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Space systems — Interface control documents between ground systems, ground support equipment and launch vehicle with payload

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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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Space systems — Interface control documents between ground systems, ground support equipment and launch vehicle with payload

Systèmes spatiaux — Documents de contrôle d'interface entre les systèmes au sol, l'équipement de soutien au sol et le véhicule de lancement de charge utile

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Contents

Page

Foreword

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 20, *Aircraft and space vehicles*, Subcommittee SC 14, *Space systems and operations*.

Introduction

This International Standard is intended for application at realization of interstate, intergovernmental or non-governmental space activity, between operators of some country and different organizations on the basis of their space activity contracts.

Interfaced (connected) devices development by two and more designers (commands, organizations, developers of other specializations, etc.) creates a need for coordination between them to prevent interfaces discrepancy for unlimited possibilities of design (construction) perfection during the creation of space technics.

This International Standard establishes basic requirements for interface control documents (ICD) writing and interface control procedures for the following items included in launch system: payload, launch vehicle, ground support equipment (according to ISO 14625:2007) and launch site (buildings with technical systems). Notably

a) ICD between payload and launch vehicle (according to ISO 15863:2003),

b) ICD between ground support equipment and payload (this International Standard),

c) ICD between ground support equipment and launch vehicle (this International Standard),

d) ICD between items of ground support equipment (this International Standard), and

e) ICD between ground support equipment and launch site (this International Standard).

ICD enables systematic creation (development), operation and management of interfaces b) to e) at all stages of life cycle of launch system. It is necessary for the purpose of guarantee of launch system normal functioning, prevention of accident and reduces of acceptable risk at joint space projects and services of space vehicles insertion into space.

Application of this International Standard at design and development stages will improve control and compatibility of all interfaces [b) to e)].

Application of this International Standard at operation stage will improve launch system safety and facilitate control of interfaces.

INTERNATIONAL STANDARD ISO 17689:2015(E)

Space systems — Interface control documents between ground systems, ground support equipment and launch vehicle with payload

1 Scope

This International Standard is applied for organizations developing ground support equipment and also for operators performing space activity.

Interface control documents format defined here does not contain the descriptions regarding various properties of ground support equipment (i.e. performance, functions or endurance to launch mechanical environment or quality assurance provisions) which are defined in technical specifications.

Control of interfaces, independently of its frequency or depth, cannot replace stages of parameters definition of high-quality production and development of technical requirements of project, design and development. Interfaces control is used as a control process that can provide necessary verification of successful finishing of design at a stated in contract period.

This International Standard establishes basic requirements for interface control documents (ICD) writing and interface control procedures for the following items included in launch system: payload, launch vehicle, ground support equipment (according to ISO 14625:2007) and launch site (buildings with technical systems). Notably

a) ICD between payload and launch vehicle (according to ISO 15863:2003),

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d) ICD between items of ground support equipment (this International Standard), and

e) ICD between ground support equipment and launch site (this International Standard).

2 Terms and definitions

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

2.1
interface control document for ground support equipment
document which describes mechanical, hydraulic, pneumatic, thermal, electric and other parameters of interfaces between ground support equipment and launch vehicle, items of ground support equipment, ground support equipment and launch site objects (building constructions with technical systems), and which is used to control these parameters

2.2
ground support equipment
units and systems necessary for the prelaunch operations and operations for launch of payload and launch vehicle (rocket fuelling systems, gas supply systems, thermostating systems, launch pad, units for LV installation on launch pad, ground support equipment control systems, etc.)

2.3
launch site
site necessary for the prelaunch and launch operations of a space vehicle and for the in-flight operations during the launch phase

[SOURCE: ISO 14620-2:2011, 3.16]

2.4
launch system
system made up of a launch vehicle, the associated launch complex, launch site, payload, ground support equipment and associated airborne equipment (including software), control systems, navigation system, trajectories, procedures, necessary personnel, and any other associated items

[SOURCE: ISO 14620-2:2011, 3.18]

2.5
launch range
systems, facilities and means, not part of the launch system, required to provide the necessary service and support for carrying out a launch campaign and to ensure safety and security of persons, assets and protection of the environment

2.6
launch complex
site assigned to or owned by a launch vehicle operator to operate a launch vehicle

[SOURCE: ISO 14620-2:2011, 3.14]

2.7
launch vehicle
any vehicle constructed for the purpose of operating in outer space, or placing one or more payloads in outer space, as well as any suborbital rocket

[SOURCE: ISO 14620-2:2011, 3.19]

2.8
payload
space vehicle or group of space vehicles on a single-launch vehicle intended to perform a specified function or series of functions

[SOURCE: ISO 14620-2:2011, 3.24]

2.9
ground safety
arrangements intended to reduce and control safety risks identified in ground prelaunch and launch activities of a manned or unmanned space vehicle

Note 1 to entry: Arrangements include protecting people, public and private property, and the environment and completing and adjusting the national regulatory laws related to occupational safety and health, workers, environment, space, etc.

[SOURCE: ISO 14620-2:2011, 3.8]

2.10
hazard
existing or potential condition of an item that can result in a mishap

Note 1 to entry: This condition can be associated with the design, fabrication, operation, or environment of the item, and has the potential for mishaps.

[SOURCE: ISO 14620-2:2011, 3.9]

2.11
mishap
accident
unplanned event or series of events resulting in damage or potential for damage

Note 1 to entry: While sometimes used synonymously, an "accident" generally means a severe type of "mishap".

[SOURCE: ISO 14620-2:2011, 3.20]

2.12
acceptable risk
safety risk, the severity and the probability of which may be reasonably accepted by humanity, without durable or irreversible foreseeable consequence on health, Earth, and the environment, at the present time and in the future

EXAMPLE A safety risk may be acceptable for crew members of a manned space vehicle when it is comparable to that of test pilots, for the personnel participating in hazardous activities when it is comparable to that of industrial workers, for people, public and private property, and the environment, when it is comparable to that of other hazardous human activities (e.g. high-speed surface travel).

[SOURCE: ISO 14620-2:2011, 3.1]

2.13
interfaces controller
specialist in the scope of launch complexes or organization of space activity which controls ICD observance by organization-executor at realization of contract of space technics creation

Note 1 to entry: Interface controller may be indicated in contract between space technics leading developer and executors. Leading developer can let a contract with controller.

3 General

3.1 ICD for ground support equipment is developed as separate document for each part included in launch system: payload, launch vehicle, items of ground support equipment, launch site (building constructions with technical systems):

a) ICD between ground support equipment and payload (this International Standard);

b) ICD between ground support equipment and launch vehicle (this International Standard);

c) ICD between items of ground support equipment (this International Standard);

d) ICD between ground support equipment and launch site (this International Standard).

The leading enterprise-developer of ground support equipment is responsible for the development of a list of ICD for this equipment.

The leading enterprise-developer of a launch site supervises types, quantity and location of interfaces of ground support equipment items which were developed by the enterprises according to ICD for items.

The developers of items of a launch site develop ICD and coordinate them with other enterprises which are developers of the items which are interfaced.

3.2 The initiative in determination of interfaces design belongs to the enterprise having a ready (existing) item or element of the device in relation to the enterprises which should develop an interfaced item or device at participation in the joint project.

The organization which performs launch services of space vehicles gives the full information about interfaces of launch pad to the organization which orders the launch services.

The payload authorities shall provide interface condition to operator.

3.3 It is necessary to have a note in the technical specification about presence of ICD on item.

Each interface shall have the code which contains the basic information about it.

EXAMPLE ICD XXXX-YYYY-000-AAA – interface code, where

— XXXX is the source item code,

— YYYY is the consumer item code,

— 000 is the interface number, and

— AAA is the code of place where the interface is located.

After interface number, a reference number or code (in brackets) may indicate the drawing (list) where this interface is figured.

EXAMPLE A110-B010-001-005 (A110.08.03.01).

Number of symbols and use of figures and letters in index should correspond to approved codes in technical specifications.

3.4 ICD can be drawn in the form of text, in the form of picture (drawing) or in complex (text and picture) form.

The specific indicator like the letter «G» may be added separately to picture (drawing) code (for example, ICD XXXX-YYYY-000-AAA-G).

The internal ICD is developed when there are many interfaces inside items of ground support equipment which need to be controlled.

For simple search, it is permitted to indicate item of ground support equipment to which the interface belongs.

3.5 The general order of drawing up ICD as follows.

Launch complex developers shall order process of drawing up ICD.

The general requirements for an ICD are as follows:

— ICD provides distribution of work and responsibility between developers;

— ICD structure has hierarchical construction (see Figure 2);

— ICD directs the control of works of developers during creation of interfaces.

Scheme of division of components launch site is presented in Figure 1. The responsible developers are defined for working out and handing in to co-authors of requirements to interfaces of launch system components.

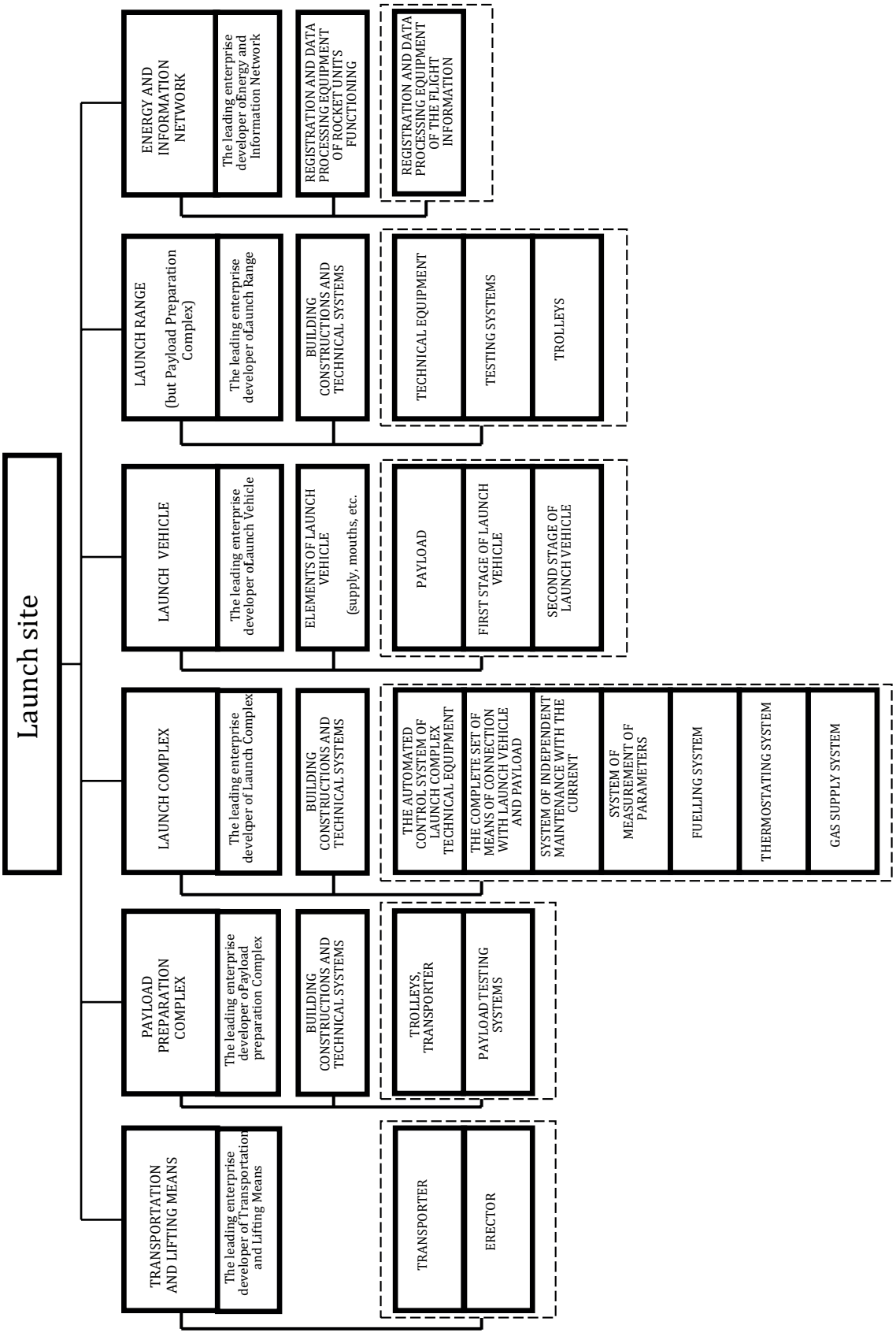


Figure 1 — Example of launch site structure

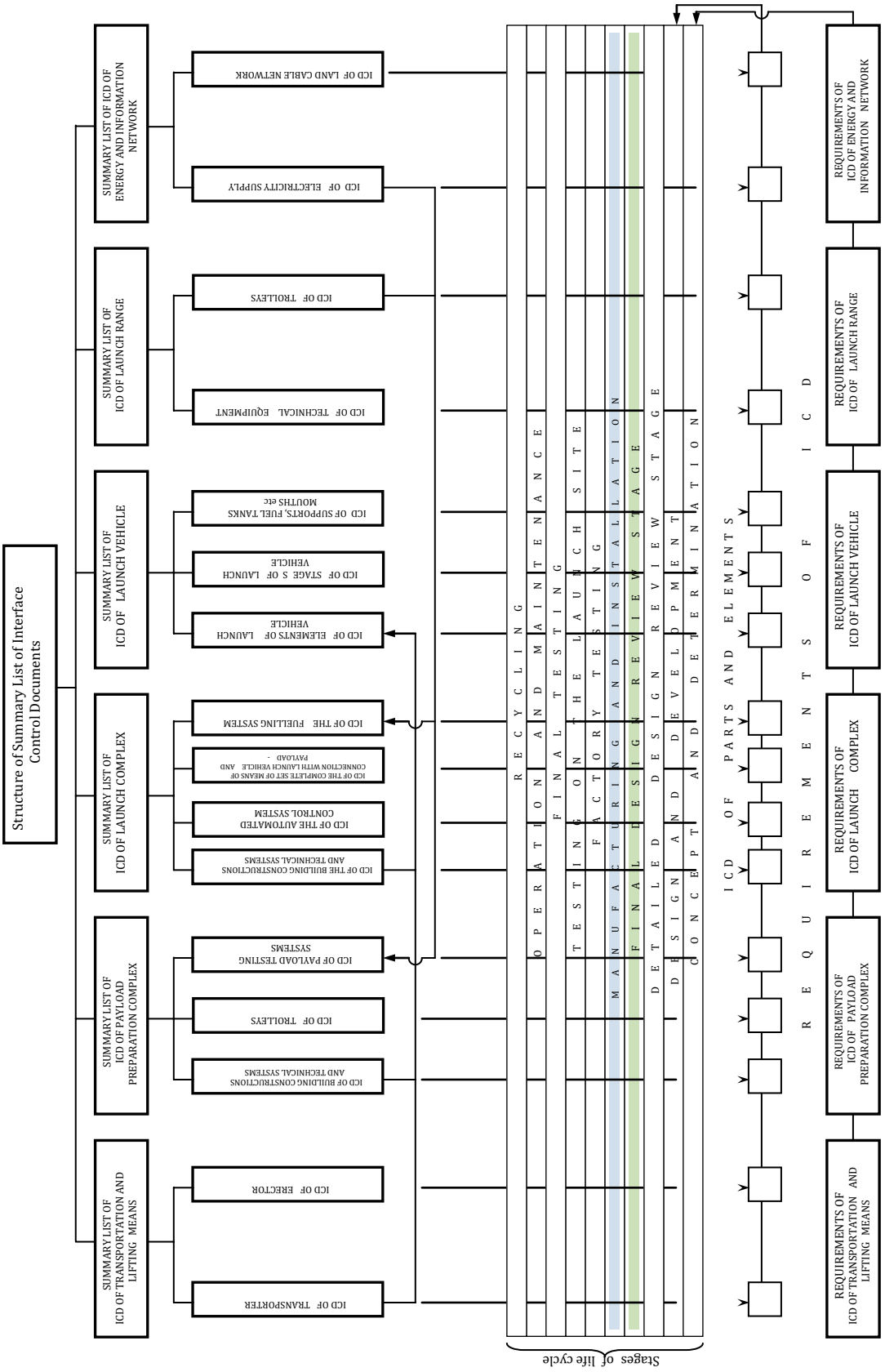


Figure 2 — Examples of structure of interface control documents of the launch site

The leading developer of components launch system hands in requirements to interfaces to the co-authors-developers of components of vehicle, to developers of complexes of launch system and to developers of components of complexes.

Developers of complexes and developers of components of complexes give proposals to leading developers of launch system in process of the coordination of requirements

— about specification of the requirements of interfaces,

— about formats of execution of the ICD,

— about division of works on interface creation,

— about dates of performance ICD, and

— about stages and terms of the control of works on realization (creation) of the interfaces, etc.

Developers of components make launch system according to ICD and according to the coordinated requirements.

4 Requirements to ICD execution

4.1 Requirements to item ICD execution

4.1.1 ICD should include the following:

— cover sheet;

— revision record;

— applicability;

— description of the interface;

— verification requirements.

4.1.2 The cover sheet of ICD should contain the following items:

— ICD title;

— ICD designation.

Formal designation intends for ICD identification. It can consist of several blocs in figures and letters.

EXAMPLE

Bloc 1	Bloc 2	Bloc 3	Bloc 4	Bloc 5	Bloc 6

This designation consists of 6 blocs which include letters/figures symbols, separated by dash.

Bloc 1 identifies project.

Bloc 2 identifies the type of document (ICD here).

Bloc 3 identifies the document item according to the product tree (or items in case of interface).

Bloc 4 is used for defining the differences of the same type, same object, but different versions.

Bloc 5 consists of one or several figures which define the number of the particular document. This number defines the type of the documents which are used for the one unit according to the dividing circuit. Figures of the number are determined by side (participant) which has own enumeration of documents.

Bloc 6 consists of two to four letters that define the enterprise which has written the document.

There are different variants of designation which can be used by participants for reliable identification of documents:

— issue date;

— issuing organization.

4.1.3 The revision record should contain the following description:

— revision number;

— revision date;

— summary of revision contents;

— authorization.

4.1.4 Applicability record should contain the following information:

— applicable documents;

— definitions;

— units of measure.

4.1.5 Description of the interface should specify title and number of units which correspond interfaces, types of interfaces (mechanical, electric, pneumatic, hydraulic, thermal, electromagnetic, radiofrequency, etc.), location (coordinate), parameters, indication of hazards, and description of the interface structure.

Information about interface should be stated clearly and definitely.

It is recommended to state information in the form of tables on types of interfaces. Interface parameters included in the table are defined by the developer on the basis of need of maximal information about interface.

EXAMPLE

Table 1 — Pneumatic interfaces of gas-supply system A110

Interface number	Operating environment	Location	Parameters			Interface drawing number
			P, MPa	T, °C	Q, m^3/c	
A110-B010–001	Liquid nitrogen (LIN)	Premises 10	20,0 ±1	25,0 ±5	0,04 ±0,01	A110-B010–001-G

Table 2 — Electric interfaces of gas-supply system A110

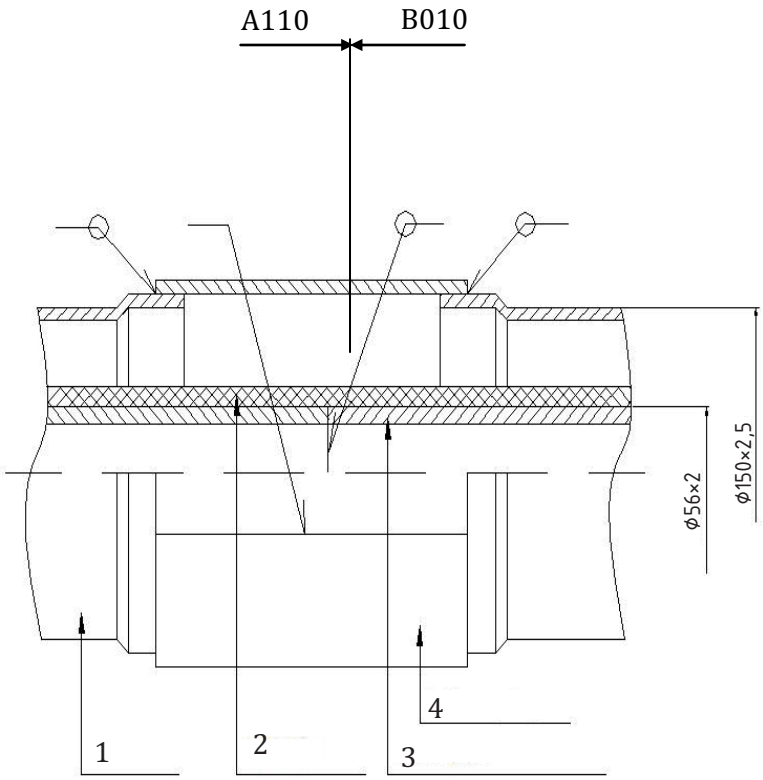
Interface number	Current type	Location	Parameters			Interface drawing number
			I (A)	U (M)	R (Ω)	
A110-E020–001	AC\DC	Build 2 room 5	1–1,5	12 ± 1	≤0,005	A110- E020–001-G

The table should include all value ranges which parameters take during setup, tests and operation. If these values are different, it should be noted what conditions correspond to that parameter value.

It is necessary, for more information, to give pictures (drawings) of premises which indicate interface location and coordinate, and pictures (drawings) of interface structure which can be included in ICD or can be registered separately as an annex.

Examples of drawing appearance are shown in Figures 3 to 6.

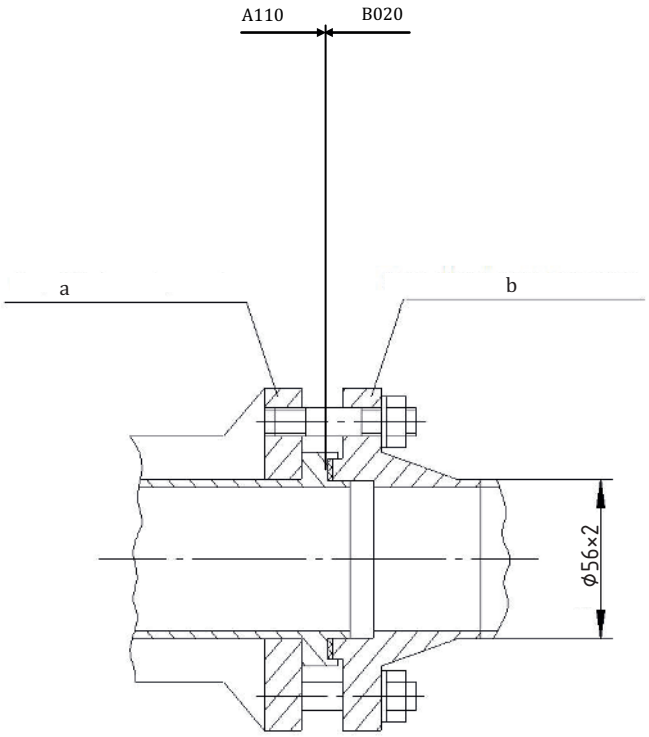
Examples of interfaces location between launch vehicle, ground support equipment and launch site (building constructions with technical systems) are shown in Figure 7.



Key

1 case
2 isolation
3 inside pipe
4 half-coupling

Figure 3 — Interface A110-B010-001 (A110.08.03.01)



Key

a Flange “O” of control system 1.

b Flange of liquid oxygen filling system.

Figure 4 — Interface A110-B020-002 (A110.08.04.01)

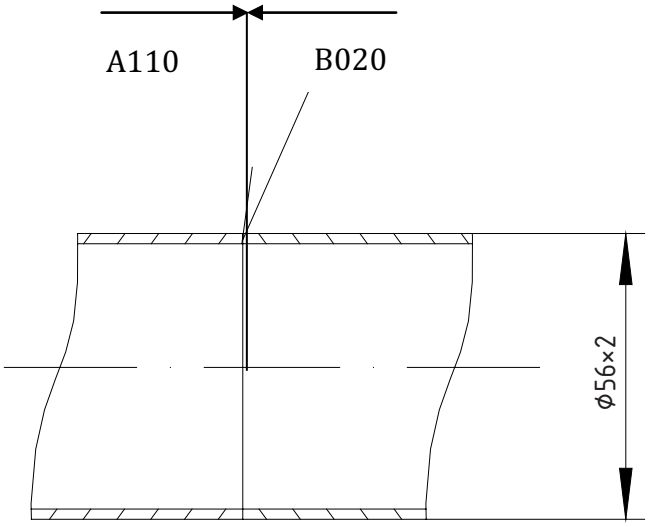


Figure 5 — Interface A110-B020-005 (A110.08.05.01)

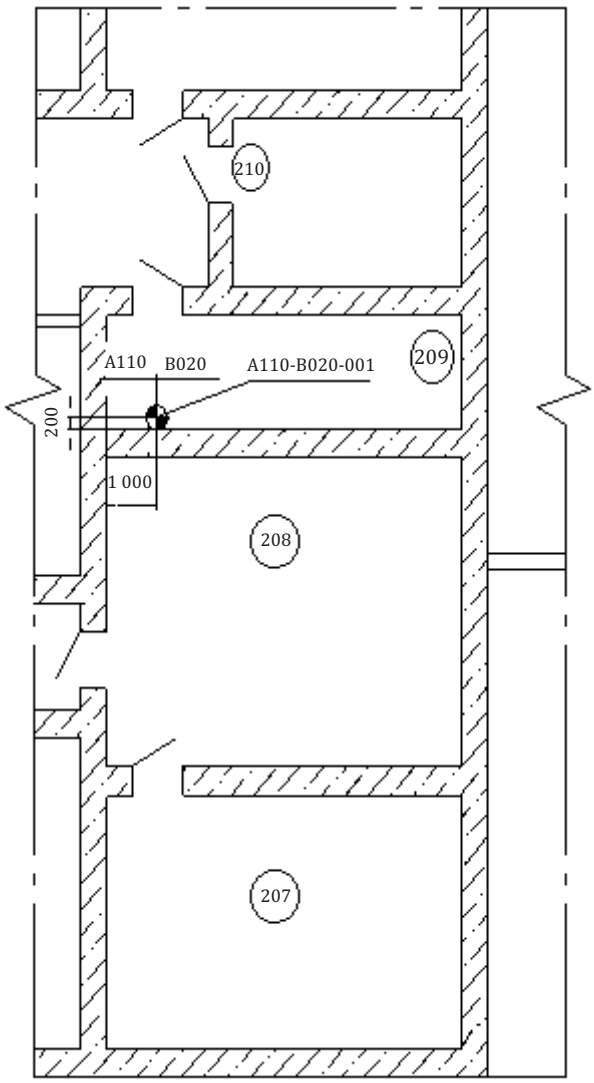
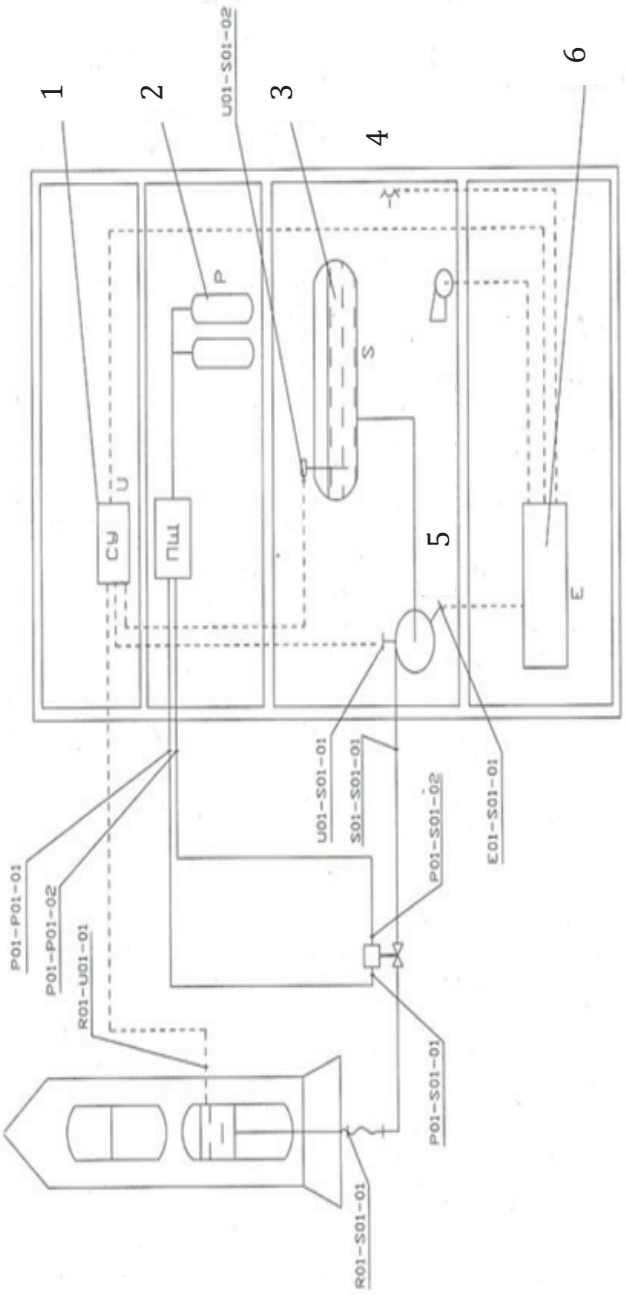


Figure 6 — Coordinate of interface A110-B020-001 (A110.08.03.01)



Key

1 control system (the technological equipment)
2 gas supply system (the technological equipment)
3 refuelling system (the technological equipment)
4 illumination (the technical system)
5 ventilation (the technical system)
6 power supply system (the technological equipment)

Figure 7 — Examples of arrangements of interfaces between a launch vehicle, objects of a launch site and elements of the grounds technology equipment

The interface information format which is more comfortable for organizations can be used but it should be approved and executed by all participants of the project. Concordance of interface information format should be conducted on early stages during preliminary design review (PDR).

4.2 Requirements to execution of summary list of launch site ICD

4.2.1 Summary list of launch site ICD is developed on basis of ground support equipment items ICD, launch vehicle ICD and other ICD.

4.2.2 Summary list of ICD is drawn in the form of a table. All objects of launch site, ground support equipment items and launch vehicle are listed in rows and columns of this table.

	LV	FS	OFS	GSS	TSS	CS	TSU
Launch vehicle (LV)	x	R010-A110–001					
Fuelling system (FS)	A110-R010–001	x		A110-B020–001			
Oxidant filling system (OFS)			x				F002-G001–001
Gas supply system (GSS)		B020-A110–001		x			
Thermostating system (TSS)					x		
Control system (CS)						x	
Transport-setup unit (TSU)			G001-F002–001				x

Interface numbers are indicated in cross if there is interface between items. If there is no interface, it should be «No».

5 ICD development, validation and verification stages

5.1 Working stages

Development, verification and validation of interfaces for launch vehicle, payload, launch site systems (buildings with technical systems) and for ground support equipment should be provided by organization-developer and operator of space services, with participation of interface controller, on basis of ICD of these objects.

These procedures are rationally to be done together with project analysis for stages established by standard IEC 61160.

Stage of life cycle	Type of project analysis	Abbreviation	Period of life cycle stages analysis	Check of ICD - interface conformity
Concept and determination	Preliminary design review	PDR	- At proposed requirements receiving - At contract or order receiving	Determination of interfaced units and preparation of ICD structure
Design and development	Detailed design review	DDR	- During design stage - After design stage - During development stage	ICD writing ICD improvement Final ICD approval
	Final design review	FDR	- After manufacturing of pre-production models - After test of pre-production models	Interface verification of ICD compliance
Manufacturing and installation	Manufacturing design review	MDR	- During support process development - At finishing of support process development - After performance of initial product examples - After delivery of initial product examples to customer	Interface verification of ICD compliance and check of interface units compliance
	Installation design review	IDR	- After installation of initial product examples - After commissioning performance	Interface validation
Operation and maintenance	Use design review	UDR	- After beginning of operation and maintenance - After selected operation periods, (for example, 1/2, 1, 5, 10 years)	Check of interface condition during maintenance Planned check of interface condition

It is rational to gather initial data for ICD after the operator and leading organization-developer have signed the contract for product creation at conception and determination (PDR) stage for design. It will enable the authors to define quantity of interfaced components, types of interfaces between them and their formats.

The principal stage of ICD development is stage of design and development (DDR). All interfaces, types of interfaces (connections), conditions of their work, coordinates and other necessary characteristics

will be defined at this stage. The rough copy of ICD is analysed, specified and supplied by all participants of product creation at obligatory participation of interfaces controller.

Final ICD development is performed in the time of design documentation development for organization-manufacturers of pre-production models. Preparation for ICD verification is performed at final period of design and development (DDR) stage. All interfaces (connections) of launch vehicle, each object of launch site and ground support equipment items shall be completely revealed and checked during preparation for ICD verification.

Verification of ICD of pre-production model is performed on organizations-manufacturers at the stage of pre-production model manufacturing.

Preparation for ICD validation is performed after pre-production model tests (FDR).

ICD correction and interfaces validation are performed after improvements of design (construction) on the basis of test results of pre-production model of launch site object or ground support equipment item. Interfaces validation shall be performed before beginning production and installation (MDR).

5.2 Verification and validation procedures

All interface parameters described in ICD should be verified. Verification methods should be described in separate clause of ICD. Measurement devices and methods shall be indicated.

The validation of interfaces is performed after tests of pre-production models. Validation results are drawn by the report indicated interfaces conformity with project and enclosed to ICD. The report of ICD performance are drawn up by customer (operator), project executor, and ICD controller.

Bibliography

[1] ISO 14620-2:2011, *Space systems — Safety requirements — Part 2: Launch site operations*

[2] ISO 14625:2007, *Space systems — Ground support equipment for use at launch, landing or retrieval sites — General requirements*

[3] ISO 15863:2003, *Space systems — Spacecraft-to-launch-vehicle interface control document*

[4] IEC 61160, *Design review*

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