INTERNATIONAL STANDARD

ISO 17401

Second edition
2023-05

Space systems — Spacecraft interface requirements document for launch vehicle services

Systèmes spatiaux — Document d'exigences d'interface du véhicule spatial vis-à-vis du service de lancement

Reference number
ISO 17401:2023(E)

COPYRIGHT PROTECTED DOCUMENT

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

Contents

Page

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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

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

This second edition cancels and replaces the first edition (ISO 17401:2004), which has been technically revised.

The main changes are as follows:

— upgrade orbit definition parameters;

— upgrade SC environment description;

— upgrade SC description (interface, thermal aspects, EMC).

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

This document gives guidelines for writing an interface requirements document (IRD) for launch vehicle (LV) services. The application of this document is intended to facilitate the technical exchanges between spacecraft (SC) and launch vehicle agencies. By reducing the amount of work necessary for requesting launch services, this document will minimize spacecraft contractor's and spacecraft manufacturer's costs.

In some cases, drawings are explicitly requested in order to provide comprehensive information. Explicit international system units are specified for all items. The corresponding scale may be adjusted if not appropriate.

SC organizations may include additional topics if required. Some sections of the IRD may refer to specificities that are not applicable to the launch services of interest, in which case they should be ignored.

Space systems — Spacecraft interface requirements document for launch vehicle services

1 Scope

This document provides spacecraft (SC) organizations with the general format for presenting the interface requirement document (IRD) for launch vehicle services. The IRD provides a list of the major technical requirements spacecraft agencies provide to launch vehicle (LV) agencies when submitting an application for launch services.

The IRD addresses the definition of the SC mission, the mechanical and electrical interfaces, the overall environment requirements (mechanical, thermal, cleanliness, radio-electrical), the SC development and test programme and, finally, launch range facilities and support requirements.

This document is applicable to all existing commercial LV and related launch facilities so as to permit SC contractors to prepare a single interface requirement document for a given SC mission, independently of the LV contractor to be selected.

The IRD, as defined in this document, includes the basic SC input data needed by LV agencies to prepare the interface control document defined in ISO 15863.

2 Normative references

There are no normative references in this document.

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

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

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1.1
usable volume
volume available to the payload within the LV fairing or carrying structure that the static envelope of the SC may not exceed in order to ensure that there is no physical contact between the SC and the LV in a dynamic environment

3.1.2
spacecraft adapter
SC adapter
structure that mates the SC to the LV and includes the separation system for SC/LV separation

Note 1 to entry: The SC adapter is a part of the LV and does not separate with the SC.

3.2 Abbreviated terms

EIRP equivalent isotropic radiated power

EMC	electromagnetic compatibility
IRD	interface requirement document
LV	launch vehicle
RF	radio frequency
SC	spacecraft
Y/N	yes/no response

4 Spacecraft mission description

4.1 Mission description

The IRD shall describe the following items:

a) purpose of the mission;

b) orbital characteristics;

c) in orbit view of SC, with drawing

4.2 SC description (optional)

The IRD may describe the following items:

a) SC platform

b) SC payload

5 Mechanical interfaces

5.1 Mechanical configuration

The IRD shall provide the following information:

a) SC mechanical drawing (launch configuration);

b) SC coordinate system, with drawing;

c) maximum height above interface plane, in metres;

d) SC overall dimensions (maximum diameter, maximum height, …), in metres;

e) SC/LV interface diameter, in metres. SC/LV interface geometrical definition.

f) available volumes of SC, in cubic meters

g) SC mass center position – relative to the reference frame which is centered in the adapter plane;

h) mean-square deviation of SC mass center position along SC axis

5.2 SC fundamental frequencies

The IRD shall provide the fundamental natural frequencies of SC (specify boundary conditions):

a) axial frequencies, in hertz;

b) lateral frequencies, in hertz.

5.3 Usable volume

The IRD shall provide the following information:

a) static envelope, with drawing;

b) SC protrusions below interface plane, with dimensioned drawings;

c) SC volumetric displacement, in cubic metres;

d) SC free air volume, in cubic metres;

e) special clearance requirements, with drawing.

5.4 Spacecraft (or SC adapter) mechanical interface

The IRD shall provide the following information:

a) mechanical interface, with drawing;

b) diameter, in metres;

c) attachments at SC interface;

d) material;

e) Young's modulus, in newtons per square metre;

f) coating:

   1) surfaces in contact,

   2) other surfaces;

g) roughness, in micrometers of surfaces in contact;

h) flatness/perpendicularity of surfaces in contact;

i) stiffness (for clampband mating system):

   1) applicable length (height), in meters,

   2) section area, in square millimeters,

   3) inertia (with respect to centre of gravity of section), in millimeters to the power of 4 (mm^4);

j) stiffness (except for clampband mating systems):

   1) radial direction, in newtons per metre,

   2) tangent direction, in newtons per metre.

NOTE This section of the IRD applies to the lower adapter interface ring for a SC provided adapter.

5.5 Connectors and microswitches (SC side of the interface)

The IRD shall provide the following information:

a) manufacturer and part number;

b) quantity;

c) location and mechanical interface, with drawing:

1) angular position, in degrees,

2) radial position, in metres,

3) height from separation plane, in metres;

d) push-on and push-off loads, in newtons;

e) energy released, in joules;

f) keying index.

5.6 Purges and fluid connection interface

The IRD shall provide the following information:

a) definition;

b) location and mechanical interface, with drawing:

1) angular position, in degrees,

2) radial position, in metres,

3) height from separation plane, in metres.

5.7 Encapsulated spacecraft access

For each access requirement to payload, the IRD shall specify the following items:

a) location in SC coordinates, in metres, with drawing:

1) X_S,

2) Y_S,

3) Z_S;

b) minimum size of access door, length and height in metres;

c) purpose.

NOTE The symbols X_S, Y_S, Z_S are the generic coordinates of any point in SC axes (or in axes parallel to the SC axes).

6 Electrical interfaces

6.1 Umbilical wiring diagram

Drawings for SC to LV and SC to ground facilities wiring shall be provided.

6.2 Umbilical connectors

The IRD shall provide the following information:

a) number of connectors required;

b) LV supplied (Y/N, to specify);

c) manufacturer;

d) connector type, name, designation and part number;

e) number of pins needed for user;

f) polarizing key type and orientation;

g) insert key location, with drawing;

h) location, with drawing;

i) backshell shielding requirement;

j) harness shielding requirement.

6.3 Umbilical wiring links (for each connector pin)

The IRD shall provide the following information:

a) pin number;

b) function(s);

c) wire type;

d) twisting and shielding characteristics;

e) maximum voltage, in volts;

f) maximum voltage at lift-off, in volts;

g) maximum current, in amperes;

h) maximum current at lift-off, in amperes;

i) maximum one way resistance, in ohms;

j) maximum voltage drop, in volts;

k) line start point;

l) line end point;

m) maximum voltage at separation (if applicable), in volts;

n) maximum current at separation (if applicable), in amperes;

o) signal type;

p) signal frequency, in hertz.

6.4 Electrical commands dedicated to spacecraft

6.4.1 Pyrotechnic commands

The IRD shall provide the following information:

a) number of commands required;

b) electrical circuit drawing, with drawing;

c) command identification;

d) number of initiators per command;

e) time of command initiation;

f) minimum time interval between commands, in seconds;

g) pulse width, in seconds;

h) voltage, in volts;

i) minimum all fire current, in amperes;

j) maximum no fire current, in amperes;

k) output isolation, in ohms;

l) wire gage;

m) wire type;

n) wire length from LV-SC interface to pyrotechnic devices, in metres;

o) circuit connectors to pyrotechnic devices;

p) initiator characteristics.

6.4.2 Dry loop commands

The IRD shall provide the following information:

a) number of commands required;

b) command identification;

c) number of redundant commands;

d) time of command initiation (on ground or in flight);

e) resistance (ON/OFF configurations), in ohms;

f) maximum, minimum and nominal output voltage, in volts;

g) maximum current, in amperes;

h) on-board circuit isolation, in ohms;

i) grounding requirements;

j) SC circuit configuration, with drawing.

6.4.3 Electrical commands

The IRD shall provide the following information:

a) number of commands required;

b) command identification

c) number of redundant commands;

d) time of command initiation (on ground or in flight);

e) minimum time interval between commands, in seconds;

f) maximum, minimum and nominal output voltage, in volts;

g) maximum current, in amperes;

h) current profile characteristics;

i) command duration, in seconds;

j) grounding requirements;

k) SC circuit configuration.

6.5 Separation status transmission

The IRD shall specify the measurement used to confirm SC separation.

6.6 SC in-flight telemetry

The IRD shall provide the following information:

a) number of channels;

b) type of measurements;

c) transducer range;

d) signal voltage, in volts;

e) sample rate;

f) encoding format;

g) source impedance, in ohms.

6.7 Power supply required from LV

The IRD shall provide the following information:

a) ground phase (Y/N, to specify);

b) flight phase (Y/N, to specify);

c) voltage and stability, in volts (±ΔV);

d) current required, in amperes;

e) frequency, in hertz;

f) maximum ripple noise, in percent.

6.8 Earth potential continuity

The IRD shall provide the following information:

a) location of reference point on SC;

b) maximum resistance between SC metallic elements and reference point, in ohms;

c) maximum resistance for SC interface plane, in ohms.

7 Radio-frequency and electromagnetic interface

7.1 Characteristics of radio-electrical systems

The IRD shall provide the following information:

a) number of units;

b) type of units;

c) unit designation;

d) function of unit;

e) frequency band (L, S, C, Ku, Ka), in compliance with the requirements of ITU radio-communication sector;

f) carrier frequency, in hertz;

g) bandwidth, in hertz, corresponding to

   1) −3 dB attenuation,

   2) −60 dB attenuation, or

   3) 99 % bandwidth;

h) carrier modulation:

   1) type,

   2) index,

   3) bit rate, in bits per second,

   4) subcarrier frequency, in hertz;

i) carrier polarization;

j) receiver frequencies, in hertz (if required by LV contractor):

   1) local oscillator,

   2) first intermediate,

   3) second intermediate (if applicable);

k) transmitter power (EIRP): maximum and nominal values, in watts;

l) field strength of receiver antenna: maximum, minimum and nominal values, in watts per square metre;

m) antenna description:

   1) antenna type ,

   2) antenna position, with drawing,

   3) pattern and gain;

n) SC transmission plan (i.e. activation plan of transmitters and receivers) and other electrical systems operation.

7.2 RF telemetry and command link

7.2.1 SC RF-link definition for ground operations

The IRD shall provide the following information:

a) number of sources and corresponding frequency bands;

b) type of link requested (if several options are available);

c) purpose of link;

d) link destinations;

e) events corresponding to link activation and timetable.

7.2.2 SC antenna coordinates

The IRD shall provide the following information:

a) identification;

b) coordinate measures in the SC reference frame, in metres;

c) field of view, with drawing.

7.2.3 RF-link implementation

The IRD shall provide the following information:

a) RF source;

b) SC location;

c) purpose;

d) RF-receivable location.

7.2.4 RF-link budget

The IRD shall provide the following information:

a) SC telecommand:

   1) at SC test equipment output:

      i) frequency of signal, in hertz,

      ii) bandwidth, in hertz,

      iii) output power (maximum, minimum, nominal), in watts,

      iv) modulation type and index;

   2) at SC omnidirectional antenna:

      i) frequency of signal, in hertz,

ii) power density (maximum, minimum, nominal), in watts per square metre.

b) SC telemetry:

1) at SC omnidirectional antenna:

i) frequency of signal, in hertz,

ii) bandwidth, in hertz,

iii) output power: EIRP (maximum, minimum, nominal), in watts;

2) at SC test equipment input:

i) frequency of signal, in hertz,

ii) power density (maximum, minimum, nominal), in watts per square metre.

7.2.5 Base band signal characteristics

The IRD shall provide the following information:

a) telemetry:

1) number of channels;

2) digital:

i) encoding,

ii) bit rate, in bits per second;

3) analogue:

i) modulation type and index,

ii) frequency, in hertz;

4) acceptable input from SC:

i) level, in volts (with tolerance),

ii) offset, in volts;

5) adjustable output to electrical support equipment:

i) level, in volts (with tolerance),

ii) offset, in volts;

b) telecommand:

1) number of channels;

2) digital:

i) encoding,

ii) bit rate, in bits per second;

3) analogue:

i) modulation type and index,

ii) frequency, in hertz;

4) acceptable input from electrical support equipment:

i) level (with tolerance),

ii) offset, in volts;

5) adjustable output to SC:

i) level (with tolerance),

ii) offset, in volts.

8 Spacecraft mission characteristics

8.1 SC input data for mission analyses

8.1.1 Mass and inertia characteristics

The IRD shall provide the following information, for the launch configuration and separation configuration, if they are different:

a) mass, in kilograms (with tolerance);

b) centre of gravity (origin on centreline, at interface plane), in metres (with tolerance):

1) X_S,

2) Y_S,

3) Z_S;

c) static unbalance, in metres (with tolerance);

d) moments of inertia (with respect to SC centre of gravity), in kilograms square metres (with tolerance):

1) I_{xx},

2) I_{yy},

3) I_{zz},

4) I_{xy},

5) I_{xz},

6) I_{yz};

e) dynamic unbalance (for spinning SC), in degrees (with tolerance).

Reference axes shall be parallel to the SC reference axes defined in 5.1.

NOTE The symbols X_S, Y_S, Z_S are the generic coordinates of any point in SC axes (or in axes parallel to the SC axes).

8.1.2 Sloshing masses (pendulum-type)

The IRD shall provide the following information:

a) type of tank (bladder, material, etc.);

b) type of propellant;

c) maximum volume of tank, in cubic metres;

d) filled volume, in cubic metres;

e) fluid fill factor, in percent;

f) mass of liquid, in kilograms;

g) coordinates of the centre of gravity of wet tank in SC reference frame, in metres:

   1) X_S,

   2) Y_S,

   3) Z_S;

h) slosh model (to be defined for a 1 *g* and a low-*g* gravity environment):

   1) mass (corresponding to sloshing fraction), in kilograms,

   2) length, in metres,

   3) coordinates of the location of attachment point with respect to the tank, in metres:

      i) X_S,

      ii) Y_S,

      iii) Z_S;

   4) first sloshing frequency (1 *g* model), in hertz.

8.1.3 SC mission constraints (when applicable)

The IRD shall provide the following information:

a) aerothermal flux;

b) solar aspect angle;

c) telemetry data acquisition;

d) angular accelerations/velocities;

e) deployment of appendages;

f) use of inertial units;

g) other.

8.2 SC orbit parameters (with tolerances)

The IRD shall provide the following information (a standard set of Kepler's elements, defining the orbit, in relation to any specified inertial frame of reference) :

a) inclination, in degrees (with tolerance);

b) altitude of perigee and earth radius, in metres (with tolerance);

c) altitude of apogee and earth radius, in metres (with tolerance);

d) argument of perigee, in degrees (with tolerance);

e) longitude of ascending node with respect to the Greenwich meridian, in degrees (with tolerance).

8.3 Launch window

8.3.1 Launch window constraints (when applicable)

The IRD shall provide the following information:

a) . solar aspect angle;

b) sun eclipse;

c) moon eclipse;

d) ground station view angle

8.3.2 Preferred window

The IRD shall specify the launch period and the launch window.

NOTE For dual or multiple launches, refer to LV user's guide.

8.4 SC pointing and separation

The IRD shall provide the following information:

a) allowable angular rate:

   1) spin, in revolutions per minute (with tolerance),

   2) roll, pitch and yaw (3-axis stabilized SC), in degrees per second (with tolerance);

b) separation attitude:

   1) separation velocity, in metres per second (with tolerance),

   2) maximum allowable pointing error (cone angle) in degrees,

   3) maximum allowable tip-off rate, in degrees per second,

   4) maximum allowable angular acceleration, in degrees per second squared.

NOTE Refer to LV user's guide for reference frame definition.

9 Environment requirements

9.1 General

Requirements in 9.2 to 9.7 apply to both flight and ground processing operations, including SC transportation (as applicable).

9.2 Mechanical environment

The IRD shall provide the following information:

a) maximum allowable acceleration (static and dynamic) longitudinal, in *g*;

b) maximum allowable acceleration (static and dynamic) lateral, in *g*;

c) allowable longitudinal sine vibration curve, with drawing;

d) allowable lateral sine vibration curve, with drawing;

e) allowable longitudinal random vibration curve, with drawing;

f) allowable lateral random vibration curve, with drawing;

g) allowable acoustic curve, with drawing;

h) allowable shock curve, with drawing.

9.3 Thermal environment

The IRD shall provide the following information:

a) allowable air temperature range in the payload area:
   1) ground processing with SC "ON", in degrees Celsius,
   2) ground processing with SC "OFF", in degrees Celsius,
   3) after encapsulation, in degrees Celsius,
   4) pre-launch phase, in degrees Celsius;

b) allowable humidity range:
   1) SC processing, in percent,
   2) after encapsulation, in percent,
   3) pre-launch phase, in percent;

c) maximum pre-launch air impingement velocity, in metres per second;

d) maximum ascent heat flux:
   1) pre-fairing jettison, in watts per square metre,
   2) post-fairing jettison, in watts per square metre;

e) maximum free-molecular heat flux:
   1) at fairing jettison, in watts per square metre,
   2) following fairing jettison, in watts per square metre;

f) heat dissipation (thermal dissipation timeline to be supplied) :
   1) SC processing, in watts,
   2) after encapsulation, in watts,
   3) pre-launch phase, in watts;

g) thermal analysis required from LV contractor (Y/N, to specify).

9.4 Static pressure

The IRD shall provide the following information:

a) maximum allowable ascent depressurization rate, in pascals per second;

b) maximum allowable ascent differential pressure, in pascals per second.

9.5 Contamination and cleanliness control

The IRD shall provide the following information:

a) fairing air cleanliness, in class of cleanliness;

b) maximum deposit on SC surfaces, in kilograms per square metre;

c) outgassing — total mass loss, in percent;

d) outgassing — volatile condensable material mass loss, in percent.

9.6 Radio frequency and electromagnetic environment

The IRD shall provide the following information:

a) SC radiation spectrum diagram, with drawing;

b) SC radiated susceptibility, with drawing.

9.7 Environment monitoring

The IRD shall provide the following information:

a) in-flight environment data acquisition:

   1) temperature (Y/N, to specify),

   2) pressure (Y/N, to specify),

   3) accelerations (low frequency vibrations) (Y/N, to specify),

   4) shocks (Y/N, to specify),

   5) random vibration and voice pressure;

b) launch range operations and transport data acquisition:

   1) temperature (Y/N, to specify),

   2) humidity (Y/N, to specify),

   3) cleanliness (Y/N, to specify),

   4) accelerations (low frequency vibrations) (Y/N, to specify),

   5) shocks (Y/N, to specify).

9.8 Exposure to sun

Acceptable exposure to sun (angle wrt reference axis of the satellite from fairing jettisoning up to SC separation, exposure to sun duration limitation, eclipse time limitation, requirement for barbecue mode …etc) may be specified.

10 SC Development and test programme

10.1 Mechanical environment qualification tests

The IRD shall provide the following information:

a) qualification rationale

b) list of applicable tests:

1) static load (Y/N, to specify),

2) modal survey (Y/N, to specify),

3) sinusoidal vibration (Y/N, to specify),

4) acoustic noise (Y/N, to specify),

5) random vibration (Y/N, to specify),

6) separation shock (Y/N, to specify);

c) flowchart and test schedules, with drawing.

10.2 LV/SC compatibility tests

The IRD shall provide the following information:

a) list of applicable tests:

1) match-mate (Y/N, to specify),

2) separation (Y/N, to specify),

3) umbilical connector pull-out (Y/N, to specify),

4) clearance measurement (Y/N, to specify),

5) EMC (Y/N, to specify),

6) end-to-end electrical (Y/N, to specify),

7) RF link (Y/N, to specify),

8) other (Y/N, to specify);

b) operations flowchart and test schedules, with drawing.

11 Launch range operations: facilities and support requirements

11.1 General logistics requirements

11.1.1 General

The requirements listed in 11.1.2 to 11.1.14 shall be defined in the IRD for each relevant facility and each item.

11.1.2 SC container and ground support equipment physical envelopes

The IRD shall provide the following information:

a) height, in metres;

b) width, in metres;

c) length, in metres;

d) mass, in kilograms;

e) location of mass center.

f) location of mass center of SC container (with and without SC)

11.1.3 Material handling equipment

The IRD shall specify the material handling equipment.

11.1.4 Electrical power for SC and ground station

The IRD shall provide the following information:

a) voltage, in volts;

b) frequency, in hertz;

c) power, in watts;

d) special requirements (Y/N, to specify):

   1) stability of power, in percent,

   2) other;

e) back-up power:

   1) continuous (Y/N, to specify),

   2) during specific periods (explain) (Y/N, to specify).

11.1.5 Umbilical lines and ground lines

The IRD shall provide the following information:

a) number of lines;

b) purpose;

c) type of lines (electrical characteristics);

d) connectors provided by SC (Y/N, to specify);

e) umbilical shielding;

f) ground reference.

11.1.6 Gas and fluid lines

The IRD shall provide the following information:

a) number of lines;

b) purpose;

c) type of lines;

d) type of fluid or gas;

e) operating pressure, in pascals (with tolerance);

f) connectors provided by SC (Y/N, to specify).

11.1.7 Clean room

The IRD shall provide the following information:

a) working dimensions:
   1) area, in square metres,
   2) height, in metres;
b) cleanliness class;
c) special sampling technique.
d) Access doors dimensions, in meters
e) Crane capacity, in metric tons
f) Hook height, in meters

11.1.8 Environmental controls for SC and ground station

The IRD shall provide the following information:

a) temperature, in degrees Celsius (with tolerance);
b) humidity, in percent (with tolerance);
c) checking frequency, in number of times per day;
d) downtime allowable in case of failure, in seconds;
e) back-up air-conditioning system required (Y/N, to specify);
f) back-up power:
   1) continuous (Y/N, to specify),
   2) during specific periods (explain) (Y/N, to specify).

11.1.9 Clothing (safety and cleanroom)

The IRD shall provide the following information:

a) location for use;
b) type of hazardous operations;
c) type of garment;
d) type of protection;
e) availability.

11.1.10 Area

The IRD shall provide the following information:

a) area available for SC, in square metres;
b) area available for ground station, in square metres;
c) area available for office space, in square metres;