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Space systems — Experience gained in space projects (Lessons learned) — Principles and guidelines

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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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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.

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ISO 16192 was prepared by Technical Committee ISO/TC 20, *Aircraft and space vehicles*, Subcommittee SC 14, *Space systems and operations*.

Introduction

In order to improve the quality of products and to work efficiently, it is important to consider past experiences and how the knowledge of those experiences is transmitted. The aim is to decrease errors (in terms of both quantity and gravity), improve working methods and decrease risks of nonconformity to specified objectives (management, technical, quality, costs and schedules).

In the process of lessons learned, future space projects or programmes are intended to draw benefit from past experience, by capturing and communicating knowledge from the past through recording, classifying and making the information available.

An efficient processing of lessons learned is considered essential for

— ongoing efficiency and quality improvement inside any organization, and

— successful project management.

Space systems — Experience gained in space projects (Lessons learned) — Principles and guidelines

1 Scope

This International Standard outlines lessons learned principles and guidelines that are applicable in all space project activities (management, technical, quality, cost and schedule).

The application of this International Standard is intended to be included in the supplier quality management system, but can be tailored in individual contracts as agreed by the customer and supplier, depending on

— the content of each project (size, technological level and novelty, particular organization, participants, etc.), and

— the interest and usefulness of the related information.

The lessons learned information can result from any situations which might be encountered in similar contexts for future projects, i.e.

— undesirable experiences that need to be avoided;

— strategies, rules, principles of design, validation, tests and operations that proved to be successful or necessary.

This International Standard neither endorses nor recommends the transmission of company proprietary information to external entities as part of a lessons learned process.

Implementing a formal lessons learned process as outlined in this International Standard makes it possible to capture and benefit from this information.

The lessons learned activity is an important contribution to the processing of the preventive and corrective actions specified in ISO 9001 and ISO 17666.

This International Standard also provides lessons learned processes and suggested lessons learned forms.

2 The role of a lessons learned activity

2.1 General

The main activities of a lessons learned process are as follows:

a) to identify and collect,

b) to analyse, classify and issue recommendations,

c) to record, and

d) to make information available.

The outputs of the activity are as follows:

— root event background,

— lessons learned, and

— recommendations.

2.2 Identification and collection

The lessons learned are established by identifying the knowledge acquired from experiences relative to the organization and the management of a project.

2.3 Analysis, classification and issuing of recommendations

Rough data, information, or experiences that have been identified and collected should be analysed for lessons learned cases or events.

Lessons learned should be classified by type, e.g. management, safety, quality, engineering and programme phase.

The recommendations related to a lesson learned (e.g. causes of anomalies, rules of design) should be included in appropriate standards or reference documents.

2.4 Recording

The lessons learned outputs should be recorded by the organization in a database. This information includes at least the following:

— facts,

— cause,

— consequence, and

— recommendations for future action.

2.5 Information availability

Information should be made available, as necessary, by referring to a collection of data and by consulting a shared database. External provision of data should be in accordance with agreements between the customer and supplier. This database should include any information considered by the participants to be useful for ongoing or future project activities.

The database should be searchable by domain, type of project, period and type of anomaly.

3 Lessons learned management

3.1 The main applications of the lessons learned

Lessons learned should be systematically applied in the following situations:

a) before the start of a space project;

EXAMPLE Information about costs and duration, technical performance and quality of previous projects are made available to a new project.

b) transition from one phase to another phase;

EXAMPLE The lesson learned during phase B (definition phase) or C (development phase) is that a qualification of an advanced technology is followed by specific inspection during manufacturing.

c) when the results from one project could benefit another coexisting project;

EXAMPLE The lesson learned from analysis of a component in a given project is directly beneficial to another project.

d) when the knowledge of one field can benefit another.

EXAMPLE The lessons learned from analysis of defects or failures during integration and tests result in improvement of the specifications of a contract.

3.2 Information sources for the lessons learned

The search for useful information is an essential step to developing lessons learned.

Suggested sources of useful information include the following:

— opinions of specialists and experts;

— documented conclusions of specialists and experts;

— technical reports, actions and recommendations resulting from reviews;

— nonconformances reports;

— failure analysis reports;

— assessments of success in meeting project objectives (at the end of a project);

— documented results of operation of models of space engineering, or results of space mission, or both;

— feedback from customers;

— alerts;

— accidents, mishaps, incidents and close calls;

— risk assessments.

4 The lessons learned process

4.1 General

Annex A provides a summary of the process in three phases with related outputs.

The process is detailed in 4.3.1 to 4.3.7 in seven steps.

4.2 Process steps

The lessons learned process is optimized by implementing a common methodology of definition, classification, description and registration.

The lessons learned process can be broken down into seven fundamental steps (see Figure 1).

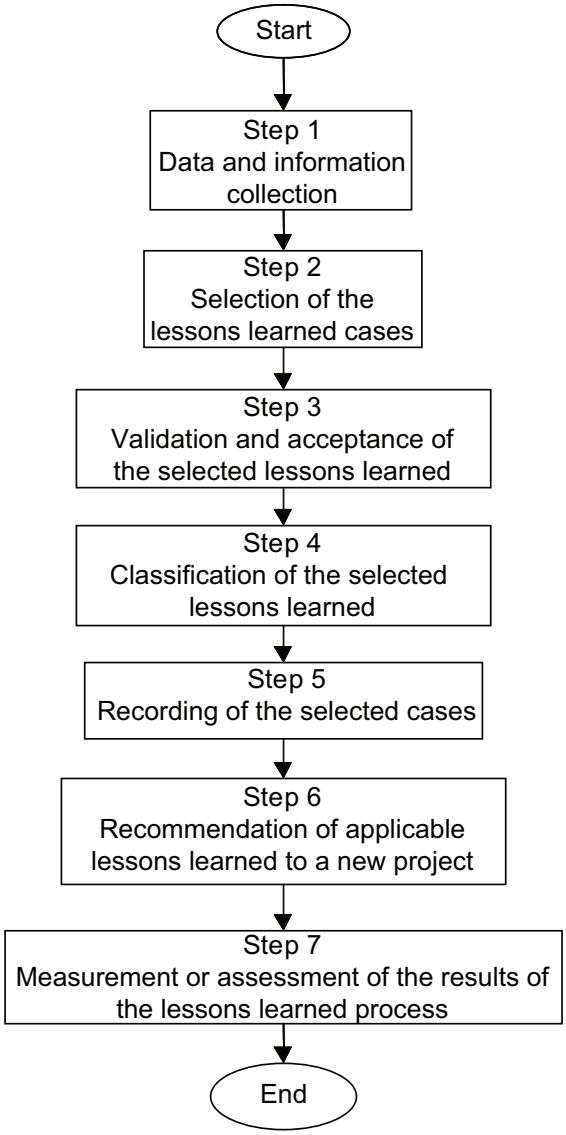

Figure 1 — Steps of lessons learned process

4.3 Description of lessons learned process steps

4.3.1 Data and information collection

Pertinent information is acquired directly from positive and negative experiences relative to the organization and management of a project. Company proprietary information should be collected but should not be transmitted to external entities in a lessons learned process.

4.3.2 Selection of the lessons learned cases

Not all the technical experiences, occurrences, or events during a project have the same interest or importance. It is necessary to select the most significant occurrences, experiences or events, and to translate them into proposed lessons learned.

4.3.3 Validation and acceptance of the selected lessons learned

The lessons learned cases or events to be recorded in the database should be reviewed, validated and accepted (approved) by a defined method, i.e. by a “lessons learned committee” or any similar organization. An assessment should be made as to the acceptability of the proposed case or event, prior to ruling on the lessons to be drawn and describing the actions needed to decrease the risk of occurrence of the problems.

The responsibility for, and frequency of, examining potential lessons learned should be defined.

4.3.4 Classification of the selected lessons learned

After acceptance, the classification of selected cases should be completed with appropriate key words or phases.

4.3.5 Recording of the selected cases

Before recording, the proposal should be checked. After validation, the database should be updated.

4.3.6 Recommendation of applicable lessons learned to a new project

The selected applicable lessons learned should be collected in reference documents, or included in standard documents.

4.3.7 Measurement or assessment of the results of the lessons learned process

Lessons learned results should be assessed in terms of costs, schedules and technical performance.

5 Content of the lessons learned record

5.1 General

The lessons learned record should contain at least four parts:

a) a brief description of the experience or event;

b) one or more lessons that may be taken from the experience or event;

c) for each lesson, one or more associated recommendations, in order to prevent a recurrence of the associated negative experience or to promote or enhance the recurrence of the associated positive experience;

d) for each recommendation accepted under 4.3.3, actions to be performed to implement the recommendation.

5.2 Detailed content

5.2.1 General

The detailed content in 5.2.2 to 5.2.4 is recommended for the lessons learned record.

5.2.2 Background of the root event

This part of the record should include the following:

— a heading intended for reference (fact);

— a synthesis of any investigations carried out;

— an analysis of the causes (possible, probable and proven) and the consequences (immediate, future and potential);

— the resulting actions directly taken.

5.2.3 The lessons learned

This part of the record documents the immediate knowledge drawn directly from the experiences associated with the causes or consequences of the root event.

NOTE Several lessons learned can be drawn from a root event.

5.2.4 Resulting recommendations and actions

This part of the record documents actions recommended to mitigate or eliminate the negative experiences or to promote or enhance the positive experiences of the root event. It may include more general or further-reaching recommendations to encompass a broader range of situations (e.g. changes to rules, standards or future contracts).

NOTE Several recommendations can be drawn from a lesson learned.

6 Lessons learned implementation

6.1 General

The lessons learned process can be implemented by using the formats provided in Annex B and Annex C.

The generic form (see Annex B) is suitable for documenting multiple lessons learned from a single root event, which in turn lead to one or more recommendations.

The short form (see Annex C) is best suited for documenting a single lesson learned and recommendation leading from a root event.

6.2 Application

Lessons learned should be applied during the following programme or project activities:

a) processing of the successes, incidents and nonconformities;

b) processing of modifications;

c) design or other reviews.

The supplier should establish a schedule for lessons learned activities in the early project-planning stages.

6.3 Responsibility

Responsibility for the lessons learned process of a project should be clearly assigned.

7 Effectiveness of the lessons learned process

Participant surveys and project audits, as well as measured indicators (e.g. the number of queries of the database, the number of lessons learned cases originating in a project, and the number of applications of recommendations issued from the lessons learned process), will help evaluate the effectiveness of a lessons learned process. The need for specific measured indicators should be considered in the initial design of a lessons learned database.

The assessment of the effectiveness of the lessons learned process in a given project should be part of the project evaluation after completion.

Annex A
(informative)

Lessons learned process

The practical lessons learned process is performed in three steps (see Figure A.1):

a) the **background** of the experience, in which the following are described in detail:

— the report of the fact;

— the analyses which comprise the identification of the causes (possible, probable and proven) and the consequences (immediate, future and potential);

— the resulting actions;

b) **lessons learned**, which are lessons drawn from the experience;

c) **recommendations** which are applicable to new projects (impact on documentation, impact on product).

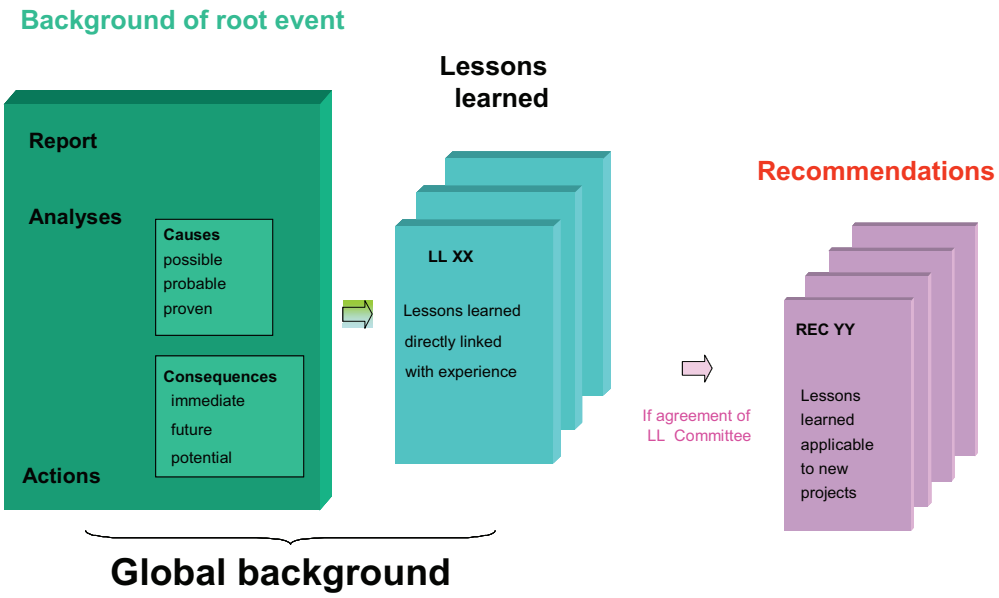

Figure A.1 — Lessons learned process

Annex B
(informative)

Generic lessons learned forms

The generic forms illustrated in Figures B.1, B.2 and B.3 are suitable for documenting multiple lessons learned from a single root event, which in turn lead to one or more recommendations.

1. NAME OF ORGANIZATION: **Contact information:**	**2. ROOT EVENT N°:** **Approval date:** **Approval:**
3. SUBJECT/TITLE/TOPIC(S):	
4. DESCRIPTION OF THE ROOT EVENT:	
5. ANALYSIS OF THE CAUSES: a) **Possible causes:** b) **Probable causes:** c) **Proven causes**:	
6. ANALYSIS OF THE CONSEQUENCES: a) **Immediate consequences:** b) **Future consequences:** c) **Potential consequences:**	
7. RESULTING ACTIONS:	

Instructions for completing root event background form:

Block 1: Enter the name and contact information of the submitting organization, company or agency.

Block 2: Enter the root event N°, the date of approval and approval name.

Block 3: Enter the name of the subject, title or topic of the lessons learned.

Block 4: Enter a complete description of the root event.

Block 5: Enter the results of analysis of causes (possible, probable and proven) of the root event.

Block 6: Enter the results of analysis of consequences (immediate, future and potential) of the root event.

Block 7: Enter the resulting actions.

Figure B.1 — Root event background form

1. NAME OF ORGANIZATION: **Contact information:**	**2. LESSONS LEARNED N°:** **ROOT EVENT N°:** **Approval date:** **Approval:**
3. SUBJECT/TITLE/TOPIC(S):	
4. DESCRIPTION OF THE LESSONS LEARNED:	

Instructions for completing lessons learned form:

Block 1: Enter the name and contact information of the submitting organization, company or agency.

Block 2: Enter the lessons learned N°, the root event N°, the date of approval and approval name.

Block 3: Enter the name of the subject, title or topic of the lessons learned.

Block 4: Enter a description of the lessons learned (technical, management, documentation, etc.) that are drawn from analysis of the root event.

Figure B.2 — Lessons learned form

1. NAME OF ORGANIZATION: **Contact information:**	**2. RECOMMENDATION N°:** **LESSONS LEARNED N°:** **ROOT EVENT N°:** **Approval date:** **Approval:**
3. SUBJECT/TITLE/TOPIC(S):	
4. RECOMMENDATIONS:	
5. ACTIONS: a) **Impact on documentation:** b) **Impact on product/equipment:**	

Instructions for completing recommendations form:

Block 1: Enter the name and contact information of the submitting organization, company or agency.

Block 2: Enter the lessons learned N°, the root event N°, the date of approval and approval name.

Block 3: Enter the name of the subject/title or topic of the lessons learned.

Block 4: Enter the recommendation drawn from a lesson learned that will prevent a recurrence of an associated negative experience or promote or enhance the recurrence of an associated positive experience.

Block 5: Enter the actions required to implement the recommendation.

Figure B.3 — Recommendations form

Annex C
(informative)

Short lessons learned form

The short form illustrated in Figure C.1 is best suited for documenting a single lesson learned and recommendation leading from a root event.

1. NAME OF ORGANIZATION: **Contact information:**	**2. LESSONS LEARNED N°:** **Approval date:** **Approval:**
3. SUBJECT/TITLE/TOPIC(S):	
4. DESCRIPTION OF THE EVENT:	
5. LESSONS LEARNED:	
6. RECOMMENDATIONS:	
7. ACTIONS:	

Instructions for completing short lessons learned form:

Block 1: Enter the name and contact information of the submitting organization, company or agency.

Block 2: Enter the lessons learned N°, the date of approval and approval name.

Block 3: Enter the name of the subject, title or topic of the lessons learned.

Block 4: Enter a description of the lesson-learned root event.

Block 5: Enter the lessons learned that have been drawn from the event.

Block 6: Enter the recommendations that will prevent the recurrence of an associated negative experience or promote or enhance the recurrence of an associated positive experience.

Block 7: Enter the actions required to implement the recommendations.

Figure C.1 — Short lessons learned form

Bibliography

[1] ISO 9001, *Quality management systems — Requirements*

[2] ISO 17666, *Space systems — Risk management*

ICS 49.020; 49.140

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