Positive Pressure Relief Assembly (PPRA)

SPECIFICATION

APPROVING AUTHORITY

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Document Change Log:

Issue/Rev	Date	Sect/Para Affected	Inititating Document Reason for Change/Remarks
Baseline	4/24/2000	-	Baseline release, incorporating CR 2452R1

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1.0 SCOPE

1.1 Purpose.

This specification establishes the requirements for the performance, design, interfaces, verification and preparation for delivery of the Positive Pressure Relief Assembly for the Mini Pressurized Logistics Module (MPLM) and for the Columbus Orbital Facility (COF). It incorporates CR2452R1 which changes the crack pressure of the MPLM Positive Pressure Relief Assembly (PPRA) from 14.89 psig to 15.05 psig as shown in MLM-DOR-EQ-0003. All other paragraphs of MLM-DOR-EQ-0003 remain unchanged.

1.2 Equipment Description

1.2.1 General Description

The Positive Pressure Relief Assembly (PPRA) shall be as described in MLM-DOR-EQ-0003 paragraph 1.2.1.

1.2.2 Major Constituents of One Branch

1.2.2.1 Vent Section

The vent section shall be as described in MLM-DOR-EQ-0003 paragraph 1.2.2.1.

1.2.2.2 Shut-Off Valve

The shut-off valve shall be as described in MLM-DOR-EQ-0003 paragraph 1.2.2.2.

1.2.2.3 Relief Valve Unit

One relief valve unit on each branch is installed on the inside of the cabin between the feedthrough plate and the shut-off valve. The relief valve opens automatically when the pressure difference reaches 1038 to 1044 hPa and closes automatically when it falls below 1029 hPa.

The relief valve unit does not include electrical valve position indicators.

The relief valve housing provides the mounting flange to the feedthrough plate with the double seal capability.

1.2.2.4 Debris Trap/Filter

The debris trap/filter shall be as described in MLM-DOR-EQ-0003 paragraph 1.2.2.4.

1.2.2.5 Mounting Provisions

The mounting provision shall be as described in MLM-DOR-EQ-0003 paragraph 1.2.2.5.

1.2.2.6 Vent Cap for COF

The vent cap for COF shall be as described in MLM-DOR-EQ-0003 paragraph 1.2.2.6.

2.0 APPLICABLE DOCUMENTS

The following documents of the stated issue and date form part of this specification to the extent specified herein.

In the event of conflict between the requirements of this specification and the requirements of the applicable documents specified herein, the following order of precedence shall apply:

- This specification

- MLM-DOR-EQ-0003

2.1 Specifications

MLM-DOR-EQ-0003 Issue 5 Rev 2 dated 6 Mar 1998

3.0 FUNCTIONAL/PERFORMANCE REQUIREMENTS

3.1 Mission Requirements

3.1.1 Flight Operation Lifetime

3.1.1.1 Equipment Lifetime

The equipment lifetime shall be the same as described in MLM-DOR-EQ-0003 paragraph 3.1.1.1.

3.1.1.2 ORU/LRU Lifetime

The lifetime of the ORU/LRU's shall be as described in MLM-DOR-EQ-0003 paragraph 3.1.1.2.

3.1.2 On-Ground Operation Effects

3.1.2.1 Ground Operation Cycles

The operation of the equipment during ground testing shall be as described in MLM-DOR-EQ-0003 paragraph 3.1.2.1.

3.1.2.2 Storage Capability

The equipment shall have the capability to be stored on ground as specified in MLM-DOR-EQ-0003 paragraph 3.1.2.2.

3.1.3 Lifetime Reference Operation Timeline

3.1.3.1 In-Orbit Operation Cycles

The in-orbit operation cycles shall be as described in MLM-DOR-EQ-0003 paragraph 3.1.3.1.

3.1.3.2 Non-Operation Period

The equipment shall be designed to operate successfully per MLM-DOR-EQ-0003 paragraph 3.1.3.2.

3.1.3.3 Exposure to Space Vacuum

The equipment shall be designed to operate successfully per MLM-DOR-EQ-0003 paragraph 3.1.3.3.

3.1.3.4 Exposure to Carbon Dioxide Atmosphere

The equipment shall survive, in case of a fire suppression event, exposure to a pure carbon dioxide atmosphere per MLM-DOR-EQ-0003 paragraph 3.1.3.4.

3.1.3.5 Operation in Carbon Dioxide Atmosphere

The valve shall be operable in the carbon dioxide atmosphere.

3.2 Performance Characteristics

3.2.1 Performance Requirements

The equipment shall meet the following performance requirements taking into account the environment conditions defined in Paragraph 3.4.

3.2.1.1 Operating Pressure Range

The equipment shall be designed to operate in a pressure range of 1.3*10E-3 Pa to 1100 hPa with a maximum differential pressure of 1048 hPa (from cabin to space vacuum).

3.2.1.2 Flow Characteristics

3.2.1.2.1 Flow Rate

The minimum air flow rate through one branch at an inlet temperature of 20°C and a pressure difference of 1063 hPa (15.42 psig) shall be 68 kg/h.

3.2.1.2.2 Characteristic Pressures

The characteristic pressures shall be:

Minimum reseat pressure:	1029 hPa (14.93 psig)
Minimum crack pressure:	1038 hPa (15.05 psig)
Maximum crack pressure:	1044 hPa (15.14 psig)
Maximum fully open pressure:	1063 hPa (15.42 psig)

3.2.1.3 Leakage Rates

3.2.1.3.1 Leakage Rate of Relief Valve

The total leakage rate shall be as specified in MLM-DOR-EQ-0003 paragraph 3.2.1.3.1.

3.2.1.3.2 Leakage Rate of Shut-Off Valve

The total leakage rate shall be as specified in MLM-DOR-EQ-0003 paragraph 3.2.1.3.2.

3.2.1.3.3 Leakage Rate Across Vent Cap

The leakage across vent cap during on orbit replacement of the internal valve shall be as specified in MLM-DOR-EQ-0003 paragraph 3.2.1.3.3.

3.2.1.4 Opening/Closing Time

The maximum opening/closing time of the electrically operated shut-off valve shall be as specified in MLM-DOR-EQ-0003 paragraph 3.2.1.4.

3.2.1.5 Discharge of Gas

3.2.1.5.1 Vent Design

The vent section design shall be non-propulsive.

3.2.1.5.2 Choking of Flow

Choking of the flow shall occur at the poppet/seat of the relief valve unit.

3.2.1.6 Debris Trap/Filter

The equipment shall be equipped with debris traps/filters on the external side of the MPLM/COF and on the internal side (cabin) to protect the valves from damage or degradation due to debris/particles.

3.2.1.7 Heater and Temperature Sensor

Not applicable

3.2.1.8 Manual Override

3.2.1.8.1 Override Implementation

The valve shall provide a manual override for electrical operation of the shut-off valve.

3.2.1.8.2 Mechanical Lock

The valve shall implement safety interlocks to prevent that unintentional operations are executed.

3.2.1.8.3 Visible Valve Position Indication

The manual override shall provide end stops or other adequate provisions to prevent damage from crew intervention.

3.2.1.9 Branch Configuration

Each branch shall consist of a pneumatic relief valve in series with an electrical shut-off valve.

3.2.1.10 Relief Function

The pressure relief shall be autonomous and power independent with open electrical shut off valve.

3.2.1.11 Vent Cap for COF

The outlet shall be as specified in MLM-DOR-EQ-0003 paragraph 3.2.1.11.

3.2.1.12 Loss of Power

All electrically commanded valves shall be as specified in MLM-DOR-EQ-0003 paragraph 3.2.1.12.

3.2.2 Electrical Performance

3.2.2.1 Electrical Configuration

The electrical configuration for the equipment and the electrical interface requirements shall be as shown in MLM-DOR-EQ-0003 paragraph 3.2.2.1.

3.2.2.1.1 Valve Position Indication of Electrical Shut-Off Valve

Valve end position indicators of the electrical shut-off valve shall be as specified in MLM-DOR-EQ-0003 paragraph 3.2.2.1.1.

3.2.2.1.2 Electrical Harness

The equipment/valve internal harness shall be as specified in MLM-DOR-EQ-0003 paragraph 3.2.2.1.2.

3.2.2.1.3 Valves Command and Monitoring

The valves shall interface with the MPLM/COF power supply system PDB/PDU as specified in MLM-DOR-EQ-0003 paragraph 3.2.2.1.3.

3.2.2.1.4 Wire Size

The wire and contact size for power and signal lines shall be as specified in MLM-DOR-EQ-0003 paragraph 3.2.2.1.4.

3.2.2.2 Power Supply

3.2.2.2.1 Valve Power Supply

Each valve shall provide its performance using a power supply as specified in MLM-DOR-EQ-0003 paragraph 3.2.2.2.1.

3.2.2.2.2 Heater Power Supply

Not applicable

3.2.2.3 Power Consumption

3.2.2.3.1 Valve Power Consumption

The electrical power consumption of one valve shall be as specified in MLM-DOR-EQ-0003 paragraph 3.2.2.3.1.

3.2.2.3.2 Heater Power Consumption

Not applicable

3.2.2.4 Power Switch-Off Failure

In case of the end position switch's malfunction the valves shall survive as specified in MLM-DOR-EQ-0003 paragraph 3.2.2.4.

3.2.3 Mechanical/Thermal performance

3.2.3.1 Audible Noise Level

Not applicable

3.2.3.2 Vibration Disturbance Levels

3.2.3.2.1 Human Exposure to Vibrations

Not applicable

3.2.3.2.2 Microgravity Disturbance Level

Not applicable.

3.2.3.3 Structural Requirements

3.2.3.3.1 Stiffness Requirements

The equipment/ORU/LRU's shall have a first fundamental frequency as specified in MLM-DOR-EQ-0003 paragraph 3.2.3.3.1.

3.2.3.3.2 Depress./Repress. Rates

The equipment shall withstand depressurization/repressurization as specified in MLM-DOR-EQ-0003 paragraph 3.2.3.3.2.

3.2.3.3.3 Ascent/Descent Pressurization

3.2.3.3.3.1 Ascent Pressurization

The equipment exposed to the module external environment shall meet its specified performance requirements after being subjected to a depressurization rate as specified in MLM-DOR-ED-0003 paragraph 3.2.3.3.3.1.

3.2.3.3.3.2 Descent Pressurization

The equipment exposed to the module external environment shall meet its specified performance requirements after being subjected to a repressurization rate as specified in MLM-DOR-EQ-0003 paragraph 3.2.3.3.3.2.

3.2.3.3.4 Ground Handling

The complete branch of the equipment as well as its ORU/LRU's shall be capable of being free-standing on a flat working surface during ground operations. Alternatively local stand-off pads shall be provided with the equipment branch/ORU/LRU as MGSE.

3.2.3.4 Thermal Control

3.2.3.4.1 Equipment Thermal Control

Thermal control for the equipment, necessary to meet the performance requirements, shall be as specified in MLM-DOR-EQ-0003 paragraph 3.2.3.4.1.

3.2.3.4.2 Heat Transfer

Heat transfer shall be as specified in MLM-DOR-EQ-0003 paragraph 3.2.3.4.2.

3.2.3.4.3 Temperatures of Exposed Surfaces

3.2.3.4.3.1 Maximum Temperatures of Exposed Surfaces

The temperature of exposed surfaces of inboard equipment shall be as specified in MLM-DOR-EQ-0003 paragraph 3.2.3.4.3.1.

3.2.3.4.3.2 Minimum Temperature of Exposed Surfaces

The temperature of exposed surfaces of inboard equipment shall be maintained as specified in MLM-DOR-EQ-0003 paragraph 3.2.3.4.3.2.

3.2.3.4.3.3 Touch Temperature for EVA

The touch temperature of outboard/external equipment shall be as specified in MLM-DOR-EQ-0003 paragraph 3.2.3.4.3.3.

3.2.4 Operational Performance

3.2.4.1 ORU/LRU Definition

Each branch of the PPRA shall be designed as specified in MLM-DOR-EQ-0003 paragraph 3.2.4.1.

3.2.4.2 Orientation

3.2.4.2.1 Zero-g Conditions

The equipment shall meet its performance requirements as specified in MLM-DOR-EQ-0003 paragraph 3.2.4.2.1.

3.2.4.2.2 On-Earth Conditions

The equipment shall meet its performance requirements as specifeid in MLM-DOR-EQ-0003 paragraph 3.2.4.2.2.

3.3 Physical Characteristics

3.3.1 Equipment Mass

The total mass of one PPRA branch including the shut-off valve (with motor and harness) and the relief valve, the debris screen/filter unit and the vent section as well as all mounting provisions shall be as specified in MLM-DOR-EQ-0003 paragraph 3.3.1.

3.3.2 Center of Gravity

The center of gravity of the equipment shall be as specified in MLM-DOR-EQ-0003 paragraph 3.3.2.

3.3.3 Moment of Inertia

The moment of inertia of the equipment shall be as specified in MLM-DOR-EQ-0003 paragraph 3.3.3.

3.4 Environmental Conditions

3.4.1 Ground Operation Environment

Requirements concerning ground operation apply as specified in MLM-DOR-EQ-0003 paragraph 3.4.1.

3.4.1.1 Mechanical Environment

During ground operation, the flight hardware shall comply with the mechanical loads as specified in MLM-DOR-EQ-0003 paragraph 3.4.1.1.

3.4.1.2 Thermal Environment

During ground operation, the flight hardware shall comply with the thermal environment requirements as specified in MLM-DOR-EQ-0003 paragraph 3.4.1.2.

3.4.1.3 Atmospheric Environment

During ground operation, the flight hardware shall comply with the atmospheric environment requirements as specified in MLM-DOR-EQ-0003 paragraph 3.4.1.3.

3.4.2 Flight Operation Environment

Requirements concerning flight operation environment apply as specified in MLM-DOR-EQ-0003 paragraph 3.4.2.

3.4.2.1 Mechanical Environment

During flight operation, the equipment shall comply with the mechanical loads as specified in MLM-DOR-EQ-0003 paragraph 3.4.2.1.

3.4.2.2 Thermal Environment

During flight operation, the equipment shall comply with the thermal environment as specified in MLM-DOR-EQ-0003 paragraph 3.4.2.2.

3.4.2.3 Atmospheric Environment

3.4.2.3.1 General Atmospheric Environment

During flight operation, the equipment shall comply with the atmospheric environment requirements as specified in MLM-DOR-EQ-0003 paragraph 3.4.2.3.1.

3.4.2.3.2 Humidity

3.4.2.3.2.1 Relative Humidity

During flight operation, the equipment shall comply with an internal atmosphere as specified in MLM-DOR-EQ-0003 paragraph 3.4.2.3.2.1.

3.4.2.3.2.2 Dew Point Temperature

During flight operation, the equipment shall comply with an atmosphere as specified in MLM-DOR-EQ-0003 paragraph 3.4.2.3.2.2.

3.4.2.3.2.3 Extreme Relative Humidity

The equipment in operational as well as in non-operational status shall comply with an atmosphere as specified in MLM-DOR-EQ-0003 paragraph 3.4.2.3.2.3.

3.4.2.3.3 Atmosphere Pressure and Composition

The equipment shall be able to be fully operational with a module internal atmosphere according to MLM-DOR-EQ-0003 paragraph 3.4.2.3.3 table 3.4.2.3.3-1 except that the Total Nominal Pressure in Operation Mode shall range from 958 to 1044 hPa.

3.4.2.4 Particulate Contamination

The equipment shall meet its specified performance requirements when exposed to the contamination environments as specified below:

3.4.2.4.1 Internal Contamination

The equipment shall comply with the internal contamination levels according to MLM-DOR-EQ-0003 paragraph 3.4.2.4.1.

3.4.2.4.2 External Contamination

The equipment exposed to external environment shall comply with the environment as defined in MLM-DOR-EQ-0003 paragraph 3.4.2.4.2.

3.4.2.5 Radiation Environment

3.4.2.5.1 General Radiation Environment

During flight operation, the equipment shall comply with the radiation environment requirements as specified in MLM-DOR-EQ-0003 paragraph 3.4.2.5.1.

3.4.2.5.2 Design Criteria

The equipment design shall be in accordance with MLM-DOR-EQ-0003 paragraph 3.4.2.5.2.

3.4.2.6 Plasma

3.4.2.6.1 Plasma Potential

Materials selection shall be as specified in MLM-DOR-EQ-0003 paragraph 3.4.2.6.1.

3.4.2.6.2 Plasma Charging Control

The design provisions to control equipment charging induced by this plasma environment shall be foreseen.

3.4.2.6.3 Plasma Environment

Material selection for module external equipment shall be as specified in MLM-DOR-EQ-0003 paragraph 3.4.2.6.3

3.4.2.7 Atomic Oxygen Exposure

Equipment exposed to the external environment shall meet its specified performance requirements as specified in MLM-DOR-EQ-0003 paragraph 3.4.2.7.

3.4.2.8 Ultraviolet Radiation

Equipment exposed to the exteral environment shall meet its specified performance requirements as specified in MLM-DOR-EQ-0003 paragraph 3.4.2.8.

3.4.3 Fluid Media

The equipment shall comply with air as specified in MLM-DOR-EQ-0003 paragraph 3.4.3.

3.4.4 Servicing Media

The equipment shall be compatible with GN2 and GHe as alternative fluid for transportation and test purposes.

4.0 SUPPORT REQUIREMENTS

4.1 Design and Construction

4.1.1 Safety

4.1.1.1 General

The equipment shall comply with the safety requirements as specified in MLM-DOR-EQ-0003 paragraph 4.1.1.1.

4.1.1.2 Cleanliness

The equipment surfaces shall be visibly clean, level sensitive, as specified in MLM-DOR-EQ-0003 paragraph 4.1.1.2.

4.1.1.3 Equipment Reactivation

After reactivation of power the equipment shall be as specified in MLM-DOR-EQ-0003 paragraph 4.1.1.3.

4.1.2 Reliability

4.1.2.1 General

The assembly shall comply with the reliability requirements as specified in MLM-DOR-EQ-0003 paragraph 4.1.2.1.

4.1.2.2 Fault Tolerance Requirements

4.1.2.2.1 Deleted

4.1.2.2.2 Deleted

4.1.2.2.3 Deleted

4.1.2.2.4 External Seal Failure

No single failure of a static or dynamic seal, when electrical and pneumatic valves closed, shall result in leakage from cabin to space above the specified performance.

4.1.2.3 Quantitative Reliability Target
The reliability target of the equipment shall be as specified in MLM-DOR-EQ-0003 paragraph 4.1.2.3.

4.1.3 Maintainability

4.1.3.1 General

The equipment shall comply with the maintainability requirements as specified in MLM-DOR-EQ-0003 paragraph 4.1.3.1.

4.1.3.2 COF Airborne Support Equipment

The COF PPRA shall provide all items as specified in MLM-DOR-EQ-0003 paragraph 4.1.3.2.

4.1.3.3 Storage and Transportation Resources

ORU/LRU's shall not require any resources until their installation.

4.1.3.4 Maintenance Time Allocation

The on-ground maintenance time for the ORU/LRU mounted in a representative environment shall be as specified in MLM-DOR-EQ-0003 paragraph 4.1.3.4.

4.1.3.5 Training

The equipment shall be designed to be maintained as specified in MLM-DOR-EQ-0003 paragraph 4.1.3.5.

4.1.3.6 Tools

4.1.3.6.1 Standard Tools

The equipment shall be designed for being maintained on-ground and in-orbit as specified in MLM-DOR-EQ-0003 paragraph 4.1.3.6.1.

4.1.3.6.2 EVA Tools

The equipment's outboard ORU's shall be designed to be maintainable using tools as specified in MLM-DOR-EQ-0003 paragraph 4.1.3.6.2.

4.1.3.7 External ORU Exchange

The external ORU's shall be designed as specified in MLM-DOR-EQ-0003 paragraph 4.1.3.7.

4.1.3.8 Debris Collection

Design provisions and/or suitable maintenance procedures shall be applied as specified in MLM-DOR-EQ-0003 paragraph 4.1.3.8.

4.1.3.9 Use of System of Units

The metric system is mandatory for the documentation, at least for all input, output and interface data and dimensions.

4.1.8 Mechanical/Thermal Design

4.1.8.1 General Mechanical/Thermal Design

The design of the equipment shall meet the requirements as specified in MLM-DOR-EQ-0003 paragraph 4.1.8.1.

4.1.8.2 Design Ground Rules for Minimum Noise and Vibration Generation

Not applicable

4.1.8.3 Structural Design

4.1.8.3.1 Safe Life Criteria

The equipment shall be designed to meet the safe life criteria as specified in MLM-DOR-EQ-0003 paragraph 4.1.8.3.1.

4.1.8.3.2 Margins of Safety

The margins of safety shall be as specified in MLM-DOR-EQ-0003 paragraph 4.1.8.3.2.

4.1.8.3.3 Fatigue

Fatigue design of the equipment structure shall be in accordance with MLM-DOR-EQ-0003 paragraph 4.1.8.3.3.

4.1.8.4 Metallic Bellows and Diaphragms

Metallic bellows and diaphragms shall be as specified in MLM-DOR-EQ-0003 paragraph 4.1.8.4.

4.1.8.5 Fire Containment

4.1.8.5.1 General

The electrical equipment shall be designed as specified in MLM-DOR-EQ-0003 paragraph 4.1.8.5.1.

4.1.8.5.2 Design Guidelines

Electrical equipment shall provide the following means for fire containment.

4.1.8.5.2.1 Venting Holes Area

Venting provisions/holes of equipment housing shall be as specified in MLM-DOR-EQ-0003 paragraph 4.1.8.5.2.1.

4.1.8.5.2.2 Venting Hole Design

The vent holes shall be as specified in MLM-DOR-EQ-0003 paragraph 4.1.8.5.2.2.

4.1.8.5.2.3 Vented Housing Wall Thickness

The vented housing shall have a minimum metal wall thickness as specified in MLM-DOR-EQ-0003 paragraph 4.1.8.5.2.3.

4.1.8.6 Buckling

Buckling shall be as specified in MLM-DOR-EQ-0003 paragraph 4.1.8.6

4.1.9 Electrical Design

The design of the equipment shall meet the requirements as specified in MLM-DOR-EQ-0003 paragraph 4.1.9.

4.1.10 Electromagnetic Compatibility and Power Quality

The design of the equipment shall meet the requirements as specified in MLM-DOR-EQ-0003 paragraph 4.1.10.

4.1.11 Nameplates and Product Marking

All the parts/items composing the equipment, including spares, shall be as specified in MLM-DOR-EQ-0003 paragraph 4.1.11.

4.2 Ground Support Equipment

The required Ground Support Equipment shall meet the requirements as specified in MLM-DOR-EQ-0003 paragraph 4.2.

4.3 Preparation for Delivery

The preparation for delivery shall be performed in accordance with MLM-DOR-EQ-0003 paragraph 4.3.

5.0 INTERFACE REQUIREMENTS

5.1 Mechanical Interface Requirements

5.1.1 Mounting Interfaces

5.1.1.1 Attachment Provisions

Specific attachment points shall be as specified in MLM-DOR-EQ-0003 paragraph 5.1.1.1.

5.1.1.2 Mounting Provisions

The mounting provisions of the branch shall be designed in accordance with MLM-DOR-EQ-0003 paragraph 5.1.1.2.

5.1.1.3 Mounting Bolts

The mounting bolts shall be as specified in MLM-DOR-EQ-0003 paragraph 5.1.1.3.

5.1.2 Interface to Vent Cap

The interface for the installation of the vent cap shall be as specified in MLM-DOR-EQ-0003 paragraph 5.1.2.

5.1.3 Envelope Requirements

The maximum envelope of one branch shall be as specified in MLM-DOR-EQ-0003 paragraph 5.1.3.

5.2 Thermal Interface Requirements

The heat transfer of the equipment shall be as specified in MLM-DOR-EQ-0003 paragraph 5.2.

5.3 Electrical Interface Requirements

5.3.1 Power Supply Interfaces

5.3.1.1 Brush Type DC Motor Interface

The motorized valves shall comply with MLM-DOR-EQ-0003 paragraph 5.3.1.1.

5.3.1.2 Heater Power Supply Interfaces

Not applicable

5.3.2 Signal Interfaces

5.3.2.1 Contact Status Sensor Interfaces

The contact status sensor interfaces shall be as specified in MLM-DOR-EQ-0003 paragraph 5.3.2.1.

5.3.2.2 Temperature Sensor Interfaces

Not applicable

5.3.3 Electrical Connector Interfaces

All electrical connector used for ORU/LRU interfaces shall be as specified in MLM-DOR-EQ-0003 paragraph 5.3.3.

5.3.4 Bonding Interface Requirements

The bonding shall be done in accordance with MLM-DOR-EQ-0003 paragraph 5.3.4.

5.4 GSE Interface Requirements

The equipment shall provide the interface to the FGSE adapter as defined in MLM-DOR-EQ-0003 paragraph 5.4. and as shown in MLM-DOR-EQ-0003 Figure 5.34.4-1.

6. IMPLEMENTATION REQUIREMENTS

The implementation requirements are covered by the "Performance Characteristics" Paragraph 3.2.

7.0 VERIFICATION

7.1 General Verification Requirements

A verification program shall be performed as specified in MLM-DOR-EQ-0003 paragraph 7.1.

7.2 Definitions

7.2.1 Verification Phases

The program verification phases are defined below.

7.2.1.1 Development

Development is primarily concerned with those design evaluation and data gathering activities that support the total design process and provide the engineering data base necessary to establish confidence that the hardware and software will meet specification requirements and that the manufacturing process will produce an acceptable product.

The data acquired will also be used to establish material selection, process, procedure, tolerances, operational characteristics and test levels to support subsequent design, production, verification, maintenance, and checkout activities.

Development testing may include: (1) Standard laboratory testing to support material selection; (2) Component, breadboard, and subsystem testing to identify the failure modes and the effects of environments and combinations of design tolerances on performance.

Development activities to be used for qualification shall be predeclared by the contractor and approved by the customer.

7.2.1.2 Qualification

Qualification includes those activities which establish that the design and manufacturing process will produce equipment and software that meet specification requirements in specified operational environments.

Qualification activities are centered around verifying performance and design requirements invoked on equipment, subsystem, system, and its software.

Compliance with performance, safety, interface, environmental and maintainability requirements is included.

Qualification tests generally consist of environmental and functional tests.

Environmental models shall be used to represent environments that cannot be achieved under the conditions of ground testing.

Environmental tests include testing to specified limits of vibration/acoustics, temperatures, pressures, humidity, etc..

Functional tests include testing to specified limits of performance such as flow, pressure, temperature, leakage, voltage, audible noise, etc.

Formal verification of the performance characteristics occurs for the full range of performance requirements during qualification.

The environmental tests shall be as specified in MLM-DOR-EQ-0003 paragraph 7.2.1.2 and Table 7.2-1.

7.2.1.3 Acceptance

Acceptance verifications are those formal verifications that are conducted to assure that the item meets the contracted or design requirements. Formal verification of performance characteristics occurs for nominal operational and critical physical requirements during acceptance.

Flight hardware/software acceptance will be accomplished to verify compliance with deliverable end item, interface documentation, and other contract requirements.

Acceptance requirements shall cover equipment, subsystems, elements and systems as identified in their respective specifications.

Once the hardware design and manufacturing process has been certified, acceptance verifications are conducted on production hardware (flight hardware). Production hardware acceptance tests use procedures, facilities and support equipment acquired and verified during the development and qualification phases.

Acceptance is an incremental process, which proceeds from acceptance of detail parts and continues through acceptance of the completed end item.

The acceptance verification data are evaluated to verify that each integrated end item meets its specified requirements and is free of defects.

The environmental test shall be as set forth in MLM-DOR-EQ-0003 paragraph 7.2.13 and Table 7.2-1.

7.2.2 Verification Methods

The verification methods are inspection, analysis, test, review of design, or a combination thereof.

The allocation of these methods is based upon design analyses, design maturity, complexity of the item, criticality category and associated cost.

7.2.2.1 Inspection (I)

Inspection is a method of verification that determines conformance to requirements without the use of special laboratory equipment, procedures, test support items or services.

Inspection uses standard quality control methods to verify compliance with requirements of construction features, document and drawing compliance, workmanship standards, and physical condition.

Emphasis is on observation of physical characteristics rather than performance.

7.2.2.2 Analysis (A)

Verification by analysis is a process used in lieu of, or in addition to, other verification methods to verify compliance to specification requirements.

The selected techniques may include, but not be limited to, engineering analysis, statistics and qualitative analysis, computer and hardware simulations, and analog modeling. Analysis may be used when it can be determined that (1) rigorous and accurate analysis is possible, (2) test is not cost effective, and (3) verification by inspection is not adequate. Verification by similarity is the process of analyzing the specification criteria for hardware configuration and application for an article to determine if it is similar or identical in design, manufacturing process, and quality control to an existing article that has previously been qualified to equivalent or more stringent specification criteria. Special effort will be made to avoid duplication of previous tests from this or similar programs.

If the previous application is considered to be similar, but not equal to or greater in severity, additional qualification tests shall concentrate on the areas of new or increased requirements.

Included is also verification by analysis using previous analysis results.

7.2.2.3 Test (T)

Test is a method of verification in which technical means, such as the use of special equipment, instrumentation, simulation techniques, and the application of established principles and procedures, are used for the evaluation of components, subsystems and systems to determine compliance with requirements.

Testing is selected as the prime method of requirements verification and shall be used when analytical techniques do not produce adequate results; failure modes exist which could compromise personnel safety, adversely affect flight systems or payload operation; or result in a loss of mission objectives. Tests shall be used to determine quantitative compliance to requirements and produce quantitative results.

The analysis of data derived from tests is an integral part of the test program, and should not be confused with analysis as defined above.

Included is verification by similarity using previous test results.

The FM acceptance tests are workmanship tests required to verify that each FM is free of defects. Therefore verification by similarity is not possible for FM acceptance.

7.2.2.4 Review of Design (R)

Review of Design means verifying compliance to requirements by evidence from documents and drawings.

7.3 Verification Matrix

The verification matrix of MLM-DOR-EQ-0003 Table 7.3-1 shall apply. Explanations and nomenclature descriptions shall be as shown in MLM-DOR-EQ-0003 paragraph 7.3.

7.4 Verification Testing Measurement Accuracy

The test set up used for certification testing shall at least achieve a measurement accuracy which is 2 times higher than the accuracy required for the value to be measured. If this is not possible, justification shall be given. In using test results for verification of requirements, due consideration has to be given to the measurement accuracy

8.0 GLOSSARY OF ABBREVIATIONS AND ACRONMYMS

C	Centigrade
COF	Columbus Orbital Facility
DC	Direct Current
EVA	Extra Vehicular Activity
GHe	Gaseous Helium
GN2	Gaseous Nitrogen
g	gravity
kg/h	Kilograms per hour
hPa	Hecto Pascals
LRU	Line Replaceable Unit
MGSE	Mechanical Ground Support Equipment
MPLM	Multi Purpose Logistics Module or Mini Pressurized Logistics Module
ORU	Orbital Replaceable Unit
PPRA	Positive Pressure Relief Assembly
psig	pounds per square inch Gage

MARSHALL SPACE FLIGHT CENTER
CONFIGURATION CONTROL BOARD DIRECTIVE (CCBD)

1. CCBD NUMBER: MP3-00-0009	2. CONFIGURATION CONTROL BOARD: Multi-Purpose Logistics Module CCB	3. DATE: APRIL 24-00
4. CHANGE NUMBER: ECR FD23-0010		5. PAGE 1 OF 2
6. PROGRAM CONTROL NUMBER: MP00009	7. RESPONSIBLE INDIVIDUAL(S) ORGANIZATION(S): Charlotte Hazel/FD23	

8. CHANGE TITLE: Baseline Release ISS-MPLM-SPEC-~~0~~001, Positive Pressure Relief Asssembly	9. END ITEM NUMBER AND NOMENCLATURE: N/A
10. EFFECTIVITY: MP01	11. BASELINE DOCUMENT AFFECTED: MLM-DOR-EQ-0003

12. IMPACTS:

	YES	NO		YES	NO
Weight	☐	☒	Memory	☐	☒
Schedule	☐	☒	Cost per Flight	☐	☒
Power	☐	☒	Environmental	☐	☒

13. IMPACT COST:

FY 2000	COST: $0	FY	COST:
FY	COST:	FY	COST:
FY	COST:	TOTAL COST:	0

14. CHANGE DISPOSITION:

1. ECR FD23-0010 IS approved as written: Baseline Release ISS-MPLM-SPEC-~~0~~001

2. The OPR, Charlotte Hazel/FD23 shall enter the date of this CCBD on ISS-MPLM-SPEC-~~0~~001, provide a signed and dated copy to Bob Fenton/FD23/PWI for submittal to the MSFC Repository for file and distribution for reference. Suspense: 5-2-00

3. Bob Fenton/FD23/PWI shall submit ISS-MPLM-SPEC-~~0~~001 and associated COF/MPLM ECLSS Document MLM-DOR-EQ-0003, Issue 05, Rev 03 to the MSFC Documentation Repository with the attached distribution list and instruct the MSFC Documentation Repository to always distribute MLM-DOR-EQ-0003 with ISS-MPLM-SPEC-0001. Suspense: 5-9-00

15. CCB MEMBERS	CONCUR YES	CONCUR NO	CCB MEMBERS	CONCUR YES	CONCUR NO
C. Allen Shariett/FD23					
Shawn Reagan/FD23					
Victor B. Hamrick/FD11					
Paul Johnson/QS30	✓				

16. CCB CHAIRPERSON

Robert G. Fenton/PWI
MPLM CCB Secretariat

Randy K. McClendon/FD23
Alternate Chairman
MPLM CCB

Randy K McClendon
24 APR 2000

1. NUMBER: FD23-0010	2. PCN: MP00009	**MSFC ENGINEERING CHANGE REQUEST (ECR)** (See Instructions: MSFC Form 2327-2)	3. DATE: 03/28/2000	4. PAGE: 1 OF 1

5. TO:	6. THRU:	7. FROM:
Randy McClendon/FD23	• Jon Holladay/FD23	Charlotte Hazel/FD23

8. TITLE OF CHANGE:

Baseline Release ISS-MPLM-SPEC-~~0~~001

9. RECOMMENDED PRIORITY:	10. NEED DATE:
☐ EMERGENCY ☐ URGENT ☒ ROUTINE	04/12/2000
11. PROGRAM(S)/PROJECT(S) AFFECTED: ISSA, MPLM	12. CONFIGURATION ITEM(S) AFFECTED BY NOMENCLATURE: Positive Pressure Relief Assembly, ECLS-ESA-DRD-ENG-04
13. RECOMMENDED EFFECTIVITY(IES): MP01	14. DOCUMENTATION AFFECTED (Specs, ICD, etc.): ECLS-ESA-DRD-ENG-04
15. RELATED CHANGES (ECR, ECP, CR, etc.) BY NUMBER: SSCN 002452	15A. INITIATING DOCUMENT NUMBER (e.g., DR, Software Trouble Report, etc.): N/A

16. JUSTIFICATION FOR CHANGE (Include effect if not incorporated. If necessary, continue on MSFC Form 2327-1, Continuation Sheet):

Per SSCN 002452 to prevent activation of the MPLM Positive Pressure Relief Assembly during transportation.

17. EFFECTS ON:

☐ HARDWARE ☐ FACILITY ☐ SCHEDULE (SEE ENCLOSURE _____ FOR IMPACT ☒ REQUIREMENTS DOCUMENTATION

☐ SOFTWARE ☐ ENVIRONMENT ☐ COST (ESTIMATED COST INCLUDED IN ENCLOSURE _____) ☐ OTHER (SPECIFY): _____

18. DESCRIPTON OF CHANGE (Include reference to enclosure. If necessary, continue on MSFC Form 2327-1, Continuation Sheet.):

Baseline MPLM Project Specification to change the crack pressure of the MPLM Positive Pressure Relief Assembly (PPRA) from 14.89 psia to 15.05 psia.

19. MOD KIT INFORMATION:

YES	NO		Enclosure	Paragraph
☐	☒	Previously issued modification instructions affected? (Explain)		
☐	☒	Proofing of modification instructions and kit installation required? (Explain)		
		Proofing location:		
☐	☒	Retest required? (Identify test invalidated by change)		
☐	☒	Requalification required? (Include description of test plan for requalification)		

Vehicle/Site & CI Serial No.	Change Period	Mod Kit Delivery Date	Est. M/H for Mod Kit Instl.	Out-of-Service Time

20. SIGNATURE OF ORIGINATOR:	DATE:	TELEPHONE NUMBER:	OFFICE SYMBOL:
Charlotte Hazel	3/28/00	544-5451	FD23

21. CONCURRENCE

SIGNATURE	ORG. CODE	DATE	SIGNATURE	ORIG. CODE	DATE
Jon B Holladay	FD23	4/3/00			
Randy L McClendon	FD23	4/4/00			

22. TECHNICAL APPROVAL

SIGNATURE	ORG. CODE	DATE	SIGNATURE	ORIG. CODE	DATE

DOCUMENT INPUT RECORD

I. TO BE COMPLETED UPON SUBMITTAL OF DATA

1 APPROVED PROJECT:	2. DOCUMENT/ DRAWING NO..	3. CONTROL NUMBER:	4. DOCUMENT DATE:	5. SUBMITTAL DATE:	6. REPORT TYPE:
MPLM	ISS-MPLM-SPEC-001	MP00009	04/24/2000	04/25/2000	SPEC.

7 CONTRACT NO /PERFORMING ACTIVITY:	8. DRD NUMBER:	9. DPD / DRL / IDRD NUMBER:	10. RETENTION & AUTHORIZATION:
FD23/PWI			

11 SUBMITTAL AUTHORITY	12 RELEASING AUTHORITY	13. SPECIAL INSTRUCTIONS.
R. MCCLENDON/FD23 544-3559	MPLM CCB ECR FD23-0010	FILE & DISTRIBUTE WITH MLM-DOR-EQ-0003, ISSUE 05, REV. 03, USING ATTACHED DISTRIBUTION LIST. RETURN ORIGINAL TO R. FENTON/FD23/PWI. PROG

14 CONTRACTOR/SUBMITTING ORGANIZATION, ADDRESS AND PHONE NUMBER:

15. ORIGINATING AGENCY NAME.
MSFC FD23

16. TITLE:
POSITIVE PRESSURE RELIEF ASSEMBLY (PPRA) SPECIFICATION

17 OFFICE OF PRIMARY RESPONSIBILITY
CHARLOTTE HAZEL/FD23

18. ABSTRACT (MAXIMUM 200 WORDS):
BASELINE MSFC MPLM POSITIVE PRESSURE RELIEF ASSEMBLY SPECIFICATION TO MODIFY CRACK PRESSURE SETTINGS IDENTIFIED IN ESA SPECIFICATION MLM-DOR-EQ-0003, ISSUE 05, REV 03 TO IMPLEMENT SPACE STATION CHANGE DIRECTIVE /CR 2452R1.

19. KEYWORDS:	20. NUMBER OF PAGES:
POSITIVE PRESSURE RELIEF ASSEMBLY	31

21. SECURITY CLASSIFICATION OF REPORT:	22. SECURITY CLASSIFICATION OF THIS PAGE:	23. SECURITY CLASSIFICATION OF ABSTRACT:
UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED

II. TO BE COMPLETED FOR ENGINEERING DRAWINGS

24 REVISION:	25. ENG. ORDER:	26. PARTS LIST:	27. CCBD:	28. CODE ID:	29. NEXT ASSEMBLY:	30. EFFECTIVITY:

III. TO BE COMPLETED FOR REPORTS, SPECIFICATIONS, ETC.

31 REVISION:	32. CHANGE:	33. VOLUME:	34. BOOK:	35. PART:	36. SECTION:
BASELINE	N/A	N/A	N/A	N/A	N/A

37. ISSUE:	38. ANNEX:	39. SCN:	40. DCN:	41. AMENDMENT:
N/A	N/A	N/A	N/A	N/A

42. APPENDIX:	43. ADDENDUM:	44. CCBD:	45. CODE ID:	46. IRN:
N/A	N/A	MP3-00-0009	N/A	N/A

IV. EXPORT AND DISTRIBUTION RESTRICTIONS

- ☐ Privacy Act (see 14CFR1212.605)
- ☐ Proprietary (see MPD 2210.1)
- ☐ Patent (see MMI 2220.1)
- ☐ ITAR (see MMI 2220.1)
- ☐ EAR (see MMI 2220.1)
- ☒ No statutory or institutional restrictions applicable – material may be distributed to public (including placement on the World Wide Web)

V. REQUESTING ORGANIZATION APPROVAL

47 NAME:	48. SIGNATURE.	49. ORG. CODE:	50. PHONE NUMBER:	51. DATE:

VI. TO BE COMPLETED BY MSFC DOCUMENTATION REPOSITORY

52. RECEIVED BY:	53. DATE RECEIVED:	54. WORK ORDER:
D.R.	4-27-00	02-00524