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Space systems — Small-auxiliary-spacecraft (SASC)-to-launch-vehicle interface control document

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National foreword

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A list of organizations represented on this committee can be obtained on request to its secretary.

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Systèmes spatiaux — Document de contrôle d'interface entre véhicules lanceurs et petits véhicules spatiaux auxiliaires

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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.

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ISO 26869 was prepared by Technical Committee ISO/TC 20, *Aircraft and space vehicles*, Subcommittee SC 14, *Space systems and operations*.

Introduction

Small auxiliary spacecraft (SASCs) are carried with primary spacecraft by using surplus launch capability, in order to make the best use of the launch vehicle (LV) extra capability. By definition, an SASC has no impact on the primary spacecraft or its mission.

Establishing a common baseline of ICD requirements between the launch vehicle side and the SASC side is a cost- and risk-minimum means of achieving success in international trade. In order to give a clear understanding of the ICD items needed to accommodate the SASC customer's requirements, there is a need for international standardization. It is hoped that this International Standard will encourage activity and lead to the increased utilization of space potential, opening the way for many more small space missions.

LV and SASC organization may include additional topics and some sections of this International Standard might refer to elements that are not applicable to a particular LV, SASC or launch range characteristics, in which case they can be ignored. For most items, except when specified, the information can be provided in SASC or LV drawings and in tabular or narrative format with figures.

INTERNATIONAL STANDARD ISO 26869:2012(E)

Space systems — Small-auxiliary-spacecraft (SASC)-to-launch-vehicle interface control document

1 Scope

This International Standard provides small auxiliary spacecraft (SASC) and launch vehicle (LV) organizations with basic rules for writing an interface control document (ICD), and a general format for the document's presentation, when the SASC has an interface (I/F) only with the LV.

It is applicable to the necessary ICD items and restrictions peculiar to SASCs, these spacecraft being as defined in the contract between the launch agency and the contractor.

The payload area covered by this International Standard is limited to SASC.

NOTE SASCs have minor priorities with respect to the main spacecraft.

2 Normative reference

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

3 Terms, definitions and abbreviated terms

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

3.1 Terms and definitions

3.1.1
primary spacecraft
main payload of the launch operation

3.1.2
small auxiliary spacecraft
SASC
small payload which is carried with primary spacecraft by using surplus launch capability, in order to make the best use of the launch vehicle's extra capability

3.2 Abbreviated terms

EMC	electromagnetic compatibility
ICD	interface control document
I/F	interface
LV	launch vehicle
RF	radio frequency
SASC	small auxiliary spacecraft
UT	universal time

4 Applicable and reference documentation

4.1 Applicable documents

This section of the ICD shall describe the list of documents in terms of a formal agreement. The list should include the applicable LV user's manual.

4.2 Reference documents

This section of the ICD shall describe the list of documents to be used to supplement this standard in terms of scope, contents and description.

4.3 Waivers

This section of the ICD shall describe the list of applicable waivers and corresponding current status.

5 SASC mission characteristics

5.1 SASC mission description

This section of the ICD shall describe the following items:

a) the purpose of the SASC mission and its orbital characteristics;

b) the general characteristics of the SASC bus, including appendages;

c) the payload equipment and its purpose.

The section should indicate the LV and SASC reference axes. It should include an in-orbit view of the SASC and may address general aspects of the mission such as ground network, coverage zones and duration of SASC and launch vehicle interaction.

5.2 SASC additional constraints

Any additional constraints on the SASC which may be necessary to preclude unacceptable effects on any LV or primary spacecraft function shall be specified in this section.

5.3 SASC simulator

This section shall describe, if required, the necessity of a SASC simulator, which may be used to maintain the launch schedule of the primary payload in case of SASC development/manufacturing delay or problems. The SASC simulator shall simulate the identified interfaces and characteristics of the SASC and information shall be provided for the SASC simulator in accordance with this International Standard for specified interface parameters.

6 Mechanical interface

6.1 General

This section of the ICD shall specify characteristics and parameters that define the mechanical I/F between the SASC (or simulator) and the LV. The information can be provided in SASC or LV drawings and in tabular or narrative format with figures.

6.2 Mechanical configuration

This section of the ICD shall include configuration drawings of the SASC (or simulator) and adapter assembly within the payload compartment, which show and define the location of all interface components. Reference axes and relative rotational orientation shall be shown.

6.3 SASC fundamental frequencies

This section of the ICD shall state the minimum allowable SASC (or simulator) fundamental frequencies in the axial and lateral directions of the LV.

6.4 Usable volume

This section of the ICD shall provide drawings that show the allowable usable volume within the payload compartment. The usable volume is determined by the physical clearances that are based on the static clearances and dynamic deflections of the LV structures, primary payload, given SASC (or simulator) and other SASC (if applicable). The section shall also provide critical clearance information, including detailed views of protrusion areas and/or protected areas with their associated dimensions.

6.5 LV-SASC adapter interface

This section of the ICD shall describe all the characteristics of the physical and geometric I/F for the SASC (or simulator) and the LV, including the general characteristics of the payload adapter, considering the following items:

a) type;

b) material;

c) geometrical shape;

d) separation system;

e) diameter of upper and lower I/F rings (if applicable);

f) mass properties of equipped adapter of SASC;

g) other significant information, as applicable.

6.6 Connector and microswitch definition

This section of the ICD defines the connector I/F, the following characteristics of which shall be considered:

a) type;

b) quantity;

c) location and mechanical I/F;

d) push-on and push-off loads;

e) separation force.

6.7 Purges and fluid connection interface

This section of the ICD defines the SASC purge and fluid connection I/F. The following characteristics shall be considered:

a) location and mechanical I/F:

   1) angular position;

2) radial position;

3) height from separation plane;

b) push-on and push-off loads;

c) energy released;

d) separation force;

e) maximum allowable leakage rate on disconnect.

7 Electrical interfaces

7.1 General

SASCs can have restrictions on command lines, flight telemetry and power supply, and redundancy of the RF link in order not to distract primary spacecraft functions.

This section of the ICD shall describe the results of coordination on those restrictions.

7.2 Umbilical wiring diagram

Provide detailed drawings of the SASC for the LV- and SASC-to-ground facilities wiring diagram.

7.3 Umbilical connectors

Organizations responsible for providing connector elements shall be identified.

Umbilical connectors shall be described for both the LV and SASC sides. The distinction shall be made between SASC servicing and SASC pyrotechnic functions that are maintained on separate LV–SASC connectors. Example figures of connectors shall be included.

Connector characteristics shall be defined as follows:

a) supplier;

b) part number;

c) number of pins available to user;

d) polarizing key orientation;

e) insert clocking;

f) location (see also 6.6);

g) backshell shielding requirement;

h) harness shielding requirement.

7.4 Umbilical wiring links

Umbilical links between the SASC and the LV, and between the SASC and the electrical checkout equipment plugs, shall be described, with the following characteristics, for each connector and connector pin:

a) pin number;

b) function(s);

c) wire type;

d) twisting and shielding;

e) maximum voltage (in volts);

f) maximum current (in amperes);

g) end-to-end resistance (in ohms);

h) line start;

i) line end;

j) maximum voltage at separation (if applicable);

k) maximum current at separation (if applicable);

l) signal type;

m) signal frequency.

The LV contractor shall define and conduct verification tests of the end-to-end, line-to-ground and line-to-line isolation resistance.

7.5 Electrical commands dedication to SASC

7.5.1 Pyrotechnic commands

The SASC contractor shall provide a schematic of the SASC electrical circuits related to pyrotechnic commands. Pyrotechnic commands shall be described considering the following characteristics:

a) command identification;

b) number of redundant commands;

c) time of command initiation;

d) minimum time interval between commands (in milliseconds);

e) pulse width (in milliseconds);

f) voltage (in volts);

g) minimum all fire current (in amperes);

h) maximum no fire current (in amperes);

i) output isolation (in ohms);

j) wire gage;

k) wire type;

l) wire length from LV–SASC I/F;

m) circuit connectors to pyro devices;

n) initiator characteristics.

The LV contractor shall indicate possible constraints applicable to the SASC circuitry, and in particular

— SASC wiring isolation requirements, and

— safety plug definition.

7.6 Separation status transmission

Indicate the measurement used to confirm SASC separation.

7.7 Power supply

The specification for electrical power provided by the LV to the SASC, if required for pre-launch or flight phases, shall be defined as follows:

a) voltage (in volts);

b) current (in amperes);

c) availability;

d) frequency;

e) ripple noise.

The LV contractor shall indicate possible constraints applicable to the SASC circuitry such as

— SASC circuit protection requirements,

— SASC wiring isolation requirements, and

— electromagnetic compatibility requirements.

7.8 Earth potential continuity

The SASC requirements in terms of electrical continuity with respect to the earth potential shall be expressed as follows:

a) location of reference point on SASC;

b) maximum resistance allowed between SASC metallic elements and reference point;

c) maximum resistance allowed for SASC interface plane.

8 Radio frequency and electromagnetic interface

This section of the ICD shall provide the characteristics of the radio-electrical systems, RF telemetry and command links, and the electromagnetic interface.

9 LV and SASC mission characteristics

9.1 SASC input data for mission analysis

9.1.1 General

The SASC contractor shall provide the input data defined in this section for all SASC configurations associated with operations conducted by the LV contractor.

9.1.2 Reference axes

The LV and SASC reference axes used for mission analysis studies shall be consistent with the mechanical configuration specified in 5.1.

9.1.3 Mass and inertia characteristics

If the SASC configuration changes before it is separated from the LV (e.g. deployment of antenna), the following data shall also be given for the alternative configuration.

The mass of the SASC with related tolerances shall be provided.

The centre of gravity coordinates and related tolerances shall be provided with respect to a reference frame parallel to the SASC reference frame with the origin located at the SASC centre of gravity. Inertia ratios between the transverse moments of inertia and the longitudinal moment of inertia shall be indicated.

The product of inertia shall be as defined in the LV–SC interface control document, in accordance with ISO 15863.

9.2 Trajectory and performance analysis

This section of the ICD shall specify that the SASC's trajectory is subject to the primary payload trajectory and SASC constraints related to trajectory analysis.

In the case of additional thrust for the SASC after the primary payload separation, the SASC's trajectory should be described according to the coordination between the LV and the SASC.

9.3 Launch windows

Launch windows shall be presented in tabular or graphical forms in UT hours.

This section of ICD shall specify that the launch window is subject to the primary payload launch window. If the primary payload launch window has some tolerance for SASC, it should be described according to the coordination between the primary payload and the SASC.

9.4 SASC pointing and separation

The LV shall define an orbital reference frame so that required SASC orientations at separation can be specified. The orbital frame orientation can be fixed with respect to the orbit plane or linked to the SASC orbital position.

The SASC shall define the SASC orientation just prior to separation.

10 Induced environment

10.1 General

This section of the ICD shall describe the environmental conditions of SASC and the compatibility with the LV.

10.2 Mechanical environment

10.2.1 Static acceleration

The static acceleration profile related to the LV flight shall be obtained from the trajectory analysis, in accordance with 9.2, with indication of axes.

10.2.2 Quasi-static loads

A synthesis of static and dynamic flight loads at the SASC centre of gravity shall be provided with an indication of the axes. It shall be a requirement that their levels be verified (if applicable) on the basis of the dynamic coupled load analysis (processed with a test verified SASC model, if applicable).

10.2.3 Low-frequency longitudinal vibration

The envelope of all longitudinal sine and transient vibrations at the SASC base shall be provided in terms of equivalent longitudinal sinusoidal vibrations over the frequency range of interest, with indication of axes. It shall be a requirement that their levels be verified (if applicable) on the basis of the dynamic coupled load analysis (processed with a test verified SASC model, if applicable).

10.2.4 Low-frequency lateral vibration

The envelope of all lateral sine and transient vibration at the SASC base shall be provided in terms of equivalent lateral sinusoidal vibrations over the frequency range of interest with an indication of axes. It shall be a requirement that their levels shall be verified (if applicable) on the basis of the dynamic coupled load analysis (processed with a test-verified SASC model, if applicable).

10.2.5 Random vibrations

The envelope spectrum of the flight-level random vibrations in the longitudinal and lateral directions shall be provided (if applicable). When applicable, it should be indicated that random loads are covered by acoustic loads.

10.2.6 Acoustic noise

The flight-level noise spectrum under the payload compartment shall be provided in terms of octaves or thirds of octaves.

10.2.7 Shock

The envelope shock spectrum generated by the LV at the LV–SASC I/F shall be provided. If the SASC is separated after the primary SC (or other SASC), the corresponding shock environment shall be presented. When the SASC provides the adapter, the SASC contractor shall provide the envelope shock spectrum generated by the SASC separation system at the I/F.

10.2.8 Critical clearances

If applicable, it shall be a requirement that static and dynamic analyses shall be conducted on SASC critical point clearances (see 6.4).

10.3 Thermal environment

10.3.1 General

The detailed SASC thermal environment related to the ground and flight phases is described in the LV–SASC final verification coupled thermal analysis. The thermal environment of the SASC should be determined by the interface coordination with the primary payload through LV.

10.3.2 Air-conditioning

A drawing showing the SASC inside the payload compartment with a representation of the airflow path may be provided. The following payload compartment air-conditioning parameters shall be indicated for the various operation phases:

a) inlet temperature;

b) outlet temperature (optional);

c) relative humidity;

d) filtration;

e) air flow rate;

f) air velocity;

g) cleanliness.

10.3.3 Aerothermal flux

The maximum aerothermal flux value shall be provided for the fairing jettisoning event and, if applicable, for any other high flux flight event with the corresponding phase duration.

10.4 Static pressure

The time history of the static pressure inside the payload compartment during the flight shall be provided.

10.5 Contamination and cleanliness

If applicable, the results of the contamination and cleanliness analysis conducted by the LV shall be provided.

The SASC organization shall provide a list of the SASC material outgassing characteristics.

This section of the ICD shall specify that the cleanliness of the SASC is subject to that of the primary payload, and that the SASC shall not have a harmful influence on the primary payload.

10.6 Radio and electromagnetic environment

10.6.1 LV-generated and other payload-generated radiation

The LV contractor shall describe the radiation emitted at a specified LV station by the LV transmitters in terms of electrical field as a function of radio frequency bands.

10.6.2 Range-generated radiation

The LV contractor shall describe the range electromagnetic environment, including telemetry, telecommand and radar transponders.

10.7 Overall compatibility

A conclusion about the compatibility of the LV, primary payload and the SASC with respect to the induced environment shall be formulated on the basis of the results presented in 10.2 to 10.6.

11 Verification tests

11.1 General

This section shall include — either explicitly or by reference to applicable documents — mandatory SASC test verification of indicated ICD environmental requirements.

11.2 SASC mechanical environment qualification and acceptance tests

If applicable, requirements for the following environmental tests shall be briefly described:

a) static load test;

b) modal survey test;

c) sinusoidal vibration test;

d) acoustic noise;

e) random vibrations;

f) separation shock test(s).

11.3 LV/SASC

The list of tests applicable to the SASC shall be indicated considering the following series of possible tests:

a) match-mate;

b) separation;

c) umbilical connector pull-out;

d) clearance measurement;

e) EMC;

f) end-to-end electrical;

g) RF link.

11.4 Primary payload/SASC

The list of tests applicable to the SASC shall be indicated considering the following series of possible tests:

a) clearance measurement;

b) EMC;

c) RF link.

12 Launch-range operation

12.1 General

This section of the ICD shall specify that the following items in the launch-range operation of the SASC shall be coordinated with the primary payload through the LV:

a) usage of facilities;

b) working area for launch operation;

c) time schedule of launch operation.

12.2 Range capabilities

12.2.1 General

The LV contractor shall provide to the SASC contractor detailed documentation describing the overall facilities and support available for launch range operations.

This section of the ICD shall mention only items specific to the SASC launch campaign. The section shall describe the restrictions on the usage of the facilities imposed by the primary payload.

12.2.2 SASC preparation facility

The LV contractor shall describe the facilities and equipment provided for processing the SASC, including specific additional requirements from the SASC contractor.

The following typical pieces of equipment or support may be listed for each relevant building area, as applicable:

a) access doors:
    1) location;
    2) size;
b) crane characteristics:
    1) capacity;
    2) hook height;
    3) range of vertical speed;
c) electrical power supply:
    1) voltage (in volts);
    2) frequency (in hertz);
    3) maximum power (in watts);
    4) stability of frequency and voltage (as a percentage);
d) environment:
    1) cleanliness class;
    2) standard temperature (in degrees Centigrade);
    3) standard relative humidity (as a percentage);
e) clothing (safety garments):
    1) location of use;
    2) type of garment;
    3) type of protection;
    4) relevant hazardous operation requiring protection;
    5) availability.

12.2.3 Special technical support equipment

The floor space required by, and the corresponding duration of time dedicated to, the SASC shall be identified for all relevant preparation areas, including

— the preparation area,

— the check-out room,

— storage areas (and associated environment), and

— offices and meeting rooms.

This section of the ICD shall describe the restrictions on the usage of the facilities imposed by the primary payload.

12.2.4 SASC consumable loading, control and final assembly facilities

The LV contractor shall describe the facilities and equipment provided for SASC consumable loading, control and final assembly operations, including specific additional requirements from the SASC contractor.

The following items may be considered, including hazardous item storage facilities:

a) weighing device:
   1) scale,
   2) load cells available;

b) dynamic balance machine:
   1) capacity (in kilograms),
   2) spin rate (in revolutions per minute),
   3) type of interface;

c) liquid propellant storage and transfer:
   1) type of liquid,
   2) quantity,
   3) period and duration of storage,
   4) storage conditions,
   5) transfer conditions;

d) SASC purge requirements,

e) SASC fluid requirements.

The LV contractor shall identify the floor space required, and the corresponding duration of time dedicated to the SASC, for all relevant SASC consumable loading, control and final assembly facilities, including

— the consumable loading area,

— the assembly area,

— the technical room,

— the control room,

— storage areas (and associated environment), and

— offices and meeting rooms.

12.2.5 Payload encapsulation facilities (if applicable)

Payload encapsulation facilities shall be used when the SASC, payload adapter(s) and payload enclosure are assembled together to form an integrated structure to be mated with the LV.

The LV contractor shall describe the facilities and equipment provided for encapsulation operations, including specific additional requirements from the SASC contractor. The LV contractor shall describe the main passenger operational requirements during combined operations.

12.2.6 Launch preparation facilities

The mating between the LV and the SASC or an encapsulated payload is performed at the launch preparation facilities. This may be performed at the launch pad.

The LV contractor shall describe the facilities and equipment provided for launch-preparation operations, including specific additional requirements from the SASC contractor. The LV contractor shall describe the main passenger operational requirements during combined operation.

12.2.7 Payload handling and transport

The LV contractor shall describe the facilities and equipment provided for payload handling and transport, including specific additional requirements from the SASC contractor.

The following items shall be described:

a) payload to transport (SASC, encapsulated payload or other);

b) itinerary and timelines (optional);

c) type of transport or hoisting operations;

d) transport or hoisting equipment;

e) container for transportation;

f) environmental conditions;

g) SASC purge;

h) SASC fluids.

The SASC contractor shall indicate any specific instructions for handling and transport operations.

12.2.8 SASC battery-charging requirements

The SASC contractor shall indicate the SASC battery-charging requirements, including how the battery charging is to be performed during launch preparation, the charging frequency needed, if applicable, and the associated restrictions.

12.2.9 Mission control centre

The LV contractor shall describe the facilities and equipment provided for mission control operations, including specific additional requirements from the SASC contractor.

12.3 Range communication facility

12.3.1 External communications

The LV contractor shall describe the external communication facilities to be provided. The SASC contractor shall define the specific equipment to be provided by the SASC.

The following items shall be considered:

a) type of lines (voice and data);

b) line distribution on the range.

12.3.2 Range communication network

The LV contractor shall describe the range communication network. The following items shall be considered:

a) operational intercom network:

   — point-to-point telephone network;

b) range telephone network:

   — closed circuit television,

   — time reference.

12.4 Umbilical lines and ground lines

12.4.1 General

This section of the ICD shall describe the restrictions on the usage of the equipment imposed by the primary payload.

12.4.2 Line description

The LV contractor shall describe the ground line and umbilical line facilities. The following items shall be considered:

a) network;

b) type of lines (electric characteristics);

c) purpose of network;

d) applicable SASC or LV–SASC combined operation.

12.4.3 Umbilical shielding and ground reference

The LV contractor shall describe the ground and flight-shielding grounding.

12.4.4 Rules for implementation of umbilical and lines

12.4.4.1 Documentation

The LV contractor shall indicate the rules and constraints to be met by the SASC contractor for the implementation of umbilical and ground lines. The following items shall be documented:

a) specific requirements (on the SASC contractor);

b) general drawing of umbilical wiring;

c) rules for end-to-end checks;

d) conformance certificate (LV and SASC contractors).

12.4.4.2 Responsibility

Responsibility for the equipment operating and for conducting tests shall be clearly established for the following:

a) installation of SASC provided equipment;

b) provisioning of connectors (SASC side and ground side);

c) connecting to ground facilities;

d) connection testing;

e) check of configured network;

f) modifications of configured network.

12.5 Overall data transmission

12.5.1 Overall network description

The LV contractor shall define the overall data transmission network of the range, including all operational types of transmissions. The following characteristics shall be indicated:

a) operations of interest;

b) facilities connected;

c) type of transmissions;

d) connected items;

e) line routing.

12.5.2 Individual network

For each type of transmission network (RF, base-band, modem or other), the LV contractor shall indicate the following:

a) connected facilities;

b) limitations on transmission volume;

c) physical interfaces (range side).

12.6 Operational constraints

The LV contractor shall list the various operational constraints to be met by the SASC contractor. The following typical items are given as examples:

— safety regulation and implementation;

— security rules;

— launch campaign;

— SASC countdown operations — time windows.

12.7 Range services

12.7.1 General

This section of the ICD shall describe the restrictions on the usage of the services imposed by the primary payload.

12.7.2 Safety facilities and support related to safety

These shall include

a) training course and briefings, and

b) the role of range-safety personnel.

12.7.3 Technical and general services

The LV contractor shall provide a list of technical and general services available on the range, for example:

a) chemical analysis laboratory;

b) mechanical and electrical workshop;

c) optical and photographic workshop;

d) measuring instruments laboratory;

e) general purpose services.

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