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# INDICATORS DEVELOPMENT FOR ASSESSMENT OF AIRNAVIGATION SYSTEM ELEMENTS OPERATIONAL SAFETY AND ENVIRONMENT DEFINITION

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*There were developed indicators for assessment of airnavigation system elements operational safety and environment definition.*

**Key words:** safety assessment methodology, operational safety and environment definition, functional hazard assessment, preliminary system safety assessment.

## Problem setting

Safety assessment methodology in airnavigation systems (Safety Assessment Methodology – SAM) was developed for reflection of efficient safety assessment ways in airnavigation systems and for instructions development in their implementation.

Safety assessment methodology describes the general process of safety assessment in airnavigation systems.

Operational Safety and Environment Definition (OSED) describes the operational concept, defined in the detailed operational description (DOD) within the area of operation.

This level defines the operational service, functional environment, scenarios, methods of application and requirements for usage. Level OSED is used as the basis for achieving the requirements for performance, safety, characteristics and interactions of adjacent systems. The data will be detailed in the requirements for safety (at SPR level - Safety and Performance Requirements). Level OSED defines service and includes procedural "expectation" of adjacent systems [4].

## Analysis of investigations and publications

Safety assessment process consists of three main steps:

- functional hazard assessment ( FHA)
- preliminary system safety assessment (PSSA)
- system safety assessment ( SSA).

Relationship between the main phases of the system life cycle is shown on Figure 1 [2].

Safety assessment methodology describes the principles of safety assessment process and does not take into account the details of the application of these principles, because they need to be determined for each separate project.

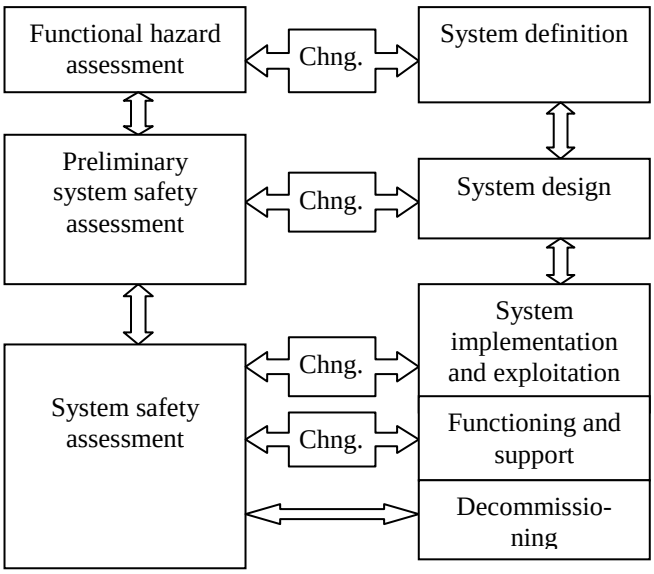


Fig.1. Interconnection between safety assessment process and full system life cycle

Methodology for safety assessment in airnavigation systems should demonstrate that safety management is realized at least on a minimum level approved by the government ("tolerant risk"). The purpose of SAM is to support airnavigation service providers in achieving of an acceptable level of safety. [3]

Safety assessment methodology in airnavigation systems is established in accordance with ESARR 4 (EUROCONTROL Safety Regulatory Requirement) [1].

**Purpose** of the work is development of indicators to assess operational safety and environment definition for airnavigation system elements.

## Indicators development

Safety assessment methodology that is applicable to aeronautical systems focused on three types of elements: human element, equipment and procedures, and their interaction (inside the system and in environment, in which the system works). Process of safety assessment is shown on Figure 2.

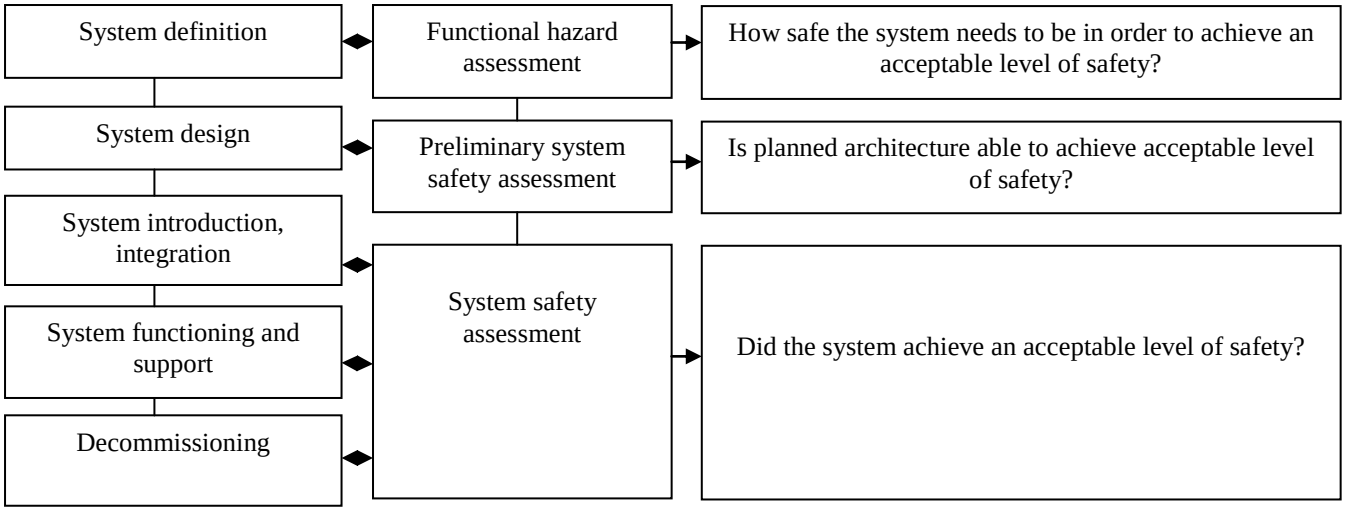


Figure 2 Safety assessment process

Safety assessment methodology for air traffic management ensures the creation of manual for:

- risk management processes;
- establishing safety requirements;
- documentation and processes for system safety assessment.

Safety Criteria (SAC) defines what is considered acceptably safe for changes implemented in the vicinity of OFA (Operational Focus Area). Process safety assessment is carried out in three stages: V1, V2 and V3. On the example of the system development within the program SESAR (Single European Sky ATM Research) each of the stages can be divided areas of responsibility of each of the stages as follows:

- V1: operational concept limits and legalization plans development;
- V2: re-development and assessment of the concept for technological supply;
- V3: construction, reinforcement and testing.

Safety criteria defined during phase V1 through safety assessment and presented on the stage of determining the operational safety and environmental performance. During the progress of the project to V2 will be achieved safety objectives (SOs). At the level of safety requirements (SPR) are defined safety requirements, which should satisfy safety aims. Physical realization of the project is conducted on the stage V3. This stage is delivered through safety requirements in relation to the human element of the system, and technical specifications in regards to the technological elements. Relationship between safety requirements at different levels of system assessment is shown on Figure 3 [3]

On the basis of documents developed at SJU (SESAR Joint Undertaking) were established seven indicators for system assessment on the OSED level. First of all, on the level of operational safety and environment definition of air navigation systems it is necessary service, their environment, usage scenarios and requirements. OSED level is used as a basis for the evaluation of operational requirements and the subsequent establishment of safety requirements. Indicators for evaluation of the level OSED is shown in Table [3].

In the detailed operational description on the OSED level should be described activities of pilots, air traffic controllers and systems, which they are using without the proposed improvements, as well as a starting point, that is the thing from which you should continue. Further development of the system involves the creation of next OSED, but the starting point will be determined prior OSED. Description of the current state of the system may also include procedures.

The section should be given a complete description on how the pilot, air traffic controller and system used work in the implementation of the improvement, to which corresponds this OSED. It is necessary to explain the main differences in the operation of current and future systems.

OSED section entitled "Detailed operational environment" is created in order to provide information about basic operational and technical characteristics of the system. Operational characteristics should include principles, limitations and assumptions about the

operation process, in particular, airspace characteristics, characteristics of traffic separation minima etc. In this section should also be specified degree of responsibility of each person that is included in the air traffic management system (pilots, air traffic controllers).

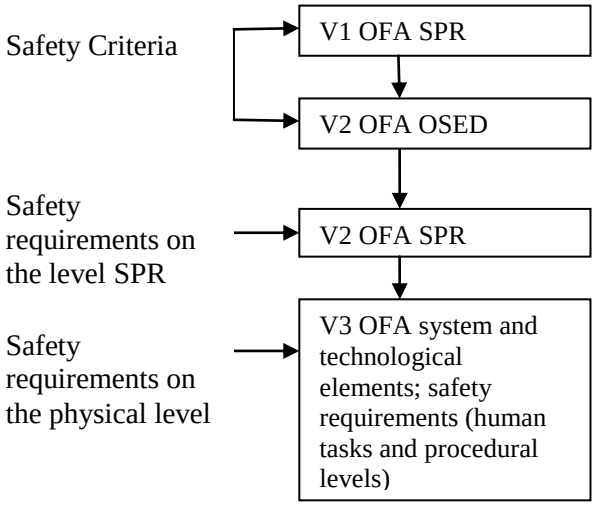


Figure 3 Interconnection between safety requirements on different levels

A necessary component of OSED is description of usage cases. Should be described as nominal situations (normal system operation without errors) as well as non nominal (work in case of failure of one of the elements, situations, to which could lead abnormal case and ways of their solution) [4].

The section shall include functional and quantitative requirements for each type of service. In order to achieve interaction between services, consolidation process is necessary. Consolidation requires creation of a set of requirements for the system, from which are excluded repetitions, omissions and conflicting requirements. Requirements for process (service) should also be defined. In case when operational services interact, a set of requirements should include requirements for the interaction between types of services. It is necessary to take into account that the indicators that are created within OSED, are largely qualitative in nature and will be converted to a quantitative on the level of safety requirements. In the annexes to the developed OSED must be given all the necessary explanation in relation to requirements.

Indicators on level OSED

| Indicator number | Description | Quality indicator | Quantity indicator |
|---|---|---|---|
| 1 | **OSED purpose and scope.**<br>Define that purpose of OSED is description of the operational concept defined in the Detailed Operational Description (DOD) in the scope of its Operational Focus Area (OFA). Indicate which Operational Focus Area (OFA) is addressed by this OSED. Necessary to add information on which part of the OFA this OSED is addressing.<br>Refer to SESAR OSED template (Par.1). | Good ☐<br>Satisfactory ☐<br>Requires action ☐ | 1<br>0,5<br>0 |
| 2 | **Summary from DOD (detailed operational description).**<br>Detail description of the operational concept in the scope of the addressed Operational Focus Area. List of the Operational Improvement steps, list of relevant DOD scenarios and use cases, list of relevant DOD environments and list of DOD requirements.<br>Refer to SESAR OSED template (Par.2). | Good ☐<br>Satisfactory ☐<br>Requires action ☐ | 1<br>0,5<br>0 |
| 3 | **Process & services.**<br>The purpose of this section is to ensure coherence between federating and primary projects regarding the used P&S in the OFA. This section shall be updated and refined to reflect the concept defined in the DOD. These updates would then need consolidation. | Good ☐<br>Satisfactory ☐<br>Requires action ☐ | 1<br>0,5<br>0 |

| | | | |
|---|---|---|---|
| | Refer to SESAR OSED template (Par.2.3). | | |
| 4 | **Detailed Operating Method.**<br>Description of previous operating method and new SESAR operating method. Explanation of differences.<br>Refer to SESAR OSED template (Par.3). | Good ☐<br>Satisfactory ☐<br>Requires action ☐ | 1<br>0,5<br>0 |
| 5 | **Detailed operational environment**.<br>Description of principles, limitations and assumptions relevant to the operational process / service description. Description of who is involved in the use of Operational Process(s). Identification of the technical constraints that might impact the concept or the solution.<br>Refer to SESAR OSED template (Par.4). | Good ☐<br>Satisfactory ☐<br>Requires action ☐ | 1<br>0,5<br>0 |
| 6 | **Use cases.**<br>New or more elaborated scenarios / Use Cases describing nominal and non-nominal situations should be added, including:<br>– error reporting,<br>– recovery needs,<br>– procedures to be followed.<br>Refer to SESAR OSED template (Par.5). | Good ☐<br>Satisfactory ☐<br>Requires action ☐ | 1<br>0,5<br>0 |
| 7 | **Requirements.**<br>Requirements for process, the operational requirements associated with an information exchange. Necessary to state SAC (safety criteria) and SO (safety objectives).<br>Refer to SESAR OSED template (Par. 6). | Good ☐<br>Satisfactory ☐<br>Requires action ☐ | 1<br>0,5<br>0 |

As it is known, there are four types of documents (Figure 4), which define the concept of the air navigation system's elements functioning within the SESAR [3].

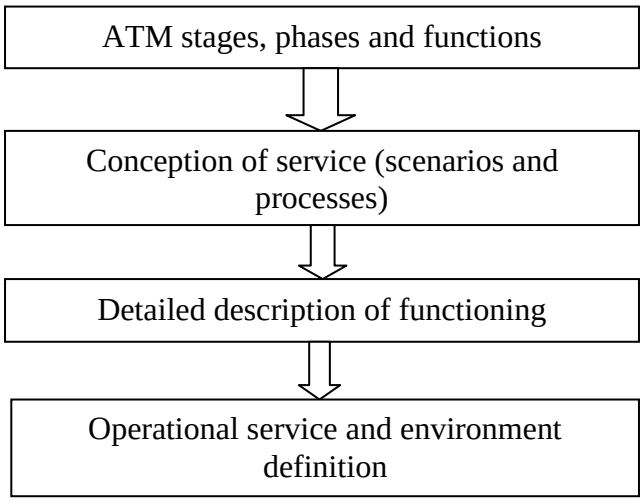


Figure 4 Documents which define the concept of the air navigation system's elements functioning

Each of the seven indicators listed in the table contains a volume of necessary information that is required or desirable for each document OSED. According to the scale given in the table, each of these indicators can be estimated on 1 point (well - there are all necessary components, no need for further editing), 0,5 points (satisfactory - for this stage of the air navigation system element this option can considered as acceptable) or 0 points (requires action - not included one of the mandatory paragraphs or main part of the necessary elements and therefore in the next edition OSED it is necessary to append this information). To assess specific example of OSED (eg project SESAR 5.6.4 Tactical en-route flow management) it is necessary to assess the relevant elements according to developed indicators and calculate the amount of points received. It is clear that the maximum amount that can be set for a specific OSED is 7 points.

Except list of necessary elements, which are included in indicators, OSED contains two appendixes.

The first one should contain information on the distribution of safety requirements, assessment of planned goals. The second appendix is linked with the new information elements, models. This section describes information elements that are exchanged by participants of air traffic services in accordance with information requirements to exchange. Description of information element shall include following elements: designator (identifier), name, description, characteristics (runway length, type of airport) rules for the application (eg aerodrome shall be equipped with at least one runway) and comments.

**Conclusions**

Safety is a condition in which the risk of harm to person or property (equipment) is reduced to an acceptable level through a process of continuous identification of hazards and risk management.

It is important to remember that hundred-percent removal of accidents and serious incidents is impossible, despite the hopes of airspace users. Errors will occur, despite the presence of the most sophisticated safety systems. It is possible to reduce the level of risk to an acceptable level, and for this it is necessary to assess safety. It is extremely difficult to assess what cannot be measured.

With the aim to measure safety level was established by Eurocontrol safety assessment methodology. Now it is believed that safety assessment methodology should include three main elements: equipment, procedures and human factor.

The main task of safety assessment methodology is to determine whether the system (elements of air navigation system) complies with established acceptable level of risk. If you want to install additional protective measures, it is necessary to determine what they should be.

Developing indicators is the first step in assessment of operational safety and environment definition of the elements of air navigation systems. The next stages are determining the levels of safety requirements and system physical implementation. The most important step is definitely the first level, because it will be based on all subsequent stages of safety assessment.

The practical application lies in the thing that the indicators can be used to assess documents OSED, which will be concerned to projects in implementation and will help to identify weaknesses and shortcomings in the structure.

**References**

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