry out "MOCK UP" trials, whenever necessary, so as to validate parameters prior to taking up the actual work.

3.14.10 Welder Qualification: The Contractor shall qualify each welder as per the requirements of the Customer / based on approved WPS & PQR in accordance with Customer supplied documents. ASME section IX or AWS specifications may be followed where Customer's documents are not adequate / not supplied. The approved welder shall be properly identifiable by the inspecting authority or his delegated representative at any time during the currency of the order. For this purpose the welder shall always wear an Identification Card bearing his photograph along with his name and his signature. Identification Card shall also be signed and stamped by the Inspecting Authority.

3.14.11 Welding Fixtures: Wherever essential for achieving accurate dimensional requirements and preventing distortion, Contractor shall design and use appropriate welding fixtures.

3.14.12 Weather conditions: Welds should not be made on wet surfaces. During period of high winds, the welding operator and the work should be effectively protected so that there is no direct draft of wind. Simple shields may be used close to the surface to be welded. Precautions shall be taken to avoid condensation in the inert gas passage of the welding gun equipment.

3.14.13 Cleanliness

3.14.13.1 Absolute cleanliness of the area where welding is done is of paramount importance. Welding should be done in a dust and draft free room to avoid contamination by dust and moisture.

3.14.13.2 The surfaces to be welded and the filler metal shall be free from moisture, grease, oil films, oxides, fume condensates or foreign matter. These contaminants may release hydrogen and other gases which get entrapped in the weld causing porosity and other

defects. The surfaces and the filler wire should be cleaned as laid down in subsequent paragraphs.

3.14.14 Preparation Of Work Piece

3.14.14.1 The parts to be welded shall be effectively pre-cleaned and scratch brushed with a stainless steel brush as described in succeeding paragraphs before welding.

3.14.14.2 Pre-cleaning: Dirt, grease, machining lubricants or any organic matter shall be removed from the areas to be welded by cleaning with suitable solvent by vapor degreasing. Chemical cleaning can be done with solvents like Butyl alcohol, Phosphoric acid, trichloroethylene, acetone or carbon tetrachloride.

3.14.14.3 The filler metal used for welding should be also pre-cleaned preferably by dry steel wool to remove the naturally forming oxide thereon.

3.14.15 Assembly For Welding

3.14.15.1 The assembled structure shall be true to the line & free from twist & bends. The fabricator shall design and use adequate and proper welding fixtures and follow appropriate welding sequence to avoid undue restraint on the work piece thus keeping distortion and residual stresses to a minimum level.

3.14.15.2 Non Destructive Test:

Dimensional check and visual inspection shall precede any NDT activity. NDT is to be carried out as per the requirements specified in Customer's documents or other standards / specifications indicated by the Customer. The Customer has the right to review the NDT requirements, its scope and extent, during the course of fabrication. The Contractor shall make available necessary calibrated NDT equipments.

3.14.15.3 NDT Plan: The Contractor is to work out detailed NDT plan, specify nature of inspection, responsibility, parameters to be recorded etc. Customers' document on NDT requirements will be provided along with working drawings on award of contract. The NDT plan shall form of Quality Control (QC) plan.

3.14.15.4 Weld Joints: All welds shall be subjected to 100% DPT & size of weld shall be checked by using fillet gauge. DP test shall be carried out after completion of each root run, all subsequent runs/passes & final pass of all butt & fillet welds. Customer's decision regarding the type and extent of NDT will be binding on the contractor.

3.14.15.5 Dye-penetrant test: A joint should be welded with minimum number of passes. Dye-penetrant test should be carried out before depositing next run and the previous run should be thoroughly cleaned. Proper heat sinks may be used in the welding fixtures to achieve narrowest possible heat affected zone.

3.14.16 Welding Plant Requirements

3.14.16.1 The welding equipment used in the Tungsten Inert gas welding (TIG)/Gas Tungsten Arc Welding (GTAW) shall be conforming to IS: 9604.

3.14.16.2 The welding equipment used in spot welding shall be conforming to IS: 819 1957.

3.15 Machining

3.15.5 Use proper machine, machine tools, drilling jigs and fixtures are employed along with standard engineering process and practices adapted during machining of the components / sub-assemblies. The rails employed are of prime importance, any deviation over the specified tolerances can cause in gross malfunctioning of the system. Therefore, it is very essential to carry out the machining of rails, within the specified limits.

3.15.6 Machining of the components / parts / assembles, is of prime importance since deviations over the specified tolerances shall result in gross malfunctioning of the system. The Contractor shall also ensure that, the permanent reference markings on the parts & interface arrangement are preserved, so that, the measurements can be carried out any time in the future.

3.15.7 To achieve accuracies, surface finish and features required on various components, the Contractor shall employ proper machining processes. Calibrated machine tools, jigs, fixtures, skilled machine operators, properly selected and calibrated inspection tools and gauges. The Contractor shall also ensure adequate QC coverage based on evolved QC Plan.

3.15.8 In case of any deviation from the laid down specifications, the same shall be immediately communicated to the purchaser for their decision.

3.16 Drilling, Punching and Reaming

3.16.5 Holes shall be made in material by drilling, reaming but in no case by gas cutting or punching.

3.16.6 All holes shall be made on assembly and not on individual parts. Wherever possible, fabricator will design and use appropriate drilling jigs and if necessary, the Contractor will be permitted to drill undersized pilot holes initially for purposes of assembly. The amount by which the diameter of a undersized hole should be less than that of the finished hole, shall be at least 1/4th the thickness of the component and in no case less than 0.8 mm. However, the final drilling or reaming to achieve the final dimension shall be done on assembly. However, this will not be binding on the Contractor. Instructions as given in the drawing for a particular component shall be followed.

3.16.7 Matching holes for bolts shall mate with each other accurately. The drilling in such cases shall be preferably done with the help of a suitable drilling jig. Debarring of all holes shall be done by grinding without destroying the shape of the hole. Poor matching of holes shall be a cause for rejection. Holes shall not be drilled in such a manner as to distort the metal. All chips lodged between contacting surfaces shall be removed before assembly.

3.17 Jigs and Fixtures

For achieving necessary accurate dimensional requirements and preventing unwanted distortions due to welding and heavy machining, the fabricator may design his own jigs and fixtures for welding and machining the various assemblies. However, the fabricator shall be responsible for giving the final product as per the tolerance levels specified in the drawings. No deviations from the tolerances specified in the drawings shall be acceptable

3.18 Tolerances

The manufacturing tolerances for various dimensions shall be asunder:

3.18.5 Tolerances on basic materials shall be as per relevant IS or other international standards as specified in material specification or in relevant drawings.

3.18.6 Tolerances on the machined components shall be as specified in relevant drawings conforming to IS: 2102 part 1 (medium grade), wherever not mentioned.

3.18.7 Geometrical tolerances for features without individual tolerances indication shall be conforming to IS: 2102 part 2.

3.19 Bolting

All the surfaces to be bolted shall be held in close contact with each other. The minimum distance from the center of any hole to the edge of the plate shall be of minimum of 1.5 d; d is the diameter of the hole or as per the details shown in the relevant drawings, whichever is greater should be followed. Finished holes shall be not more than 1.5 mm or 2.00 mm (as the case may be) in diameter of bolt passing through them, unless other specified by the engineer. In all cases the full bearing of the bolt is to be developed, the bolts shall be provided with a washer of sufficient thickness under a nut to avoid any threaded portion of the bolt being within the thickness or parts bolted together. A spring washer shall be provided in-between the plain washer and a nut to avoid loosening of nut/bolt due to vibrations. The thread shall project beyond the nut for a minimum of one turn. Nuts shall be properly, but not excessively tightened. Wherever required, lock nuts conforming to IS: 3063 should be used.

3.20 Finish - Treatment and Painting

The Mechanical / Structural systems with other sub- systems shall be cleaned, treated and painted as specified here under. This shall be done after inspection and approval of the system by the inspector. All steel components except the threaded bolts, nuts, pins and bushes shall be painted as specified herein. Painting shall be carried out either on components / parts level or on assembly level as applicable.

3.20.5 The inner surface of pin holes and bolt holes shall not be painted.

3.20.6 Painting need not be carried out for the components where different types of fits like turning, rotating or sliding are involved. The component interfaces, having relative motion shall be protected using suitable grease. The contractor shall get prior approval for the grade of grease to be used. Similarly, the protection for the hydraulic components shall be provided.

3.20.7 Repair of painted surfaces- All the damages caused to the paint coating during transportation or erection shall be carried out as per procedure laid down for maintenance of painting in IS:1477 part II. Also, damages caused to the parts/ components of launcher during transportation & handling shall be rectified before carrying out the maintenance of painting work.

3.20.8 Applicable standards for painting:

- IS 5:2007:- Colors for ready mixed paints and enamels

- IS 2524 (Part I Pretreatment) -1968:- Code of practice for painting of non-ferrous metals in building
- IS 2524 (Part II Painting) -1968:- Code of practice for painting of non-ferrous metals in building
- ASTM B-499:- Standard test method for measurement of coating thickness by the magnetic method: Nonmagnetic coating on magnetic basis metals
- IS:9954-1981:- Pictorial surface preparation standards for painting of steel surfaces
- IS: 13238-1991:- Epoxy based Zinc phosphate primer
- IS: 13183: 1991:- Aluminum paint, Heat Resistant-Specification

SECTION VIII
QUALITY ASSURANCE

8.1 General

The supplier is responsible for the performance of all Quality Assurance requirements as specified herein. Except as otherwise specified, the supplier may utilize his own or any other Quality control facilities and services acceptable to the Quality Assurance and approving officer. Quality Assurance /Control records of the examinations and tests shall be kept complete and made available to the inspector as specified in the order. The Government reserves the right to perform any inspection set-forth in the specification where such inspections are deemed necessary to assure that supplies and services conform to prescribed requirements.

8.2 Quality Assurance Authority

8.2.1 Quality assurance of the embossed canister assembly, its sub-assemblies and parts shall be carried out by the "Inspection Authority".

8.2.2 The responsibilities of the Inspecting Authority shall be inspection of the raw materials, checking of the fabrication drawings and procedures, die punching facilities, welding facilities, fabrication facilities, approval of quality control plan submitted by the industry partner based on designers quality assurance plan & process plan etc. as laid down in the subsequent paragraphs.

8.2.3 Inspection

8.3 Repair

No part of the work shall be repaired or spoiled work corrected without the approval of the "Inspection Authority".

8.4 Dispatch

8.5 No components shall be dispatched until it has been officially approved and accepted for release.

8.6 Raw Material

8.7 The contractor will ensure that the material meant for use in fabrication of the equipment is from the inspected and approved lot. Wherever necessary, the authorized inspector may draw random samples from the approved lot and get same re-tested, if found necessary.

8.8 All steel / aluminum raw materials shall be properly stamped for purpose of identification.

8.9 Prior approval of the raw material shall be obtained before the same are incorporated in prototype / pilot sample / production.

8.10 Stage Inspection

8.11 Contractor shall satisfy himself regarding the acceptable standards and quality of the stores / job prior to tendering the same for inspection to the inspection agency. He will carry out his own inspection through his quality control group. He will forward all such internal quality control test reports for each store / job at each stage of fabrication to the inspection authority. Inspection by inspection authority shall be carried out only on receipt of such internal inspection reports.

8.12 Stage Inspection shall be the responsibility of the contractor. The equipment will be offered for stage inspection after completion of fabrication of various parts/sub-assemblies and assemblies

8.13 The contractor shall provide all stage inspection records to the inspector whenever required. The contractor shall decide his own sequence of fabrication and finalize the same after discussions and consultations with the inspection authorities. The inspection / test of the finished canister, its sub-assemblies and parts shall be carried out as specified in inspection plan & ATP.

8.14 If the inspector has over looked any defect during the stage inspection, the supplier shall be responsible for the rectification of such defect as soon as the same is noticed.

8.15 Inspecting Officer or his representative shall be afforded access to any part of the factory premises to satisfy without having anyway made responsible thereafter that the required standards are maintained at all stages and during all process of production.

8.16 Testing Facilities

The contractor shall provide all the necessary facilities to the inspecting officer for tests to be carried out by him and intimation of the tests to be carried out shall be given by the inspector to the contractor.

8.17 Notification of Results of Inspection

On completion of the inspection, the contractor will furnish the inspector with necessary inspection results and certificates.

8.18 Sampling Procedure

The inspection authority shall be the sole judge in deciding the sampling procedure that may be adopted. If as a result of inspection during the initial stages it is revealed that the stores are not coming up to the acceptable standards, further inspection shall be suspended. Rejections of the samples by the inspecting officer shall be considered as final and binding on the supplier and the stores rejected by the inspecting officer shall be replaced by the supplier.

8.19 Marking of Rejections

8.20 The rejected stores will be suitably defaced or destroyed by the inspecting officer in mutual consultation with the supplier so that they may not be resubmitted.

8.21 On completion of the inspection, the inspector will furnish the supplier with necessary inspection results and certificate.

8.22 Examination

8.23 The VLU assembly, its sub-assemblies and parts shall be examined for the defects listed below. Presence of one or more defects shall be a cause of rejection.

(a) Dimensions not as specified – including Dimensions beyond limits of tolerances etc.

(b) Missing parts and components

(c) Incompleteness or incorrectness of assembly

(d) Materials not as specified

(e) Treatment and painting not as specified

(f) Cracks at the welds and bends.

(g) Weld defects such as cracks, serious porosity, lack of penetration, unacceptable inclusions, undercutting of base metal etc.

(h) Dirty components

(i) Manufacturing defects – any one or more of them

(j) Incorrect manufacturing process adopted for any item/component

(k) Non-inspected components by RDE as per

8.24 Production inspection shall be in strict accordance with the samples approved. Tests as deemed necessary by the inspecting officer shall be arranged by the contractor on the same lines as in the case of the pilot sample.

8.25 Quality Assurance Facilities:

Supplier shall extend the Inspecting Authority or his authorized representative free of cost, all reasonable facilities for satisfying himself that the stores are manufactured in accordance with specifications and drawings for this purpose, the Inspecting Authority or his authorized representative shall have free access to the supplier or his sub-suppliers works at all times during the currency of the contract.

8.26 Quantities of Materials

Quantities of materials given in the drawings / schedule of materials are only for the guidance of the supplier. Actual quantities required for fabrication may vary. Supplier shall work out the quantities separately and if any major variance is observed from those given in the drawings, the same shall be brought to the notice of the Inspecting Authority, who shall amend the drawings appropriately. Since the quantities given in the drawings are only for the guidance of the contractor, no financial compensation shall be admissible to the contractor on account of such major variances in the quantities observed by the contractor. Further, the contractor is responsible for fabricating and supplying the equipment as per drawings and specifications.

SECTION IX

INSPECTION & TESTING PLAN

10.1 General

This section covers the Inspection Test Plan for raw material, bought out items, die punch, consumables, fabrication/ manufacturing, integration, installation, testing & trials of Structural / Mechanical Systems. This is issued to assist / guide the inspector and industry partners for quality assurance / control during fabrication / manufacturing of VLU assembly. Detailed check list / sheet for inspections of individual components / sub- assemblies shall be prepared by the Inspector.

10.2 Inspection Criteria for Checking of Dimensions

Inspection for dimensional checks for various parts / sub-assemblies and assemblies of the canister shall be responsibility of the contractor / fabricator. The equipment along with its accessories will be offered at various stage inspections after completion of the parts / components / sub-assemblies and assembly of the canister for their dimensional checks. For ease of dimensional checks, the dimensions of the VLU assembly and its major parts / components / sub-assemblies are divided into three categories as given below:

10.2.1 Critical Dimensions

Dimensions of the parts / components which are critical in nature, considering their application for their interchangeability, ease for fitment and for smooth function of the equipment. These dimensions should be maintained within the tolerances specified on the relevant drawings. These dimensions are to be checked 100%. Such dimensions are maintained within the fine class / grade of tolerances specified in their relevant drawings.

10.2.2 Major Dimensions

Dimensions of the parts / components those are not critical in nature but are important from assembly point of view to be maintained within the tolerances specified in the relevant drawings. Tolerances of such components / parts are generally maintained within medium class/grade of tolerances specified in their relevant drawings. If such dimensions are not obtained during fabrication, initially, the components / parts can be offered for rework /re-machining to obtain the parts within the specified medium grade of tolerances. Dimensions identified as major dimensions are to be checked on random sample basis.

10.2.3 Minor Dimensions

Dimensions of the parts / components which are neither critical nor major are said to be minor dimensions which are made within the coarse class / grade of tolerances. Minor dimensions may be checked by the inspection authority as found necessary.

10.2.4 Critical requirements / Parameter

1. Machine accuracy / calibration should be taken into account & calibration of m/c to be confirmed. Machining accuracy of top plate, bottom plates and clearances lock for plume/water leakage is of utmost importance.

2. Deviation due to welding distortion at plume deflector structure, plenum uptake chamber should not exceed more than ± 1 mm on either side in both X & Y plane.

3. The measurement of distance between the center of top plate and bottom plate should be checked on machine. Measurement by tape in steps shall not be allowed.

4. The checking of the Parallality of top plate, bottom plate and plume deflector structure base shall be ensured.

5. All Fillet welds shall be subjected to die penetration test and all Butt welds shall be subjected for Radiographic test wherever specified hereafter or in drawings.

10.3 Measuring Instruments

10.3.1 Standard gauges / templates shall be used for checking of weld sizes.

10.3.2 Following measuring instruments are required for measuring dimensions of the embossed canister and its accessories components.

(a) Steel scale
(b) Steel tape
(c) Vernier calipers / Micrometer
(d) Dial gauge
(e) Height gauge
(f) Plumb bob and set square
(g) Bore Gauge
(h) 3D Laser Tracker
(i) Any other

10.3.3 The measuring instruments shall be calibrated and calibration certificates shall be produced by the contractor/contractors for their accuracy and validity.

10.4 Testing Facilities / Equipment

Testing facilities / equipment used for the following tests and other specified tests / trials as applicable of the various materials, components, sub-systems, and system shall be calibrated and calibration certificates shall be produced by the contractor / contractors for the accuracy and validity of the test facilities / equipment.

10.4.1 Mechanical Testing of Materials, Components, / Sub-Systems

10.4.2 Operational / Functional trials of total system

10.4.3 Plume Leakage Test of VLU assembly system

10.4.4 Loading /unloading of canisterised missiles in the VLU

Hang Fire testing shall be provided separately not in the scope of this tender enquiry.

SECTION XI

SYSTEM INTEGRATION, TEST AND TRIALS

11.1 Integration

11.1.1 After completion of machining/welding/coating/bending/fabrication/ manufacturing of structural sub-systems of VLU assembly and duly cleared by "inspecting Authority" the Contractor will commence the integration of all sub-systems at R&DE (Engrs) / DRDL Hyderabad. Inspection/ performance/ testing of the equipment at the Contractor's premises will be carried out by the contractor. The Contractor shall ensure that all the systems are functioning properly and there are no undue stresses in any part of the structure. Any modifications suggested as a result of the trials and inspection shall be carried out by the firm to the entire satisfaction of , R&DE(Engrs), Dighi, PUNE – 411 015. All defects/ deficiencies shall be resolved before this stage so that no extra efforts are required to be put in at site to rectify the defects.

11.1.2 The integration shall involve broadly the following work:

(a) Fabrication, machining and welding of top plate
(b) Fabrication, machining and welding of bottom plate
(c) Fabrication, machining and welding of VLU structure
(d) Preparatory work on the top plate and bottom plate for interfaces welding/bolting
(e) Fabrication and welding of collar assembly on bottom plate
(f) Integration of other sub-systems mainly disc springs to the bottom plate assembly
(g) Fabrication, machining and welding of Plume deflector structure
(h) Fabrication, machining and welding of plenum uptake chamber
(i) Coating (thermal) on plume deflector structure and plenum uptake chamber
(j) Fabrication and welding of Plenum uptake chamber door assembly (EM actuator, motors, clutches, gear box and linkages)
(k) Door locking and unlocking mechanism and related sensors
(l) Ensuring the sealing required at each interfaces
(e) Bolting/welding assembly of interface structure with ship deck
(f) Fabrication and Mounting of pair of turnbuckles to VLU assembly
(g) Fabrication, welding and mounting of stool table
(h) Mounting of Lifting lugs to the assembly

(i) Closing and sealing of openings for mechanisms

(j) Functional test of the full system and assemblies.

11.2 System Assembly

The contractor shall carryout the assembly of components, sub-systems along with other related systems, Installation & Commissioning of the System as per following sequence.

Sr. No.	**Nomenclature**	**Parameters to be checked**	**Instruments used**	**Remarks**

11.3 Testing / Trials:

After the assembly of the System, the contractor shall carryout the following prescribed testing & trials of the system along with other related systems.

Sr. No.	Operations	Mode	Remarks
1.	Visual Inspection	• Measurement of Dimensions	Overall major dimensions to be within the specified limit
2.	Structural Tests	• Lift the complete VLU assembly and check for its structural integrity	
3.	Operational/ Performance Tests	• Proper alignment for concentricity of assembly • Plume uptake chamber door opening / closing • Disc spring assembly • Thermal coating • Sealing • Turnbuckle tension • EM actuator, clutch, moto, break, Gear box operations	With the help of dummy article check the accuracy all along the length. Article shall slides all along the length of VLU assembly without any obstruction. Operation of mechanisms to be checked. Locking/unlocking of door to be checked. Opening/closing of the door to be checked

		• Door lock/unlock sensors operation	
4.	Leakage test	• Leakage of plume from plume uptake chamber • Leakage of water from outside into the VLU assembly	
5.	Functional Tests	• Loading and unloading of CMs in the VLU as it is mounted in ship • Other functional tests (including tests with electronics components and cabling like checking connectivity, functionality of all items as per laid down procedure)	Crane or material handling devices etc to be arranged by the vendor

Cabling from canister to VLU is in the scope of vendor for conduct of functional tests.

11.4 Improvements

11.4.1 Any improvements suggested or required as a result of the trials and inspection & subsequently incorporated in the respective sub-systems, shall be documented simultaneously by the firm to the entire satisfaction of , R&DE(Engrs), Dighi, PUNE – 411015. Incorporation of all improvements & preparation of document shall be the responsibility of the contractor.

11.5 Limited Testing & Trials

11.5.1 After incorporation of improvements, the industry partner will be responsible to conduct the limited testing & trials of the system to ensure that the system is performing its defined role to the satisfaction of inspecting authority.

SECTION XII

HANDLING, SAFETY AND TRANSPORTATION

12.1. GENERAL

12.1.1. The Complete System consists of following Sub-Systems including.

1. VLU Structure Assembly:
    a. Top Mounting Plate (1 no.)
    b. VLU Structure (1 no.)
    c. Bottom Plate (1 no.)
    d. Collars and assembly (8 Nos.)
    e. Plume Deflector Structure (1 no.)
        i. Deflector Plate
        ii. Thermal Coating
    f. Plenum Uptake Chamber (1 no.)
        i. Plenum chamber structure
        ii. Thermal Coating
        iii. Top Hatch Door
        iv. Door Opening Mechanism:
            - EM Actuator and assembly (brakes, motors, clutch) (2 Nos)
            - Linkage Mechanism (2 Nos)
2. Interface Structure with ship deck
3. System interconnection cables and harness
4. Pair of turnbuckles (2 pairs)
5. Fire Fighting Equipment
6. Weatherproof Non-Controlled Shelter for Tools and Spares
7. Ladders and stool table

All Sub-Systems are required to be mounted & integrated to form the full VLU assembly. For this, the accuracy of the fabricated and machined components shall be maintained during the handling. As well as safety of the individuals handling the equipment shall be given top most priority.

12.2. HANDLING AND SAFETY:

12.2.1. All the sharp corners of the fabricated components / parts / sub-assemblies / assemblies shall be ground / machined to avoid the injuries to the individuals / workers during handling of the fabricated parts.

12.2.2 For shifting of fabricated parts from one shop to another shop for machining/ assembly purpose the proper material handling equipments / devices shall be used. Overhead cranes shall be used wherever possible for shifting the fabricated components. While shifting the components by crane, the parts shall be properly secured by slings / ropes to avoid the accident during handling stores.

12.2.3 The structural components / sub-systems being fairly large, precision machined and torsionally not so rigid, shall be handled with utmost care. Proper location shall be used to slings these components. Suitable handling beams may be used to ensure to avoid the permanent distortion in these components.

12.2.4 Care shall be taken in handling all the other components so as not to get damaged. Also, the mating interface surfaces shall be properly covered during handling, and the components shall be shifted properly without damaging interface surfaces. Extra care shall be taken to handle the seal so that they do not get any surface damage.

12.2.5 Suitable lifting hooks / pints shall be provided to the all manufactured components for easy handling.

12.2.6 Proper lifting provision shall be made to lift the entire system / sub-systems in horizontal position after assembly is completed along with other related systems on the platform by single crane.

12.3. STORAGE

12.3.1. After fabrication and painting, components/assemblies of the systems shall be stored in a dry place clear off the ground. When temperature, and moisture conditions are such that condensation may take place. As far as possible effort should be made to store the material in heated and ventilated storage area.

12.4. PRESERVATION

12.4.1. Care shall be taken preserving all the components so as not to get spoiled. Also, the mating interface surfaces shall be properly covered with oil /grease or respective preservative materials, and the components shall be stored properly. Extra care shall be taken to preserve the seal so that they do not get any surface damage /or spoiled from environmental

conditions. Such parts or bought out items shall be preserved as per manufacturers recommended guidelines.

12.5. IDENTIFICATION & MARKING

12.5.1. The following details shall be engraved on an Aluminium plate/sheet of suitable size and this shall be fixed to upper portion of the assembly:

a) Designed & Developed by R&DE (Engrs)

b) Nomenclature

c) Part Number of the item

d) Serial number of the item

e) Month and year of manufacture

f) Name of the Manufacturer

(Note: All mechanism and subsystems of VLU system to be labelled)

12.5.2. The size of the letters shall be appropriate for visibility.

12.5.3. The part number and the serial number of the item shall be given by the Manufacturer.

12.5.4. All spares and loose items packed in boxes will also be marked and tags should be placed on them giving the identification.

12.6. Transportation of the System

12.6.1. The canister assembly along with all spares, accessories, tools and bought out items shall be transported to the R&DE (Engrs) or DRDL Hyderabad (as per required) by road / rail transportation. Responsibility of carrying the system & items without any damage during transportation lies with the contractor. All the bought out items shall be properly packed so as to avoid any damage to the equipment. Loading at contractor's place and unloading at site shall also be the responsibility of the contractor. Suitable mobile cranes shall be provided by the contractor for loading / unloading of the system / parts at firm's premises as well as at the R&DE (Engrs) or DRDL Hyderabad (as per required).

SECTION XIII
INTELLECTUAL PROPERTY

The title to the ownership of the design of this "Technology Product" including copyrights and intellectual property rights will rest exclusively with R&DE (E). The Contractors shall not take any action inconsistent with this title and Ownership.

Annexure A

Submission Format

The submission of bid shall be in two parts:

1. Technical Bid
2. Price Bid

- The technical bid should cover the technical specification / details, component / material specification, test plan etc. for the complete system.

- The Price Bid and Technical Bid shall be sealed in two separate envelops and then both envelops should be sealed in a common envelop. Tender Enquiry No. and the due date shall be put on envelops.

SECTION XIV

PAINTING PROCEDURE AND CORROSION PREVENTION SCHEME

1. GENERAL

A. All painting works including surface preparation and application of shop primer shall be performed.

B. Surface preparation by Shot Blasting (Sa2½ ---ISO 8501-1:2007), Mechanical tool cleaning for welded area, and solvent cleaning for machined surface of components

C. Painting works shall be performed by "Airless" spray as far as possible, and roller and/or hand brush shall be used where the use of airless spray is restricted due to the lack of working space, etc.

D. Cleaning of dust, dirt, oil, etc. shall be carried out.

E. Machinery units and electrical equipment shall be shop-finished in accordance with the standard practice of respective manufacturers.

F. Touch up painting shall be done at site if necessary

G. Generally, galvanized parts, chromium plated parts, brass, bronze, aluminum, stainless steel, plastic, glass, rubber, etc. shall not be coated with paint except otherwise specified

H. The color scheme shall be in accordance with the Customers' requirement. But the color of electric equipment and the machinery units shall be manufacturer's standard.

I. Interior surfaces within Air-tight areas shall not be coated.

J. Interior surface of no air-tight areas which has holes shall be coated.

K. All steel plates and sections of thickness of less than 6 mm shall not be shot blasted.

L. Auxiliary structure as ladders, inspection platforms and handrails shall be coated with paint.

M. Where more than one (1) coat shall be applied, subsequent coating shall not be applied until the preceding coating has become properly dry and hard according to Maker's recommendations.

N. All working part of machinery, electric parts, etc. shall be properly protected before spray painting is applied in the vicinity of these items.

O. Film thickness for particular paints, if specified in the Specifications, shall be attached at least 85% of the whole area and may not be attained on remaining area, but at least 75% thickness of specified film thickness shall be attained on remaining 15% of area except plate edge, etc

Coating System

A. Items under Water

Process	**Mark**	**Kind of Paint**	**Film Thickness**
Surface Preparation	---	Blasting (SIS Sa 2.5)	
Coating	Epoxy	Intersheild 300	150µ x 2 Coat

Coating System – Other Main Structures

B. Items above Water

Process	**Mark**	**Kind of Paint**	**Film Thickness**
Surface Preparation	---	Blasting (SIS Sa 2.5)	
Coating	Modified Epoxy	Interzone 954	350µ x 1 Coat
	Polyurethane	Interthane 990	50µ x 1 Coat

Coating System – Others

C. Items above Water

Process	**Mark**	**Kind of Paint**	**Film Thickness**
Surface Preparation	---	Blasting (SIS Sa 2.5)	
Coating	Modified Epoxy	Interzone 954	100µ x 1 Coat
	Polyurethane	Interzone 990	50µ x 1 Coat

2. Surface preparation before painting

A. General

Mark of surface preparation and shop primer in the following painting schedule are listed as follows:

Surface preparation

Mark	Preparation
S	Shot-blasting
H	Mechanical tool cleaning (St 2 of SIS)
SO	Solvent cleaning
—	No treatment or maker's standard

B. Primary Surface Preparation

I) Shot blasting

Following steel plates shall be shot-blasted.

i. All steel plates and sections of 6 mm and above in thickness for structural member, brackets, etc.

ii. Steel plates and sections for auxiliary structural parts.

II) Mechanical tool cleaning

The following parts shall be cleaned by mechanical tools. Disc-sander, power wire brushes and wire hand brushes shall be used as mechanical tools.

a. Surfaces of thin plate of 4.5 mm and below in thickness, brackets taken from scraps, small stiffeners, bars, etc.

b. Surface of fittings and equipment which are coated with paint, except shot-blasted surface.

c. Outside surface of steel pipes which are coated with paint.

III) Power tool cleaning

a. Damaged parts such as welding joints, burnt areas, etc. of shop primed surfaces shall be cleaned with mechanical tools, and touched up.

b. Damaged parts or bare spots in the preceding coat shall be cleaned with mechanical tools and touched up with paints in accordance with painting schedule

3. Painting Scheme

A. Main Structure

	Surface Preparation		**Coating of Paint**	
	Primary	**Secondary**	**1st**	**2nd**
VLU	S	H	Interzone 954	Interthane 990
Canister	S	H	Interzone 954	Interthane 990

B. Others

	Surface Preparation		**Coating of Paint**	
	Primary	**Secondary**	**1st**	**2nd**
Ladders etc.	S	H	Interzone 954	Interthane 990
Control Cabin	---	H	Interzone 954	Interthane 990
Machined surface	---	H/SO	Interzone 954	Interthane 990
Electrical Comp.	---	H/SO	Interzone 954	Interthane 990
Touch-Up	---	H	Interzone 954	Interthane 990

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4. Corrosion Prevention Scheme

   a. Special type of Paint (Intershield 300; Interzone 954) shall be used.

   b. All forged components shall be coated with Zinc-Chromate Conversion Coating to ensure a minimum 96 hour salt spray coating for the protection of the components.

   c. All fasteners shall be dacrotized.

   d. Hydraulic fittings shall be made of SS-316L material.

Technical Specification of Canister (VL SRSAM)

11 /12 /2020

R&DE(E)

Government of India, Ministry of Defence
Defence R&D Organization
Research & Development Establishment (Engineers)
Kalas, Alandi Road, Dighi PO
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(Dr MD Limaye)

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TECHNICAL SPECIFICATION OF CANISTER - VL SRSAM

SPECIFICATION NO: **DRDO-RDEE-SRCAN-TSP-02-2020**

This specification or any patterns, drawings or other information issued in connection therewith may only be used for a specific order placed by the 'COMPETENT AUTHORITY'. It is not to be used for any other purpose whatsoever without the express written sanction of the Authority.

N O T E

When Government drawings, specifications, or other data are used for any purpose other than in connection with a definitely related government procurement operation, the Indian Government thereby incurs no responsibility nor any obligations whatsoever and the fact that the Government may have formulated, furnished or in any way supplied the said drawings, specifications, or other data is not to be regarded by implication or otherwise as in any matter licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture, use or sell any patented invention that may in any way be related thereto.

C E R T I F I C A T E

Certified that the specification No: **DRDO-RDEE-SRCAN-TSP-02-2020** contains 91 pages, which are serially numbered from 01 to 91.

Date: 11 Dec 2020

Name: Prasad Shivdas
Designation: Sc 'D'
Group: EMSG

AMENDMENT RECORD SHEET

DOCUMENT TITLE: TECHNICAL SPECIFICATIONS OF CANISTER FOR VL SRSAM

Sr. No.	Date of amendment	Ref. to para. / clause	Amendment carried Out	Ref to authorization	Signature of the person authorizing it

SECTION I
GENERAL AND SCOPE OF WORK

1.1 GENERAL

It is intended to develop Canister (Qty: 06 No.) for VL SRSAM Missile which will be used for transportation, storage and launch of missile. The Canister Assembly consists of Canister shell structure, Guide Rail, Wing Rails, Article Lock mechanism, Umbilical Retraction Mechanism, Rear Stopper mechanism, Front Hatch Door Opening / Closing Mechanism and Rear Rupture Disc. The Canister Assembly will be tested for its intended function and specification.

1.1.1. Brief Specifications: This specification covers the brief description, material specification, fabrication, manufacture, workmanship, quality control, inspection, integration, Canister for VL SRSAM Missile.

1.1.2. The competent authority reserves the right to incorporate any changes to this specification and drawing without assigning any reasons whatsoever.

1.1.3. This specification holds good only for the particular supply order placed / to be placed by a competent authority for which it has invited quotations.

1.1.4. This specification with accompaniments shall be returned with submission of tender/on completion of order.

1.1.5. Any sealed sample/pattern issued to the contractor will be taken for guidance only. It will not at any time supersede laid down specifications.

1.1.6. Nothing shall relieve the manufacture responsibility for the safety aspects in respect of all operations.

1.1.7. The Industry Partner/Vendor shall extend support to the Director R&DE(E) or his authorized representative, free of cost, all reasonable facilities including inspection gauges for satisfying himself that the stores are manufactured in accordance with specifications and drawings and for this purpose, the authorized representative shall have free access to the contractor's or his sub-contractor's works at all times during the currency of the contract.

1.1.8. For any work or part of work sub-contracted, prior written permission shall be obtained from R&DE(E). The main contractor shall remain responsible for any press working / fabrication/ machining/ inspection etc., carried out by the sub-contractor.

1.1.9. R&DE(E) shall be the inspection authority, and all correspondence on technical matters relating to this specification shall be referred to Director, R&DE and an Officer(s) deputed by Director will be Inspecting &/or Approving Officer (s). The Government reserves the right to appoint reputed third party inspection agency for inspection.

1.1.10. The Industry Partner/vendor shall prepare and check all drawings and get it approved before commencing manufacturing. Any errors, omission or ambiguity if found shall be immediately reported in

writing and work shall not proceed further unless discrepancy reported is clarified in mutual discussions and contractor advised to proceed further.

1.1.11. The Industry Partner/vendor is responsible for supplying the equipment as per approved drawings and technical specifications.

1.1.12. No part of the work intended herewith shall be repaired or corrected without the approval of R&DE (E).

1.1.13. No components shall be dispatched until it has been officially directed/instructed to do so.

1.1.14. The Vendor shall provide to Inspection authority copies of sub orders with particulars of work or process sub-contracted to.

1.1.15. No deviation from the governing drawings/design/specifications, shall be accepted without concurrence in writing from R&DE(E). No request for any deviation will be entertained from the sub-contractor, if any, but only through the main contractor.

1.1.16. Any proposals for the improvement in this specification shall be submitted to R&DE(E) for approval. No deviations shall, however, be used without the prior written approval from R&DE(E).

1.1.17. Whenever references of other specifications or drawings are quoted, always the latest copies of the said document are intended for the purpose. The Industry Partner shall ensure availability of the latest copies of all specifications, standards mentioned in the drawings and this specification at his works for reference whenever required.

1.1.18. To fulfill the aim of the development, detailed process plan(s), QA plan(s) and test plan(s) shall be prepared by the vendor and approved by R&DE.

1.1.19. Publications of work & Intellectual Property Rights: The Industry Partner shall not permit or allow any information regarding the contracted work to be published in any Scientific, Engineering Journal or Newspaper, Periodicals without obtaining written consent from R&DE(E). The design of the equipment is sole property of R&DE(E)/DRDO and R&DE /DRDO reserves all Intellectual Property Rights.

1.1.20. Drawings: Various details appearing in and connected to these specifications such as engineering drawings, sketches etc. are meant for guidance only and are not to be treated as final manufacturing drawings for fabrication purpose. The contractor is required to make the detailed manufacturing drawings in consultation with R&DE (E), which should be submitted to R&DE for approval before fabrication is undertaken. **No manufacturing shall be done without approval of drawings, Process plan(s) and Quality Control plan(s). In case, any manufacturing work is done without approval of above documents or without following the process and quality plan(s), the inspection agency has full right to reject the job.**

1.1.21. All the documents, process plans, 3D models and drawings prepared by contractor will be the property of Director R&DE(E). No logo or Trade Mark of any vendor/Proprietor/OEM shall be used in any form in any document; only DRDO or R&DE logo shall be displayed or presented at appropriate places in its original format only in all documents.

1.2 SCOPE OF WORK

1.2.1. Brief of Scope of Work

a. **Preparation and Submission of final detailed drawings and manufacturing process plans for approval as per R&DE(E)'s format/drawing template (soft and hard copy)**
b. **Manufacture, integration, testing and supply of Canister Assembly as per approved drawings and specifications**
c. **Procurement of raw materials, bought out items etc.**
d. **Physical and Chemical testing of the procured material irrespective of size, weight, shape, number etc from NABL accredited lab**
e. **Qualification of welders and submission of the welder's qualification report**
f. **Physical testing of weld joints (for weld joint strength) from NABL accredited lab and submission of the report. Inspection of all weld joints.**
g. **Component, sub-assembly and assembly level testing as per test plan(s)**
h. **Performance trial within the factory**
i. **Loading/unloading trials of dummy missile inside canister at site or at location stated by R&DE(E). Dummy Missile shall be provided by R&DE at R&DE, which may be transported to the work site by the vendor at its cost. Necessary drawing details (with tolerances etc.) of Dummy Missile may be made available to the vendor during preparation of manufacturing drawings for the canister. This testing is intended to be on ground in horizontal position of canister.**
j. **Conducting Pressure testing and Factory Acceptance Test of Canister as per approved ATP document. Details of testing, its procedure, data acquisition, record of data and report format shall be provided by R&DE (like sensors, harnessing, sampling size or rate etc.). Qualification testing of canister assembly (apart from QT of subsystem components) need to be carried out as per test plan approved by R&DEE. This qualification test shall simulate the load conditions (structural and pressure loads) appropriately.**
k. **Loading/unloading trials of canister with missile inside VLU at site or at location stated by R&DE(E). This testing is intended to be on ground in vertical position of VLU as it is mounted in ship.**
l. **Delivery of Canister Assembly and dummy canister etc. at R&DE(E) including spares, tools etc.**
m. **Delivery of Canister pressurization set/kit with nitrogen gas cylinder.**
n. **Supply of special tools (if any) for operation of canister mechanism**
o. **Submission of Documents (soft editable & hard copy format)**
    i. **Technical Manual**
    ii. **User Manual**
    iii. **Maintenance Manual**
    iv. **All drawings and solid models (drawings in Autocad in R&DE(E) template and solid model compatible with solid works)**

v. **Manufacturing Process Plans**
vi. **Inspection Reports**
vii. **Material Test Certificate**
viii. **FAT report**
ix. **Welder Qualification Report**

1.2.2. This specification covers the following work involved in Sheet metal - punching or embossing, bending of sheets, fabrication and manufacturing of quantity 10 Nos of Canister Structural Assembly, Guide rails, Front hatch door opening /closing mechanism, umbilical mechanism, article lock / unlock mechanism and rear rupture disc etc.

1.2.3. Preparation of manufacturing drawings, preparation of drawings of assemblies, sub-assemblies, components & drawings related to site testing/ working including integration of canister. Drawings to be approved by R&DE(E) before starting of manufacturing. All updated drawings shall be submitted to R&DE before commencement of job.

1.2.4. The job involves high capacity press working, the contractor shall in-house design and develop the die and punch required for the press working or embossing of the sheet metal. If any cracks or thinning more than 15 % of the thickness of the sheet is observed during press work or bending, the contractor shall modify the die and punch profile or use advanced press working techniques to reduce thinning of the metal sheets. The contractor should have sound knowledge in manufacturing of die and punch and press work/sheet metal wrok.

1.2.5. The contractor should prepare the process plan and bill of materials for manufacturing of the canister and submit to R&DE (E) for approval.

1.2.6. Incorporation of improvements/ changes/ additions/ alterations as required in the system during manufacturing process and after testing at site.

1.2.7. Preparation of layout and submission of two sets of approved drawings to the inspecting authority of the same before commencing the manufacturing. One set of drawings dully approved shall be sent to the manufacturer.

1.2.8. Manufacturing/ Fabrication /Press Work/Bending Work of complete canister structure assembly as per specifications and approved manufacturing drawings.

1.2.9. The contractor shall design and develop the suitable fixtures during press working, fabrication/welding of sheet metal, bending of sheets to avoid distortions and shrinkages. Also the contractor shall follow proper welding and press working practices. Any failure like thinning of sheets, development of the cracks on sheet and welding distortion shall not be acceptable, and the contractor will be responsible for the job.

1.2.10. The contractor shall test and measure the thinning of the sheet metal after press working and should ensure that the thinning is within the allowable limits. The thinning of the sheet will be witnessed by the R&DE(E) representative nominated by the Director R&DE(E).

1.2.11. Only water jet cutting shall be implemented/used for cutting process or for producing hollow pockets on aluminum sheets

1.2.12. Magnetic particle testing shall be conducted on all fasteners used in canister. This test will be witnessed by R&DE(E) rep.

1.2.13. The contractor shall carry out the crack detection test at all the embosses or punches and bends which will be witnessed by the R&DE(E) representative nominated by the Director R&DE(E).

1.2.14. Fabrication, manufacturing, assembly and testing of Front Hatch door mechanism, Article locking mechanism, umbilical retraction mechanism, rear stopper plate, Guide rail, wing guide rails and rupture disc.

1.2.15. The contractor shall inspect all the weld joints using ultrasonic/dye penetrant tests which will be witnessed by R&DE (E) representative nominated by the Director R&DE (E).

1.2.16. Integration of guide rail and wing rails using 3D laser tracker in canister with reference to approved drawings of R&DE (E) to meet the geometrical and dimensional tolerances. The contractor shall inspect the guide rail and wing rail assembly using 3D laser tracker after complete assembly of canister to meet the required straightness and flatness as mentioned in the drawing. This test will be witnessed by R&DE (E) representative nominated by the Director R&DE(E). Inspection of any other part may call for measurement by 3D laser tracker to achieve the accuracy required or to establish commonality among the canisters/missiles.

1.2.17. Integration of mechanisms in canister with reference to approved drawings by R&DE(E) to meet the geometrical and dimensional tolerances shall be done and R&DE(E) or any site specified by R&DE(E). Vendor has to give necessary and required assistance to carry out Integration of mechanisms in canister.

1.2.18. The contractor is also responsible for electronic and feedback control systems for operation of canister mechanism and also supply of power for pyro bolt explosion. The contractor is also responsible for cabling, MIL grade hermetically sealed connectors and proper aesthetic cable routing for canister mechanism. The contractor is also responsible for umbilical cable, umbilical connectors and its routing. All the electronic items used shall be rugged MIL grade standard. LCSO certificate for cables, connectors and other electrical & electronic items shall be provided by the contractor. Proper sealing of the connector and canister interface is the responsibility of the contractor. Fire retardant cables for all items are intended to be used for the purpose.

1.2.19. The contractor shall develop an electronic table top pendent for operation of the canister mechanism for testing purpose. Its functioning is to be demonstrated to RDE for verification of intended use of the software and hardware; any modification may be incorporated as required.

1.2.20. The contractor shall use good quality stainless steel helicoils for screwing of Aluminum components.

1.2.21. The first unit of mechanisms for canister shall be manufactured and tested and integrated on canister with electronics and electrical items by the contractor. After successful manufacturing, testing and acceptance of first canister unit, the other mechanisms set for second canister to be manufactured with incorporating any changes/modifications in design/drawing as specified by R&DE (E).

1.2.22. The contractor firm shall prepare and forward detailed QAP and Acceptance Test Plan document based on the guide line QAP and FAT documents/formats for review and approval by the Director R&DE (E). The system shall be tested as per above approved documents.

1.2.23. Inspection and testing of raw material, component, assembly/module and subsystem levels for various structural, mechanical subsystems as per approved QA plan.

1.2.24. The contractor shall submit the material test reports (physical as well as chemical), inspection reports, heat treatment reports to Director R&DE (E). The Material Test certificate shall mention yield strength, % elongation, impact strength at -30˚ C, chemical composition, etc.

1.2.25. The contractor shall check the weld strength (yield strength of weld joint- lap/fillet and butt joint) of the material as per standard procedures.

1.2.26. Performance and Acceptance testing as per approved ATP

1.2.27. The drawings given along with Tender Document are Engineering Design Drawings. The contractor shall be responsible for preparing manufacturing / fabrication drawings along with Process Plan in consultation with R&DE (E) and forward these drawings for approval of R&DE (E).

1.2.28. Surface treatment and painting of fabricated assemblies, sub-assemblies and components at manufacturer's premises as per specifications laid down in "Manufacture, Workmanship and Finish".

1.2.29. The contractor shall provide corrosion resistant protection to required components of the canister. Also where ever there are dissimilar materials are in contact, the contractor shall provide suitable means to prevent the galvanic or bimetallic corrosion.

1.2.30. Mechanical and electrical assembly, integration, mounting, interfacing and cable harnessing of mechanisms to be carried out at contractor's premises or at any other site specified by R&DE(E).

1.2.31. Supply of the canister pressurization /charging kit, of reputed make & model for filling of nitrogen from nitrogen cylinders inside the canister. The charging kit shall also include rugged digital pressure gauge of suitable least count to monitor 1.2 bar absolute pressure. The selection of pressurization kit will be decided by R&DE(E). Commercial grade Nitrogen cylinder (Qty 1 no) to be provided for 16 canisters (two VLUs). Minimess with suitable end connectors of 15 to 20m length of 5 bar min. capacity is to be considered. Cylinder opening key, Pressure gage of 2 or 5 bar range and flow control valve shall be provided.

1.2.32. Vendor shall make available DFT instrument for measuring thickness of painted aluminum assemblies.

1.2.33. Functional testing of canister structure and all mechanisms as per test plan at manufacturer's premises before dispatch to the R&DE(E). A separate test set up shall be prepared by vendor for endurance testing of door mechanism and article lock mechanism with approval of R&DE(E) and conduct of QT test on one no. of mechanism each till its failure. Prepare record of the test report and submit to RDE. Similarly, QT test of rupture disc (20 nos) shall be conducted by the vendor by preparing suitable test up with prior approval of R&DE(E). Prepare record of the test report and submit to R&DE(E). To ascertain the spring constant of the springs used in the mechanism(s), at least 2 samples of each spring shall be prepared/manufactured and tested for its spring constant value. Prepare record of the test report and submit to RDE.

1.2.34. Missile smooth loading and unloading trials inside canister shall be carried out and demonstrated by the contractor using suitable mechanized, mobile trolley. Concept, Design, necessary Drawings, or photos/3D model etc. for the trolley shall be provided by RDE. Vendor has to manufacture the trolley and deliver as a part of canister. The dummy missile for this test will be supplied by R&DE (E). Missile interface testing with canister will also be carried out by the contractor. This shall be done on ground horizontally

1.2.35. The contractor shall carry out Canister with dummy missile loading / unloading test inside VLU at his place. This shall be done in vertical position as VLU is positioned in ship for all 8 canister places in the VLU

1.2.36. The contractor shall carry out the Canister Internal Pressure and leak testing as per approved test plan at manufacturer's premises before dispatch to the R&DE (E). The internal pressure of 0.5 bar (gauge) max. is to be maintained inside canister without refilling for 48 hrs.

1.2.37. The connectors used for cables shall be hermetically sealed in order to prevent leakage from the canister.

1.2.38. The contractor shall ensure proper sealing of the front doors mechanism, umbilical mechanism, article lug locking mechanism, rupture disc, etc. All the openings of the canister shall be properly covered with sealing. The seals shall withstand high temperature up to temperature range of 80 to 90 degree Celsius. The seals or o-rings shall have shelf life of at least 5 years

1.2.39. The contractor shall provide valid calibration certificates for all the machines & instruments used for fabrication, testing, inspection etc. related to this job.

1.2.40. Final painting and finishing of the entire integrated equipment after completion of all functional trials. Detailed painting scheme is provided as a guideline to the vendor Appendix -B. Paints mentioned shall be used for the painting of items. Naval standard for painting shall be adhered to.

1.2.41. The contractor shall provide thermal paint inside canister for protection against the high temperature missile plume for temperature of 3000 K for 0.4 sec.

1.2.42. Transportation of canister structure assembly to the R&DE (E) in wooden containers with proper provision of cushions all-round the canister.

1.2.43. Engraved metallic/brass name plates shall be affixed for identification of the components/systems. Display of 'Ministry of Defense' emblem in the form of radium stickers as per details shall be provided/pasted on the cansiter.

1.2.44. The name plate on canister shall include "Design & Development by R&DE(E), Pune". The nameplate will be approved by R&DE(E).

1.2.45. The contractor shall provide all spares as specified in the relevant section in this document, consumables and a set of tools required for normal operation, maintenance and upkeep of this system. The maintenance tools accessories, consumables and spares list shall be finalized in consultation with R&DE (E).

1.2.46. Weight(s) of all the components shall be recorded in weight register. The Weight shall be punched / marked on major assemblies with handling instructions. Also the center of gravity symbol with missile and without missile shall be marked on the canister.

1.2.47. The tender enquiry document does not include the cost of the spares. However, the contractor shall work out detailed list of spares based on the following:

a. Field maintenance
b. Depot/ base level maintenance
c. Long term supply of spares

This list shall be submitted by the Contractor to the Purchaser. The Purchaser, if so desires shall place a separate order for spares after reviewing the list of spares submitted by the contractor.

1.2.48. Submission of one set of hard copies along with the soft copy on compact disc of all approved documents as per list enclosed, editable 3D solid model (in solid works s/w) and drawings in AutoCAD format with R&DE(E) template.

1.2.49. Deliverables

As per approved drawings based on reference drawings and scope of work, following are the deliverables of Canister Assembly. The list of drawings is mentioned in section 1.2.48.1

One Canister Assembly Consisting of following sub-systems

1. Canister Embossed Shell Structure
2. Article Lock Mechanism
3. Rear Stopper Plate
4. Umbilical Retraction Mechanism
5. Front Hatch Door Opening/Closing Mechanism
6. Rear Rupture Disc
7. Pressure Sensors
8. Humidity Sensor and desiccant
9. Canister Pressurization kit – 1 no for sixteen canisters (two VLUs)
10. Cable harnesses for mechanism and hermetically sealed connectors
11. Umbilical cable and hermetically sealed connectors
12. Pendent for canister mechanism operation and required cables and connectors
13 Trolley for Missile loading/unloading in canister – 1 no
14 Dummy canister covers – for each canister (10 nos)

1.2.49.1. List of Drawings

List of drawings is as mentioned below:

Sr. No.	Description	Qty.	Drawing No.
1.	Canister Assembly	1	VLSC010000000
2.	Front Guide Rail	1	VLSC010000100
3.	Rear Guide Rail	1	VLSC010000200
4.	Wing Rail	4	VLSC010000300
5.	Article Lock Assembly	1	VLSC011000000

6.	Umbilical Retraction Mechanism	1	VLSC012000000
7.	Rear Stopper Mechanism	1	VLSC013000000
8.	Hatch Door Assembly	1	VLSC014000000
9.	Rupture Disc Assembly	1	VLSC015000000

1.2.50. System Requirements and Performance Specifications

Sr. No.	Parameters	Requirements / Specifications	
1.	Type of Canister	Embossed Canister	
2.	Payload	VL SRSAM Missile	
3.	Canister Capability	Capability of storing, transporting, holding and launch of VL SRSAM Missile	
4.	Overall Dimension (approx.)	Length = 4064 mm Width at canister front flange = 546 mm Height at canister front flange = 641 mm	
5.	Mechanisms / Sub-assemblies	Article Lock Mechanism	As per drawing
		Rear Stopper Mechanism	As per drawing
		Umbilical Retraction Mechanism	As per drawing
		Front Hatch Opening/Closing Mechanism	As per drawing
		Rear Rupture Disc	As per drawing
6.	Mounting Arrangement	Front Flange	
7.	Dummy Pyro Bolts with Nut	For Front door – 1no.	
8.	Sensors	Limit Switches : For Front door: 4no. For article lock/unlock: 4no. For missile presence-2 no.	
		Missile left indicator- 1 no.	
		Pressure Indicator-1 no.	
		Humidity Sensor – 1 no.	
		Plume detection sensor	
9.	Purging valve	1 no.	
10.	NRV	1 no.	
11.	Desiccant	2 packs of 200 gm	
12.	Connectors & JB	Hermitically Sealed Connectors (As reqd.)	
		Junction Box	
13.	Cable Duct	On sides; as specified	
14.	Operating Panel	Switch Type; As per specification	

1.3 Environmental Conditions

The Canister shall maintain its specified performance when exposed to all environmental conditions specified herein:

1.3.1 Natural (climatic) Environmental Conditions

1.3.1.1 Low Temperature

a. Operating temperature: -10°C +/- 3˚C

b. Storage temperature: -20°C +/- 3˚C

1.3.1.2 High Temperature (Not exposed directly to solar radiation (Indoor))

a. Operating temperature: +55°C +/- 3˚C

b. Storage temperature: +65°C +/- 3˚C

1.3.1.1 High Temperature (Exposed directly to solar radiation (Outdoor))

a. Operating temperature: +55°C +/- 3˚C

b. Storage temperature: +85°C +/- 3˚C

1.3.1.2 Humidity

All VLSRSAM VLU equipment shall maintain the specified performance when exposed to relative humidity of 95% ± 5 % at +45°C ± 2 ˚ C for both continuous and intermittent periods, including conditions wherein water condensation takes place in and on the equipment. The humidity test shall meet the requirements specified in MIL-STD-810F or other equivalent standard.

1.3.1.3 Corrosion (Salt Fog)

All VLSRSAM VLU equipment shall withstand the effects of corrosion environment as encountered in sea area. The corrosion test shall meet the requirements, specified in MIL-STD-810F or other equivalent standard.

1.3.1.4 Solar Radiation (For Actinic Effects Only)

All exposed VLSRSAM VLU equipment shall withstand the effects of solar radiation in its operating and non-operating state and maintain its specified performance when exposed to 1120W/m2. Actinic effect is covered by MIL-STD-810F Method 505.4 Procedure II- steady state for constant energy of 1120 W/m^2 and constant Temperature of 39 °C, 44°C or 49°C.

1.3.1.5 Rain

The rain test shall meet the requirements specified in MIL-STD-810F, Method 505.4

1) Operating

All exposed VLSRSAM VLU equipment shall withstand the effects of 10mm/Hr rain at 18m/s wind.

2) Non-operating

All exposed VLSRSAM VLU equipment shall withstand the effects of 36mm/Hr rain at 18m/s wind.

1.3.1.6 Degree of Enclosure

a. Ground equipment exposed to weather (unsheltered)

All VLSRSAM VLU equipment exposed to weather condition (unsheltered) will withstand degree of enclosure of IP 67.

b. Ground equipment un-exposed to weather (Sheltered)

The degree of enclosure specified for sheltered equipment (all consoles and cabinets that require air circulation) should withstand degree of enclosure according to IP 67.

1.3.1.7 Fungus

The equipment shall be resistant to fungus and maintain its specified performance, in both operating and non-operating conditions, when exposed to fungus growth. The fungus proof shall be done by using analysis or similarity.

1.3.1.8 Wind Velocity

A wind static resistance analysis shall be performed to check that the equipment meets the following requirement.

1) Operating

The exposed VLSRSAM VLU equipment shall withstand and maintain its specified performance when exposed to relative wind velocity up to 90 km/hr.

2) Non-operating

The VLSRSAM VLU shall withstand without damage, winds having a relative velocity up to 120 km/hr (survival).

1.3.2 Induced Environmental Conditions

1.3.2.1 Vibration

a. Operating

1) The vibration test for Operating Mode shall meet the requirements specified in MIL-STD-810F Method 514.5, Cat.4 or other equivalent standard (no packaging) as follows

2) VLSRSAM VLU - will withstand the vibration established during missiles firing, and due to winds per 2.2.1.8 as well as any other vibration established by the VLSRSAM VLU such as generator, EF Motors etc.

b. Non-Operating

The VLSRSAM VLU shall not suffer damage or be unable to meet the specified performance after it is subjected to vibration environment expected during transportation in its original form (non-operational) by:

1) Wheeled vehicles / Trailers (MIL-STD-810F Method 514.5, Cat 4)
2) Air (MIL-STD-810F Method 514.5, Cat 7)
3) Sea-Onboard ship (MIL-STD-810F Method 514.5, Cat 10)
4) Railroad – ((MIL-STD-810F Method 514.5, Cat 11)

1.3.2.2 Acceleration

The acceleration test shall meet the requirements specified in MIL-STD-810F Method 513.5.

1) Operating

N/A

2) Non-Operating

The VLSRSAM VLU shall not suffer damage or subsequently fail to meet the specified performance when subjected to the acceleration during Non-active state of :

During road/air/rail transportation:

Longitudinal X	+/-3g
Transversal Y	+/-1.5g
Vertical Z	+/- 2g

Due to ship motions:

	Sea State 7 (survival)	**Sea State 5 (operational)**
Longitudinal X	0.6 g	0.5 g
Transversal Y	1.3 g	0.9 g
Vertical Z	2.5 g	2.2g

(Note: a load factor of 15% is to be taken over the ‘g’ values due to ship motion)

1.3.2.3 Acoustic Noise

The VLSRSAM VLU equipment shall not suffer damage or subsequently fail to meet the specified performance when subjected to the Acoustic Noise of 150dB. Workspace noise shall be reduced to level that

permit necessary direct (person to person) and telephone Communication and established an acceptable acoustical work environment shall not exceed 65dBA.

1.3.2.4 Contamination

All ground equipment exposed to weather (unsheltered) shall withstand pollutant material such as fuel gas, oil condition that BTP/LPI Systems (Generator vehicle) comply with the contamination requirements defined for it.

SECTION II

SYSTEM DESCRIPTION

2.1 Introduction:

VL SRSAM Canister serves both as a launch platform and as an environment protection canister for missile. All missiles are stored in a ready to fire configuration, enabling instantaneous firing of any of them, directly from their canisters, in fully automatic, computer controlled operational sequence.

VL SRSAM Missile can be launched directly from its fully sealed canister, which during firing fulfills function of a guide rail and provides missile's mechanical as well as electrical interfaces with Canister and WCS respectively, prior to launch.

VL SRSAM Canister shall enable smooth and safe launch of missile. In addition, canister shall serve the purpose of transportation, storage, and handling of missile. These Canisters need to be filled with inert gas to provide protection from outside environment during storage and transportation. The missile lugs are supported on guide rail of canister for easy and smooth travel of missile inside canister during normal loading/unloading and during firing. The Canister is also provided with wing rails to support and guide folded wings of missile. The Canister is also provided with pyro based automatic hatch opening & closing mechanism, umbilical connector panel, pyro based automatic missile front shoe lock or atrticle lock unit, missile rear stopper and rear rupture disk, hermetically sealed connector panel for umbilical, NRV for pressurization, Purging Valve, Humidity indicator, Desiccant. The tree diagram shown in ***Figure 1***gives the sub assembly details of the canister assembly. All the systems and subsystems of the canister are shown in ***Figure 2***.

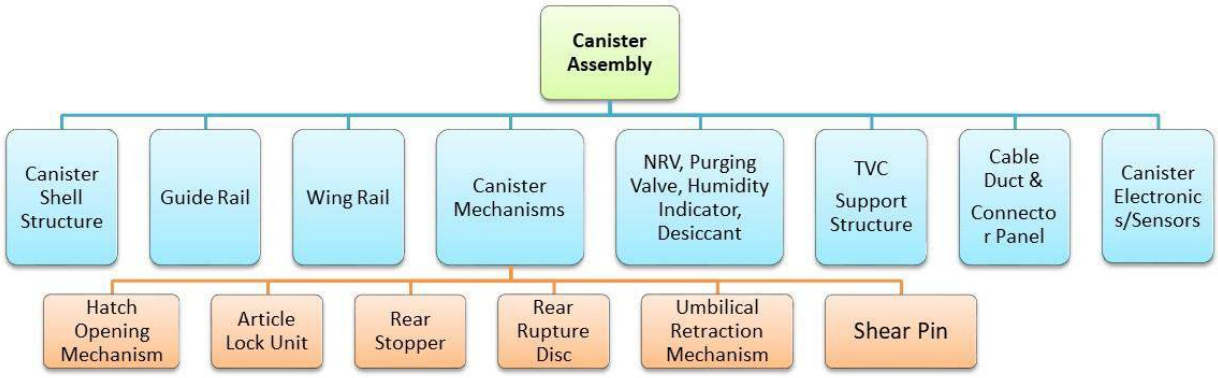


Figure 1 **Tree Diagram of canister assembly**

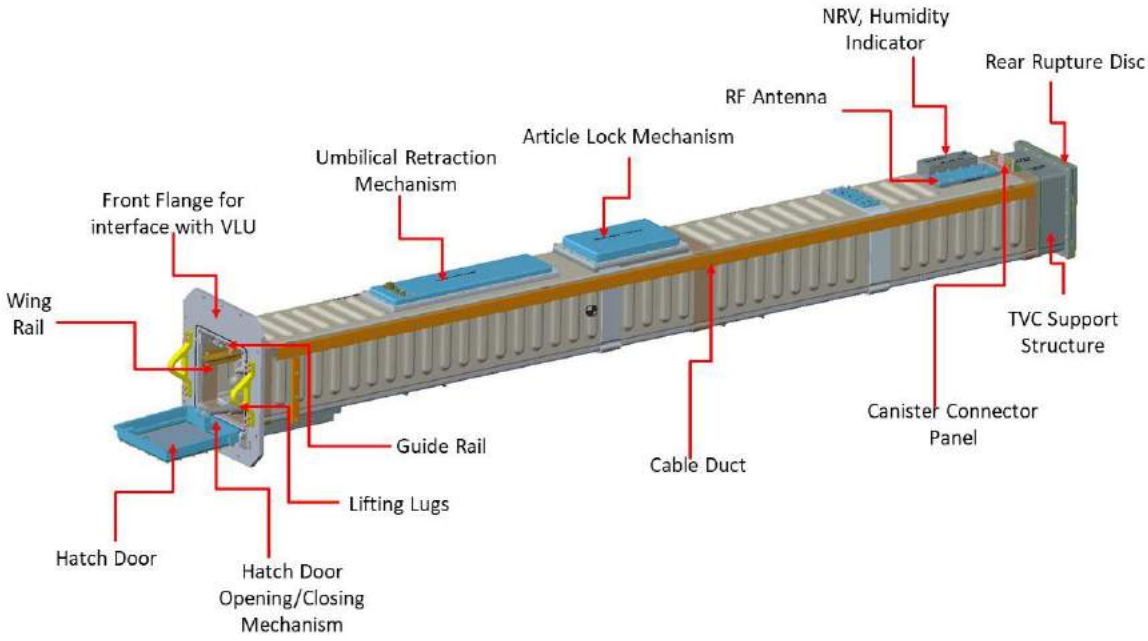


Figure 2 Canister Assembly Systems and Subsystems

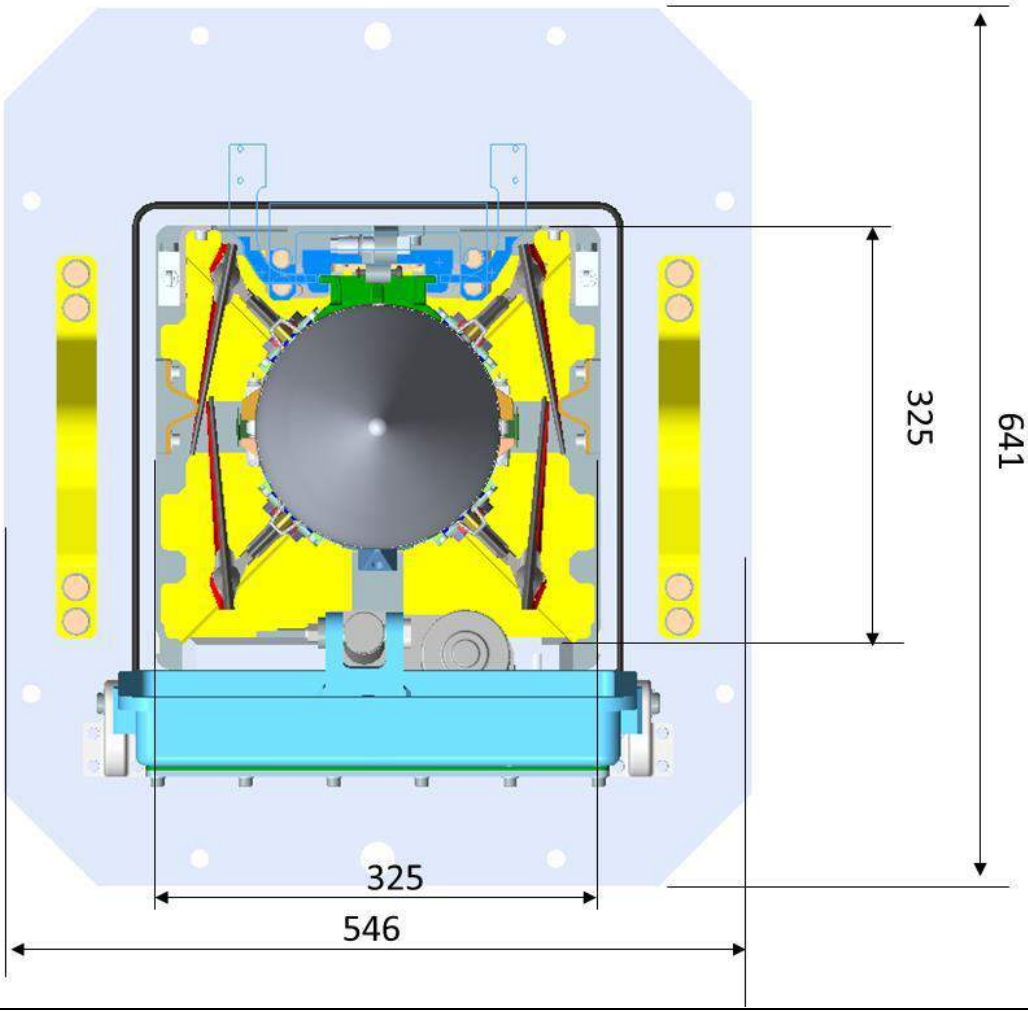


Figure 3 Canisterised End View - Details

An end view of Canistersied Missile is shown in ***Figure 3***, which displays internal configuration of canister.

The overall canisterised missile iso-metric view is shown in ***Figure 4*** which also shows the overall length of the canisterised missile.

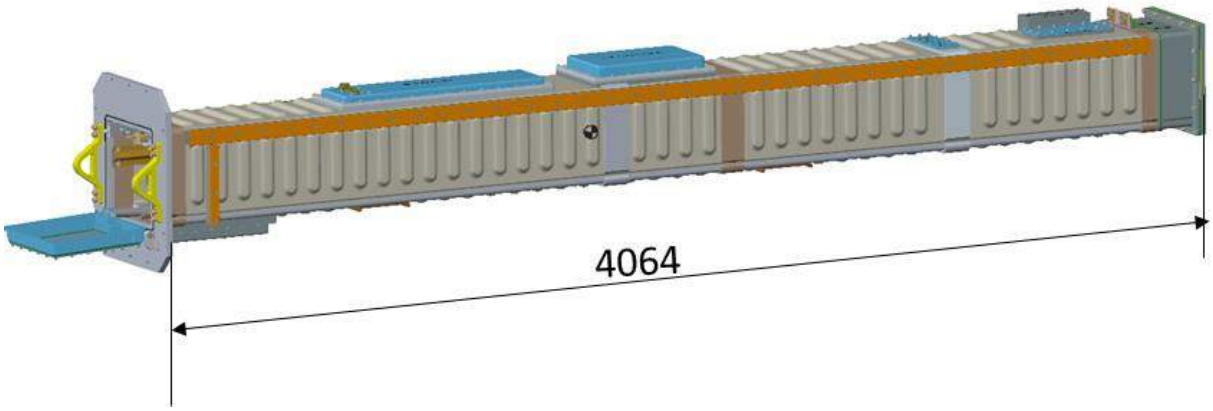


Figure 4 Canister Assembly

2.2 Role of the Systems

The canister is to be realized for housing of the article during handling, replenishment, transportation, storage and launching. The canister will be pressurized to 0.2 bar (g) to maintain an pressurised environment around the article during storage.

2.2.1 Functional Requirements

- To accommodate, support & hold the article securely during replenishment transportation, handling and launch.
- To accommodate and provide support for mounting of
    - Guide rails
    - Wing rails
    - Article locking mechanism
    - Rear stopper mechanism
    - Hatch opening / closing mechanism
    - Umbilical mechanism
    - Pressurization point with non return valve.
    - Humidity indicator and desiccant
    - Canister lifting brackets
    - Canister front flange
    - Rear rupture disc
- To provide means for article replenishment, handling, loading / unloading and

Transportation.

2.3 General Description of the System:

The Canister system consist of the following sub-systems:

a) Embossed Canister structure
b) Canister Hatch door at front
c) Article locking mechanism
d) Rear Stopper mechanism
e) Shear Pin Assembly
f) Guide rail
g) Pressurizing and venting valve and refilling arrangement
h) Humidity indicator and desiccant
i) Rear Rupture Disc

2.3.1 Embossed Canister Structure

The canister is manufactured using sheet metal which is embossed to increase the stiffness and strength of the canister. The 3-dimensional embossing of the sheet provides adequate stiffness to canister to withstand loads due to transportation, emplacement, articulation and firing of missile in single as well as in ripple modes.

Table 1 Specifications for Embossed Canister Structure

S. No	**Description**	**Parameter/ Value**
1	Construction	Embossed Type Square Cross Section
2	Overall Dimensions	Internal: 325 W x 325 H External : 366 W x 366 H Front Flange dim: 641 x 546 x 22 thk. Length: 4151 mm
3	Sheet Metal Thickness	4 mm
4	Material	AA 5083 Temper O or AA 5059 Temper O
5	Weight	Not to exceed 175 kg (including all mechanisms and covers)
6	No. of Support Points	Front flange: M12 bolts (Qty. 8no.)
7	Quantity	6 No.
8	Mounting & Interface Provisions	• Front Flange Mounting for interface with VLU • Umbilical connectors & Cables

		• Accessories & Attachments for Handling/Lifting & Loading/Unloading of canister • Mechanism (front hatch door, article lock, umbilical, rupture disc, etc) mounting interfaces • Sensors/indicators mounting interfaces • 2no. of plates at the base for horizontal resting of canister

2.3.2 Guide Rail

The canister should provide suitable means for smooth and easy travel of missile during loading/unloading and vertical launch.

A guide rail that support missile through its lugs is provided in canister. The guide rail runs from front end of canister to rear lug of missile i.e. supporting missile until exit of its rear lug from canister. This guide rail also guide missile during loading/unloading in canister. A detailed configuration of guide rail can be seen in figure 6-3. The total length of guide rail is 3100.5 mm and missile-guiding length is 3070.5 mm. The guide rail is housed inside canister assembly as shown in the figure 7. The distance between two lugs of the missile is 1222 mm.

The clearances between the missile lugs and guide rail have been finalized based on the requirement of enabling a smooth forward movement of lugs in guide rail during take-off. In addition, requirement of arresting/constraining unwanted lateral and vertical movement of lugs of missile during ship motion, launching and transportation has been taken into consideration while evolving the configuration of guide rail.

Based on the above requirements and considerations, dimensions of guide rail is arrived at 110 mm (W) x 31.5 mm (H) & 3070.5 mm (L) with the clearance provided between the lug and rail being 0.5 mm approximately shown in figure 6-4. Being long in length guide rail is divided in two parts of length 1633.4 mm and 1464.5 mm. These individual guide rails are fixed to canister assembly top portion from inside by means of Allen headed counter bore screws. The guide rails are made out of Aluminium Alloy 6061 using 40 mm thick flat sections. The surface is treated by a hard anodizing to get a surface hardness of 35 - 40 HRC to provide good wear resistance. The contact surfaces of the rail are precision machined to provide a smooth surface finish and ensure dimensional accuracy of high order. A ‘C’ type cross section of the guide rails has been selected to accommodate and smoothly guide the missile lugs as shown.

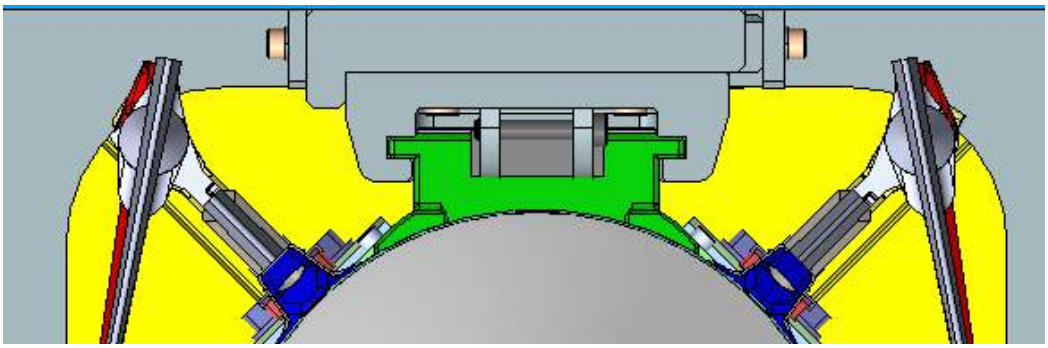


Figure 5 End View of the canister showing guide rails and the Missile Lugs

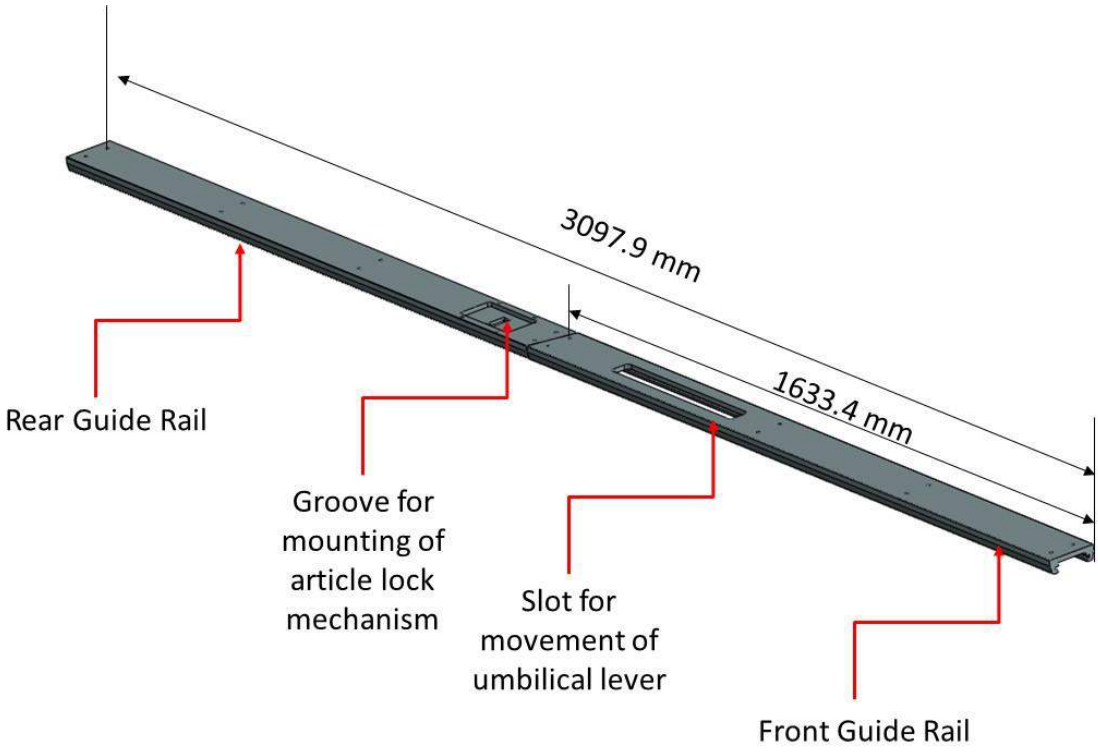


Figure 6 Guide Rail

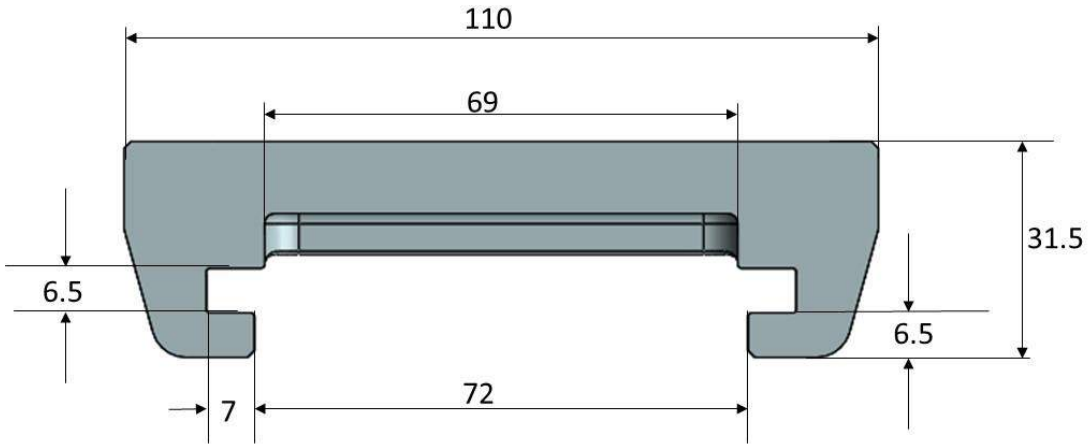


Figure 7 Dimensional Details of the Guide rails

Table 2 Technical Specificat for Guide Rails

S. No.	Description	Parameter/Value
1	Material of Guide Rail	AA 6061 Cond T6
2	Construction	Inverted C type
3	Quantity	6sets x 2 No.

4	Size	110 W x31.5 H x 3070.5 L
5	Fastening to pads	M6, Allen Head (suitable Helicoils to be used on pads)
6	Fastener material	Alen head High Tensile Stainless Steel (Dacro coated) Property class 8..8
7	No. of bolts	16 No.s
8	Clearance between guide rail and lug	0.5 mm
9	Mechanical Interface	- Machined mounting pads – 8 Nos. with M6 Helicoil inserts -16 Nos. - Article lug locking mechanism - Cutout for Umbilical retraction mechanism
10	Heat Treatment	Hard Anodizing 35-40 HRC
Note: **1.** All fasteners to be coated with corrosion resistance coating. **2.** Galvanic corrosion to be avoided using suitable means.		

2.3.3 Wing Rails

The VL SRSAM missile is a folded fin and wing configuration. These fins and wings are spring loaded. The canister should provide smooth surface for resting and guiding missile fins and wings during loading / unloading and launch of missile.

Inside canister, two wing rails are provided on both sides to support and guidance of wing rails. These rails are formed using folded sheet metal, made of aluminum, and have supporting pads for mounting in canister. A configuration view of wing rails are shown in figure below.

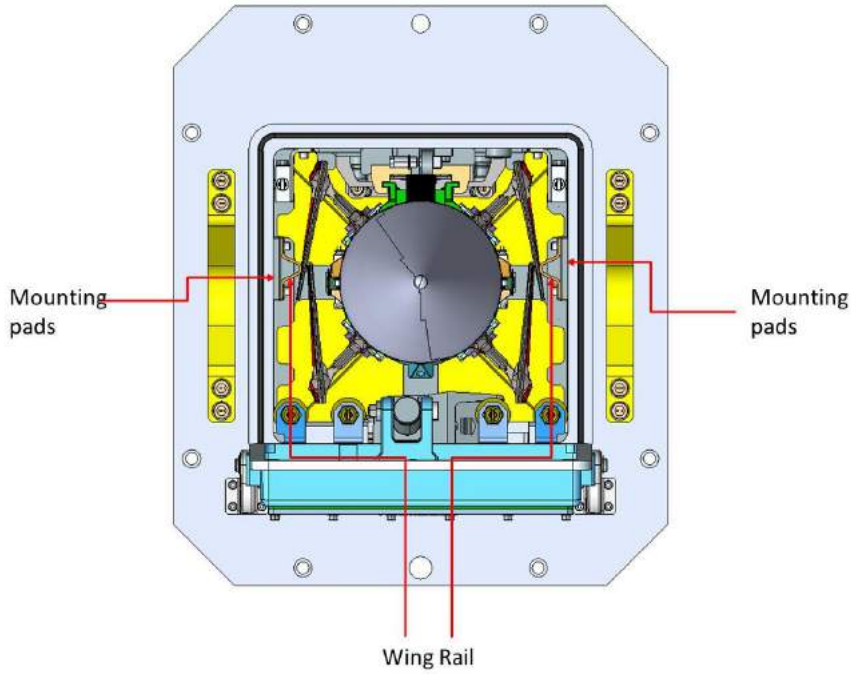


Figure 8 Canister and Wing Rail Assembly

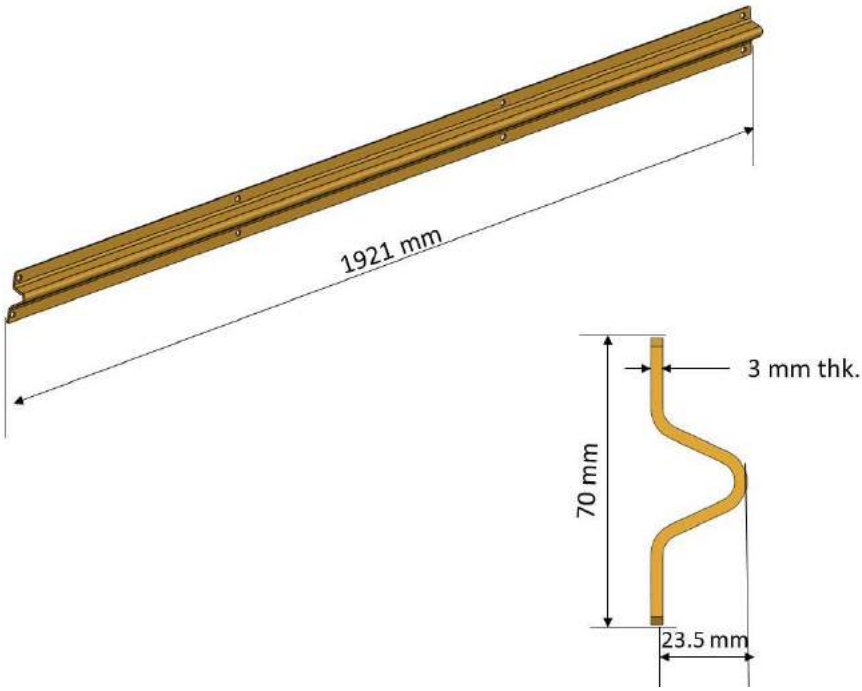


Figure 9 Wing Rail

Table 3 Technical Specificat for Wing Rail

S. No.	Description	Parameter/Value
1	Configuration	Folded profile of sheet
2	Quantity	4 Nos. per canister (2 nos. on LHS & 2 nos. on RHS)
3	Material	Al Alloy 5083 , Temper 'O'
4	Overall Dimensions	23.5 (W) x 70 (H) x 1921 (L) mm
5	Sheet Metal Thickness	3 mm
6	Overall Weight	Not to exceed 1 kg per wing rail
7	No. of screws	M6 screws (Qty. 8no. per wing rail)
8	Mounting & Interface Provisions	• Provide support to missile fins and wings • Machined mounting pads – 4 Nos. per wing rail with M6 Helicoil inserts

2.3.4 Canister Hatch Door Opening / Closing Mechanism

VL SRSAM missile canister is a pressurized canister, which will enable environment protection of missile during storage and transportation. The hatch door should ensure pressurized storage of missile and it should be quick open prior to launch of missile.

VLSRSAM VLU consists of eight canistersied missile. The hatch door of CMs opens as shown in figure below.

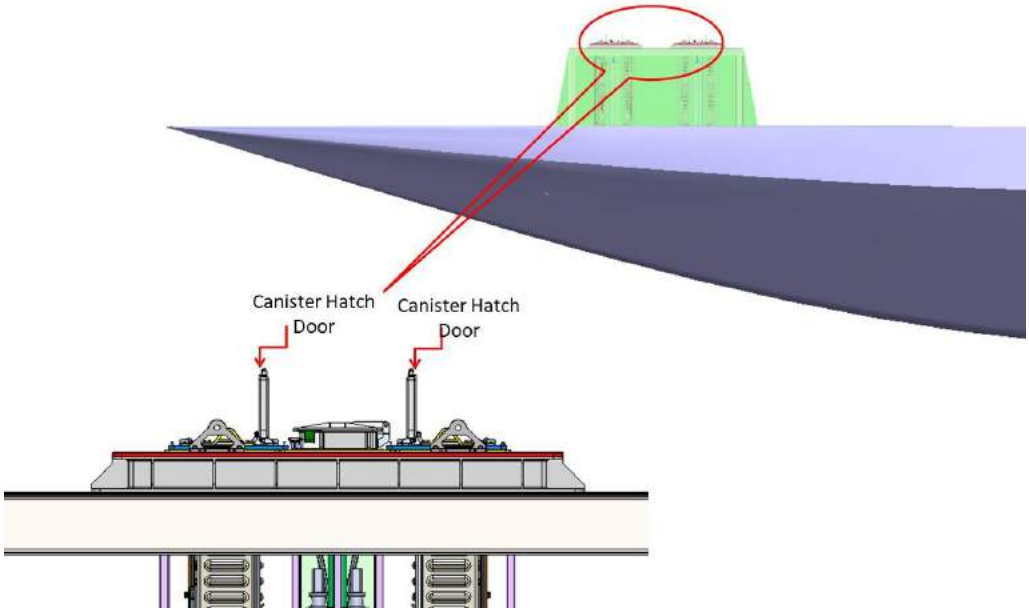


Figure 10 Canister Door Opening within VLU

The hatch should be opened from a single command from Canister Mechanism Relay Unit (CMRU) prior to launch of missile. During storage and transportation of missile canister will be pressurized with 1.15 bar absolute pressure. Hatch should have leakage proof locking for this purpose. Also, quick opening prior to launch and near close position post launch is required. The configuration and concept of operation of the front door opening mechanism is explained below paragraphs.

The location of the hatch opening and closing mechanism is shown in the figure below,

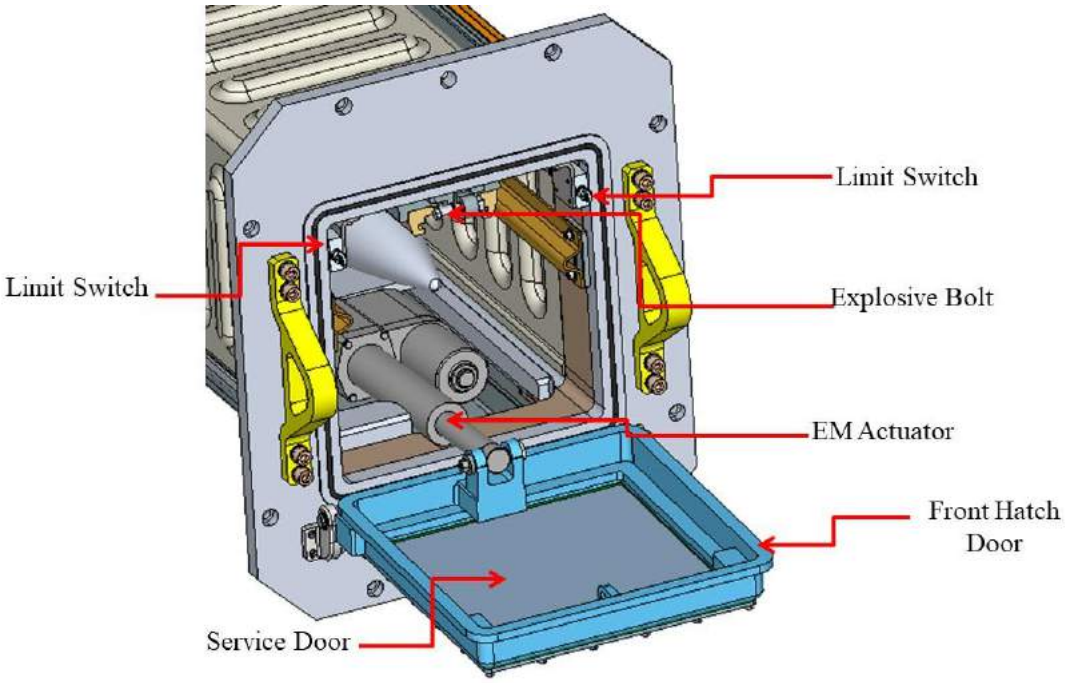


Figure 11 Front Hatch Door Opening/Closing Mechanism

This door mechanism enables both opening and closing of the door. The configuration of door mechanism is shown in the figure below.

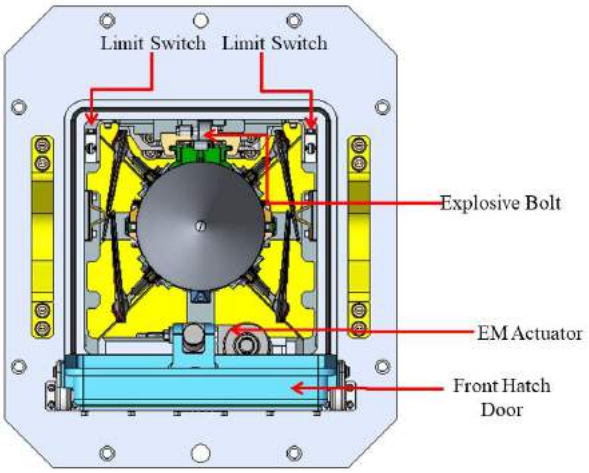


Figure 12 Front Hatch Door Opening/Closing Mechanism (Front View)

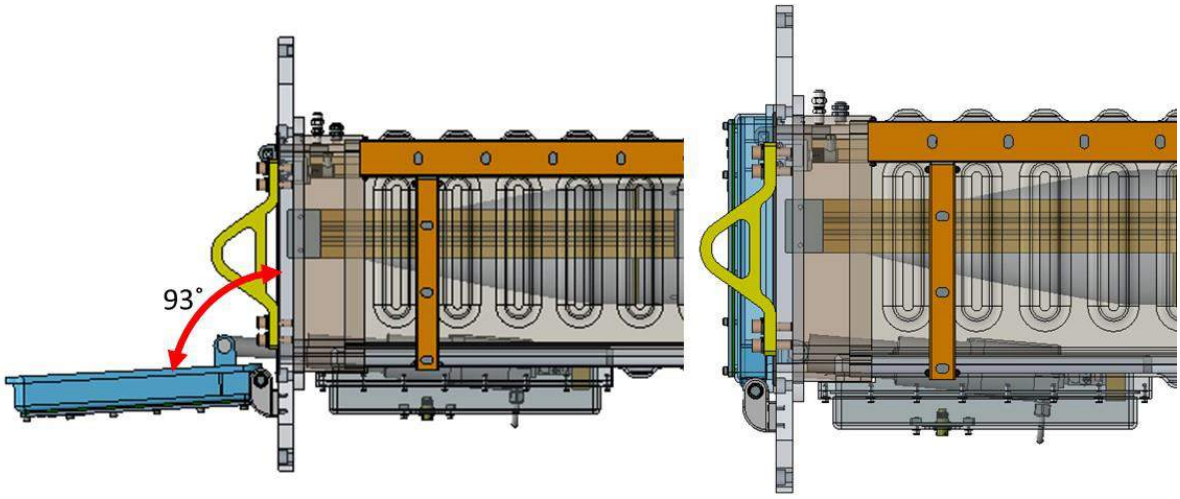


Figure 13 Door in Open and Closed Position

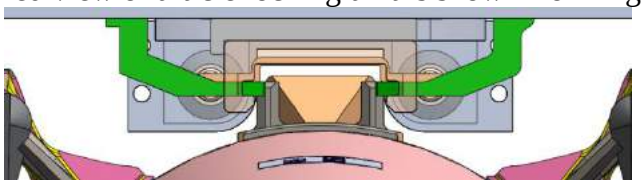
Table 4 Technical Specifications for Hatch Door Opening / Closing Mechanism

S. No.	Item	Technical Specification
1.	**Front Hatch Door**	Material: AA 5083 'O' grade Weight < 4kg Door Opening Time < 3 seconds Opening Angle : 93˚ Dimensions: 378 mm x 378 mm (approx.) Mountings/Brackets/Attachments: 1. Pivoted at one end 2. EM actuator top pivot bracket 3. Service door 4. Closing washer for nut 5. Groove for sealing 6. Door Stopper arrangement.
2.	**Front Door EM Actuator**	1. Actuator Specifications: a. Closed length: 340 mm b. Open Length: 457 mm c. Stroke: 117 mm d. Max. Axial Force acting on actuator =500 N e. Linear speed 75 mm/sec f. Selected EM Actuator: • Make: Thomson • Model: Electrak HD • HD24-B017-0150-EXD-2-MMSD, 24 V DC • Max static load capacity : 18 kN • Max dynamic load capacity : 1.7 kN • Stroke: 150 mm • Linear Speed: 75 mm/sec @ 500 N

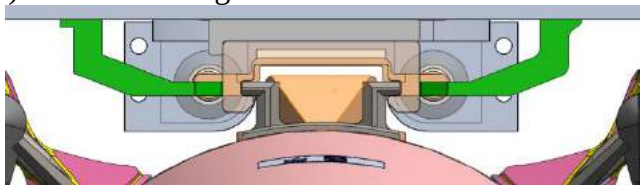
		• Ball screw driven with inbuilt safety brakes • 25% duty cycle • IP 69 K protection • Hall encoder feedback plus end of stroke indication • Wt: 6.7 kgActuator g. Top Pivot Bracket • *Material – AA7075 T735* • *Pivot pin – Material En 19, Dia. – 12mm* h. Actuator Bottom Pivot Bracket • *Material – AA7075 T735* • *Pivot pin – Material En 19, Dia. – 12 mm*
3.	**Seals**	O ring NBR 70, Parker
4.	**Limit Switches**	Honeywell 25EN9-6, Qty. 4No.

2.3.5 Article Front Lug Locking Mechanism

The VL SRSAM missile is loaded in canister in under slung manner, where both lugs of missile guided through guide rail. The rear lug of missile is stopped through rear stopper plate as discussed earlier. An article lock unit arrests the front lug of missile for any forward motion of missile during transportation. This unit has tapered locking jaw which obstruct missile front lug. This jaw is inserted via a groove provided on guide rail near front lug location. A detailed view of article locking unit is shown from Figure 14 to Figure 16



(a) Article Locking mechanism in Locked Condition



(b)Article Locking mechanism in Un-Locked Condition

Figure 14 End View of Canister - Article Locking Mechanism

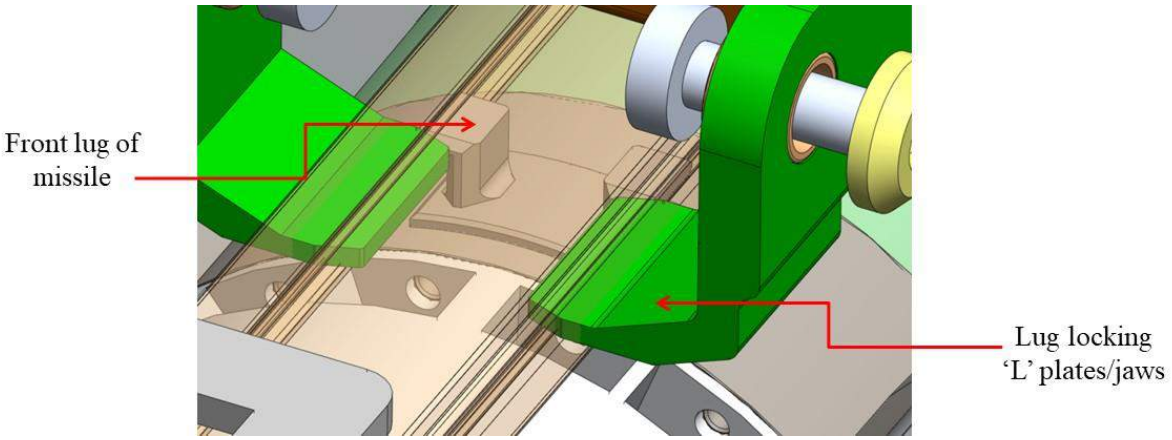


Figure 15 Article Lock Unit in Locked postion

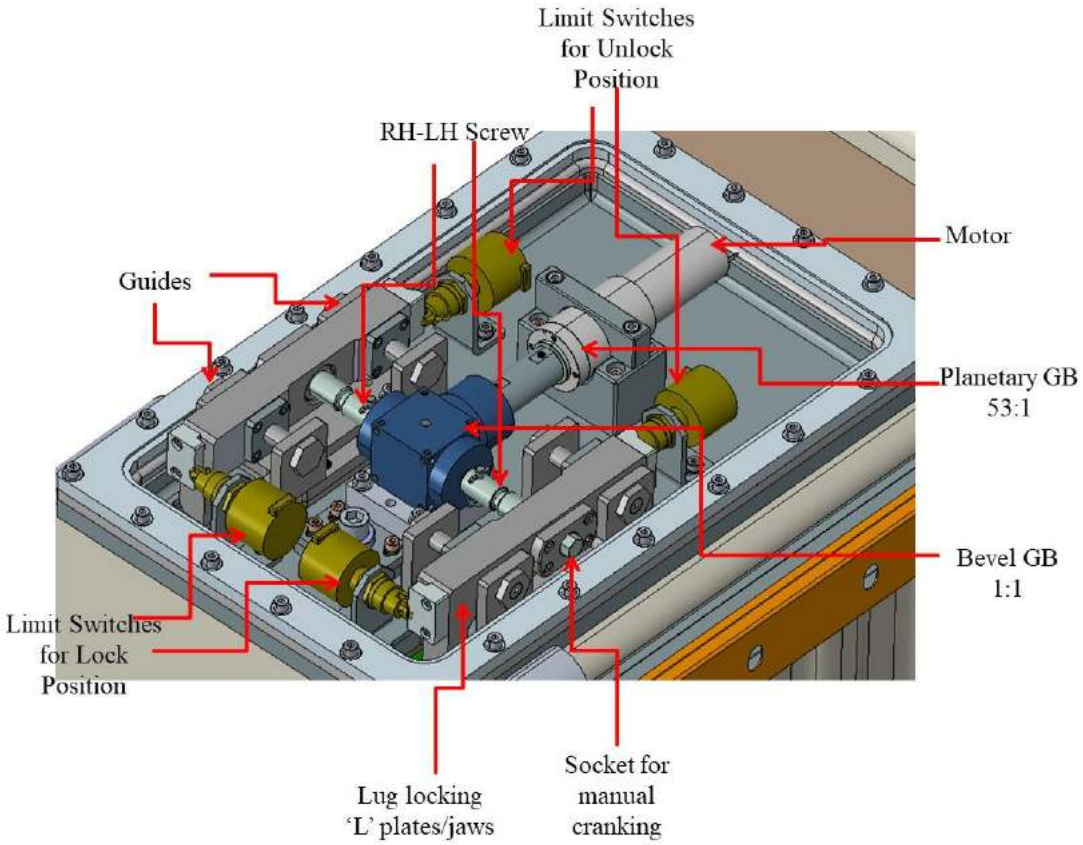


Figure 16 Article Locking Mechanism

Table 5 Technical Specifications for Article Locking Mechanism

S. No	Description	Parameter/Value
1	Materials	a. Lug locking Jaws – AA 7075 T735 b. Mechanisms – AA 7075 T735 c. Screws – En 19 Cond T
2	Power Screws	Self locking – Square threads – φ16 x 4 mm LH-RH threads, Stroke = 19 mm
3	Motor Input Speed	8853.3 rpm
4	Time of actuation	19 mm in less than 1.5 seconds
5	Output torque required	15.5 Nm
6	Gear box ratio	Planetary Gear Ratio: 43:1 Bevel Gear Ratio: 1:1
7	Input Motor torque	0.6 Nm
8	Motor Specifications	Maxon DCX35L, 18V (to be operated on 24V)
9	Gear Box	Planetary Gearbox: Maxon: GPX 42 Bevel Gearbox: Graessner P45
10	Limit Switches	Honeywell 25EN9-6 , Qty – 4 No.

2.3.6 Shear Pin

- To arrest linear movement of the Missile due to ship motion when the article lock mechanism is in unlock position
- Should withstand the total force of 300 kg prior to shear failure

Shear Pin is fastened to the front lug of the missile. The shear pin is located within the cover of the article locking mechanism. It arrests the forward movement of the missile when the article lock mechanism is in unlock position. The shear pin configuration is shown in the figure below,

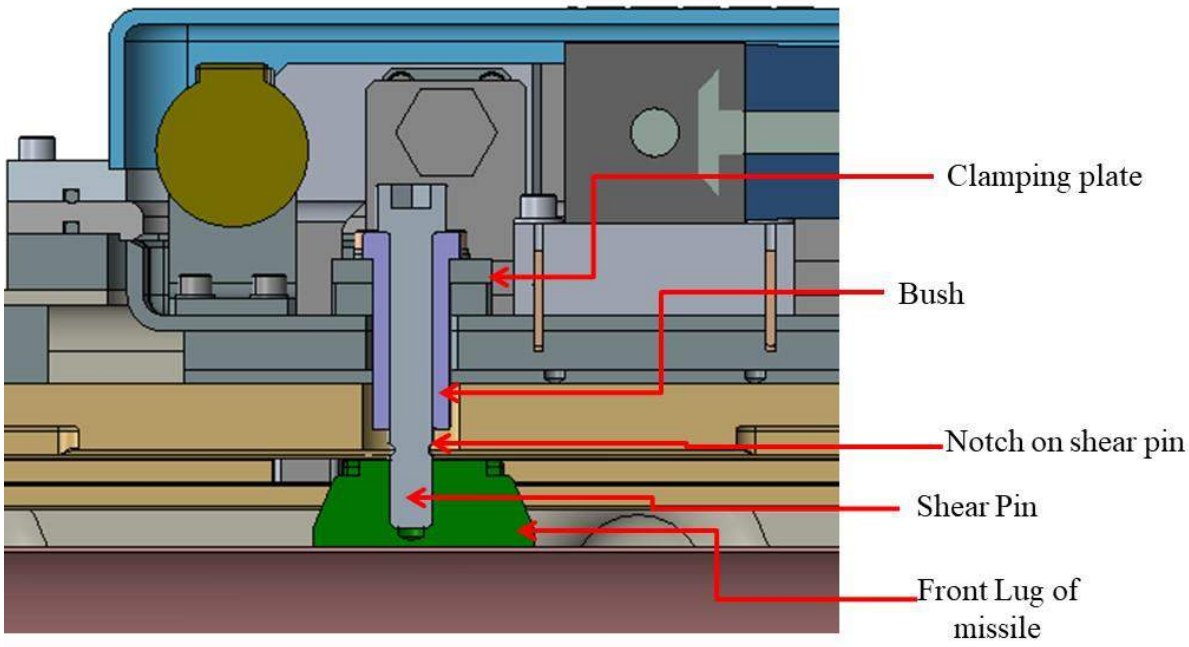


Figure 17 Shear Pin Assembly

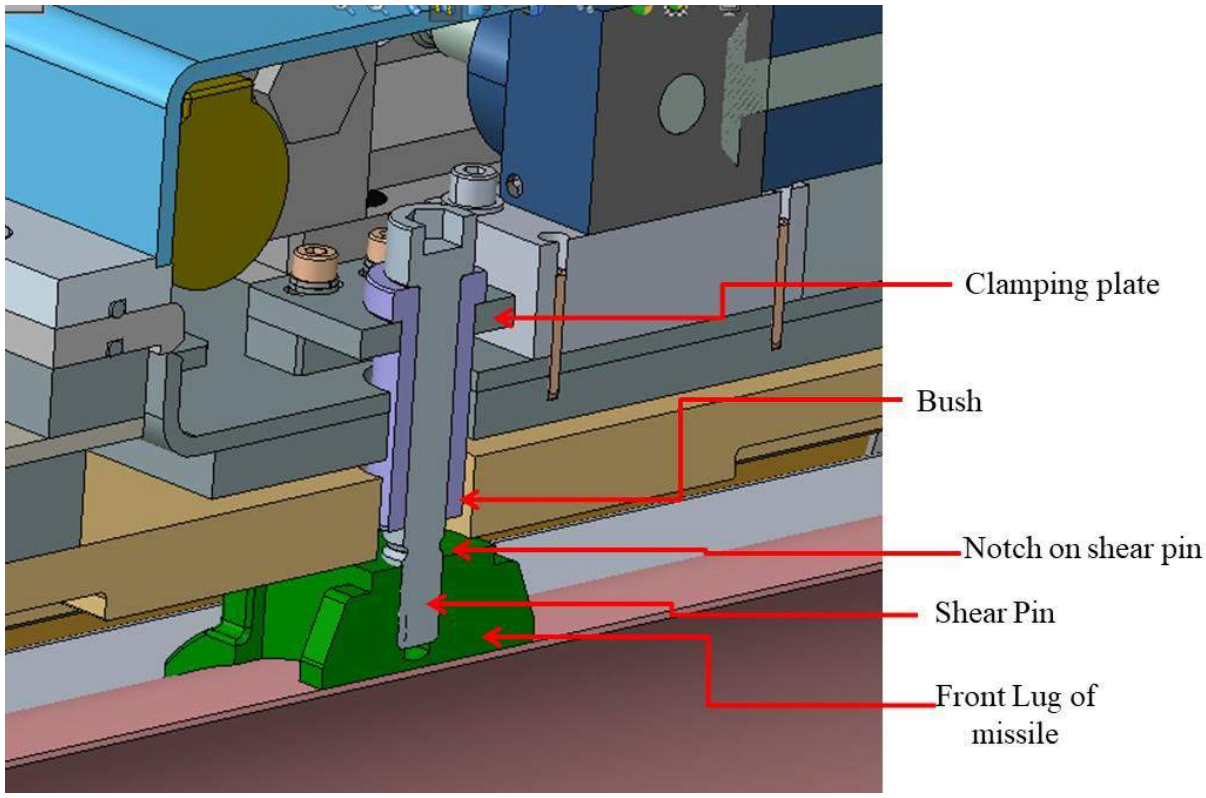


Figure 18 Shear Pin Assembly (Isometric Cut View)

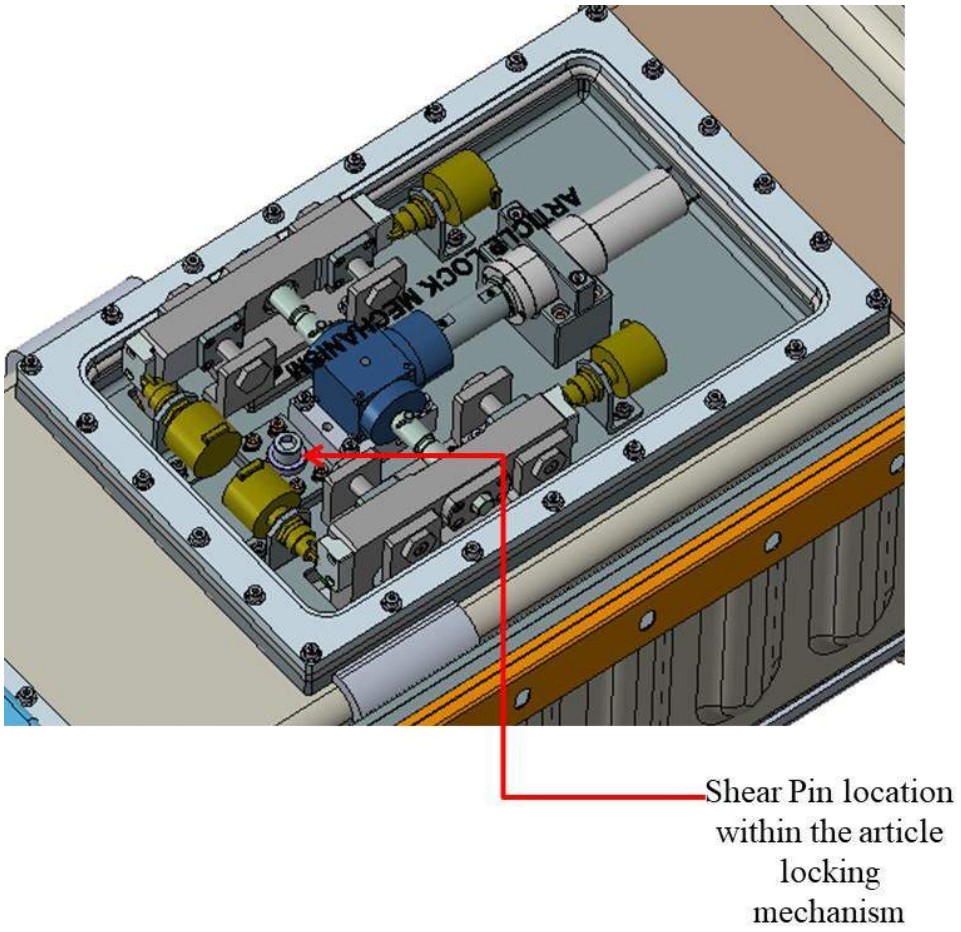


Figure 19 Shear Pin location within article locking mechanism

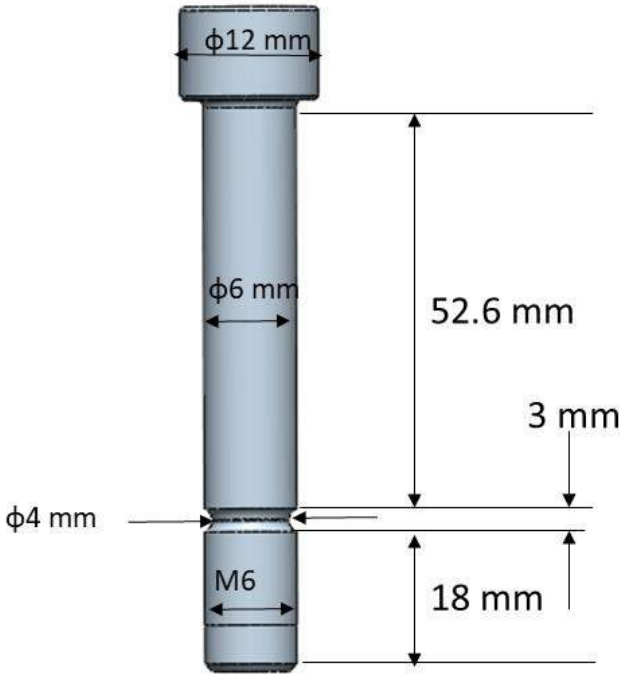


Figure 20 Shear Pin Dimensions

Material for shear pin: SS 304
Qty: 200 no.
Testing & Qualification of shear pin will be in the scope of the vendor
Vendor to design and develope a suitable test setup for qualification of shear pin. Vendor must get approval for test setup from R&DE(E).
At least 100 no. of shear pins to be tested using the test setup for consistency in shear pin failure.

2.3.7 Rear Stopper Mechanism

Article rear stopper is mounted on the canister and its main purpose is to support the weight of the missile when canister is held vertically within VLU as shown in the end view of the canister Figure 23. When article is loaded in the canister the rear shoe of the article rests against an actuating plate, which will push a pin which in turn pushes one face of the disc springs as shown in Figure 21 & Figure 22. Disc springs are sandwiched between the actuating plate and rear stopper housing. The rear stopper housing is bolted on the rear end of canister assembly. Thus the impact load developed during operating condition like transportation of the article is transferred to canister structure via disc spring. The disc spring will partly absorb the impact load. Rear stopper assembly also is designed to take the transportation loads and ship motion loads. The disc springs are designed to take the 2.5g longitudinal loads arising during sea state 5 condition. The rear stopper assembly is shown in Figure 23.

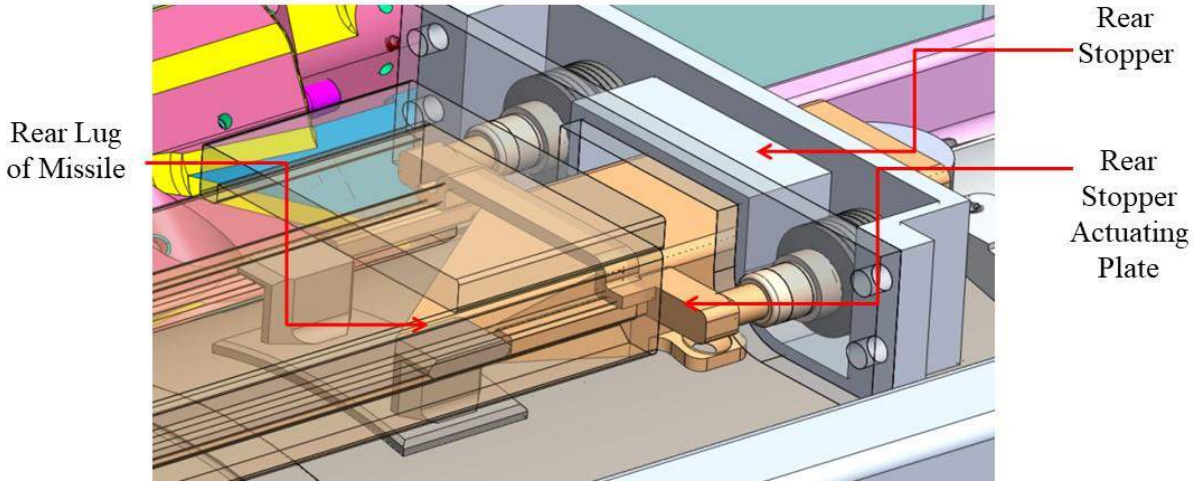


Figure 21 Detailed view of canister showing rear lug resting on the rear stopper plate

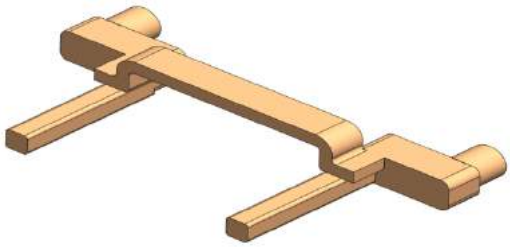


Figure 22 Rear stopper actuating plate forming interface between rear Lug and rear Stopper Assembly

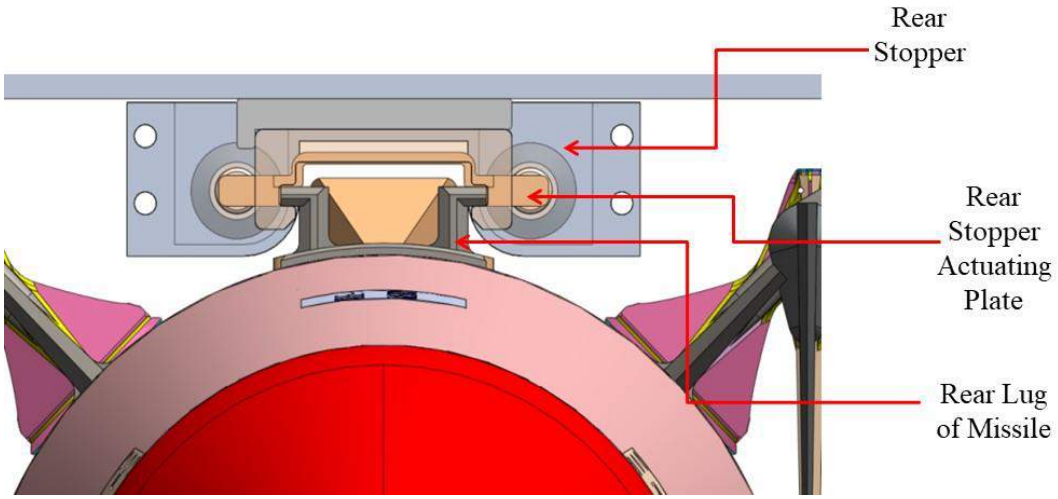


Figure 23 End View of the canister

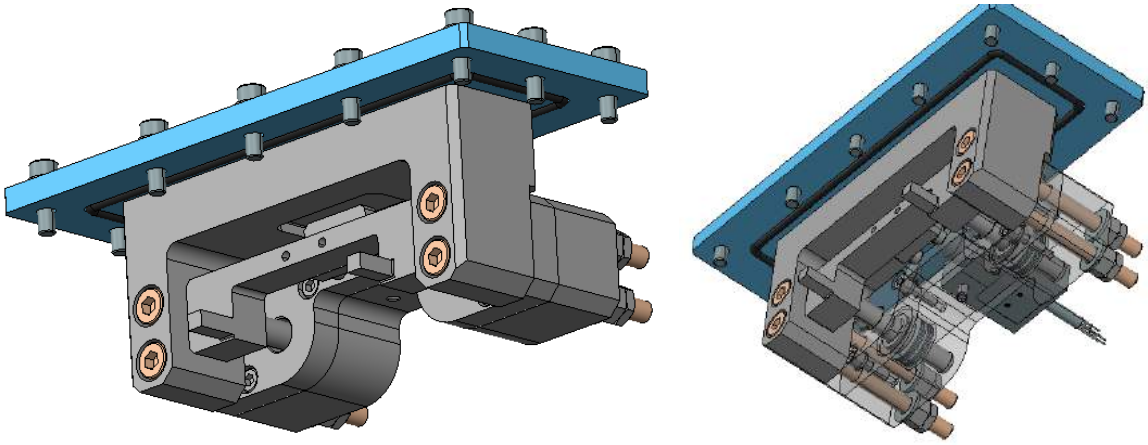


Figure 24 Rear Stopper Assembly

The missile presence limit switch is also mounted over the rear stopper assembly as shown in figure below,

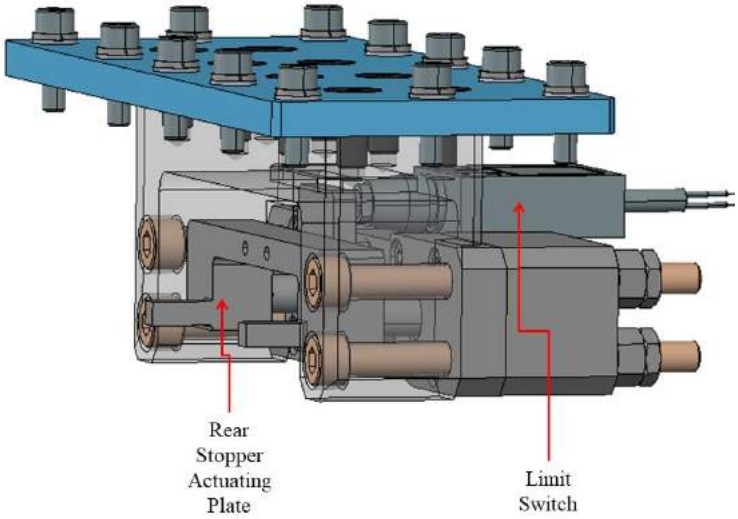


Figure 25 Missile Presence Limit Switch – Qty 2 no.

As shown in above figure, as the actuating plate is pushed back by the missile rear lug, the plunger of limit switch gets pressed and the missile presence is sensed.

In Rear Stopper, there are three Belleville Springs in Parallel attached in series with another arrangement of three Belleville springs in Parallel. This combination of six springs is in Series with same combination of six springs as explained above. Further, we have 2 combinations of these 12 springs.

For Parallel springs, Load is shared by three springs but the deflection of the springs remain the same, while for springs in series, load remains the same and the deflection is shared by three springs.

Arrangement of Disc Springs is as shown below:

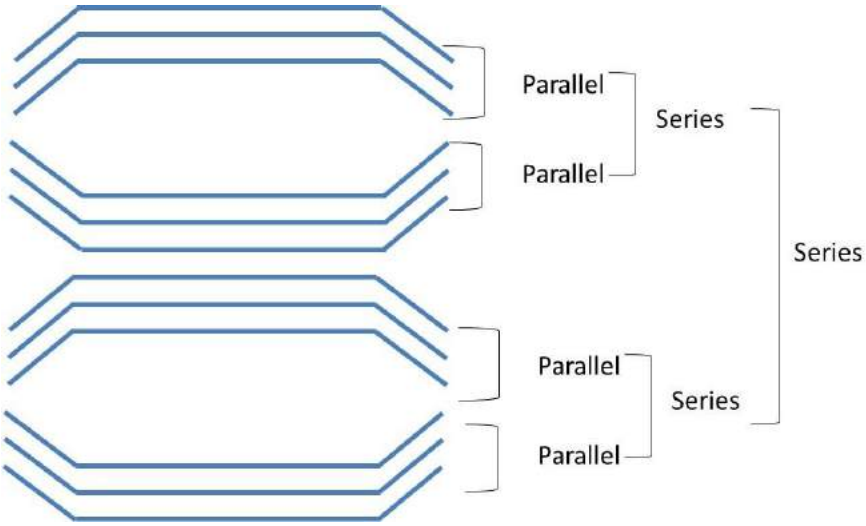


Table 6 Technical Specifications for Rear Stopper Plate

S. No	Description	Parameter/Value

1	Configuration	Machined block
2	Quantity	1 no. per canister
3	Material for rear stopper components	AA 7075 T735
4	Overall Dimensions	165(W) x 79 (H) x 82 (thick) mm
6	Conical Disc Spring	IS 12511 (Par 2): 2004: Series B, Group 1 De: 22.5 mm Di: 11.2 mm t: 0.8 mm l0: 1.45mm F: 710 N S: 0.49 mm Qty: 12 No.
6	No. of screws	M6 screws (Qty. 12no.)
7	Mounting & Interface Provisions	• Provide support to missile rear lug
8	Limit Switches	Honeywell 25EN9-6 , Qty – 4 No.

2.3.8 Umbilical Locking Mechanism

Provision for mounting of umbilical retraction mechanism has to be provided as shown in Figure 27Figure 28below. This interface in the form of opening, support and mounting point is to provided for the umbilical retraction mechanism base as per the requirement projected by the project. The umbilical retraction mechanism is shown in Figure 28

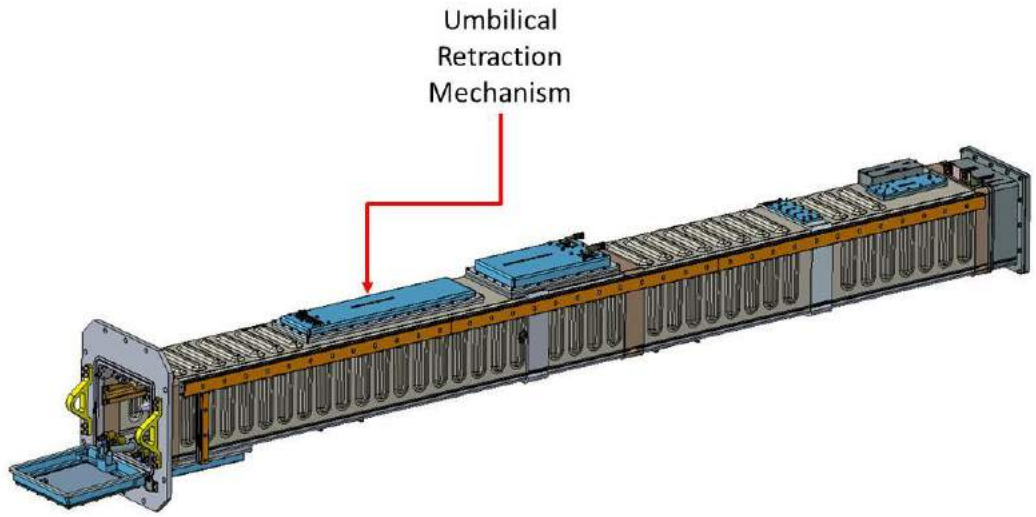


Figure 26 Canister Assembly - Location of Umbilical Retraction Mechanism

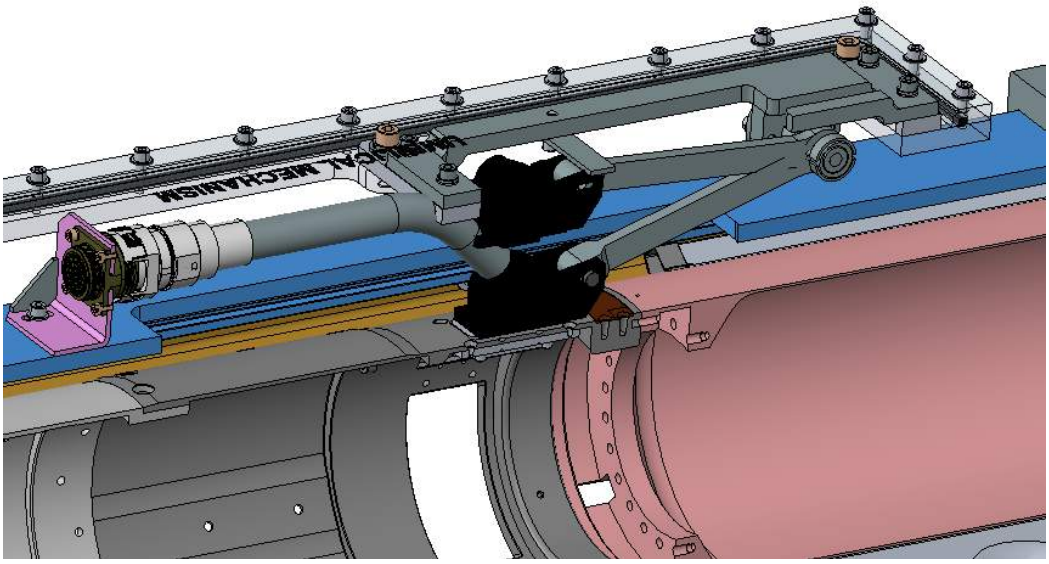


Figure 27 Umbilical Retraction Mechanism

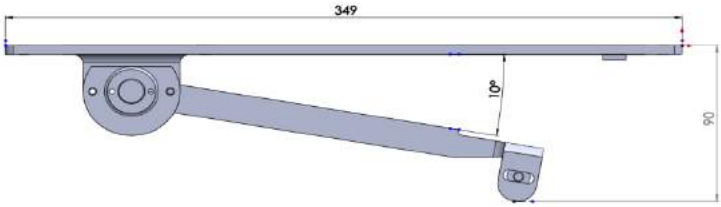


Figure 28 Umbilical Retraction mechanism - provision for 10deg twist

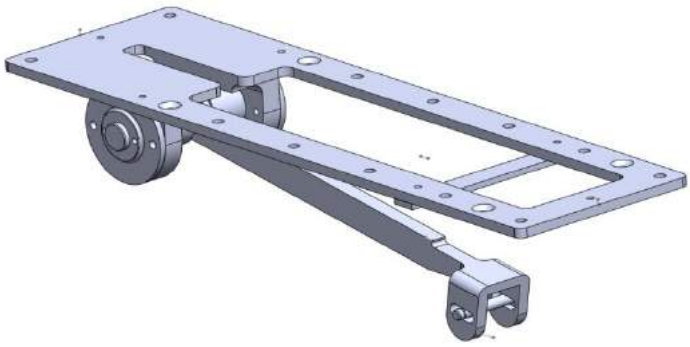


Figure 29 Umbilical Retraction mechanism Assembly

2.3.9 Rear Rupture Disc

The rupture disc encloses the rear opening of the canister. This rupture disc opens in the form of four petals due to impingement of missile thrust. A metallic cover protects the rupture disc during transportation. This cover is removed before loading of the canister inside VLU.

This rupture disc provides sealed closure to pressurized canister from rear side during storage and transport of canister. The location of the rupture disc on canister is shown in the figure below,

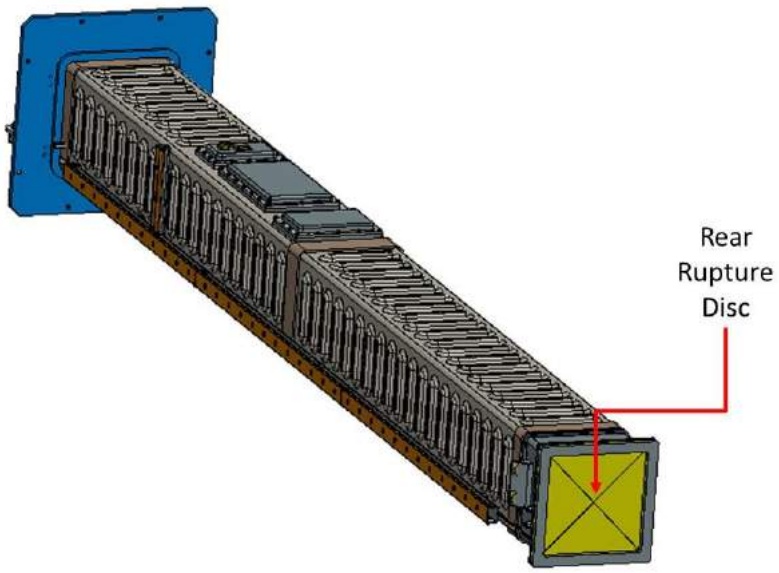


Figure 30 Rupture Disc Location on Canister (view 1)

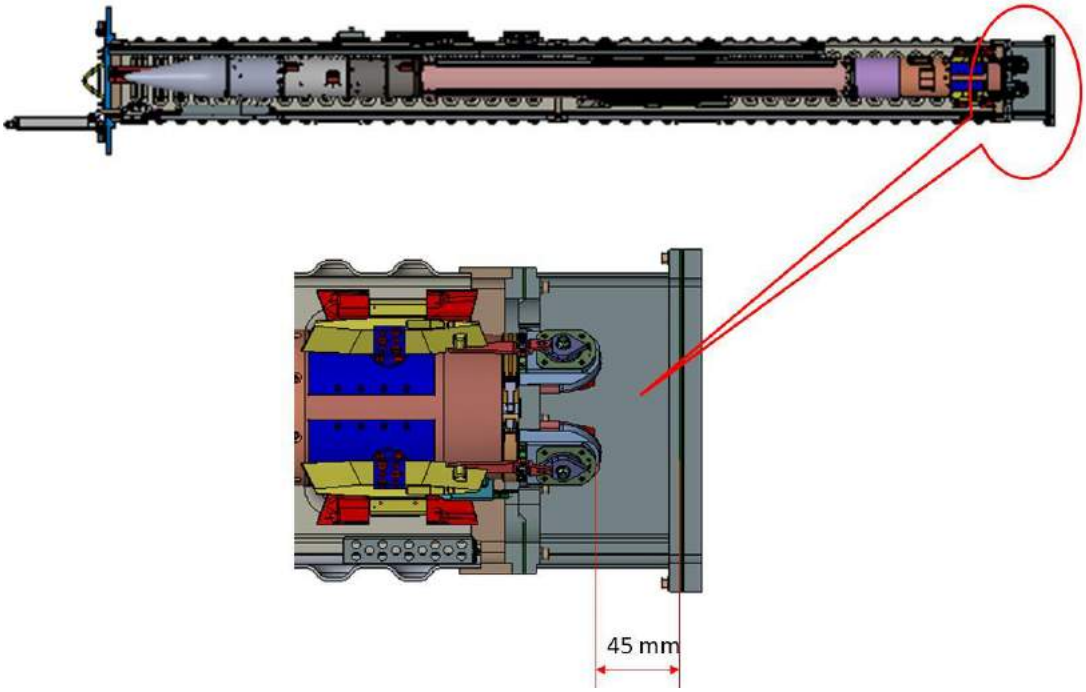


Figure 31 Rupture Disc Location on Canister (view 2)

Objective of Rupture Disc is to enable desired bursting of the disc in the form of four petals under the impact of plume pressure and providing passage for plume from rear side of canister. The rupture disc is AA 19000 sheet of 1.5mm thickness. There are cross grooves provided on the rupture disc to enable to open it in the form of four petals. The groove depth is within the range of 1.00 to 1.3 mm. The grooves are shown in the figure below,

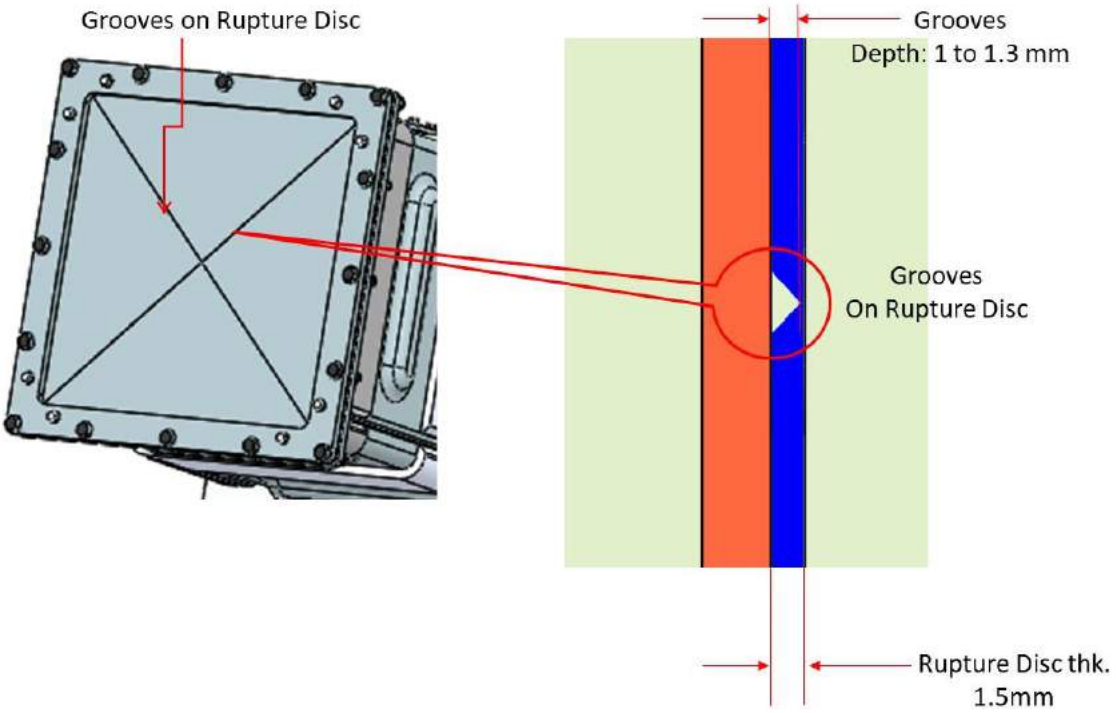


Figure 32 Rupture Disc Configuration

Table 7 Technical Specifications of Rear Rupture Disc

S. No.	Item	Technical Specification
1.	**Rupture Disc**	Material: AA 19000 Dimensions: 390 mm x 390 mm Thickness: 1.5 mm Notch depth: 1 to 1.3 mm Burst Pressure : 0.6 to 0.7 bar Quantity – 1 No. per canister O ring at the interface between canister flange and rupture disc Rupture disc to be coated with glass fibre/heat resistive cover (this cover shall open in the form of petal along with rupture disc) Suitable protective cover to be provided during transportation

2.3.10 TVC Support Plate

This plate is used to take the load of the TVC in case of accidental detachment of TVC from missile body in case of failure of pyro bolt holding the TVC. There is gap of 0.5 mm between the TVC and the resting plate of the TVC support structure. During failure 110 kg load will be acting on to the TVC support structure.

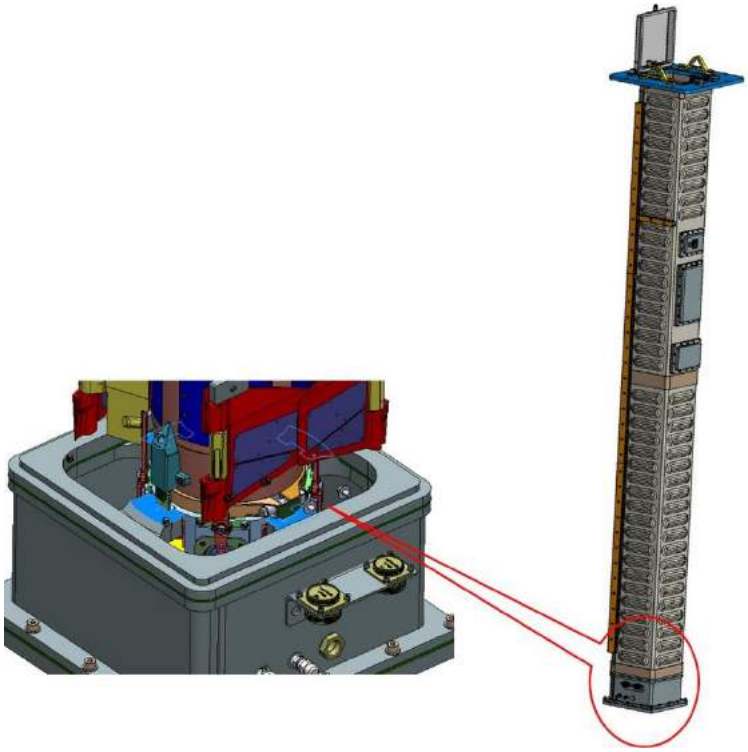


***Figure 33 TVC Support* Structure**

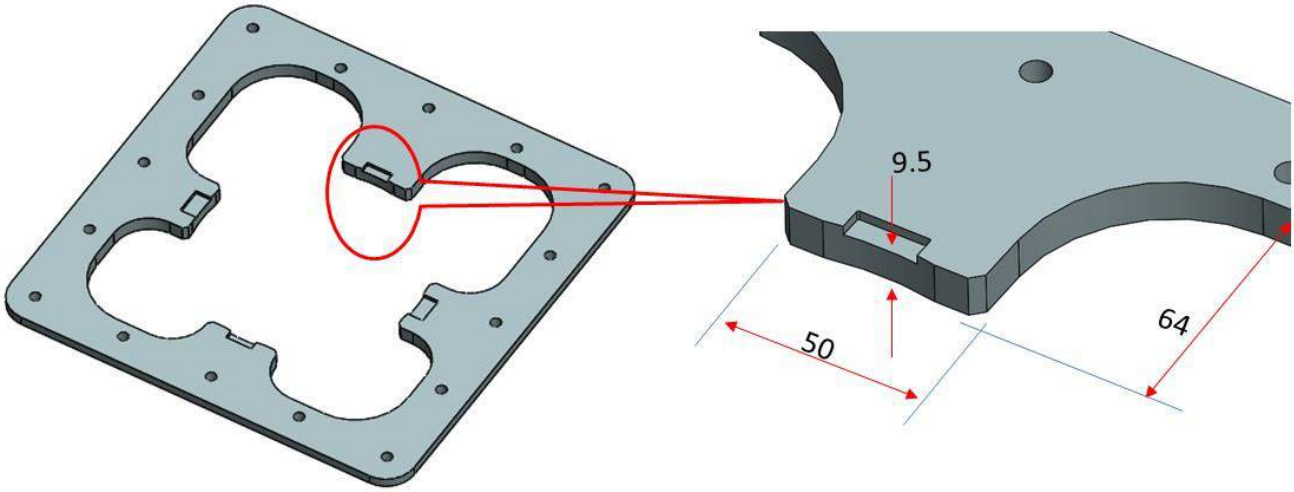


Figure 34 TVC Support Plate

Table 8 Technical Specifications of TVC Support Plate

S. No.	Item	Technical Specification
1.	**TVC Support Plate**	Material: AA 6061 T6 Outer Dimensions: 349 mm x 349 mm Thickness: 12.5 mm Four internal support points for TVC: 50x12.5 mm (9.5 mm at the resting point) Quantity – 1 No. per canister O ring at the interface between canister flange and TVC support Plate

2.3.11 Canister Lifting Brackets

The canister lifting brackets are used to lift the canisters vertically. These are used for loading of canister into the VLU in vertical direction. The lifting brackets are shown in the figure below,

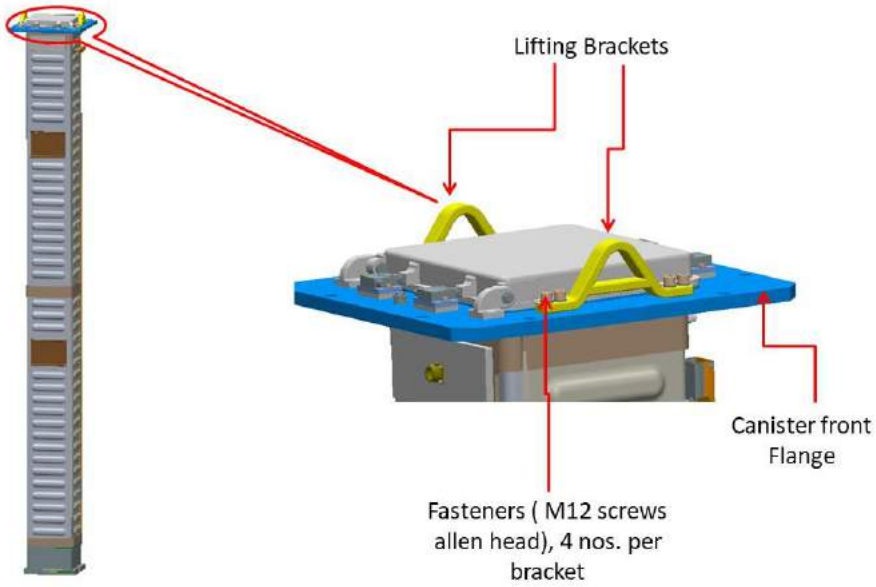


Figure 35 Canister Lifting Brackets

There are two lifting brackets provided per canister. Each lifting bracket is fastened to the canister front flange using M 12 allen headed screws of propert class 12.9.

Table 9 Technical Specifications of Canister Lifting Brackets

S. No.	Item	Technical Specification
1.	**Canister Lifting Bracket**	Material: AA 6061 T6 Cross section : 30 x 15 mm Qty. 2 no. per canister Fasteners: M12 (property class 12.9), Qty. 4 no per bracket

2.3.12 Canister Stacking Frame

The removable stacking frame will be used for storage and transportation of canister in horizontal condition. During storage atleast four no. of canister will be stacked one above the other and during transportation two no. of canister will be stacked. The stacking frames will be made of a suitable wooden blocks. Suitable foam shall be used between the wooden frame and canister to prevent scratches and dents on the canister body.

At the base of the canister plates are provided where the wooden stacking frames will be attached with the canister as shown in figure below,

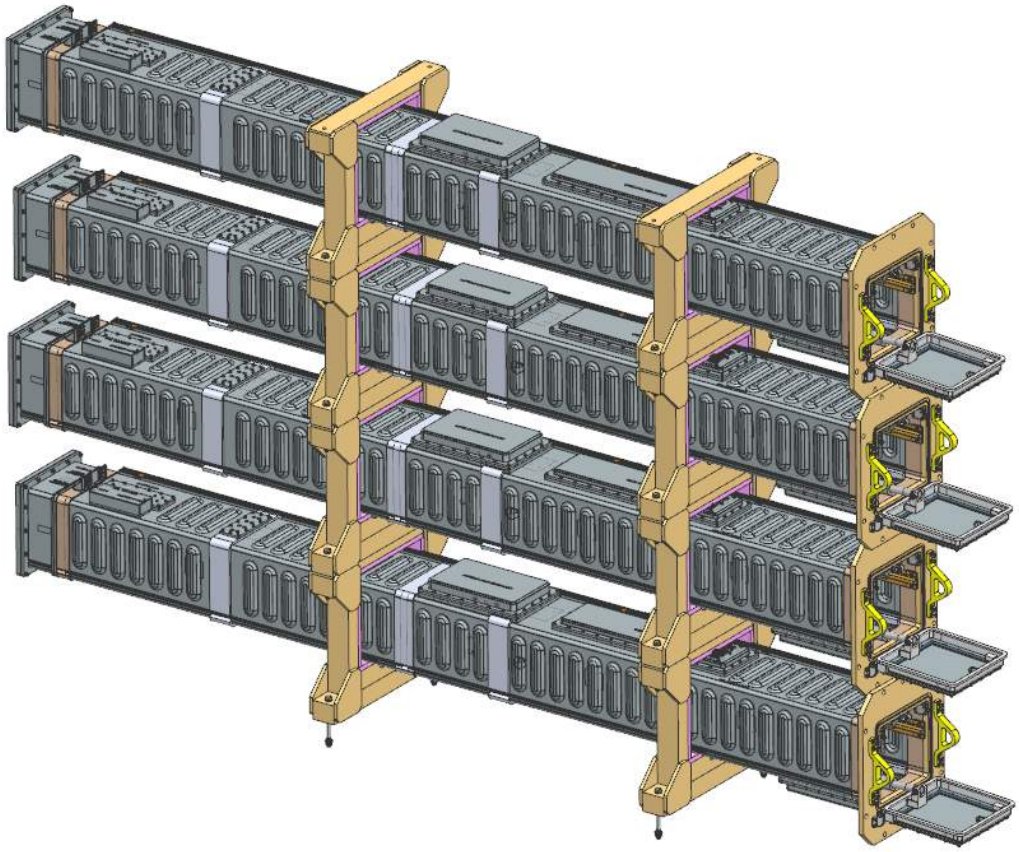


Figure 36 Canister Stacking Frame

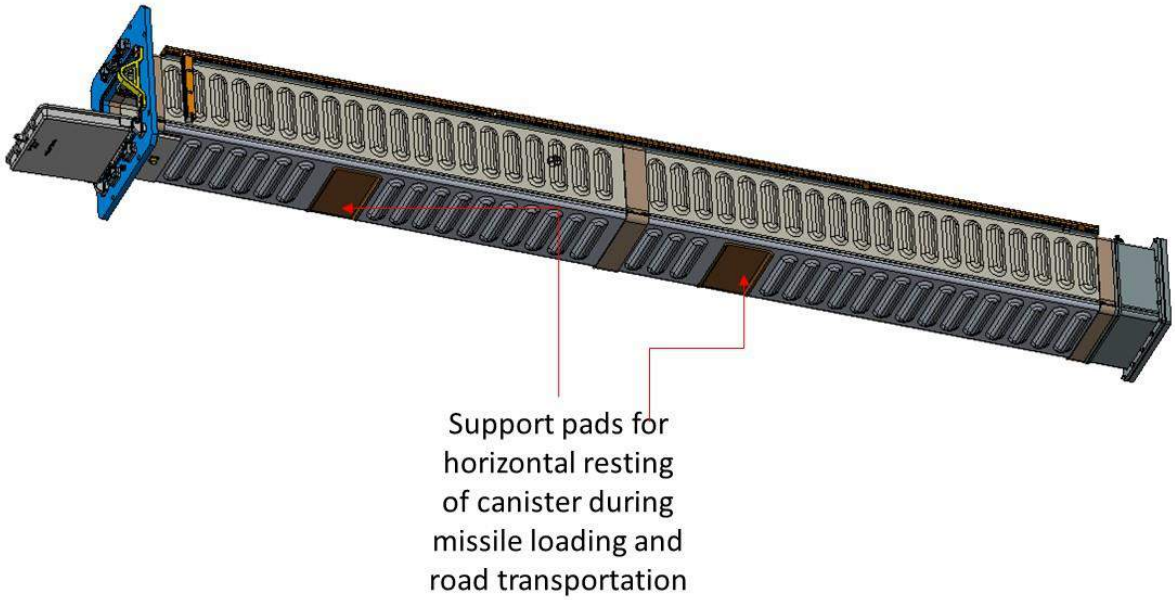


Figure 37 Canister Resting Plates

The same stacking frames can be used for horizontal lifting of canister as shown in the figure below

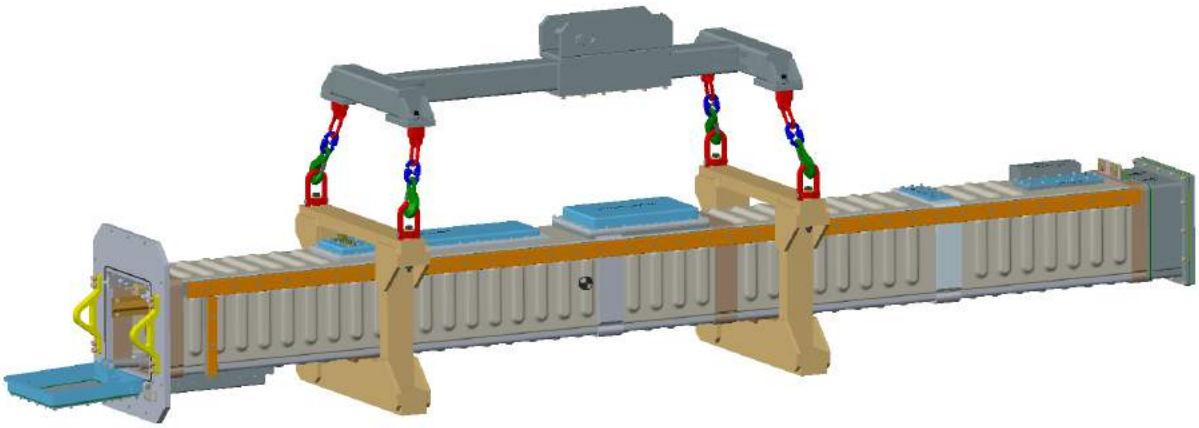


Figure 38 Horizontal Handling of Canister

2.3.13 Other Accessories

It includes following items for each canister:

Table 10 **Other Accessories**

S.No.	Item Description	Make & Model	Oty
1.	NON RETURN VALVE (NRV)	STAUFF or equivalent	1 no.

		Model no. SKK-20 –G1/4-B-C-W3	
2.	TEST HOSE	STAUFF or equivalent Model: SMS-20/M1/4B-OR-400-A-W3	1 no.
3.	DESICANT	CLARIANT or equivalent Model: DESI PAK-4U B006601	2 no.
4.	HUMIDITY INDICATOR PLUG	AGM or equivalent Model: TA284-6789P	1 no.
5.	PRESSURE SWITCH (TBD)	HONNEYWELL or equivalent Model: LP-F-00120-T-T-Y-N-K-BA -A-01	1 no.
6.	PURGING VALVE	PARKER or equivalent Model: 4M-PG4-L-SS	2 no.
7.	LIMIT SWITCHES FOR MISSILE PRESENCE	Honeywell or equivalent	1 no.
8.	PLUME DETECTION SENSOR	WIRE TYPE (TBD)	1 No.
9.	FIELD CABLE with PROPER SHIELDING + Hermatically sealed connectors (Fire retardant cable)	TBD	As required
10.	O-ring for umbilical mechanism cover, article locking mechanism cover, front door, rupture disc, connectors, etc	Parker or equivalent	As required

Note:

i. All sensors/indicators shall be mounted flush with the canister wall; there shall be minimum projections of sensors/indicators from the canister surface.

ii. All connectors chosen shall be hermetically sealed connectors.

iii. All seals shall have shelf life of minimum 10 years and should withstand sea environment

iv. Material for fasteners: High strength Stainless Steel (Property class 12.9)

v. Precautions to be taken for bimetallic corrosion wherever applicable

vi. All limit switches, sensors to be covered by metallic covers.

vii. Proper earthing to be provided for each canister

viii. All subsystems of canister to be labelled by metallic nameplates

ix. Symbol of CG of the canister to be marked (with & without missile)

x. Supply of rugged digital pressure gauge and hose will be in the scope of vendor

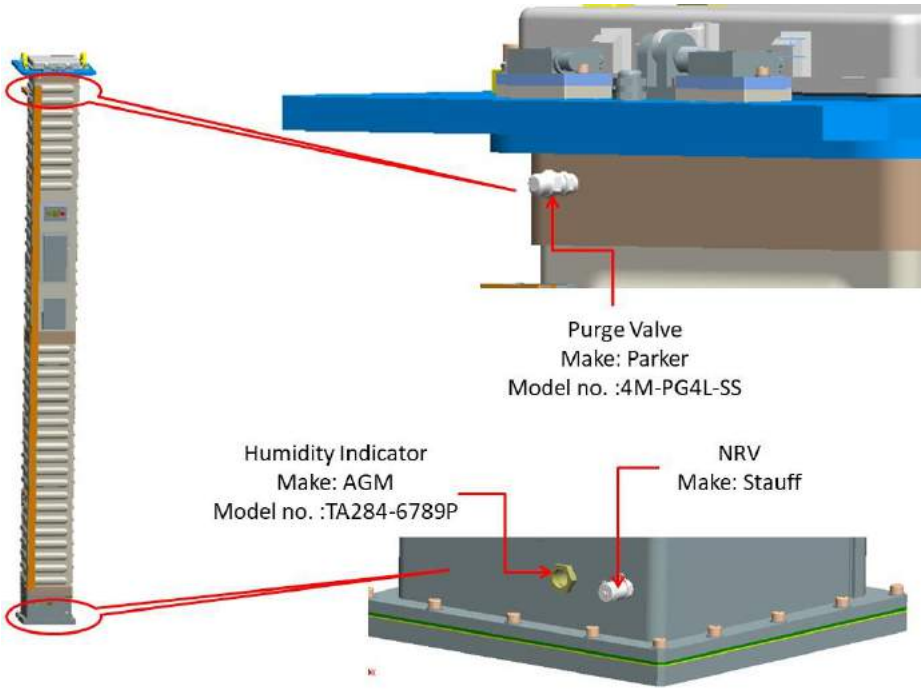


Figure 39 Humidity Indicator, Purge Valve & NRV locations on Canister

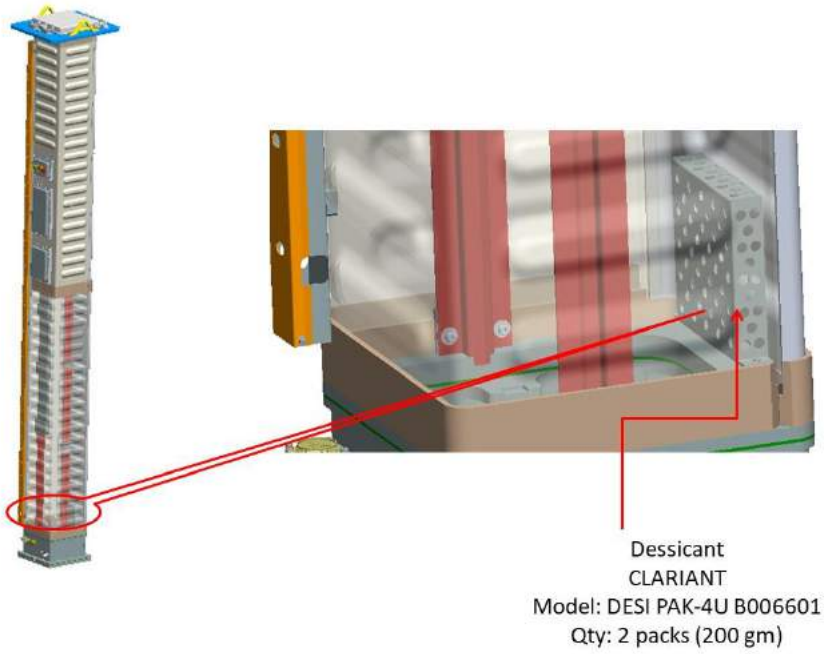


Figure 40 Dessicant

2.3.14 Electronics and Feedback Control System

2.3.14.1 Sensors

The sensors are required to detect various positions of mechanical subsystems and to detect the article plume. For mechanical position Limit Switches will be used.

A combustible wire type sensor will be used for detecting the Missile plume. This sensor comprises of a combustible wire mounted at plume end of canister diagonally. The electrical continuity ensures that the wire is intact. But when the Missile is fired the high temperature generated by plume melts this wire causing the disruption in the electrical circuit indicating the control system that Missile plume has fired.

There will not be a separate sensor provided for sensing canister presence. The electrical mating of the canister I/O connector will indicate that the canister is present

Table 11 List of sensors

Sr. No.	Purpose	Sensor Type	Qty	Remarks
1.	Hatch OPEN	Limit Switch (Four Circuit Double Break)	2	2 sensors will be used for series & parallel connection of contacts
2.	Hatch SHUT	Limit Switch (Four Circuit Double Break)	2	
3.	Missile LOCK	Limit Switch (Four Circuit Double Break)	2	

4.	Missile UNLOCK	Limit Switch (Four Circuit Double Break)	2	
5.	Missile Presence	Limit Switch (Four Circuit Double Break)	2	
6.	Plume Detection	Combustible wire type	1	
7.	Canister Presence	Connector Loop Back	1	Two contacts on I/O Connectors will be used for loop back
8.	Humidity Indicator	Humidity sensitive Chemical	1	Humidity Indicator Plug No Electrical interface

The limit switch has been selected as sensors for sensing end limits and giving a feedback of extremities for implementing system safety interlocking and sequencing scheme. The Limit switches will be used for Hatch OPEN/SHUT, Missile LOCK/UNLOCK and Missile Presence. The major criterion for selection of limit switches are as follows:

(a) Compact size MIL-grade COTs item

(b) Environmentally sealed contacts

(c) High MTBF

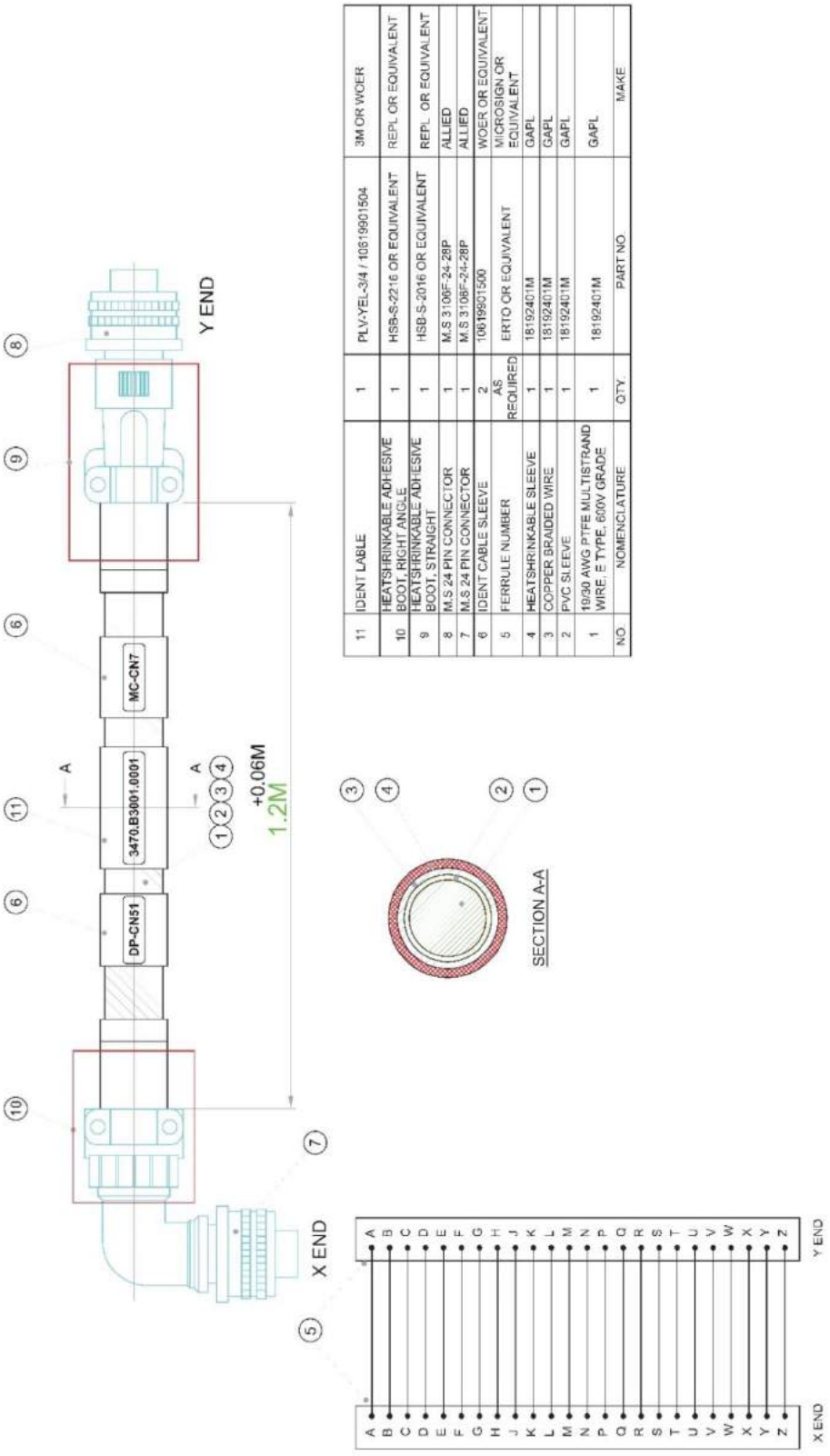
Table 12 Technical Specification of Limit Switch

Sr. No.	**Specification**	
1.	Image	
2.	Make	Honeywell
3.	Model	EN Series
4.	Voltage	9~36VDC
5.	Switching options	SPDT, snap action contacts (1NC/1NO)
6.	Mechanical life	up to 10 million (up to 5 million for wobbles)
7.	Operating temperature	-54 ℃ to 125 ℃
8.	Vibration	10 g

9.	Shock	100 g
10.	Protection	IP 67

2.3.14.2 Cables & Harness:

The cabling layout / routing will be simple and easy to identify and trace. Power signals and sensor signals will be routed separately. Proper care to shield and isolate signals from power signals will be maintained. Cabling will be done using proper color codes for signals in addition to ferrules for easy maintenance and identification. Cabling scheme will be designed in such a way that input / outputs can be isolated for fault finding. All cable/harness shall be designed as per MIL specifications to withstand JSS-55555 environmental specifications. A sample cable design is shown in fig 41



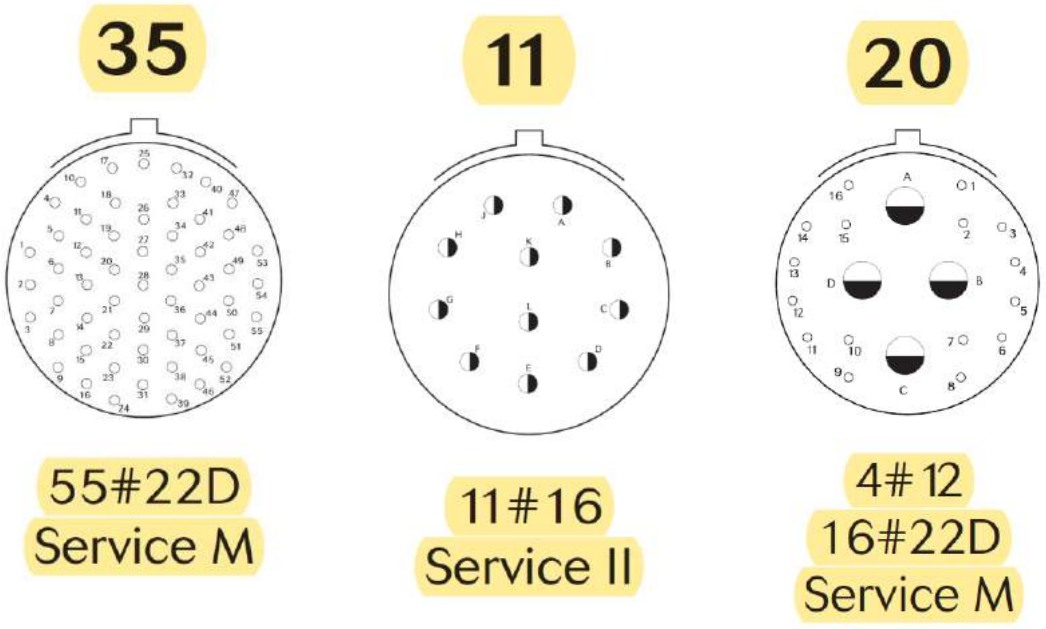
NO.	NOMENCLATURE	QTY	PART NO	MAKE
11	IDENT LABLE	1	PLY-YEL-3/4 / 10619901504	3M OR WOER
10	HEATSHRINKABLE ADHESIVE BOOT, RIGHT ANGLE	1	HSB-S-2216 OR EQUIVALENT	REPL OR EQUIVALENT
9	HEATSHRINKABLE ADHESIVE BOOT, STRAIGHT	1	HSB-S-2016 OR EQUIVALENT	REPL OR EQUIVALENT
8	M.S 24 PIN CONNECTOR	1	M.S 3106F-24-28P	ALLIED
7	M.S 24 PIN CONNECTOR	1	M.S 3106F-24-28P	ALLIED
6	IDENT CABLE SLEEVE	2	10619901500	WOER OR EQUIVALENT
5	FERRULE NUMBER	AS REQUIRED	ERTO OR EQUIVALENT	MICROSIGN OR EQUIVALENT
4	HEATSHRINKABLE SLEEVE	1	18192401M	GAPL
3	COPPER BRAIDED WIRE	1	18192401M	GAPL
2	PVC SLEEVE	1	18192401M	GAPL
1	19/30 AWG PTFE MULTISTRAND WIRE, E TYPE, 600V GRADE	1	18192401M	GAPL

Figure 41 Harness Design

2.3.14.3 Connectors

MIL Spec D38999 Series Hermetically Sealed or Equivalent type of connectors will be used in the system. Male connectors shall be mounted on the Canister body and female connectors shall be used for cables coming from Launcher Control system. if Male connector is mounted on cable there is a change of short circuit between male pins as they are directly exposed. Selection of same shell size connectors used on any one junction box will be chosen with Key feature such a way that interchange of connectors will not be possible in any way.

There will be two I/O connectors will be mounted on a mounting plate on one side of canister. Out of these two I/O connectors one will be dedicated for sensor connection and other will be used for pyros. The Sensor connector (17/E Shell Size) will have 55 Nos. of 22AWG contact ratings for interfacing limit switches, plume sensor etc. The Pyro connector (19/F Shell Size) will have 11 Nos of 16 AWG contacts for interfacing Pyros. The pyro and limit switches related to missile lock and unlock are located inside a separate space with a cover. Hence a separate connector is required to be placed on this cover. This connector (17 Shell Size) will have 16 Nos. of 22AWG contact ratings for interfacing limit switches and 4 Nos of 12 AWG contacts for interfacing Pyros. Both connector layout are shown in Fig 42 below:



(a) **(b)** **(c)**

Figure 42 MIL 38999 Connectors (a) Sensor Connector (b) Pyro Connector (c) Missile Lock / Unlock Connector

2.3.14.4 Terminal Connection Diagrams (TCD)

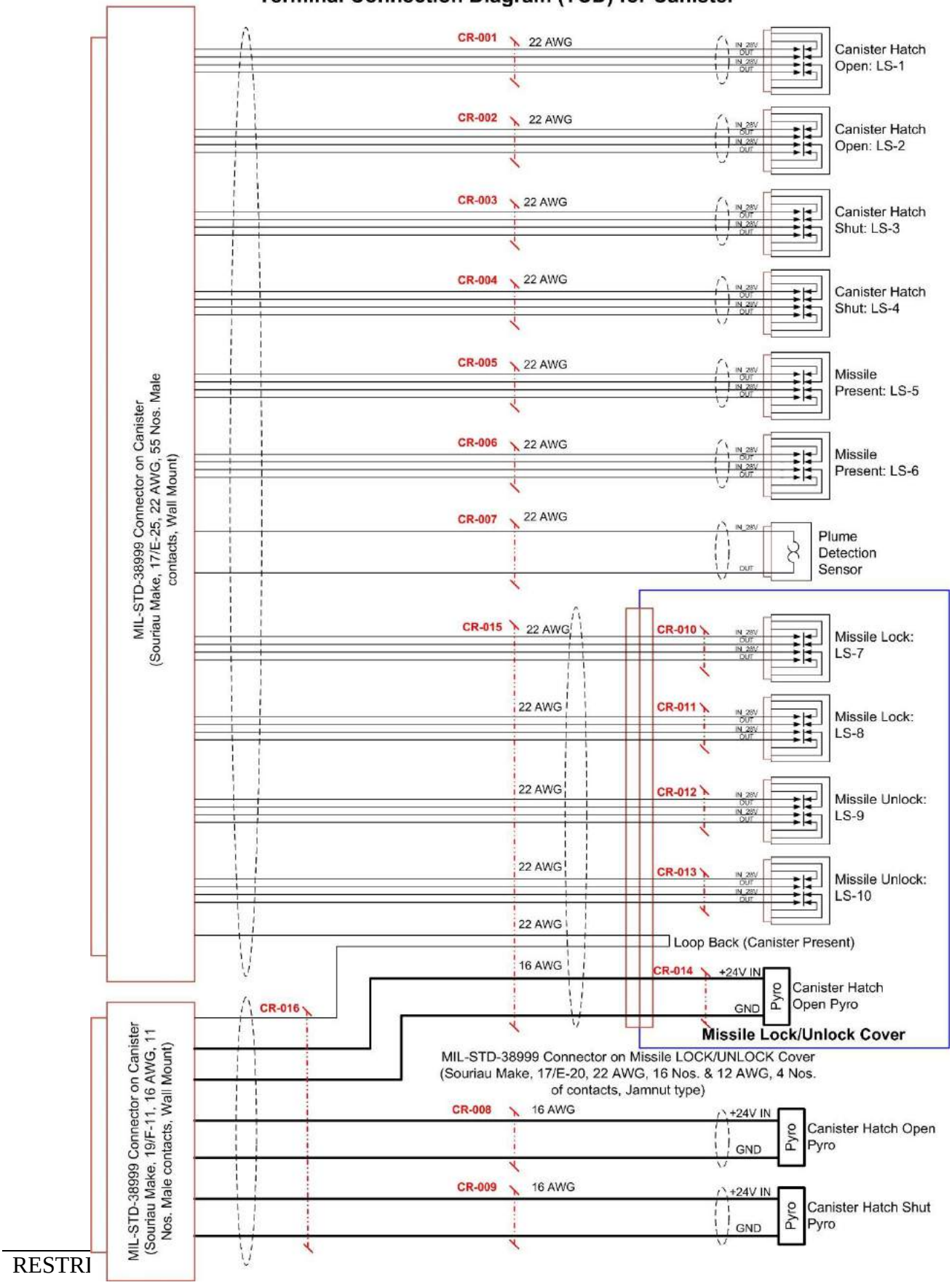
The Terminal Connection Diagrams (TCDs) will be prepared in two formats. The AutoCAD TCD will be in the form of diagrams which will clearly indicate source, destination, type of connector, type of cable and core details with signal names etc. The other format shall be in excel as shown in Table below.

Table 13 TCD Excel Format

	Cable Route:	CR-001		
	Type:	PTFE/Zero Hal/ Radiation		
	Part no:			
	Type of cores:	Single/Twisted, 12AWG (3.1)		
	No of Cores			
	Source of Manufacturer			
	Purpose			
	Cable OD			
	Cable Resistance			
	Bending Radius			
	Length:	5		
Core No. / Colour	**Unit From (xxx)**	**Unit To (yyy)**	**Signal Mnemonic**	**Remarks**
	Connector Patt. No. on Equipment (4615 012 059 27 D38999/24WE06SN)	**Connector Patt. No. on Equipment** **(**4615 012 060 24 D38999/24WE06PN		
	Connector Patt. No. on Cable (4615 010 059 13 D38999/26WE06PN)	**Connector Patt. No. on Cable** **(**4615 010 060 10 D38999/26WE06SN)		
	Connector name on Equipment (J9)	**Connector name on Equipment** (J10)		
1	Pin No. A	Pin No. A	F1R220	220V ACOS
2	Pin No. B	Pin No. B	F1Y220	
3	Pin No. C	Pin No. C	F1B220	
4	Pin No. D	Pin No. D	SPARE	
5	Pin No. E	Pin No. E	SPARE	
6	Pin No. F	Pin No. F	SPARE	
CSHLD	BKSHL ADPTR	BKSHL ADPTR	SHIELD	

The Terminal Connection drawings showing the Electrical connectivity of canister sensor and actuator, connector Type, cable details etc. is shown in Fig 43

Terminal Connection Diagram (TCD) for Canister



2.3.15 Painting Scheme

Refer Annexure B

The contractor shall prepare a painting sequence of operation/paint inspection plan and get it duly approved from R&DE (E).

SECTION III

LIST OF DELIVERABLES

1.1. List of Deliverables

The scope of work is for Manufacturing, Integration, Testing and Supply of Canister Assembly (6 nos.) as per drawing no. VLSM610000 00 0 consisting of following items:

Sr. No.	Deliverable Items	Quantity per set	Remarks
1	Canister Structural System	01 No.	
2	Front Door opening/closing and locking mechanism	01 No.	
3	Umbilical Locking Mechanism	01 No.	
4	Article Lug Locking Mechanism	01 No.	
5	Rear Stopper Mechanism	01 No.	
6	Rear Rupture Disc	01 No.	
7	TVC Support plate	01 No.	
8	Shear Pin	100 Nos.	
9	Shear Pin Test Setup	01 No.	
8	Slings for lifting	1 set	4 slings with end connectors
9	Canister Pressurization set (Minimum 2 nos,15m long) Commercial grade Nitrogen cylinder – 1 no,99.99% purity of N2) cylinder opening key – 1 no, end connectors, clamping brackets or frame for cylinder, hardware etc.)	1 Set	One set for 16 canisters mounted in two VLUs
10	Trolley for loading/unloading of Missile	1 No	
11	Lifting Beam	2 No.	

3.2 List of Deliverable Documents
(Documents be supplied along with the System)

Sr. No.	Description of Document	Quantity		Remark
		Hard Copy	Compact Disc's	
1.	Manufacturing Drawings of all sub- systems	1 Set	1 Set	On AutoCAD with R&DE(E) template
2	All layouts prepared at all stages & As Built Drawings	1Set	1 Set	On AutoCAD in R&DE(E)template

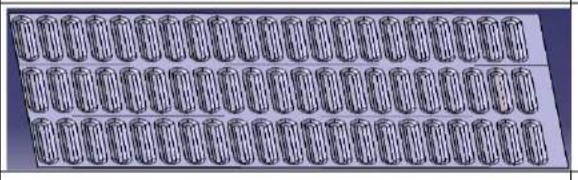
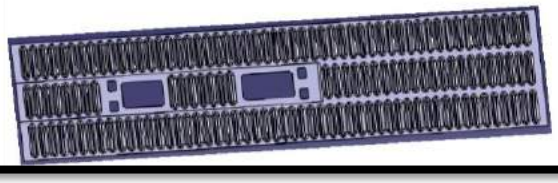
3	Editable 3D Solid Model	-	1 Set	Compatible with Solid works
4	All inspection reports pertaining to stage and final inspection with all internal inspection reports, manufacturer's certificates wherever applicable, including material test certificate/ reports in the form of document, heat treatment reports, welding inspection reports, emboss thinning reports, dye penetrate reports for emboss and bends in sheet	1 Set	-	
5	Test Certificates of all Bought Out Materials , including all Consumables:- welding electrodes/ wires, shielding gases, paints, FOL etc.	1 Set	-	
6	Process sheets & Process Plan	1 Set	1 Set (in editable word format)	
7	Quality Assurance Plan	1 Set	1 Set	
8	Calibration reports of all equipments & Instruments used	1 Set	-	
9	Welder Qualification Records including WPS,PQR, WPQ/ WPQR, Weld test reports,(Destructive & Non-destructive)	1 Set	-	
10	Acceptance Test Plan	1 Set	1 Set	

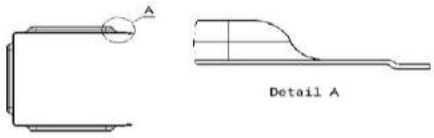
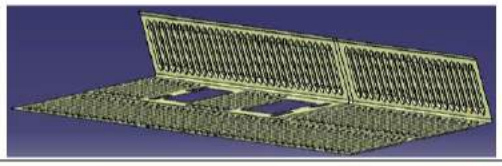
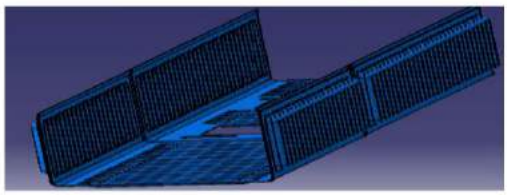
SECTION IV
Guidelines for Manufacturing of Canister

The aim of this design process is to design and develop a manufacturing process by which following tasks can be achieved.

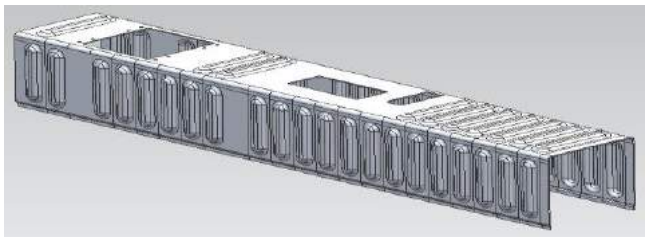
1. Simplification in the process of manufacturing
2. Reduction in welding requirements
3. Reduced weld distortions during fabrication of the structure
4. Meet all the functional requirements
5. Maintaining the geometrical tolerances

The stages of manufacturing process (indicative for reference only) are explained below:

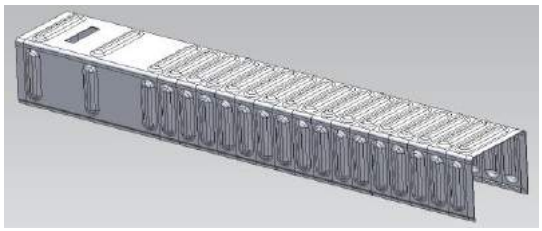
Sr No.	Part Image	Process	Machine	Tool
1.		Cut to Rect. Blank	Shearing	
2.		 Emboss	Ton Press	Emboss Die
3.		Trim Edges	Shearing	

Sr No.	Part Image	Process	Machine	Tool
4.		Joggle	Ton Press	Joggle Die
5.		Bend 1	Press Break	R10 Bending Punch
6.		Bend 2	Press Break	R10 Bending Punch

7. Front and Rear Outer Shell Top Portion:



Front Outer Shell top

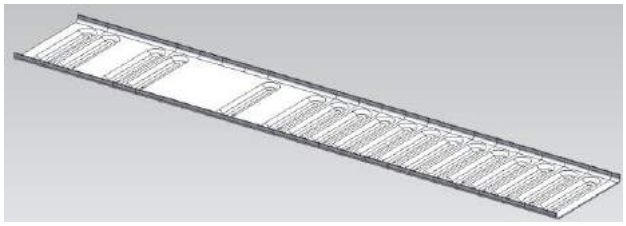


Rear Outer Shell top

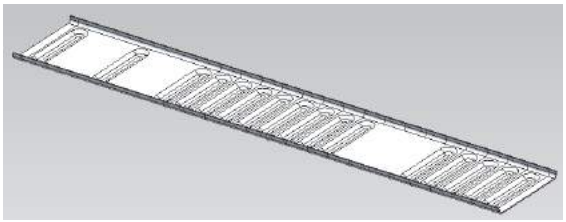
Part Description	Operation Sequence	Tool required	Machine required	Remarks
Front & Rear Outer Shell Top	1) Shear to strip		Shearing m/c	
	2) Shear to blank	-	Shearing m/c	
	3) Embossing & Joggle	Embosing & Joggle tool	800T Press m/c	Out source
	4) Water Jet cutting	-	Water Jet cutting m/c	Out source
	5) Bending	Bending tool	CNC Bending m/c	Out source

	6) Deburring	-	-	
	7) Final Inspection	-	CMM	

1. Front and Rear Outer Shell Base Portion:



Front Outer Shell base



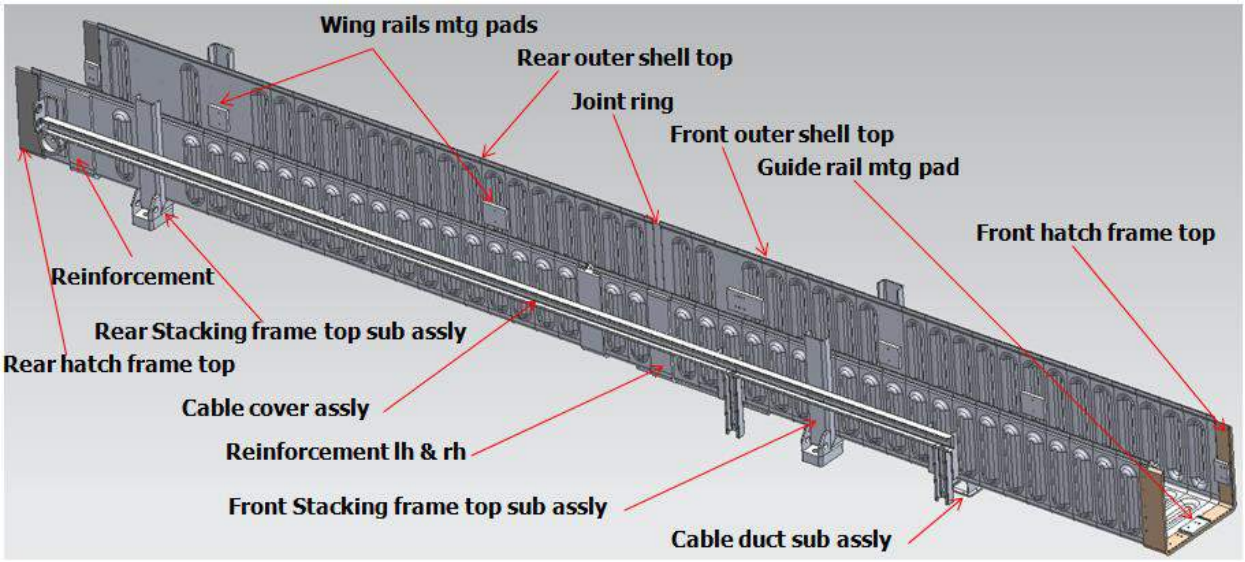
Rear Outer Shell base

Part Description	**Operation Sequence**	**Tool required**	**Machine required**	**Remarks**
Front & Rear Outer Shell Base	1) Shear to strip	-	Shearing m/c	
	2) Shear to blank	-	Shearing m/c	
	3) Embossing	Embossing tool	800T Press m/c	Out source
	4) Water Jet cutting	-	Water Jet cutting m/c	Out source
	5) Bending	Bending tool	CNC Bending m/c	Out source
	6) Deburring	-	-	
	7) Final Inspection	-	CMM	

2. Front and Rear Outer Shell Top Assembly:

Assembly of:

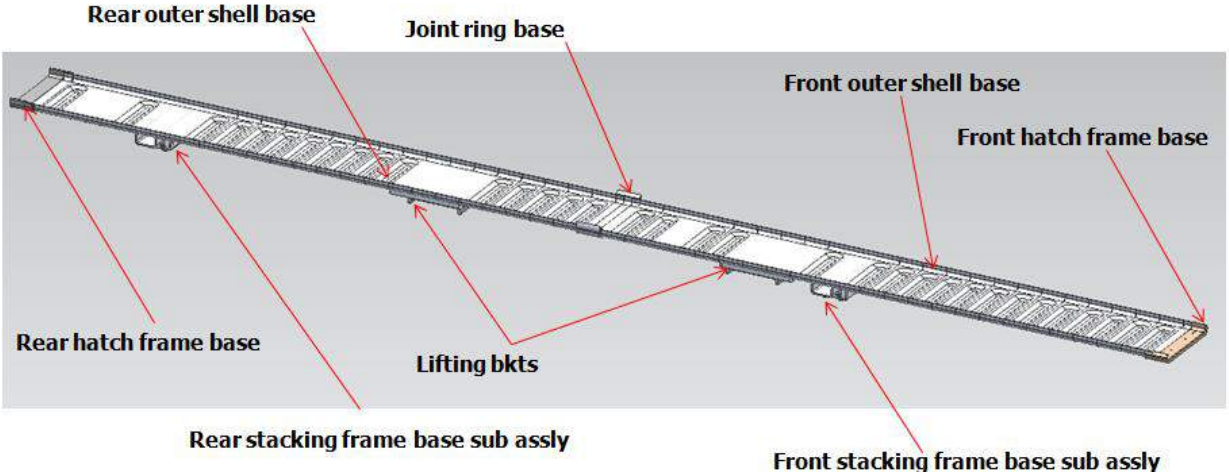
Front & Rear outer shell top, Guide & Wing rails mtg pads, Joint ring top, Reinforcement, Reinforcement lh & rh , Outside reinforcement 1 & 2, Pyro bolt unit mtg pads, Front & Rear hatch frame top, Plug holder, front & rear stacking frame top sub assly, Cable duct sub assly & Cable cover assly TIG welding (100% Argon) - Tack & Full welding



3. Front and Rear Outer Shell Base Assembly:

Assembly of:

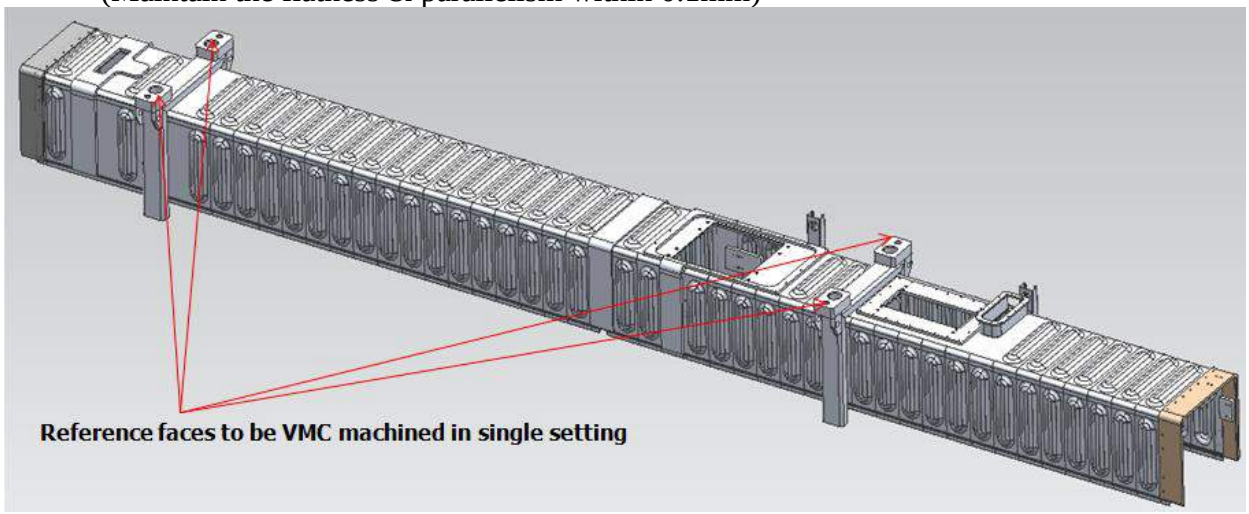
Front & Rear outer shell base, Joint ring base, Lifting bkts, Front & Rear hatch frame base and front & rear stacking frame base sub assly TIG welding (100% Argon) - Tack & Full welding



4. Front and Rear Outer Shell Top Sub Assembly Machining Stage 1 :

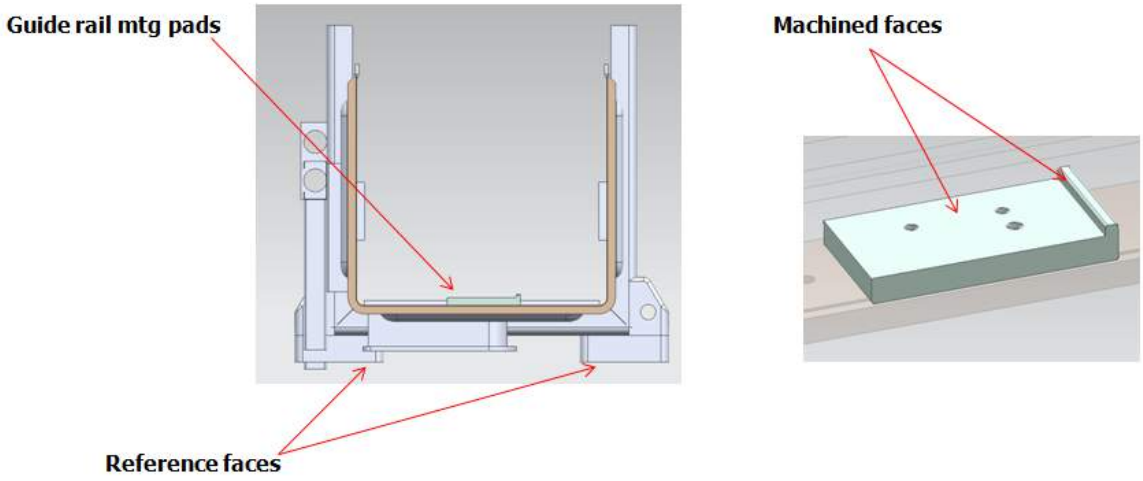
Front & rear stacking frame top sub assly pads reference faces to be machined in single setting by locating the inside profile of outer shell.

(Maintain the flatness & parallelism within 0.1mm)



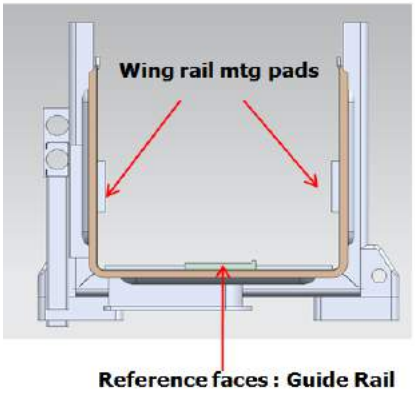
5. Front & Rear Outer Shell top sub assly machining stage-2:

   Guide rail mtg pads machining in single setting by resting the reference faces.
   Maintain the flatness & parallelism within 0.1mm

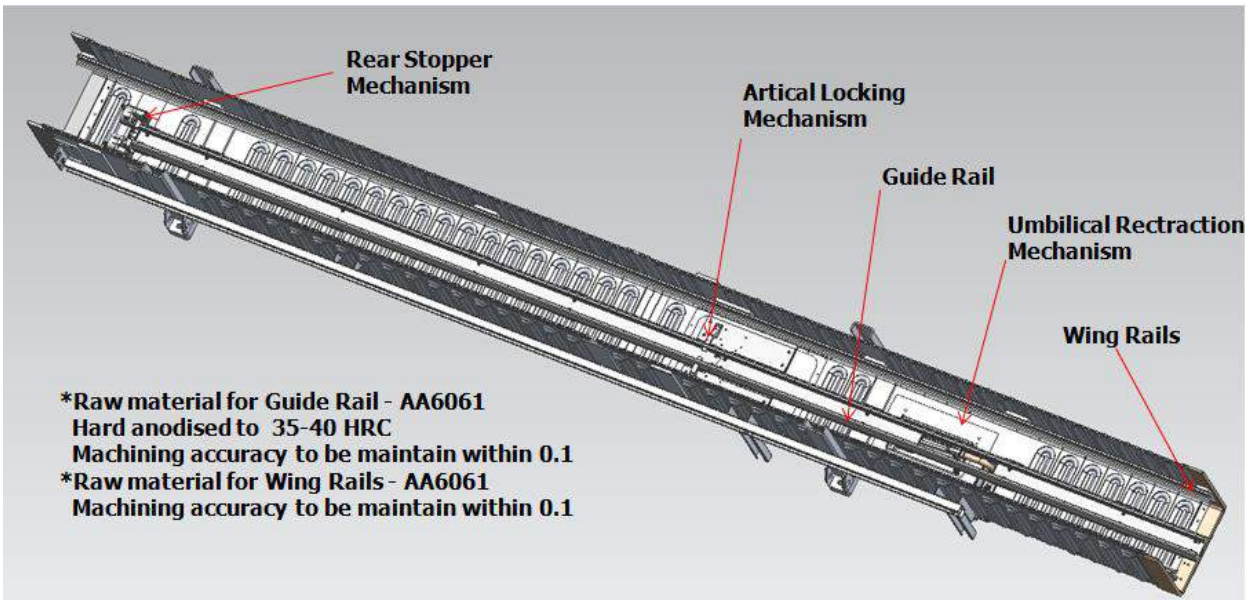


6. Front & Rear Outer Shell top sub assly machining stage-3:

   Wing rail mtg pads machining in single setting with ref to guide rail by resting the reference faces.
   Maintain the flatness & perpendicularity within 0.1mm

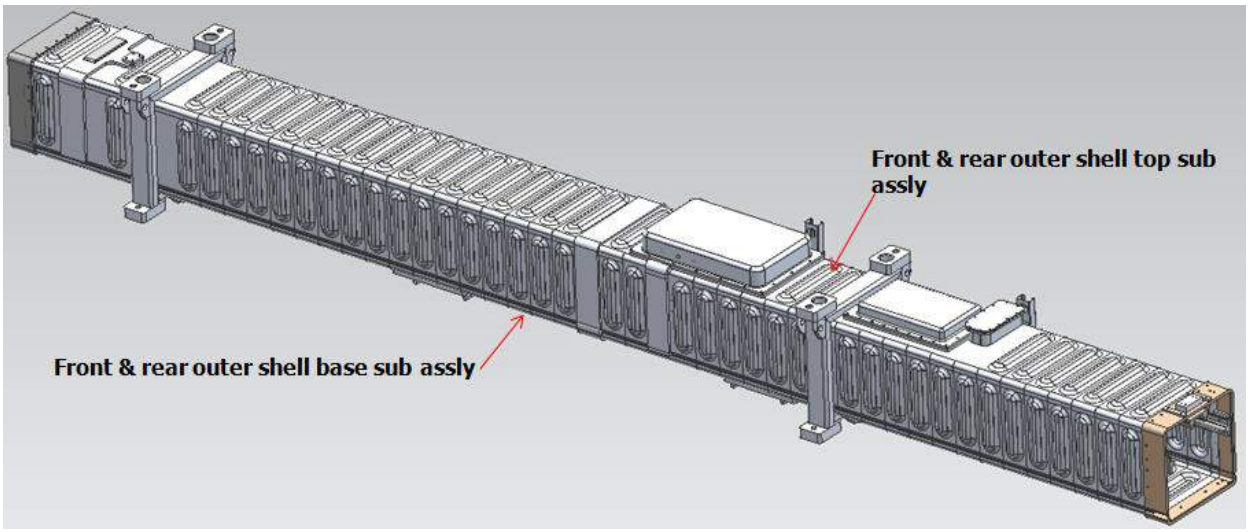


7. Guide rail , Article Locking Mechanism , Rear Stopper Mechanism , Umbilical Retraction Mechanism , Wing Rails fitting:

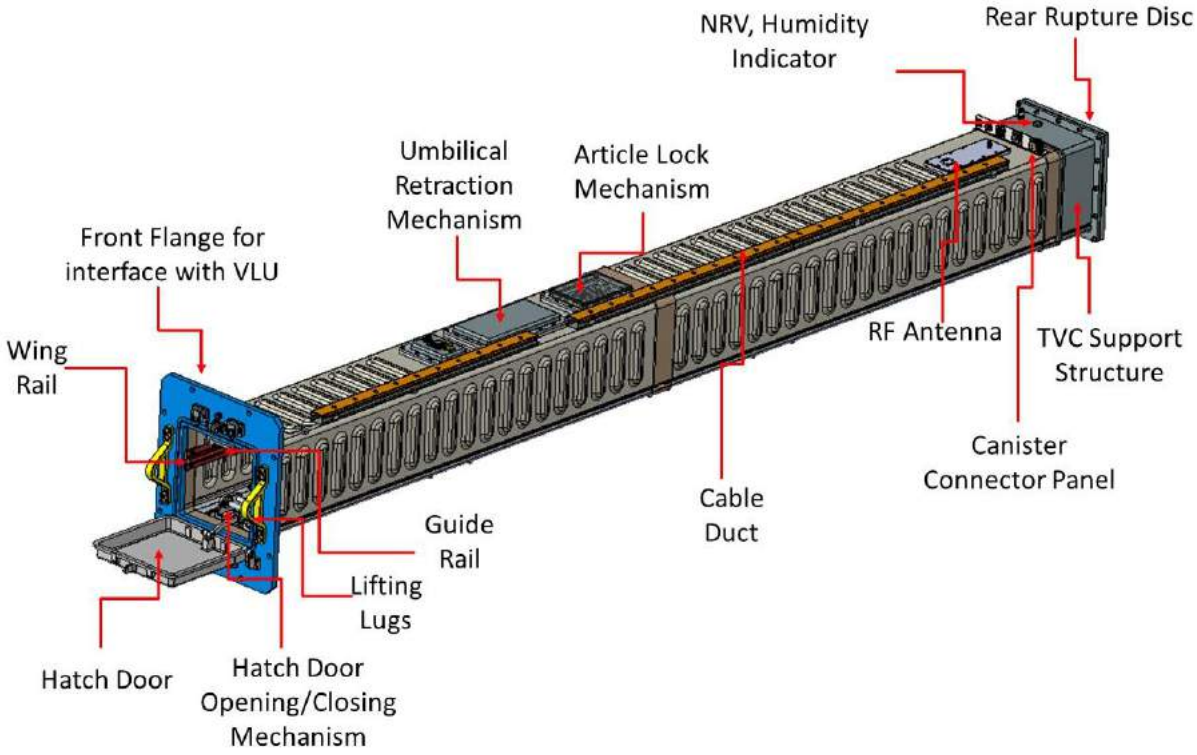


8. Front & Rear Outer Shell top & base sub assly TIG welding :

Front & Rear Outer Shell top & base sub assly. TIG welding (100% Argon) - Tag & Full welding



9. Final Assembly: All Mechanism, Fitment, Seals and Missile Loading



(The above mentioned manufacturing plan is for reference only)

The contractor shall use efficient welding techniques for Aluminum AA 5083 welding.

Welding Rod for AA 5083 (as per ASTM standard) - 5183 shall be used.

100 % Argon gas shall be used to prevent oxidation during welding

The contractor shall use proper welding fixtures to avoid the welding distortion.

SECTION V
MANUFACTURE, WORKMANSHIP AND PAINTING

5.1. LAYING OUT, MARKING, IDENTIFICATION AND PREPARATORY OPERATIONS:

5.1.1. All steel, aluminum plates & other sections shall be cleaned by using wire brush or by sand blasting to remove rust, paint, chalk, graphite and other contaminants used for marking before welding. For identification & verification of the material, the contractor shall put the transfer of stamps once the marking on material is done for cutting or machining. Stamps shall be marked such way that they are available & visible on each component or part. All the material used for particular component / subassembly shall be traceable to the material certificate. Stamp transfer shall be carried out & the record of the same shall be kept in the form of cutting diagrams. The transfer of stamping activity shall be carried out in presence of "Inspecting Authority"

5.1.2. STRAIGHTENING

5.1.2.1. All cleaned and prepared plates shall be welded using proper jigs and fixtures and proper welding sequence to avoid warping. While using welding rods for welding the plates and other sections, both the electrodes and the plates and other sections would be preheated as per the recommendations of the electrode manufacturer.

5.1.2.2. All material used in fabrication shall be straight, unless required to be in curvilinear form. Any further straightening including correction of distortion arising from cutting or machining shall be done as per engineering standard processes / practices & manner so as not to cause any injury and the resulting member shall be free from twist, sharp kinks or bends.

5.1.3. CUTTING

5.1.3.1. Cutting shall be done by machining, shearing or sawing. Band saws and circular saws as per procedure laid down in IS: 800. Shearing or cutting of any part of the material shall be done neatly and accurately. Lubricants of soluble oil types are recommended. Flame cutting and plasma cutting, preferably by mechanically controlled torch, shall be permitted subject to the approval of inspecting authority. The sharp edges shall be clean, square and free from any distortion. All sharp edges, burs & corners likely to cause injury during handling should be removed & suitably rounded off. Sheared edges should normally be subsequently machined to remove edge cracks and shall be filed and finished smooth.

5.1.4. Die Punch and Bending

5.1.4.1. The contractor shall design the die required for punching of the emboss following standard practices. During punching of the embosses the thinning of the sheets should be minimum i.e.; less than 10 to 15 percent of the metal sheet thickness. Accordingly the contractor shall design the die ensuring minimum thinning and there should be no cracks developing near the emboss. Also during bending operation the contractor should ensure there are no cracks developed. The emboss and bending should be checked for thinning and cracks should be checked by dye penetrate test. The contractor shall ensure proper fixturing of the

emboss sheets during welding of sheets and machining. No distortion in the emboss and bending will be accepted.

5.2. FABRICATION

5.2.1. The manufacture of the embossed canister system shall be in strict accordance with the drawings supplied and no deviation is permitted without prior approval of the Inspection.

5.2.2. All workmanship on structure shall be of the order and in accordance with the engineering production standards and practices for ensuring quality of product. Prior approval of inspecting authority shall be obtained, if Non-standard / special process is to be employed by the firm, during die punching/ bending/fabrication. Fabrication of structural and mechanical systems shall be in accordance with the standards referred in this specification.

5.2.3. No dimensions shall be scaled from the drawings. All components shall conform to shape and dimensions shown on the drawings. All sharp edges, burs & corners likely to cause injury during handling should be removed & suitably rounded off. Contractor shall prepare a detailed process planning report indicating the various processes used, time, characters to be checked, method(s) of checking, quantum check, acceptance standard, related records, inspection & witness etc. The same shall be submitted to R&DE (E) for approval before starting the fabrication.

5.2.4. Interchangeability of the components, sub-assemblies/assemblies is the highest priority, which is to be ensured by the manufacturer.

5.2.5. The contractor shall maintain a register showing details of various types of raw material received, raw material expended and balance raw material available.

5.2.6. The contractor shall prepare schedule of materials/cutting schedules of raw materials for various components. Whenever welding is involved, the dimensional details of edge preparation shall be got approved from the inspecting authority.

5.2.7. While handling raw material or embossed panels or fabricated components, care shall be taken to prevent scratching and damage. Wherever required, pieces of wood or other soft material shall be inserted between the contacting surfaces

5.2.8. If raw material is stored in damp conditions where condensation can take place superficial corrosion may cause staining. Since such staining is not desirable, as far as possible all material shall be stored in a dry place, clear off the ground. When temperature and moisture conditions are such that condensation may occur, as far as possible, efforts should be made to store the material in heated and ventilated storage area.

5.2.9. Contact with other metals and materials like cement and damp timber shall be avoided. Plates and sheets shall be stored on edge and not in direct contact with each other.

5.3. WELDING

5.3.1. Welding process incorporated for welding of embossed sheet and frames shall be as per Boiler pressure vessel code ASME section VIII, mandatory Appendix 17 for dimpled or embossed assemblies. The welding control shall also be as per given appendix of BPVC ASME section VIII, and shall include proof testing for procedure and process qualification and workmanship samples.

5.3.2. All aluminium components/parts shall be welded by Tungsten Inert gas (TIG) welding process. Welding should be done in dust and draft free enclosure.

The Contractor shall employ qualified & experienced welders with strict and reliable regime of supervision. Welders and work areas shall be protected from wind, rain etc. Weld consumable shall be subjected to proper calcinations cycle and level of diffusible Hydrogen should be within the permissible limit, as specified in the relevant documents.

5.3.3. Welding Electrodes/ wire:

5.3.3.1. Visual Examination: The filler wires for the TIG welding processes shall have a smooth finish and shall be free from surface imperfections, corrosion product, grease, oxide or other foreign matter which would adversely affect the properties of the weld.

5.3.3.2. Chemical Composition: The filler wire shall also be subjected to analysis for chemical composition. In the chemical composition analysis particular attention shall be given for the proper content of elements and low hydrogen contain. All other elements also shall be as per the specifications within limits. Normal sampling and sealing procedure shall be adopted while drawing the samples for testing and sealing the bulk.

5.3.3.3. Suitable filler rod as per ASTM standard to be used. Weld testing to be done to verify the weld strength, accordingly the welding current to be adjusted.

5.3.4. Approval of welders: Any welder, who is engaged in the welding of aluminum, is required to be approved by the Inspecting Authority based on results of the welders approval tests described in the succeeding paragraphs. Only the approved welders by the Inspecting authorities should be employed on the welding jobs. For the purpose of approval, the welders shall have to qualify the prescribed tests.

5.3.5. Welding Procedure & Qualification Record: The Contractor shall prepare welding procedure specification (WPS) & maintain all procedure qualification records (PQR's) and qualify each welding procedure. These records shall be submitted to the Customer for approval. The Contractor shall carry out "MOCK UP" trials, whenever necessary, so as to validate parameters prior to taking up the actual work.

5.3.6. Welder Qualification: The Contractor shall qualify each welder as per the requirements of the Customer/Or based on approved WPS & PQR in accordance with Customer supplied documents. ASME section IX or AWS specifications may be followed where Customer's documents are not adequate / not supplied.

5.3.6.1. The approved welder shall be properly identifiable by the inspecting authority or his delegated representative at any time during the currency of the order. For this purpose the welder shall always wear an Identification Card bearing his photograph along with his name and his signature. Identification Card shall also be signed and stamped by the Inspecting Authority.

5.3.7. Welding Fixtures: Wherever essential for achieving accurate dimensional requirements and preventing distortion, Contractor shall design and use appropriate welding fixtures.

5.3.8. Weather conditions: Welds should not be made on wet surfaces. During period of high winds, the welding operator and the work should be effectively protected so that there is no direct draft of wind. Simple shields may be used close to the surface to be welded. Precautions shall be taken to avoid condensation in the inert gas passage of the welding gun equipment.

5.3.9. CLEANLINESS

5.3.9.1. Absolute cleanliness of the area where welding is done is of paramount importance. Welding should be done in a dust and draft free room to avoid contamination by dust and moisture.

5.3.9.2. The surfaces to be welded and the filler metal shall be free from moisture, grease, oil films, oxides, fume condensates or foreign matter. These contaminants may release hydrogen and other gases which get entrapped in the weld causing porosity and other defects. The surfaces and the filler wire should be cleaned as laid down in subsequent paragraphs.

5.3.10. PREPARATION OF WORK PIECE

5.3.10.1. The parts to be welded shall be effectively pre-cleaned and scratch brushed with a stainless steel brush as described in succeeding paragraphs before welding.

5.3.10.2. Pre-cleaning: Dirt, grease, machining lubricants or any organic matter shall be removed from the areas to be welded by cleaning with suitable solvent by vapor degreasing. Chemical cleaning can be done with solvents like Butyl alcohol, Phosphoric acid, trichloroethylene, acetone or carbon tetrachloride.

5.3.10.3. The filler metal used for welding should be also pre-cleaned preferably by dry steel wool to remove the naturally forming oxide thereon.

5.3.11. ASSEMBLY FOR WELDING

5.3.11.1. The assembled structure shall be true to the line & free from twist & bends. The fabricator shall design and use adequate and proper welding fixtures and follow appropriate welding sequence to avoid undue restraint on the work piece thus keeping distortion and residual stresses to a minimum level.

5.3.12. Non Destructive Test: Dimensional check and visual inspection shall precede any NDT activity. NDT is to be carried out as per the requirements specified in Customer's documents or other standards / specifications indicated by the Customer. The Customer has the right to review the NDT requirements, its scope and extent, during the course of fabrication. The Contractor shall make available necessary calibrated NDT equipments.

5.3.12.1. NDT Plan: The Contractor is to work out detailed NDT plan, specify nature of inspection, responsibility, parameters to be recorded etc. Customers' document on NDT requirements will be provided along with working drawings on award of contract. The NDT plan shall form of Quality Control (QC) plan.

5.3.12.2. Weld Joints: All welds shall be subjected to 100% DPT & size of weld shall be checked by using fillet gauge. DP test shall be carried out after completion of each root run, all subsequent runs/passes & final pass of all butt & fillet welds. Customer's decision regarding the type and extent of NDT will be binding on the contractor.

5.3.12.3. Dye-penetrant test: A joint should be welded with minimum number of passes. Dye-penetrant test should be carried out before depositing next run and the previous run should be thoroughly cleaned. Proper heat sinks may be used in the welding fixtures to achieve narrowest possible heat affected zone.

5.3.13. WELDING PLANT REQUIREMENTS

5.3.13.1. The welding equipment used in the Tungsten Inert gas welding (TIG)/Gas Tungsten Arc Welding (GTAW) shall be conforming to IS: 9604.

5.3.13.2. The welding equipment used in spot welding shall be conforming to IS: 819 1957.

5.4. MACHINING

5.4.1. Use proper machine, machine tools, drilling jigs and fixtures are employed along with standard engineering process and practices adapted during machining of the components / sub-assemblies. The rails employed are of prime importance, any deviation over the specified tolerances can cause in gross malfunctioning of the system. Therefore, it is very essential to carry out the machining of rails, within the specified limits.

5.4.2. Machining of the components / parts / assembles, is of prime importance since deviations over the specified tolerances shall result in gross malfunctioning of the system. The Contractor shall also ensure that, the permanent reference markings on the parts & interface arrangement are preserved, so that, the measurements can be carried out any time in the future.

5.4.3. To achieve accuracies, surface finish and features required on various components, the Contractor shall employ proper machining processes. Calibrated machine tools, jigs, fixtures, skilled machine operators, properly selected and calibrated inspection tools and gauges. The Contractor shall also ensure adequate QC coverage based on evolved QC Plan.

5.4.4. In case of any deviation from the laid down specifications, the same shall be immediately communicated to the purchaser for their decision.

5.5. DRILLING, PUNCHING AND REAMING

5.5.1. Holes shall be made in material by drilling, reaming but in no case by gas cutting or punching.

5.5.2. All holes shall be made on assembly and not on individual parts. Wherever possible, fabricator will design and use appropriate drilling jigs and if necessary, the Contractor will be permitted to drill undersized pilot holes initially for purposes of assembly. The amount by which the diameter of a undersized hole should

be less than that of the finished hole, shall be at least 1/4th the thickness of the component and in no case less than 0.8 mm. However, the final drilling or reaming to achieve the final dimension shall be done on assembly. However, this will not be binding on the Contractor. Instructions as given in the drawing for a particular component shall be followed.

5.5.3. Matching holes for bolts shall mate with each other accurately. The drilling in such cases shall be preferably done with the help of a suitable drilling jig. Debarring of all holes shall be done by grinding without destroying the shape of the hole. Poor matching of holes shall be a cause for rejection. Holes shall not be drilled in such a manner as to distort the metal. All chips lodged between contacting surfaces shall be removed before assembly.

5.6. JIGS AND FIXTURES

For achieving necessary accurate dimensional requirements and preventing unwanted distortions due to welding and heavy machining, the fabricator may design his own jigs and fixtures for welding and machining the various assemblies. However, the fabricator shall be responsible for giving the final product as per the tolerance levels specified in the drawings. No deviations from the tolerances specified in the drawings shall be acceptable

5.7. TOLERANCES

The manufacturing tolerances for various dimensions shall be asunder:

5.7.1. Tolerances on basic materials shall be as per relevant IS or other international standards as specified in material specification or in relevant drawings.

5.7.2. Tolerances on the machined components shall be as specified in relevant drawings conforming to IS: 2102 part 1 (medium grade), wherever not mentioned.

5.7.3. Geometrical tolerances for features without individual tolerances indication shall be conforming to IS: 2102 part 2.

5.8. BOLTING

All the surfaces to be bolted shall be held in close contact with each other. The minimum distance from the centre of any hole to the edge of the plate shall be of minimum of 1.5 d; d is the diameter of the hole or as per the details shown in the relevant drawings, whichever is greater should be followed. Finished holes shall be not more than 1.5 mm or 2.00mm (as the case may be) in diameter of bolt passing through them, unless other specified by the engineer. In all cases the full bearing of the bolt is to be developed, the bolts shall be provided with a washer of sufficient thickness under a nut to avoid any threaded portion of the bolt being within the thickness or parts bolted together. A spring washer shall be provided in-between the plain washer and a nut to avoid loosening of nut/bolt due to vibrations. The thread shall project beyond the nut for a minimum of one turn. Nuts shall be properly, but not excessively tightened. Wherever required, lock nuts conforming to IS: 3063 should be used.

5.9. FINISH - TREATMENT AND PAINTING

The Mechanical / Structural systems with other sub- systems shall be cleaned, treated and painted as specified here under. This shall be done after inspection and approval of the system by the inspector. All steel components except the threaded bolts, nuts, pins and bushes shall be painted as specified herein. Painting shall be carried out **either on components / parts level or on assembly level as applicable**.

5.9.1. The inner surface of pin holes and bolt holes shall not be painted.

5.9.2. Painting need not be carried out for the components where different types of fits like turning, rotating or sliding are involved. The component interfaces, having relative motion shall be protected using suitable grease. The contractor shall get prior approval for the grade of grease to be used. Similarly, the protection for the hydraulic components shall be provided.

5.9.3. Repair of painted surfaces- All the damages caused to the paint coating during transportation or erection shall be carried out as per procedure laid down for maintenance of painting in IS:1477 part II. Also, damages caused to the parts/ components of launcher during transportation & handling shall be rectified before carrying out the maintenance of painting work.

5.9.4. Applicable standards for painting:

- IS 5:2007:- Colours for ready mixed paints and enamels
- IS 2524 (Part I Pretreatment) -1968:- Code of practice for painting of non-ferrous metals in building
- IS 2524 (Part II Painting) -1968:- Code of practice for painting of non-ferrous metals in building
- ASTM B-499:- Standard test method for measurement of coating thickness by the magnetic method: Non magnetic coating on magnetic basis metals
- IS:9954-1981:- Pictorial surface preparation standards for painting of steel surfaces
- IS: 13238-1991:- Epoxy based Zinc phosphate primer
- IS: 13183: 1991:- Aluminum paint, Heat Resistant-Specification

SECTION VI
QUALITY ASSURANCE

6.1. GENERAL

The supplier is responsible for the performance of all Quality Assurance requirements as specified herein. Except as otherwise specified, the supplier may utilize his own or any other Quality control facilities and services acceptable to the Quality Assurance and approving officer. Quality Assurance /Control records of the examinations and tests shall be kept complete and made available to the inspector as specified in the order. The Government reserves the right to perform any inspection set-forth in the specification where such inspections are deemed necessary to assure that supplies and services conform to prescribed requirements.

6.2. Quality Assurance Authority

6.2.1. Quality assurance of the embossed canister assembly, its sub-assemblies and parts shall be carried out by the "Inspection Authority".

6.2.2. The responsibilities of the Inspecting Authority shall be inspection of the raw materials, checking of the fabrication drawings and procedures, die punching facilities, fabrication facilities, approval of quality control plan submitted by the industry partner based on designers quality assurance plan & process plan etc. as laid down in the subsequent paragraphs.

6.3. Inspection

6.2.3. Repair

No part of the work shall be repaired or spoiled work corrected without the approval of the "Inspection Authority".

6.2.4. Dispatch

No components shall be dispatched until it has been officially approved and accepted for release.

6.2.5. Raw Material

6.2.5.1. The contractor will ensure that the material meant for use in fabrication of the equipment is from the inspected and approved lot. Wherever necessary, the authorized inspector may draw random samples from the approved lot and get same re-tested, if found necessary.

6.2.5.2. All steel / aluminum raw materials shall be properly stamped for purpose of identification.

6.2.5.3. Prior approval of the raw material shall be obtained before the same are incorporated in prototype / pilot sample / production.

6.2.6. Stage Inspection

6.2.6.1. Contractor shall satisfy himself regarding the acceptable standards and quality of the stores / job prior to tendering the same for inspection to the inspection agency. He will carry out his own inspection through his quality control group. He will forward all such internal quality control test reports for each store / job at each stage of fabrication to the inspection authority. Inspection by inspection authority shall be carried out only on receipt of such internal inspection reports.

6.2.6.2. Stage Inspection shall be the responsibility of the contractor. The equipment will be offered for stage inspection after completion of fabrication of various parts/sub-assemblies and assemblies

6.2.6.3. The contractor shall provide all stage inspection records to the inspector whenever required. The contractor shall decide his own sequence of fabrication and finalize the same after discussions and consultations with the inspection authorities. The inspection / test of the finished canister, its sub-assemblies and parts shall be carried out as specified in inspection plan & ATP.

6.2.6.4. If the inspector has over looked any defect during the stage inspection, the supplier shall be responsible for the rectification of such defect as soon as the same is noticed.

6.2.6.5. Inspecting Officer or his representative shall be afforded access to any part of the factory premises to satisfy without having anyway made responsible thereafter that the required standards are maintained at all stages and during all process of production.

6.2.7. Testing Facilities

The contractor shall provide all the necessary facilities to the inspecting officer for tests to be carried out by him and intimation of the tests to be carried out shall be given by the inspector to the contractor.

6.2.8. Notification of Results of Inspection

On completion of the inspection, the contractor will furnish the inspector with necessary inspection results and certificates.

6.2.9. Sampling Procedure

The inspection authority shall be the sole judge in deciding the sampling procedure that may be adopted. If as a result of inspection during the initial stages it is revealed that the stores are not coming up to the acceptable standards, further inspection shall be suspended. Rejections of the samples by the inspecting officer shall be considered as final and binding on the supplier and the stores rejected by the inspecting officer shall be replaced by the supplier.

6.2.10. Marking of Rejections

6.2.10.1. The rejected stores will be suitably defaced or destroyed by the inspecting officer in mutual consultation with the supplier so that they may not be resubmitted.

6.2.10.2. On completion of the inspection, the inspector will furnish the supplier with necessary inspection results and certificate.

6.2.11. Examination

6.2.11.1. The embossed canister, its sub-assemblies and parts shall be examined for the defects listed below. Presence of one or more defects shall be a cause of rejection.

(a) Dimensions not as specified
(b) Missing parts and components
(c) Incompleteness or incorrectness of assembly
(d) Materials not as specified
(e) Treatment and painting not as specified
(f) Thinning of the embossed sheets more than specified (thinning expected 10 to 15% of the thickness of the sheet metal)
(g) Cracks at the embosses and bends.
(h) Weld defects such as cracks, serious porosity, lack of penetration, unacceptable inclusions, undercutting of base metal etc.
(i) Dirty components

6.2.11.2. Production inspection shall be in strict accordance with the samples approved. Tests as deemed necessary by the inspecting officer shall be arranged by the contractor on the same lines as in the case of the pilot sample.

6.4. Quality Assurance Facilities:

Supplier shall extend the Inspecting Authority or his authorized representative free of cost, all reasonable facilities for satisfying himself that the stores are manufactured in accordance with specifications and drawings for this purpose, the Inspecting Authority or his authorized representative shall have free access to the supplier or his sub-suppliers works at all times during the currency of the contract.

6.5. Quantities of Materials

Quantities of materials given in the drawings / schedule of materials are only for the guidance of the supplier. Actual quantities required for fabrication may vary. Supplier shall work out the quantities separately and if any major variance is observed from those given in the drawings, the same shall be brought to the notice of the Inspecting Authority, who shall amend the drawings appropriately. Since the quantities given in the drawings are only for the guidance of the contractor, no financial compensation shall be admissible to the contractor on account of such major variances in the quantities observed by the contractor. Further, the contractor is responsible for fabricating and supplying the equipment as per drawings and specifications.

SECTION VII
INSPECTION & TESTING PLAN

7.1. General

This section covers the Inspection Test Plan for raw material, bought out items, die punch, consumables, fabrication/ manufacturing, integration, installation, testing & trials of Structural / Mechanical Systems. This is issued to assist / guide the inspector and industry partners for quality assurance / control during fabrication / manufacturing of canister. Detailed check list / sheet for inspections of individual components / sub- assemblies shall be prepared by the Inspector.

7.2. Inspection Criteria for Checking of Dimensions

Inspection for dimensional checks for various parts / sub-assemblies and assemblies of the canister shall be responsibility of the contractor / fabricator. The equipment along with its accessories will be offered at various stage inspections after completion of the parts / components / sub-assemblies and assembly of the canister for their dimensional checks. For ease of dimensional checks, the dimensions of the canister system and its major parts / components / sub-assemblies are divided into three categories as given below:

7.2.1. Critical Dimensions

Dimensions of the parts / components which are critical in nature, considering their application for their interchangeability, ease for fitment and for smooth function of the equipment. These dimensions should be maintained within the tolerances specified on the relevant drawings. These dimensions are to be checked 100%. Such dimensions are maintained within the fine class / grade of tolerances specified in their relevant drawings.

7.2.2. Major Dimensions

Dimensions of the parts / components those are not critical in nature but are important from assembly point of view to be maintained within the tolerances specified in the relevant drawings. Tolerances of such components / parts are generally maintained within medium class/grade of tolerances specified in their relevant drawings. If such dimensions are not obtained during fabrication, initially, the components / parts can be offered for rework /re-machining to obtain the parts within the specified medium grade of tolerances. Dimensions identified as major dimensions are to be checked on random sample basis.

7.2.3. Minor Dimensions

Dimensions of the parts / components which are neither critical nor major are said to be minor dimensions which are made within the coarse class / grade of tolerances. Minor dimensions may be checked by the inspection authority as found necessary.

7.2.4. Critical requirements / Parameter

1 Machine accuracy / calibration should be taken into account & calibration of m/c to be confirmed.

Machining accuracy of rails is of utmost importance.

2 Deviation due to welding distortion in the center line of rail structure should not exceed more than ± 1 mm on either side in both X & Y plane.

3 The measurement of distance between the holes center of guide rail mounting on canister shall be checked on machine. Measurement by tape in steps shall not be allowed.

4 The checking of the Parallality of bottom pad and top guide rails shall be ensured.

5 All Fillet welds shall be subjected to die penetration test and all Butt welds shall be subjected for Radiographic test wherever specified hereafter or in drawings.

7.3. Measuring Instruments

7.3.1. Standard gauges / templates shall be used for checking of weld sizes.

7.3.2. Following measuring instruments are required for measuring dimensions of the embossed canister and its accessories components.

(a) Steel scale
(b) Steel tape
(c) Vernier calipers / Micrometer
(d) Dial gauge
(e) Height gauge
(f) Plumb bob and set square
(g) Bore Gauge
(h) 3D Laser Tracker
(i) Any other

7.3.3. The measuring instruments shall be calibrated and calibration certificates shall be produced by the contractor/contractors for their accuracy and validity.

7.4. Testing Facilities / Equipments

Testing facilities / equipments used for the following tests and other specified tests / trials as applicable of the various materials, components, sub-systems, and system shall be calibrated and calibration certificates shall be produced by the contractor / contractors for the accuracy and validity of the test facilities / equipments.

7.4.1. Mechanical Testing of Materials, Components, / Sub-Systems

7.4.2. Operational / Functional trials of total system

7.4.3. Leakage Test of Canister System

7.4.4. Loading /unloading of missile in the cansiters

7.4.5. Loading /unloading of canisterised missiles in the VLU

SECTION VIII
SYSTEM INTEGRATION, TEST AND TRIALS

8.1. Integration

8.1.1. After completion of embossing/die punching/bending/fabrication/ manufacturing of structural sub-systems of canister and duly cleared by "inspecting Authority" the Contractor will commence the integration of all sub-systems at R&DE (Engrs). Inspection/ performance/ testing of the equipment at the Contractor's premises will be carried out by the contractor. The Contractor shall ensure that all the systems are functioning properly and there are no undue stresses in any part of the structure. Any modifications suggested as a result of the trials and inspection shall be carried out by the firm to the entire satisfaction of the Director, R&DE(Engrs), Dighi, PUNE – 411 015. All defects/ deficiencies shall be resolved before this stage so that no extra efforts are required to be put in at site to rectify the defects.

8.1.2. The integration shall involve broadly the following work:

(a) Fabrication and welding of top and bottom sections of embossed sheets
(b) Fabrication and welding of first and second half of embossed sheets
(c) Fabrication and welding of the front and rear frame for front and rear rupture disc assembly
(d) Preparatory work on the canister inside to mount guide & wing rails and other components.
(e) Fabrication and welding of mounting brackets for resting/lifting of the canister.
(f) Integration of other sub-systems mainly guide rails to the container.
(g) Integration of hatch opening/ closing mechanism including sealing with canister
(e) Mounting of article locking mechanism in the canister.
(f) Mounting of rear stopper mechanism in the canister.
(g) Mounting of shear pin
(h) Mounting of umbilical mechanism in the canister
(i) Mounting of TVC support plate
(j) Mounting of all sensors/indicators, etc
(k) Cabling of canister and fitment of connectors
(l) Closing and sealing of openings for mechanisms
(m) Functional test of the full system and assemblies.
(n) Pressure test of the canister

8.2. System Assembly

The contractor shall carryout the assembly of components, sub-systems along with other related systems, Installation & Commissioning' of the System as per following sequence.

Sr. No.	**Nomenclature**	**Parameters to be checked**	**Instruments used**	**Remarks**

1.	Canister Embossed first half top U section: • Plain sheet of 4mm thick is punched on the Hydraulic press • The punched sheet is bended at two location to form an inverted U type First half top section • Joggle at the edges for increasing welding area	a. Check dimensions b. Check thinning c. Check cracks at embosses and bends using dye penetrate test	Measuring Tape Vernier Calipers Visual inspection	Fixture to be used for proper punching and bending
2.	Canister Embossed first half bottom U section: • Plain sheet of 4mm thick is punched on the Hydraulic press • The punched sheet is bended at two location to form an inverted U type First half top section • Joggle at the edges for increasing welding area	a. Check dimensions b. Check thinning c. Check cracks at embosses and bends using dye penetrate test	Measuring Tape Vernier Calipers Visual inspection	Fixture to be used for proper punching and bending
3.	Bending and fabrications of Front frame (10 mm sheet thickness) which is used for assembly of front door	a. Check dimensions b. Check thinning c. Check cracks at embosses and bends using dye penetrate test	Measuring Tape Vernier Calipers Visual inspection Check Welds	Fixture to be used for proper punching and bending
4.	Canister Embossed second half top U section: • Plain sheet of 4mm	a. Check dimensions b. Check thinning	Measuring Tape Vernier	Fixture to be used for proper punching and

	thick is punched on the Hydraulic press • The punched sheet is bended at two location to form an inverted U type First half top section • Joggle at the edges for increasing welding area	c. Check cracks at embosses and bends using dye penetrate test	Calipers Visual inspection	bending
5.	Canister Embossed second half bottom U section: • Plain sheet of 4mm thick is punched on the Hydraulic press • The punched sheet is bended at two location to form an inverted U type First half top section Joggle at the edges for increasing welding area	a. Check dimensions b. Check thinning c. Check cracks at embosses and bends using dye penetrate test	Measuring Tape Vernier Calipers Visual inspection	Fixture to be used for proper punching and bending
6.	Bending and fabrications of Rear frame (10 mm sheet thickness) which is used for assembly of rear door	a. Check dimensions b. Check thinning c. Check cracks at embosses and bends and welds using dye penetrate test	Measuring Tape Vernier Calipers Visual inspection Check Welds	Fixture to be used for proper punching and bending and welding
7.	Bending and fabrications of middle frame (10 mm sheet thickness) which is used for welding of first and second half	a. Check dimensions b. Check thinning c. Check cracks at embosses and bends and welds using dye penetrate	Measuring Tape Vernier Calipers Visual inspection	Fixture to be used for proper punching and bending and welding

		test	Check Welds	
8.	Welding of first and second half top U sections	a. Check the weld joint for cracks and pin holes using dye penetrate or radiography test	Check Welds	Proper Fixture to be used for proper welding to avoid distortion and shrinkage
9.	Weld the guide rail and wing rail mounting pads to the top half U section	a. Check the weld joint for cracks and pin holes using dye penetrate or radiography test	Check Welds	Proper Fixture to be used for proper welding to avoid distortion and shrinkage
10.	Weld the bottom plates for resting of canister in horizontal condition	a. Check the weld joint for cracks and pin holes using dye penetrate or radiography test	Check Welds	Proper Fixture to be used for proper welding to avoid distortion and shrinkage
11.	Machining of the bottom plates which were indented to support canister in horizontal direction	a. Dimensional check. b. Machining accuracy c. Proper mounting	Vernier, Measuring tape OpticalMeasurement	
12.	Machining of the guide rail and wing rail mounting pads w.r.t bottom plates	a. Dimensional check. b. Machining accuracy of Rails c. Proper mounting	Vernier, Measuring tape OpticalMeasurement	Fixturing to be done during machining of the guide rail and wing rail pads to avoid distortion of the sheet and distortion of the embosses.

13.	Welding of top and bottom U sections on two vertical sides at joggle locations	a. Check the weld joint for cracks and pin holes using dye penetrate or radiography test	Check Welds	Proper Fixture to be used for proper welding to avoid distortion and shrinkage
14.	Welding of front and rear frames (10 mm thick sheet) which will be used for assembly of front and rear doors	a. Check the weld joint for cracks and pin holes using dye penetrate or radiography test	Check Welds	Proper Fixture to be used for proper welding to avoid distortion and shrinkage
15.	Weld the front flange for mounting of canister on VLU	a. Check the weld joint for cracks and pin holes using dye penetrate or radiography test	Check Welds	Proper Fixture to be used for proper welding to avoid distortion and shrinkage
16.	Weld the rear flange for mounting of canister on VLU	b. Check the weld joint for cracks and pin holes using dye penetrate or radiography test	Check Welds	Proper Fixture to be used for proper welding to avoid distortion and shrinkage
17.	Machining of the front and rear flange	a. Dimensional check. b. Machining accuracy c. Proper mounting	Vernier, Measuring tape OpticalMeasurement	
18.	Assembly of components • Mounting of Guide rail and wing rail • Fitment of hatch covers	a. Dimensional check. b. Machining	Vernier, Measuring tape	

	mechanism • Fitment of article locks mechanism • Fitments of rear stopper plate • Fitment of umbilical mechanism • Fitment of TVC support plate	accuracy ofRails c. Proper mounting d. Functionality test e. Pressure test f. Loading of missile inside canister g. Loading of canister within VLU	OpticalMeasurement	

8.3. Testing / Trials:

After the assembly of the System, the contractor shall carryout the following prescribed testing & trials of the system along with other related systems.

1. Sr. No.	2. Operations	3. Mode	4. Remarks
1.	5. Structural Tests	• Lift the canister with dummy article and check for its structural integrity 6.	7.
2.	8. Operational/ Performance Tests	• Proper rail alignment for article movement • Hatch opening / closing • Article locking • Rear stopper plate • Umbilical Mechanism • TVC support plate	9. With the help of dummy article check the accuracy all along the length. Article shall slides all along the length of rails without any obstruction. 10. Operation of mechanisms to be checked. 11. Locking/unlocking of hatch to be checked. 12. Opening/closing of the hatch to be checked 13.
3.	14. Leakage test	• Leakage of air from canister • Permissible leakage rate is derived based on pressure drop from 1.2 bar (abs) to 1.17 bar (abs) in 30 days. • For high temperature of 55 deg C, the internal pressure rises to 0.35 bar (g) from 0.2 bar (g). So	15. Air shall be filled inside the canister till the pressure reaches 1.2 bar absolute. No leakage of air shall be found. 16. 17. 18. The deformation if any in the canister for pressure test of 0.4 bar (g) to be

		canister to be tested for pressure of 0.4 bar (g)	noted. The vendor shall accordingly carry out the stiffening of the canister if any deformation found.

8.4. Improvements

8.4.1. Any improvements suggested or required as a result of the trials and inspection & subsequently incorporated in the respective sub-systems, shall be documented simultaneously by the firm to the entire satisfaction of the Director, R&DE(Engrs), Dighi, PUNE – 411 015. Incorporation of all improvements & preparation of document shall be the responsibility of the contractor.

8.5. Limited Testing & Trials

8.5.1. After incorporation of improvements, the industry partner will be responsible to conduct the limited testing & trials of the system to ensure that the system is performing its defined role to the satisfaction of inspecting authority.

SECTION IX
HANDLING, SAFETY AND TRANSPORTATION

9.1. GENERAL

9.1.1. The Complete System consists of following Sub-Systems including.

(a) **Canister Embossed Structure**
(b) **Front Flange**
(c) **Guide rail**
(d) **Wing rail**
(e) **Front Hatch Opening /Closing Mechanism**
(f) **Article Locking Mechanism**
(g) **Rear stopper Mechanism**
(h) **Shear Pin**
(i) **Umbilical Mechanism**
(j) **TVC support plate**
(k) **Sensors/indicators/limit switches**
(l) **Connectors and cable**
(m) **Nitrogen refilling arrangement**

All Sub-Systems are required to be mounted & integrated to form the full canister assembly. For this, the accuracy of the fabricated and machined components shall be maintained during the handling. As well as safety of the individuals handling the equipment shall be given top most priority.

9.2. HANDLING AND SAFETY:

9.2.1. All the sharp corners of the fabricated components / parts / sub-assemblies / assemblies shall be ground / machined to avoid the injuries to the individuals / workers during handling of the fabricated parts.

9.2.2. For shifting of fabricated parts from one shop to another shop for machining/ assembly purpose the proper material handling equipments / devices shall be used. Overhead cranes shall be used wherever possible for shifting the fabricated components. While shifting the components by crane, the parts shall be properly secured by slings / ropes to avoid the accident during handling stores.

9.2.3. The structural components / sub-systems being fairly large, precision machined and torsionally not so rigid, shall be handled with utmost care. Proper location shall be used to slings these components. Suitable handling beams may be used to ensure to avoid the permanent distortion in these components.

9.2.4. Care shall be taken in handling all the other components so as not to get damaged. Also, the mating interface surfaces shall be properly covered during handling, and the components shall be shifted properly without damaging interface surfaces. Extra care shall be taken to handle the seal so that they do not get any surface damage.

9.2.5. Suitable lifting hooks / pints shall be provided to the all manufactured components for easy handling.

9.2.6. Proper lifting provision shall be made to lift the entire system / sub-systems in horizontal position after assembly is completed along with other related systems on the platform by single crane.

9.3. STORAGE

9.3.1. After fabrication and painting, components/assemblies of the systems shall be stored in a dry place clear off the ground. When temperature, and moisture conditions are such that condensation may take place. As far as possible effort should be made to store the material in heated and ventilated storage area.

9.4. Preservation

9.4.1. Care shall be taken preserving all the components so as not to get spoiled. Also, the mating interface surfaces shall be properly covered with oil,/grease or respective preservative materials, and the components shall be stored properly. Extra care shall be taken to preserve the seal so that they do not get any surface damage /or spoiled from environmental conditions. Such parts or bought out items shall be preserved as per manufacturers recommended guidelines.

9.5. Identification & Marking

9.5.1. The following details shall be engraved on an Aluminium plate/sheet of suitable size and this shall be fixed to upper portion of the assembly:

a) Designed & Developed by R&DE (Engrs)
b) Nomenclature
c) Part Number of the item
d) Serial number of the item
e) Month and year of manufacture
f) Name of the Manufacturer

(Note: All mechanism and subsystems of canister to be labelled)

9.5.2. The size of the letters shall be appropriate for visibility.

9.5.3. The part number and the serial number of the item shall be given by the Manufacturer.

9.5.4. All spares and loose items packed in boxes will also be marked and tags should be placed on them giving the identification.

9.6. Transportation of the System

9.6.1. The canister assembly along with all spares, accessories, tools and bought out items shall be transported to the R&DE (Engrs) by road / rail transportation. Responsibility of carrying the system & items without any damage during transportation lies with the contractor. All the bought out items shall be properly packed so as to avoid any damage to the equipment. Loading at contractor's place and unloading at site shall

also be the responsibility of the contractor. Suitable mobile cranes shall be provided by the contractor for loading / unloading of the system / parts at firm's premises as well as at the R&DE (Engrs).

SECTION X

INTELLECTUAL PROPERTY

The title to the ownership of the design of this "Technology Product" including copyrights and intellectual property rights will rest exclusively with R&DE(E). The Contractors shall not take any action inconsistent with this title and Ownership.

Annexure A

Submission Format

The submission of bid shall be in two parts:

1. **Price Bid**
2. **Technical Bid**

The technical bid should cover the technical specification / details, component / material specification, test plan etc. for the complete system.

The Price Bid and Technical Bid shall be sealed in two separate envelops and then both envelops should be sealed in a common envelop. Tender Enquiry No. and the due date shall be put on envelops.

Technical Specifications of Launcher Control System (LCS) for VL SRSAM

10/12/2020

R&DE(E)

Government of India, Ministry of Defence

Defence R&D Organization

Research & Development Establishment (Engineers)

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(Dr MD Limaye)

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1. INTRODUCTION

1.1 Aim / Need Analysis

Launcher Control System (LCS) for Vertical launcher for SRSAM (VL-SRSAM) is required for controlling the Plume Uptake Chamber Hatch and mechanisms of the VL-SRSAM Canister for launch of 8 canisterised VL-SRSAM missiles in sequence or in salvo of 3.

The aim of this document is to correlate the design parameters to the user's requirements and present the design approach. The overall system configuration, System/Subsystem specification, Safety/Reliability aspect and other communication issues have been taken into account and the design approach is presented in this document, so that the equipment will meet the user's requirements.

1.2 System Overview

The VLU consist of eight missile canisters and a Plume Uptake Chamber (PUC). All eight canisters and the PUC are integrated into a single mechanical structure. The PUC has electromechanically operated door and has separate Electro Mechanical (EM) actuators for door locking / unlocking in closed position of PUC door. The status of this PUC door i.e. OPEN/SHUT and LOCK /UNLOCK shall be monitored by the control system.

Each canister houses one missile. The canister has a hatch on the top which can be OPENED and CLOSED using EM actuators. The hatch is kept in LOCKED condition when in closed position using a Pyro bolt. This pyro bolts needs to be fired to UNLCOK the hatch before opening the hatch. The missile is secured inside the canister using LOCK/UNLOCK mechanism which is also driven by EM actuators. At the bottom of the canister, there is a rupture disc which is ruptured by missile plume pressure during firing. Missile presence inside the canister needs to be sensed all the time along with Hatch OPEN/SHUT and Missile LOCK/UNLOCK status. The plume also needed to be detected using a special combustible wire type sensor.

The Main role of Launcher Control System is to control various functions like PUC Door OPEN/SHUT/LOCK/UNLOCK, canister hatch OPEN/SHUT, Missile LOCK/UNLOCK etc. in Auto mode from MCU or in maintenance mode from local console.

The launcher system consists of Vertical Launch Unit (VLU) and Launcher Control System (LCS). The Launcher Control System hardware is housed in to two cabinets i.e. Power Supply Cabinet and Launcher Controller Cabinet. Both the cabinets are identical and their design is based on Naval approved forced air-cooled cabinets. The Launcher Control system is designed based on Single point fault tolerant design philosophy using end to end redundancy. The overall System Block Diagram is shown in Figure 1-1.

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The Power Supply Cabinet consists of following electrical / electronic subsystems:

i. Main and Redundant Delta to Star Step-Down Transformer
ii. Main and redundant AC-DC and DC-DC converters
iii. Switching Control from MCU
iv. Power ON Feedback to MCU
v. Main and Redundant Fan Blowers, Protection circuit, indicators, voltage and Current readouts

The Power Supply Cabinet gets single input feeder of 380 VAC, 3Ø Delta, 50 Hz power from an Auto Changeover Switch. The Auto Changeover switch internally carries out fast switching between forward and AFT 380 VAC, 3Ø, 50 Hz supplies and provided uninterrupted power supply for all consumers.

The power supply cabinet consist of identical Main and Redundant hardware set consisting as listed above. The 380VAC, 3Ø, 50Hz input is reduced to 220VAC, 3Ø, 50 Hz using a Delta to Star step down transformers. The power supply scheme uses 220VAC supply for Fan blowers and Anti-Condensation Heaters. A contactor is placed at the output of transformer to switch ON&OFF the power to electronics if Launcher Controller Cabinet. The power ON / OFF Control will be activated by MCU remotely. A set of potential free contacts are also provided as a feedback of power ON status to MCU. The 220VAC, 3Ø is then rectified using three phase diode rectifiers to approximately 300VDC. The rectified high voltage DC then converted to required 28V DC for controller and field consumers using DC-DC Converter.

The Launcher Controller Cabinet will consist of following hardware

i. VPX based Controller Hardware consisting of Single Board Computer (SBC), I/O Cards and Power Supply
ii. Canister and PUC Door I/O Signal conditioning consists of Relays and Signal Conditioning Unit
iii. Ethernet switch
iv. Common 10.4” LCD Display and a KVM switch
v. Main and Redundant Anti-Condensation heater
vi. Main and Redundant Fan Blowers, Protection circuit, indicators, voltage and Current readouts

There will be a VPX hardware based controller which will control and monitor all operation of launcher. It will be based on 3U VPX Architecture. The single board computer and I/O cards will be

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housed in Standard IEEE 3U cage. Controller will read the sensor status and will actuate the actuators through digital/analog I/O cards.

The software will be developed on Real Time Operating System platform to achieve performance and reliability. A 10.4" touch screen display will be provided within the cabinet to operate the launcher locally during Maintenance and Setting To Work (STW). In the normal circumstances, the Launcher control system will receive command over Dual Redundant Ethernet from MCU for operation.

Anti-Condensation heaters (M&R) will be provided in Launcher controller cabinet to prevent condensation during switch off condition of the system. The ACH will be automatically switched ON once the power to Launcher Control System (LCS) is switched off and vice -versa. Each of Main and redundant ACH will be powered by respective 220V AC supplies. The Transformers of Power supply cabinets will be always ON generating sufficient heat, hence there is no need of ACH in power supply cabinet.

The Canister and PUC door signal conditioning Unit will consist of relays for actuating pyros, Pyro health check circuit and H-Bridge drivers for motors. The connectors provided on the top of the cabinets will be used to interface the Canister system with Launcher controller.

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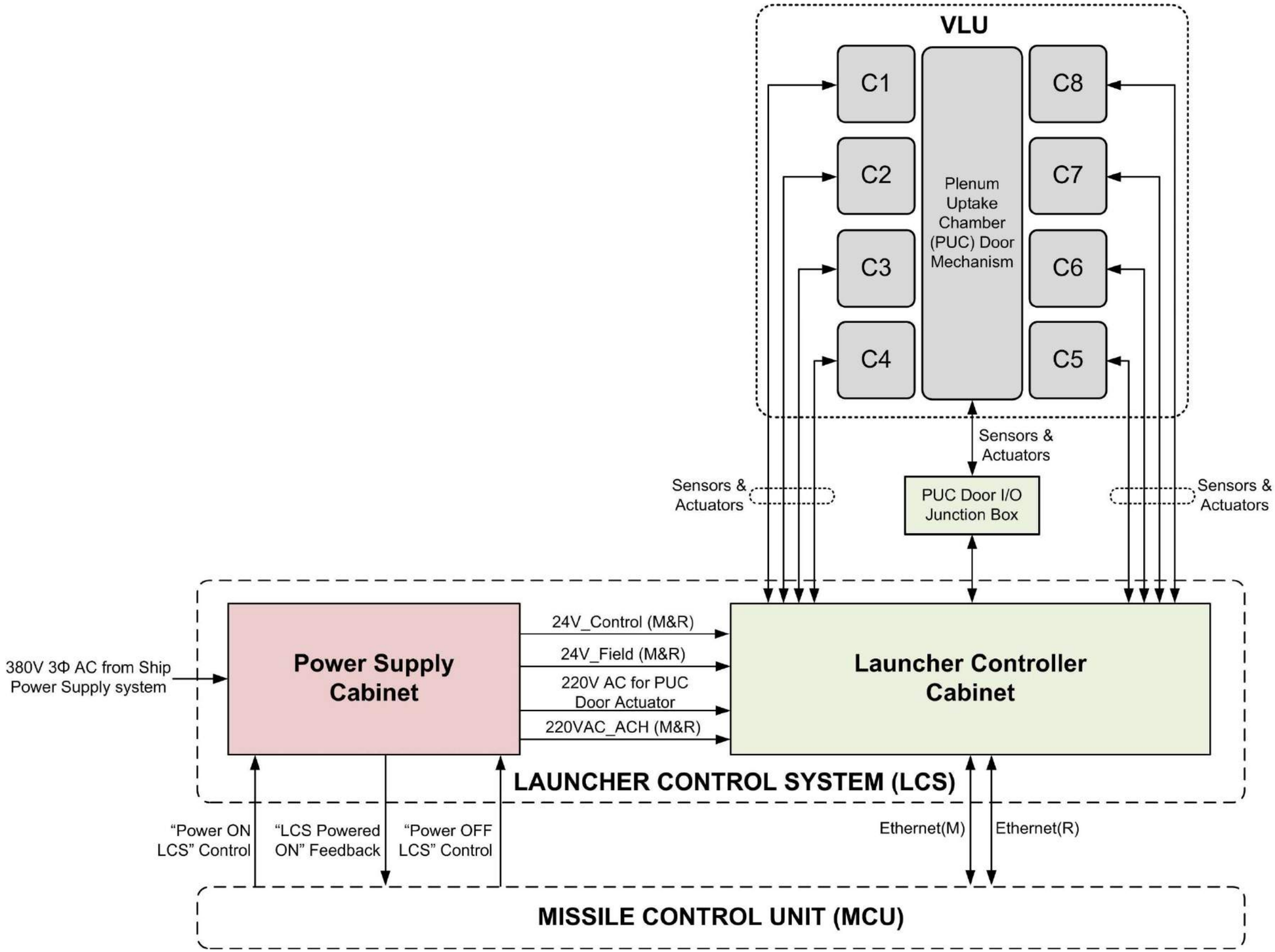

Figure 1-1 : VL-SRSAM Launcher Control System Architecture

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1.3 Role of Launcher Control System

The role of launcher control system is to provide safe, manual as well as automatic operations of the VL-SRSAM. The launcher control system is integrated with VL-SRSAM on mechanical subsystems of RANVIR Class Ship. The design and configuration of the Launcher Control System has been evolved to meet the following functional requirements

1.3.1 Functional Requirements of Launcher Control System

1. To provide automatic canister mechanism control operations like Missile UNLOCK, Hatch OPEN & SHUT
2. To provide continuous monitoring of canister mechanism like Hatch OPEN / SHUT, missile LOCK / UNLOCK, canister & Missile presence, plume detection.
3. To provide automatic PUC mechanism control operations like PUC Door LOCK / UNLOCK and PUC Door OPEN/CLOSE.
4. To communicate with Missile Control Unit (MCU) over Dual redundant Ethernet link for Auto Mode operations
5. To communicate with MCU and provide Launcher status, health and fault conditions.
6. To implement a pre-defined sequence operation and control of Launcher mechanism as per the standard sequence of operation and ensure a reliable and safe operation
7. To provide safety interlocks.
8. To provide means for data logging during execution of various commands
9. To provide for a 'Built-in Test Equipment' (BITE) as well as a Self -Test & Self-diagnostic facility for the Launcher Control electronics and VLU
10. Displaying status of power supply system (UPS, Mains, other voltage generated by power supply systems)
11. To provide appropriate signal conditioning to operate loads like Motors, Solenoids and pyros
12. LCS shall have hour meter to exploit total run time of LCS

1.3.2 Launcher Control System (LCS) Modes of operation

The launcher control system will operate in following two modes

a) **Auto Mode:** The default mode of operation is Auto Mode where the commands for operating the Canister & PUC Door comes from Missile Control Unit (MCU) to LCS.

b) **Manual Mode:** In manual Mode the operator enables the Manual Mode using the Hardwired switches / 10.4" Touch screen LCD display on Launcher Controller Cabinet. In this Mode the MCU communication link need not be available. Operator can carry out Maintenance and stand alone training activities

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There are two regimes of operation. By default, the system will not be in any regime. It will be only monitoring the complete launcher system.

a) **Combat Regime:** In Auto Mode, Combat Regime, all launcher operations will be carried out sequentially and automatically under command of Missile Control Unit (MCU).

b) **Training Regime:** Training Regime may be selected in Auto or Manual Mode. In Training Regime, simulated operations can be carried out in various predefined scenarios. This regime will be used for standalone LCS or integrated Weapon system training of operators.

c) **Maintenance Regime:** In Maintenance Mode, the operator can carry out various operations of LCS by using a touch screen display. All the sequence of operations has to be carried out manually as per the User Handbook. During the Manual Operation, all the necessary interlock will be taken care by controller software and operator will be prompted in case of any fault or wrong sequence of operation. In this mode activities like health check of I/Os, health check of drives, logged data retrieval etc. can also be carried out.

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2. SENSORS AND ACTUATORS

2.1 Sensors

The sensors perform essential job of providing feedback to control system. The sensors are required to detect various positions of PUC Hatch and mechanisms of canister. Limit Switches will be used for position sensing of different mechanisms of PUC and canisters as listed in the Table 2-1.

The presence of canister will be detected by employing loopback method on the connectors mounted on canister. If the canister is loaded in the VLU and the cable harness are connected from canister to Launcher Controller Cabinet, then canister presence will be automatically known. A separate sensor is not catered to sense canister presence.

As pyro-bolt is employed for hatch locking, sensor based feedback cannot be done for the same and hence related sensor is not included in the list.

Table 2-1 : List of sensors

Sr. No.	Purpose	Sensor Type	Qty	Total Qty/VLU	Remarks
1.	Hatch OPEN	Limit Switch (Four Circuit Double Break)	2	16	2 sensors will be used for series & parallel connection of contacts
2.	Hatch SHUT	Limit Switch (Four Circuit Double Break)	2	16	
3.	Missile LOCK	Limit Switch (Four Circuit Double Break)	2	16	
4.	Missile UNLOCK	Limit Switch (Four Circuit Double Break)	2	16	
5.	Missile Presence	Limit Switch (Four Circuit Double Break)	2	16	
6.	PUC Door OPEN	Limit Switch (Four Circuit Double Break)	2	2	
7.	PUC Door SHUT	Limit Switch (Four Circuit Double Break)	2	2	
8.	PUC Door LOCK	Limit Switch (Four Circuit Double Break)	2	2	
9.	PUC Door UNLOCK	Limit Switch (Four Circuit Double Break)	2	2	
10.	Plume Detection	Combustible wire type	1	8	
11.	Canister Presence	Connector Loop Back	1	8	Two contacts on I/O Connectors will be used for loop back

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2.1.1 Limit Switch

The limit switch has been selected as sensors for sensing end limits and giving a feedback of extremities for implementing system safety interlocking and sequencing scheme. The Limit switches will be used for sensing feedback as mentioned in table 2-2. The major criterion for selection of limit switches are as follows:

a) Compact size MIL-grade COTs item
b) Environmentally sealed contacts
c) High MTBF

Table 2-2 : Technical Specification of Limit Switch

Sr. No.	Specification		
1.	Make	Honeywell	
2.	Model	EN Series	
3.	Voltage	9~36VDC	
4.	Switching options	DPDT-DB, snap action contacts	
5.	Mechanical life	up to 10 million (up to 5 million for wobbles)	
6.	Operating temperature	-54 °C to 125 °C	
7.	Vibration	10 g	
8.	Shock	100 g	
9.	Protection	IP 67	

2.1.2 Combustible Wire Sensor for Plume detection

A combustible conductive wire type sensor will be used for detecting the Missile plume. This sensor comprises of a combustible & conductive wire mounted at rear end of canister diagonally. The electrical continuity will ensure that the wire is intact and missile has not been fired yet. When the Missile is fired the high temperature generated by plume will melt this wire causing the disruption in the electrical continuity indicating to the control system that Missile has fired.

2.2 Actuators

The various Canister mechanisms are operated using the following type of Actuators :

a) AC Servo Electric Linear Actuators
b) DC Servo Electric Linear Actuators

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c) ON/OFF Type Linear Actuators

d) Pyro Actuators

The actuators are used to operate canister Hatch, Missile Lock/Unlock mechanism and PUC Door. The type of actuators used are listed below:

Table 2-3: List of Actuators

Sr. No.	Purpose	Actuator Type	Qty	Total Qty/VLU	Remarks
1.	PUC Door OPEN / CLOSE (Right)	AC Servo Electric Linear	2	2	
2.	PUC Door OPEN / CLOSE (Left)	AC Servo Electric Linear	2	2	
3.	PUC Door LOCK / UNLOCK Right	ON/OFF Type Linear Actuators	1	1	
4.	PUC Door LOCK / UNLOCK Left	ON/OFF Type Linear Actuators	1	1	
5.	Canister Hatch Unlock	Pyro Actuators	1	8	
6.	Canister Hatch OPEN / SHUT	ON/OFF Type Linear Actuators	1	8	
7.	Missile UNLOCK	ON/OFF Type Linear Actuators	1	8	

2.2.1 Servo Electric Linear Actuators

The linear actuators are used for the PUC Door Open/Shut mechanism. The motors used in these actuators are AC Servo Brushless Synchronous Motors. A servo control drive will be used to control these motors. The LCS will control the operation of these actuators through the drive. The technical specification of the Servo Linear Actuator is given in Table 2-4:

Table 2-4: Technical Specification of AC Servo Electric Linear Actuator

Sr. No.	Specification		
1.	Make	ABB	
2.	Model	HDS65-0206A	
3.	Operating Voltage	230VAC	
4.	Current Nominal	5 Amps	

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Sr. No.	Specification		
5.	Current Peak	17 Amps	
6.	Rated Torque	1.8 Nm	
7.	Rated Power	600 W	
8.	Protection Class	IP65	

2.2.1.1 AC Servo Drive

A typical drive will have interfaces as shown figure 2-1**.** The technical Specification of the motor and drive is given in Table 2-5.

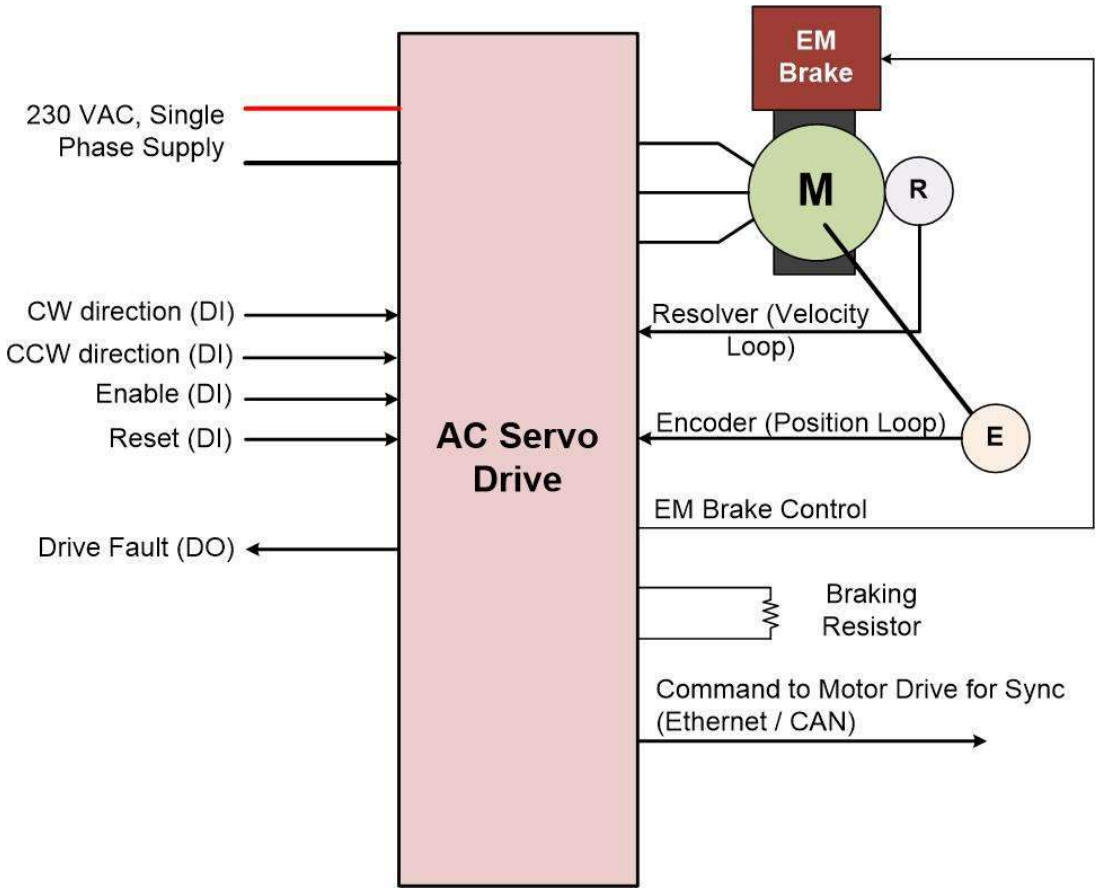

Figure 2-1 : Electric Servo Drive Interfaces

Table 2-5: Technical Specification of Servo Drive

Sr. No.	Specification		
1.	Make	EPH	

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2.	Model	SPM-2X-10A-230V-A	
3.	Input Voltage	230 AC 50 Hz +/- 10%	
4.	Auxiliary Power Supply	24VDC	
5.	Continuous Current	10 Amps	
6.	Peak Current	20 Amps	
7.	Motor Feedback	Encoder	
8.	Sync port	Ethernet / CAN	
9.	I/O interface	Opto-isolated Digital input/outputs Analog Inputs for position/velocity commands Analog outputs	
10.	Temperature Measuring Range	-30 °C to +55 °C	

2.2.1.2 Main and Redundant Motor Operation for PUC Door

In case of failure of Main Motors or its Drive during the PUC door Open/Shut operation, the Redundant motors will be activated for completion of the operation. The switch over from main motor to redundant motor is controlled by the Launcher Control System.

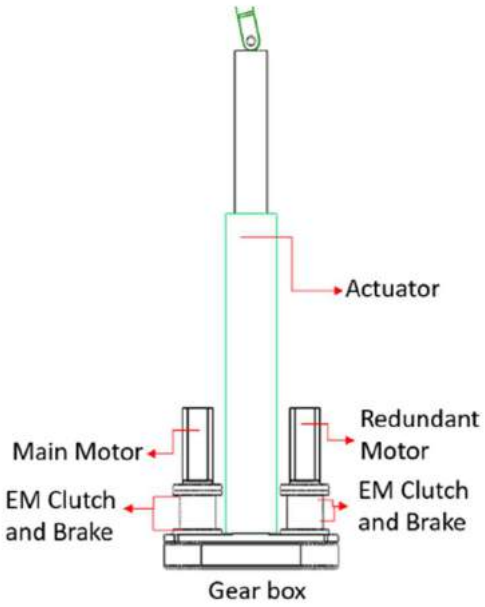

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Figure 2-2 : PUC Door Main and Redundant Motor arrangement

a) **No Operation/ OFF Condition** –The EM clutch is in disengaged position while EM brake is in engaged condition and the actuator is in OFF condition.

b) **Main Motor Operation**– On invoking the PUC Door Open/Shut signal, Brakes are released on both sides and EM clutch on main motor side will be engaged. At this condition, the main motor is operated for PUC Door Open/Shut.

c) **Redundant motor Operation** – Whenever a failure is encountered in any of the two main motors or its Drive, the LCS will Switch over the operation to the Redundant Motor. For this, the clutch on the Main Motor side will be disengaged and redundant motor side clutch will be engaged.

2.2.2 ON/OFF Type Linear Actuators – with integrated DC Motor

These linear actuators are used for Hatch Open/Shut and PUC Unlock operation. The linear actuator is integrated with DC motor and the actuator is controlled by giving supply to motor. By reversing the polarity, the direction of actuation can be changed. The required signal conditioning will be provided in the PUC & Canister I/O Signal Conditioning Unit. An over current detection circuit will give output to indicate the faulty actuator. The specifications are as follows.

Table 2-6 : Technical Specification of Linear Actuator

Sr. No.	Specification		
1.	Make	Thomson	
2.	Model	Electrak.10	
3.	Operating Voltage	24VDC	
4.	Continuous Current	17 Amps @ 24V DC	
5.	Protection Class	IP65	
6.	Motor protection	Auto reset Thermal Switch	

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2.2.3 ON/OFF Type Linear Actuators – with external DC Motor

This ON/OFF type Linear Actuator will be used for the Missile Unlock Operation. The Linear actuator is integrated with a COTS DC Motor. By changing the input supply to the motor, the direction of the Linear Actuator can be reversed. Based on the performance requirement of the Missile Unlock operation, the motor will be operated at 24 VDC.

Table 2-7 : Technical Specification of DC Servo Electric Linear Actuator

Sr. No.	Specification		
1.	Make	Maxon	
2.	Model	DCX 35L	
3.	Operating Voltage	18VDC	
4.	Current Nominal	5.32 Amps	
5.	Rated Torque	1.98 mNm	
6.	Operating Temperature	-40 to +100	

2.2.4 Pyro Actuators

The pyro actuators are used Hatch UNLOCK mechanism. This will be one time use actuators. The specification of this pyro is as follows:

Table 2-8 : Technical Specification of Pyro Actuator

Sr. No.	Specification		
1.	Make	Ordinance Factory	
2.	Operating Voltage	28V (22-32V) DC	
3.	All Fire Current	4.5A	
4.	Recommended Fire Current	5.5A	
5.	No Fire Current	1.5A	
6.	Resistance Value	1 ±0.1 Ω	

2.3 Comprehensive I/O Signals Listing

The tentative list of digital/analog input outputs is prepared based on the launcher system requirements, sensors and actuators. The same is placed in Table 2-9.

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Table 2-9 : I/O List of Launcher Control System

Sl. No.	Purpose	DI	DO	AI	Ether net	RS-232	Voltage (V)	Current (mA)	Type of Sensor / Actuator	No. Of sensors	Remarks
	PUC Mechanism I/Os										
1	Limit switch-PUC Door Open	1					24V	10mA	Limit Switch	2	2Nos. Of DPDT limit switches will be mounted at each position. Their contacts will be wired for series parallel combination
2	Limit Switch-PUC Door Close	1					24V	10mA	Limit Switch	2	
3	Limit Switch-PUC Door Lock Right	1					24V	10mA	Limit Switch	2	
4	Limit Switch-PUC Door Lock Left	1					24V	10mA	Limit Switch	2	
5	Limit Switch-PUC Door Unlock Right	1					24V	10mA	Limit Switch	2	
6	Limit Switch-PUC Door Unlock Left	1					24V	10mA	Limit Switch	2	
7	PUC Door OPEN/SHUT Motor (M) Drive Right- CW direction (INA)		1				24V	100mA	OptoIsolated Drive input		
8	PUC Door OPEN/SHUT Motor (M) Drive Right- CCW direction (INB)		1				24V	100mA	OptoIsolated Drive input		
9	PUC Door OPEN/SHUT Motor (M) Drive Right- Enable		1				24V	100mA	OptoIsolated Drive input		
10	PUC Door OPEN/SHUT Motor (M) Drive Right- Reset		1				24V	100mA	OptoIsolated Drive input		
11	PUC Door OPEN/SHUT Motor (M) Drive Right- status	1					24V	10mA			
12	PUC Door OPEN/SHUT Motor (M) Drive Right - Spare	1					24V	10mA			
13	PUC Door OPEN/SHUT Motor (M) Drive Right - Spare		1				24V	100mA	OptoIsolated Drive input		
14	PUC Door OPEN/SHUT Motor (M) Clutch Right Release		1				24V	4A	Relay		
15	PUC Door OPEN/SHUT Motor (M) Clutch left Release		1				24V	4A	Relay		
16	PUC Door OPEN/SHUT Motor (R) Drive Right- CW direction (INA)		1				24V	100mA	OptoIsolated Drive input		

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Sl. No.	Purpose	DI	DO	AI	Ether net	RS-232	Voltage (V)	Current (mA)	Type of Sensor / Actuator	No. Of sensors	Remarks
17	PUC Door OPEN/SHUT Motor (R) Drive Right- CCW direction (INB)		1				24V	100mA	OptoIsolated Drive input		
18	PUC Door OPEN/SHUT Motor (R) Drive Right- Enable		1				24V	100mA	OptoIsolated Drive input		
19	PUC Door OPEN/SHUT Motor (R) Drive Right- Reset		1				24V	100mA	OptoIsolated Drive input		
20	PUC Door OPEN/SHUT Motor (R) Drive Right - Spare		1				24V	100mA	OptoIsolated Drive input		
21	PUC Door OPEN/SHUT Motor (R) Drive Right- status	1					24V	10mA			
22	PUC Door OPEN/SHUT Motor (R) Drive Right - Spare	1					24V	10mA			
23	PUC Door OPEN/SHUT Motor (R) Clutch Right Release		1				24V	4A	Relay		
24	PUC Door OPEN/SHUT Motor (R) Clutch left Release		1				24V	4A	Relay		
25	PUC Door OPEN/SHUT Motor (M) Drive Left - CW direction (INA)		1				24V	100mA	OptoIsolated Drive input		
26	PUC Door OPEN/SHUT Motor (M) Drive Left - CCW direction (INB)		1				24V	100mA	OptoIsolated Drive input		
27	PUC Door OPEN/SHUT Motor (M) Drive Left - Enable		1				24V	100mA	OptoIsolated Drive input		
28	PUC Door OPEN/SHUT Motor (M) Drive Left - Reset		1				24V	100mA	OptoIsolated Drive input		
29	PUC Door OPEN/SHUT Motor (M) Drive Left - status	1					24V	10mA			

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Sl. No.	Purpose	DI	DO	AI	Ether net	RS-232	Voltage (V)	Current (mA)	Type of Sensor / Actuator	No. Of sensors	Remarks
30	PUC Door OPEN/SHUT Motor (M) Drive Left - - Spare	1					24V	10mA			
31	PUC Door OPEN/SHUT Motor (M) Drive Left - - Spare		1				24V	100mA	OptoIsolated Drive input		
32	PUC Door OPEN/SHUT Motor (R) Drive Left - CW direction (INA)		1				24V	100mA	OptoIsolated Drive input		
33	PUC Door OPEN/SHUT Motor (R) Drive Left - CCW direction (INB)		1				24V	100mA	OptoIsolated Drive input		
34	PUC Door OPEN/SHUT Motor (R) Drive Left - Enable		1				24V	100mA	OptoIsolated Drive input		
35	PUC Door OPEN/SHUT Motor (R) Drive Left - Reset		1				24V	100mA	OptoIsolated Drive input		
36	PUC Door OPEN/SHUT Motor (R) Drive Left - Spare		1				24V	100mA	OptoIsolated Drive input		
37	PUC Door OPEN/SHUT Motor (R) Drive Left - status	1					24V	10mA			
38	PUC Door OPEN/SHUT Motor (R) Drive Left - Spare	1					24V	10mA			
39	PUC Door LOCK/UNLOCK Motor Right CW direction (INA)		1				24V	100mA	1 No H-Bridge, 24V, 20A rating		
40	PUC Door LOCK/UNLOCK Motor Right CCW direction (INB)		1				24V	100mA			
41	PUC Door LOCK/UNLOCK Motor Right ON/OFF		1				24V	100mA			
42	PUC Door LOCK/UNLOCK Motor Right Current feedback			1			0-10V		Hall Effect Sensor	1	
43	PUC Door LOCK/UNLOCK Motor Left CW direction (INA)		1				24V	100mA	1 No H-Bridge, 24V, 20A rating		
44	PUC Door LOCK/UNLOCK Motor Left CCW direction (INB)		1				24V	100mA			

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Sl. No.	Purpose	DI	DO	AI	Ether net	RS-232	Voltage (V)	Current (mA)	Type of Sensor / Actuator	No. Of sensors	Remarks
45	PUC Door LOCK/UNLOCK Motor Left ON/OFF		1				24V	100mA			
46	PUC Door LOCK/UNLOCK Motor Left Current feedback			1			0-10V		Hall Effect Sensor	1	
	Canister Mechanism I/Os (for 8 Canisters)										
47	Canister Hatch Unlock -Pyro		24				24V	100mA			3 Relay for one Pyro. 3 X 8 Canisters = 24
48	Canister Hatch Open/Shut Motor CW direction (INA)		8				24V	100mA	8 No H-Bridge, 24V, 20A rating		
49	Canister Hatch Open/Shut Motor CCW direction (INB)		8				24V	100mA			
50	Canister Hatch Open/Shut Motor ON/OFF		8				24V	100mA			
51	Canister Hatch Open/Shut Motor Current feedback			8			0-10V		Hall Effect Sensor	8	
52	Missile Unlock Motor CW direction (INA)		8				24V	100mA	8 No H-Bridge, 24V, 20A rating		
53	Missile Unlock Motor CCW direction (INB)		8				24V	100mA			
54	Missile Unlock Motor ON/OFF		8				24V	100mA			
55	Missile Unlock Motor Current feedback			8			0-10V		Hall Effect Sensor	8	
56	Canister plume exit Detection	8					24V	10mA	Combustible Wire	8	1 Sensor per canister
57	Canister Presence Detection	8					24V	10mA	Loop back	8	Canister presence will be detected by looping back one pair of contact in I/O connector of canister
58	Article Presence	8					24V	10mA	Limit Switch	16	2 Nos. Of DPDT limit switches will be
59	Canister Hatch Open	8					24V	10mA	Limit Switch	16	

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Sl. No.	Purpose	DI	DO	AI	Ether net	RS-232	Voltage (V)	Current (mA)	Type of Sensor / Actuator	No. Of sensors	Remarks
60	Canister Hatch Close	8					24V	10mA	Limit Switch	16	mounted at each position. Their contacts will be wired for series parallel combination
61	Missile Lock	8					24V	10mA	Limit Switch	16	
62	Missile Unlock	8					24V	10mA	Limit Switch	16	
63	Sensor Supply Control Relay		1				24V	100mA	Relay	1	
	Common I/Os										
64	Cabinet Temperature			1			0-10V		Temperature Sensor	1	
65	Loop Back Checks for DI/DO AP Modules	3	4								
66	Fan Failure Detection	4							Leaf switch	4	One leaf switch switch per fan/blower
67	Power Supply DC Voltage			2					Voltage Divider	2	For 24V_Control and 24V_Field
68	Launcher Controller - MCU Interface (M)				1						
69	Launcher Controller - MCU Interface (R)				1						
	Total	77	107	21	2						
	20% Spare	15.4	21.4	4.2							
	Total	**92.4**	**128.4**	**25.2**	**2**						
	Round-off Total	**92**	**128**	**25**							
	Acropack Modules required	2.888	4.013	2.1	1						
	Round-Off	**3**	**4**	**2**	**1**						

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3. LAUNCHER CONTROLLER CABINET

3.1 Brief Description

The Launcher Controller Cabinet (LCC) shall be based on VPX bus-based architecture. There will be a Single Board Computer and Digital / Analog I/O cards for controlling all actuators and reading the sensor data. The Two Ethernet connections on SBC will be used for LCS-MCU communication link.

LC will have following hardware components:

Table 3-1 : VPX based Controller Components

Components	Qty
5 slot VPX Backplane with chassis	1
VPX Power Supply	1
Intel based Single Board Computer (SBC)	1
VPX4500 3U Acropack Carriers	3
AP441 32 channel Opto-isolated Digital Input Acropack Module	3
AP445 32 channel Opto-isolated Digital Output Acropack Module	4
AP342 14 Bit, 12 Differential Channel ADC Acropack Module	2
VPX4500-RTM-LF Rear Transition Module	3
Anti-Condensation Heater	2
10.4” foldable rugged Display with touch screen	1
Signal Conditioning Unit	1
Fan Blower Tray	1

The software will be developed on a Real Time Operating System (RTOS) RedHat RT Linux. The LCS of VL-SRSAM will be interfaced to MCU (WCS) over redundant ethernet channels. LCS will interface with sensors and drives for actuators, pyro-bolts over digital and analog channels. LCS will control drives by sending discrete signals for CW and CCW actuation in real time. Sufficient I/Os are also provided in VPX Hardware in order to implement the actuators operation. The LCS will control all mechanism of PUC and 8 canisters as per launch sequence. LCS will continuously monitor the status of all mechanisms and share these status with the WCS. Also the status will be visible on rugged Display. A comprehensive Ethernet communication protocol agreed between LCS and MCU will be implemented in LCS software.

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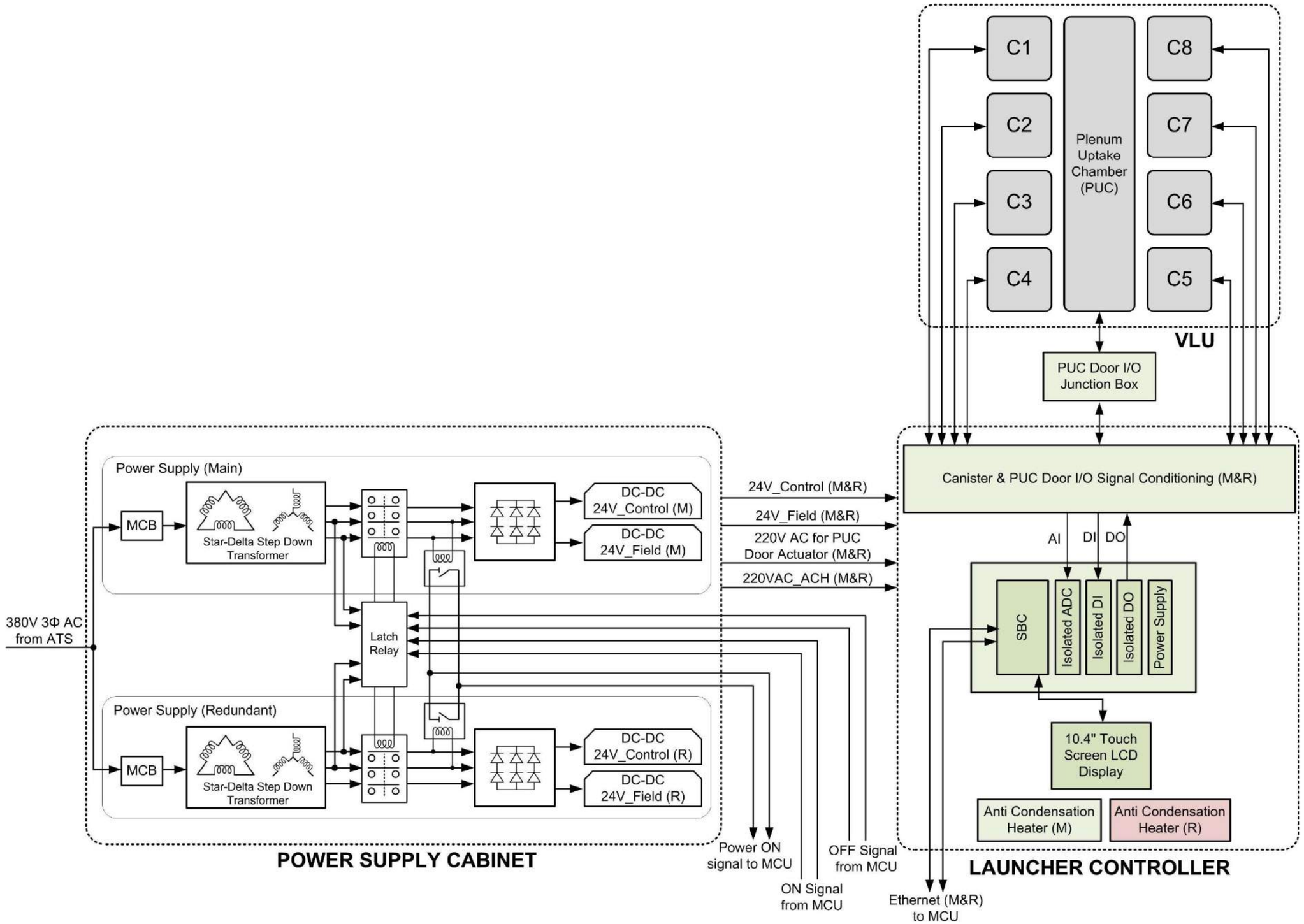

Figure 3-1 : Launcher Control System Architecture

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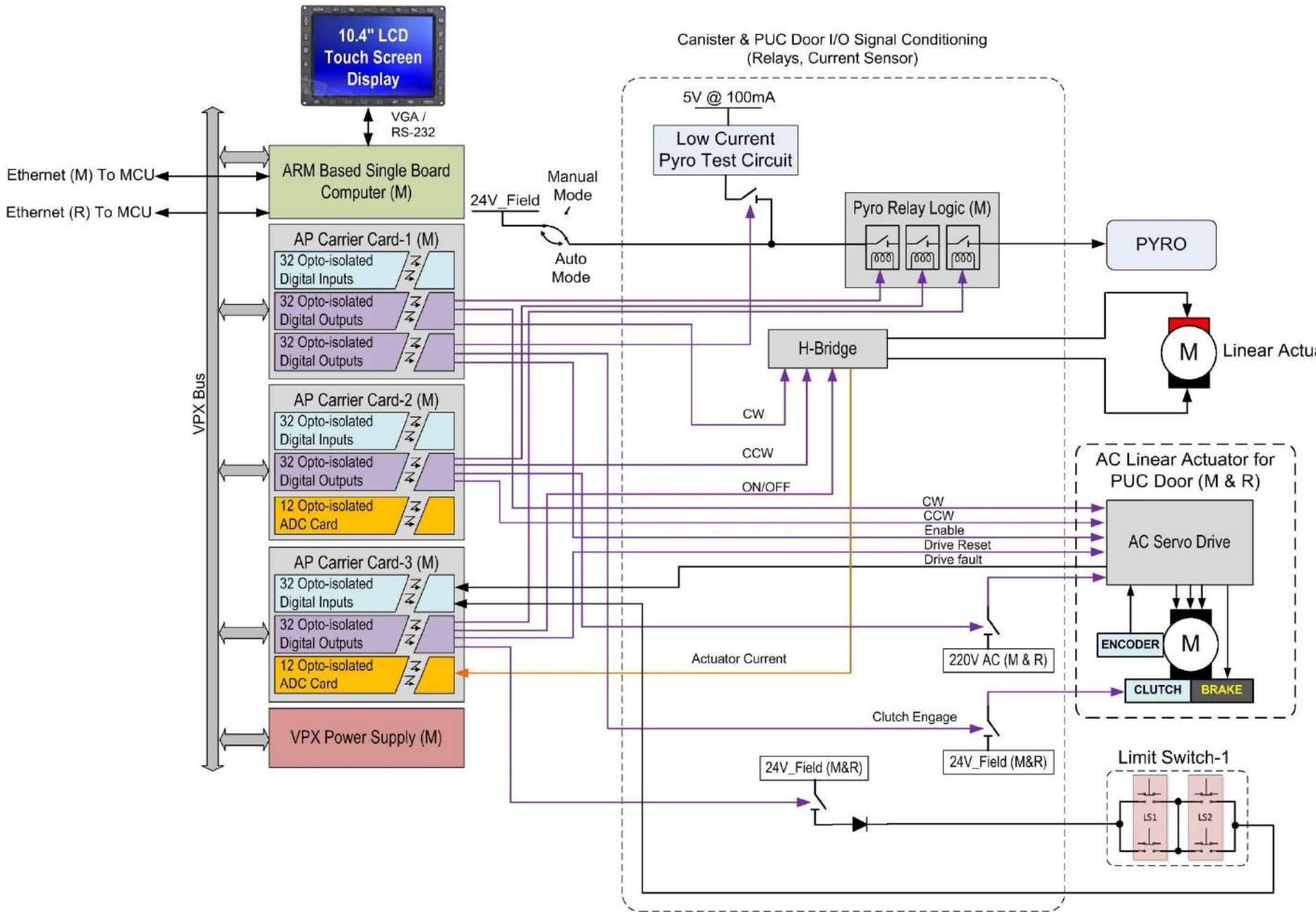

Figure 3-2 : VL-SRSAM Launcher Controller Cabinet internal Architecture

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3.1.1 Launcher Controller Cabinet Design

The Launcher Controller will be housed in Naval approved forced air-cooled cabinet. The figure 3.3 shows the physical location of all the components of Launcher Controller cabinet. The Anti-Condensation filter will be kept at the bottom most location inside the cabinets. Above Anti-Condensation filter, the COTS based SBC, Carrier Cards, Ethernet Switch and Power Supply will be kept. A 10.4" rugged touch screen LCD Display will be mounted above VPX Hardware. A removable fan/blower tray will be provided on top of the LCD. The inlet and outlet air axis of fan/blower tray will be 90° to each other. Above the fan blower tray, the canister & PUC door I/O signal conditioning, consisting of Relays and Current sensors will be located. On top of that Input EMI filters, fan failure indicator, Power On indicator will be placed. The input & output power and I/O signal connections will be provided on the cabinet top panel.

The COTS based cards (SBC, Carrier Cards & Power Supply) will be packaged as Line Replaceable Units (LRUs) which will slide inside the cabinet with blind mating connector in the back.

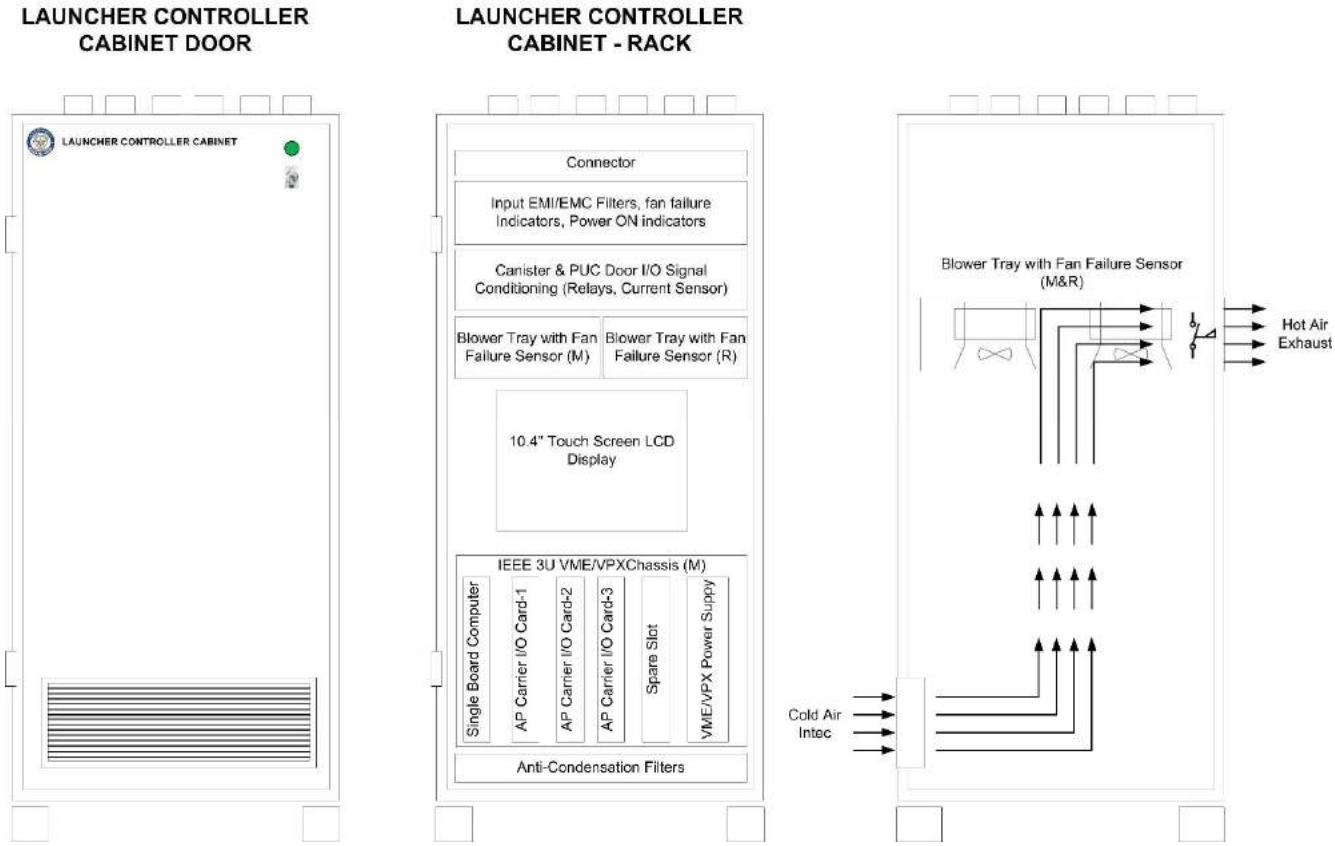

Figure 3-3 : Launcher Controller cabinet Layout

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3.1.2 SBC & I/O Card Specification

3.1.2.1 Single Board Computer

a) Make: Curtiss-Wright
b) CPU : 5th Gen Intel Core i7 “Broadwell”
c) Quad Core (8-thread) i7-5850EQ with 2.7 GHz with Turbo upto 3.2 GHz (47W)
d) Memory: Upto 16 GB DDR3L at 1600 MT/s
e) Upto 32 GB SATA NAND Flash
f) Back Plane I/O :
g) 8 X PCIe data Plane
h) Supports Gen1 (2.5 GT/s), Gen2 (5.0 GT/s), Gen3 (28.0 GT/s), expansion Plane,
i) One XMC Mezzanine Site
j) Dual Gigabit Ethernet Port
k) 2x RS 232, 2x RS 422, 3x USB 2.0, 1x RGB/VGA graphics Port, Intel HD audio input and stereo output
l) Max Power Consumption: 57W
m) Operation Temp: -40°C to + 85°C
n) Conduction Cooled/ Air Cooled SBC
o) Microsoft Windows/VxWorks/ linux Real Time Operating system based software compatible

Figure 3-4 : VPX Single Board Computer

3.1.2.2 Acropack Digital Input Card

a) Make: Acromag
b) PCI Express
c) 32 optically isolated digital inputs
d) Input Voltage: ±16 to ±40V DC or AC peak
e) Conduction Cooled
f) Operating temperature -40°C to +85°C

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g) Vibration and Shock Resistant

h) Qty: 3 Nos

Figure 3-5 :Acropack Digital Input Card

3.1.2.3 Acropack Digital Output Card

a) Make: Acromag

b) PCI Express

c) 32 optically isolated digital Outputs

d) ±60V AC/DC voltage range

e) High Speed Processing

f) Conduction Cooled

g) Operating temperature -40°C to +85°C

h) Vibration and Shock Resistant

i) Qty: 4 Nos

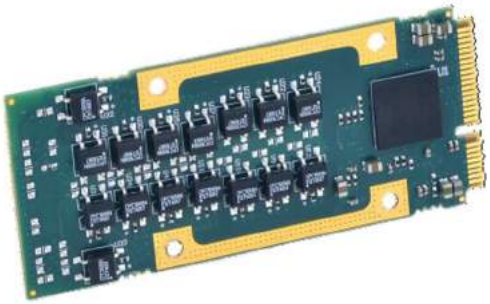

Figure 3-6 : Acropack Digital Output Card

3.1.2.4 Acropack Analog Input Card

a) Make: Acromag

b) PCI Express

c) Six Isolated,14-bit ADC

d) 12 Differential inputs with ±10V input range

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e) Maximum throughput rate: 8µS/conversion

f) Conduction Cooled

g) Operating temperature -40°C to +85°C

h) Vibration and Shock Resistant

i) Qty: 1 No

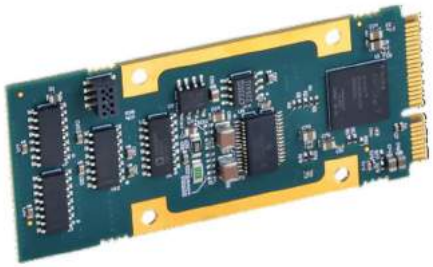

Figure 3-7 : Acropack Analog Input Card

3.1.2.5 VPX Power Supply Module

a) Open VPX – VITA 62

b) 18 – 45V input voltage range

c) 600W output power

d) 3U Open VPX power supply

e) Conduction cooled

f) I2C monitoring and control

g) Input voltage reverse-polarity protection

h) Overcurrent, overvoltage and overtemperature protections

i) IPC 610 class 3

j) No aluminum electrolytic capacitors

k) Enable, inhibit, system reset and power fail controls

l) Accredited laboratory military standard compliance:

m) -MIL-STD-704F

   a. -MIL-STD-461G

   b. -MIL-STD-810G

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Figure 3-8 : VPX Power Supply Module

3.1.2.6 LCD Display

A 10.4" rugged LCD Display will be used for maintenance/ Training purpose. The display can be mounted in a foldable rack inside the Launcher controller Cabinet. The Graphical User Interface (GUI) will be developed using QT/ Open GL. GUI will be implemented to indicate the canisters & PUC Door status and it will have provision for the operator to carryout diagnostics test. The touch screen display will be by default kept in OFF condition. Only on need basis the operator can open the Launcher Controller Cabinet Door and switch ON the display unit to perform necessary operation.

Figure 3-9 : Touch Screen LCD Display

3.1.3 PUC and Canister I/O Signal Conditioning Unit

The PUC & Canister Signal Conditioning Unit will consist of relays and H-Bridge drivers for interfacing PMDC Motor actuators, AC Motor Drives and Pyros with VPX Hardware.

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3.2 Test Jig for PUC Door & Canister Emulation

A test jig will be developed to emulate the interfaces of Launcher Control System with PUC Door and Canister. The test jig will consist of toggle switches & indicators. Toggle switches to emulate state of different mechanisms of each canister & PUC Door and indicators will emulate the actuators related signals for each canister PUC Door. The connectors on test jig shall be same as used on canisters and PCU Door.

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4. POWER SUPPLY CABINET

The Power Supply Cabinet (PSC) includes the components/units required for providing conditioned power to different power consumers like Launcher Controller Cabinet, sensors, actuators etc. The PSC will receive 380VAC, 3Ø, 50Hz from the ship and convert it to 220VAC, 1-φ, 50Hz and 24VDC for consumption. Appropriate fuses with fuse blown indicator, MCB and single phase failure detection circuit will be provided in the power supply cabinet. The Power Supply block diagram is shown in figure 4-1. The power supply cabinet will provide two separate rated power supply outputs i.e. Main and Redundant channels for each type of consumer. Both channels will always remain powered ON simultaneously.

4.1 Delta to Star Step Down Transformer

A Delta-Star Step Down Transformer is used to convert input 380VAC, 3Ø, 50Hz to 220VAC, 3Ø, 50Hz. A detail power requirement analysis was carried out and approximately 10kVA transformer is required for this system. The neutral of the secondary star connection will not be used and hence will be kept inside the cabinet only.

4.2 AC-DC Conversion

The 220VAC, 3Ø, 50Hz output of step-down transformer will then be rectified, filtered and DC output will be given to DC-DC converters filters. The DC-DC converter will convert high voltage DC to 24V DC. There will be two separate rectifiers and two DC-DC converters, one for 24VDC for control and other is 24VDC for field.

A schematic for conversion is configured using modules of Vicor make and is shown in figure 3-22. The TPM series modules available from Vicor takes 220VAC 3Ø, 50Hz input and has in-built rectifier and filtering module reducing the no. of separate elements required to do the same. This module produces 311VDC output which is fed to bus converter (BCM4414 module of Vicor make) producing low voltage dc from high voltage DC which produces a low output of 38.4VDC as its transformation ratio is 1/8. The output is then fed to an array of isolated DC-DC converters (DCM module of Vicor Make) which produces an output of 24VDC (which is settable from 22 VDC to 30.8 VDC). Additional filters and capacitors will be added at appropriate points in the scheme to achieve the compliance for EMI/EMC requirements. The same scheme is used to generate the four DC outputs namely, Control_24V(M), Control_24V(R), Field_24V(M), Field_24V(R).

The AC-DC converter as per schematic in figure 4-2 will be packaged as a single LRU with blind mating connectors at the rear with switches and indicators on front facia. Each output will be protected with fuse and fuse blown indicator.

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4.3 Power Control Logic

The power control of the Launcher Control system is through MCU (WCS). Hence a three-phase contactor is provided at the output of transformer. When the contactor is OFF only Anti Condensation Heater (ACH) will be powered ON through NC Contacts. The AC contactor coil will be switched through a DC latch relay. This DC latch relay is turned ON / OFF from MCU remotely. If the Latch relay is ON then the AC contactor coil will get 220VAC supply and the contactor will be turned ON. Once the contactor is ON, 220V AC will be available which will turn ON fan blowers and provide input power to three phase rectifier. A single-phase AC relay coil is connected to one of the phases of 220V AC which will be turned ON as soon as 3 phase AC contactors is turned ON. The pole and NO contact of this AC relay are used by MCU to sense the power ON status of Launcher Controller.

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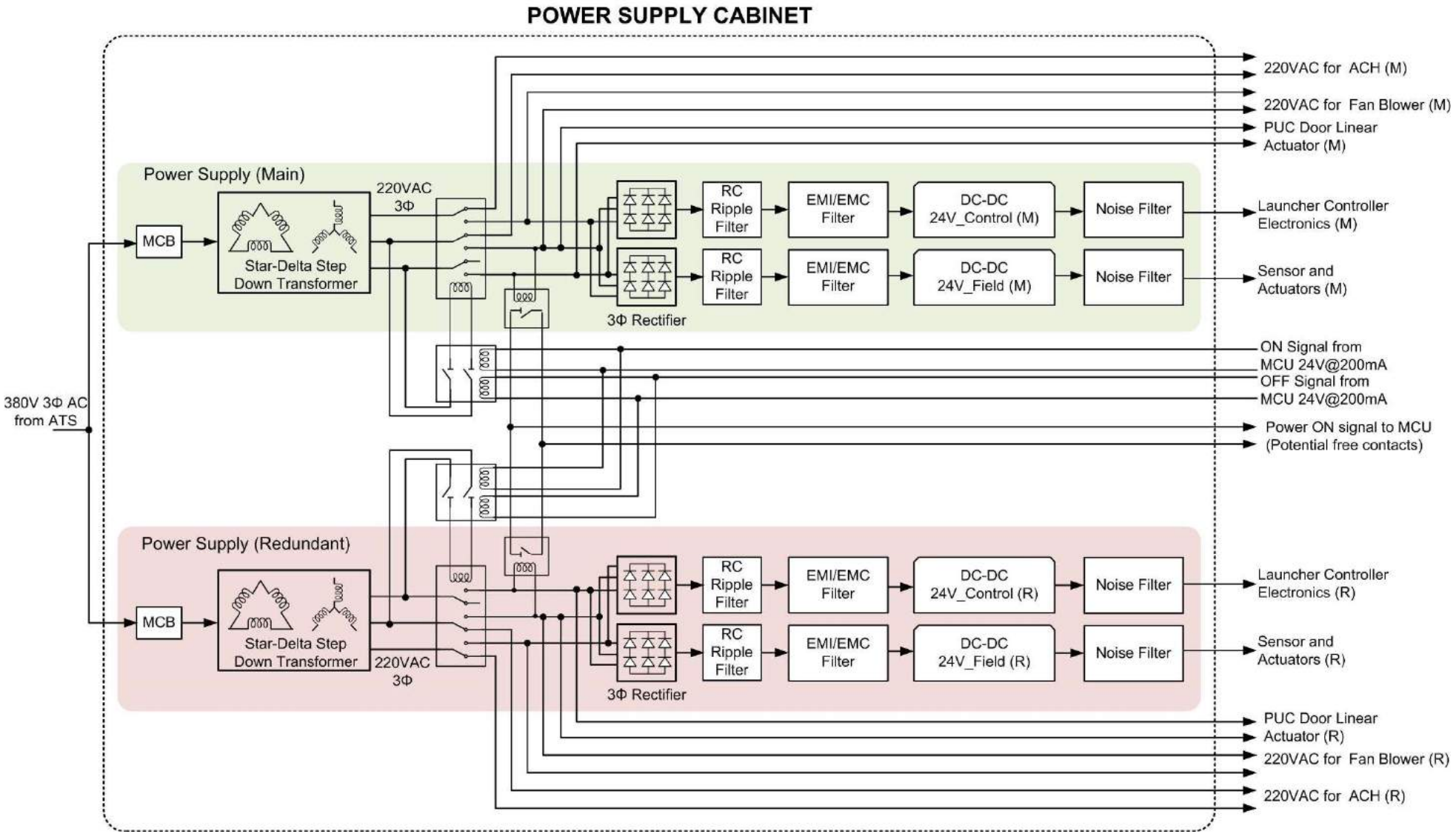

Figure 4-1 : Block diagram of Power Supply

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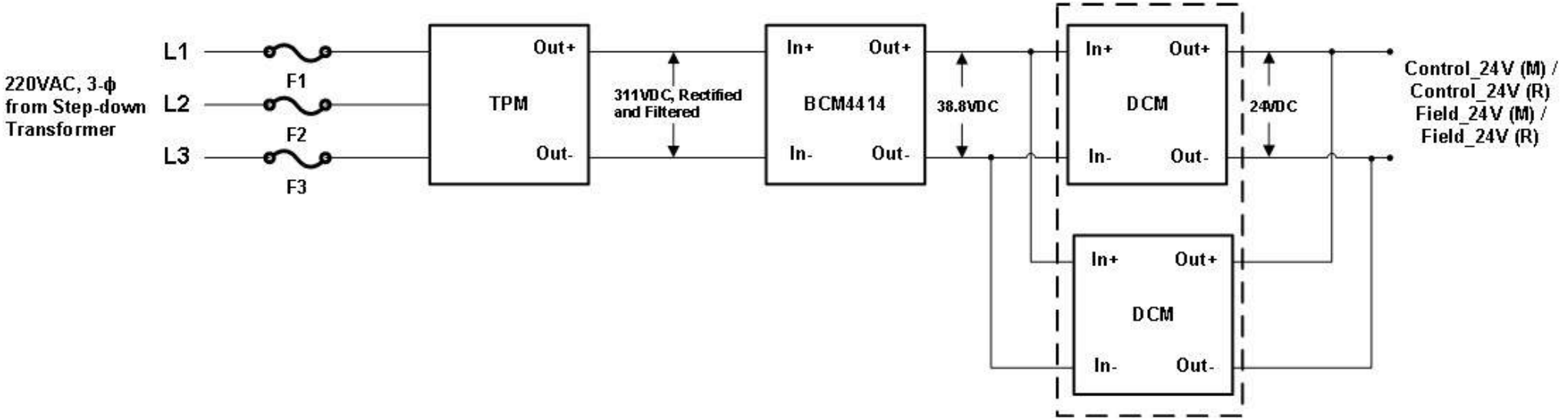

Figure 4-2 : AC-DC Conversion Schematic

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4.3.1 Power requirement & Heat Load Calculation

In this section, system and sub system level power requirement and heat generated by them is calculated. The input power requirement is required for the platform power system and heat load data is used to provide proper Air-conditioned cooling from the platform.

A top down approach is followed for assessing the power requirement and the calculating the heat load. First the power required for VLU actuators, pyros and sensors were calculated. Then the power required for electronics of Launcher controller and other peripherals is calculated. This gives the load on both DC-DC converters i.e. 24VDC_Control and 24VDC_Field. After considering the efficiency of DC-DC converters the load on rectifiers and Transformer is calculated.

The power requirement and heat load are calculated considering worst case scenario during operation which is when salvo of 3 articles is executed.

The AC power consumers of VLU and Launcher Control System are supplied power from 220VAC output of transformer. DC power consumers of VLU are supplied power from two different DC-DC Converters (24VDC_Control and 24VDC_Field) arranged in main and redundant configuration. It is important to calculate the load on these AC and DC power supplies so as to size them properly and ensure that sufficient power is always available for worst case scenario.

A power requirement analysis from bottom to top is required for estimating the wattage of different power conditioning units.

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4.3.1.1 Summary of Power Requirement and Heat Load

Table 4-1 : Summary of Power requirement and Heat Load

Sr. No.	Subsystem	Power Requirement / Heat Load (W)
1.	24VDC_Field (M)	**977 W**
2.	24VDC_Field (R)	**977 W**
3.	24VDC_Control (M)	**140 W**
4.	24VDC_Control (R)	**140 W**
5.	Heat Dissipated in Launcher Controller Cabinet	**128.4W**
6.	**Power Supply Cabinet**	
	Total Load on One Transformer	**4746 W**
	Transformer rating with 0.8 power factor	**5.93 kVA**
	Actual Transformer Rating considering the derating of 1.5	**8.9 kVA**
	Heat Dissipated in Power Supply Cabinet	**1526 W**
Total Power Requirement		
	Total Power required for Main and Redundant Channel	**5404 W**
	Input Power in kVA rating with 0.8 power factor	**6.76 kVA**
	Total Input Power Requirement	**10.14kVA**
Total Heat Load		
	Total Heat Load of Launcher Control Cabinet	**128.4W**
	Total Heat Load of Power Supply Cabinet	**1520W**

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4.3.2 Power Supply Cabinet design

The Power supply will be housed in Naval approved forced air-cooled cabinet. The figure 3-23shows the physical location of all the components of power supply cabinets. The transformers being heavy will be kept at the bottom most location inside the cabinets. Rectifier and DC-DC converter units will be kept above transformers. A removable fan/blower tray will be provided on top of DC-DC converters. The inlet and outlet air axis of fan/blower tray will be 90° to each other. All contactors and relay will be located above the fan blower tray. On top of that MCB, Switches, fan failure Indicators, Power ON indicators, Voltage / Current Readouts will be placed. The input & output power connections will be provided on the cabinet top panel.

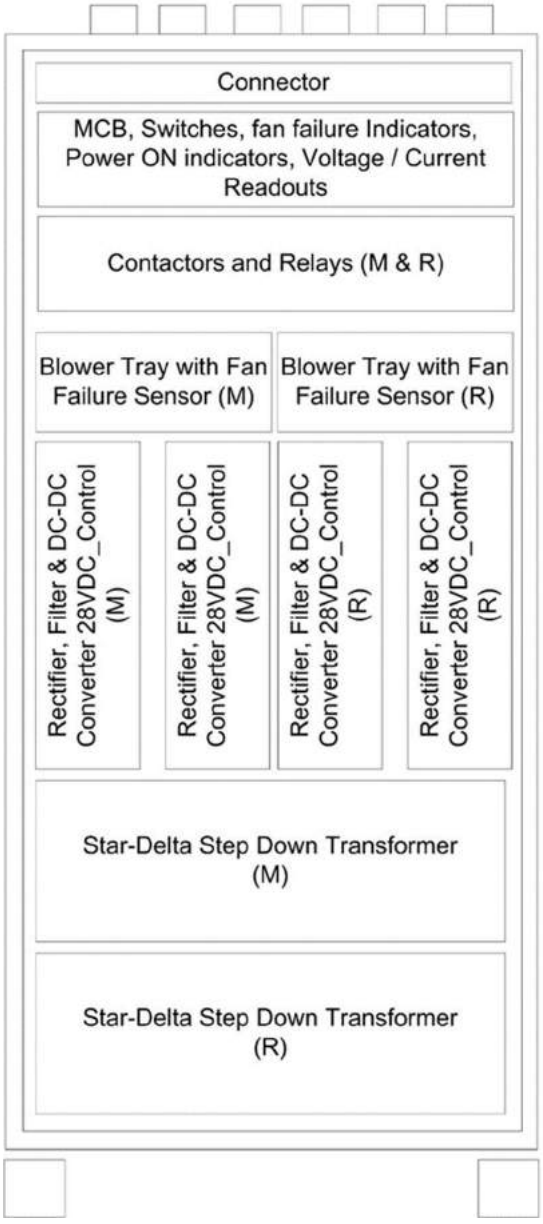

Figure 4-3 : Power supply cabinet Layout

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The transformers will always remain ON to power the Anti-condensation heaters of launcher cabinets. As the transformers will be continuously ON, the self-heat generated will provide the effect of anti-condensation heater for the Power Supply Cabinet.

The rectifier, ripple filter, EMI/EMC Filter and DC-DC converter will be packaged as Line Replaceable Units (LRUs) which will slide inside the cabinet with blind mating connector in the back.

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5. CABINET DESIGN

5.1 Introduction

The Electronics "Cabinet of Control System" houses PCBs, switching units, power supplies, relay cards etc. of the control system. It provides proper shielding and structural integrity to the system they contain and also ensure reliable operation. The cabinets are designed for open loop forced air cooling, series flow. It has got 5 levels of packaging to house various electronics units of the system. The inter-cabinet connections will be done through the connectors mounted on the top connector plate of the cabinet.

The airflow pattern inside these cabinets has been designed to have minimum components temperature under steady state operating conditions. The cabinet is specifically designed for naval applications and meets the requirements of structural integrity, maintainability, serviceability and operational convenience under harsh conditions. The modular designs have been selected for cabinets in view of convenient installation at desired location, light weight, high density packaging with maximum rigidity.

Following are the features included in the design of cabinets:

a) All the cabinets are designed for a specified IP protection (IP - 23) standard and use forced air open loop cooling.
b) Main sub-units of system are manufactured in the form of easily removable units/modules. The design of the modules is based on a card cage concept, which ensures that modules are mated without difficulty.
c) Maintenance of the cabinet is provided from the front side only. The modules are plugged in a card cage and are mated at the rear on a VPX motherboard/connector panel.
d) Equipment panels and cabinets are manufactured from nonmagnetic or low magnetic aluminum alloy materials.

5.2 Five Level Cabinets

The basic dimensions of the cabinet is 650mm(W) x 540mm(D) x 1371mm(H) which enables convenient handling at the time of installation.

The cabinet is divided into five levels of packaging for housing the various units. The sub-systems like power supplies are planned to be housed in the bottom level while other light weight units can be accommodated in upper levels of cabinet. The bare weight of each cabinet is approximately 117 kg.

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The cabinet structural frame is welded. Front and Rear covers are hinged and are removable. The use of a positive locking ensures proper tightness with the frame and use of latch mechanism for covers facilitate easy and quick removal and assembly of the systems during maintenance and servicing. The structure is catered for EMI protection, water tightness and convenient handling. Provision for proper earthing is available. Structural material is non-magnetic, high quality Aluminum alloy extrusion as per IS 64430 (HE-30) and IS 64432 (HE-9). Aluminum alloys provide high stiffness to weight ratio and excellent workability. To improve the corrosion resistance suitable epoxy resign type paint (fire retardant dove grey) is applied on all parts subsequent to the application of appropriate acid etch primer suiting to the requirement of each part.

5.3 Cooling Arrangement

The open loop, forced air-cooling is employed in these cabinets. The air flows vertically upwards from one level to another level. Air is sucked from front and it is discharged into the compartment through the opening at the rear top of the cabinet after absorbing the heat generated in all levels.

5.4 Grounding Scheme

Provision is available for proper earthing and bonding in the cabinets. All cabinets are to be grounded individually with hull with minimum wire length. Power grids and grounds are provided at each level. All PCBs grounds are interconnected to the common ground provided in the level through the edge connectors. The grounding of all levels is taken to a grounding point provided at the top of the cabinet. A common grounding line joins all cabinets and is finally grounded to the platform. The cabinets are electrically isolated from the platform by the isolation pad and Teflon bushes. Each cabinet is provided with a ground bar running inside through all levels. This copper bar will be used to common the ground of subsystems in the Cabinet.

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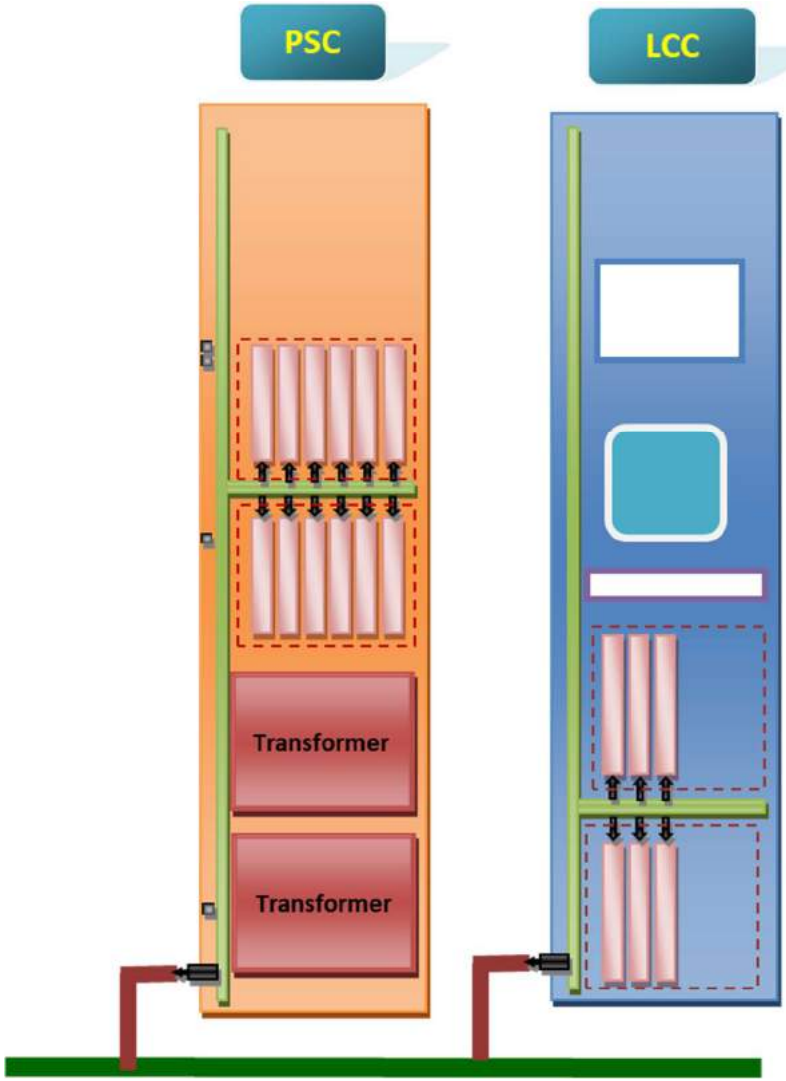

	COPPER BRAID
	SHIP GROUND
	VPX CAGE
	COPPER STRIP FOR CHASSIS GROUND
	GROUND STUD
	BRAID CONNECTING POWER SUPPLY CHASSIS GROUND
	POWER SUPPLY MODULES

Notes:

1) Isolation transformers are provided in PDP cabinet which converts 380 V, 3Φ, 50 Hz DELTA to 220 V, 3Φ, 50Hz, STAR.
2) All power supply grounds are floating and are not connected to chassis of Cabinet.
3) EMI-EMC filters are provided in all AC-DC modules and DC-DC modules

Figure 5-1 : Grounding Scheme for Cabinet

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5.5 Mounting of Cabinets

These cabinets have been designed to withstand severe shock and vibration levels due to underwater explosions of a specific nature. The cabinets are provided with 4 wire type shock and vibration mounts at the bottom and two at the rear top. The mounting arrangements of the rear shock mounts are to be decided to suit the installation location. The shock mount selection is based on weight of cabinet along with units and vibration frequency spectrum of the proposed naval vessel. For cabinet to withstand the dynamic vibration loads, the amplification characteristics of isolators are to be selected in view of forcing frequency of naval vessel.

5.6 Anti - Condensation Heaters

The cabinets will be provided with anti-condensation heaters with proper indicators, redundancy in ACH and ACH supply, heater cut off arrangement. The heater will become operational automatically when the cabinets are switched OFF. In no circumstance, the anti-condensation heaters will remain ON when cabinets are in working condition.

5.7 Materials

The materials being used for magnetic, electric and mechanical parts will be approved as per naval warship application. NES-502 may be referred for guidance. MIL grade components will be used as far as feasible.

5.8 Paint Specification

The paint specifications for cabinets, consoles, junction boxes and other units of the system will be as per NES-503**, fire retardant dove gray paint outside the units and white paint inside the units will be as per NES-507.

5.9 Toxicity of Non-Magnetic Materials:

Toxicity of non-metallic materials will not be more than index level 3 as specified in NES 713.

5.10 Tally Plates:

Suitable tally plates will be provided on individual devices for identification. Text and size of tally plates will be finalized during development.

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5.11 Lifting Arrangement:

Suitable arrangements like eyebolts will be provided for all units and sub-assemblies weighing more than 40 kg. The eyebolts may be removable.

5.12 Fan Failure Indication

A hardwired circuit is to be designed and implemented to display the status of the faulty cooling fans along with the audio alarms (buzzer) to draw operator attention. Reset Button is provided to reset the alarm. Alarm comes up automatically in case of fan failure, as well as temperature build up within the cabinet. The temperature and fan failure data will also be communicated to MCU (WCS) periodically.

Tentative design of cabinet is shown in figure 5-2.

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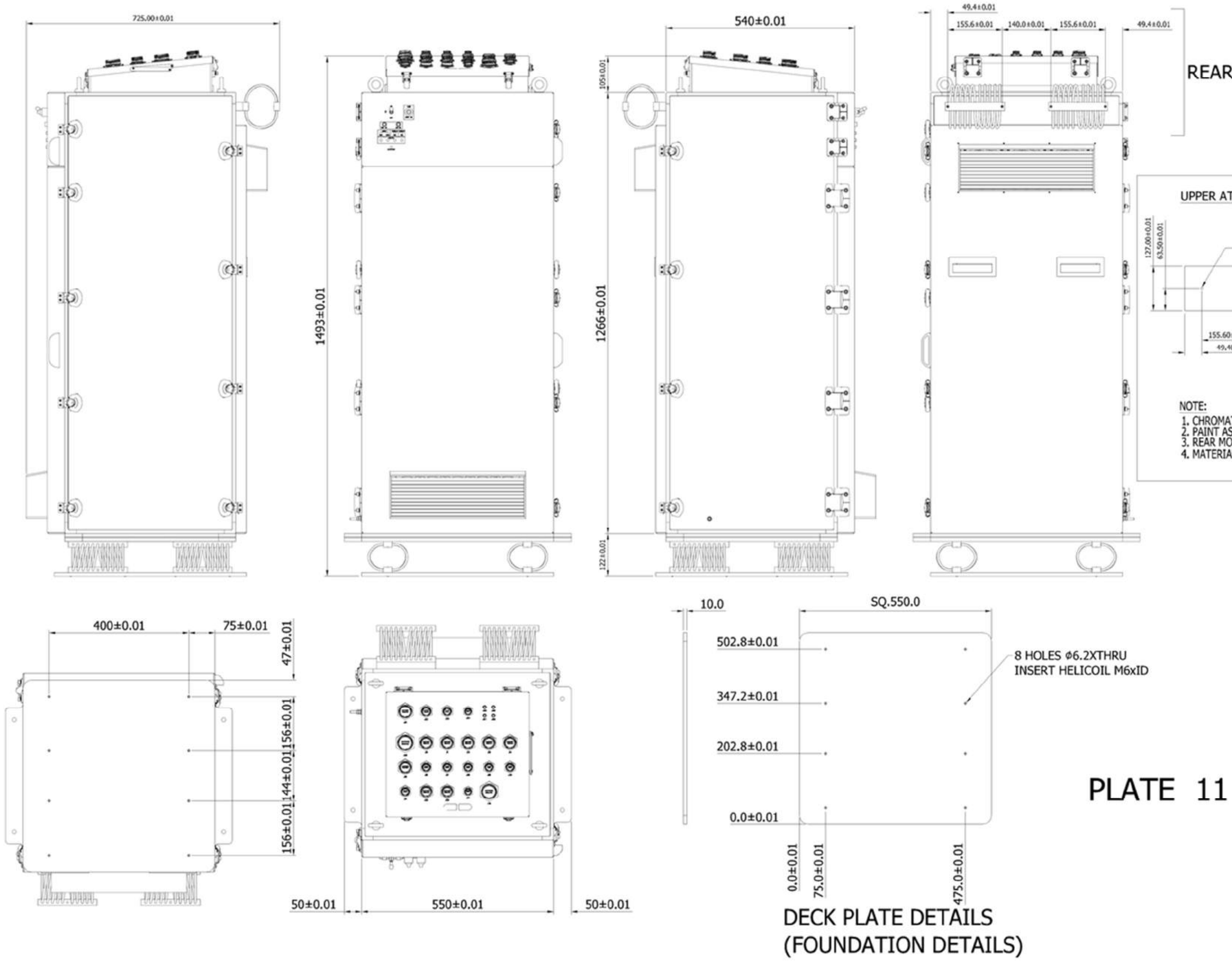

Figure 5-2 : Cabinet Design

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6. CABLE & CONNECTORS

6.1 Cables

The cabling layout / routing will be simple and easy to identify and trace. Power signals and sensor signals will be routed separately. Proper care to shield and isolate signals from power signals will be maintained. Cabling will be done using proper color codes for signals in addition to ferrules for easy maintenance and identification. Cabling scheme will be designed in such a way that input /outputs can be isolated for fault finding. Cable harness of Tyco Electronics ***System 25*** or equivalent to be used. All cable/harness on system should be able to withstand rain conditions and not allow any water to leak inside the connectors and cables.

6.2 Connectors

MIL Type D38999 Series or Equivalent type of connectors will be used in the system. Proper selection of connectors i.e. male/female sockets will be done to avoid shorting with system body when connectors are disconnected for testing etc. Selection of same shell size connectors used on any one junction box will be chosen with Key feature such a way that interchange of connectors will not be possible in any way. Choice of proper connectors depending on direction of harness layout i.e if harness is turning downwards a right-angle connector will be used etc.

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7. LAUNCHER CONTROL SYSTEM SOFTWARE

Launcher Control System will be developed on RedHat Real Time Linux (RHEL) operating system. The software shall be developed in compliance with DSSD as per the specifications detailed in this chapter.

7.1 Functional Requirement

The LCS software will meet following functional requirements and capabilities:

1. Feedback from sensors of PUC and all 8 canisters of VLU as listed in Table 2-9 shall be read for the purpose of status monitoring and system state detection.
2. Status monitoring of power supply cabinet.
3. LCS software shall be able to control the following operations
    a. PUC Door Unlocking
    b. PUC Door Opening/Closing
    c. Canister Hatch Locking / Unlocking
    d. Canister Hatch Opening / Closing
    e. Article locking/Unlocking
4. The operations shall be carried in a pre-defined sequence to prevent unsafe conditions for mission execution.
5. There shall be safety interlocks implemented in the software related to all the operations to prevent any damage to system
6. LC shall implement a communication interface with MCU (WCS)
    a. To send status of different mechanism of PUC and all 8 canisters of VLU
    b. To receive command for execution of PUC or canister related operation
    c. To send message codes indicating acknowledgements, errors, warnings etc.
7. LC software shall implement a GUI
    a. To display the real time status feedback from different mechanisms of PUC and all 8 canisters.
    b. To provide an interface for carrying out operations of PUC and all 8 canisters for maintenance purpose.
    c. For updating system configuration related parameters.
8. System Initialization and Built In Test Equipment (BITE) shall be implemented in software
9. Fault Diagnosis and Error Handling
10. Data & Event Logging with time stamp

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7.2 Software Architecture

The software is designed in different layers. The layered approach to software development ensures that the different components can be developed independently and also reused across all the CSCIs. The components will be designed with high degree of cohesion and low degree of coupling. Cohesion helps in designing components that have very specific goals and clearly defined purposes. Coupling is a measure of the strength of association established by a connection from one software-component to another. Strong coupling among objects complicates a system since the component is highly interrelated with another component. The architecture diagram is explained in **Error! Reference source not found.**.

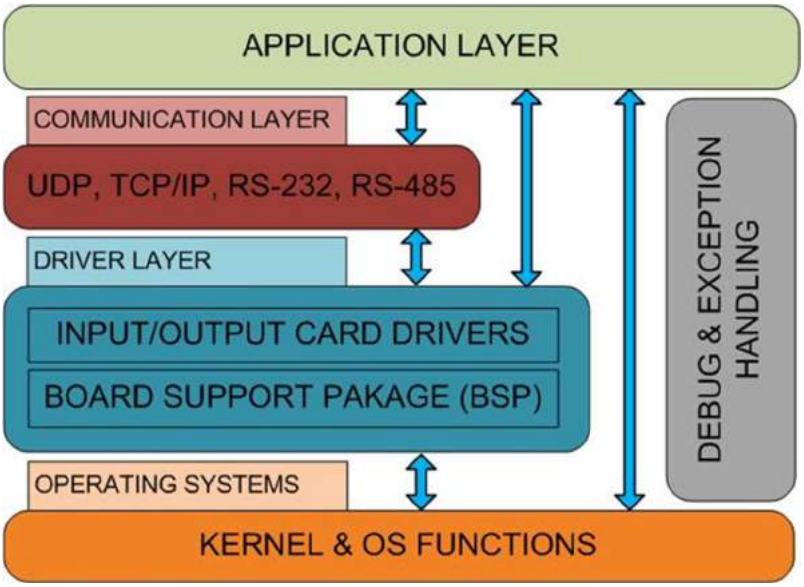

Figure 7-1 : Launcher Software Architecure

LCS software consists of following Computer Software Configuration Items (CSCI):

i. Launcher Control System CSCI

7.2.1 Launcher Control System CSCI Requirements

The requirements of Launcher Control System CSCI are as follows:

1. LCS has to control all the actuators and monitor sensors for all 8 canisters of VLU.
2. LCS has to establish and maintain Ethernet communication with MCU (WCS)
3. Built In Test Equipment (BITE) to be implemented in LCS software
4. All modes and regimes shall be implemented in LC software
5. Data Logging with time stamp to be implemented in LCS software. Operator should be able to download the logged data form LCS directly.
6. Health check and diagnostic features to be provided in the LCS software.

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7. The faults in system to be reported to MCU(WCS).
8. Safety interlocks to be implemented in the LC software for safe and reliable operation
9. All sensor status to be continuously sent to MCU (WCS) at regular intervals of 1sec by LCS software
10. LCS software should be based on a Multi-Tasking Real Time Operating System platform
11. Supervisory / monitoring tasks to be implemented in LCS software
12. Watch dog mechanism to be implemented in LCS software to detect and come out of software failure situations.
13. Interrupt based I/O reading to be implemented in LCS software for efficiently utilizing the CPU time.

7.2.2 Method, Tools and Techniques

Development Methodology	: Preferably OOAD
Development Environment	: Desktop PCs, networked with LAN, Workbench version No x.x
Target Environment	: Intel Core i7
Operating System	: Real Time Linux
Language	: C/C++
GUI	: QT / OpenGL
Design Tool	: IBM Rational Rose
Graphics Package	: NA
Configuration Control Tool	: ClearCase or equivalent
Code analyzer (static)	: Polyspace or equivalent

7.2.3 Communication Interfaces

Ethernet is main communication link between the Launcher Control system and the MCU (WCS). The Launcher Control System will have two ethernet ports which will be connected to MCU (WCS) as main and redundant link. UDP protocol will be used for link check and TCP/IP protocol will be used for data transfer between LCS and MCU (WCS). The communication interfaces of Launcher Control System with the external entities are as shown in figure 7-2 below.

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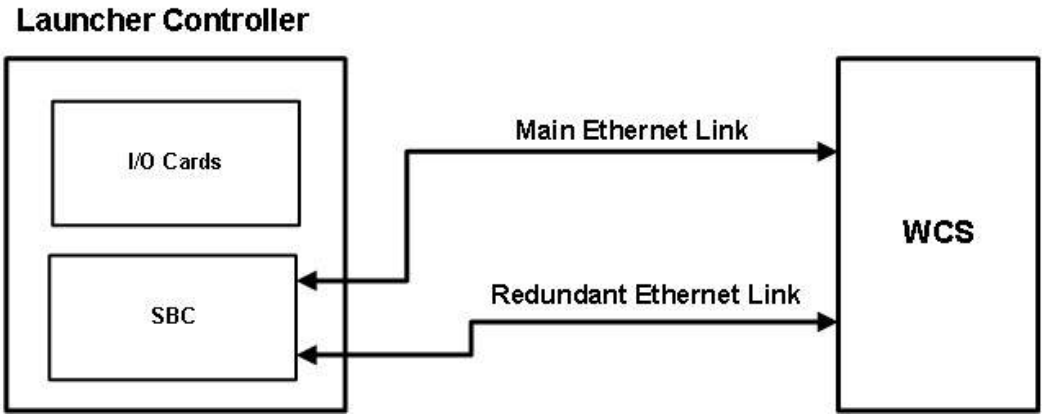

Figure 7-2 : Communication Interface Diagram of VL-SRSAM

7.2.3.1 Link Check

Link check shall be carried out by MCU (WCS) at periodicity of the one second. The status of this link check will be available on LCD continuously. The link check is implemented using the connectionless UDP (User Datagram Protocol) socket. MCU (WCS) shall send link check packets and receive acknowledgement from LCS back to confirm the link. The link can be declared bad after three consecutive retries, however MCU (WCS) shall still continue to send the link check packets defined interval. At any time, MCU (WCS) starts receiving the acknowledgement packet from LCS again, it shall update the link state to good.

7.2.3.2 TCP/IP Communication

The TCP/IP is a connection-oriented reliable data transfer protocol for LAN. It is based on the client server methodology. In this case Launcher Control System will be server and all other ethernet interfaced systems will be client.

7.2.4 LCS and MCU (WCS) Command / Data Exchange

Launcher Control System is interfaced to MCU (WCS) over Ethernet communication link. The MCU (WCS) shall carry out link check every 1 second. The command and data Exchanged between LCS and MCU (WCS) are shown in figure 7-3.

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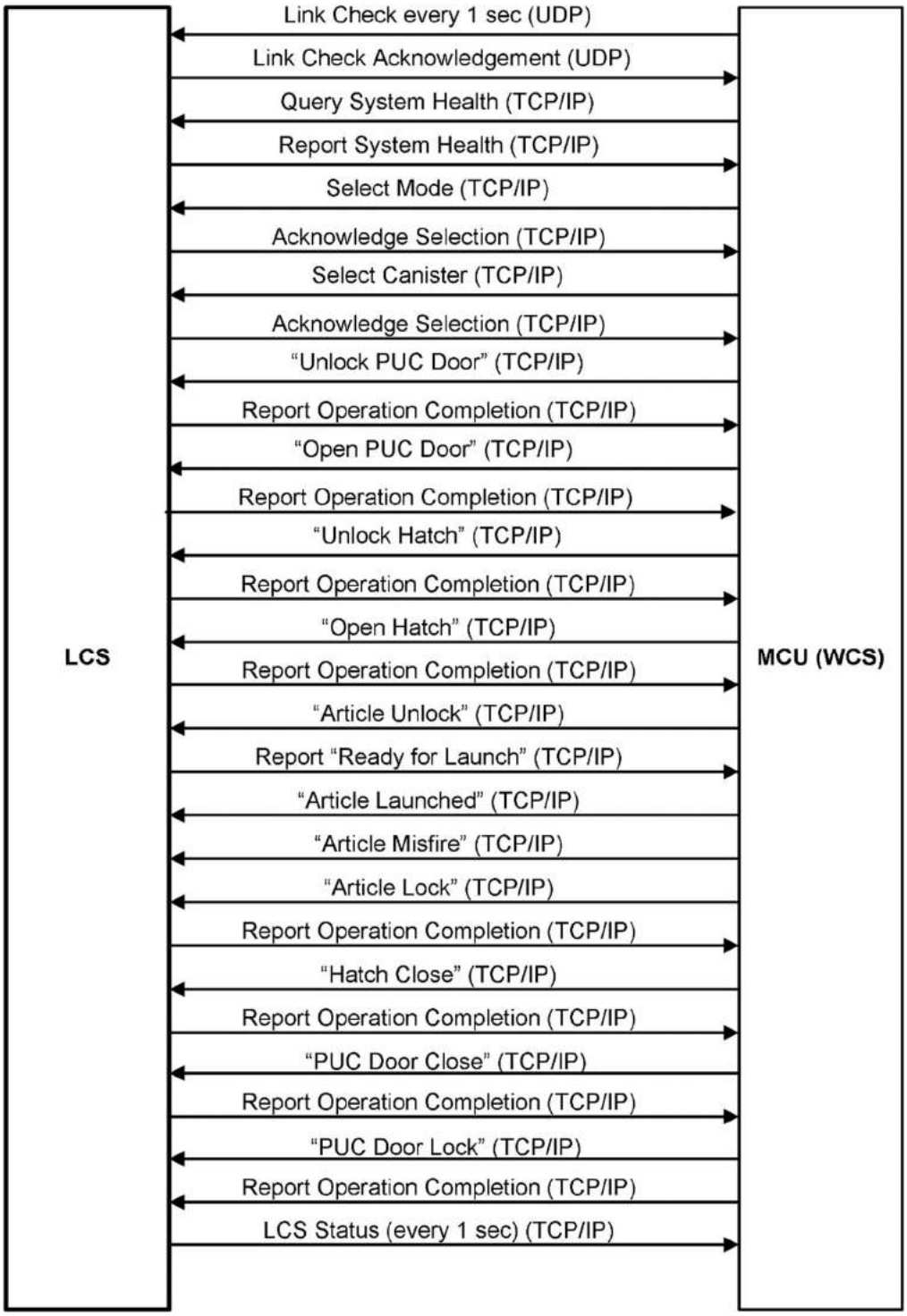

Figure 7-3 : LCS- MCU(WCS) Command / Data Exchange

The messages are explained as follows:

i. Link Check

The MCU(WCS) sends its own IP address every one second over UDP to LCS as a link check packet. The LCS responds to it by sending an acknowledgement packet. This information shall be used by MCU(WCS) to indicate the link status between MCU(WCS) and LCS.

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ii. **Query System Health**

MCU(WCS) will send a query packet to the LCS for verifying whether LCS is in healthy state or there is some error which can prevent successful execution of the Launcher operations. Once received and processed, LCS will update its health ststaus to MCU(WCS) via "Report System Health" packet

iii. **Select Mode**

The Select Mode command is sent by MCU(WCS) to LCS. The command will contain a value for mode to be selected based on which LCS will change its operating mode to selected mode. Once successfully executed by the LCS, an acknowledgement will be sent to MCU(WCS) via "Acknowledge Selection' packet.

iv. Select Canister

The Select Canister command is sent by MCU(WCS) to LCS. The command will contain the canister number to be selected based on which LCS will make the selected canister as active canister and further commands from MCU(WCS) will be executed for the active canister only. Once successfully executed by the LCS, an acknowledgement will be sent to MCU(WCS) via "Acknowledge Selection' packet.

v. Unlock PUC Door

This command is sent by MCU (WCS) to LCS. Once the command is received, after verifying interlocks, 'Unlock PUC Door' operation will be executed. Operation execution (success or failure) will be informed to MCU(WCS) through values in the "Report Operation Completion" packet.

vi. **Open PUC Door**

This command is sent by MCU (WCS) to LCS. Once the command is received, after verifying interlocks, 'Open PUC Door' operation will be executed. Operation execution (success or failure) will be informed to MCU(WCS) through values in the "Report Operation Completion" packet.

vii. **Unlock Hatch**

This command is sent by MCU (WCS) to LCS. Once the command is received, after verifying interlocks, 'Unlock Hatch' operation will be executed. Operation execution (success or failure) will be informed to MCU(WCS) through values in the "Report Operation Completion" packet.

viii. Open Hatch

This command is sent by MCU (WCS) to LCS. Once the command is received, after verifying interlocks, 'Open Hatch' operation will be executed. Operation execution

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(success or failure) will be informed to MCU(WCS) through values in the "Report Operation Completion" packet.

ix. Article Unlock

This command is sent by MCU (WCS) to LCS. Once the command is received, after verifying interlocks, 'Article Unlock' operation will be executed. Operation execution (success or failure) will be informed to MCU(WCS) through values in the "Report Operation Completion" packet.

x. Report 'Ready to Launch'

After article unlocking, LCS will re-confirm the status of all actuators of active canister and PUC door to ensure the state of canister and PUC mechanisms are as required to launch the article successfully. Once ensured, LCS will send "Ready to Launch" status to MCU (WCS).

xi. Article Launched / Article Misfire

These statuses will be received from MCU (WCS). A knowledge of these status for a given canister will help LCS in implementing safety interlocks.

xii. Article Lock

This command is sent by MCU (WCS) to LCS. Once the command is received, after verifying interlocks, 'Article Lock' operation will be executed. Operation execution (success or failure) will be informed to MCU(WCS) through values in the "Report Operation Completion" packet.

xiii. Hatch Close

This command is sent by MCU (WCS) to LCS. Once the command is received, after verifying interlocks, 'Hatch Close' operation will be executed. Operation execution (success or failure) will be informed to MCU(WCS) through values in the "Report Operation Completion" packet.

xiv. PUC Door Close

This command is sent by MCU (WCS) to LCS. Once the command is received, after verifying interlocks, 'PUC Door Close' operation will be executed. Operation execution (success or failure) will be informed to MCU(WCS) through values in the "Report Operation Completion" packet.

xv. PUC Door Lock

This command is sent by MCU (WCS) to LCS. Once the command is received, after verifying interlocks, 'PUC Door Lock' operation will be executed. Operation execution

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(success or failure) will be informed to MCU(WCS) through values in the "Report Operation Completion" packet.

xvi. LCS Status

The LCS will send status of all 8 canisters and PUC door mechanism to MCU (WCS) every one second along with health (temperature, fan failure status, hardware) of LCC and PSC. It will consist health status, actuator status, canister status etc.

7.3 Context Diagram and Dataflow diagram

7.3.1 Context Diagram for Launcher Control System

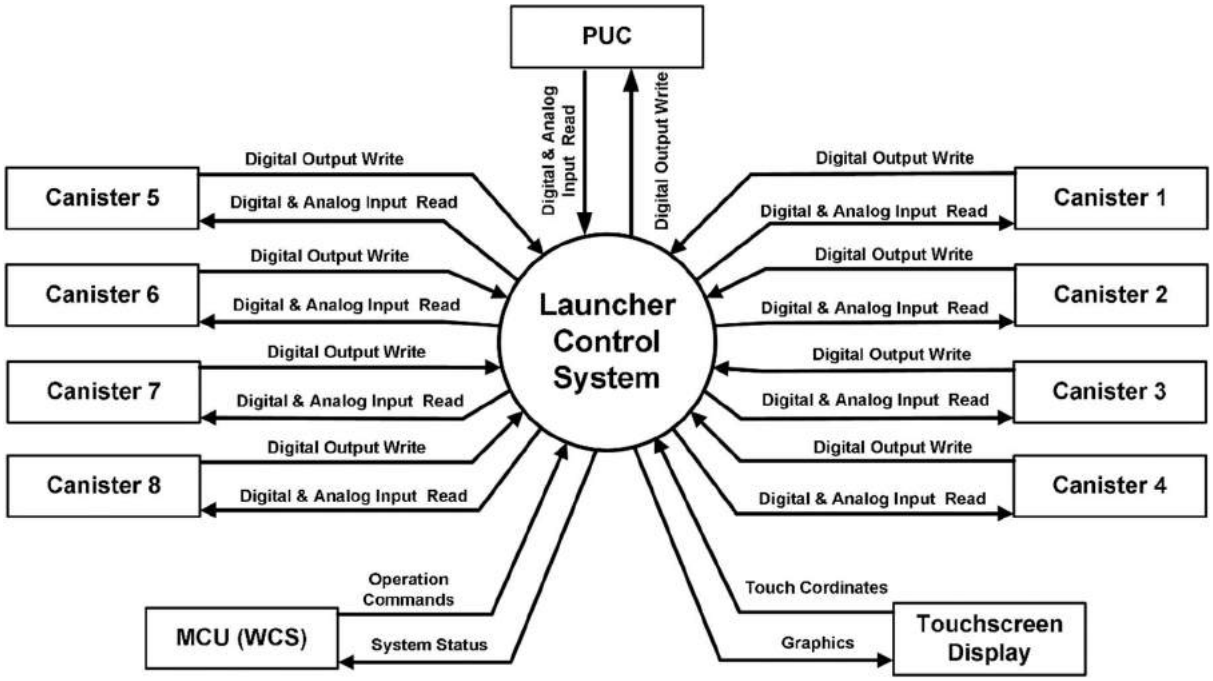

Figure 7-4 : Context Diagram of Launcher Control System

7.3.2 List of Tasks for Launcher Control System software

The tentative tasks along with their priorities are listed in table 7-1. The lower the priority numbers higher the task priority.

Table 7-1 : List of Launcher Control System Software Tasks

Sr. No.	Task Name	Priority	Purpose
1.	Timer Task	1	Timer task will trigger every 20mS and will provide timing reference for other tasks and activities
2.	DI, AI Read Task	2	This task will read all DI, AI card inputs at every 100mS

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3.	DO & AO Write Task	3	This task will write all DO and AO card outputs at every 100mS
4.	Ethernet Receive Task	4	This task will be invoked whenever there is a message received over Ethernet
5.	Ethernet Transmit Task	5	This task will be synchronized to be invoked whenever the input transmit buffer has got message to be transmitted over Ethernet
6.	MCU (WCS) Handler Task	6	The protocol between MCU & Launcher Control System will be implemented in this task.
7.	Launcher Operation Task	7	This task will be invoked every 100mS and it will provide the core functionality of the complete launcher. All the interlock and safety logics will be implemented here.
8.	Monitor Task	8	This will monitor all other tasks and will triggering watchdog mechanism at regular intervals. In case of software failure, the watch dog will cause system reset and re-initialization.
9.	Data logging Task	9	This task will provided data logging with time stamp
10.	GUI Task	10	This task will update the update the information on GUI at every 500ms /1 sec

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8. QUALITY MANAGEMENT SYSTEM

The supplier or firm shall have ISO 9001certification or the Prime Vendor shall have ISO 9001 certification. There shall be a quality management policy and quality organizational structure. There shall be dedicated team for QA/QC activities for inside and outside the firm. There shall be defined and documented quality control functions and responsibilities.

8.1 Quality Management Policy

The quality management policy as per firm's quality QMS/Quality manual

8.2 Quality Organization

The firm shall maintain details of the quality organization structure with responsibilities.

8.3 QC Function and Responsibility

a) Incoming, in-process and final inspections are performed at appropriate stages to ensure quality of raw materials, Bought Out Items, COTS items and manufactured items.

b) QC ensures to maintain requisite documentation, records, identification and traceability of the items. QA agencies will have free access to these documents.

c) Manufacturing process flow and inspection stages from Raw material to final acceptance to be defined in consultation with the designer. Manufacturing Process plan will be approved by project/designer prior to commencement of job.

d) Calibration of Measuring and Test equipment will be ensured from NABL accredited laboratories.

e) Control of Documents is ensured as per QMS policy. All the sub-sequent amendments. Inclusions/Deletion should be project approved and CCD released.

f) The Firm QC shall maintain QAR is maintained and inter-stage clearance certificate issued at appropriate stages.

g) The Firm QC to liaise with external QA agency for all QMS related activities.

h) Product will be only accepted after successful completion on the requisite tests and checks.

i) Rejection management activities with reference to traceability, record keeping disposal and accountability and should be accessible for checks to project and QA agencies.

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8.4 PRODUCTION DESCRIPTION

The LCS has number of parts and sub-assemblies which will be either manufactured or standard bought outs COTS item or customized manufactured item from various suppliers and vendors. Both the category of parts and assemblies will be having different QA process and different inspection and test criteria to meet their requirements. The details about the QA process for all the items are as follows i.e. from '1' to '13'.

1. Process Flow Diagram as shown in Figure 8.1.
2. Inspection Matrix
3. Material Properties
4. Manufacturing Processes
5. Integration process
6. Functional Test and Acceptance Tests
7. Test equipment
8. Equipment calibration
9. Safety Requirement
10. Acceptance and Clearance Criteria (MSQAA)
11. Identification, Marking and Traceability
12. Non Conformance management
13. Packing, Handling, Dispatch and Delivery

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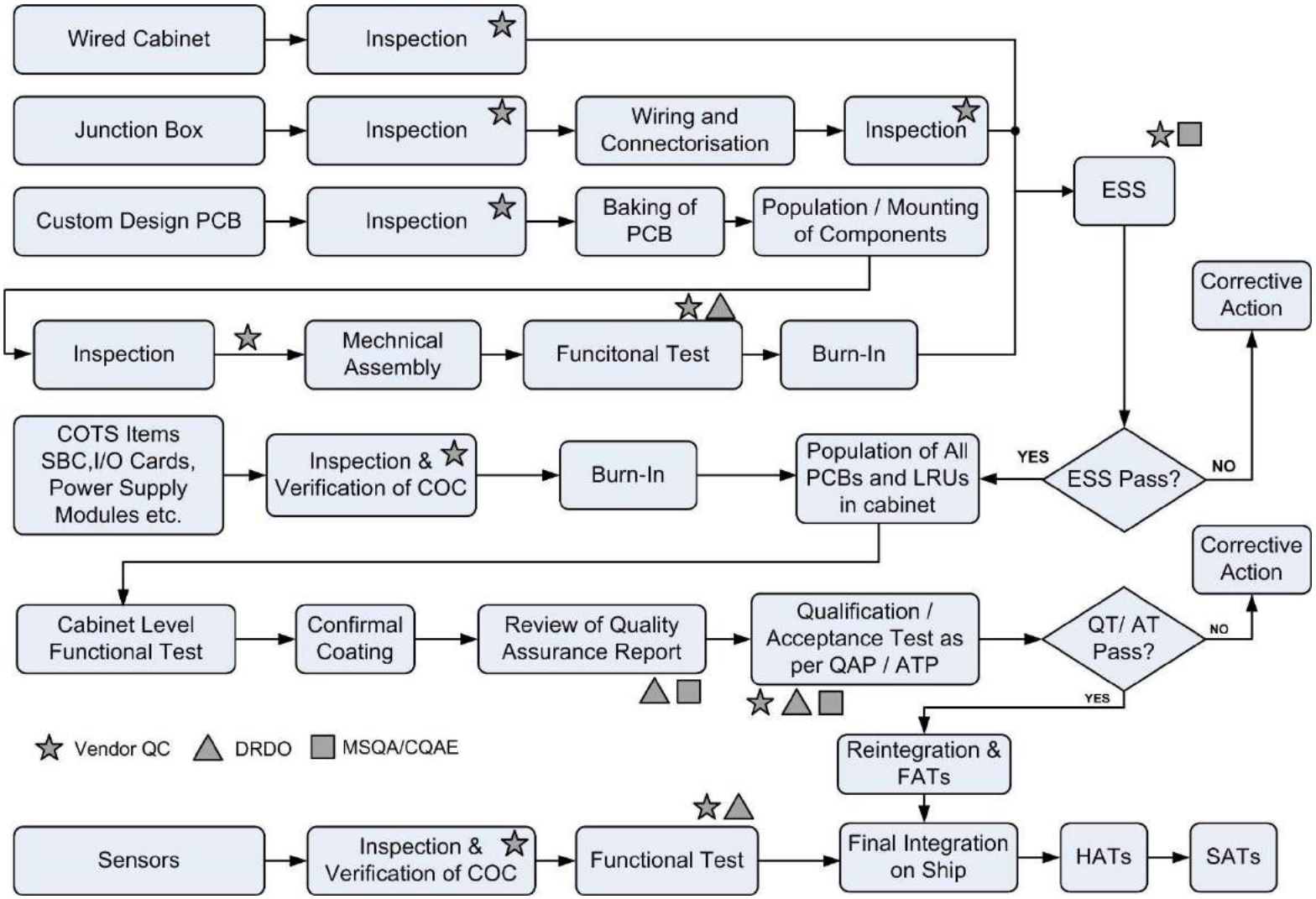

Figure 8-1 : Process flow diagram for integration of LCS

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9. QT/AT FOR LCS OF VL-SRSAM

The Qualification Test and Acceptance Test for Launcher Control System of VL-SRSAM is extracted from the "Environmental Test Specification for Weapon Control System of VL-SRSAM" document. The document (No: "VL-SRSAM-WCS-EnTest Specs, Version No. 1) is attached as Appendix A for reference.

It is proposed to develop two LCS, out of which one will go through AT and one will be subjected to QT. The details of the QT and AT tests are described in the following sections.

9.1 Qualification Tests

Qualification shall be performed on one unit. The components/parts/subsystems mentioned in applicability matrix in following section will undergo qualification tests as per QT document.

9.1.1 Test Sequence

The sequence of tests for units undergoing qualification will be as given in figure 9-1

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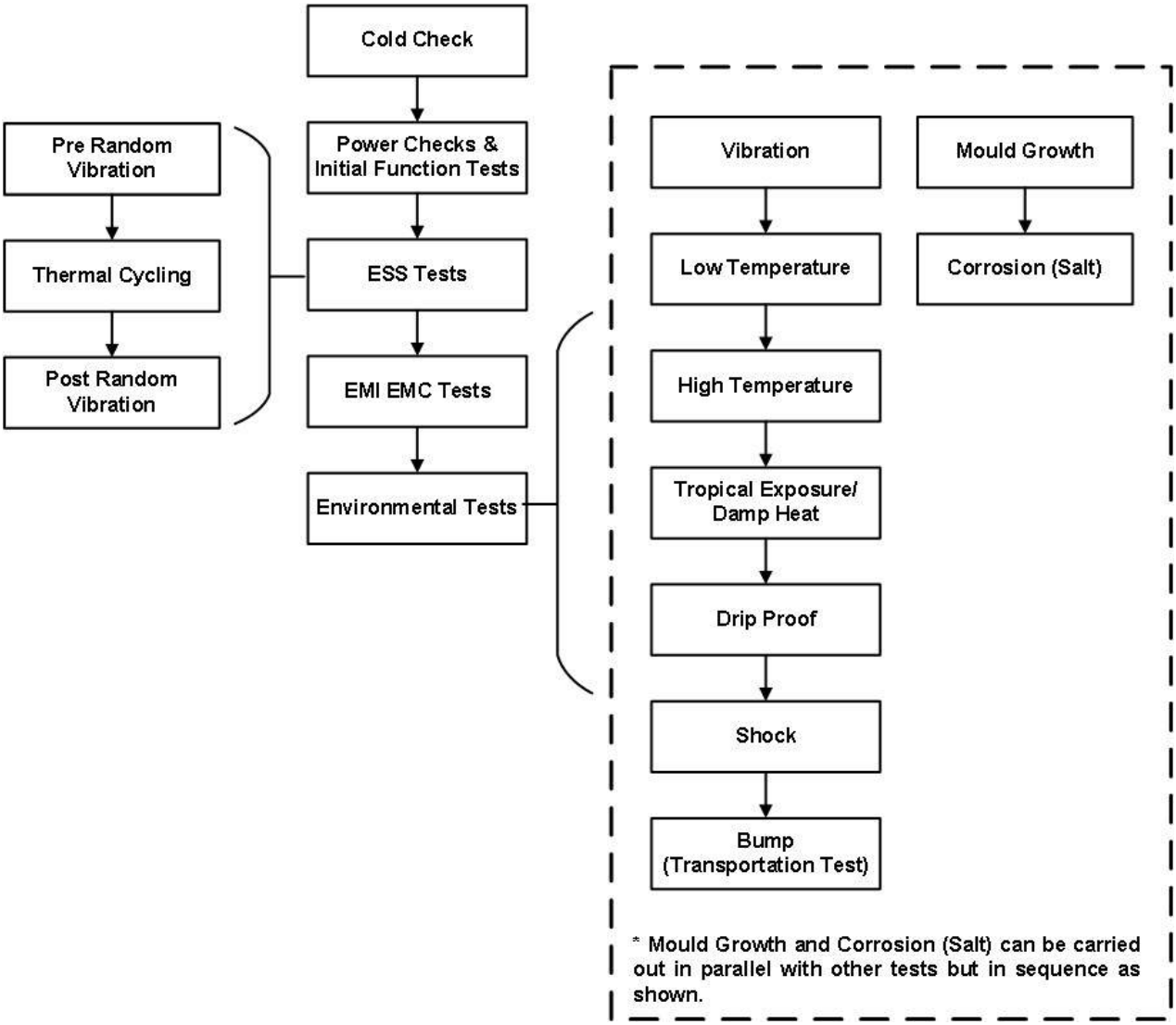

Figure 9-1 : Qualification Tests Sequence

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9.1.2 Applicability Matrix for Qualifications Tests (QT) on Components/Parts/Sub-Systems of Launcher Control System

9.1.2.1 Applicability Matrix for ESS Tests

Table 9-1 : Applicability Matrix for ESS Tests

Tests	Specifications	COTs	Custom Designed PCB	Custom designed Assembly	Wired Cabinets	Junction Box (Integrated)	Canister Cable Harness	Integrated Power Supply Cabinet	Integrated Launcher Controller Cabinet	System Cable Harness	Remarks
Pre-Random Vibration	a) All the three mutually perpendicular axes according to the levels given in figure 9-2 for 5 minutes per axis.	NA	A	A	A	A	A	NA	NA	A	• EUT shall be kept energized during the vibration test • PREET, INSET and POET
Thermal cycling	Cycle: As given in figure 9-3 No. of cycles: 10										• PREET and POET • INSET as per Figure 8-3
Post Random Vibration	Same as Pre-Random Vibration										• EUT shall be kept energized during the vibration test • PREET, INSET and POET

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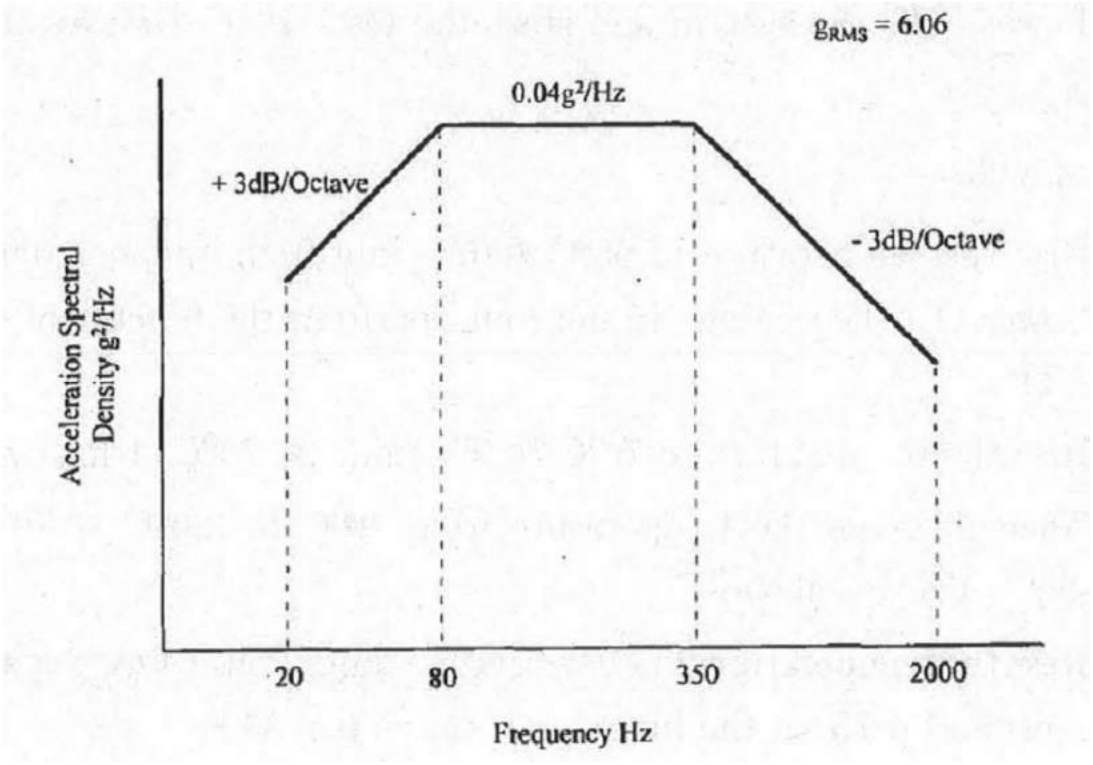

Figure 9-2 : Random Vibration Levels

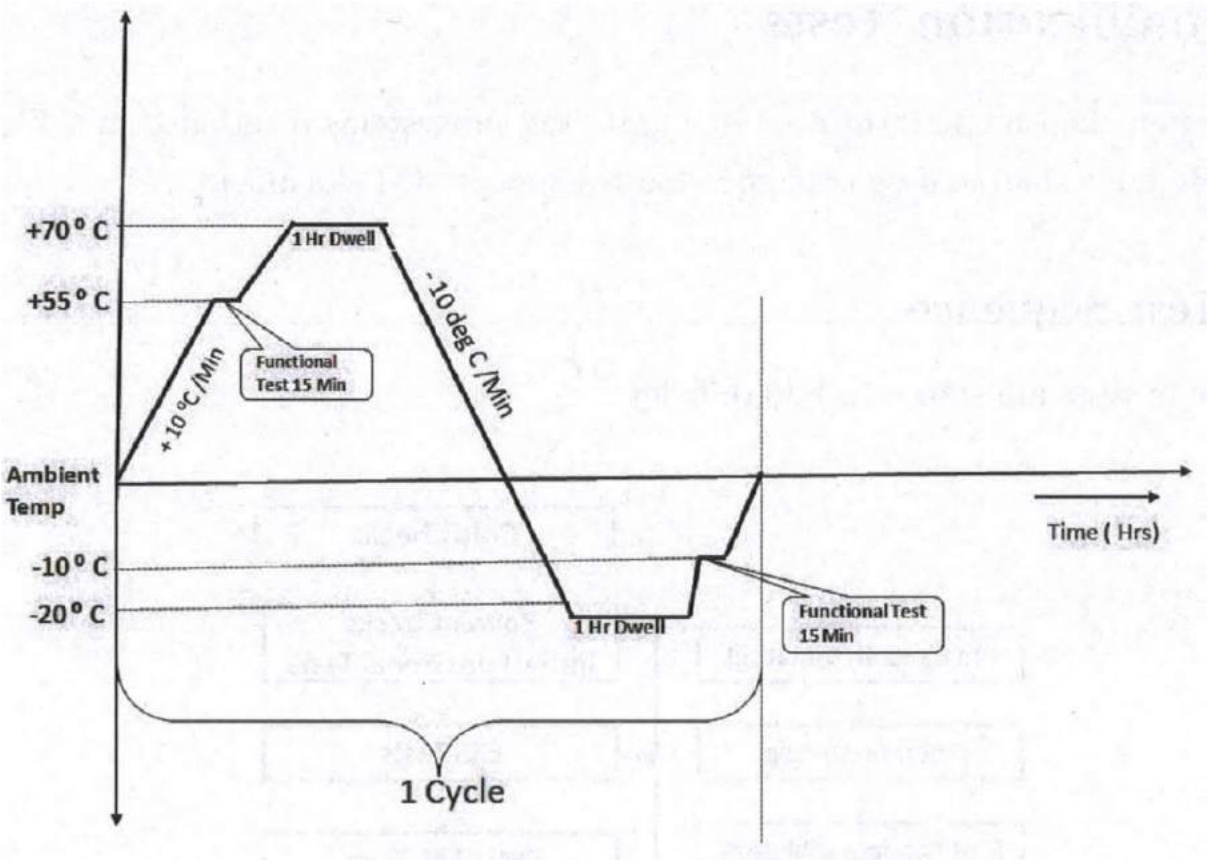

Figure 9-3 : Thermal Cycling Test Cycle

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9.1.2.2 Applicability Matrix for EMI/EMC Tests

Table 9-2 : Applicability Matrix for EMI/EMC Tests

Tests	Specifications	COTs	Custom Designed PCB	Custom designed Assembly	Wired Cabinet	Junction Box (Integrated)	Canister Cable Harness	Integrated Power Supply Cabinet	Integrated Launcher Controller Cabinet	System Cable Harness	Remarks
CE102	a) Applicability: Power Leads Individually b) Specifications: 10kHz to 10MHz c) Limit: Figure CE102-1. CE102 limit (EUT power leads, ac and dc) for all applications	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**A**	**A**	**NA**	
CS101	a) Applicability: High-Sides of Power Leads Only and power cable b) Specifications: 30Hz to 150kHz for DC starting from the second harmonic of the EUT power Frequency and extending to 150 kHz. c) Limit: Figure CS101-1. CS101 voltage limits For all applications curve #1 and figure CS101-5 and CS101-4.	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**A**	**A**	**NA**	
CS114	a) Applicability: Interconnecting Cables b) Specifications: 10 kHz to 200 MHz c) Limit: Table VI. CS114 limit curves. Of ships (metallic) (below decks) for navy, Figure CS114-1. CS114 calibration limit for all applications curve #2	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**A**	**A**	**NA**	
CS116	a) Applicability: Interconnecting Cables b) Specifications: 10 kHz to 100 MHz c) Limit: Figure CS116-2. CS116 limit for all applications. For army and navy procurement, I max = 10 amperes	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**A**	**A**	**NA**	
RE101	a) Applicability: Unit with All Cables b) Specifications: 30 Hz to 100 MHz c) Limit: Figure RE101-2. RE101 limit for all navy applications.	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**A**	**A**	**NA**	

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RE102	a) Applicability: Unit with All Cables b) Specifications: 10 kHz to 18 GHz c) Limit: Figure RE102-1. RE102 limit for surface ship applications.	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**A**	**A**	**NA**	
RS101	a) Applicability: Unit with All Cables b) Specifications: 30 Hz to 100 kHz c) Limit: Figure RS101-1. RS101 limit for all navy applications.	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**A**	**A**	**NA**	
RS103	a) Applicability: Unit with All Cables b) Specifications: 2 MHz to 18GHz c) Limit: Table VII. RS103 limits of ships (metallic) (below decks) for navy Limit level: 10V/m.	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**A**	**A**	**NA**	
CS118 (HESD)	a) ± 8 KV for contact discharge method. b) 5 positive discharge and 5 negative discharges to each EUT test point c) EUT shall be powered On condition during the test.	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**A**	**A**	**NA**	

Note:

1) In case Junction Box will have active components, EMI/EMC test applicability will change and most likely all EMI/EMC Test has to be done.

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9.1.2.3 Applicability Matrix for Environmental Tests

A brief of specifications has been mentioned, however, details shall be referred in Table 3-5 (JSS 55555-2012 Rev 3.) and relevant test procedures as given in JSS 55555-2012 Rev 3.

Table 9-3 : Applicability Matrix for Environmental Tests

Tests	Specifications	COTs	Custom Designed PCB	Custom designed Assembly	Wired Cabinet	Junction Box (Integrated)	Canister Cable Harness	Integrated Power Supply Cabinet	Integrated Launcher Controller Cabinet	System Cable Harness	Remarks
Vibration	Refer JSS 55555, 2012, Rev 3; Test No: 28, Table 4-28-2, Notes 2,3 a) Levels (Freq. Range - Amplitude): 5 to 14 Hz - ± 1.25 mm constant displacement 14 to 23 Hz - ± 0.45 mm constant displacement 23 to 33 Hz - ± 0.125 mm constant displacement b) Duration: 1-hour endurance conditioning at each resonance frequency or frequency specified	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**A**	**A**	**A**	• Along all 3 axes • This test is not applicable for units already undergone ESS test
High Temperature	Refer JSS 55555, 2012, Rev 3, Test No: 17, Procedure 6 Test Condition K a) Operation at 55 °C ± 3°C for 16hr b) Storage at 70°C + 3°C for 16 hr	**NA**	**NA**	**NA**	**NA**	**A**	**A**	**A**	**A**	**A**	• PREET & POET at ambient • INSET at final hour of the period, applicable for operational test only.
Low Temperature	Refer JSS 55555, 2012, Rev 3; Test No: 20, Test Condition H a) Operation at -10°C ± 3°C for 16hr b) Storage at -20°C ± 3°C for 16 hr	**NA**	**NA**	**NA**	**NA**	**A**	**A**	**A**	**A**	**A**	• PREET & POET at ambient • INSET at final hour of the period, applicable for operational test only.

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Tests	Specifications	COTs	Custom Designed PCB	Custom designed Assembly	Wired Cabinet	Junction Box (Integrated)	Canister Cable Harness	Integrated Power Supply Cabinet	Integrated Launcher Controller Cabinet	System Cable Harness	Remarks
Damp Heat	Refer JSS 55555, 2012, rev 3; Test No: 10 a) Temperature @ 40°C ± 2°C and RH @ 93±5% respectively. b) Duration 16 hrs.	**NA**	**NA**	**NA**	**NA**	**A**	**A**	**A**	**A**	**A**	• PREET & POET • INSET during last 30 minutes of the test • This test shall be strictly carried out prior to Corrosion (salt) & Mold growth test. If not feasible, separate equipment be used for this test • Either Tropical Exposure or Damp Heat can be done based on the availability of test facility. • **If both facilities are available, only Tropical Exposure shall be conducted.**
Tropical exposure	Refer JSS 55555, 2012, Rev 3; Test no: 27 Test Condition: A a) Duration: 7 cycles	**NA**	**NA**	**NA**	**NA**	**A**	**A**	**A**	**A**	**A**	• Unpacked & Power OFF condition • PREET & POET at ambient • INSET at 7th Cycle • Either Tropical Exposure or Damp Heat can be done based on the availability of test facility. • **If both facilities are available, only Tropical Exposure shall be conducted.**
Drip Proof	Refer JSS 55555, 2012, Rev 3; Test No: 11 a) Duration 15 minutes	**NA**	**NA**	**NA**	**NA**	**A**	**NA**	**A**	**A**	**NA**	• PREET, INSET and POET
Mould growth/fungus	Refer JSS 55555, 2012, Rev 3, Test No: 21	**NA**	**A***	**A***	**A***	**A***	**A***	**A***	**A***	**A***	• Visual examination after Test • Separate equipment can be used for this test. • For sealed equipment a dummy unit may be used and this test may be applied only to the components and finishes located outside the seal. * On Sample Coupons

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Tests	Specifications	COTs	Custom Designed PCB	Custom designed Assembly	Wired Cabinet	Junction Box (Integrated)	Canister Cable Harness	Integrated Power Supply Cabinet	Integrated Launcher Controller Cabinet	System Cable Harness	Remarks
Salt Corrosion	Refer JSS 55555, 2012, Rev3; Test No: 9 Procedure 2 a) Temperature of 35°C ± 2° C and a relative humidity of 90 to 95% for a period of 7 days as per Procedure 2. b) Test Duration: 3 cycles	**NA**	**A***	**A***	**A***	**A***	**A***	**A***	**A***	**A***	• Visual examination after Test • Separate equipment can be used for this test. • For sealed equipment a dummy unit may be used and this test may be applied only to the components and finishes located outside the seal. • This test shall be strictly carried out after Tropical exposure & Mould growth test. * On Sample Coupons
Shock (operational)	Refer JSS 55555, 2012, Rev 3; Test No: 24 18ms, 30g 3 shocks in each 6 faces (Total 18 Shocks)	**NA**	**NA**	**NA**	**NA**	**A**	**A**	**A**	**A**	**A**	• Specifications applicable for light weight EUT up to 205 kg • PREET • POET on completion of test on each face
Bump	Refer JSS 55555, 2012, Rev 3; Test No: 5 a) No of bumps: 4000±10 b) Peak acceleration 100 m/s2 c) Pulse duration 16 ms	**NA**	**NA**	**NA**	**NA**	**A**	**A**	**A**	**A**	**A**	• PREET and POET
Water Immersion	As per MIL-HDBK-508 & MIL-STD-202	**NA**	**NA**	**NA**	**NA**	**NA**	**A**	**NA**	**NA**	**A**	• PREET, INSET and POET
Humidity Test	As per MIL-HDBK-508 & MIL-STD-202	**NA**	**NA**	**NA**	**NA**	**NA**	**A**	**NA**	**NA**	**A**	• PREET, INSET and POET

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Tests	Specifications	COTs	Custom Designed PCB	Custom designed Assembly	Wired Cabinet	Junction Box (Integrated)	Canister Cable Harness	Integrated Power Supply Cabinet	Integrated Launcher Controller Cabinet	System Cable Harness	Remarks
Moisture Resistance Test	As per MIL-HDBK-508 & MIL-STD-202	**NA**	**NA**	**NA**	**NA**	**NA**	**A**	**NA**	**NA**	**A**	• PREET, INSET and POET
Hi-Impact Shock Test	As per MIL-HDBK-508 & MIL-STD-202	**NA**	**NA**	**NA**	**NA**	**NA**	**A**	**NA**	**NA**	**A**	• PREET, INSET and POET

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9.2 Acceptance Tests

Acceptance tests will be performed on all units. The components/parts/subsystems mentioned in applicability matrix in following section will undergo acceptance tests as per AT document.

9.2.1 Test Sequence

The sequence of tests for units undergoing acceptance will be as given in figure 9-4.

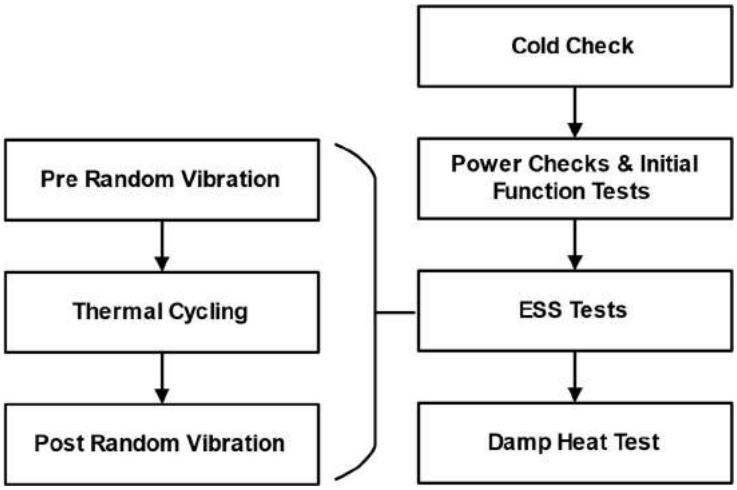

Figure 9-4 : Acceptance Tests Sequence

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9.2.2 Applicability Matrix for Acceptance Tests (AT) on Components/Parts/Sub-Systems of Launcher Control System

Table 9-4 : Applicability Matrix for Acceptance Tests (AT)

Tests		Specifications	COTs	Custom Designed PCB	Custom designed Assembly	Wired Cabinet	Junction Box (Integrated)	Canister Cable Harness	Integrated Power Supply Cabinet	Integrated Launcher Controller Cabinet	System Cable Harness	Remarks
ESS	Pre-Random Vibration	All the three mutually perpendicular axes according to the levels given in figure 9-2 for 5 minutes per axis.	**NA**	**A**	**A**	**A**	**A**	**A**	**NA**	**NA**	**A**	• EUT shall be kept energized during the vibration test • PREET, INSET and POET
	Thermal Cycling	Cycle: As given in figure 9-3 No. of cycles: 10										• PREET and POET • INSET as per Figure 8-3
	Post RV	Same as Pre-Random Vibration										• EUT shall be kept energized during the vibration test • PREET, INSET and POET
Environmental Test	Damp Heat	Refer JSS 55555, 2012, rev 3; Test No: 10 Temperature @ 40°C ± 2°C and Humidity @ 93±5% respectively. Duration 4 hrs.	**NA**	**NA**	**NA**	**NA**	**A**	**A**	**A**	**A**	**A**	• PREET & POET • INSET during last 30 minutes of the test

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10. SCOPE OF WORK

The scope of work as per this Technical Specification document for development of Launcher Control System (LCS) is listed below:

a) Detail engineering and Development of Launch Controller Cabinet and Power Supply Cabinet based on the conceptual Schematics and Circuit diagrams for modules and subsystems provided by R&DE(E)

b) Preparation of enclosure drawings and wiring diagrams for cabinet

c) Procurement of all COTs items required for LCS

d) Manufacturing of all internal Electronic hardware, PCBs, Modules, Relay boards, Fan trays, power supplies, Transformers etc. required form Launcher Controller and Power Supply Cabinet.

e) Wiring, connectorisation and Integration of COTs items / components and all other custom designed hardware inside the LCC and PSC cabinets.

f) Manufacturing and supply of internal cable harnesses as per DEF STD 61 standards, and connectors. The vendor shall prepare the drawings of all the external cables / harness required for LCS. All External cables will be Free Issue Material (FIM) to the vendor.

g) Module level and Sub system level integration for LCC and PSC

h) Development of Application software and GUI for LCS as per functional requirement and in compliance with DSSD.

i) Table top testing of Sub systems

j) Participation in IV&V of LCS Software. IV&V will be conducted by DRDL SQA.

k) Development, Manufacturing and Supply of Electrical Test Jig and VLU emulator

l) Preparation of Terminal Connection Drawings (TCDs)

m) Integration of LCC and PSC with VLU

n) Preparation of software and hardware documents as per list of deliverables

o) The QT and AT will be carried out at DRDO test facilities. Only the logistics required for Performing Qualification tests (QT) on one LCS including LCC, PSC, JB and Harness and Acceptance Test (AT) on remaining one unit shall be provided by the vendor. QT and AT shall be carried out as per the Chapter-9 of this specification

p) Performing Factory Acceptance Trials (FATs)

- Verification and Validation of functional requirement of LCS for all Modes and Regimes of VLU operations

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- Verification & Validation of sensor interfaces of VLU
- Verification of interface with MCU (WCS)

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11. LIST OF DELIVERABLES

The deliverables for Launcher Control System for three VLUs are listed below:

Sr. No.	Item		Item-Grade	Qty.
1.	Launcher Controller Cabinet (LCC) Launcher Controller Cabinet will contain the following Hardware and Software:-		MIL- Grade	02 No.
	Hardware:	**Qty**		
	(a) 5 slot VPX Backplane with chassis	01		
	(b) VPX Power Supply	01		
	(c) Intel based Single Board Computer (SBC)	01		
	(d) VPX4500 3U Acropack Carriers	03		
	(e) AP441 32 channel Opto-isolated Digital Input Acropack Module	03		
	(f) AP445 32 channel Opto-isolated Digital Output Acropack Module	04		
	(g) AP342 14 Bit, 12 Differential Channel ADC Acropack Module	02		
	(h) VPX4500-RTM-LF Rear Transition Module	03		
	(i) 4 Port Rugged Ethernet Switch - 04 Individual Copper Ports - L2 Managed Switch - MIL-D38999 Circular Connector - Power Input: 24VDC	01		
	(j) Anti-Condensation Heater	02		
	(k) 10.4” foldable rugged Display with touch screen	01		
	(l) Signal Conditioning Unit - Pyro Relays - Pyro Health Check Circuit - H-Bridge Circuit - Power switching relays and contactors	01		
	(m)Fan Blower Tray (with Main & Redundant Fans)	01		
	(n) Switches, Indicators, Fuse with Fuse fail indicators, MCBs, EMI/EMC Filters	01 Set		
	(o) Cabinet as per specs defined in Chapter 3 & 5	01		
	(p) Internal Cables and Connectors	01 Set		
	Software:			
	a) Application software based on RedHat Real Time Linux Operating System as per Chapter-7 - Source code of all software developed by Seller and all the drivers is to be supplied as deliverable item on CD / DVD - Executable Files	01		
	b) BSPs, Drivers and Libraries	01		

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<table>
<tr><th>Sr. No.</th><th>Item</th><th>Item-Grade</th><th>Qty.</th></tr>
<tr><td>2.</td><td>Power Supply Cabinet (PSC)
Power Supply Cabinet will contain the following Hardware
<table>
<tr><th>Hardware</th><th>Qty</th></tr>
<tr><td>a) 5.67KVA Delta-Star Step down transformer (380VAC 3Ø to 220VAC 3Ø)</td><td>02</td></tr>
<tr><td>b) 3Ø Rectifier Modules</td><td>04</td></tr>
<tr><td>c) Non Isolated High Voltage to Low Voltage Bus Converter DC-DC</td><td>04</td></tr>
<tr><td>d) Isolated DC-DC Converter</td><td>10</td></tr>
<tr><td>e) MCU Power Switching Relays and Contactors</td><td>02 Set</td></tr>
<tr><td>f) Fan Blower Tray (with Main & Redundant Fans)</td><td>02</td></tr>
<tr><td>g) Switches, Indicators, Panel Meters, Fuse with Fuse fail indicators, MCBs, EMI/EMC Filters</td><td>01 Set</td></tr>
<tr><td>h) Cabinet as per specs defined in Chapter 3 & 5</td><td>01</td></tr>
<tr><td>i) Internal Cables and Connectors</td><td>01 Set</td></tr>
</table></td><td>MIL- Grade</td><td>02 No.</td></tr>
<tr><td>3.</td><td>Junction Boxes
- IP 67 Metallic Junction Boxes
- With EMI/EMC and Rubber gasket
- Approximate Quantity-02Nos.
- The shape, size, number of terminal strips will be decided during the detail design.</td><td>MIL- Grade</td><td>04 Nos.</td></tr>
<tr><td>4.</td><td>Cables & Harness for external interfaces of LCC, PSC, JBs, sensors and actuators
<u>Cables:</u>
(a) Power Supply Cabinet to Launcher Controller Cabinet
(b) Control System to VLU cables
(c) Control System to JB cables
(d) PSC to JB
(e) JBs to Sensors and Actuator Cables
(f) LCC to MCU Ethernet Cables
<u>Connectors:</u>
MIL Grade Connectors for above cables
(a) MIL Type D38999 Series</td><td>MIL- Grade</td><td>02 sets of all cables & connectors, with all detailed drawings & documents</td></tr>
<tr><td>5.</td><td>Electrical Test Jig and VLU Emulator
<table>
<tr><th>Hardware:</th><th>Qty</th></tr>
<tr><td>(a) LCS-MCU Ethernet Protocol Simulator</td><td>01</td></tr>
<tr><td>(b) Electronic Test Jig for emulating VLU (All sensors and Actuators of Canister and PUC Door)
- Emulation of Voltage and current as per the sensors and actuators</td><td>01</td></tr>
</table></td><td>MIL / Industrial Grade</td><td>01 Set</td></tr>
</table>

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Sr. No.	Item		Item-Grade	Qty.
	Software:	**Qty**		
	Application software for LCS-MCU Ethernet Protocol Simulator (a) Source code of all software developed by Seller and all the drivers is to be supplied as deliverable item on CD/DVD. (b) Executable	01		

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Sr. No.	Item	Item-Grade	Qty.
6.	**Documents** The documents are to be supplied taking MIL-STD-498/IEE 12207 as guideline for software and JSS-0256/01 for H/W. The documents are to be as per customer's specifications. The Supplier shall prepare the following documents, print in hard copies and shall offer for necessary review and approval by the customer. The approved documents shall again be printed and supplied along with soft copies as per the list below: **Hardware:** a) System-Sub-system Specifications(SSS) b) Hardware Requirement Specification Document (HRS) c) Hardware Design Document (HDD) d) GUI document e) Parts List, Parts Specification f) Bill of Material (Bound Hardcopy of all data sheets) g) COC for components used. h) Complete equipment Schedule i) Wiring diagrams, Wiring list, Cable form lists. j) Terminal connection drawings (TCDs- AutoCAD format & Excel sheet format) k) Layout drawing of system up to PCB level. l) Composite Interface Specifications (CIS) / Interface Control Document (ICD) m) FMEA analysis Report n) FMECA Analysis Reports o) Operator/User manuals for all equipment's/Final version of interlocks and operation logics. p) Factory Acceptance Trials (FATs Document) q) Quality Assurance Plan (QAP) r) Test reports format and test data. s) Service manuals/Fault finding procedures/Maintenance manual. t) User handbook u) Technical manual v) Equipment Log book w) Mechanical / Electrical drawings of full system including enclosure, cables with expanded view. x) ISPL (Illustrated Spare Parts List) y) Definition dossier / Equipment dossier. z) Drawings & master list of drawings. aa) Process sheet / process qualification criteria.	JSS-0256/01/ MIL-STD-498/DRDO Standard for Software Development (DSSD)	1 Set

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Sr. No.	Item	Item-Grade	Qty.
	Software: a) Software Requirement Specifications (SRS) b) Interface Requirements Specifications (IRS) c) Software Design Description (SDD) d) Software Development Plan (SDP) e) Software Test Plan (STP) f) Interface Control Document(ICD) g) Software Verification and Validation Plan (SVVP) h) Software Verification and Validation Report (SVVR) i) Software Test Description (STD) j) Software Quality Assurance Plan (SQA) k) Software Test Report (STR) l) Software User Manual (SUM) m) Version Description Document(VDD) n) Source Code & Listings of all Software developed (including Flow charts) **NOTE:** A soft copy of all final and frozen documents shall also be supplied on CD along with the Hard Copies.		

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FIM Details

1. Following FIM will be provided by DRDO for preparation of VL-SRSAM launcher components.

No.	Item Description	Qty	Cost
1	Dummy article for canister passenger	02	800000
2	Canister antennae	6	348000
3	TNC for SMA adapter	6	93000
4	Multi coupler unit	2	704000
5	MIC	2	250000
6	Explosive bolt	20	154680
7	1553 coupler	36	486000
8	PMS	01	1800000
		Total	4635680

2. FIM will be provided based on the readiness of items in the scope of vendor. Vendor need to intimate DRDO at least 01 month in advance for supply of FIM.

Delivery & Payment Schedule

1. Following delivery schedule shall be fulfilled by the vendor to meet DRDL requirements.
2. Instance of each item is described using PP-NN scheme. (PP describes the item and NN describes the serial number of the item).
3. Major deliverable items are described as
    a. For Launcher: VLU-01 & VLU-02 in full (ready-for -launch) configuration with Plume management system (PMS)
    b. For Canister: C-01 till C-06
    c. For LCS: LCS-01 & LCS-02
4. **Delivery Schedule**:

Stage No.	**Description of Item**	**Schedule**	**Remarks**
1	VLU-01 with C-01	T0 + 3 months	In configuration suitable for Hang fire test
1.a			Hang-fire test is in scope of DRDO. DRDO will supply new PMS for refurbishment of VLU-01
1.b	Refurbishment of VLU-01	20days from receipt of new PMS from DRDO	Refurbishment includes inspection of Launcher, PMS. It also includes preparation of VLU-01 for full (ready-to-launch) configuration.
2	VLU-01 (refurbished)	schedule in 1.b + 10 days	full (ready-to-launch) configuration
3	1. QT for C-06 & LCS-01 2. Supply of C-06 & LCS-01 to DRDO	T0 + 5 months	QT for canister is in the scope of vendor. QT for LCS will be carried out by vendor at DRDO facility. QT documentation is in scope of the vendor Supply of these items in full configuration with all necessary documentation, software & clearances.
4	VLU-02 C-02 till C-05 LCS-02	T0 + 7 months	All elements are in full (ready-to-launch) configuration with all necessary documentation, software and clearances

5. **Payment Schedule**: Linked with successful completion of the delivery schedule mentioned above. Amount is described in terms of percentage of total basic cost, with applicable taxes and duties.

Stage No.	**Description of Item**	**Payment**	**Remarks**
1	VLU-01 with C-01	20 %	For configuration suitable for Hang fire test
2	VLU-01 (refurbished)	-	-
3	QT for C-06 & LCS-01	-	-
4	VLU-02 C-02 till C-05 LCS-02	80%	Final payment after completion of all remaining tasks.

Signature Not Verified
Digitally signed by KALAGOTLA VARSHA
Date: 2020.12.12 16:39:21 IST
Location: Ministry of Defence-MES