INTERNATIONAL STANDARD

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# Space systems — Project reviews

*Systèmes spatiaux — Revue des projets*

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# 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.

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 21349 was prepared by Technical Committee ISO/TC 20, *Aircraft and space vehicles*, Subcommittee SC 14, *Space systems and operations*.

# Introduction

Space systems are very complex, incorporating many different technologies. Space programmes can last for many years, progressing through several different stages from conception to disposal or other disposition. When a space programme advances from one stage to another, substantial changes in the type and amount of resources required can occur. In addition, there may be attendant risks to either the success of the project or to the well being of project equipment or to personnel. Well-regulated project reviews can be an important factor in ensuring that all factors are ready for these changes, and that the risks are well understood and accepted. Use of this International Standard as a basis for the activities comprising a review, their necessary resources, controls, inputs and results is intended to enhance communication between different organizations that participate in a review process, and to reduce the costs of planning and performing reviews.

# Space systems — Project reviews

## 1 Scope

This International Standard provides process requirements for project reviews as a set of required functions. The requirements and recommendations cover the function inputs, outputs, mechanisms and controlling conditions. It is intended for use in implementing the review requirements of ISO 14300-1, ISO 14300-2, ISO 15865 and such other space systems and operations standards that require formal reviews**.**

This International Standard specifies the responsibilities of a review board and gives guidance concerning review board composition.

This International Standard is applicable to reviews for a project at any level within a larger project, as well as for major milestone reviews at the top level of a major project. It is intended to be used either by an independent developer as a basis for enterprise processes, or as a basis for an agreement between a supplier and a customer.

This International Standard also provides normative descriptions of the kinds of reviews that are commonly useful in assuring the success of a space project.

## 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 14300-1:2001, *Space systems — Programme management — Part 1: Structuring of a programme*

ISO 17666, *Space systems – Risk management*

## 3 Terms and definitions

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

**3.1**
**independent expert**
person highly qualified in some aspect of the technical content of the project review who does not have a personal conflict of interest concerning the outcome of the review

**3.2**
**milestone**
designated project status that indicates the amount of progress made toward project completion, or that should be achieved before the project proceeds to a new phase

**3.3**
**milestone criteria**
observable facts that indicate a milestone has been reached

**3.4**
**project data files**
collection of requirements, specifications, plans, technical result documentation and all other project data that serves to represent the project status

**3.5**
**project decision authority**
entity with authority to certify that the preconditions for a review are met, to initiate the review process, to reach decisions on the review board recommendations and to cause the agreed project actions to be carried out

**3.6**
**project expert**
person well acquainted with the project status and documentation and highly qualified in some area of the technical content of the project review

**3.7**
**project review team**
body consisting of project experts, charged with preparing all evidence for the review and formulating responses to action items

NOTE The best practice for conducting a review involves two separate teams of experts: the project review team and the review board (3.8). The project review team is composed of persons well acquainted with the project, and is responsible for assembling information concerning the actual status of the project.

**3.8**
**review board**
body, organized into sub-entities, as necessary, consisting of a review board chairperson or delegated person and review board members, charged with evaluating the evidence of project status, along with identifying issues and necessary corrective actions, to determine that the objectives and success criteria of a review milestone have been met

NOTE The purpose of the review board is to prepare an objective evaluation of the project status. Achievement of an objective evaluation is aided by use of independent experts who have no prior association with the project and no personal conflict of interest with respect to the outcome of the review.

**3.9**
**review board chairperson**
leader of the review board, who approves the review policy, objectives, success criteria, organization of the review board and nomination of review board members

**3.10**
**review board member**
independent expert, sometimes termed a subject matter expert, who is a participant in the review board

**3.11**
**review policy**
policy that provides either requirements or guidance (or both) for the overall conduct of the review

# 4 General

## 4.1 Purpose of a review

The purpose of a project review is to establish whether or not the project has reached a defined project milestone and to identify specific actions necessary for the project to proceed to the next phase.

NOTE The flow of activities to achieve this purpose is one of identifying the participants and the plan, preparing the evidence of the project status, evaluating the evidence relative to milestone criteria, followed by preparation of specific recommendations based on the evaluation and performing actions identified by the review.

Typical milestones and their relation to space project phases are defined in ISO 14300-1, and in Clause 6 of this International Standard.

## 4.2 Process model

### 4.2.1 Function hierarchy

The project review process is presented in the framework of a model using the syntax and semantics in IEEE Std. 1320.1-1998. This model identifies the necessary functions to be performed in terms of the function name and purpose, its inputs, outputs, mechanisms and controls. For reference, the essential features of the modelling syntax and semantics used in this International Standard are summarized in Annex A. This International Standard uses the diagrammatic portion of IEEE Std. 1320.1-1998 as a framework and does not claim full compliance with IEEE Std. 1320.1-1998.

For clarity in communicating the relationships between the review functions, the model is construed as a three-level hierarchy of functions, as shown in Figure 1. This hierarchy can be used for guidance in planning reviews; but for a conforming application of this International Standard, use of this hierarchy to represent the process is not required.

In a conforming application, the twelve functions at the third level of the hierarchy of Figure 1 shall be implemented. Detailed requirements and guidance for these functions are given in Clause 5.

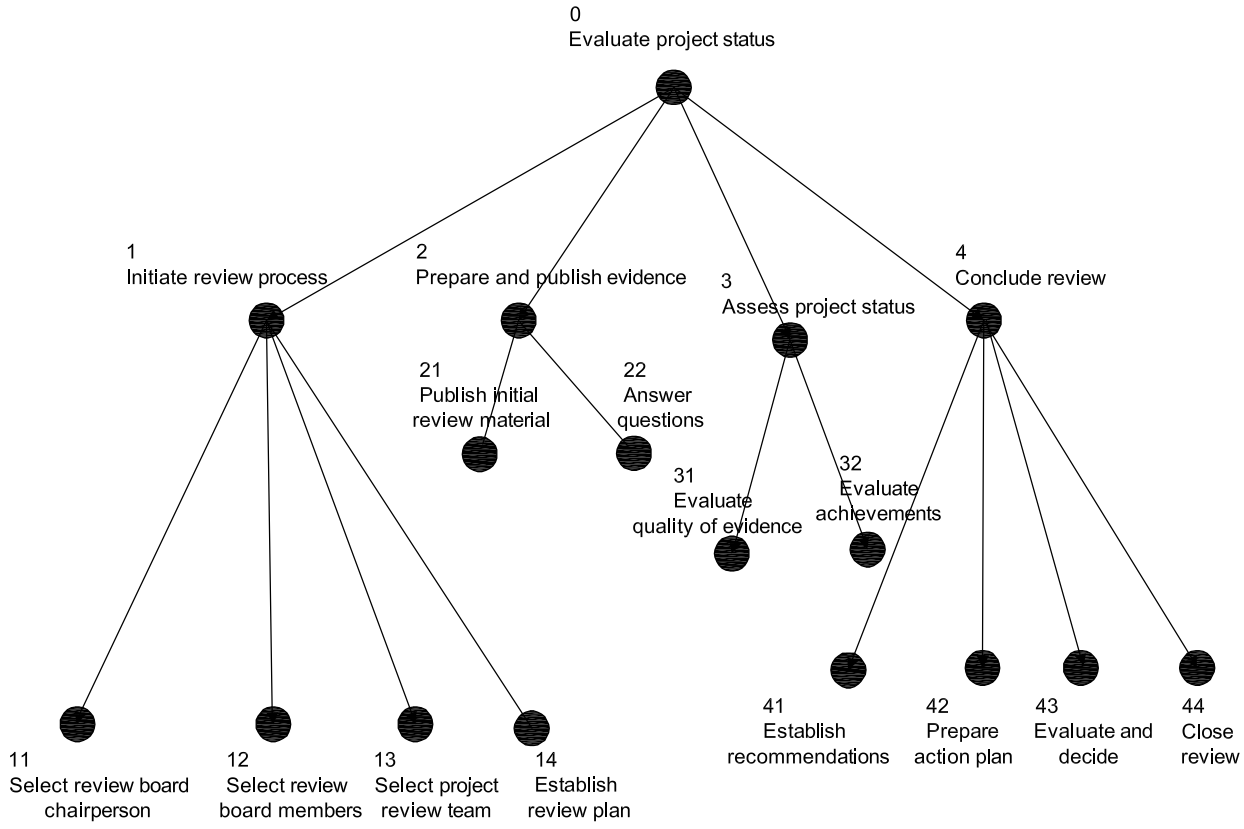


**Figure 1 — Function hierarchy**

### 4.2.2 Co-ordination of functions

A function may be performed concurrently with any other function and in any order that is appropriate, so long as the necessary inputs, controls and mechanisms are in place for the performance of the function. The performance of a function may be interrupted if this is appropriate, for example, because of resource conflicts.

In many cases the inputs, outputs and controls can consist of many increments of data or other material that are available at distributed times. Similarly, not all personnel participating in implementing a function are needed for the production of some specific increment of output. In these cases, outputs may be produced incrementally, rather than held until the total output has been completed.

## 4.3 Review context

The review context, corresponding to level 0 of Figure 1, is shown in Figure 2. The central box represents the function performed by the complete review process. The function of the review process, as stated in 4.1, is to evaluate project status relative to a specified project milestone. For the purposes of the diagram, this is abbreviated to “Evaluate project status”. The incoming arrows at the top and bottom, and on the left of the function box represent necessary preconditions for the review to be performed. Specifically,

a) the review process is controlled by the project review policy and the milestone criteria;

b) the input to the review process is the total set of project data files; and

c) the mechanism for performing the review process includes

   1) available independent experts,

   2) available project experts, and

   3) the project decision authority.

Requirements for these preconditions are given in 4.4.

The concrete result of the review is an agreed report of conclusions, recommendations and action items, and an approved plan for resolving any remaining problems. These outputs are shown on the right of the function box in Figure 2. Requirements for these outputs are given in 5.5.

Every model is an abstraction and includes only factors that are important from a certain viewpoint. The review process model used in this International Standard uses the viewpoint of project management.

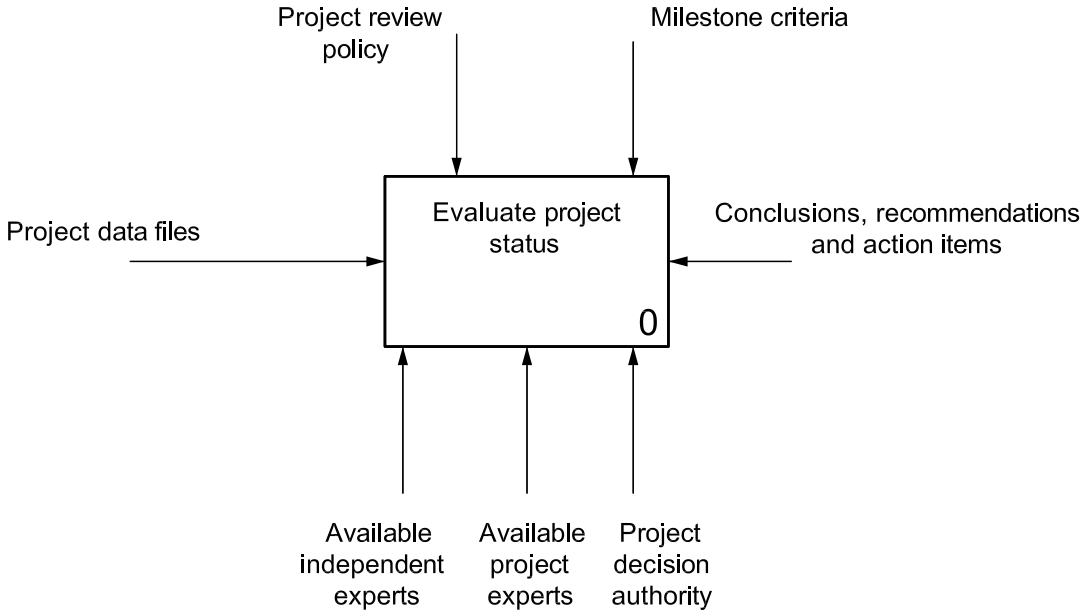


**Figure 2 — Context diagram for the top-level function "Evaluate project status"**

## 4.4 Preconditions for a review

### 4.4.1 General preconditions

#### 4.4.1.1 Project review policy

The project shall have a review policy. Factors that should be considered for inclusion in the review policy include the following:

a) selection of review board chairperson and review board members;

b) qualifications of review board members;

c) number of review board members and distribution of technical expertise;

d) style, format and medium of review publications, presentations and responses;

e) rules of order for conduct of meetings;

f) rules and procedures for the review board to reach recommendations;

g) rules and procedures for reaching decisions which involve both the project decision authority and the review board;

h) selection of members of the project review team; and

i) establishment of a review plan.

#### 4.4.1.2 Project decision authority

The project decision authority for the review shall be identified.

The project decision authority may be a single individual or a group of individuals that can reach a decision by vote, consensus or some other established method.

In a project carried out under a contract between two or more parties, the contract should define the project decision authority for each review or type of review.

NOTE The project decision authority can, depending on the terms of a contract, include representatives of the customer, the supplier, or both the customer and the supplier. In the case of internal reviews, it can consist solely of representatives of the supplier.

#### 4.4.1.3 Milestone criteria

The project shall have measurable criteria for assessing whether or not a milestone has been reached. These criteria shall include

— identification of technical achievements, and

— specification of how each technical achievement is to be evaluated for completeness and correctness.

### 4.4.2 Specific preconditions

#### 4.4.2.1 Milestone criteria

A project can have internal progress reviews that result in changes in the overall project plan and changes in the specific milestone criteria. Such changes can also result from prior milestone review action items. Replanning can also result from a variety of other factors. The project decision authority should confirm that milestone criteria to be used for the review are valid, taking into account any replanning that has occurred.

#### 4.4.2.2 Technical preconditions

Conducting of the review depends on technical evidence. Examples of such evidence include test results, simulation results, trade-off studies, equipment inspections and analyses. The project decision authority should ensure that evidence appropriate to the milestone exists in the project data files and should receive assurance that project personnel believe this evidence will support an assessment that the milestone has been achieved.

#### 4.4.2.3 Certification of precondition conformance and deviations

The project decision authority should certify that the preconditions of 4.4 have been met before initiating the review process.

If there are known deviations from these preconditions, the project decision authority may still decide to initiate the review. This should only be done if such a decision is consistent with the overall project plan and with any contractual agreements that exist.

If the decision to proceed is made in the presence of deviations, these deviations shall be incorporated in a published modification to the review policy or the milestone criteria, as appropriate.

# 5 Review process

## 5.1 Overview of required review functions

Figure 3 shows the relationships between the functions at the second level of the hierarchy shown in Figure 1. It also shows the relationships between these second-level functions and the preconditions shown in the context diagram, Figure 2.

The required review functions are detailed in 5.2 to 5.5.

NOTE In this clause, the requirements specify that specific persons or groups of persons are responsible for carrying out the functions. The particular responsibilities were chosen with a view to preserving the independence of the review results, while at the same time encouraging teamwork between the reviewers and the project personnel.

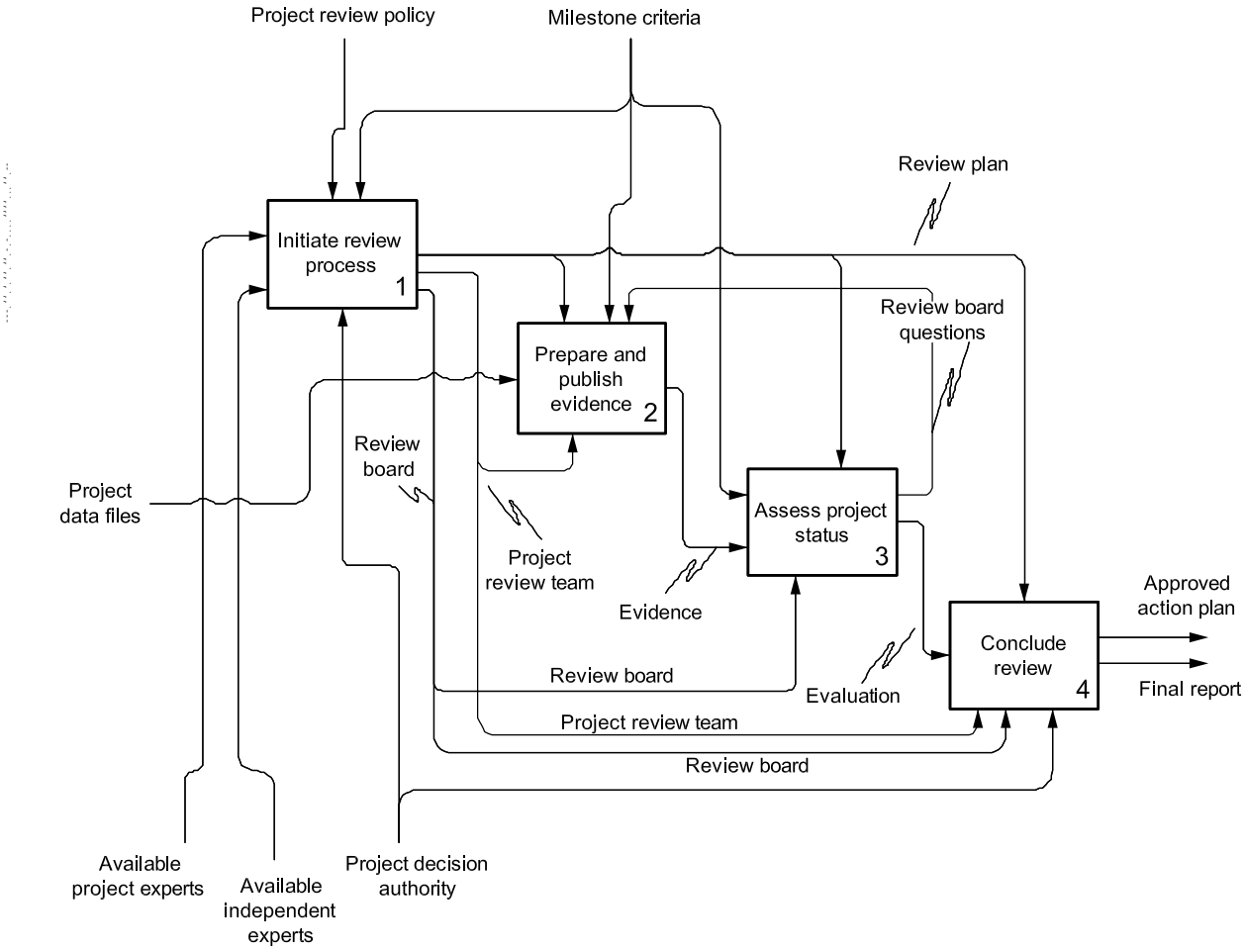


**Figure 3 — Subfunctions of "Evaluate project status"**

## 5.2 Initiate review process [1]

### 5.2.1 Overview

Figure 4 shows the relationships between the required review functions for initiating a project review, functions [11]–[14]. Elements of both the milestone criteria and the project review policy can participate in the control of each of these required review functions. Therefore, these controls are shown as merged at the top of the figure.

The purpose of this group of functions is to put in place the controls and mechanisms necessary for the remainder of the review process.

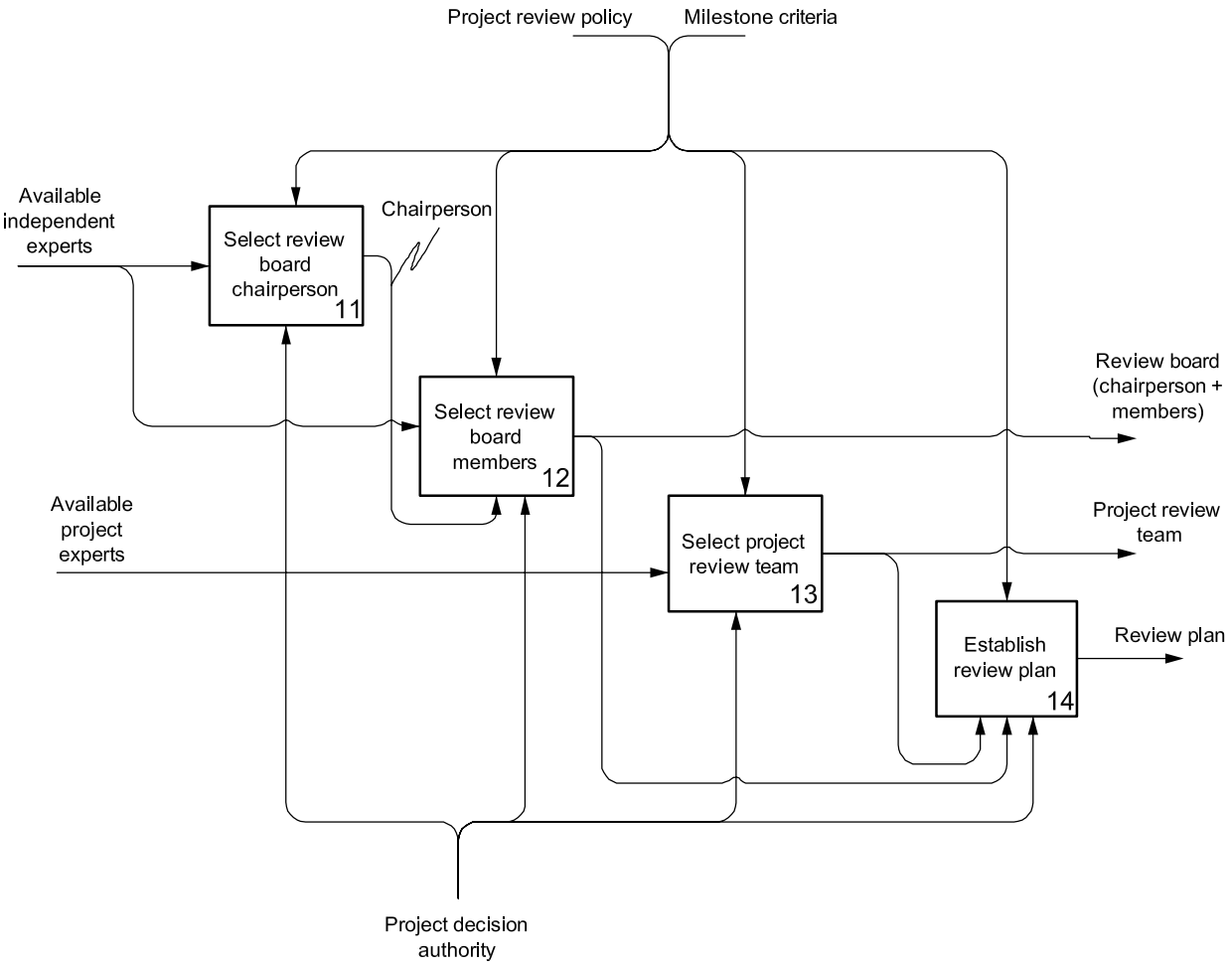


**Figure 4 — Initiate review process**

### 5.2.2 Select review board chairperson [11]

The project decision authority shall appoint a review board chairperson from the field of available independent experts, guided by the technical demands of the specific milestone criteria and by the project review policy.

### 5.2.3 Select review board members [12]

The review board chairperson shall select review board members with the concurrence of the project decision authority, guided by the technical demands of the milestone criteria and by the project review policy.

### 5.2.4 Select project review team [13]

The project decision authority shall select a project review team, guided by the technical demands of the milestone criteria and by the project review policy.

### 5.2.5 Establish review plan [14]

The review board chairperson shall establish a review plan with the participation and consent of the review board members, the project decision authority and the project review team.

The participants should consider the following factors in preparing the plan:

a) scheduling of publication and availability of evidence;

b) meeting format and schedule;

c) particular goals of each meeting;

d) means of recording the proceedings of the review and communications; and

e) medium, format and style of publication.

## 5.3 Prepare and publish evidence [2]

### 5.3.1 Overview

Figure 5 shows the functions required for preparation and publication of evidence. The purpose of these functions is to provide detailed technical evidence that the project milestone has been reached. The term “publication” is used here with a broad interpretation.

The type of evidence depends on the technologies involved and the phase of the project. The evidence should contain information about the methods used to reach conclusions, as well as the conclusions themselves. Depending on the specific milestone criteria, the project review team should consider including the following types of evidence:

a) test methods and results,

b) functional analyses,

c) design drawings,

d) mission scenarios and operations concepts,

e) inspection reports,

f) simulation methods and results,

g) trade-off study reports, and

h) risk analyses.

Evidence can be ambiguous or incomplete when viewed by the review board. Therefore, this function has two subfunctions: “publish initial review material” and “answer questions”. The evidence for achievement of the milestone consists of the combined results of both of these.

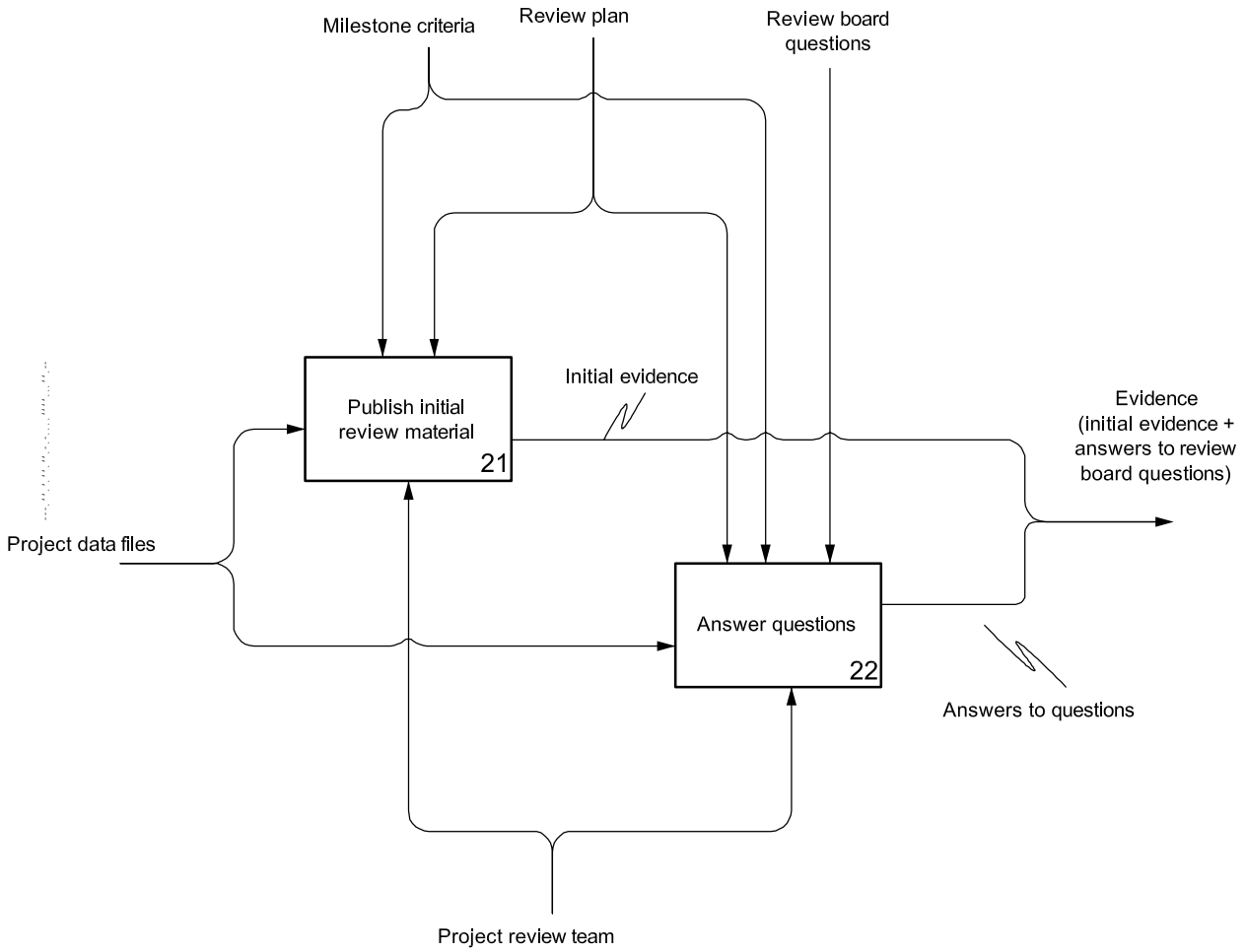


**Figure 5 — Prepare and publish evidence**

### 5.3.2 Publish initial review material [21]

The project review team shall prepare and publish initial evidence of the achievement of the milestone criteria. The format, schedule and content of these publications shall be in accordance with the review plan.

### 5.3.3 Answer questions [22]

The project review team shall prepare answers to questions from the review board concerning ambiguities or incompleteness of the initial evidence.

## 5.4 Assess project status [3]

### 5.4.1 Overview

Figure 6 shows the functions used to assess project status. It is important that the inputs consist of both the evidence prepared by the review board and the milestone criteria. The output is the initial evaluation of the project status relative to the milestone criteria.

NOTE Functions [31] and [32] are logically separate functions, but this does not imply they are necessarily performed sequentially at different times, as they could be performed concurrently. Logically, the evaluation of the achievements can only be based on evidence that is accepted by the review board as complete and unambiguous.

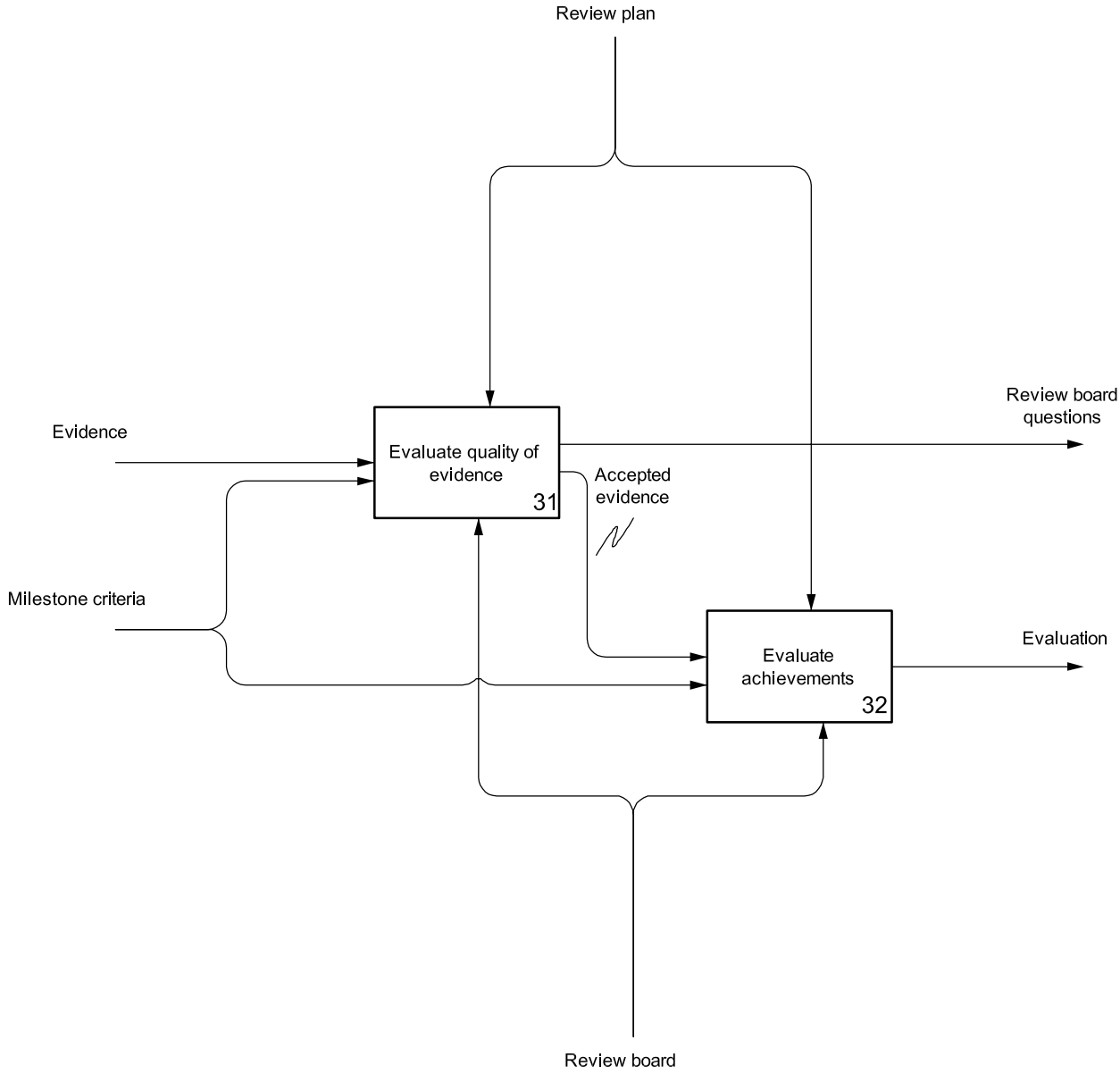


**Figure 6 — Assess project status**

### 5.4.2 Evaluate quality of evidence [31]

The review board shall evaluate all evidence submitted for completeness, consistency and unambiguity, and shall submit questions and requests for clarification or completion to the project review team. The review board shall similarly evaluate responses from the project review team to determine if the updated evidence is complete, consistent and unambiguous; if not, further clarification shall be sought.

### 5.4.3 Evaluate achievements [32]

Based on the accepted evidence and in conjunction with the milestone criteria, the review board shall produce an evaluation of the project status relative to the milestone criteria. The evaluation should include

— identification of milestone criteria that have been achieved; and

— identification of milestone criteria that have not been achieved.

For those criteria that have not been achieved, the evaluation should include an estimate of the risk to the project, as defined in ISO 17666, if the next phase is entered without achievement of these.

NOTE Risk is defined in ISO 17666 as an “undesirable situation or circumstance that has both a likelihood of occurring and a potentially negative consequence on a project”. An estimate of risk includes both of these parameters. The management of risk, i.e. the establishment of a number of possible courses of action and choosing between them, is a responsibility of project management and is not covered by this International Standard.

## 5.5 Conclude review [4]

### 5.5.1 Overview

Figure 7 shows the functions used to conclude the review. The purpose of this set of functions is to identify and carry out any actions that are necessary for the project to proceed to the next phase.

NOTE In the best case, there will be no additional actions needed. In the worst case, there will be no actions the review board considers adequate to justify proceeding to the next phase. In either case, this is an enterprise management or a contractual issue. The function of the review is to present as objectively as possible the true project status and a recommended path for correction if necessary. It is the sole job of appropriate management to decide what course to take.

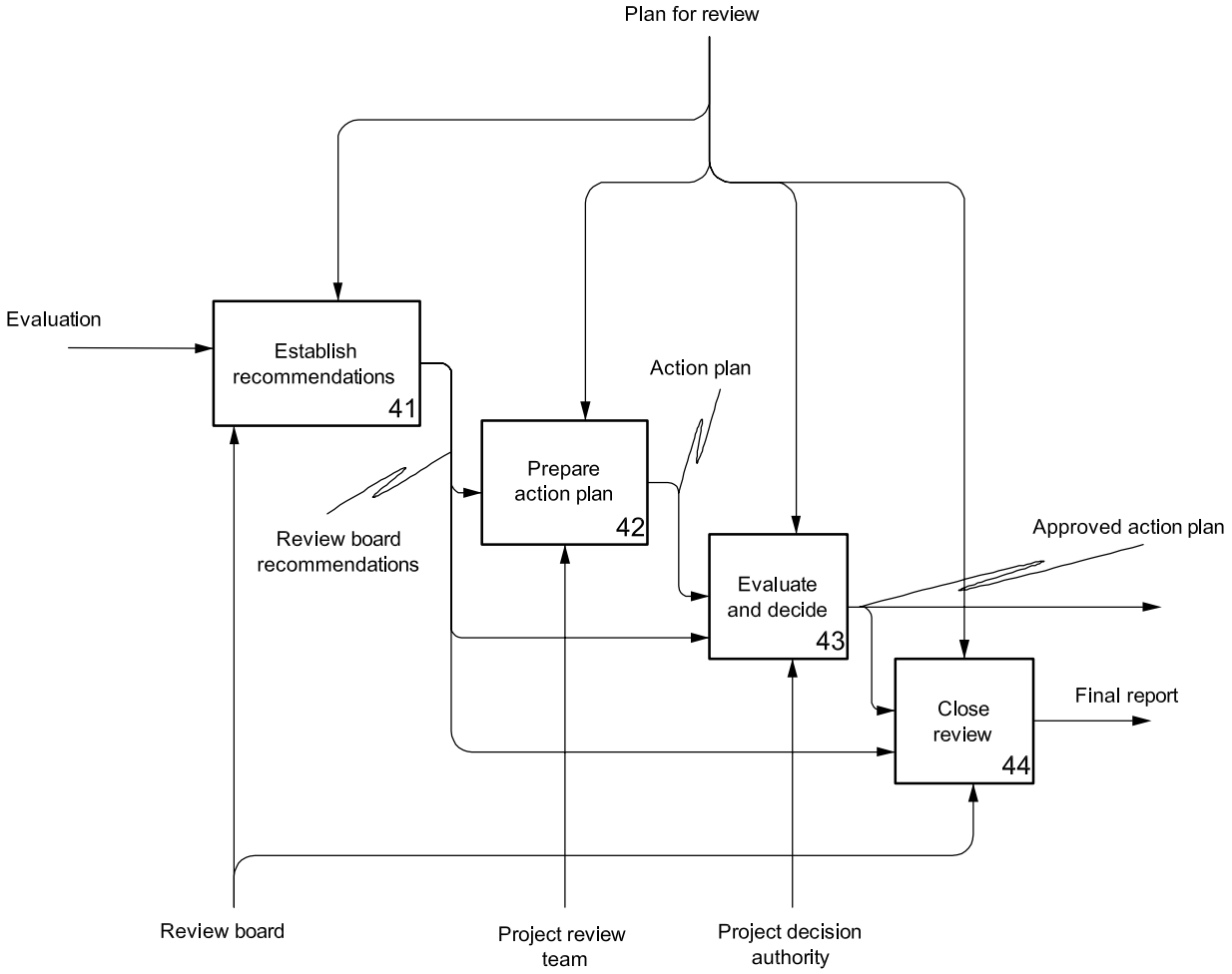


**Figure 7 — Conclude review**

### 5.5.2 Establish recommendations [41]

The review board shall examine the achievements and issue recommendations for correction of any deficiencies that were identified in the evaluation.

Recommendations may include development of plans to do further technical work or otherwise replan the next phase, as well as recommendations for completion of technical tasks not yet completed satisfactorily.

NOTE Since it is generally in the best interests of the project to close out the review and since some technical corrections can take significant time to achieve, it is sometimes the best policy to make new plans for the next phase that take into account a different technical starting point. Whether this is to be done is a management and contractual issue.

### 5.5.3 Prepare action plan [42]

The project review team shall prepare an action plan according to the recommendations. The decision of not taking into account a recommendation shall be regarded as a risk and managed in accordance with ISO 17666.

NOTE 1 The management of any lessons learned will form the subject of a future International Standard (ISO 16192).

NOTE 2 The project review team may be augmented at any point where this is necessary to perform its role, including this point. “Select project review team” is a function, not a discrete event, and can be carried out in parallel with any other function.

### 5.5.4 Evaluate and decide [43]

The project decision authority shall approve the action plan prepared by the project review team based on the recommendations, conclusions and action items of the review board.

### 5.5.5 Close review [44]

The review board shall close the review and issue a final report that records the results of the review.

## 6 Reviews designated in ISO 14300-1

The specific reviews listed in Table 1 are required or recommended in ISO 14300-1. Additional types of review are contained in Annex B.

**Table 1 — Reviews required or recommended by ISO 14300-1**

| Name of review | Programme milestone (phase ending) | Typical milestone criteria |
|---|---|---|
| Preliminary Requirements Review (PRR) | End of phase A | Function tree issued<br>Reference Functional Specifications issued<br>Preliminary Technical Specifications<br>Assessment of each potential concept (technical, cost and schedule) and the associated risks |
| System Requirements Review (SRR) | During phase B | System Technical Specification issued<br>Main interfaces defined<br>Allocation of performances to lower levels issued |
| Preliminary Design Review (PDR) | End of phase B | System Technical Specification approved<br>Main critical Technical Specifications issued<br>Choice of solution to be developed<br>Development plan issued |
| Critical Design Review (CDR) | End of detailed design activities | Design data file issued<br>Qualification test plan issued |
| Qualification Review (QR) | End of phase C in case of separated C and D phases<br>End of C/D phase in case of integrated C and D phases | End of qualification tests<br>Design justification data file issued |
| Pre-Shipment Review (PSR) | During or at end of phase D, after end of manufacturing and verification of each product to be delivered | End item data package issued<br>Verification of delivered product completed |

# Annex A
(informative)

# Main elements of the process diagrams

## A.1 Introduction

The diagrams used in Clauses 5 and 6 of this International Standard conform to the syntax and semantics of the IDEF0 standard for process modelling as published in IEEE Std. 1320.1-1998. This is, for the purposes of this International Standard, the same as the IDEF0 standard presented by the US National Institute for Standards and Technology, Federal Information Processing Standard: FIPSPUB183. This annex presents an overview of the elements of the IDEF0 modelling standard that are used in Clauses 4 and 5.

IDEF0 diagrams are used widely for description and specification of "what to do" models in business and industry. They were developed as part of a US Air Force project to develop ways of improving manufacturing operations. They are currently in use within the development effort for the various parts of ISO 10303, *Industrial automation systems and integration — Product data representation and exchange* for the development of application reference models (ARMs).

## A.2 Basic concepts

The IDEF0 diagrams provide a formal graphical syntax and semantics for describing or specifying processes. Figure A.1 shows the main elements of the IDEF0 standard that are needed for specification of the project review process.

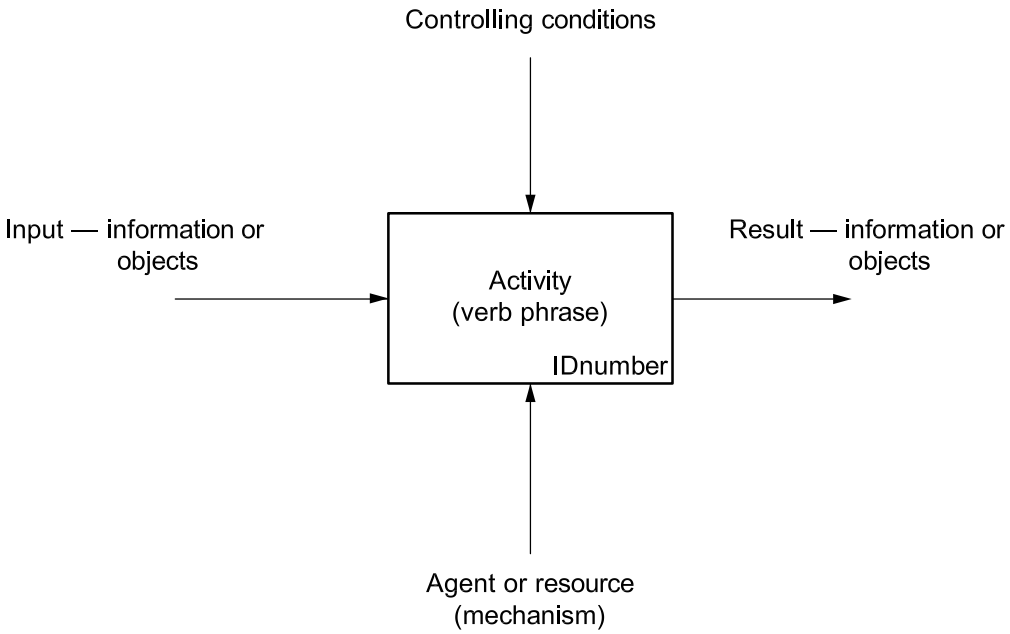


**Figure A.1 — IDEF0 diagram basics**

The main points are as follows.

a) Functions.

   1) A function is an activity, process or transformation identified by a verb or verb phrase that describes what must be accomplished.

   2) A box represents a function.

   3) The content of the box is the verb phrase characterizing the function.

   4) A function can be decomposed into sub-functions.

b) Input arrows.

   1) An input arrow represents the input data or objects passed to a function for transformation.

   2) Input arrows enter the function box on the left.

c) Output (or result) arrows.

   1) An output arrow represents a result or output of a function.

   2) Output arrows leave the function box on the right.

d) Mechanism arrows.

   1) A mechanism arrow represents an agent, resource or other means used to perform a function.

   2) Mechanism arrows enter the function box at the bottom.

e) Control arrows.

   1) A control arrow represents the controlling conditions required to produce correct output.

   2) Control arrows enter the function box at the top.

## A.3 Context diagram

The process is bounded (i.e. the scope defined) by means of a top-level context diagram (Figure 2), consisting of a single function box representing the total process, with bounding arrows representing the total interface of this process with the world outside the process (to the level of abstraction of the intended specification or description).

# Annex B
(informative)

# Other reviews

## B.1 Other milestone reviews

Table B.1 lists other reviews commonly used but which are not specified in ISO 14300-1. In some cases, there are alternative names that are used for similar milestones. Reviews are listed in alphabetical order for ease of reference.

**Table B.1 — Commonly used reviews not specified in ISO 14300-1**

| Review name | Programme milestone (phase ending) | Typical milestone criteria |
|---|---|---|
| Acceptance Review | During or at end of phase D, after end of manufacturing and verification of each product to be delivered | Completion of flight model production, and verification (including acceptance) or proto-flight tests<br>End item data package and LB |
| End of Life Review | Utilization phase | Completion of mission objectives |
| Flight Readiness Review<br>Launch Readiness Review | Launch campaign phase at a launch site (launch site acceptance test phase) | Completion of launch site acceptance tests<br>Launch safety confirmation<br>Risk assessment<br>Launch permission by relevant authorities |
| Mission Definition Review | Mission analysis phase | Completion of mission definition, evaluation of its costs, schedule and risks |
| Operational Readiness Review | Last phase prior to committing the product to operations (e.g. for an Earth satellite mission, the transfer to orbit phase) | Completion of the designated final pre-operational phase (for example, for an earth satellite mission, completion of the transfer orbit phase) |
| Commissioning Review | Last phase prior to committing the product to operations | Completion of the designated final pre-operational phase |
| Production Readiness Review, sometimes termed a Manufacturing Readiness Review | Detailed design stage during or at the end of development phase | Completion of production plan |
| Software Specification Review | Software specification stage during or at the end of definition phase | Completion of hardware Technical Specification (TS) and software TS |
| System Functional Review | Functional Specification (FS) stage, during mission analysis and feasibility phase | Completion of mission definition and its FS |
| Test Readiness Review | During production phase | Completion of flight model manufacture<br>Detailed test procedure documents |

## B.2 Interim reviews

In addition to the milestone reviews, a well-regulated project often has interim progress reviews, which can take place periodically (quarterly, for example), on an ad-hoc basis or on some other planned basis. These reviews are referred to as Peer Reviews, Interim Technical Reviews or other similar names.

## B.3 Ground segment reviews

Table B.2 lists other reviews commonly used but which are not specified in ISO 14300-1. In some cases, there are alternative names that are used for similar milestones. Reviews are listed in alphabetical order for ease of reference.

**Table B.2 — Ground segment reviews not specified in ISO 14300-1**

| Name of review | Programme milestone (phase ending) | Typical milestone criteria |
|---|---|---|
| Ground Segment Requirements Review (GSRQR) | Mission operations concept established, and mission implementation requirements agreed | Mission implementation plan, space–ground interface, and requirements for GS elements established |
| Ground Segment Design Review (GSDR) | Completion of GS design definition | Design definition documents for all GS elements |
| Ground Segment Implementation Review (GSIR) | Development of all GS elements complete | Verification of GS elements<br>GS integration plan |
| Ground Segment Readiness Review (GSRR) | GS elements, procedures and personnel are ready for validation | GS elements integrated<br>Operations procedures, validation plans and mission data established |
| Operations Readiness Review (ORR) | GS elements, procedures and personnel are validated and ready for operations | Approved and validated operations plans and procedures<br>Trained and certified personnel |
| Commissioning Review | See Table B.1 | Commissioning test results |

# Bibliography

[1] ISO 15865, *Space systems — Qualification assessment*

[2] IEEE Std. 1320.1-1998, *Standard for Functional Modeling Language — Syntax and Semantics for IDEF0*

**ICS 49.140**

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