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Space systems — Format for spacecraft launch environment test report

Systèmes spatiaux — Format de rapport d'essais d'environnement de lancement de véhicule spatial

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 19933 was prepared by Technical Committee ISO/TC 20, *Aircraft and space vehicles*, Subcommittee SC 14, *Space systems and operations*.

Introduction

This International Standard provides spacecraft (SC) manufacturers with a specific format to write launch environment test reports required to qualify the SC to the launch environment conditions. The format has been applied satisfactorily for many years to most of the commercial launch vehicle (LV) systems in agreement with SC manufacturers worldwide.

The format follows the overall guidelines of ISO 17566 with the objective of generating self-contained documents. Relevant sections of the standard test plan, specification, procedure, and report documents are combined to form the comprehensive and compact SC launch environment test reports requested by LV service providers.

The format for the following sections of the test reports is independent of the nature of the test: introduction, documentation, nomenclature, test objectives, test article configuration, test facility configuration, test description, test result evaluation, test deviations, and test conclusions. For this reason, a unique format is specified for all types of tests in Clauses 4, 5, 6, 7, 8, 9, 10, 12, 13, and 14.

The format for the presentation of test results is specific to the test in question. For this reason, Clause 11 is divided into multiple subclauses, corresponding to all types of tests that are required to qualify SC to the launch environment.

In principle, there is one test report per type of test; however, several test reports may be combined if deemed appropriate.

SC organizations may include additional test topics if required. Conversely, some sections of this test report format may not apply to the launch services in question, in which case it is advisable that they be ignored.

Space systems — Format for spacecraft launch environment test report

1 Scope

This International Standard provides a specific format to report the test process and results of spacecraft (SC) qualification to the launch environment. The following types of tests are considered:

— static load;

— modal survey;

— sine vibration;

— acoustic noise;

— random vibration;

— shock; and

— electromagnetic compatibility (EMC).

The definition of test specifications and test requirements are derived from launch vehicle (LV) user's manuals as defined in ISO 14303. Only those tests that are intended to demonstrate the compliance of a given SC design with its LV environment are taken into consideration.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 14303, *Space systems — Launch-vehicle-to-spacecraft interfaces*

ISO 15863, *Space systems — Spacecraft-to-launch-vehicle interface control document*

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1.1
SC adaptor
structure that mates the SC to the LV and includes the separation system for SC/LV separation

3.1.2
line load of a force
ratio of the resultant axial force applied to the SC centre of gravity (CG) to the perimeter of the SC adaptor interface

3.1.3
line load of a moment
ratio of the resultant moment applied to the SC CG to the surface area delimited by the perimeter of the SC adaptor interface

NOTE The line load definition is not applicable to point-to-point interfaces.

3.2 Abbreviated terms

CG centre of gravity

CLA coupled-loads analysis

dB decibel

EMC electromagnetic compatibility

g acceleration unit (9.81 m/s^2)

Hz hertz

LV launch vehicle

m metre

N Newton

PSD power spectral density

rms root mean square

s second

SC spacecraft

V volt

4 Introduction section of a test report

4.1 General

This section shall provide general information about the technical content of the test report in question. It shall include a brief description of the test or sequence of tests. The overall test objective shall be described, and the criteria for the test article qualification or acceptance shall be stated.

4.2 Overall test sequence

This section shall summarize the overall sequence of environmental tests conducted to demonstrate the qualification or acceptance status of the SC to the launch environment and shall explain how the test in question fits into this sequence.

The following types of tests shall be considered if applicable to the SC test programme:

— static load;

— modal survey;

— sine vibration;

— acoustic noise;

— random vibration;

— shock; and

— EMC.

5 Referenced documentation section of a test report

5.1 General

This section shall contain a list of documents to which reference is made in the test report in question. The documentation list may include

— normative references,

— applicable references, or

— informative references.

5.2 Normative references

Normative references are published standards and specifications which provide requirements or constraints for conducting the test. The required format for the list of normative documents is shown below.

Document number	Document description	Revision level and release date

5.3 Applicable references

Applicable references are programme-related documents which provide requirements or constraints for conducting the test. The required format for the list of reference documents is shown below.

Document number	Document description	Revision level and release date

5.4 Informative references

Informative references are documents included for information only, which amplify or clarify the document content but do not contain requirements applicable to the test. The required format for the list of informative documents is shown below.

Document number	Document description	Revision level and release date

6 Nomenclature section of a test report

The Terms and definitions section shall define the specific terms used in the test report in question. In some cases, a project dictionary or glossary may be referenced.

The Symbols section shall give a list of the symbols used in the test report in question. Unless there is a need to list symbols in a specific order to reflect technical criteria, all symbols shall be listed in alphabetical order.

The Abbreviations section shall define the abbreviations used in the test report in question.

7 Test objective section of a test report

7.1 General

This section shall detail the general and specific test objectives in the context of the SC design and launch environment test requirements of the LV service provider.

7.2 Test strategy matrix

The test strategy matrix shall define the testing strategies that will be used to demonstrate compliance with the LV service provider's requirements related to the SC design and tests as specified in the LV user's manual (ISO 14303) and in the LV-SC interface control document (ISO 15863). The required format for the strategy matrix is shown below.

Document	Paragraph reference	Requirement	Test strategy to demonstrate compliance

8 Test article configuration section of a test report

8.1 General

This section shall describe the general test article configuration, including the corresponding reference frame definition and mass properties, relevant figures or the references of relevant drawings. When necessary, it shall document how the configuration supports the overall test objectives.

8.2 Identification and general configuration matrix

All major pieces of hardware and equipment and all the critical launch environment structural elements (including, but not limited to, the primary structure, platforms, supporting struts, propellant tanks and associated support structures and fastenings, pressure vessels, solar panels and related mechanisms, battery packs, reflectors, antennas and critical payload package) shall be listed in the configuration matrix and identified as flight-standard, flight-representative, or simulated items. The required format for the configuration matrix is shown below.

Item	Flight-standard	Flight-representative	Simulated

8.3 Deviations from flight configuration

Deviations of the general test article configuration from the flight configuration that are critical for the qualification of the SC with respect to the launch environment shall be identified (see 8.2). The qualification logic with respect to the overall system qualification of those items that are not in the flight standard category shall be explained.

8.4 Functional configuration

The state of physical systems of the test article shall be described and compared to the expected SC launch configuration. Any change of functional configuration in the course of the test shall be mentioned. The functional configuration addresses the operational mode of the test article and the state of the major electrical systems, including, but not limited to, radio-electrical, pyrotechnic, attitude control and thermal subsystems.

9 Test facility configuration section of a test report

9.1 General

This section shall describe the overall test facility configuration as run during the test. In addition, the test facility, its location and the test date(s) shall be indicated.

9.2 Test configuration

9.2.1 General configuration

The general test set-up shall be briefly outlined, including relevant figures or the references of relevant drawings. This outline shall include concise information about the test equipment, instrumentation, interfaces to the test article, environmental conditions, data acquisition system and any specific infrastructure required to perform the test.

9.2.2 Test adaptor

Special emphasis shall be given to the description of the interface between the test facility and the test article (test adaptor) if the behaviour of the test article during the test can be affected by the adaptor. In this case, the Test result section (see Clause 11) shall explain how the characteristics of the test adaptor affect the test results with respect to mechanics, acoustics and EMC.

9.2.3 As-run configuration

If the planned test configuration is modified as the test develops, the resulting changes, their causes and the potential effects on the test procedure or test results (see Clause 11) shall be explained.

9.3 Test facility constraints and limitations

Potential constraints related to operational or safety limitations of the test facility shall be indicated when these limitations have an effect on the test objectives. The nature of these limitations shall be explained in the Test description section (see Clause 10) and in the Test results section (see Clause 11).

10 Test description section of a test report

10.1 General

This section shall provide a description of the test, test flow, test prediction analyses, test input data and instrumentation.

10.2 Test approach and methodology

A description of the logic behind the test approach and of the methods used shall be provided.

10.3 Test flow

The various steps of the test shall be listed with the corresponding levels and durations relative to the nominal test goal (full level, nominal duration).

10.4 Supporting analyses

A general description of the analyses performed in support of the test execution shall be provided with the references of the corresponding documentation.

10.5 Input parameters, tolerances and limits

For each step of the test, the actual test input data shall be provided in numerical and/or in tabular form as appropriate. The corresponding tolerances and limits related to the performance of the test facility and associated control system shall be clearly indicated (including alarm levels and abort limits).

10.6 Instrumentation

The complete list of measurement devices used during the test shall be provided with the following characteristics:

— identification;

— measurement type;

— calibration method;

— measurement range and tolerances; and

— exact location with respect to the reference frame of the test article.

When useful, a drawing of the measurement devices arrangement shall be provided.

10.7 Success criteria

The success criteria of the test shall be listed and their applicability shall be defined for each step of the test.

11 Test results section of test reports

11.1 Static load

11.1.1 Interface loads

The resultant maximal forces at the SC or SC structural model interface shall be presented in the format of the table below. The components of the interface forces shall be taken either from direct measurements or deduced by calculation from the set of applied loads and corresponding locations.

Test case identification	Type (comp./tension)	Longitudinal force N	Lateral force N	Moment N · m	Test/reference analysis

The following definitions shall apply:

— test case identification: reference name or number of test case;

— test case: definition of the load or combination of loads applied for this load case;

— type (comp./tension): compression load or tension load;

— longitudinal force: resultant of maximal applied longitudinal forces, in newtons;

— lateral force: resultant of maximal applied lateral forces, in newtons;

— moment: resultant of maximal applied moments, in newton-metres;

— test/reference analysis: ratio between the results of the test case and a reference analysis.

NOTE In practice, the reference analysis can be a LV-SC dynamic coupled-loads analysis.

11.1.2 CG equivalent accelerations

The resultant maximal equivalent accelerations at the SC or SC test model CG calculated from the set of applied loads and corresponding locations shall be presented in the format of the table below.

Test case identification	Type (comp./tension)	Longitudinal CG acceleration g	Lateral CG acceleration g	Maximum line load N/m	Test/reference line loads

The following definitions shall apply:

— test case identification: reference name or number of test case;

— test case: definition of the combination of equivalent accelerations applied for this load case;

— type (comp./tension): compression acceleration or tension acceleration;

— longitudinal CG acceleration: maximal equivalent longitudinal acceleration about the CG, in g;

— lateral CG acceleration: maximal equivalent lateral acceleration about the CG, in g;

— maximum line load: line load resulting from maximal applied equivalent accelerations, in newtons per metre;

— test/reference line loads: ratio in terms of line load of the results of the test case to the equivalent loads defined in the LV user's manual.

NOTE It is advisable to indicate the test article mass properties used for the calculation of the line load with consistent units.

11.1.3 Additional test results

Upon LV service provider request, additional test results shall be provided for individual components of the test article, including, but not limited to, applied loads, stresses, strains and displacements.

11.2 Modal survey

11.2.1 Modal test correlation table

The results of the SC or SC structural model modal survey test shall be presented in the format of the table below. The modal test correlation table shall contain all of the measured structural modes that may have a significant effect on the responses of the SC dynamic structural model.

Mode identification	Measured mode frequency Hz	Calculated mode frequency Hz	Measured modal effective mass kg	Calculated modal effective mass kg	Measured modal damping %	Mode description	Notes

The following definitions shall apply:

— mode identification: reference name or reference number of the structural mode;

— measured mode frequency: frequency of the structural mode, in hertz, as measured during the test;

— calculated mode frequency: frequency of the structural mode, in hertz, as calculated in the SC dynamic structural model;

— measured modal effective mass: modal effective mass of the structural mode, in kilograms, as measured during the test;

— calculated modal effective mass: modal effective mass of the structural mode, in kilograms, as calculated in the SC dynamic structural model;

— measured modal damping: damping of the structural mode, in terms of percentage of critical damping, as measured during the test;

— mode description: physical characteristics of the structural mode (SC part and type of deformation);

— notes: optional additional information provided for clarification.

11.2.2 SC dynamic structural model update

The potential mathematical model updates to be completed in order to achieve an acceptable correlation between the SC structure and the SC dynamic structural model shall be indicated by referring to the results presented in the modal correlation table.

11.3 Sine vibration

11.3.1 General

In general, only the full-level sine test runs shall be considered in the SC sine vibration test report.

11.3.2 Input profiles

For each SC axis submitted to a sine vibration test, the actual full-level input acceleration injected at the SC interface shall be presented in a graph as a function of the frequency with indication of the corresponding sweep rate. The comparison with the predicted input shall be made on a separate diagram with the same scale.

When available, the same type of information shall be provided for the actual full-level input force or moment injected at the SC interface. As a minimum, the maximum value of the input force or moment shall be indicated. In addition, the method of measurement shall be explained.

11.3.3 SC dynamic model definition

The definition of the SC dynamic model used for the corresponding LV-SC coupled-loads analysis and sine test prediction shall be given with the reference of the related documentation.

11.3.4 Active limiting accelerometers

For each SC axis submitted to a sine vibration test, the list of active limiting accelerometers shall be presented in the format of the table below.

Accel. No.	Node	Active axis	Limit value g	Peak response g	Ratio peak/limit	Peak frequency Hz	Response frequency range Hz

The following definitions shall apply:

— accel. no.: reference number of accelerometer;

— node: number and description of the corresponding node of the finite element model used for the reference LV-SC coupled-loads analysis (when applicable);

— active axis: description of the accelerometer-sensitive axis versus the SC reference coordinate system;

— limit value: limit response, in g, specified for the limiting accelerometer;

— peak response: peak response, in g, of the limiting accelerometer as measured during the test (including any potential overshoot);

— ratio peak/limit: ratio of the peak response to the limit value of the limiting accelerometer;

— peak frequency: frequency, in hertz, of the limiting accelerometer peak response;

— response frequency range: frequency range, in hertz, where the accelerometer is active as a base input limiter.

11.3.5 Accelerometer response summary

The responses of the accelerometers installed on the SC shall be listed in the format of the table below.

Accel. No.	Component description	CLA grid	Accelerometer active axis	Peak response x-axis, g	Peak frequency x-axis, Hz	Peak response y-axis, g	Peak frequency y-axis, Hz	Peak response z-axis, g	Peak frequency z-axis, Hz	CLA response, g	Maximum of all runs/CLA	Component qualification level, g	Component design limit, g

The following definitions shall apply:

— accel. no.: reference number of accelerometer;

— component description: description of the accelerometer location in terms of physical component;

— CLA grid: number and description of the corresponding node of the finite element model used for the reference LV-SC coupled-loads analysis (when applicable);

— accelerometer active axis: description of the accelerometer-sensitive axis versus the SC reference coordinate system;

— peak response x-axis: maximal accelerometer response, in g, measured during the SC x-axis test run;

— peak frequency x-axis: frequency, in hertz, of the maximal accelerometer response measured during the SC x-axis test run;

— peak response y-axis: maximal accelerometer response, in g, measured during the SC y-axis test run;

— peak frequency y-axis: frequency, in hertz, of the maximal accelerometer response measured during the SC y-axis test run;

— peak response z-axis: maximal accelerometer response, in g, measured during the SC z-axis test run;

— peak frequency z-axis: frequency, in hertz, of the maximal accelerometer response measured during the SC z-axis test run;

— CLA response: maximal response, in g, of the corresponding node degree of freedom in the reference coupled-loads analysis (when applicable);

NOTE 1 If a safety factor is included in the coupled-loads analysis responses, it is advisable to state this factor explicitly.

— maximum of all runs/CLA: ratio between the maximal accelerometer response measured during the x-, y- and z-axis runs and the corresponding response of the node degree of freedom in the reference coupled-loads analysis (when applicable);

NOTE 2 It is advisable to update the coupled-loads analysis responses to take into account the actual amplification factor of appendage responses when it is higher than predicted.

— component qualification level: maximal acceleration, in g, to which the component was submitted during subsystem or component qualification tests;

— component design limit: equivalent to maximal component capability or maximal acceleration, in g, to which the component can be submitted without being damaged (if this information is available).

11.3.6 Additional test results

Upon LV service provider request, acceleration and/or displacement graphs of specific individual components shall be provided in an agreed format.

11.4 Acoustic noise

11.4.1 General

In general, only the full-level acoustic test run shall be considered in the SC acoustic noise test report.

11.4.2 Input levels

The input sound pressure levels shall be presented in the format of the table below.

Full or 1/3 octave centre frequency Hz	**Required level** dB	**Measured microphone levels** dB				**Mean measured test level** dB	**Level difference** dB	**Tolerance** dB
		M_1	M_2	…	M_n			
Overall, dB								
Nominal test duration, s:						**Test duration**, s:		

The following definitions shall apply:

— full or 1/3 octave centre frequency: mean frequency, in hertz, of the corresponding frequency band;

— required level: minimal acoustic level, in decibels, required for the duration of the test in the corresponding full or 1/3 octave band;

— measured microphone levels: levels, in decibels, of the sound pressure measured by all test microphones in the corresponding full or 1/3 octave band;

— mean measured test level: average, expressed in decibels, of the sound pressure levels measured by all test microphones in the corresponding full or 1/3 octave band;

— level difference: difference, in decibels, between the average test level and the required level in the corresponding full or 1/3 octave band (a negative value means that the requirement is not met);

— tolerance: maximal acceptable variations, in decibels, of the input acoustic level in the corresponding full or 1/3 octave band;

— M_1, M_2, …,M_n: identification number of microphones;

— overall: overall sound pressure, expressed in decibels;

— nominal test duration: minimal duration, in seconds, required for the test run;

— test duration: actual test duration, in seconds.

11.4.3 Accelerometer responses

The responses of the accelerometers installed on the SC shall be listed in the format of the table below in terms of root mean square (rms) acceleration:

Accel. No.	Component description	Accelerometer active axis	Accelerometer response			Component qualification level			Component design limit		
			g_{rms}	g^2/Hz	Hz	g_{rms}	g^2/Hz	Hz	g_{rms}	g^2/Hz	Hz

The following definitions shall apply:

— accel. no.: reference number of accelerometer;

— component description: description of the accelerometer location in terms of physical component;

— accelerometer active axis: description of the accelerometer-sensitive axis versus the SC reference coordinate system;

— accelerometer response: accelerometer response, in g_{rms}, measured during the acoustic test run;

— accelerometer response: maximal PSD level, in g^2/Hz, measured during the acoustic test run;

— accelerometer response: frequency, in hertz, associated with the maximal PSD level measured during the acoustic test run;

— component qualification level: maximal acceleration, in g_{rms}, to which the component was submitted during subsystem or component qualification tests;

— component qualification level: maximal PSD level, in g^2/Hz, to which the component was submitted during subsystem or component qualification tests;

— component qualification level: frequency or frequency range, in hertz, associated with the maximal PSD level to which the component was submitted during subsystem or component qualification tests;

— component design limit: equivalent to maximal component capability or maximal acceleration, in g_{rms}, to which the component can be submitted without being damaged;

— component design limit: equivalent to maximal component capability or maximal PSD level, in g^2/Hz, to which the component can be submitted without being damaged;

— component design limit: frequency or frequency range, in hertz, associated with the maximal PSD level, to which the component can be submitted without being damaged.

11.5 Random vibration

11.5.1 General

In general, only the full-level random test runs shall be considered in the SC random vibration report.

11.5.2 Input levels

For each SC axis submitted to a random vibration test, the actual full-input levels injected at the base of the SC shall be presented in the format of the table below.

Frequency range Hz	**Density** g^2/Hz	**Base acceleration** g_{rms}

The following definitions shall apply:

— frequency range: frequency band, in hertz, with constant power spectral density input random vibration;

— density: PSD, in g^2 per hertz, of the input random vibration in the corresponding frequency range;

— base acceleration: root mean square value, in g_{rms}, of the base random acceleration.

When available, the same type of information shall be provided for the actual full-level input force or moment injected at the SC interface. As a minimum, the maximum value of the input force or moment shall be indicated. In addition, the method of measurement shall be explained.

11.5.3 Accelerometer responses

The responses of the accelerometers installed on the SC shall be listed in the format of the table below in terms of root mean square (rms) acceleration.

Accel. No.	**Component description**	**Accelerometer active axis**	**Accelerometer response**			**Component qualification level**			**Component design limit**		
			g_{rms}	g^2/Hz	Hz	g_{rms}	g^2/Hz	Hz	g_{rms}	g^2/Hz	Hz

The following definitions shall apply:

— accel. no.: reference number of accelerometer;

— component description: description of the accelerometer location in terms of physical component;

— accelerometer active axis: description of the accelerometer-sensitive axis versus the SC reference coordinate system;

— accelerometer response: accelerometer response, in g_{rms}, measured during the random test run;

— accelerometer response: maximal PSD level, in g^2/Hz, measured during the random test run;

— accelerometer response: frequency, in hertz, associated with the maximal PSD level measured during the random test run;

— component qualification level: maximal acceleration, in g_{rms}, to which the component was submitted during subsystem or component qualification tests;

— component qualification level: maximal PSD level, in g^2/Hz, to which the component was submitted during subsystem or component qualification tests;

— component qualification level: frequency or frequency range, in hertz, associated with the maximal PSD level to which the component was submitted during subsystem or component qualification tests;

— component design limit: equivalent to maximal component capability or maximal acceleration, in g_{rms}, to which the component can be submitted without being damaged;

— component design limit: equivalent to maximal component capability or maximal PSD level, in g^2/Hz, to which the component can be submitted without being damaged;

— component design limit: frequency or frequency range, in hertz, associated with the maximal PSD level to which the component can be submitted without being damaged.

11.6 Shocks

11.6.1 General

SC shock test results can be obtained either

a) from direct measurements of SC component responses to a prescribed input shock spectrum that envelopes all shock events related to the LV flight, or

b) by extrapolation from the responses of the SC components to an input shock profile that does not cover the expected flight environment.

The same format shall be used in both cases for the presentation of the results.

11.6.2 Actual input levels

For each direction submitted to a shock test, the actual SC base input shock spectrum specification shall be compared with the LV provider corresponding requirement in the format of the table below. A graph of the same input shall be provided as complementary information.

Frequency range		**Axial direction**		**Lateral direction**	
Hz		g		g	
Test	Requirement	Test	Requirement	Test	Requirement

The following definitions shall apply:

— frequency range: frequency band, in hertz, for which input shock levels are required;

— axial direction: intensity of axial input shock, in g, in the corresponding frequency band;

— lateral direction: intensity of lateral (radial or tangential) input shock, in g, in the corresponding frequency band.

11.6.3 Method of extrapolation

In case the actual input shock spectrum is different from the required input spectrum, the approach used to determine the responses of the sensitive pieces of SC equipment to the required input shall be explained, including the following steps:

— determination of the transfer functions between the shock input interface and the sensitive pieces of SC equipment for the actual shock test;

— replacement of the actual test input and related interface by the specified shock level at the SC interface;

— extrapolation of the resulting shock levels on the sensitive pieces of SC equipment.

11.6.4 Unit qualification shock status

The status of the qualification of the sensitive pieces of SC equipment to the LV shock environment shall be summarized in the format of the table below.

Subsystem unit	Unit description	Location of measurement	Part number	Dimensioning shock	Shock specification	Post-test functional test	Comments on test result	Reference figure	Qualification status versus LV specification

The following definitions shall apply:

— subsystem unit: definition of the subsystem to which the unit belongs;

— unit description: name of the unit;

— location of measurement: definition of the shock measurement location on the unit;

— part number: reference number of SC part;

— dimensioning shock: distinction between the source of the dimensioning shock (LV or SC) with definition of the related event;

— shock specification: reference document or reference graph in present test report;

— post-test functional test: reference of functional test report, test date, and status of test result (satisfactory or not satisfactory);

— comment on test result: any comment on shock test or functional test relevant to qualification status of unit; mention if possible undertesting is acceptable;

— reference figure: reference of graph defined in 11.6.5;

— qualification status versus LV specification: specify if qualification is achieved; if qualification is not achieved, indicate alternative solution(s) and related documentation.

11.6.5 Graphics

At LV service provider request, graphs of the shock spectra obtained during the shock test for the sensitive pieces of equipment shall be provided in an agreed format with the following information:

— identification of unit and measurement location;

— measured shock spectrum at equipment level;

— extrapolated LV service provider shock requirement at equipment level;

— equipment qualification shock spectrum.

11.7 Electromagnetic compatibility

11.7.1 General

The electromagnetic spectra considered for EMC test results shall take into account envelopes of the SC, the LV and the launch base electromagnetic spectra of radiated intentional and spurious emissions as specified in the LV user's manual (ISO 14303) and in the LV-SC interface control document (ISO 15863).

11.7.2 SC-radiated emission

The spectrum of the SC intentional and spurious radiated emissions measured from EMC tests shall be presented in the format of the table below. A graph shall be produced as complementary information.

Type of SC emission	**Frequency range** Hz	**SC-radiated emission** V/m	**LV-radiated susceptibility limit** V/m	**Margin** V/m

The following definitions shall apply:

— type of SC emission: intentional emission with identification of transmitter or spurious emission;

— frequency range: frequency band, in hertz, with constant envelope of SC-radiated electrical field;

— SC-radiated emission: SC-radiated electrical field, in volts per metre, measured at the LV-SC interface plane;

— LV-radiated susceptibility limit: electrical field, in volts per metre, acceptable by the LV at the LV/SC interface plane in the corresponding frequency range;

— margin: difference between the LV-acceptable and SC-radiated emission, in volts per metre.

NOTE It is advisable to indicate actual measurement locations used for SC EMC tests when different from the LV/SC interface plane.

11.7.3 SC-radiated susceptibility

The spectrum of the SC-radiated susceptibility measured from EMC tests shall be presented in the format of the table below. A graph shall be produced as complementary information.

Frequency range Hz	SC-radiated susceptibility limit V/m	LV- and launch-base -radiated emission V/m	Type of LV and launch base emission	Margin V/m

The following definitions shall apply:

— frequency range: frequency band, in hertz, with constant envelope of SC-radiated susceptibility limit;

— SC-radiated susceptibility limit: electrical field, in volts per metre, acceptable by the SC at the LV-SC interface plane in the corresponding frequency range;

— LV- and launch-base-radiated emission: LV- and launch-base-radiated electrical field, in volts per metre, measured at the LV-SC interface plane;

— type of LV and launch base emission: intentional emission with identification of transmitter or spurious emission;

— margin: difference, in volts per metre, between the SC-acceptable electrical field and the LV- or launch base-radiated emission.

NOTE It is advisable to indicate actual measurement locations used for SC EMC tests when different from the LV/SC interface plane.

12 Test result evaluation section of a test report

For all types of tests, test results shall be evaluated with respect to the corresponding LV specifications. Any non-compliance shall be treated separately. The qualification of undertested pieces of hardware shall be demonstrated by selecting one or several of the following alternatives:

— evaluation of delta-qualification test results;

— evaluation of subsystem test results;

— qualification by similarity; or

— theoretical analysis.

13 Test deviations section of a test report

For all types of tests, any anomaly in the execution of the test or any failure of the test article shall be the subject of a specific report, including

— a full description of the anomaly or failure,

— the various steps undertaken to correct the problem, and

— the logic retained for subsequent qualification of the test article.

14 Test conclusion section of a test report

A final conclusion shall be provided in the light of the launch environmental tests with the confirmation that the relevant test requirements have been met.

Bibliography

[1] ISO 17566, *Space systems — General test documentation*

ICS 49.140

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