RRS-IFS-201
February 1991

EXPERIMENT MODULE/SUPPORT MODULE INTERFACE SPECIFICATION FOR THE REUSABLE REENTRY SATELLITE

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CONTENTS

FIGURES

TABLE

1.0 SCOPE

This Interface Specification (IFS) identifies, defines, and controls the interface between the Reusable Reentry Satellite (RRS) Vehicle (RRV) Experiment Module (EM) and the Support Module (SM) equipment. Contained in this specification are the physical, functional, and environmental interface requirements for the SM and EM. This specification is tailored to the unique requirements of the EM associated with the Rodent Module. The addenda to this specification contain the requirements for alternate EMs.

1.1 ITEM DEFINITION

The RRV is a spacecraft which can accommodate a variety of experimental Payload Modules (PMs) during long-duration orbital missions with a precision land recovery. The PM receives all utility sources from the RRV. The PM can be separated into two modules - an Experiment Module (EM) which houses the experiment, and a Support Module (SM) which contains the ECLSS, EM, pressure vessel, and electronics for the EM. A block diagram of the interfaces between the SM and EM is shown in Figure 1. A description of each major item follows:

a) RRV - The RRS Vehicle is the system of flight hardware which supports and maintains the Flight PM in orbit during a mission. The RRV is configured as shown in Figure 1a.

b) PM - The RRS Flight PM is an integrated module containing and enclosing the RRS payload (specimens and/or experiment peculiar equipment) and equipment to: (1) maintain life support, (2) control temperature, (3) control atmosphere composition and humidity, (4) maintain mechanical and structural integrity, (5) condition and control electrical power, (6) collect and store data, and (7) control the module. Three generic types of Flight Payload Modules are anticipated: a General Biology Module (GBM), a Rodent Module (RM), and a Botany Module. The PM is configured as shown in Figure 1b.

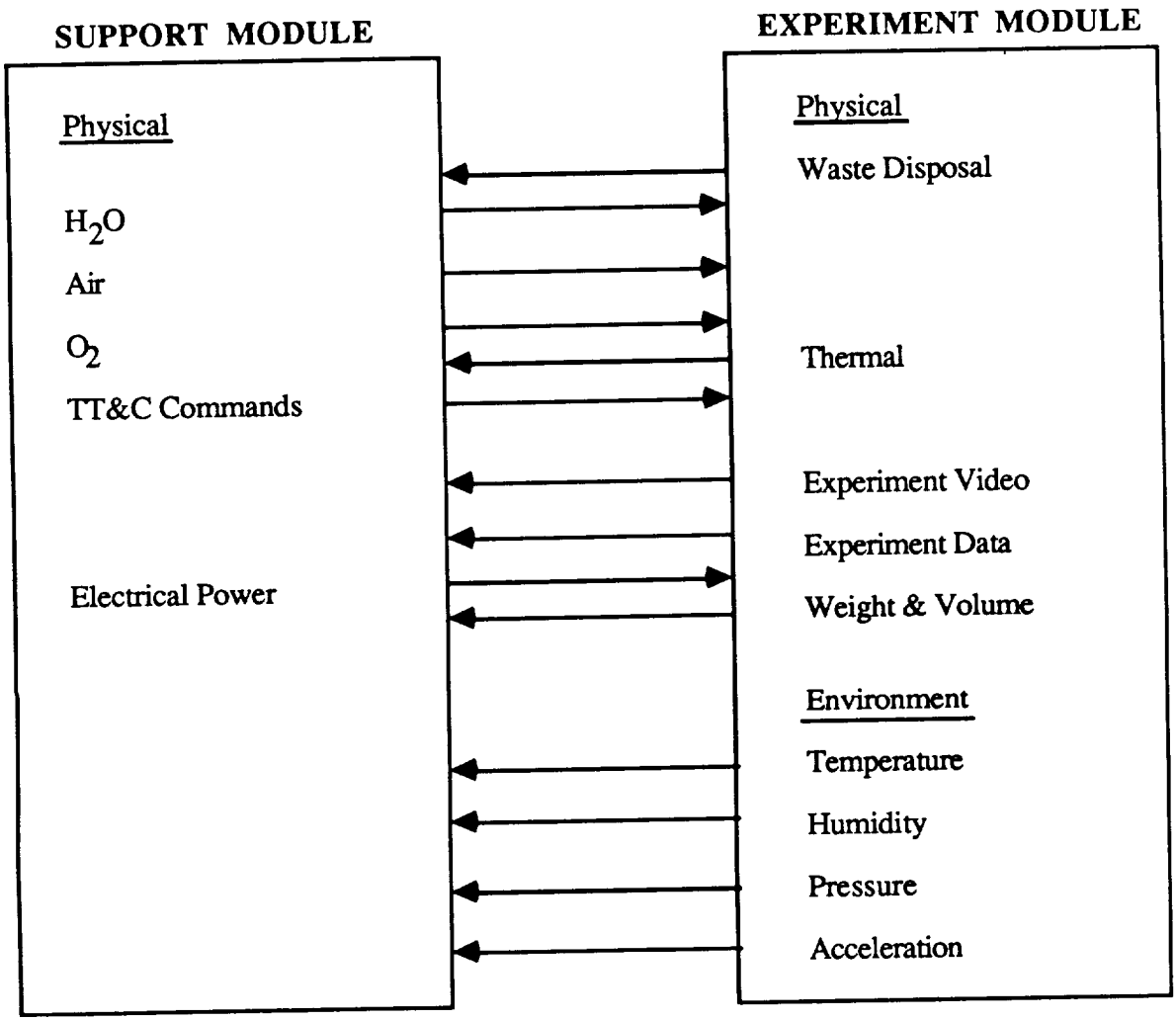

Figure 1. EM/SM Interface Block Diagram

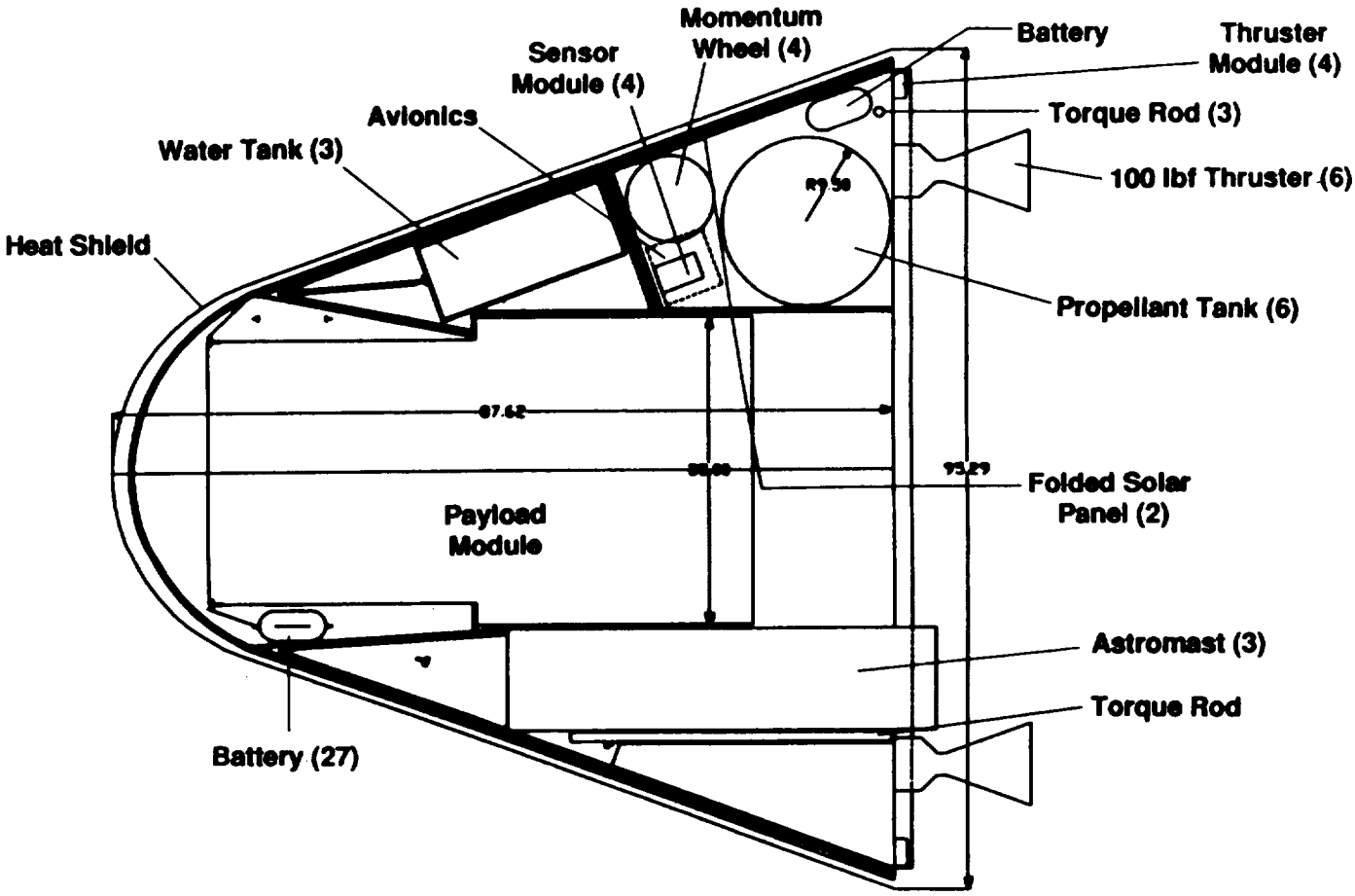

Figure 1a. RRS Side View

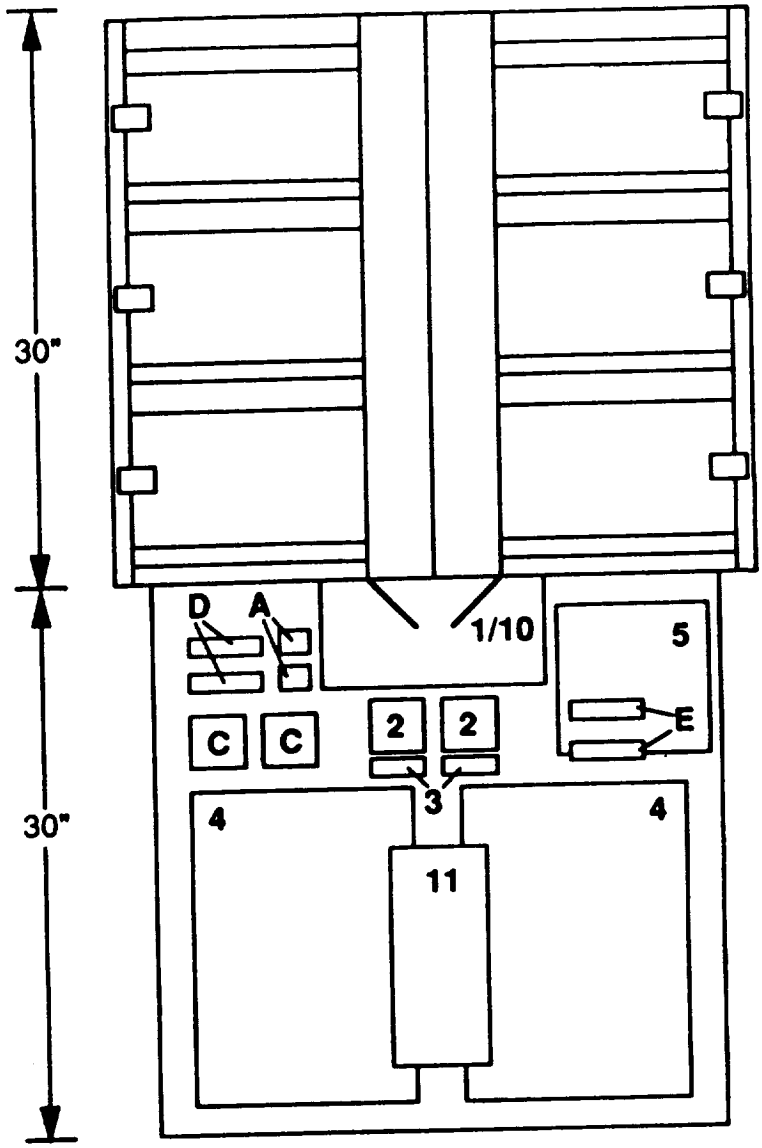

Figure 1b. RM Configuration (Side View)

c) EM - The Experiment Module houses and supports living payloads, containing (for the RM) the cages, lighting, food, water, atmosphere, instrumentation, waste control, ventilation, and imaging systems. The EM is configured as shown in Figure 1c.

d) SM - The Support Module contains the ECLSS, imaging system, lighting harness, instrumentation assembly, and waste container and supporting structure, as well as the requisite interconnectors, wiring harness, external interface connectors, tubing runs and attach fittings. The SM is configured as shown in Figure 1d.

1.2 SIGNATORY AGENCIES/CONTRACTORS

The RRS satellite contractor is responsible for the preparation, approval, distribution, and retention of the IFS. The following signatories must approve this IFS to make it effective:

a) RRS Vehicle Contractor
b) Payload Module Contractor
c) NASA Johnson Space Center
d) NASA Ames Research Center

1.3 ORGANIZATIONAL RESPONSIBILITIES

TBD

2.0 APPLICABLE DOCUMENTS

As specified in RRS-SS-100, Section 2.

3.0 INTERFACE REQUIREMENTS

3.1 PHYSICAL

All physical interfaces shall comply with RRS-SS-100, RRS-RRV-200, and RRS-PM-200.

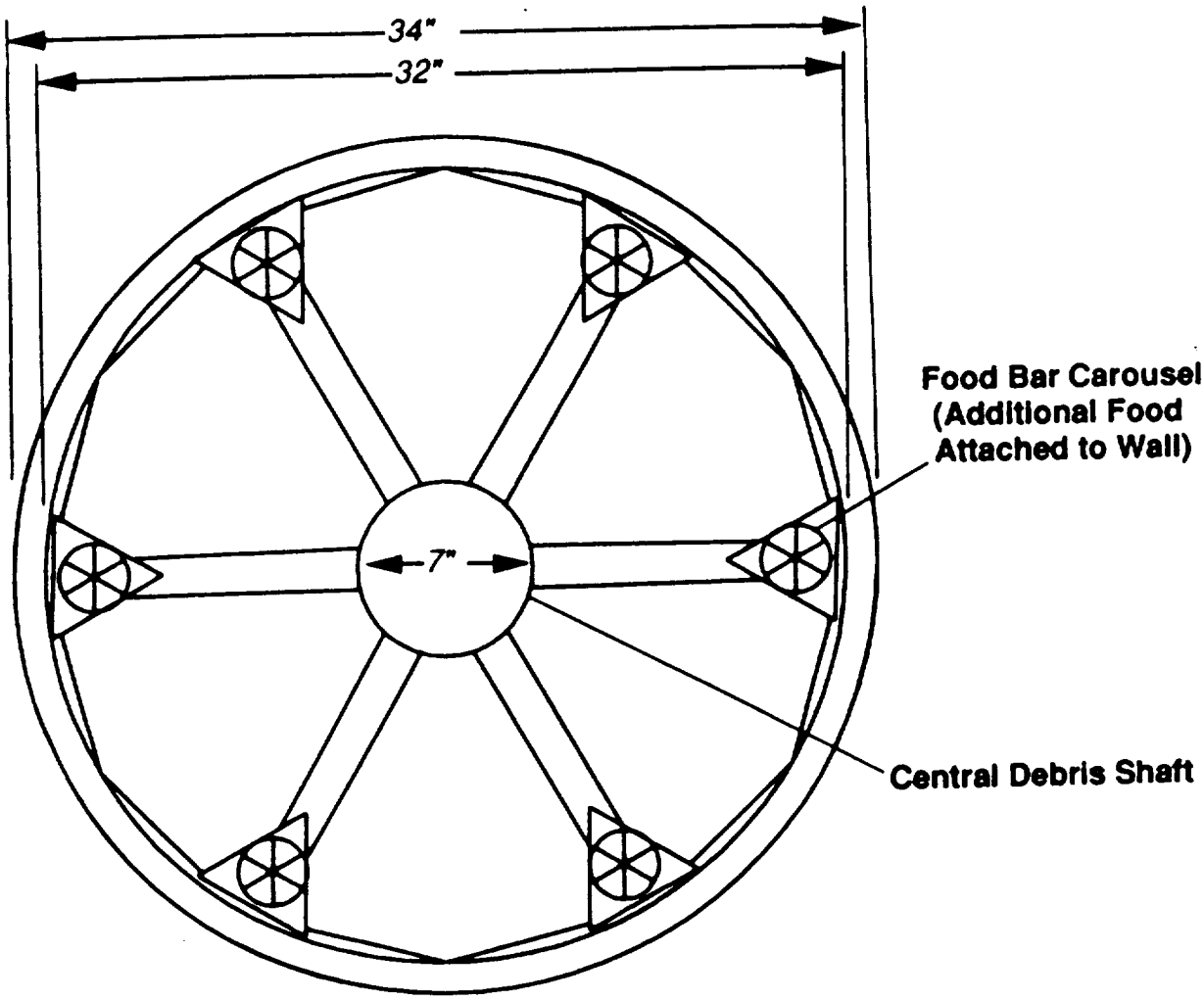

Figure 1c. Cage Layout (Top View)

1/10 = Debris Trap/WasteFilter
4 = CO_2 Absorber
5 = Heat Exchanger
9 = Fans
11 = Pressure Relief Valves
12 = Air Flow Control Valve

A = CCD Camera
B = Hard Disk
C = Cassette Tape
D = PM Processor
E = Power Converters

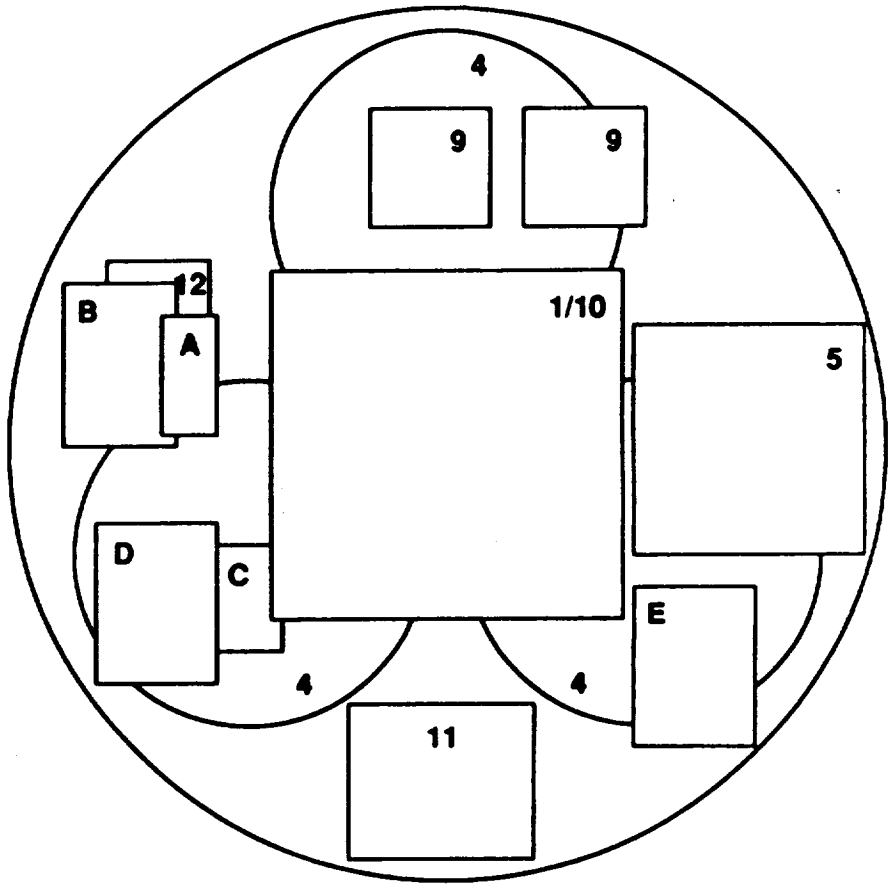

Figure 1d. SM Layout (Top View)

3.1.1 Size. The SM pressure vessel shall be physically capable of housing the EM during all phases of the mission from pre-launch to recovery.

3.1.1.1 Dimensions. Figure 2 (TBD) identifies the basic configuration of the PM and distinguishes between the SM and EM. The SM shall allocate the following dimensions for housing an EM:

a) Height - 29 inches.
b) Diameter - 33 inches.

3.1.1.2 Clearance. The SM shall be designed with adequate clearance to allow for proper structural mounting and ease of insertion/removal of an SM with maximum dimensions defined in 3.1.1.1.

3.1.2 Weight

a) The weight of the EM shall not exceed 270 lbs fully loaded.

b) The combined EM/SM weight shall not exceed 640 lbs.

c) External consumables housed within the RRV are not included in this weight budget.

d) The EM/SM combination shall comply with RRS-PM-201.

3.1.3 Center of Gravity

a) The coordinate system for the EM and SM shall be as defined in Figure 3)

b) At the time of launch, the CG for the EM shall be in the center of the EM along the Z-axis.

c) The combined EM/SM CG shall comply with RRS-IFS-101.

d) During the course of the mission, shifts in the CG shall not exceed TBD inches towards the base of the SM. Shifts in the +Z-direction shall not exceed TBD.

e) CG determination does not include consumables stored in the RRV.

TBD

Figure 2. Basic PM Configuration

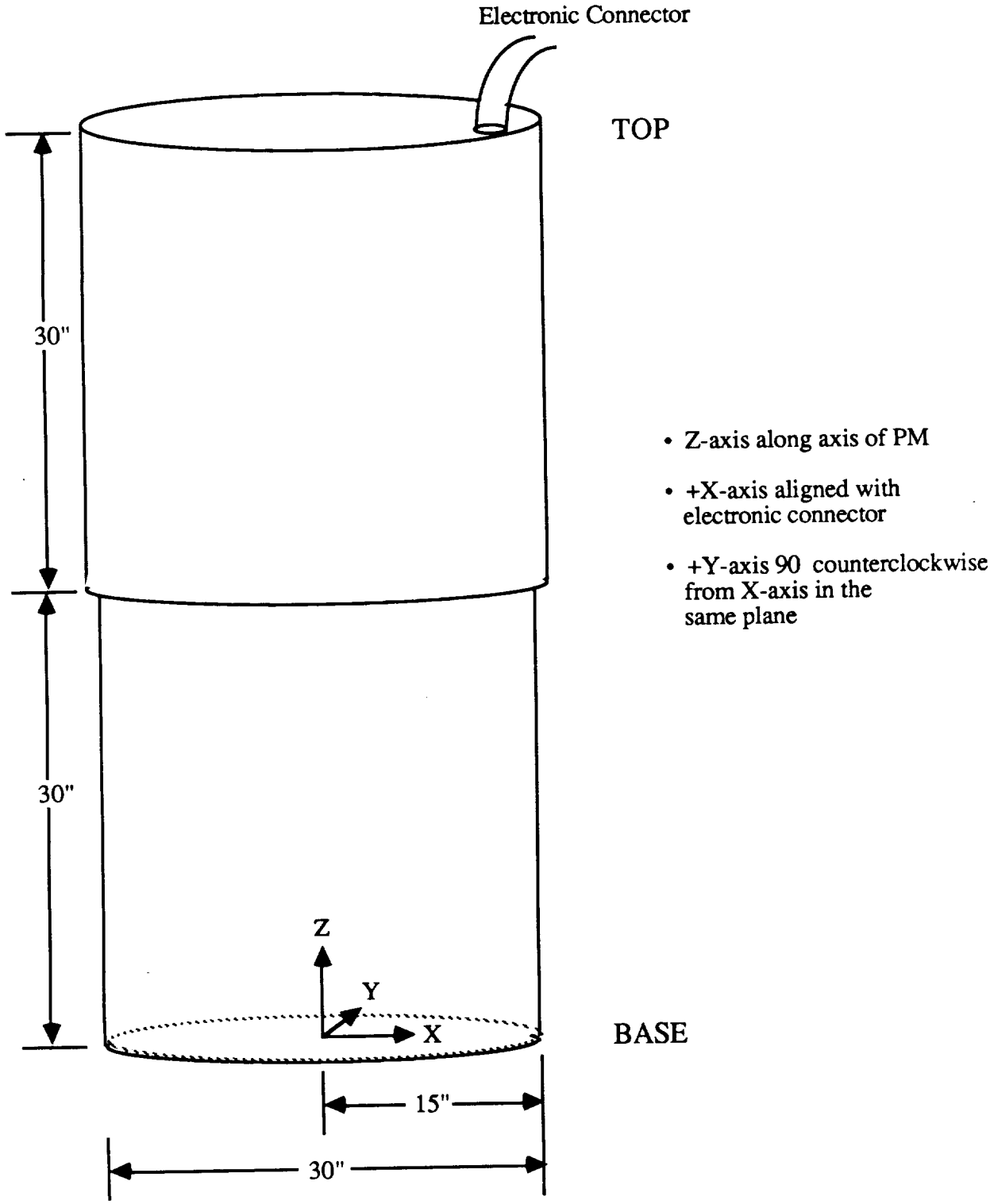

Figure 3. RM Coordinate System

3.1.4 Inertial Properties

a) The EM shall not be the source of any sustained inertial momentums.

b) Random inertial forces within the EM shall not exceed TBD.

3.1.5 EM Mounting

a) The SM shall provide the structural mounts necessary to secure the EM to the SM.

b) The EM shall provide its own support structure.

3.1.5.1 EM Mounting Requirements. The structural mounts shall be designed to have sufficient strength to withstand the effects of loads, temperature, and environmental conditions without experiencing detrimental performance.

3.1.5.2 Allowable Distortion. The structural dynamics of the EM shall be such that its interaction with the SM does not result in a degradation of performance.

3.1.6 Connector Practices and Definitions

3.1.6.1 Electrical Connector Constructions. The interface connectors for all electrical/electronic connectors shall comply with TBD.

3.1.6.2 Fluid Connectors. The interface connectors and components for the fluid subsystems and components shall be in accordance with MIL-STD-1522 and NHB 1700.7.

3.1.7 Materials. The materials selected shall be of sufficient proven quality to allow the space equipment to meet the functional performance, reliability, and strength required during its life cycle, including all environmental degradation effects.

3.1.7.1 Acceptable Metals. Materials shall be selected that have demonstrated their suitability for the applications intended.

3.1.7.2 Dissimilar Metals. Protection of dissimilar metal combinations shall be in accordance with MIL-STD-889.

3.1.8 Thermal. The SM shall be responsible for rejecting the thermal load from the EM during mission phases as defined below.

3.1.8.1 Pre-Launch

a) During the pre-launch phase of the mission, cooling shall be provided by the SM connected through the RRV to GSE.

b) The heat load shall nominally be 300 BTU/hour.

3.1.8.2 Orbit

a) During the "lights on" phase of the mission, the SM shall be capable of rejecting a nominal load of 500 BTU/hour from the EM.

b) The nominal heat load shall be 300 BTU/hour during the "lights off" phase.

3.1.8.3 Reentry

a) During reentry, the SM shall not be able to connect to the RRV coolant loop.

b) The SM shall have the capacity to provide for cooling of the EM.

c) The SM shall provide for up to three hours of cooling of the EM before GSE must be connected after touchdown.

3.1.8.4 Recovery

a) During the recovery phase prior to removal of the EM, the SM shall provide cooling via its interface to GSE through the RRV.

b) The heat load shall nominally be 300 BTU/hour.

3.1.9 Access. The operation and design of the SM shall be such that access to the experiment within the EM can be realized according to the following timelines.

3.1.9.1 Pre-Launch Access

a) Final installation of the EM into the SM shall occur no later than liftoff minus 12 hours.

b) All preparations shall be completed no later than liftoff minus four hours.

3.1.9.2 Post-Landing Access. Removal of the EM from the SM shall occur no later than two hours after touchdown at the landing site.

3.2 FUNCTIONAL

3.2.1 Electronic. All electronic interfaces are defined in ICD TBD.

3.2.1.1 Command. The command interface shall:

a) Communicate commands from the SM processor to the EM hardware.

b) Be controlled exclusively by the processor within the SM.

c) Provide event timing signals as listed in Table I (TBD).

Table I. Event Timing Signals

TBD

3.2.1.2 Data Interface

a) The data interface shall provide communication of experimental data from the cages to the SM processor.

b) The SM shall gather SOH and satellite data for inclusion with the experiment data.

3.2.2 Electrical Power. The SM shall receive electrical power from the RRV and provide it to the EM as required.

3.2.2.1 Characteristics. The SM shall provide conditioned power for use by the EM.

3.2.2.2 Quality

a) The direct current power shall be of TBD Vdc ±TBD V.

b) Alternating current power shall be provided at TBD ±TBD.

3.2.2.3 Demand and Duty Cycle

a) The EM power demand may be continuous for some periods and variable with time in a repetitive cycle for other periods.

b) The SM shall be capable of providing a peak power to the EM of 75 W for periods of up to five minutes.

c) The SM shall provide a total of no less than 75 kWH of power to the EM.

d) EM power demands during the pre-launch, reentry, recovery, and post-recovery shall be limited to life support critical hardware.

3.2.3 Fluids

a) The SM shall provide the consumable water for use by the EM.

b) A redundant watering capability shall be provided.

3.2.3.1 Fluid Pressure. The pressure of consumable water shall be maintained by the SM at TBD psia.

3.2.3.2 Fluid Flow Rate. Consumable water shall be provided on an as-required basis with a flow rate not to exceed 3.0 ppd.

3.2.3.3 Fluid Temperature. TBD

3.2.3.4 Fluid Quantity. The SM shall be capable of providing up to 133 lbs of water to the EM.

3.2.4 Air. The SM shall provide the necessary air and oxygen to maintain the total pressure in the EM within the range of 14.0 - 14.9 psia.

3.2.4.1 Air Composition

a) Air flow shall keep the pressure above 14.4 ±0.2 psia.

b) Oxygen shall be used to keep the pressure above 14.7 ±0.2 psia.

c) The SM shall maintain the trace contaminants to below the limits in Table II)

d) The composition shall be 20 ±2% O_2N_2.

Table II. Trace Contaminants*

Contaminant	MAC (ppm)	Generate Rate (gm/man-day)**	Required Air Vent Rate (lb/man-day)**
Ammonia	25	2.5^{-1}	1.84
Methane	1000	4.70^{-2}	8.66^{-2}
Acetaldehyde	10	8.30^{-5}	1.53^{-2}
Acetone	100	1.30^{-4}	2.39^{-3}
Ethyl Alcohol	17	4.00^{-3}	4.33^{-1}
Methyl Alcohol	13	1.40^{-3}	1.98^{-1}
n-Butyl Alcohol	3	1.30^{-3}	7.98^{-1}
Methyl Mercaptan	0.1	8.30^{-4}	1.53
Hydrogen Sulfide	1	7.50^{-5}	1.38^{-1}

* NASA specification SXHS 7800, Revision H
** Estimate 18 rodents = 1/2 man

3.2.4.2 Air Pressure

a) The SM shall maintain the total pressure of the EM to 14.0 - 14.7 psia.

b) A pressure relief valve shall be available to limit the pressure to under 15.1 ±0.2 psia.

3.2.4.3 Air Flow Rate. A nominal flow rate of 0.2 ppd is required to maintain the pressure.

3.2.4.4 Air Temperature. TBD

3.2.4.5 Air Quantity

a) The quantity of oxygen shall be 49 lbs for a 60-day mission.

b) The quantity of air shall be 24 lbs for a 60-day mission.

3.2.4.6 Placement. The vents to maintain airflow shall be at the perimeter of the EM.

3.3 ENVIRONMENTAL

The SM shall provide the operating environment for the EM during all phases of the mission.

3.3.1 Vibration

3.3.1.1 Mechanical. The mounting interface between the EM and SM shall be constructed such that mechanical vibrations inside the EM do not exceed the levels contained in the Spacelab Payload Accommodation Handbook.

3.3.1.2 Shock. The mounting interface between the EM and SM shall be designed such that at no time does the g-loading exceed 8 g's.

3.3.1.3 Acoustic. Sound resolution between the SM and EM shall limit the acoustical noise to less than 73 db in the frequency range of 200 - 40 kHz.

3.3.2 Electromagnetic Interference/Radio Frequency Interference (EMI/RFI). The equipment shall be designed to comply with TBD.

3.3.3 Radiation

a) The configuration of the SM shall preclude the EM from being exposed to radiation during the orbital phase.

b) The level of EM radiation exposure shall be variable by changing the SM pressure vessel shielding.

c) Equipment in the SM shall provide its own shielding.

3.3.4 Acceleration. The SM shall perform its tasks during all acceleration environments as required for the specific EM mission.

3.3.4.1 Fractional Gravity. The RRV shall be capable of subjecting the RM to sustained artificial gravitational forces while on-orbit.

a) The g-forces shall be in the -Z direction with respect to the RRV coordinate system)

b) The g-forces shall be selectable in 0.1-g increments between 0.1 g and 1.5 g's for any flight.

c) The g-forces shall be maintained within a range of ±10%.

3.3.4.2 Microgravity

a) The RRV shall be capable of supporting the RM in a microgravity environment which is less than 10^{-5} g's for at least 90% of the flight)

b) During the remainder of the flight, the artificial gravity acceleration shall not exceed 10^{-3} g's except during launch, reentry, and recovery.

3.3.5 Temperature. The SM shall maintain the temperature in the EM within the range of 65 - 79°F ±3.6°F.

3.3.6 Humidity. The relative humidity shall be 55% ±15%.

3.4 SAFETY

As specified in RRS-SS-100, paragraph 3.3.6.

4.0 QUALITY ASSURANCE PROVISIONS

5.0 NOTES

10. APPENDIX I. Reserved

20. APPENDIX II. Reserved

A. ADDENDUM A. SM/EM (Non-rodent)

Addendum A will address the parallel requirements of the SM/EM (non-rodent) interface on a by exception basis.

A.1.0 SCOPE

A.1.1 Item Definition

A.1.2 Signatory Agencies/Contractors

A.1.3 Organizational Responsibilities

A.2.0 APPLICABLE DOCUMENTS

A.3.0 INTERFACE REQUIREMENTS

A.3.1 Physical

A.3.2 Functional

A.3.3 Environmental

A.3.4 Safety. As specified in RRS-SS-100.

A.4.0 QUALITY ASSURANCE PROVISIONS

A.5.0 NOTES