SPACE RIDER SYSTEM – PAYLOAD INTERFACE REQUIREMENTS DOCUMENT TEMPLATE

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APPROVAL

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DISTRIBUTION

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1. SCOPE OF THE TEMPLATE

Scope of this document is to provide a common template for use by all Space Rider System potential Customers to compile their Payload Interface Requirements Document (IRD) to forward their requirements suitable to allow a preliminary feasibility assessment of their mission on a Space Rider Flight.

The template foresees a first part where payload mission and project overview are described, and a second part where payload requirements in terms of mission, interfaces and operations are detailed. In each section, a brief description of the expected input is given between square brackets.

The resulting Payload IRD is not an ESA document, as such the document shall be prepared and configured according to Customer formal documentation standards.

In Annex 1 the resulting expected table of contents of the payload Interface Requirements Document is reported for reference.

2. ACRONYMS

[To complement the following list as needed with any payload specific acronym]

MPCB	Multi-Purpose Cargo Bay
AIT	Assembly, Integration and Test
PGCC	Payload Ground Control Centre
TM	Telemetry
TC	Telecommand
MMU	Mass Memory Unit
MTL	Mission Time Line
TRP	Temperature Reference Point
VCC	Vehicle Control Center
UPOC	User Payload Operation Center

3. DEFINITIONS

[To complement the following list as needed with any payload specific acronym]

Payload	One unit allocated in the MPCB, it could either be a Laboratory carrying Experiments or an individual Experiment.
Laboratory	A facility dedicated to host and manage a defined number of Experiments during the mission.
Experiment	A unique item accommodated in a Laboratory or provided as an individual item.
Experiment Owner	The entity in charge of the development of a single Experiment.
Sub Aggregator	The Entity owning one or more Payloads.
Customer	Each Sub Aggregator of a Space Rider flight.

MPCB Aggregate	The configured list of Payloads to compose the Space Rider Payload; defined, developed, and qualified for a specific Space Rider mission.
MPCB Operator	The Entity in charge of definition, development and management of the MPCB Aggregate configuration dedicated to a specific mission, from Payloads selection to Experiments retrieval. NOTE: Limited to SRS Maiden Flight preparation, this role will be covered by ESA Project.
Prime	The prime contractors of the Space Rider System, in charge of development qualification manufacturing and mission preparation and implementation of the system.

Payload categories

For the definition of the flight-only safety requirements it is necessary to define three classes of PL embarked on Space Rider:

- **Fixed Payload**: any Payload which does not separate from Space Rider MPCB and remain fixed to the MPCB.
- **Deployable Payload (D-PL)**: any Payload, which can separate from Space Rider MPCB into its own free-flying mission, divided in three sub-classes:
  - Payload deployable with no manoeuvre capability (**D-PL (NM)**)
  - Payload deployable with manoeuvre capability (**D-PL (M)**)
  - Payload deployable with operations within the Space Rider Keep Out Zone (retrieval/re-visitation) (**D-PL (KZ))**
- **Movable Payload**: any Payload which does not separate from Space Rider MPCB but perform movement inside it (i.e. robotic arm)

P/L Keep Out Zone (KOZ)

Zone inside which the Deployable Payload operations are considered dangerous for Space Rider. The Space Rider KOZ is 200 m (TBC) radius sphere centered at the Space Rider vehicle center of mass.

P/L Approach Zone (AZ)

The Space Rider Approach Zone (AZ) is the zone around Spacer Rider in which it is necessary to measure the relative position between the Payload and Space Rider to avoid collision.
The Space Rider AZ is a 1 km (TBC) radius sphere centered at the Space Rider center of mass.

P/L Approach Corridor

The Approach Corridor is the spatial envelope to be followed by the Payload in the Keep Out Zone (KOZ). The notion of corridor, generally understood as a cone originating from the target in which the Payload makes its approach, is extended to address at least:

- Relative trajectory including margin (the relative trajectory might not be a linear translation)
- Range-rate profile (profile of the relative rate versus the relative distance)
- Relative attitude (angles and rates) profile

The qualitative parameters (e.g. reference frame) and quantitative parameters are mission specific.
The Space Rider Approach Corridor is a 10˚ (TBC) cone centered to the docking port axis (Space Rider MPCB) within the KOZ.

P/L Abort Corridor

The Abort Corridor is the spatial envelope, which if exceeded, in case of Payload GNC loss, creates hazardous collision between the Payload and Space Rider. The Abort Corridor, it addresses at least:

- Relative trajectory
- Range-rate profile
- Relative attitude (angles and rates) profile

The qualitative and quantitative parameters are mission specific. The Abort Corridor typically is larger/around the Approach Corridor although some parameters might be different (e.g., a too small relative range rate might not be part of the Abort Corridor whereas it might part of the Approach Corridor).
Violating the Abort Corridor results in an Abort.

4. APPLICABLE DOCUMENTS

The following section reports the document that shall be taken as Applicable in the compilation of the payload IRD.

Number	Reference	Title
[AD1]	ESA-STS-SR-ST-2022-0001	Space Rider System - Payloads Safety, Space Debris and Collision Avoidance Requirements
[AD2]	ESA-STS-SR-TN-2018-0002	Space rider User Guide

5. DOCUMENT CONFIGURATION

[To include approval flow and change recording along the issue evolution of the document, if any, as per following example]

APPROVAL

Title	
Issue Number 1	Revision Number 0
Author	Date
Approved By	Date of Approval

CHANGE LOG

Reason for change	Issue Nr	Revision Number	Date

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6. TABLE OF REQUIREMENTS

[To include a summary table collecting and numbering all payload requirements defined in the relevant sections of this document]

7. PAYLOAD MISSION OVERVIEW

7.1. General

[To describe the general scope of the project and specific purpose of the mission, i.e.: science, tech, manufacturing, etc...]

7.2. Payload classification and application

[To provide detailed description of the payload typology[1], application and mission scope.]

7.3. Space segment description

[Main description of the Payload to be embarked on the MPCB of Space Rider, including:

- Main dimensions and mass[2]
- Specify if it is a single Experiment or multiple Experiment carrier
- Hosting facility (Laboratory), if any (e.g., pressurize vessel, incubator)
- Main elements of the payload (e.g., Single experiment or Laboratory + Experiments, as applicable. In case of multiple experiments, list by broad lines the mission and purpose of all carried experiments).
- Description of configuration changes in case of e.g., movable items, deployable structures, etc
- Specify any Micro vibration source (e.g., pumps, etc.)
- Specify EMC disturbance source (e.g., antenna, electromagnetic actuators, etc.)
- Description of payload thermal control and power architecture]

7.4. Ground segment description

[1] Please refer to §3 for payloads categories.
[2] Any available CAD, drawings and schematics can be included or attached.

[Payload User Ground control facilities and communication logic description, including interfaces with SR ground segment architecture and services.]

7.5. Concept of Operations

[To describe general payload operations on all SR mission phases, considering specific aspects for ground and flight phases.
To include a description of the payload mission phases from integration on the vehicle until retrieval after landing with description of the required payload technical and schedule conditions and constraints. To inform about intended use (if any) of dedicated Payload communication frequencies and their characteristics, as soon as available and in coherence with overall SRS development planning and inform on status of Payload request for such frequencies to competent authorities.
To prepare a synthetic and quantified list of Payload activities during flight lifetime together with their planned updates, including possible updates to be identified and implemented during flight operations, defining for each operational mode (e.g., ON/OFF/STAND-BY/SURVIVAL/ANY OTHER):

- Description of needed services in terms of integration, payload operations, power, data, and comms
- Duration of each mode
- Environmental constrains for each mode
- Identification of degraded cases

The Mission phases here identified shall be used throughout the document for coherence defining corresponding payload operational modes:

Mission Phases	Payload operational mode	Description	Duration [time]
On-ground (integration until LV lift-off)			

From LV ascent until SR commissioning			
Payload commissioning			
Orbital phase – Payload active			
Orbital phase – Payload Survival mode			
Orbital phase – Payload Stand-By mode			
Orbital phase – Payload Mode n		[if needed]	
Post-operations and up to landing			
Post-landing			

]

7.6. Mission profile and timeline

[To prepare a graphical synthesis of the nominal mission profile (Timeline, Gantt), showing, for each phase indicated in §7.5 and in line with the rest of the paragraphs:

- Power consumption
- Thermal dissipation to the MPCB support plates and expected temperature variation of the TRP
- Needed TM downlink, data storage on SR mass memory, TC uplink
- Attitude changes

To inform on payload nominal timeline main parameters tolerance margins, i.e.: acceptable scatter on time tagged foreseen events, on power needs, data exchange flow, etc.., based on the level of detail currently available in coherence with Payload project definition status.

Provide general information on possible Payload Timeline re-planning needs during flight operations, that would imply changes based on shorter than one week standard and confirm they can be pre-programmed; express the level of autonomy of the loaded Payload in the execution of the Timeline providing information on needed vehicle on board software management support.]

7.7. Payload mission success criteria

[To Indicate the mission success criteria and the relevant operational activities to be performed to achieve the PL mission success criteria of each experiment. Primary and secondary objectives can be defined by priority.]

8. PAYLOAD PROJECT OVERVIEW

8.1. Project organisation

[To describe the project industrial organisation, including funding sources and HW/SW providers, synthetic organisational charts as needed.]

8.2. Project design status

[To report on current project phase and describe up to date product tree and payload mechanical, thermal, electrical, SW design characteristics and choices,
To report on payload qualification levels and describe the status of their verification according to project current status, i.e.: design, development, qualification phase.]

8.3. Payload development and qualification plan

[To describe the development and qualification logic of the project, including information on design, manufacturing, qualification, and acceptance plans, including description of:

- Critical technologies and expected TRLs
- Payload models for development and qualification testing

8.4. Project major milestones

[To include Project timeline and main milestones for development, manufacturing, and qualification, including readiness dates for qualification and flight models.]

9. PAYLOAD REQUIREMENTS

9.1. Payload mission requirements

9.1.1. Orbit and Attitude parameters

[To include the orbital parameters range acceptable to carry on the purposed mission, as well as the Payload attitude requirements (if any).
Indicate, where applicable, the desired Payload pointing and the relevant accuracies, including possible variations of these parameters by Payload mission design and eventually during operative flight lifetime. See [AD2] for more information.**Error! Reference source not found.**

LEO orbit Altitude nominal	
LEO orbit altitude acceptable range [km]	
LEO orbit inclination nominal	
LEO orbit inclination acceptable range [deg]	
Pointing direction (desired attitude)	
Pointing accuracy [deg]	
Pointing minimum duration [h or weeks]	

]

9.2. Payload interface requirements

9.2.1. Mechanical I/Fs

Payload type	**[Fixed/D-PL(NM)/D-PL(M)/D-PL(KZ)/Movable]**[3]
External dimensions [L x W x H] mm	

[3] See definitions in section 3. If P/L is not Fixed, add columns to the right to indicate MCI properties in each foreseen configuration, as needed.

Footprint [area of base desired to be IF with plate]	
Upmass [kg]	
Mechanical mounting IF	
CoG	
Natural frequency [Hz]	
Requires late access for sample cartridge installation before launch	[YES/NO]
Requires early retrieval for sample cartridge removal after landing	[YES/NO]
Late access cartridge dimensions [L x W x H] mm	
Late access cartridge mounting IF	
Late access cartridge mass [kg]	
Late access CoG	
Field of View	[YES/NO]
Field of View typology	Optical, spectrum, other
Field of View [deg]	
Field of View direction	
Field of View acceptable obstruction (%)	
Field of View forbidden materials	
Microvibration level required [g]	[frequency range, g, sensitive component, if any]
Microvibration level minimum duration	
Microvibration level induced [g]	[frequency range, g, source if any]

In terms of Mechanical loads: Payload qualification status; if applicable, please provide any available analyses or test results:

QSL	
Sine vibration	
Random vibration	

Shock	
Depressurization/repressurization	

9.2.2. Power I/Fs

[To indicate for each SR mission phase the required power budget per PL operational mode:

Mode	**Power [W]**		**Duration**
	Nominal	**Peak**	
[Mode 1]			
[Mode 2]			
[Mode n]			
Voltage [V]			
Current [A]			
Position of installed connectors on PL physical architecture [4]	[To be provided by CAD or preliminary sketch]		

9.2.3. Thermal I/Fs

[To specify for each SR mission phase, the required temperature range (min/max) at the interface PL-to-MPCB Support Plate ($T_{I/F}$), for each PL operational mode, to keep the Payload within its (internal) temperature limits:

Mode	**$T_{I/Fmin}$ [degC]**	**$T_{I/Fmax}$ [degC]**	**Duration**
[Mode 1]			

[4] According to the Aggregate level power distribution, one of the following connectors will be assigned, as per [AD2]:

- 40 W: Connector type DEMA-09P-NMB
- 100 W: Connector type 340105601B06-15-19PN
- 200 W: Circular connector type 340105601B06-13-98PN
- 400 W: Circular connector type 340105601B06-13-98PN

[Mode 2]			
[Mode n]			

To specify for each Mode/Phase, the Power Consumption (P_x) and Heat Dissipation (Q_x) in the following range of MPCB Support Plate interface temperatures ($T_{I/F}$), according also to the durations specified in §7.5.

Phase x	**$T_{I/F}$ [degC]**	0	5	10	15	20	25	30	35	40
[Mode 1]	P_1 [W]									
	Q_1 [W]									
[Mode 2]	P_2 [W]									
	Q_2 [W]									
[Mode n]	P_n [W]									
	Q_n [W]									

9.2.4. EMC I/Fs

Electromagnetic actuators (e.g., motors, solenoids, coil, relays, etc)	[YES/NO] To provide characteristics
Antenna or another radiofrequency source	[YES/NO] To provide characteristics
ESD protection or grounding points	[YES/NO]

9.2.5. Communication I/Fs

[To identify the Telecommands and Telemetry (experiment science and HK data) that are expected to be uplinked/downlinked for P/L monitoring, command & control in the tables below, include descriptions, if necessary, in text format.

Data communication with ground through SR	[YES/NO]
Data storage required on-board SR	[YES/NO]
Data storage required on-board SRS [MB]	quantify
Data storage bandwidth on-board SR [MB/s]	quantify
Communication protocol	Ethernet/RS422/SpaceWire
Compliance to PUS service standard (ECSS-E-ST-70-41A)	[YES/NO]
Telemetry needed	[YES/NO]
Type of data	[Science[5]/Housekeeping/Both]
TM Real Time Constraints[6]	Is real time TM needed? Y/N If Y, what data volume to download? If N: what max. TM download delay? What data volume?
Telecommands needed	[YES/NO]
Data latency per TC	
TC Data encryption need[7]	[YES/NO] Express any constraints on the matter;
TMTC Data segregation need	[YES/NO] Express any constraints on the matter;
PGCC data archiving need	[YES/NO]

[5] Please indicate if your science data include images or video.
[6] Applicable only to PUS compliant payloads.
[7] All the telecommands sent to Space Rider are already encrypted, but they are decrypted by the vehicle SW before reaching the PLs. There is the need to know if the PL needs double encryption, i.e., if the command needs to reach the PL encrypted.

	Mention any data distribution limits and constraints, describe data archiving approach and whether that will be requested at Payload Ground Control Centre

To include for each mission phase, TMTC and storage need per operational mode:

PHASE x	TM [GB/day]	TC [kbit/time]	Type of TC[8]	Estimated SR's storage size[9]	Data rate to SR MMU [Kbps]
[Mode 1]					
[Mode 2]					
[Mode n]					

]

9.2.6. Software I/Fs

[If any]

9.2.7. Optical I/Fs

[If any]

9.3. Operational requirements

9.3.1. Ground operations

[8] Please indicate if the PL operational timeline starts automatically (i.e., after power is provided to PL) or if it needs to be switched ON by a specific command. The same for PL turn OFF.
Software updates are possible for PUS compliant PLs with Service 6 implemented. If the PL is not PUS compliant, Space Rider Ground Segments needs to have full visibility on how the PL plans on doing this.
[9] From this line on, please indicate N/A in case of no data interface.

[To report Payload AIT and campaign operational requirements and constraints, including quantified service needs, i.e.: power, data exchange, thermal constraints.
Where applicable, specify late access and early retrieval needs in terms of specific dimensional, functional, operational and schedule (timing) constraints, including physical characteristics and environmental and cleanliness constraints applicable.
To report Constraints linked to a potential launch postponement or launch abort, where applicable to identify specific cases connected to life sciences Payloads and experiments such as those relevant to biomaterial cartridges (e.g.: postponement before or after cartridges installation).

Phase	Description	Operation Duration [time]
On-ground before SRS integration in LV	[including the description of services at the launch site]	
LATE ACCESS (On-ground after SRS integration in LV)	Describe the need for Late Access, if any. Include information on operational constraints and data about late access items to be loaded in SRS. Specify the time constraint required before Payload activation in orbit	
Post-operations and up to landing	[e.g., stand-by, ON, checks before launch, other relevant details]	

9.3.2. Flight operations

[To describe Payload operations according to the mission phases and modes, including durations where relevant. In particular:

- Constraints about Start and End of operations
- Duration of activities (including PL commissioning) and stand-by periods
- For each operational mode, environmental needs before, during and after payload operation

To identify foreseen degraded cases of Payload operations, if any, and indicate with the same table format, the relevant information.
Identify and describe constraints linked to a potential mission abort.

Phase	Description	Duration [time]
From LV ascent until SR commissioning	[e.g. stand-by, OFF, other relevant details]	
Payload commissioning	[e.g. operative, ON, other relevant details]	
Orbital phase – Payload active	[e.g. operative, ON, other relevant details]	
Orbital phase – Payload Survival mode	[if applicable]	
Orbital phase – Payload Stand-By mode	[orbital phase, but payload not actively operating]	
Orbital phase – Payload Mode n	[if needed]	

]

9.3.3. Payload Ground Facility requirements and logistics

[To report Payload facilities and GSE needs at launch and landing sites for payload preparation and post-processing, including detailed list of required services, laboratories, laboratory tools, facilities, equipment and consumables where needed.
Connected logistic and transport requirements shall be included here].

9.3.4. Special requirements

[To include here any requirement implying services not reported in AD2]

9.4. Outreach requirements

[If any]

9.5. Other requirements

[To report any other requirement or service need not mentioned in the previous paragraphs.]

ANNEX 1 - PAYLOAD INTERFACE REQUIREMENT DOCUMENT

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