# ExoMars 2018

## Assembly, Integration, and Verification Requirements Document

**EXM-M2-RSD-ESA-00004**

**Issue 2, Rev. 1**

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<tr>
<td>M. Braghin (TEC-MXC) and the ExoMars Team, and the AIV-AIT Working Group</td>
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<tr>
<td>A. Haldemann (SRE-PEH) ESA ExoMars Payload and AIV Manager</td>
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<td>L. Elshanskiy Deputy Head Roscosmos ExoMars Operating Group</td>
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<td>D. McCoy (SRE-PE) ESA ExoMars Project Manager</td>
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<td>V. Voron Head Roscosmos ExoMars Operating Group</td>
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# DOCUMENT CHANGE LOG

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<td>31-07-13</td>
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<td>Change of document number to EXM-M2-RSD-ESA-00004 and update of changed NR/IR document number references</td>
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**AIV-AIT WG Edits:**

3.2  
- Editorial corrections of: 2018 MSRD document number; Missions Envir. Spec title; OIRD title and document number.  
- Joint Verification Plan (JVP) document added to list as [IR 10], since referenced by several WG edits.

5.1  
- AVT-VER-30, Lav applicability added.

5.2  
- AVT-VER-70, how to handle non-applicability to Lav is specified.

5.5  
- Clarification of model philosophy model descriptions to be in JVP so that jointly shared.

5.5.2.1  
- Incorrect reference link repaired ([NR 1] is the correct reference)

5.6.1  
- AVT-VER-251: role of JVP added to this requirement.  
- AVT-VER-220: Lav approach to verification reporting to be indicated in JVP.

5.7.1  
- AVT-HAZ-30 options for RHU integration specified

6.1.2  
- AVT-QAL-130 SCC-level thermal balance tests were identified as TBC by the WG.

- AVT-QAL-140 Russian standard expression equivalent for Thermal Vacuum test added for clarification. Note expanded to indicate explicit need for agreement between Lav and TAS for SCC thermal test planning.

- AVT-QAL-160 WG recommendation that TV test be to acceptance limits
# ExoMars Project

## Issue/Revision, Date, Modified pages / section, Observations

<table>
<thead>
<tr>
<th>Issue/Revision</th>
<th>Date</th>
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<td>AVT-QAL-200 WG recommendation to review this requirement later; ‘TBR’ added</td>
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<td>AVT-QAL-250 Additional means to achieve requirement objective added to wording to indicate that the alternative is acceptable (without further waiver)</td>
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<td>AVT-QAL-426 clarification added that RM thermal vacuum testing (qualification) is done stand-alone.</td>
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<td>AVT-INT-20: wording added to clarify that dummy pyrotechnical devices are used to accomplish this requirement</td>
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<td>AVT-ACC-90: proof pressure test of fluidic subsystems to be performed already at subsystem level. Note added.</td>
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<td>AVT-ACC-255: CM CE-CS requirement added</td>
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<td>AVT-ACC-256: CM RE-RS requirement added</td>
</tr>
</tbody>
</table>
Table of Contents

1 DOCUMENT SCOPE ...........................................................................................................8

2 INTRODUCTION ................................................................................................................9

2.1 Convention for Requirements Numbering, Priorities, and Comments .................................9

3 REFERENCE DOCUMENTS ...............................................................................................10

3.1 Normative Documents ..................................................................................................10

3.2 Informative Documents ...............................................................................................10

4 SYSTEM DESCRIPTION ....................................................................................................12

5 VERIFICATION PROCESS ...............................................................................................13

5.1 Objectives .......................................................................................................................13

5.2 Methods .........................................................................................................................13

5.3 Verification Levels .........................................................................................................13

5.4 Verification Stages .........................................................................................................14

5.4.1 Qualification stage ....................................................................................................14

5.4.2 Acceptance stage .....................................................................................................15

5.4.3 In-flight verification stage .........................................................................................15

5.5 Model Philosophy .........................................................................................................15

5.5.2 Hardware Matrix ......................................................................................................15

5.6 Verification Implementation ..........................................................................................16

5.6.1 Verification Documentation .......................................................................................16

5.6.2 AIT Support Tools ...................................................................................................17

5.7 Hazardous Flight Equipment AIV Requirements ................................................................18

5.7.1 Radioisotope Heating Unit .......................................................................................18

5.7.2 Payload Radioactive Sources ...................................................................................18

5.8 Planetary Protection AIV Requirements ..........................................................................18

5.9 Database and Software Verification and Validation ..........................................................19

5.9.1 Database Verification and Validation ........................................................................19

5.9.2 Software Verification and Validation .......................................................................19

5.9.3 Verification Support Software ................................................................................20

6 TEST REQUIREMENTS ....................................................................................................21

6.1 Mandatory Qualification tests ..........................................................................................21

6.1.1 System Level Testing ...............................................................................................21

6.1.2 Spacecraft Composite Element Level Qualification Testing ........................................22

6.1.3 DM Element Level Qualification Testing ..................................................................23

6.1.4 Rover Module Element and ROCC Level Qualification Testing ....................................26

6.1.5 Carrier Module Level Qualification Testing ................................................................27

6.1.6 Equipment Level Qualification Testing .....................................................................28
6.1.7 Bioburden Control Qualification Testing ........................................................................... 28
6.2 Mandatory Acceptance Tests ................................................................................................. 29
6.2.1 System Level Acceptance Testing ...................................................................................... 29
6.2.2 Spacecraft Composite Element Level Acceptance Testing .................................................. 29
6.2.3 DM Element Level Acceptance Testing .............................................................................. 30
6.2.4 Rover Module Element Level and ROCC Level Acceptance Testing .................................. 31
6.2.5 Carrier Module Level Acceptance Testing ......................................................................... 32
6.2.6 Equipment Level Acceptance Testing ................................................................................ 33
6.2.7 Bioburden Acceptance Testing ......................................................................................... 33

7 Integration REQUIREMENTS ....................................................................................................... 34
7.1 Equipment Level Integration Tests ........................................................................................ 34
7.2 Sub-system Level Integration Tests ........................................................................................ 35
7.3 Element Level Integration Tests ............................................................................................ 35

8 Facility REQUIREMENTS ........................................................................................................... 36
8.1 Integration Facilities ............................................................................................................... 36
8.2 Test Facilities ....................................................................................................................... 36
8.3 Special Test Facilities ............................................................................................................ 36

9 LIST OF ACRONYMS AND ABBREVIATIONS ....................................................................... 37
1 DOCUMENT SCOPE

This document provides the specific assembly, integration and verification rules to be applicable to all ESA provided elements of the ExoMars 2018 Mission.

The objective of this ExoMars 2018 Assembly, Integration and Verification (AIV) Requirements Document is to assure qualification and acceptance of the system and of its flight hardware and software. Ultimately this objective must be consistent with in-time availability, fulfilling the ExoMars 2018 technical and mission requirements.

A Verification Matrix and Database is to be established, defining the Methods of Verification to be applied at system level to the requirements documents defined in the ExoMars Statement of Work (SOW).

The Prime Contractors (both European and Russian) shall critically review the relevant AIV requirements and propose their implementations in line with the schedule and financial constraints imposed by the ExoMars project, identifying and justifying any deviations from these requirements for approval by the Agencies.
2 INTRODUCTION

The Contractors have full responsibility for AIV activities at equipment, subsystem, element (or module) and system level including responsibility for the AIV activities at system, element (or module) and sub-system levels when payload equipment (instruments) are incorporated.

The Verifications to be performed at each deliverable Element level (eg. SCC, CM, DM, RM) and at the System level as well as generic unit level requirements are defined in this document. The specific Element level verifications for a particular module shall be performed at that level but may be combined with higher level verifications if fully justified and agreed to by the ESA ExoMars project based on proof that the lower level module requirements are fully covered.

2.1 Convention for Requirements Numbering, Priorities, and Comments

Requirements are numbered and written in italicized text, and each expresses a single mandatory requirement. Where any specific implementation is directly implied by the requirement, the contractor is invited to propose an alternative (with justification), which still respects the same intent of the customer requirement, but does not necessarily follow the implied implementation. Plain (un-numbered, non-italic) text between requirements is explanatory.

The following convention is adopted for numbering requirements:

Acronyms in the second part of the number:

- GEN: General AIV requirements;
- VER: Verification requirements;
- TST: general testing requirements
- HAZ: hazardous materials requirements
- PP: Planetary protection requirements
- SW: software requirements (flight software, test software, and operations software)
- QAL: Qualification testing requirements
- ACC: Acceptance testing requirements
- INT: Requirements for the integration process
- FAC: Facility requirements

"-" is used as a separator between acronyms denoting the parts of the system to which the requirement is applicable;

"/" is used as a separator for denoting interfaces between parts of the system.

Each requirement is clearly numbered and, a requirement may be preceded or followed by a commentary (an explanatory note). This text may describe the context in which a requirement has to be understood, explain the rationale for the requirement, or refer to the source of the requirement.
3 REFERENCE DOCUMENTS

The documents listed here are available on request to the ExoMars Project Office.

3.1 Normative Documents

Normative References (NR) are fully applicable in their entirety to this document and are listed below as dated or undated references. For the explicit, dated or versioned, references, subsequent amendments to, or revisions of, any of those references do not apply to this document. The version of any other references to be used is given in the list of documents constituting the contractual baseline.

In case of conflict between this document and normative documents listed herein the European and Russian Contractors shall inform the ESA and Roscosmos Project Offices for resolution.

The normative documents applicable to the ExoMars AIV Requirements Document, reference in the text as [NR x] are:


3.2 Informative Documents

Informative References (IR) are applicable to this document only when specifically called up in the text with references to specific parts of the document that are to be applicable. Otherwise the documents below are listed for information and as an aid for understanding.

For the explicit, dated or versioned, references, subsequent amendments to, or revisions of, any of those references do not apply to this document. Other Informative References are listed for information and as an aid for understanding.

In case of conflict between this document and specifically called up applicable requirements in an informative document listed herein, the European and Russian Contractors shall inform the ESA and Roscosmos Project Offices for resolution.

[IR 8] ExoMars Statement of Work, EXM-MS-SOW-ESA-00004
[IR 9] 2018 S/C to Proton IRD, tbs
4 SYSTEM DESCRIPTION

The description of the system definition and the mission phases is contained in chapter 2.1.3 and 2.2 of the MSRD [IR 1] and in chapter 1.2.1 and 1.3 of the Rover Requirements [IR 7].
5 VERIFICATION PROCESS

5.1 Objectives

The verification objectives are defined by the following requirements:

AVT-VER-10  The verification process shall qualify the design according to [NR3.]

AVT-VER-20  The verification process shall demonstrate that the product is in agreement with the qualified design is free from workmanship defects and acceptable for use.

AVT-VER-30  The verification process shall verify that the space system and ground segment (including tools, procedures and resources) will be able to fulfill the applicable requirements as defined in the ExoMars SoW [IR 8] normative references, and for Lavochkin their relevant applicable SoW.

AVT-VER-40  The verification process shall confirm product (ExoMars System and Elements) integrity and performance, after agreed steps of the project life cycle (e.g. Integration, Launch, and commissioning)

AVT-VER-50  The verification process shall confirm bioburden levels during integration, up to Launch.

AVT-VER-60  An adequate verification strategy, in which appropriate verification methods, verification levels, verification stages and models have been selected, shall be prepared by each product supplier and submitted to the customer for agreement.

5.2 Methods

AVT-VER-70  Verification methods shall be those of [NR 3], the ECSS Verification standard. As this standard is not applicable to Lavochkin, inter-Agencies agreement shall be taken to keep consistency.

AVT-VER-80  The default verification method for ExoMars shall be Test.

AVT-VER-90  The choice of one mission phase environment as worst case or driving case for testing shall be justified and documented.

5.3 Verification Levels

AVT-VER-100  The requirement verification shall be performed incrementally at different verification levels.

AVT-VER-120  The ExoMars AIV Process verification levels shall be applicable to the verification at System and Element) Level Requirements and to all lower level specifications that will be derived from them.
AVT-VER-140 The set of verification levels for ExoMars 2018 derived from the System definition in chapter 2.2 of [IR1] shall at least contain the following System, Element, Subsystem, and Equipment verification levels:

System level: **ExoMars System includes:**
- Ground Segment,
- Ground Support Equipment (GSE),
- Launch Facilities
- Launcher interfaces
- Space Segment (e.g. SCC, CM, DM, RM)

Element level: **Spacecraft Composite (SCC),**
- Element level: Carrier Module (CM)
- Element level: Descent Module (DM),
- Element level: Rover Module (RM),
- Element level: Rover Operations Control Center (ROCC)
- Element level: Surface Platform Operations Control Center (SPOCC)

Subsystem level: all subsystems (e.g. avionics, thermal, ALD, etc.)

Equipment level: all equipment, including scientific instruments

Note 1: **System Verification Level** applies when only some, but not necessarily all, of the System parts listed above are implicated.

Note 2: the ExoMars **Element Verification Levels listed above** are an imbricated set, or nested set of Element Levels as described [NR 3] Section 4. All these ExoMars Element Levels are nevertheless superior to Subsystems as described in [NR 3], and inferior to the System Level.

5.4 Verification Stages

**AVT-VER-150** The verification process shall be implemented in the following verification stages during the program life cycle.

(i) Qualification,
(ii) Acceptance,
(iii) In-flight verification

5.4.1 Qualification stage

**AVT-VER-170** The Qualification shall demonstrate that the design meets all applicable requirements and includes proper margins.
5.4.1.1 Re-qualification

The Qualification stage may also include re-qualification in the case that the design is modified after initial qualification has been achieved.

AVT-VER-175 All GSE and S/C models necessary to perform re-qualification of ExoMars hardware, software and operational sequences shall be maintained and kept operational until end of the ExoMars mission.

5.4.2 Acceptance stage

AVT-VER-180 The Acceptance shall demonstrate that the item is free of material and workmanship defects, integration errors, and within the bioburden allocation (where applicable) and is ready for subsequent operational use.

5.4.2.1 Re-certification

AVT-VER-181 The acceptance stage shall also include re-certification in the case that the representative configuration is disassembled (e.g. due to late integration or repair actions), or where it has undergone long-term storage.

5.4.3 In-flight verification stage

AVT-VER-194 In-flight verification shall characterize the system under operational conditions especially for the aspects that cannot be fully tested before the launch.

5.5 Model Philosophy

The objective of building Test Models is to achieve the required qualification by test before the Flight Models are assembled, integrated, tested and finally accepted or to avoid submitting the Flight Models to unnecessary stress. The types of Test Models employed has to be among those described in [NR 3], Annex B. As this reference document is not applicable to Lavochkin, bilateral agreements between TAS-I and Lavochkin will be reflected in the Joint Verification Plan [IR 10].

AVT-TST-10 The Contractor shall propose a model philosophy that ensures full qualification and acceptance verification at all levels.

5.5.2 Hardware Matrix

The Hardware Matrix identifies the equipment qualification status and the required models at all levels.

AVT-TST-100 A Hardware Matrix shall be prepared for each product on the basis of the selected model philosophy and on the basis of the qualification status of the equipment.

5.5.2.1 Equipment Qualification Status

Equipment classification for the Hardware Matrix has to follow the guidelines of [NR 3] Annex B, sub clause B.1.3. It is typically classified according to the following categories:
Category A: Off-the-shelf equipment requiring no modification which has been subjected to a qualification test program for space applications at least as severe as that imposed by the actual project specifications. Further qualification testing is not required.

Category B: Off-the-shelf equipment requiring no modifications that have already been tested and qualified but subjected to a different qualification program or to a different environment. A delta qualification test program shall be decided and performed case by case.

Category C: Off-the-shelf equipment requiring minor design modifications. A delta or full qualification test program shall be decided on a case-by-case basis depending on the impact of the required modification.

Category D: Newly designed and developed equipment or existing equipment requiring major re-design. A full qualification test program shall be imposed.

The selection of Off-the-shelf hardware has to comply with the requirements of [NR1] Chapter 10.

The type and the extent of the test program to be imposed for each category depend also on the project model philosophy. The requirements for the test program definition are provided in [NR 2].

5.6 Verification Implementation

5.6.1 Verification Documentation

AVT-VER-251 The overall engineering approach to verify the ExoMars space and ground segment shall be described in the ExoMars 2018 "Design-, Development- and Verification-Plan". The joint verification activities agreed between TAS-I and Lavochkin shall be defined in the Exomars 2018 Joint Verification Plan [IR 10].

AVT-VER-220 The Verification Control Document (VCD) shall show for all requirements the selected verification methods for the different verification levels in the applicable verification stages. The equivalent reporting of the verification close-out of requirements under Lavochkin responsibility shall be detailed by Lavochkin in the Joint Verification Plan [IR 10].

AVT-VER-230 Each contractor specification shall include the relevant Verification Matrix, reflecting the allocation of the standard verification methods (as per paragraph 5.2 of this document), to each specification requirement, at the appropriate level of verification (as per paragraph 5.3 of this document). For requirements under Lavochkin responsibility, Russian Standards will apply and shall be defined in the Joint Verification Plan [IR 10].

AVT-VER-231 The Verification Matrices, shall be generated as initial version of the VCD, with the same format, so that the later verification control can be compared with the planned methods.

The Verification Control Document is defined and described as AV-8 in the ExoMars DRD [IR 6]

AVT-VER-252 The detailed verification approach for each module shall be described in a module specific Verification Plan. The description and implementation of the selected verification approach shall be in line with the mission phases and their environmental and operational constraints.

AVT-VER-260 An AIT Plan shall be written for each model, which describes the AIT flow of the model and contains task sheets for each of the AIT tasks of the flow. The equivalent documentation written by Lavochkin under Lavochkin standard shall be described in the Joint Verification Plan [IR 10].
The AIT Plan is defined and described as AV-6 in [IR 6]

### 5.6.2 AIT Support Tools

#### 5.6.2.1 MGSE

The Mechanical Ground Support Equipment (MGSE) includes all mechanical equipment, which is necessary to support the equipment, subsystem, element, or system level AIT activities as well as the launch operations.

- AVT-VER-280 All MGSE shall be designed, manufactured and handled such that flight hardware, for which it is intended, never experiences any environmental condition outside the defined envelope.

- AVT-VER-290 All MGSE interfaces shall be compatible with the spacecraft hardware.

- AVT-VER-300 All MGSE interfaces shall be compatible with the facilities including the launch site, and shall be demonstrated prior to use and formally accepted.

- AVT-VER-310 All MGSE shall be designed to avoid contamination (chemical, biological) of either the spacecraft or facility.

#### 5.6.2.2 EGSE

The Electrical Ground Support Equipment (EGSE) includes all electrical and electronic equipment required to support the activities defined by the AIT Plan.

- AVT-VER-330 The Contractor shall define and document the EGSE general requirements (including design, construction, reliability, maintainability etc.) which apply to all EGSE, and also to the key equipment sets which might include a Central Checkout System (CCS), Specific Checkout Equipment (SCOE), RF suitcase and Spacecraft Interface Simulator (SIS).

The CCS is a core part of the System EGSE from which all testing is prepared, controlled, and the results archived. It would present operator interfaces, and single-point control for supporting all aspects of the system-level, or even parts of the element-level ATI program.

- AVT-VER-340 The EGSE shall support remote access to tests and test data.

- AVT-VER-350 The EGSE shall be designed to be upgradeable during the duration of the ExoMars project.

- AV-VER-360 The EGSE shall be compatible with the Mission Database design.

- AVT-VER-370 The Contractor shall identify SCOE requirements for the EGSE.

Special Checkout Equipment (SCOE) are those EGSE components which are necessary to interface directly with particular on-board units requiring non-generic, or specialized interfaces or test-equipment which are not readily available in the standard set (CCS).

- AVT-VER-380 EGSE in contact with flight hardware shall be designed to avoid contamination (chemical, biological) of the spacecraft and facilities, and to avoid EMI.
5.7 Hazardous Flight Equipment AIV Requirements

5.7.1 Radioisotope Heating Unit

AVT-HAZ-10  Any Assembly, Integration and Verification operation involving handling of RHUs by personnel shall be compliant with the general safety requirements in chapter 6 of [NR 1].

AVT-HAZ-20  Any operation involving handling of RHUs shall only be executed by personnel with the required safety and handling training.

AVT-HAZ-30  It shall be possible to perform RHU (re)integration into the Rover Module and the Descent Module either at Lavochkin premises, or at Lavochkin-selected locations inside the launch complex at Baikonur.

AVT-HAZ-40  After RHU installation is performed, disassembled and reassembled interfaces will have to be rechecked.

5.7.2 Payload Radioactive Sources

AVT-HAZ-50  Any Assembly, Integration and Verification operation involving handling of radioactive sources of Payload Elements by personnel shall be compliant with the general safety requirements of [NR 1].

AVT-HAZ-60  Any operation involving handling of radioactive sources of Payload Elements shall only be executed by personnel with the required safety and handling training.

AVT-HAZ-70  Installation of radioactive sources of Payload Elements shall be performed without major disassembly that would require to repeat acceptance testing of the Element and/or spacecraft.

5.8 Planetary Protection AIV Requirements

The planetary protection constraints of the ExoMars mission impose the need for microbial and organic chemical contamination control to be applied to the manufacturing, integration and test phases of the Flight Models and Flight Spares. Implementation of the appropriate protocols suggests development of the protocols in conjunction with Development Models and Tests, and suggests qualification of the protocols in conjunction with Qualification Models and Tests.

Planetary Protection is applicable to this project; it will be a contributing factor for the AIV strategy to be defined for the flight hardware development process, from (P)FM parts production to (P)FM unit assembly, then (P)FM spacecraft elements integration and protoflight/acceptance test. The ExoMars AIV activities will have to be organized in order to comply with the ExoMars Planetary Protection Requirements called up by the Product Assurance requirements in [NR 1]
5.9 Database and Software Verification and Validation

5.9.1 Database Verification and Validation

The mission specific spacecraft databases for the Spacecraft Composite, the Carrier Module, the DM with its payload and the Rover with its Pasteur Payload, are prepared defining the basic telecommand and telemetry structures for communication and control as defined in section 2.1 and annex A2 of [IR 5]. Furthermore, the flight dynamics database is prepared as defined in annex A3 of [IR 5]. These databases must be verified and validated before delivery to the Spacecraft operators.

Database Verification Plan

AVT-FSW-10 A Database Verification Plan (covering both the spacecraft and flight dynamics Database preparation and validation/verification) shall be delivered by the contractor. The goal shall be 100% validation of all telecommand and telemetry parameters.

Database & Operational Documentation

AVT-FSW-20 The validation of compliance of the actual Spacecraft (Proto) Flight Model with the Spacecraft operational documentation, i.e. the Spacecraft User Manual and the Spacecraft Database shall take place at subsystem, element and system level by a combination of test, simulation and analysis.

Spacecraft Database Dangerous Commands

AVT-FSW-30 Dangerous commands which could jeopardise human safety or hardware integrity during AIT shall be marked in the Mission Database for use of protective measures, which shall prevent erroneous execution of these commands.

5.9.2 Software Verification and Validation

Software Development Environment

AVT-FSW-50 A Software Development Environment (SDE) shall be used to support the Software validation at different levels during the development, testing and maintenance phase of each software component.

AVT-FSW-60 Test tools in the Software Development Environment shall support the same telemetry and telecommand Mission Database as used in Spacecraft (Proto) Flight Model level testing).

AVT-FSW-70 The SDE shall allow Software testing without instrumentation of the target code.

AVT-FSW-80 The SDE shall support automated test and validation of Software images or parts of it.

AVT-FSW-81 The SDE shall include a flight representative hardware processing platform.
Independent Software Verification and Validation (ISVV)

It is good engineering practice to perform ISVV for all safety and mission critical software

AVT-FSW-82  ISVV shall make use of flight representative avionics

Onboard Control Procedures (OBCPs)

AVT-FSW-95  As part of the verification at system level, the contractor shall verify the OBCP function as well as the OBCP development and test environment. Based on an ESOC provided specification, a set of test OBCPs shall be produced and tested with the OBCP development environment, which shall then be loaded and executed on flight representative avionics in a flight representative configuration.

Flight Control Procedures (FCPs)

AVT-FSW-100  All flight control procedures to be delivered to the Mission Operations Centre shall be verified on flight representative avionics

AVT-FSW-110  The Flight Control Procedures Verification Plan shall be delivered to ESA and Roscosmos.

5.9.3 Verification Support Software

Software Simulators and Software Models

AVT-FSW-120  Software simulators and models required for the ExoMars development shall be designed and developed such that they are portable among different simulation environments and operating systems (platform independence) and are reusable within the different AIT facilities throughout the project.

Note: This is currently being supported by the SMP2 method described in chapter 2 of [IR 4] (SMP2 handbook), and this is the preferred method to be used.
6 TEST REQUIREMENTS

Unless otherwise specified, the ExoMars Test Requirements will be the requirements of [NR 2] for the appropriate verification level.

AVT-TST-20  Unless otherwise specified, the ExoMars testing shall be performed in the appropriate flight-representative environment.

The following paragraphs are intended to provide more accurate, but not necessarily a complete apportionment of test requirements to ExoMars Verification Levels. The Contractors shall add further test requirements as necessary to achieve a full qualification.

6.1 Mandatory Qualification tests

6.1.1 System Level Testing

As defined in AVT-VER-140 the ExoMars System includes besides the Space(craft) Segment (SS) also the Launcher and the Ground Segment (GS) which itself consists of the Control Centers, GSE and AIT facilities. Verification requirements related to GSE are contained in chapter 5.6.2 and test facility requirements are given in chapter 8. The launcher interface shall be qualified by verification of the SCC mechanical and electrical interfaces to the launcher and the environmental test campaign covering the launch loads.

The main objective of the System Validation Test (SVT, also known as End to End Test) is to demonstrate overall compatibility between the spacecrafts (SCC in space, Surface Platform and RM on Mars), the Control Centers (MOC, SPOCC, ROCC) and the communication infrastructure (including Mars Orbiter Relay) linking these together. These SVTs may initially link only the (simulated) communication “endpoints” and then become more representative by replacing simulated communication links by real flight- and ground hardware. Furthermore since RF parameters play an important role in the performance of the link between SS and GS, dedicated tests between a model of the SC TT&C subsystem and a reference ground station will be performed.

AVT-QAL-05  RF compatibility between ExoMars elements, and with the Ground Segment shall be tested with a RF suitcase for all frequencies used operationally.

AVT-QAL-10  System End-to-End Testing (including Surface Platform and Rover remote TM/TC and verification of autonomous functions) shall be conducted.

AVT-QAL-11  Spacecraft Composite to Ground Segment, and Rover Module and Descent Module/Surface Platform to Ground Segment via Mars Relay Compatibility Tests (System Validation Tests, SVTs) shall be performed per [IR 5], OIRD section 4.6.

Another objective of the SVTs is to validate the Monitoring- and Control System (MCS) in the Mission Operations Center with regard to its TM and TC interactions with the SCC, RM or DM/SP.

The SVTs shall be performed finally directly with the actual spacecraft model linked to the control center via a data communications network.

AVT-QAL-12  Prior to the SVTs with the space vehicle, the Ground Segment shall be verified with the aid of a dedicated spacecraft model.
**6.1.2 Spacecraft Composite Element Level Qualification Testing**

The tests described here are necessary to qualify the Spacecraft Composite (SCC) design against the relevant functional and environmental design requirements. If it is deemed necessary to optimize the verification approach and project planning, these tests may be performed at CM or DM element verification level and avoided at SCC element verification level, provided that sufficient analytical justification is made available.

**AVT-QAL-20**  The functional verification of the Spacecraft Composite Element shall be performed by means of the Composite Functional Test (CFT) and the Abbreviated Functional Test (AFT).

The CFT is a System Functional Test (SFT) in the sense of [NR 2], equivalent to the IST. The AFT is equivalent to the ISC in both [NR 2] and this document.

**SCC Functional Tests**

**AVT-QAL-30**  The CFT shall be performed at the start and end of the test campaign.

**AVT-QAL-40**  The AFT shall be conducted before and after each environmental test, providing the criteria for judging the successful survival of the space vehicle in a given test environment.

**AVT-QAL-50**  The AFT (or part of it) shall also be performed during environmental tests, i.e. while the environment is being imposed.

**AVT-QAL-60**  The AFT shall be performed during thermal tests, to the operational extent required by the simulated space flight conditions.

**AVT-QAL-90**  Prior to the SVTs with the Ground Segment, the Spacecraft Composite shall be verified with a CFT.

**SCC Mechanical Tests**

**AVT-QAL-100**  A Sine vibration test shall be conducted.

**AVT-QAL-110**  An Acoustic vibration test shall be conducted.

**AVT-QAL-120**  Shock Tests shall be performed.

**SCC Thermal tests**

**AVT-QAL-130**  Deleted.

**AVT-QAL-140**  Deleted.
The purpose of the Thermal Vacuum (TV) test shall be to demonstrate that the space vehicle is capable of achieving its design and performance requirements in its operational modes under the vacuum and thermal conditions encountered during the mission.

The TV test shall be carried out at upper and lower temperature extremes equivalent to the element acceptance limits.

A proper selection of TV test set-up, test modes, and methods shall be made, in order to achieve these limits on selected units.

The pressure during the TV test shall be $\leq 10^{-5}$ hPa. (TBC)

For protoflight units, an abbreviated sequence with only one hot and one cold 12-hour exposure prior to the extended exposures can be used. (TBC)

In addition to the temperature cycles, the chamber shall be programmed to simulate the various mission phases, and the applicable operational sequences performed by running through a complete functional test of all on-board equipment.

Equipment susceptible to corona or other high voltage effects shall be protected by monitoring the pressure and by applying high voltage below critical pressures.

Vacuum temperature cycling chambers shall be equipped with cryo-surfaces, which operate at cryogenic temperatures throughout the test to prevent space vehicle contamination. A way to achieve the same objective is to use cold shrouds filled with LN2 all along the thermal test, and providing thermal flux to the spacecraft by cal-rods or infrared lamps or similar means. (TBC)

The separation of the DM from the CM shall be verified by a representative test on ground, the Descent Module Separation Test.

Separation actuators activation and correct detachment of the two elements of the space vehicle shall also be part of the qualification test.

Conducted Emission- Conducted Susceptibility (CE-CS) Tests shall be performed (TBC).

Radiated Emission-Radiated Susceptibility Tests (RE-RS) shall be performed (TBC).

Self-compatibility Tests shall be performed.

The tests described here are necessary to qualify the Descent Module design against the relevant functional and environmental design requirements.

Tests are expected to be conducted in appropriately flight-representative environments.
If it is deemed necessary to optimize the verification approach and project planning, these tests may be performed at subsystem verification level and avoided at element verification level, provided that sufficient analytical justification is made available.

The Contractor shall consider [IR 3] chapter 3 for a description of the scope of EDL sequence verification and interface considerations to further development of the ExoMars 2018 EDL testing requirements.

**Functional Tests**

**AVT-QAL-700** The functional verification of the DM shall be performed by means of the DM Full Functional Test (FFT) and the DM Abbreviated Functional Test (AFT).

The DM FFT is a Functional Test (SFT) in the sense of [NR 2], equivalent to the IST. The DM AFT is equivalent to the ISC in both [NR 2] and this document.

**AVT-QAL-705** The DM FFT shall be performed at the start and end of the test campaign.

**AVT-QAL-710** The DM AFT shall be conducted before and after each environmental test, providing the criteria for judging the successful survival of the space vehicle in a given test environment.

**AVT-QAL-715** The DM AFT (or part of it) shall also be performed during environmental tests, i.e. while the environment is being imposed.

**AVT-QAL-720** The DM AFT shall be performed during thermal tests, to the operational extent required by the simulated space flight conditions.

**AVT-QAL-725** Prior to the SVTs with the Ground Segment, the DM shall be verified with a DM FFT.

**DM Mechanical Tests**

**AVT-QAL-730** A Sine vibration test shall be conducted.

**AVT-QAL-735** An Acoustic vibration test shall be conducted.

**AVT-QAL-740** Shock Tests shall be performed.

**DM Thermal tests**

**AVT-QAL-745** A DM Thermal balance test shall be performed to demonstrate the ability of the thermal control system to maintain temperatures inside the specified limits and to correlate the thermal mathematical model.

**AVT-QAL-750** A DM Thermal Vacuum test shall be performed.

**AVT-QAL-755** The purpose of the Thermal Vacuum (TV) test shall be to demonstrate that the DM is capable of achieving its design and performance requirements in its operational modes under the vacuum and thermal conditions encountered during the mission.

**AVT-QAL-760** The TV test shall be carried out at upper and lower temperature extremes equivalent to the element acceptance limits.

**AVT-QAL-765** A proper selection of TV test set-up, test modes, and methods shall be made, in order to achieve these limits on selected units.
AVT-QAL-770  The pressure during the TV test shall be $\leq 10^{-5}$ hPa. (TBC)

AVT-QAL-775  Deleted.

AVT-QAL-780  In addition to the temperature cycles, the chamber shall be programmed to simulate the various mission phases, and the applicable operational sequences performed by running through a complete functional test of all on-board equipment.

AVT-QAL-785  Equipment susceptible to corona or other high voltage effects shall be protected by monitoring the pressure and by applying high voltage below critical pressures.

AVT-QAL-790  Vacuum temperature cycling chambers shall be equipped with cryo-surfaces, which operate at cryogenic temperatures throughout the test to prevent space vehicle contamination.

DM Electrical Tests

AVT-QAL-320  Electrical functional tests shall be performed on the DM to verify the integrity of all electrical circuits and components, as well as their related software.

Electrical functional test description is found in [NR 2]

DM Entry, Descent and Landing Sequence Tests

AVT-QAL-330  Tests shall be developed, planned, and executed that verify phases of the ExoMars Entry, Descent and Landing sequence of events (EDL Sequence Tests)

AVT-QAL-340  The EDL Sequence Tests shall in particular consider the mode changes and activations that are an integral part of the EDL sequence of events.

DM Entry and Descent Tests

AVT-QAL-350  The atmospheric entry phase of the DM shall be verified with the aid of high-speed wind tunnel testing on scaled models. (TBC)

AVT-QAL-360  Supersonic Parachute deployment and performances shall be verified with the aid of wind tunnel testing.

AVT-QAL-370  A representative test for entry-load verification shall be performed.

DM Landing and Surface Tests

AVT-QAL-380  The DM landing sequence shall be verified by test on a 1:1 scale QM (TBC), representative of impact conditions

AVT-QAL-385  The DM surface mission sequence (including Rover egress) shall be tested on ground at Martian conditions (TBC).

AVT-QAL-830  The SPOCC capability to adequately command, control and plan the Surface Platform operations.
6.1.4 Rover Module Element and ROCC Level Qualification Testing

The tests described here are necessary to qualify the Rover Module (RM) design against the relevant functional and environmental design requirements.

RM Functional Tests

AVT-QAL-800 The functional verification of the RM shall be performed by means of the RM Full Functional Test (FFT) and the RM Abbreviated Functional Test (AFT).

The RM FFT is a Functional Test (SFT) in the sense of [NR 2], equivalent to the IST. The RM AFT is equivalent to the ISC in both [NR 2] and this document.

AVT-QAL-805 The RM FFT shall be performed at the start and end of the test campaign.

AVT-QAL-810 The RM AFT shall be conducted before and after each environmental test, providing the criteria for judging the successful survival of the space vehicle in a given test environment.

AVT-QAL-815 The RM AFT (or part of it) shall also be performed during environmental tests, i.e. while the environment is being imposed.

AVT-QAL-820 The RM AFT shall be performed during thermal tests, to the operational extent required by the simulated space flight conditions.

AVT-QAL-825 Prior to the SVTs with the Ground Segment, the RM shall be verified with an RM FFT.

RM Mechanical Tests

AVT-QAL-422 The mechanical (envelope) and electrical compatibility (TBC) of the RM with the DM shall be verified by test prior to shipment of the RM to the launch site for integration.

AVT-QAL-423 Quasi-static load, sine- and acoustic vibration tests shall be conducted.

AVT-QAL-424 Shock tests (simulating applicable shock environments) shall be performed.

Note: Applicable shock environments (e.g. HDRM and frangibolt opening, landing, pyro firings, launcher separation) at different verification levels need to be assessed to ensure that the shock envelope is properly addressed for RM level.

RM Thermal Tests

AVT-QAL-425 A Rover Module thermal balance test shall be performed, representing cruise phase conditions. (RM stand alone test)

AVT-QAL-426 A Rover Module thermal vacuum test shall be performed on the RM FM (stand alone RM test).

RM Other Tests

AVT-QAL-427 EMC auto compatibility, CE-CS and RE-RS tests shall be performed.
AVT-QAL-428 The compatibility of the RM with Lavochkin AIT and PP/CC procedures shall be demonstrated.

Rover Surface Mission Sequence tests

AVT-QAL-430 The complete mission sequence planned for the Rover shall be tested on ground, (Rover Surface Mission Sequence Test).

AVT-QAL-431 The ROCC capability to adequately command, control and plan the Rover operations within the system limits and constraints, including time constraints shall be verified as part of the Rover Surface Mission Sequence Test.

Rover Module Electrical Functional Test

AVT-QAL-460 An Electrical Functional test shall be performed on the Rover Module.

Rover Surface Environmental tests

AVT-QAL-470 A Thermal Cycling Low Pressure Test (Mars surface thermal test) of the Rover Module shall be conducted.

AVT-QAL-480 The capability of the Rover to perform its required mission according to the specified performances shall be verified by test under simulated Mars surface environment conditions, including dust transport and deposition.

Rover Locomotion Tests

AVT-QAL-490 Verification by test of the specified Rover Module locomotion performances, depending on the reference types of soil, shall be performed using a representative Rover model.

6.1.5 Carrier Module Level Qualification Testing

The tests described here are necessary to qualify the Carrier Module (CM) design against the relevant functional and environmental design requirements. If it is deemed necessary to optimize the verification approach and project planning, these tests may be performed at subsystem verification level and avoided at element verification level, provided that sufficient analytical justification is made available.

Carrier Module Functional Tests

Since the CM will be controlled by the DM, it should be determined to which extent functional tests will have to be performed on the CM in stand-alone configuration (e.g. with a DM simulator)

AVT-QAL-600 The functional verification of the CM shall be performed by means of the CM Full Functional Test (FFT) and the CM Abbreviated Functional Test (AFT).

The CM FFT is a System Functional Test (SFT) in the sense of [NR 2], equivalent to the IST. The CM AFT is equivalent to the ISC in both [NR 2] and this document.

AVT-QAL-605 The CM FFT shall be performed at the start and end of the test campaign.

AVT-QAL-610 The CM AFT shall be conducted before and after each environmental test, providing the criteria for judging the successful survival of the space vehicle in a given test environment.
AVT-QAL-615 The CM AFT (or part of it) shall also be performed during environmental tests, i.e. while the environment is being imposed.

AVT-QAL-620 The CM AFT shall be performed during thermal tests, to the operational extent required by the simulated space flight conditions.

AVT-QAL-625 Prior to the SVTs with the Ground Segment, the CM shall be verified with a FFT.

CM Mechanical Tests

AVT-QAL-630 A Sine vibration test shall be conducted. Sine vibration conducted at SCC level as part of the joint qualification process.

CM Thermal tests

It should be determined to which extent thermal tests will have to be performed on the CM in stand-alone configuration or could be included in the acceptance tests on SCC level (during SCC Electrical tests in the Thermal Vacuum Chamber) --- TBC.

AVT-QAL-645 An CM Thermal balance test shall be performed to demonstrate the ability of the thermal control system to maintain temperatures inside the specified limits and to correlate the thermal mathematical model.

Note: This test is expected to be performed at SCC PFM level in the frame of the planned “Radio-electrical tests in vacuum with temperature cycling” test at Lavochkin premises in Russia.

6.1.6 Equipment Level Qualification Testing

Qualification testing at equipment level will have to be defined in accordance with [NR 2]

AVT-QAL-505 An instrument interface representative simulator of the Rover shall be built and provided to the Rover payload developer to allow for early verification of the Rover-payload interface.

Payload science instruments are considered to be equipment level items.

6.1.7 Bioburden Control Qualification Testing

AVT-QAL-510 The capability to

(a) control the bioburden, and

(b) apply bioburden reduction techniques able to satisfy the Planetary Protection requirements
shall be demonstrated by test.

6.2 Mandatory Acceptance Tests

6.2.1 System Level Acceptance Testing

The tests described here are required to accept the Spacecraft Composite (CM and DM) and Rover Module (proto) flight models against the relevant interface requirements with each other, the launch vehicle and the Ground Segment.

Launcher Interface Mating Testing

AVT-ACC-01 A launcher interface mating test shall be performed to verify compatibility with the launch vehicle as defined in [IR 9]

System End-to-End Testing

AVT-ACC-10 A System End-to-End Test (including Surface Platform and Rover remote TM/TC and verification) shall be conducted using the ExoMars (Proto)Flight Elements

AVT-ACC-11 System Validation Tests with the Ground Segment shall be performed

AVT-ACC-13 Telecommunication acceptance testing shall be performed between the Rover and ROCC via Mars Relay Orbiter (e.g. TGO or a flight representative simulator of it) store-and-forward.

AVT-ACC-15 Telecommunication acceptance testing shall be performed between the DM/Surface Platform and MOC/SPOCC via Mars Relay Orbiter (e.g. TGO or a flight representative simulator of it) store-and-forward.

6.2.2 Spacecraft Composite Element Level Acceptance Testing

The Spacecraft Composite Element level Acceptance Test campaign will have to be defined according to [NR 2] Acceptance testing, Element test requirements. The tests described here are required to accept the Spacecraft Composite (proto) flight model against the relevant functional and environmental design requirements.

Electrical and Functional Tests

AVT-ACC-30 CFTs shall be performed.

AVT-ACC-40 Abbreviated Functional Tests shall be performed.

AVT-ACC-50 Special Performance Tests shall be performed.

Mechanical Tests

AVT-ACC-70 Alignment tests shall be performed.

AVT-ACC-80 Acoustic vibration test shall be performed
AVT-ACC-81  Mechanical testing as specified by the LV-IRD [IR 9] shall be assessed for consistency with the ExoMars 2018 Mission qualification and acceptance test planning, in order to assure full compatibility of the ExoMars 2018 Spacecraft with the selected launcher.

SCC Electrical test in vacuum
   AVT-ACC-85  Electrical tests in vacuum with temperature cycling shall be performed, including (TBC) limited thermal balance and the thermal acceptance for the CM.

Pressure tests
   AVT-ACC-90  Proof pressure tests (on integrated fluidic subsystems) shall be performed.

   Note: The proof pressure tests may be performed at CM level or at subsystem level, if it is shown that testing at those levels is sufficient to demonstrate integrity of the assembled fluidic subsystems as part of their acceptance process.

Leakage tests
   AVT-ACC-100 Leakage tests (on integrated fluidic subsystems, global and local) shall be performed (TBC).

EMC Tests
   AVT-ACC-110  CE-CS Test shall be performed (TBC).

   AVT-ACC-120  RE-RS Test shall be performed (TBC).

   AVT-ACC-130  Self-compatibility Test shall be performed (TBC).

6.2.3 DM Element Level Acceptance Testing

   The tests described here are required to accept the Descent Module (proto)flight model against the relevant functional and environmental design requirements.

DM Electrical and functional tests
   AVT-ACC-140  DM Integrated Spacecraft Test shall be performed (TBC).

   AVT-ACC-142  DM Abbreviated Functional Tests shall be performed.

   AVT-ACC-145  DM Special Performance Tests shall be performed (TBC).

   AVT-ACC-150  A DM dead (discharged) battery, cold start-up test shall be performed if the DM contains rechargeable batteries (TBC).

DM Mechanical Tests
   AVT-ACC-152  Alignment tests shall be performed.

DM Thermal tests:
DM Pressure tests
AVT-ACC-182  Proof pressure tests (on integrated fluidic subsystems) shall be performed (TBC).

Leakage tests
AVT-ACC-183  Leakage tests (on integrated fluidic subsystems, global and local) shall be performed (TBC).

EMC Tests
AVT-ACC-184  CE-CS Test shall be performed (TBC).
AVT-ACC-185  RE-RS Test shall be performed (TBC).
AVT-ACC-186  Self-compatibility Test shall be performed (TBC).

DM Surface Test
AVT-ACC-192  The DM surface operation including activation and operation of its science payload shall be verified by an AFT.

6.2.4 Rover Module Element Level and ROCC Level Acceptance Testing

RM Electrical and Functional Tests
AVT-ACC-300  CFTs shall be performed.
AVT-ACC-305  Abbreviated Functional Tests shall be performed.
AVT-ACC-310  Special Performance Tests shall be performed.
AVT-ACC-196  EMC auto compatibility, CE-CS and RE-RS tests shall be performed

RM Mechanical Tests
AVT-ACC-194  An acoustic vibration test shall be performed.

RM Thermal Tests
AVT-ACC-195  A Rover Module vacuum thermal cycling test shall be performed, representative of cruise phase conditions.

Rover Surface Mission Sequence tests
AVT-ACC-200  An abbreviated Rover Surface Mission Sequence Test shall be performed.
AVT-ACC-201  The ROCC capability to adequately command, control and plan the Rover operations within the system limits and constraints, including time constraints shall be re-confirmed as part of the abbreviated Rover Surface Mission Sequence Test.

Rover Mars environment Thermal tests
AVT-ACC-230  Thermal Cycling low pressure Test (Mars surface thermal test) shall be performed.

Rover Electrical tests
AVT-ACC-240  A Rover Module dead (discharged) battery, cold start-up test shall be performed.

6.2.5 Carrier Module Level Acceptance Testing
The tests described here are required to accept the Carrier Module (CM) (proto)flight model against the relevant functional and environmental design requirements.

CM Electrical and functional tests
AVT-ACC-250  CM Integrated Spacecraft Tests shall be performed.
AVT-ACC-251  CM Abbreviated Functional Tests shall be performed.
AVT-ACC-252  CM Special Performance Tests shall be performed.
AVT-ACC-253  An CM dead (discharged) battery, cold start-up test shall be performed.

CM EMC Tests
AVT-ACC-255  CE-CS Test shall be performed
AVT-ACC-256  RE-RS Test shall be performed

CM Mechanical Tests
AVT-ACC-254  Alignment tests shall be performed.

CM Pressure tests
AVT-ACC-257  Proof pressure tests (on integrated fluidic subsystems) shall be performed as part of the integration process.

CM Leakage tests
AVT-ACC-258  Leakage tests (on integrated fluidic subsystems, global and local) shall be performed.
6.2.6 Equipment Level Acceptance Testing

Acceptance testing at equipment level will have to be defined in accordance with [NR 2].

6.2.7 Bioburden Acceptance Testing

AVT-ACC-260 Bioburden verification assays shall be performed on all bioburden controlled flight hardware.
7 INTEGRATION REQUIREMENTS

In addition to the above tests required at the system and element levels, the process of building up the ExoMars 2018 flight segment requires a methodical and systematic integration and test philosophy beginning with the lowest level integrations. This section provides detailed requirements for tests to be performed as a part of the integration process.

7.1 Equipment Level Integration Tests

ExoMars shall follow a classical AIT approach where all equipments are checked for grounding and bonding, followed by a detailed electrical circuit characterisation of all electrical lines and finally a functional check of the equipment.

AVT-INT-10 A complete spacecraft electrical integration campaign shall be performed based on full electrical performance and functional verifications at all stages of the integrations process. No reductions due to similarity are acceptable. Table 7.1-1 lists the required integration tests.

<table>
<thead>
<tr>
<th>INTEGRATION TEST</th>
<th>SCOPE OF TEST</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bonding and Isolation</td>
<td>Grounding connection verification and unit bonding at the spacecraft</td>
</tr>
<tr>
<td>Electrical Interfaces Power</td>
<td>In-rush current at start-up and power consumption in operations modes</td>
</tr>
<tr>
<td>Electrical Interfaces Signals</td>
<td>Detailed electrical characterization and verification against design</td>
</tr>
<tr>
<td>Functional Tests</td>
<td>Verification of basic function of nominal and redundant units. Also verify spacecraft database integrity</td>
</tr>
<tr>
<td>HW/SW Tests</td>
<td>For units having SW verify correct operations and failure cases</td>
</tr>
<tr>
<td>RF Integration Tests</td>
<td>For RF units detailed performance checks including power, threshold, Doppler, ranging on all unit combinations.</td>
</tr>
</tbody>
</table>

Table 7.1-1: Integration tests required for Spacecraft AIT

AVT-INT-20 Pyrotechnic verifications shall be based on a test programme employing end-to-end tests including environmental effects (TBC). The Pyrotechnic subsystem shall include end-to-end testing use full firing current. Simulated pyrotechnic devices are used.

AVT-INT-30 Flight equipment which is dismounted for repair or modification shall be fully re-integrated in the spacecraft and re-tested in order to ensure correct operation and performance margins.

Note: retesting will be focused on the modified/repaired equipment.
7.2 Sub-system Level Integration Tests

After completion of the unit integrations which constitute a sub-system a check of the functioning of the entire sub-system is required to ensure overall integrity of the main and redundant channels as well as cross-strapping where relevant.

AVT-INT-40 Integrated Sub-System Tests (ISST) shall be used to verify a sub-system functional operation to the maximum extent after all sub-system units have completed I&T activities. The ISST shall include cross-strapping of the nominal and redundant units.

AVT-INT-50 An ISST shall be performed on both the main and redundant chains including any cross-strapping.

7.3 Element Level Integration Tests

After integration of two elements a series of tests shall be performed acting as a regression test for the increasing level of integration. The tests will be based on existing module level tests in order to permit a comparison of before and after integration.

AVT-INT-60 Integrated System Tests (IST) shall be used to re-verify assembled Element functional operation to the maximum extent possible after physical integration of modules has occurred. The IST shall be based on previously run element level tests for comparison of results prior to and after integration.
8 FACILITY REQUIREMENTS

The facilities to be used in the ExoMars 2018 AIV campaign will be recommended by the Prime Contractors based on the requirements of the mission verification requirements and special needs of the ExoMars 2018 mission. The test facilities used for flight hardware will have to comply with the requirements of [NR 1] Chap. 4.4. (TBC). Planetary Protection Requirements shall be respected for all flight hardware integration and test facilities.

AVT-FAC-10 A Facility Plan shall be produced by the Prime contractors detailing the facilities recommended for use in the ExoMars 2018 mission.

AVT-FAC-20 The Facility Plan shall detail the tests to be performed in each facility and the time frame for the tests in order to ensure an overall coordination of facility availability and avoid conflicts.

AVT-FAC-30 The Facility Plan shall describe the general capabilities of the facility for the tests to be performed there.

AVT-FAC-42 The Contractors shall develop and maintain a Mars Data Relay Link Special Checkout Equipment at a location to be defined for telecommunication verification between Martian landed elements and the Mars Relay Orbiter (e.g. TGO).

8.1 Integration Facilities

AVT-FAC-50 An ISO 8 or cleaner environment integration facility shall be used for all ExoMars integrations, depending on their cleanliness requirements.

8.2 Test Facilities

AVT-FAC-70 The contractors shall be responsible for the booking of test facility time according to the needs of the AIV campaign.

AVT-FAC-80 The contractors shall be responsible for verifying the suitability of test facilities for the ExoMars test campaign.

8.3 Special Test Facilities

ExoMars will require the use of a number of special test facilities such as drop towers, dust environments and wind tunnels for example. The Prime contractor shall identify all facilities available in the world for any extraordinary tests.

AVT-FAC-100 Any special facilities required by the ExoMars 2018 AIV campaign shall be identified in the Facilities Plan along with back-ups for risk mitigation purposes. The operational state of the facilities and availability in the required timeframe shall be stated.
# 9 LIST OF ACRONYMS AND ABBREVIATIONS

<table>
<thead>
<tr>
<th>AFT</th>
<th>Abbreviated Functional Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>AIT</td>
<td>Assembly, Integration and Test</td>
</tr>
<tr>
<td>AIV</td>
<td>Assembly, Integration and Verification</td>
</tr>
<tr>
<td>ALD</td>
<td>Analytical Laboratory Drawer</td>
</tr>
<tr>
<td>AVM</td>
<td>Avionics Model (= full flight representative model of the spacecraft avionics and data handling subsystem)</td>
</tr>
<tr>
<td>CCS</td>
<td>Central Checkout System</td>
</tr>
<tr>
<td>CE</td>
<td>Conducted Emission</td>
</tr>
<tr>
<td>CFT</td>
<td>Composite Functional Test</td>
</tr>
<tr>
<td>CM</td>
<td>Carrier Module</td>
</tr>
<tr>
<td>CS</td>
<td>Conducted Susceptibility</td>
</tr>
<tr>
<td>DDV</td>
<td>Design, Development (and) Verification</td>
</tr>
<tr>
<td>DM</td>
<td>Descent Module</td>
</tr>
<tr>
<td>DRD</td>
<td>Document Requirements Definition</td>
</tr>
<tr>
<td>ECSS</td>
<td>European Committee for Space Standardization</td>
</tr>
<tr>
<td>EDL</td>
<td>Entry, Descent and Landing</td>
</tr>
<tr>
<td>EDLS</td>
<td>Entry, Descent and Landing System</td>
</tr>
<tr>
<td>EGSE</td>
<td>Electrical Ground Support Equipment</td>
</tr>
<tr>
<td>EM</td>
<td>Engineering Model</td>
</tr>
<tr>
<td>EMC / EMI</td>
<td>Electromagnetic Compatibility / Electromagnetic Interference</td>
</tr>
<tr>
<td>EQM</td>
<td>Engineering Qualification Model</td>
</tr>
<tr>
<td>ESA</td>
<td>European Space Agency</td>
</tr>
<tr>
<td>ESAC</td>
<td>European Space Astronomy Centre</td>
</tr>
<tr>
<td>ESOC</td>
<td>European Space Operations Centre</td>
</tr>
<tr>
<td>FCP</td>
<td>Flight Control Procedure</td>
</tr>
<tr>
<td>FFT</td>
<td>Full Functional Test (= Element Level IST)</td>
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<tr>
<td>FM</td>
<td>Flight Model</td>
</tr>
<tr>
<td>GS</td>
<td>Ground Segment</td>
</tr>
<tr>
<td>GSE</td>
<td>Ground Support Equipment</td>
</tr>
<tr>
<td>HDRM</td>
<td>Hold Down Release Mechanism</td>
</tr>
<tr>
<td>HW</td>
<td>Hardware</td>
</tr>
<tr>
<td>I&amp;T</td>
<td>Integration and Test</td>
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<tr>
<td>I/F</td>
<td>Interface</td>
</tr>
<tr>
<td>ICD</td>
<td>Interface Control Document</td>
</tr>
<tr>
<td>Abbreviation</td>
<td>Definition</td>
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<td>--------------</td>
<td>-----------------------------------------------</td>
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<tr>
<td>IR</td>
<td>Informative Reference</td>
</tr>
<tr>
<td>ISC</td>
<td>Integrated Spacecraft Check</td>
</tr>
<tr>
<td>ISST</td>
<td>Integrated Subsystem Test</td>
</tr>
<tr>
<td>IST</td>
<td>Integrated Spacecraft Test</td>
</tr>
<tr>
<td>IST</td>
<td>Integrated System Test</td>
</tr>
<tr>
<td>ISVV</td>
<td>Independent Software Verification and Validation</td>
</tr>
<tr>
<td>LV</td>
<td>Launch Vehicle</td>
</tr>
<tr>
<td>MCS</td>
<td>Monitoring and Control System</td>
</tr>
<tr>
<td>MSRD</td>
<td>Mission and System Requirements Document</td>
</tr>
<tr>
<td>MGSE</td>
<td>Mechanical Ground Support Equipment</td>
</tr>
<tr>
<td>NR</td>
<td>Normative Reference</td>
</tr>
<tr>
<td>OBCP</td>
<td>Onboard Control Procedures</td>
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<tr>
<td>OIRD</td>
<td>Operations Interface Requirements Document</td>
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<tr>
<td>PA</td>
<td>Product Assurance</td>
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<tr>
<td>PFM</td>
<td>Protolflight Model</td>
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<tr>
<td>QM</td>
<td>Qualification Model</td>
</tr>
<tr>
<td>RE</td>
<td>Radiated Emission</td>
</tr>
<tr>
<td>RF</td>
<td>Radiofrequency</td>
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<tr>
<td>RHU</td>
<td>Radioisotope Heating Unit</td>
</tr>
<tr>
<td>RM</td>
<td>Rover Module</td>
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<tr>
<td>ROCC</td>
<td>Rover Operations Control Center</td>
</tr>
<tr>
<td>RS</td>
<td>Radiated Susceptibility</td>
</tr>
<tr>
<td>SCC</td>
<td>SpaceCraft Composite</td>
</tr>
<tr>
<td>SCOE</td>
<td>Specific Checkout Equipment</td>
</tr>
<tr>
<td>SDE</td>
<td>Software Development Environment</td>
</tr>
<tr>
<td>SES</td>
<td>Support and Egress System</td>
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<tr>
<td>SFT</td>
<td>System Functional Test</td>
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<tr>
<td>SIS</td>
<td>Spacecraft Interface Simulator</td>
</tr>
<tr>
<td>SMP</td>
<td>Simulation Model Portability</td>
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<tr>
<td>SoW</td>
<td>Statement of Work</td>
</tr>
<tr>
<td>SP</td>
<td>Surface Platform</td>
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<tr>
<td>SPOCC</td>
<td>Surface Platform Operations Control Centre</td>
</tr>
<tr>
<td>SS</td>
<td>Space Segment</td>
</tr>
<tr>
<td>STM</td>
<td>Structural Thermal Model</td>
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<td>SW</td>
<td>Software</td>
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<td>Thermal Balance</td>
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<td>Description</td>
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</tr>
<tr>
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<tr>
<td>TC</td>
<td>Telecommand</td>
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<tr>
<td>TM</td>
<td>Telemetry</td>
</tr>
<tr>
<td>TV</td>
<td>Thermal Vacuum</td>
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</tbody>
</table>