SINGLE EUROPEAN SKY (SES) REGULATIONS

INTERMEDIATE REPORT ON THE DRAFT REGULATORY APPROACH FOR

THE DEVELOPMENT OF A RISK CLASSIFICATION SCHEME FOR THE DESIGN OF ATM

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# TABLE OF CONTENTS

**DOCUMENT CHANGE RECORD** ................................................................. 2

**TABLE OF CONTENTS** .................................................................. 3

**EXECUTIVE SUMMARY** ................................................................. 5

1. **INTRODUCTION** ........................................................................ 6
   1.1 Risk Classification Scheme Mandate ............................................. 6
   1.2 Context for the Development of Regulatory Material ..................... 6
   1.3 Document Purpose .................................................................... 6

2. **Management of the Work** ......................................................... 7
   2.1 Working Methods .................................................................... 7
   2.2 Consultation to Date ................................................................. 7
   2.3 Next Stage .............................................................................. 7

3. **The Risk Classification Scheme** .................................................. 8
   3.1 Consolidation & Harmonisation of Safety in a Total ATM Approach .... 8
   3.2 High-Level Principles of a Risk Classification Scheme .................... 9
   3.3 Continuation of Activities Harmonising Overall ATM Safety .......... 9

4. **ATM SYSTEM WITHIN THE SCOPE OF THE MANDATE** .......... 10
   4.1 ATM Functional System ............................................................ 10
   4.2 Scope of the RCS ................................................................. 12
   4.3 Conclusion on the Scope of the RCS ........................................... 13
   4.4 Total ATM System: Ground, Airborne and Space Segments .......... 13
   4.5 The Need for a Pan-European RCS ............................................ 14

5. **DEFINITION OF A RISK CLASSIFICATION SCHEME (RCS)** .... 16
   5.1 Severity Classification and Risk Classification Scheme .................. 16
   5.2 Safety Targets ...................................................................... 20
   5.3 Risk Classification Methodology ................................................. 20
   5.4 Assurance Level Approach ....................................................... 21

6. **DIFFERENCE BETWEEN RCS AND MEASUREMENT OF SAFETY PERFORMANCE** ......................................................... 24
   6.1 Acceptable Level of Safety ........................................................ 24
   6.2 Achieved Levels of Safety ........................................................ 25
   6.3 Measurement of Achieved Level of Safety .................................... 25

7. **DERIVING SAFETY TARGETS FOR ATM DESIGN** ............... 27
   7.1 Need for Apportionment in Order to Establish Safety Targets ......... 27
   7.2 Safety Targets versus Performance of the System ....................... 28
   7.3 Consistency Between Safety Target and Performance of the System ... 28

8. **VALUES OF SAFETY TARGETS** ............................................... 29
   8.1 Scope of RCS and ESARR 4 Value Severity 1 .............................. 29
   8.2 Calculation and Assumptions ....................................................... 29
   8.3 Clarification of the Aircraft and Operation Under Consideration ....... 30
   8.4 Complexity of Airspace and Amount of Air Traffic ...................... 31
   8.5 Links Between Safety Targets & Safety Performance: Closing the Loop ... 31
9. FACTORS DETERMINING THE REGULATORY .................................. 32
   9.1 Structure of the Regulatory Material ........................................ 32
   9.2 Role of the NSAs / States ......................................................... 33
   9.3 Levels of Detail of the Rule and Advisory Material ..................... 34
   9.4 Assessment of the Alternatives for a European RCS .................. 36
   9.5 Assessment of the RCS Concept ................................................. 37
   9.6 Assessment of the Scope of Application .................................... 37
   9.7 Assessment of the Achievement of the RCS Target ..................... 37
   9.8 Options Associated with the Chosen Alternative ....................... 37

10. PRELIMINARY IMPACT ASSESSMENT AND CONSULTATION .......... 42
    10.1 Stakeholders Affected .......................................................... 42
    10.2 Impact on Existing Rules ....................................................... 42
    10.3 Economic and Efficiency Impact ............................................. 42
    10.4 Impact on Advisory Material and Specifications ..................... 43
    10.5 Recommendations After Informal Consultation ....................... 43
    10.6 Choice of the Alternative ..................................................... 43
    10.7 Choice of Options ............................................................... 44
    10.8 Need for Definitions and Harmonised Terminology ................... 44
    10.9 Rates of the RCS ............................................................... 44
    10.10 Advisory Material ............................................................. 45
    10.11 Conclusion of the Consultation Process ................................ 45

11. PROPOSED REGULATORY APPROACH ........................................... 47
    11.1 Structure of the Regulatory Material ..................................... 47
    11.2 Scope and Type of Rule ........................................................ 47
    11.3 Regulatory Material to be Inserted into the Rule .................... 48
    11.4 Advisory Material ............................................................. 48
    11.5 Principles for the Regulatory Approach ................................ 49

12. REFERENCES ................................................................................. 51

13. TERMS AND ABBREVIATIONS ......................................................... 53

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EXECUTIVE SUMMARY

Within the framework of the Single European Sky Regulations, a Mandate has been issued to EUROCONTROL to support the European Commission in the development of a Risk Classification Scheme for the Design of ATM.

Commission Regulation (EC) No. 2096/2005 (Common Requirements) contains a severity classification scheme for the identification of the effects of ATM/CNS-related hazards on the safety of aircraft. EUROCONTROL Safety Regulatory Requirement No. 4 ‘Risk Assessment and Mitigation in ATM’ (ESARR 4) contains a risk classification scheme with a maximum tolerable rate for ATM directly contributing to accidents in the ECAC region.

This Intermediate Report contains the results of the first phase of work undertaken on the tasks required by the Mandate. An analysis of the subjects that will be covered by the proposed regulatory material is included, as well as proposals for the selected regulatory approach.

A RCS is a risk based approach aiming at a harmonised Pan-European framework for safety assessment and mitigation and helps to answer the questions: what are the worst credible effects on operations? Are those effects tolerable? If yes, at which likelihood?

The RCS helps to estimate, as objectively as possible, if the changes to the ATM Functional System are tolerably safe by providing a framework in order to:

- design ATM functional systems,
- perform the safety assessment and mitigation of changes in ATM,
- provide criteria to support risk mitigation and actions to prevent risk.

Extensive informal stakeholder consultation has been conducted to support examination of the alternatives prior to the final proposal of a regulatory approach. The regulatory approach proposes that regulatory material should be developed at two different levels of prescription which should be composed of:

- a regulation, dedicated to the definition of a RCS and associated high-level principles of prescriptive material,
- advisory material, whose contents should include the necessary detailed guidelines for the use of RCS by National Supervisory Authorities (NSAs) or by Air Navigation Service Providers (ANSPs).

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1. INTRODUCTION

1.1 Risk Classification Scheme Mandate

Within the framework of the Single European Sky (SES) regulations, a mandate has been issued to EUROCONTROL to support the European Commission (EC) in the development of a Risk Classification Scheme (RCS) for the design of Air Traffic Management (ATM).

The scope of this mandate is to propose draft regulatory material to ensure that the risks associated with hazards stemming from any new implementation, or a change to the ATM functional system, are systematically and formally identified, assessed and managed, within acceptable levels, prior to introduction into operational service.

1.2 Context for the Development of Regulatory Material


Safety is an integral part of ATM and the SES initiative. The development of common safety rules will enhance European safety levels and contribute to the success of the SES initiative, while also contributing to the uniform quality of services to citizens, transparency and the achievement of a level playing field for all service providers.

The Common Requirements contain a severity classification scheme for the identification of the effects of ATM/CNS related hazards on the safety of aircraft. ESARR 4 contains a risk classification scheme with a maximum tolerable rate for ATM directly contributing to accidents in the ECAC region (i.e. severity class 1: the most severe, leading to an accident). Maximum tolerable rates for severity classes 2 (serious incidents) to 5 (less severe occurrences) have still to be developed. In accordance with Recital 16 of the Common Requirements, EU Member States and the EC, acting together with EUROCONTROL, should complete and update those values.

1.3 Document Purpose

This Intermediate Report is one of the major deliverables required by the EC Mandate. It contains the results of the initial work undertaken on the tasks required by the mandate, as specified in the Initial Plan. An analysis of the subjects which will be covered by the regulatory material is included, as well as the assessment of a number of alternatives in determining a proposed Regulatory Approach.

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2. MANAGEMENT OF THE WORK

2.1 Working Methods

In accordance with the Initial Plan related to this Mandate, EUROCONTROL established:

- A group of technical experts – the RCS Technical Working Group – whose tasks include the drafting and technical development of the regulatory approach, the regulatory material, the justification material and related impact assessments.

- A stakeholder consultation mechanism – the RCS Focal Points Group (FPG) – comprising a geographically wide range of representatives of National Supervisory Authorities and Air Navigation Service-Providers, as well as representatives of airspace users and manufacturing industry.

- An internal review mechanism – the RCS Review Group – whose role is to review key deliverables of the mandate work to ensure compliance with the mandate, and consistency with the general principles of mandate development undertaken by EUROCONTROL on behalf of the EC.

2.2 Consultation to Date

Following development of initial material to support the Regulatory Approach, a wide range of different aspects relating to the application of regulatory material in this field were identified. These included clarification of the role and purpose of the scope of application of the RCS as well as the scope of application and the degree of specification that the regulatory material should contain.

In a significant number of areas, different alternatives and options have been identified, each of which has required evaluation and assessment prior to final proposals being made. These have been the principal areas of discussion of the FPG, as well as the subject of exhaustive consultation (with FPG) by means of a questionnaire.

In accordance with the Initial Plan, this questionnaire was sent to the Focal Point Group on the 9th January 2007, with replies received back on the 21st February 2007. Chapter 7 of this report presents the framework of this consultation and the results which were obtained.

This method worked well, with a high rate of response giving a good level of information from which to draft the main features of the regulatory structure addressing the RCS, with high confidence in the proposals being made.

2.3 Next Stage

The next stage in the development of the regulatory material will be the:

- development of the rule itself,
- development of advisory material dealing with the implementation of the RCS for different types of service provision,
- development of justification material,
- formal consultation on the rule.
3. THE RISK CLASSIFICATION SCHEME

3.1 Consolidation and Harmonisation of Safety in a Total ATM Approach

Safety is the first priority in aviation and safety regulation is a key process for establishing, overseeing and enforcing safety levels in the public interest. National Supervisory Authorities (NSAs) bear a national responsibility for the safety of operations within their national airspaces. Whilst Air Navigation Service Providers (ANSPs) have prime responsibility for providing services based on systems which have been designed safely, the definition of harmonised ATM safety levels represents a specific responsibility for NSAs, States and/or authorities (as applicable).

The safety regulatory community in Europe has identified the need for urgent actions in the areas of, inter alia, safety management, risk assessment and mitigation and monitoring of safety levels in ATM. The experience drawn from the application of ESARR 4 has raised several issues with regard its quantitative aspects. The development of the RCS mandate presents an opportunity to clarify and improve this specific part of the safety risk assessment and mitigation approach.

The safe design of any system relies on the implementation of solutions aimed at eliminating potential risks, controlling the consequences of potential risks to a tolerable level and reducing uncertainties. The RCS is an approach to achieve these aims and is applied throughout the life cycle of the system. The solutions chosen are determined by estimating the consequences of the hazard(s) on the system and balancing the risk of the occurrence of an undesirable event against the possible benefits.

RCS is currently used to support this process within other aviation sectors (e.g. airborne systems) and other safety-related industries (e.g. the nuclear industry). Once developed in ATM at a pan-European level, it will provide an input to harmonise the way to design ATM systems safety and to maintain and improve their safety.

However, whilst ANSPs’ initiatives are essential pre-requisites for the design of tolerably safe ATM systems, they are not in themselves sufficient to ensure that the objective of “tolerable safety” will be achieved. Experience has shown that the principles which are vital to the achievement of this objective, both now and in the future, require to be applied with legal effect through regulatory mechanisms. ATM stakeholders agree on the added value of such a regulatory policy applied to the safety of ATM functional systems, and have stressed the benefits of a quantified approach.

This mandate is an important opportunity to better harmonise safety risk assessment and mitigation practices of ATM design within a Total System Approach which includes ground, airborne and spatial segments. The RCS is therefore a step forward in the integration of safety of those segments.
3.2 **High-Level Principles of a Risk Classification Scheme**

The estimation of safety with regard to the RCS development relies on the combination of the overall probability, or frequency of occurrence of a harmful effect induced by a hazard, and the severity of that effect. This combination is the “risk”. Therefore, the safety of any system needs to be assessed in terms of the harm which must be prevented and the rates at which this harm can be tolerated to occur.

This rate can be set on the basis of past experience, historical data and expert judgment, but other factors should be taken into account, such as the estimation of traffic growth in the next decades. All the elements contributing to the definition of the RCS should be agreed and justified in order to ensure harmonisation at European level. In that context, the establishment of a pan-European Safety Target for the design of the ATM functional system represents an international commitment to the convergence towards common and measurable practices, avoiding discrepancies in levels of safety within European service-provision.

The EC Common Requirements:

- entrust to States the application at national level of European safety requirements for ATM systems.
- Define a qualitative categorisation of severity, based on an evaluation of the effects of the harm to the total ATM system,
- Provide a reference against which States may implement measures to enhance safety, or take other appropriate measures to improve it.

However, more detailed regulatory actions are needed in order to achieve effective and measurable risk assessment and mitigation against harmonised safety levels within a Total System Approach. This is a first step towards converging safety rates between ATM and airborne systems.

3.3 **Continuation of Activities Harmonising Overall ATM Safety**

Previous work in this field has applied the above concepts within particular aspects of ATM operations, such as the planning and design of certain changes to the ATM system, including the airborne segment.

There is now a need to carry on such work within a Total System Approach. The increased integration of airborne and ground systems has already led to a more consistent and harmonised way to take into account the risk assessment and mitigation process.

The definition of a RCS is therefore an essential pre-requisite. It not only enables a harmonised approach to ATM system design, but also provides a basis for the harmonisation of the risk mitigation strategies. Application of RCS on a pan-European basis and within segments of ATM is therefore as essential step in meeting regional safety objectives.
4. ATM SYSTEM WITHIN THE SCOPE OF THE MANDATE

The RCS Mandate, para. 5.1(1) states …

The requirements for risk assessment and mitigation with regard to a new system or changes to an existing system (part 3.2 of Annex II of the Common Requirements) apply to the ATM functional system and supporting arrangements under the managerial control of the ATS/CNS-provider (ATS, ATFM, ASM and CNS). Additionally, it will be assessed whether or not similar requirements would be applied to other services; taking into account the applicability of the Common Requirements and the ESARRs to those types of ANS providers (MET, AIS).

This requirement of the Mandate expresses the need to better define some fundamental notions and terms, as well as the relationships between the various entities and functionalities which are aiming to provide ATM services. In particular, certain concepts have to be clarified in the context of the regulatory material prior to the establishment of quantified targets. These include:

- ATM system: Ground, airborne and spatial segments.
- ATM Functional System and supporting arrangements and,
- The relationships between ANS and CNS service provision and MET, AIS, ATFM and ASM.

According to the Common Requirements,

…providers of Air Traffic Services and CNS providers shall ensure that hazard identification, as well as risk assessment and mitigation, is systematically conducted for any change to those parts of the ATM functional system and supporting arrangements within his managerial control, in a manner which addresses the airborne, ground and spatial components of the ATM functional system. These safety assessment and mitigation activities shall be performed through co-operation with responsible parties. This process shall take into consideration equipment, procedures and human resources of the ATM functional system, the interactions between these elements and the interactions between the constituent parts under consideration and the remainder of the ATM functional system.

4.1 ATM Functional System

The ATM functional system is defined as ‘the set of systems, procedures and human resources organised to perform a function within the context of ATM. It includes ATFM, ASM and the need to use information provided by MET and AIS’.

SES regulations do not define the term “function”, and while ICAO documentation uses the term in numerous places without giving a specific definition, a definition can be inferred. According to ICAO, ‘Air Navigation Services’ comprises ATM, Communication / Navigation / Surveillance (CNS) and other services. In turn, each of these services can be broken down into elements aimed at providing certain parts of those services.

The term ‘function’ (CNS function or CNS/ATM function) is used to denote these elements. The term ‘function’ therefore addresses parts of the ATM which are combined to support a service provision. A single function (for instance ASM) cannot systematically provide ATM services, and an ATM service can therefore be considered to rely on a combination of functions.
The terms “ATM Functional System” in SES regulations and “ATM system” in ESARR 4 therefore address the same object.

In order to better understand the concept of “ATM functional system” the following diagram (from the OATA project) identifies a structure distinguishing the systems involved in air traffic operations from those identified variously as “support”, “provided data” or “shared element”. This figure is only an example of the numerous components of the ATM system which are interconnected in order to provide the required services. The exhaustive list of the components of an ATM system cannot be fully described here, and this diagram has therefore been used to illustrate the main components which combine to create/enable ATM service provision.

![Diagram](image.png)

**Figure 1: Example of various components of ATM Functional System (as described in OATA Project)**

However, EC Regulation 552/2004 does identify a list of technical systems for air navigation services which are part of the EATMN and which support service provision:

1. Systems and procedures for airspace management.
2. Systems and procedures for air traffic flow management.
3. Systems and procedures for air traffic services, in particular flight data processing systems, surveillance data processing systems and human-machine interface systems.
4. Communications systems and procedures for ground-to-ground, air-to-ground and air-to-air communications.
7. Systems and procedures for aeronautical information services.
8. Systems and procedures for the use of meteorological information.
9. The ATM functional system relies on those technical systems, but also includes procedures and human resources (in accordance with the relevant definition in the Common Requirements).
However, it should be noted that, according to the Common Requirements (Annex II, §3.2.1), the safety risk assessment and mitigation process shall be performed on ATM functional system within the managerial control of the ANSP. Therefore the functions of the ATM functional system should be:

- submitted to certification in the scope of the Common Requirements, and,
- interfaced with those functions which are not submitted to certification, because they are (or could be) provided externally and they are out of the scope of the Common Requirements (ATFM, ASM, AIS and MET).

### 4.2 Scope of the RCS

According to the SES Framework Regulation (EC Regulation 549/2004), ANS comprise air traffic services; communication, navigation and surveillance services; meteorological services for air navigation; and aeronautical information services.

The RCS applies to ANS; but it is necessary to consider which parts of the ATM functional system contribute to the calculation of the Safety Targets in order to ensure that those targets are, and remain, valid for the service provision. Indeed, the validity of the RCS’s applicability to ANS relies on the quality of the data, including externally provided data, contributing to the calculation of the RCS Safety Targets and the control of this quality is ensured through the safety oversight made by NSAs.

Those RCS Safety Targets should be traceable to the intended functions within the ATM functional system when used to allocate a severity class and/or mitigate a risk. If the Safety Targets of the RCS are not valid, the safe operation of the ATM functional system would itself not be valid.

Accidents can have a contribution from any part of the ATM functional system. As examples, ASM and ATFM can all contribute to an accident, as well as corrupted information from MET and AIS (these examples are discussed further below). While some functions are exempted from certification/designation, all functions are subject to applicable safety regulatory requirements, and their oversight by the NSA is foreseen by the Commission Regulation establishing a NSA safety oversight function.

**ATFM and ASM**

In the specific cases of ATFM and ASM functions it is concluded that:

- ATFM and ASM are exempted from certification/designation, but are subject to the application of safety regulatory requirements and oversight by NSAs on the basis of safety regulatory requirements identified in “Regulation Establishing a Safety oversight function”.

Provisions and changes in ATFM and ASM could impact the safety of ATM system. Being within the ATM functional system, such changes are subject to hazard identification and risk assessment and mitigation, though the legal basis for this is not totally harmonised at European level because only national rules should apply to those functions.

The respective implementing rules for ASM and ATFM have identified specific safety requirements applying to these functions, which apply irrespective of the national or international institutional arrangements by which these functions support service-provision.
**AIS and MET**

In the specific cases of AIS and MET services, it is concluded that:

- AIS and MET are subject to Annex III and IV of EC Regulation 2096/2005.
- The provision of data to ANS is maintained in accordance with international rules defined by ICAO. In particular, AIS and/or MET service providers shall ensure the quality of their data provision (i.e. timely delivery, update, integrity and accuracy) which is subject to oversight by their respective NSAs.
- At the same time, information from these services is made available to providers of ATS and, according to the Common Requirements, those providers shall confirm the level of quality and accuracy of the information received.
- According to the Common Requirements, MET and AIS service providers are under the supervision of their respective NSA’s. As these are not necessary the same entity, arrangements at NSA level are required in order to define the safety levels required to ensure the safe provision of the ATM services.
- The Safety Targets of the RCS take into account the failure rate of external provision of data.
- The RCS is built taking into account a certain level of quality of service provision by external providers. However, the RCS does not itself apply to AIS and MET. In the case of a non-conformity with the required safety levels by external providers, adequate measures should be foreseen to protect the ATM service provision from safety problems caused by external data. The RCS should define Safety Targets which take into account this protection.

### 4.3 Conclusion on the Scope of the RCS

The description above aims to clarify the scope of the RCS within the ATM functional system. In conclusion, the RCS will apply to ANS which rely on the ATM functional system, including CNS, ASM and ATFM functions.

The RCS does not apply to AIS and MET service provision. However, the contribution of AIS and MET to overall ATM safety is included in the calculation of RCS Safety Targets, except for those AIS or MET induced accidents which do not have ATM implications.

### 4.4 Total ATM System: Ground, Airborne and Space Segments

The increased integration of ATM functions, especially between aircraft and the ground, implies that the aircraft is no longer autonomous and should be considered as an enabler to ATM in any risk assessment and mitigation process.

Hazards usually result from a chain of events and any part of the air navigation service can participate in this chain of events. Therefore, some hazards will result from a combination of failures/errors originating from both the airborne and ground segments of the ATM system.
The Total ATM System, comprising ground-based, airborne and space-based ATM components, is considered as one part of the ATM Functional System. Some changes to the ATM Functional System may not have a direct interaction with the airborne or space segments. In such cases, there will only be a need to show that no such interaction exists.

Each State is responsible for the safety of its national airspace; this includes the specification and promulgation via the national AIS of the required aircraft equipage to fly in the national airspace and related airspace classes.

The overall safety of the airspace is related, inter alia, to the level of equipage and adequacy of operations of aircraft flying into that airspace. If aircraft fly into a specific class of airspace (e.g. 8-33kHz or RVSM airspace) without being equipped according to equipment/performance requirements, they jeopardise the safety of this airspace, and therefore the safety of all other aircraft flying into that airspace.

A Total System Approach is therefore essential to the management of safety in aviation. The implications are that:

- Any risk mitigation strategy should be developed and validated in a co-ordinated manner, involving all stakeholders involved in the implementation of a change to the national ATM Functional System, so that the safety requirements bearing on the various parts of the ATM Functional System are feasible, effective and consistent,
- Potential ATM-related safety requirements bearing on the aircraft segment (be it equipage or operations) should then be promulgated in Aeronautical Information Services by the State having sovereign jurisdiction over that airspace,
- NSAs should verify that adequate co-ordination has taken place between the ATM service provider(s) and other stakeholders, not only during requirement development and validation, but also during design, implementation and commissioning. NSAs should also verify that provisions have been made for continuing co-ordination to take place, specifically for future modifications and for on-going monitoring of the ATM Functional System,
- NSAs should also verify the consistency of what is being promulgated via AIS with the safety requirements included in the safety argument/safety assurance documentation.

ATM safety regulators should co-ordinate related safety oversight activities, to the extent feasible, with the national authorities responsible for issuing airworthiness certificate(s) and operational approval(s) for aircraft/operators flying into the national airspace.

4.5 The Need for a Pan-European RCS

Errors in the design, operation, maintenance or failures of the ATM Functional System could, through a decrease in safety margins, result in, or contribute to, aircraft accidents. Increasingly, more reliance and therefore a greater safety burden, is being placed upon the overall ATM system, including airborne segment in a Total System approach.
The increased interaction of ATM across State boundaries requires that a consistent and more structured approach be taken to the risk assessment and mitigation of all ATM system elements throughout the States. Accordingly, a harmonised approach to the identification, assessment and management of risk is a necessary step in ensuring high levels of ATM safety across Europe, including those States who participate in the harmonisation of ATM in Europe but who do not belong to the EU.

The ESARR 4 approach is applicable to ECAC Member States. In the SES context, however, ESARR 4 requirements are covered by EC Regulation 2096/2005. The regulatory material developed under the RCS mandate aims to complement these regulatory provisions, recognising that in order to ensure harmonisation of safety regulations, the need exists to establish a pan-European SES-based approach.
5. DEFINITION OF A RISK CLASSIFICATION SCHEME (RCS)

The RCS Mandate, para 5.1 requires that the concept of an RCS is explained and defined.

Accordingly, a RCS is a risk based approach which helps to answer the questions: what are the worst credible effects on operations? Are those effects tolerable? If yes, at which likelihood? The RCS helps to estimate, as objectively as possible, whether the changes are tolerably safe, by providing a harmonised framework in order to:

- design the ATM functional system,
- perform the safety assessment and mitigation of changes in ATM within consistent bounds by taking into account, through apportionment, the operating environment of the system within the ATM design process.

The RCS itself provides:

- required Safety Targets as thresholds not to be exceeded when designing the system,
- the way to use it in safety assessment and mitigation process.

In an RCS, a Table is used to associate the severity of an effect with the maximum allowable rate of its occurrence in order to quantify a tolerable level of risk. This rate is called a Safety Target. The FPG considered the question of whether an RCS is just a Table/Matrix providing rates associated to the potential impact of ATM failures, or a methodology, and concluded that the RCS is more than just a table - it is a structured approach which aims at classifying the risk. It is not a safety assessment methodology per se.

5.1 Severity Classification and Risk Classification Scheme

The Severity Classification is the means by which the magnitude of the effects of hazards on flight operations are ranked or graded. In ESARR4, the Severities are ranked from 1 (most severe) to 5 (least severe).

A Severity Classification Scheme usually provides examples of the hazardous effects which are to be considered in each severity class. An example of such a scheme is shown in the table below and another example is reproduced from ESARR 4 (Table 2).

The classification of the severity of the effects of the hazard in ESARR 4 takes into consideration the effect of the hazard on:

- aircrew (e.g. workload, ability to perform their functions);
- Air Traffic Controllers (e.g. workload, ability to perform their functions);
- The aircraft's functional capabilities;
- The functional capabilities of the ground part of the ATM Functional System;
- The ability to provide safe ATM services (e.g. magnitude of loss or corruption of ATM services/functions).
As the effects of the hazard could have a very different impact on the operations, the term 'effect' should be more accurately defined. In particular, the Severity Scheme in Table 1 determines the worst credible effect, i.e. the most credible/probable\(^1\) effect of the hazard under the worst case scenario as defined by ESARR 4 [Ref SAM FHA Chapter 3 GM D &G] arising from a hazard. This notion relates to the ATM failure occurring in the most unfavourable conditions (e.g. high levels of traffic or extreme weather disruption) and that it is not unreasonable to expect such a scenario to occur in the operational environment under consideration.

The worst credible effect therefore may be used to determine the severity class during risk assessment. This approach is helpful to ANSPs in that it does not require identification of all the possible effects arising from a hazard and their probabilities of occurrence.

However, as the assessment is focused on identifying worst credible effects only, there is a need to complement this with other arguments because less severe effects which are more likely to occur, and which could constitute a greater risk, might not be identified. Therefore, the issue is that the overall risk from the hazard might not be determined completely, and if the unidentified effects happen to be in the higher severity classes this could result in the Safety Targets being set too low.

In order to avoid this problem, another approach is possible using the probability of the different effects resulting from a given hazard. In this way, the severity of the effects of hazards in a given environment of operations should be more objectively determined by, instead of the worst credible effect, using a severity classification which relies on a specific argument demonstrating the most probable effect of hazards, under the worst-case scenario. This approach has been chosen by several States, but it should be noted that the methods used in order to establish the probability (feedback from incident analysis or advices of experts) should be validated.

Both approaches are valid, but both have limitations which should be controlled.

As previously identified, the Total ATM approach is part of the regulatory framework of this mandate. In order to ensure harmonisation, the impact of an ATM failure on different ATM segments (airborne, space) needs to be developed more precisely. For instance, the classification of severity of the effect of the hazard should take into account criteria, additional to those initially identified in ESARR 4, specifically addressing the design of parts of the ATM functional system level, for instance:

- Exposure to the threat (time, possible number of aircraft exposed to the threat),
- Recovery (detection, contingency measures, delays).

---

\(^1\) ESARR 4 uses the term 'credible' and the Common Requirements (ECreg.2096/2005) uses the term 'probable'.
<table>
<thead>
<tr>
<th>Severity Class</th>
<th>1 (Most Severe)</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>No Immediate Effect on Safety</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effects on Operations</td>
<td>Accidents</td>
<td>Serious Incidents</td>
<td>Major Incidents</td>
<td>Significant Incidents</td>
<td>No Immediate Effect on Safety</td>
<td></td>
</tr>
<tr>
<td>Effect on Air Navigation</td>
<td>Total inability to provide or maintain safe service</td>
<td>Serious inability to provide or maintain safe service</td>
<td>Partial inability to provide or maintain safe service</td>
<td>Ability to provide or maintain safe but degraded service</td>
<td>No safety effect on service</td>
<td></td>
</tr>
<tr>
<td>Service within the area of responsibility</td>
<td>Workload, stress or working conditions are such that they cannot perform their tasks at all</td>
<td>Workload, stress or working conditions are such that they are unable to perform their tasks effectively</td>
<td>Workload, stress or working conditions such that their ability is significantly impaired</td>
<td>Workload, stress or working conditions are such that their abilities are slightly impaired</td>
<td>No effect</td>
<td></td>
</tr>
<tr>
<td>ATCO and/or Flight Crew</td>
<td>Total loss of functional capabilities</td>
<td>Large reduction of functional capabilities</td>
<td>Significant reduction of functional capabilities</td>
<td>Slight reduction of functional capabilities</td>
<td>No effect</td>
<td></td>
</tr>
<tr>
<td>Working Conditions</td>
<td>Unable to cope with adverse operational and environmental conditions</td>
<td>Large reduction of the ability to cope with adverse operational and environmental conditions</td>
<td>Significant reduction of the ability to cope with adverse operational and environmental conditions</td>
<td>Slight reduction of the ability to cope with adverse operational and environmental conditions</td>
<td>No effect</td>
<td></td>
</tr>
</tbody>
</table>

Table 1 – Severity Classification Scheme (Example from Integrated Risk Picture)(IRP)

(Space Left Intentionally Blank)
<table>
<thead>
<tr>
<th>Severity Class</th>
<th>1  [Most Severe]</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5 No safety effect  [Least Severe]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effect on Operations*)</td>
<td>Accidents</td>
<td>Serious incidents</td>
<td>Major incidents</td>
<td>Significant incidents</td>
<td>No immediate effect on safety</td>
</tr>
<tr>
<td>Examples of effects on Operations Include*)</td>
<td>• one or more catastrophic accident,</td>
<td>• large reduction in separation (e.g. a separation of less than half the separation minima), without crew or ATC fully controlling the situation or ability to recover from the situation.</td>
<td>• large reduction (e.g. a separation of less than half the separation minima) in separation with crew or ATC controlling the situation and able to recover from the situation.</td>
<td>• increasing workload of the air traffic controller or aircraft flight crew, or slightly degrading the functional capability of the enabling CNS system.</td>
<td>No hazardous condition i.e. no immediate direct or indirect impact on the operations.</td>
</tr>
<tr>
<td></td>
<td>• one or more mid-air collision</td>
<td>• one or more aircraft deviating from their intended clearance, so that an abrupt manoeuvre is required to avoid collision with another aircraft or with terrain (or when an avoidance action would be appropriate).</td>
<td>• minor reduction (e.g. a separation of more than half the separation minima) in separation with crew or ATC fully controlling the situation, hence jeopardising the ability to recover from the situation (without the use of collision or terrain avoidance manoeuvres).</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• one or more collision on the ground between two aircraft</td>
<td></td>
<td>• minor reduction (e.g. a separation of more than half the separation minima) in separation with crew or ATC controlling the situation and fully able to recover from the situation.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• one or more controlled Flight Into Terrain</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• total loss of flight control.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>No independent source of recovery mechanism, such as surveillance or ATC and/or flight crew procedures can reasonably be expected to prevent the accident(s).</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 2 – ESARR 4 Severity Classification: Effects on Operations
5.2 Safety Targets

In the context of the definition of the RCS, a Safety Target specifies the overall maximum frequency of the occurrence of all effects, of any type, having a given Severity Class, whatever the ATM cause.

Thus, as shown in the ‘Bow Tie Model’ (see 5.3 and fig.2 below), there is a Safety Target for each Severity Class. ESARR 4 defines the Safety Target for severity 1. In order to allow the ANSP to better control the design of the system, this value should be traceable to the overall safety performance for ATM at ECAC and national levels, by periodically evaluating the overall ATM performance at those levels. In addition, several means can be used by the ANSP to subsequently validate the tolerable/acceptable Safety Targets, for instance by using the results of continuous improvements based on feedback experience (as a result of ESARR 2 implementation).

The advantage of having quantitative Safety Targets is that they can be translated into design safety requirements for the ATM functional system in question, and they can provide a basis for subsequent safety assessment of the new system or change to the existing system. The limitation of the use of the quantitative Safety Targets is that the accuracy of the value can lead to inappropriate judgement based solely on the figures without consideration being given to other kind of arguments, including qualitative arguments, and associated evidences.

5.3 Risk Classification Methodology

The safety assessment and mitigation process is outside of the scope of this mandate, as it only deals with safety regulation and not with safety management. However, the RCS methodology is best understood in the context of a model currently used in safety assessment and mitigation processes. In order to illustrate the use of the RCS, two examples are provided in this section and in section 5.4 below.

The so-called “Bow-Tie” model has been developed and is commonly used in industrial applications as well as in aviation, and is introduced here to highlight how such a model can be used in setting Safety Targets for ATM.

The model gives a graphical representation of the risk assessment process. The left hand side represents the sources of ATM failure which can become a hazard. The right hand side represents how a hazard can have effects on different severities – depending on a range of factors, such as the conditions prevailing at the time, and the mitigation(s) available. The risk assessment process is described briefly as follows:

1) The ATM functional system is subject to a Hazard Analysis and the potential effects of the hazards are investigated for all possible outcomes in a given environment. The prevailing circumstances and/or mitigation in place will determine the outcome in each case. Some of the effects might have lesser safety significance (e.g Severity Class 4) while others could have catastrophic consequences (i.e. Severity Class 1).

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2 Refer to Sections 7.3 and 8.5 of this document.
2) The Safety Target for each Severity Class is determined prior the
development of the system. This determines the maximum tolerable
frequency of occurrence of the hazard effects.

3) The Safety Objective refers to the tolerable frequency of the Hazard itself; this
tolerable frequency may be less demanding than that of the associated effect,
if it can be shown that the effect will not occur for every occurrence of the
hazard. However, as many different hazards can lead to one category of
effect, when apportioning Safety Targets into safety objectives, safety
objectives could be more demanding than the Safety Targets.

4) The Safety Objective becomes the quantified objective for the design of the
elements of the ATM functional system which, combined together, could
contribute to this hazard. This Safety Objective is therefore considered as a
“safety budget” which needs to be apportioned to the elements of the ATM
functional system. The resulting apportionments are translated into Safety
Requirements for the system elements.

Several safety models exist so far and the RCS which is developed in this Mandate
aims to be consistent with most of safety models currently used in ATM. In the next
stages of the development of the Mandate, a comparison of existing safety models
will be provided within the justification material.

5.4 **Assurance Level Approach**

One way to cope with the different levels of severity without establishing values for
certain rates is to make a link between severity levels and the implementation of
design practices which will be established through a scale of five levels - called the
“System Design Assurance” Levels.
The example below illustrates a qualitative risk assessment methodology which can be used by an ANSP when a RCS does not require demonstration of achievement of quantitative Safety Targets. The principle of assurance levels should take into account rules for designing equipment, software, human parts of the system and procedures. As an example\(^3\), those levels could be (from the most demanding to the less demanding):

- A – Very High,
- B – High,
- C – Medium,
- D – Minor,
- E – Demonstration of no negative effect.

And the process would take into consideration such stages as:

- Identify all the hazard effects,
- Allocate the severity class to each effect,
- Estimate the probability (\(P_e\) : probability that the hazard generates an effect\(^4\)),
- Allocate the Safety Objective by applying System Design Assurance Level Matrix.

Using the System Design Assurance Level Matrix, and depending on the Severity Class and the frequency of the hazard effect, the most stringent System Design Assurance Level (A to D) is selected. Safety Objectives are identified for the hazard in qualitative terms.

This assurance level process can have the disadvantage of increasing the costs of the development, if it is used without careful consideration.

<table>
<thead>
<tr>
<th>Probability of an effect ((P_e))</th>
<th>Severity of the Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Very possible</td>
<td>A</td>
</tr>
<tr>
<td>Possible</td>
<td>B</td>
</tr>
<tr>
<td>Very unlikely</td>
<td>C</td>
</tr>
<tr>
<td>Extremely Unlikely</td>
<td>D</td>
</tr>
</tbody>
</table>

\(\text{Table 3 – System Design Assurance Level Matrix}\)

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\(^3\) In several situations, experience shows that assurance level can use only 4 levels instead of 5.

\(^4\) The approach used by airworthiness considers only the first line of the matrix above, the “very possible” row.
The following figure illustrates the process of setting the Safety Objective using this method.

Figure 3: System Assurance Level Mechanism

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6. DIFFERENCE BETWEEN RCS AND MEASUREMENT OF SAFETY PERFORMANCE

The RCS Mandate (para 5.1 first bullet) demands an examination of “…Whether or not relationships between the risk classification scheme for the design of ATM and the requirements of ICAO Annex 11, section 2.26 regarding the establishment of tolerable/acceptable level of safety for the provision of ATS, may be established”

The EUROCONTROL approach to this mandate task is to provide clarification of tolerable/acceptable levels of safety [TLS] as required by ICAO Annex 11, the feasibility for apportionment for monitoring the national TLS, as well as a definition of “tolerable levels of safety” and “achieved level of safety” (ALS), their scope and how to express them.

In order to determine if an ALS is being achieved, it is necessary to measure actual safety performance according to some prescribed rules and standard criteria.

6.1 Acceptable Level of Safety

ICAO Annex 11\(^5\) introduces Safety Metrics whereby an Acceptable/Tolerable Level of Safety is defined in terms of Performance Indicators which are, in turn, translated into Safety Performance Targets. The relationship between Acceptable Level of Safety, Safety Performance Indicators, Safety Performance Targets, and Safety Requirements as expressed in Annex 11 is summarised in Figure 4 below.

ICAO envisages that “within each State, different acceptable levels of safety may be established between the oversight authority and individual operators/service providers”. According to ICAO Doc 9859, ‘acceptable’ means that no further [mitigation] action needs to be taken (unless the risk can be reduced further at little cost).

It is the frequency of an accident or incidents with ATM contribution that determines an acceptable level safety for ATM. Safety Performance Targets are expressed in these terms. ESARR 2 includes categories of accidents and incidents that can be used for monitoring purposes in this regard.

ICAO has required States to set quantitative values for the safety of ATM operations, which is similar in nature to the intent of the Risk Assessment and Mitigation process. However, it is considered that the values required by ICAO are more closely associated with the concept of Performance Indicators, which are required to monitor the Safety Performance of the existing ATM Functional System.

However, within the EU, the concept of Key Performance Indicators can involve other factors than the calculation of accidents and incidents rates. Furthermore, those indicators and their monitoring and oversight mechanisms are still under development, and are therefore outside the scope of this document, which is dedicated specifically to the establishment of the Safety Target for the design of the system.

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\(^{5}\) The SES regulation will take into consideration ICAO requirements and particularly the calculation will take into account the values defined for navigation systems in advisory material associated to the RCS.
The ECAC safety minimum, which has been initially defined in ESARR 4 but will be revised a part of the RCS development, is essentially a minimum Safety Performance Target and therefore represents a minimum acceptable level of safety regarding the ATM contribution to accidents in ECAC. It has been only used as input to the design in ESARR 4 as a maximum tolerable Safety Target for severity 1.

### Figure 4: Acceptable Levels of Safety

#### 6.2 Achieved Levels of Safety

The Achieved Level of Safety (ALS) refers to the actual performance of ATM against the Safety Performance Target. Specific analysis should demonstrate that the Safety Performance Target has been achieved by the ATM design against a Safety Target or a Safety Objective.

Some States may require risks to be reduced ‘As Low As Reasonably Practicable’ (ALARP). Such an approach theoretically requires application of cost benefit analysis (CBA). However, the term “reasonably practicable” is often interpreted as “workable” systems or operations, without a clear expression of what is tolerable or not. Such interpretations could vary and are difficult to harmonise at a Pan-European level. Under an ALARP approach, ANSPs are required to develop systematically specific justifications of any changes to the ATM, even if the risks of the change under consideration are lower than the Safety Target of this particular change.

#### 6.3 Measurement of Achieved Level of Safety

The direct measurement of ALS at an ECAC level relies on the collection and analysis of accident and incident data over time. Given that the accident rate is relatively low it can take a significant number of years before a trend in accident rates is revealed.

Safety improvements come from analysing the causes and contributory factors to incidents and implementing remedial actions.
Assessment of the ALS at an NSA and ANSP level usually relies on indirect measures of risk, such as losses of separation, runway incursions, etc., which in the majority of cases do not result in an accident. Another approach to calculate the risk attributed to the components of the ATM functional system combines these using a logic tree approach to determine the achieved level of risk.

Where the ALS is deemed to be unacceptable, this means [according to ICAO Doc 9859] “that operations under the current conditions must cease until the risk is reduced to at least the tolerable level”. However, regarding the state of art of this type of calculation, the accuracy of such a calculation gives, at most, an indication of the actual performance of the system.
7. DERIVING SAFETY TARGETS FOR ATM DESIGN

RCS Mandate para 5.1(Second bullet) demands an examination of “....Whether or not the maximum tolerable probability for ATM may be established on the basis of historical performance data coming from existing European occurrences reporting processes;”

7.1 Establishment of Safety Targets and the Need for Apportionment

ESARR 4 assumes an overall Safety Target for ATM at ECAC and national levels in terms of the maximum tolerable probability of ATM directly contributing to an accident of a commercial aircraft. This effectively sets an overall Safety Target for Severity Class 1 effects in ATM and is founded on calculations justified using actual historical data [Ref SRC Pol Doc1]. As the scope of the RCS regulatory material is not the same as that of ESARR 4, the SRC POL DOC 1 value will be reviewed.

At the time of the introduction of the ESARR4 value for Severity Class 1, there was no data available upon which to base Safety Targets for Severity Classes 2 to 5, in a way which would give some credibility in the light of past experiences. ESARR 4 suggested that Safety Targets required for severity classes 2 to 5 could make use of reporting mechanisms put in place to collect occurrences of incidents.

Now, this issue has to be resolved, if quantitative Safety Targets for severities 2 to 5 are to be determined for ATM. In order to provide Safety Targets for the different severities, data on reported accidents, as well professional judgement, can be used.

An additional factor is that even when/if such targets are defined; they cannot be used directly for ATM design without some method of apportioning the overall probability to the constituent parts of the ATM Functional System. Such an apportionment can only be achieved by using quantitative terms and the issue in this case is how this should be done.

The safety of the ATM functional system relies not only on the development of harmonised systems, but also on the environment of operations (density of traffic, number of movements, complexity, level of equipments, airports, en route centres, etc.) which can vary significantly from one place to another. However, the Safety Target for ATM service provision should be harmonised across Europe. Those factor related to the operating environment for service provision should therefore be taken into account in the calculation of the safety objectives (and therefore in the design of the ATM system) in order to achieve commonly agreed Safety Targets.

The quantitative approach is not exclusive from other approaches and a mixed approach using quantitative (whenever possible) associated with qualitative arguments is highly recommended (cf. EC Regulation 2096/2005Common Requirements).
7.2 Safety Target versus Performance of the System

At first sight, an association between the derived Safety Target and the actual performance of the existing ATM Functional System could be made. Basically, the assumption made is that the actual performance of the system can be assessed systematically and that it can meet the Safety Target.

It is essential to note that this approach will fail to prove that the existing system is safe, for the following reasons:

- The severity schemes used to define the severity of the effect in occurrences classification, for instance in ESARR 2, and for system design are slightly different. Therefore, some ATM incidents classified under the occurrence classification scheme will be matched against the incorrect Safety Target.

- The gathering of historical data of ATM events monitors the actual system performance, which includes the element of “providence” in the resulting severity classification. As the Risk Assessment and Mitigation process tends to look at the worst case, or at the most probable effect of hazards, not all cases are taken into consideration. It is likely that the derived Safety Target will be generally more stringent than the monitored performance. Again, monitored performance will generally “under-indicate” against the required performance.

- Even when the system has undergone many changes, maybe replacing 50% over 20 years, it is still not likely that the Safety Target and the historical data monitoring would show any association.

- There will always be “under-sampling” in the reported incidents, so the monitoring figure is likely to always be lower than reality. This increases the chances that when the actual performance is periodically assessed against the safety Target, it will indicate that the result is acceptable.

- Incidents are harder to classify unambiguously than accidents.

- Sampling theory would indicate that due to the low number of incidents in relation to the number of scenarios considered in the Risk Assessment and Mitigation, the measured performance would be expected to vary considerably depending on the sampling period.

7.3 Consistency between Safety Target and Performance of the System

However, having Safety Targets for design increases the prospect that they can be compared to ATM Safety Performance Targets, and thus help to “close the loop” in that regard.

For instance, ANSPs can establish specific objectives for the design of an ATM Functional System which may be derived from the RCS Safety Targets. This may necessitate further apportionment of the RCS Safety Target to the constituent parts of the ATM functional system. They may be expressed as maximum tolerable probability of a particular outcome, according to its severity. They are used in order to give a more stringent framework to the design than the NSA’s Safety Target, and therefore can help to establish and implement ANSP’s “ambition factors” for ground components. Achieving these targets may be equated to an Acceptable Level of Safety, as explained above.
8. VALUES OF SAFETY TARGETS

8.1 Scope of RCS and ESARR 4 Value for Severity 1

When the Safety Target for Accidents was set by SRC, the scope of ATM included ATM (with ATFM and ASM) and CNS. Under the SES, the Safety Target has an increased scope, as it includes ATM (with ATFM and ASM), CNS, and the contributions to the provision of services coming from AIS and MET. The RCS does not therefore apply to AIS and MET, but takes into account their safety levels.

The rational question has been asked as to whether the Safety Target needs to increase to take into account this enlarged scope, as it is likely that new failure mechanisms, and hence new accident scenarios could be added. The fact that no MET or AIS induced accidents occurred in the sample period has been used as a suggestion that the Safety Target does not reflect the contribution from these sources.

It should then be noted that any sample period will result in a different subset of accidents. Another period, equally representative of the population, could have included MET or AIS induced accidents and no accidents from another ANS source. It is proposed that the existing Safety Target should be reviewed in accordance with proposed scope.

8.2 Calculation and Assumptions

The original safety target was derived in two steps:

- Firstly, from the set of all accidents.
- Secondly, from a multiplier relating to the ATM contribution, which was based on a subset of accidents for which ATM had a direct contribution and from a multiplier addressing the potential increase of the traffic.

It is also of note that the multiplier addressing the ATM contribution indicated by this data was modified – by professional judgement – from 1% to 2% as the group already considered that the data might be incomplete. However, this still remains to be confirmed. Recent EUROCONTROL studies, such as the Integrated Risk Picture (IRP), based on the analysis of accidents revealed that those rates should be reviewed and eventually changed (or confirmed).

The recently developed EUROCAE document ED125 “Process for Specifying Risk Classification Scheme and deriving Safety Objectives in ATM in compliance with ESARR 4” offers one prospect for achieving apportionment in practice. It proposes a set of Safety Targets for each of the Severity Classes in ESARR 4 and a method for ANSPs to convert these into Safety Objectives for ATM, taking into account traffic levels and airspace complexity. The table below gives the values of the Safety Targets in ED125. The approach is similar to that previously published by EUROCONTROL in SAM and already used by some ANSPs in their applications.

The apportioned Safety Targets in ED125 can be interpreted as estimates of the relative risk of an accident. This appears reasonable and it is probably fair to say that if, and when, actual data becomes available to complete ESARR 4 as originally intended, the figures will not be so different as to have a significant effect on risk assessments.
The Safety Targets to be applied at ANSP level have been made more onerous by applying an Ambition factor (for ground components). This may be an unnecessary complication for those ANSPs that already have several risk classes in their RCS (e.g. DFS and NATS).

<table>
<thead>
<tr>
<th>Safety Target</th>
<th>ECAC (European) Regulator Safety Target</th>
<th>National Regulator Safety Target</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(/ flight hour)</td>
<td>National Regulator Ambition Factor</td>
</tr>
<tr>
<td>ST1</td>
<td>1.55E-08</td>
<td>1.55</td>
</tr>
<tr>
<td>ST2</td>
<td>1E-05</td>
<td>1</td>
</tr>
<tr>
<td>ST3</td>
<td>1E-04</td>
<td>1</td>
</tr>
<tr>
<td>ST4</td>
<td>1E-02</td>
<td>1</td>
</tr>
<tr>
<td>ST5</td>
<td>n/a</td>
<td>n/a</td>
</tr>
</tbody>
</table>

**8.3 Clarification of the Aircraft and Operation under Consideration**

ESARR 4 is currently scoped to include ATM and underlying CNS directly contributing to an accident of a Commercial aircraft only. However, when it comes to the design of ATM any fatalities at all would be deemed unacceptable by ANSPs. Therefore all aircraft flying in GAT should be included. At present, reliable statistical data exists relating to aircraft with a Minimum Take Off Weight (MTOW) of 5670 kg. The RCS values should probably take into consideration hazards involving or affecting commercial aircraft above this weight.

ESARR 4 includes catastrophic accidents, mid-air collisions, collisions between aircraft on the ground, controlled flight into terrain and total loss of flight control. One issue arising from this is the need to consider the phase of flight when carrying out risk assessment of ATM design, and to make a distinction between those ATM services that are interpreted directly by the pilot (e.g. flight information, navigation) and the services provided by ATC. A different RCS may be required for these two cases e.g. EASA CS 25.1309 and related means of compliance might be more appropriate for the pilot interpreted systems.

The further development of the RCS should take into account the existing safety process and system of reference for airborne components. Those systems of reference should be complementary and take into account the work already done, particularly EUROCAE Standard ED-78A which aims to identify the safety aspects applicable to each segment. The safety demonstration of airborne systems should be integrated to EASA certification process.
8.4 Complexity of Airspace and Amount of Air Traffic

The severity of the effect of a hazard, and the tolerability of its occurrence, may vary depending upon the complexity of the airspace and the nature and level of the traffic in it. The issue here is that there is scope for discrepancy in how States interpret the risks for different ATM applications – for example, the ATM Safety Objectives for Approach or Area Control Centre may be underestimated (a potential safety issue) or overstated (unnecessary cost issue). EUROCAE ED125 introduces four categories of complexity for APP and ACC which may be helpful to ANSPs for use in their risk assessments, and can result in the derivation of more equitable Safety Objectives by ANSPs, though the Safety Targets remain the same.

8.5 Links between Safety Targets and Safety Performance: Closing the Loop

As the mandate task is concerned primarily with a RCS for ATM design, it potentially excludes consideration of how the actual ATM safety performance corresponds to the Safety Objectives set for the system.

However, “closing the loop” by using the same RCS for risk assessment of both ATM design and ATM performance would be advantageous for validating the RCS at NSA level, but more importantly to ensure that risks are being managed in a manner consistent with the Safety Targets set.

The NSA must ensure that the ANSP is designing the system against Safety Target(s) whose values give a representation of the acceptability of risk which is commonly understood within the ATM community.

One method of achieving this is to verify periodically that the allocation process within the ANSP is adequately deriving the Safety Requirements from the Safety Objectives, then verifying that the achieved system performance is meeting the Safety Requirements.

A complementary method is to make the link between the safety requirements and the assurance levels applied to the design of the system and which give to the NSA sufficient confidence with regard to the changes.

(Space Left Intentionally Blank)

 Footnote: The airborne components are submitted to a similar process which establishes that any potentially unsafe condition is properly addressed and corrected and is based on a co-operative approach with the aircraft manufacturer’s airworthiness Authorities (refer to the Annex of Commission Regulation 1702/2003, Part 21, Certification of Aircrafts and Related Products, Parts and Appliances, Section 21A.3: Failures, Malfunctions and Defects.)
9. FACTORS DETERMINING THE REGULATORY APPROACH

Several criteria have been identified during FPG consultation which needs to be taken into account in determining the framework of the regulatory approach.

9.1 Structure of the Regulatory Material

The evolutionary context of ATM, including its concepts of operations and its technology, argues for a certain flexibility of the regulatory material. The regulatory material must therefore remain consistent with future developments of ATM.

The application of regulation in this area should facilitate the design and the integration of the parts of the ATM functional system which are developed in other segments, such as Airborne and Spatial segments, and should not lead to an over engineering of the ATM functional system.

The regulatory material should have a level of prescription similar to the approach chosen for airborne system, in order to facilitate the integration in the future of the ATM Functional System within a Total System approach.

Accordingly, the development and consultation process has determined the need for regulatory material developed at two different levels, namely:

- **A Regulation** dedicated to the definition of an RCS and associated high level principles of mandatory material, such as:
  - Scope and applicability;
  - Responsibility of the NSA: apportioning the EU Safety Target to its own airspace, allocating a Safety Target to ANSPs operating within its airspace;
  - Definition of the RCS and other associated definitions;
  - Qualitative Identification of the Safety Targets without figures, principle for the use of a RCS and identification of its limitations;

- **Advisory Material**, whose contents should include the necessary detailed guidelines for the use of RCS by the NSA and/or ANSP, to include:
  - Guidance for the NSA/State in order establish and update a quantitative Risk Classification Scheme, including apportionment principles,
  - Guidance for the calculation of Safety Target at European Level, significant units to be used in order to express the rate;
  - values of the rates associated to severity levels and risks models;

At this stage, the form of the Advisory Material has not yet been determined. Options include EUROCONTROL Guidance Material as well as EUROCONTROL Specifications and/or possible Community Specification. The term “Advisory Material” is therefore used to indicate whichever form of material will eventually be chosen.
9.2 Role of the NSA’s

Approval of the Means of Compliance by the NSA

It is proposed to keep maximum of flexibility in the choice of risk models which should be used to achieve Safety Targets. Several risk models for risk assessment and mitigation could therefore be proposed as means of compliance to the RCS rule. This highlights the important task of the NSA in validating the proposed means of compliance with the rule.

A flexible approach is used by EASA which has developed “Certification specifications” and a specific process aiming at defining a certification basis. This “baseline” identifies the means of compliance (methods, tools) which will be used for the certification of a particular aircraft. EASA approves the certification baseline used by the aircraft manufacturer, who can change elements of the certification baseline only subject to approval by EASA.

The further “safety oversight regulation”, which will transpose ESARR 1 into EC law, describes (in its article 8) a process for the “safety oversight of changes”. It is the application of this process which is the means by which the NSA can ensure compliance with the RCS rule.

Co-ordination by the NSA with other NSA’s, States and Other Authorities

Causes of accidents and incidents can originate from equipment, procedures and human beings and from their interactions. Changes to the environment of operations may also have a safety impact as some of the characteristics of environment may be used as safety assumptions in the assessment of a change to the ATM system. For these reasons, the performance of external systems such as airborne equipments, ATF, AIS, MET should be taken into consideration in the establishment of a RCS.

State can nominate multiple NSA’s. In addition, in the context of Functional Airspace Blocks, NSAs and ANSPs do not necessarily belong to the same state. For these reasons, there is a need to coordinate at the highest level the NSAs, States and other Authorities (EASA but also non European authorities in case of the involvement of airborne segments) in order to ensure that the assumption relying on the safety performance of external systems are consistent and accurate.

The need for such coordination is historically well known. Such mechanisms already exist, for instance addressing this co-ordination of ATM/CNS requirements development between EUROCONTROL and the Joint Aviation Authorities (JAA).

Review of the Values of the Risk Classification Scheme

The NSA must ensure consistency of the Safety Target(s) in the RCS and the safety performance of the system. The earlier value included in ESARR 4 was an objective based on forecast system performance in 2015, but needs to be kept under regular review in order to take into account the evolution of the system.

More generally, the NSA / State has an overall responsibility to ensure the improvement of the safety of the ATM functional system and, in particular, that the values used for designing the system contribute to the improvement of the design of ATM functional system.
In the case of the RCS, a similar process should exist at the Pan European level; periodically the Safety Target which is defined for a certain period of time should be reviewed in order to keep the objective for the design of the system relevant and up-to-date. Advisory material for establishing Safety Targets at State and Pan European level should therefore be developed.

9.3 Levels of Detail of the Rule and Advisory Material

Based on options agreed by the FPG, the Consultation questionnaire addressed the levels of detail required in the contents of the regulation and the advisory material. Three possible alternatives for the levels at which to establish a Risk Classification Scheme were proposed to stakeholders, each having significantly different impact:

- EU level,
- EU level and at State level,
- EU level, State level and ANSP level.

Note: Where Functional Airspace Blocks (FAB’s) have been implemented, development of a RCS at FAB level would replace the State-level RCS.

In addition, each alternative contains a range of different options in order to express the:

- impact on operations associated to the severity levels,
- type of RCS (quantitative, qualitative, assurance levels, mixed, etc. approaches),
- consideration of the types of services provided,
- rate associated to severity levels when the alternative has been chosen,
- balance between regulation and possible further advisory material.
The table below summarises proposed combination of alternatives and options:

<table>
<thead>
<tr>
<th>Regulatory approach</th>
<th>Overview of prescriptions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Alternative 1</td>
</tr>
<tr>
<td>Alternative for the establishment of the RCS</td>
<td>EU level</td>
</tr>
<tr>
<td>Irrespective of alternatives</td>
<td>• RCS Concept (risk-based approach)</td>
</tr>
<tr>
<td></td>
<td>• Scope</td>
</tr>
<tr>
<td></td>
<td>• (ASM, ATF, AIS, MET, ...) : ATM functional system</td>
</tr>
<tr>
<td></td>
<td>• people, procedure, equipment</td>
</tr>
<tr>
<td></td>
<td>• ground, airborne, spatial ATM</td>
</tr>
<tr>
<td></td>
<td>Airspaces (ACC, APP, Airport),</td>
</tr>
<tr>
<td>Procedures</td>
<td>• Procedures addressing the validation of the RCS</td>
</tr>
</tbody>
</table>

**Sets of possible options when an the alternative has been chosen :**

- Definition of the severity
  - As established in Common Requirements Regulation 2096/2005,
  - As established in Common Requirements and in addition more detailed information on the impact on operation.

- For each alternative there are five possible options for the expression of the rates of RCS
  - QL : qualitative (words for expressing the rates)
  - QT : quantitative
  - AL : assurance level
  - Mixed : quantitative and other arguments
  - Additional AM : ambitions factors

- For each there are two possible options for the types of provided services to users
  - All services provided to a/c
  - Or services provided to Commercial a/c

**Options for the RCS rates**

<table>
<thead>
<tr>
<th>O1</th>
<th>O2</th>
<th>O3</th>
<th>O4</th>
<th>O5</th>
</tr>
</thead>
<tbody>
<tr>
<td>No rates</td>
<td>S1 : extremely exceptional</td>
<td>S1 : 1.55 $10^{-5}$</td>
<td>S1: 10$^8$</td>
<td>S1: from 10$^{-3}$ to 10$^{-2}$</td>
</tr>
<tr>
<td>No values.</td>
<td>S2 : exceptional</td>
<td>S2 : $10^{-5}$</td>
<td>S2: 10$^{-5}$</td>
<td>S2: from 10$^{-6}$ to 10$^{-3}$</td>
</tr>
<tr>
<td></td>
<td>S3 : unlikely</td>
<td>S3: 10$^{-3}$</td>
<td>S3: 10$^{-3}$</td>
<td>S3: from 10$^{-5}$ to 10$^{-2}$</td>
</tr>
<tr>
<td></td>
<td>S4 : plausible</td>
<td>S4: 10$^{-2}$</td>
<td>S4: 10$^{-2}$</td>
<td>S4: from 10$^{-3}$ to 10$^{-1}$</td>
</tr>
<tr>
<td></td>
<td>S5 : no effect</td>
<td>S5: no effect</td>
<td>S5: no effect</td>
<td>S5: no effect</td>
</tr>
</tbody>
</table>

- For each alternative there are two possible options for the establishment of the values of the RCS
  - In IR
  - Or in Guidance Material

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7 The values of the options O4 and O5 are not validated, they are only examples aiming at helping to choose the preferred way to express quantitative values.
9.4 Assessment of the Alternatives for a European RCS

**Alternative 1: RCS at EU Level**

This alternative aims at establishing a RCS value to be defined at EU level. Its role would be to contribute towards safety regulatory safeguards (at the EU level) against the risk of ATM contributing to aviation accidents and incidents. The choice of an EU-wide scope is intended to achieve consistency with, and take account of, the expansion of European air traffic, especially in the eastern part of Europe. This alternative is the least prescriptive. It is consistent with the existing regulation as the EC regulation 2096/2005 establishing the Common Requirements.

**Alternative 2: RCS at EU and State Levels**

This alternative aims at establishing a RCS to be defined at EU level with, additionally, the State also defining its own RCS according regulatory requirements established specifically by the rule, for instance taking into account the features of the national traffic. Its role would be to contribute towards safety regulatory safeguards, at both EU and State levels, against the risk of ATM contributing to aviation accidents and incidents.

This alternative is more flexible and adaptive to States with small geographical size and airspace. It is more accurate for assessing the overall performance of the design of the ATM functional system and therefore increases the visibility at European level. EUROCAE document ED125 provides guidance to ensure the development of mandatory RCS at STATE/FAB level.

The limitations of this choice are an increase of the complexity of the activities of the NSA in order to establish the RCS and to ensure the follow up of design performance. This alternative is more prescriptive but consistent with the principles of the Single Sky Regulations, and offers a good level of consistency with what it is already being developed by States.

**Alternative 3: RCS at EU, State and ANSP Levels**

This alternative aims at establishing a mandatory RCS to be defined at EU level, the State also defining its own RCS and, in addition, a mandatory requirement for the Service providers to define their own RCS, taking into account the characteristics of traffic handled within their airspace. The role of such an RCS would be to contribute towards safety regulatory safeguards, at the EU, State and Service-Provider levels, against the risk of ATM contributing to aviation accidents and incidents.

For the service-provider, therefore, in addition to meeting the National regulatory RCS, this role further protects its business and staff against the risk of its organisation contributing to aviation accidents and incidents. Further, it facilitates the apportionment of RCS at ANSP level, and offers better conditions to ensure the follow up of design safety performance.

However, the limitations of this alternative are the significant increase of the complexity of the activities of the NSA for ensuring the consistency of a big amount of information coming from the oversight of the ANSPs data. This approach also requires a good level of maturity in safety management process from the ANSP. Particularly, it requires a very good consistency of the methods used by the ANSPs which could be difficult to achieve if the ANSPS are numerous with big differences in the services they provide. Another limitation is the possible competition between ANSPs with regards to safety matters.
9.5 **Assessment of the RCS Concept**

There is an identified need to harmonise the understanding of what is meant by an RCS. There are many variations in existence, applying variously to a Risk Matrix/Table, or to the Risk Table and associated Severity Classes. The terms are also used in relation to the RCS as a scheme comprising these elements and the procedure and criteria for applied. In ESARR 4 the terms are used simultaneously to describe both the scheme and the risk table. A definition of RCS has therefore been proposed to stakeholders.

9.6 **Assessment of the Scope of Application**

Deriving from the analysis relating to an ATM functional system (in Section 3 of this document), it is proposed that the regulation establishes a Risk Classification Scheme and associated procedures concerning Air Navigation Services (to include ATM, CNS and interfaces with MET and AIS, as well as including ATFM and ASM).

9.7 **Assessment of the Achievement of the RCS Target**

It has been proposed that procedures should be established in order to validate the achievement of the RCS target for ground components.

1) Prior to implementation of the system: a methodology will be developed by the ANSP in order to ensure that the achievement of the safety objectives is ensured all along the development of a change contributing to effects of a given severity within ATM functional system. This safety assurance methodology shall take into account the specifications of the change, its design, its safety assessment and mitigation, its verification process.

2) During the operational life of the system: When changing a component which is part of the ATM functional system with an equivalent one, the safety objectives shall not be degraded. Therefore the ANSP shall ensure that the safety objectives continue to be achieved during the operational life of the system.

9.8 **Options Associated with the Chosen Alternative**

Once an alternative for the establishment of the risk classification scheme has been chosen, a range of several options have to be considered. The objective of such a choice is to identify the level of prescription of the additional regulatory material as well to identify what should be the regulation itself and what should be in the advisory material.

The options addressed included:

- Definition of severity, and refinement of the severity levels;
- Ways to express the rates of occurrence associated with severity levels in RCS advisory material;
- Consideration to types of services provided to users;
- Values of the RCS associated with severity levels.

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*For airborne components the airworthiness EASA process is applicable.*
Severity and Refinement of the Severity Levels

A severity classification scheme has already been established in the Common Requirements, this scheme needs refinement to ensure that the effects of hazards and the severity of the impact the safety of operations of the various parts of the ATM functional system are fully investigated, and that the values of the RCS are established accordingly on the basis of a harmonised approach.

It is therefore proposed that the regulatory material includes a requirement to refine the severity classification scheme established in the Common Requirements taking into account:

- The aircraft and ground functional capabilities,
- Workload of ATCO and air crew and their ability to perform their respective tasks,
- Magnitude of loss or corruption of Air Traffic Management services/functions,
- Risk Exposure Time,
- Means of Detection and Recovery,
- All elements which contribute to the development of hazardous situations.

In order to ensure harmonisation with the other aviation segments (airborne and space) by using a Total System approach, the impact from different segments on ATM service provision needs to be developed more precisely.

This more-detailed definition of severity criteria is close to what is proposed and fully developed in the EUROCONTROL Safety Assessment Methodology (referred to in SAM as severity indicators).

Rates of Occurrence and Severity Levels in RCS Regulatory Material

Stakeholders were asked for their views on the several ways to express the links between the severity levels and rates of occurrence when determining the requirement on the design of the system in the regulatory material. Initially, FPG were asked to choose between:

- a strictly qualitative approach (QL),
- a strictly quantitative (QT) approach,
- or a Mixed approach.

The Group made the point that a mixed approach was preferred. The quantitative rates should be identified in RCS and they should be complemented with qualitative arguments and evidences.
Types of Services and Users

ESARR 4 essentially addressed commercial air traffic, with its target value for severity category being established on the basis of commercial air traffic with Take Off Weight greater than 2.5 tons. The framework of Common Requirements takes into consideration all services provided to GAT, not only those limited to commercial aircraft. This implies a choice between RCS rates restricted to Commercial Air Traffic and RCS rates which should consider any kind of traffic.

The consequence is a need to define the methodology to apportion the Safety Targets to different levels of service provision and to define the criteria on which this apportionment relies upon.

Values of the RCS Associated to Severity Levels

Several options have been taken into consideration in order to express the rates of occurrence associated to severity levels. The advantages and limitations of the options O1 to O5 in the table above are described in this section.

Option O1: No Qualitative and No Quantitative Requirements for Safety Targets

This option is equivalent to the existing requirement in EC regulation 2096/2005 establishing Common Requirements. In this case, the severity levels are not associated to specific rates. This solution has the advantage to give a maximum of flexibility to ANSPs to achieve the Common Requirements.

However this solution does not give a framework in order to reach harmonisation for a quantitative approach and to apply adequate mechanism to deal with this approach. Therefore it does not complete the establishment of a Risk Classification Scheme as identified in the recital 16 of the EC Regulation 2096/2005 establishing the Common Requirements.

Option O2: Descriptive Qualitative Values for Severity 1 to 5

This option confirms the segregation of different severity associated to ATM failure and gives a framework in order to associate severity level with tolerable Safety Target for ATM. It is easy to explain and to understand. It offers a consistent approach of the use of RCS in ATM and a certain flexibility to identify the quantitative rates associated to those qualitative words (to be developed in specifications at a later stage).

This approach is a step forward for obtaining the harmonization of the tolerability of ATM failure, and is consistent with the approach in airborne equipments. However its efficiency relies on the quality of further development of specifications on which an agreement of the ATM stakeholders is needed.
Option O3: Existing Quantitative value for Severity 1

The option which has been proposed for the informal consultation is the existing value of ESARR 4 as the target value for severity 1, and qualitative words for the severities 2 to 5. It is therefore equivalent to the existing situation in ESARR 4 (supported and established by States through PC/CN Decision No. 83. In addition it gives some discretion to the states to adapt their own approach. However, the experience gained with such a Safety Target is that it is not easy to use. It does not achieve harmonisation for severity 2 to 5. Further developments would be needed in advisory material as the scope and applicability of the RCS is different from those of ESARR 4.

Options O4 & O5: Quantitative Values for Severity 1 to 4

These options provide a means for associating a severity level with a Safety Target for ATM. This will give the opportunity to maintain a consistent approach of the use of RCS in ATM. It also offers certain flexibility to identify the numerical rates and to help to the ANSP to establish and achieved them according to the characteristics of their environment and provided services.

This approach is a step forward for obtaining the harmonization of the tolerability of ATM failure, and is consistent with the approach in airborne equipments. However, its efficiency depends on the quality of further development of advisory material, on which an agreement of the ATM stakeholders is necessary.

The Use of Assurance Levels

Taking into account the informal consultation undertaken, it was considered necessary to further develop the way in which qualitative arguments would be identified and applied:

- Firstly, to rely upon safety arguments and evidence. This option already established in Common Requirement and do not need further development.
- Secondly, to introduce “assurance levels” as a means of linking the quality level of the design practices and the depth of verification of the design, thus establishing a scale of good practices consistent with the severity. More specifically, this method improves and harmonises design methods by making a direct link between the safety assessment and mitigation practices on the one hand, and the severity level being addressed on the other.

It is proposed to apply the regulation to the different ranges of assurance levels which address, as a minimum the:

- use of good practices or well proven methods for the specification, the design and the safety analysis of the changes of the components of the ATM functional system (people, equipments and procedures)
- depth of verification of the ATM component, before and after implementation of the change.
- need for the independence of the activities dealing with the specification, the design and the verification of the system.
A similar approach is developed for airborne systems and, in ATM, in the scope of ESARR 6, this approach makes the link between the safety levels required for the development of the software system and the effective practices for designing the ATM functional system.

This approach is a way to harmonize the ATM design process with the development of airborne equipments, therefore facilitating further integration. It offers further improvement by introducing quantitative targets and gives a guarantee of fair and equal treatment by the NSA of management of changes made by the ANSP.

The limitations of this approach are:

- Safety assurance levels do not provide safeguard to the ALARP approach, there is a need to clarify the link between values and design methods, if the decision to develop quantitative safety levels is made,
- There is a need to develop advisory material in order to provide guidance for design methodology on the basis of safety assurance levels for equipment, human factors and procedures.

**Additional Proposals in Relation to RCS**

During the first stage of the consultation process, the use of ambition factors for ground components at NSA and ANSP levels was considered. An Ambition Factor is a value applied to the Safety Targets for a design change. Its purpose is to raise the safety levels of an organisation above those required by the NSA (Safety Target), in order to satisfy safety management principles and other objectives, such as public perception or business performance. The Ambition Factor is therefore a way to protect the organisation when changes are dealing with new operational concepts or technology.

The limitations of the ambition factors are possible issues with regard to the feasibility, establishment and demonstration of their implementation. Therefore, it is proposed that the use of Ambition Factors should be described in advisory material in the framework of ground components only.
10. PRELIMINARY IMPACT ASSESSMENT AND CONSULTATION

This preliminary impact assessment compares the three alternatives of the regulatory approach in terms of impact on stakeholders, and makes recommendations for the drafting of the regulatory material. It also presents the outcome of the consultation undertaken with stakeholder, including FPG, on the alternatives and options discussed above.

10.1 Stakeholders Affected

The regulatory material will affect the following stakeholders:

- NSAs within EU Member States,
- ANSPs within EU Member States,
- Aircraft and equipment manufacturers
- Aircraft operators when they act as holders of supplemental type certificates (STC).

10.2 Impact on Existing Rules

The Common Requirements should be complemented by the regulatory material addressing the Risk Classification Scheme. Depending on the alternative and the options chosen, the Common Requirements could be impacted to different extents.

As the certification of the ANSP on the basis of Common Requirements is an ongoing activity, a special attention has been given to limit the impact of the potential change to the Common Requirements.

10.3 Economic and Efficiency Impact

The benefits of a RCS are:

- Contributing to the reduction of the risk associated with the introduction of changes in European ATM functional systems, and particularly it reduces the risk that those changes could lead to accidents.
- ensuring that future systems introduced in European ATM meet common safety performance levels,
- in particular, ensuring a better integration with airborne systems, which will lead to safe standardization of products, therefore:
  - reducing the costs of the development of safe systems.
  - reducing the direct and indirect cost linked to accidents by contributing to accident prevention,
  - optimising the development of a safe ATM functional system by promoting convergences of methods and practices.

For the time being, the benefits of making the link between safety regulation and the development of the overall ATM Functional System, have not been quantified. However, RCS regulatory material complements existing regulations and builds on practices related to ESARR 4 and EC Common Requirements which should already be implemented by stakeholders.
In conclusion, the RCS should not lead to an over engineering of ATM systems and components, and must avoid increasing of Stakeholders’ workload through the impact of regulatory measures which are too complex to establish and to monitor.

10.4 Impact on Advisory Material and Specifications

Several other sources of advisory material and specifications have been identified, most already developed through the EUROCONTROL Safety Assessment Methodology and ED125. These may need to be updated and revised to a limited extend according to the new regulation with particular respect to the:

- Establishment of the rates of RCS at EU level (or at EU and State levels, or EU and state and ANSP levels) and for different types of service provision,
- Use of the RCS (ANSP, NSA),
- Use of ambition factor for ground components,
- Apportionment into failure rates to human / procedure / software,
- Definition of best practices for identifying adequate assurance levels taking into account the severity of the effects of hazard on the components of ATM functional system (human, procedures, equipment),
- Guidance material in relation to ESARR 1 or the transposed ESARR 1
- Use of the severity classification scheme and refinement of the analysis of the effects of hazard.

10.5 Recommendations After Informal Consultation

The questionnaire has been sent to the Focal Point Group for informal consultation, the results being reviewed at the FPG meeting on 5th March 2007. The level of responses was satisfying, 89% completed questionnaires having been received, allowing agreement on all the major points raised in the initial consultation phase.

10.6 Choice of the Alternative

The results clearly showed a preference for an RCS to be regulated and developed at EU level.

<table>
<thead>
<tr>
<th>Alternatives</th>
<th>Choice</th>
</tr>
</thead>
<tbody>
<tr>
<td>EU</td>
<td>73%</td>
</tr>
<tr>
<td>EU+State</td>
<td>7%</td>
</tr>
<tr>
<td>EU+State+ANSP</td>
<td>20%</td>
</tr>
</tbody>
</table>

Stakeholders’ consultation clearly showed that the NSA should have the responsibility of apportioning the EU TLS to its own airspace, and allocating a TLS to ANSPs operating within its airspace for ATM service provision. This apportionment will take into account the existing Safety Targets of the airborne equipment and of the externally provided services.
10.7 Choice of Options

FPG members clearly pointed out that the mandate should develop a rule to be applied by the ANSP and the NSA for Air Navigation Services. However, there is also a clear need to develop advisory material in order to propose best practices for safety management and use of the RCS. In particular, the stakeholders also pointed out those options which, in their view, address safety management aspects (rather than safety regulation), and whose place is therefore in advisory material.

10.8 Need for Definitions and Harmonised Terminology

The Risk Classification Scheme introduces new concepts and methods which have not been already defined in existing EC legislation. Therefore it is proposed that regulatory material should propose new definitions to complement those in the Common Requirements. Through consultation, Stakeholders have identified the following terms as requiring specification.

For inclusion in the Rule:

- Risk Classification Scheme,
- Safety Target,
- Severity,
- Severity Class,
- Severity Classification scheme.

For inclusion in the Advisory Material:

- Tolerable risk,
- ATM function,
- Safety Risk,
- Safety Objective.

10.9 Rates of the RCS

The different options for the establishment of the values for the rates of the RCS have been considered. After the consultation by questionnaire, most stakeholders considered that rates should be expressed numerically for all severities and not only severity one (dealing with accidents).

However, informal consultation has shown that a variety of approaches are used by stakeholders when making assessments on severity. For incidents (severities 2 to 5) some stakeholders use values for events based on historical performance measurement, while others are use predictive means (for instance based on ED125).

An agreement on a single risk model for total ATM system is therefore needed, but such an agreement does not currently exist. The Regulatory Approach for RCS proposes an open and flexible approach which allows the existing risk models and which is open to their further improvements while ensuring a good control of the processes, of the incident rates and of the safety targets for accidents.
The definition of quantitative Safety Targets for the design of ATM is mandatory for severity 1 (accidents). For incidents (i.e. severities 2 to 5), the establishment of tolerable rates by the State will be mandatory. These rates will establish a basis which could be used either for the historical follow up of the incidents, or in order to define a predictive Safety Target for design for those severities (2 to 5). It is therefore for the State to choose the approach, but whichever is chosen, States should be requested to use the chosen approach consistently.

The advisory material will help ANSP’s and NSA’s to establish those principles for severity 2 to 5.

In order to ensure maximum flexibility for ensuring the introduction of future system in European ATM, it has been proposed that the values themselves should be established in Advisory Material and not within the rule.

### 10.10 Advisory Material

A preliminary list of guidance procedures was proposed to stakeholders in order to:

- review and to complement values for Safety Targets (severity 1 to 4) at EU level,
- update ED125 in accordance with the regulatory proposal regarding the development of RCS,
- provide advisory to the States in order to define their own RCS,
- complement guidance with explanation on the use of ambition factors for ground components,
- harmonise and improve the maturity of the methodology used by stakeholders in the apportionment methodology (on the basis of existing methodology as SAM),
- monitor activities of the use of RCS,
- help NSAs and ANSPs in using assurance levels.

These were seen as being essential ingredients to Advisory Material. At the same time, however, stakeholders’ priorities focussed firmly on the development of advisory material addressing:

- the establishment of a RCS at EU level,
- and providing information for the apportionment process.

### 10.11 Conclusion of the Consultation Process

The main conclusions resulting from this consultation process are that the RCS:

- is meaningful at EU level;
- should combine quantitative and qualitative approach as it is already established in SES regulation and Common Requirement;
- the definitions in regulation should be limited to the RCS definition itself and use which have not been already defined in the Common Requirements;
in order to allow a good flexibility to the change in concepts of operations, in technology, it is advised to establish quantitative rates at EU level in advisory material, as well as for the provision of guidance for the application to different levels of service; The advisory material should describe the verification process by the NSA.

These elements are within the scope of the mandate.

However, other elements have been identified, and proposed for inclusion in Advisory Material, but are outside the scope of this mandate. These include:

- refinement of severity levels,
- assurance levels,
- ambition factors for ground components,
- verification of RCS,

and should be developed later in further specifications.
11. PROPOSED REGULATORY APPROACH

The work undertaken in this phase of the Mandate, together with the results of the stakeholder consultation undertaken, leads EUROCONTROL to propose the following regulatory approach to the introduction of a Risk Classification Scheme for the Design of ATM.

11.1 Structure of the Regulatory Material

The approach proposes the development of regulatory material in two layers. A part of this regulatory material will be inserted in a rule and another part, addressing the details of the implementation, will be established in a set of Advisory Material, the structure and status of which will need to be determined in subsequent stages of mandate development.

To maximise regulatory harmonisation, the work to be done for the EC under this mandate, and the results thereof, are to also be used within EUROCONTROL to update and improve the efficiency of ESARR 4. Specifically, ESARR 4 material, which was to be updated for severity 2 to 5, will be modified according to the results of this mandate, in order to satisfy Article 4 of the Service Provision Regulation.

11.2 Scope and Type of Rule

The EC Mandate to EUROCONTROL calls for the development of an RCS for the Design of ATM. However, development work in accordance with the Initial Plan has shown it necessary to calculate its targets based on the “ATM functional system”. Indeed, the RCS targets will rely on the quantitative contribution to safety issued from all parts of the ATM functional system, including those which are out of the scope of Annex II of the Common Requirements (such as AIS and MET) and functions which are not submitted to certification under the Common Requirements (such as ATFM and ASM).

As the domain of definition of the targets is wider than the scope of the Common Requirements, the regulatory material should take the format of a specific Commission Regulation, being a separate implementing rule of the SES Service Provision Regulation.

In a similar way to the Commission Regulation Establishing a Safety Oversight Function by National Supervisory Authorities (the transposed ESARR 1), and as it also cross-refer to the RCS identified in the Common Requirements, this separate implementing rule will have the effect of amending the Common Requirements.

In addition, the scope of this Regulation should be consistent with the Commission Regulation for the Safety Oversight of ATM Establishing a Safety Oversight Function to be exercised by NSA’s (transposing ESARR 1).

The Rule will call for the implementation of an RCS at the EU level only, leaving further extension of its application to NSA’s and ANSP’s to determine.
11.3 Regulatory Material to be Inserted in the Rule

ATM services and supporting technologies will evolve in the next decades. Due to the evolution of air traffic, new safety requirements can emerge and the regulatory material could need to be revised accordingly. The regulatory material must therefore be structured to accommodate further developments.

The provisions of the Regulation will concentrate on the principles of RCS implementation (i.e. it will be objective-based), with detailed implementation material, such as the values of the rates of the RCS according to the different levels of services, being contained in Advisory Material and/or specifications.

A possible structure for the Regulation (illustrative at this stage) is as follows:

1. Objective and scope of the rule.
2. Definitions (required for the interpretation of the rule).
3. Field of application of the rule.
4. Requirements for RCS.
5. Deployment of RCS.
6. Implementation conditions.
7. Requirements for implementation dates by NSAs, ANSPs.

The main objectives and recommendations for principal aspects of the Regulation are summarised in the table at the end of this Section. Again, the aim is to capture the points so far raised and clarified by stakeholders, but the list is not considered as exhaustive.

11.4 Advisory Material

The Interoperability Regulation expressed that agreed safety management and reporting methodologies shall be established to achieve high level of safety and that a "harmonised set of requirements for the design, implementation, maintenance and operation of systems and their constituents, both for normal and degraded modes of operation, shall be defined".

Therefore the Advisory Material for the ANSPs\(^9\), the form of which has not yet been finally determined, would address inter alia the values of the rate harmonised at European level for the RCS. It is likely that it would take the format of EUROCONTROL specifications, part or all of which could become a Community Specification further to the publication of its reference in the Official Journal.

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9 For airborne components the airworthiness process is applicable and specific advisory material, if necessary will be developed later.
### 11.5 Principles for the Regulatory Approach

<table>
<thead>
<tr>
<th>Subjects for prescriptions</th>
<th>Nature of prescription</th>
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<tbody>
<tr>
<td><strong>Regulatory Coverage of the RCS</strong></td>
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</table>
| Objective of the rule | • to establish a RCS:  
  o To support the development of harmonised systems for ATM service provision  
  o To enable objective Safety Targets to be derived such that future systems introduced in European ATM meet common safety performance |
| Scope | • Air Navigation Services to all GAT in managed airspaces (SES EC regulation 550/2004) |
| **Regulatory Coverage of Deployment Conditions** | |
| Field of application | ▪ The Risk Classification Scheme applies to Air Navigation Services that have the potential to contribute to an aircraft accident  
  ▪ The Risk Classification Scheme applies to people, procedures, equipments  
  ▪ The Risk Classification Scheme applies to the airborne, ground and, if appropriate, spatial components of the ATM functional system, through cooperation with responsible parties |
| Responsibilities | The NSA to apportion the EU Safety Target to its own airspace and to allocate a Safety Target to ANSPs operating within its airspace  
  The ANSP to develop the ATM functional system according to the tolerable rate of the RCS. |
| Definitions | Risk Classification Scheme  
  Safety Target  
  Severity  
  Severity Class  
  Severity Classification scheme |
| Risk classification scheme | The RCS is used for assessing the safety risk. A risk table is associated with RCS and contains the tolerable rate of occurrence of an effect having a certain severity. |
### Subjects for prescriptions

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<tr>
<th>Subjects for prescriptions</th>
<th>Nature of prescription</th>
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<tbody>
<tr>
<td><strong>Regulatory Coverage of Deployment Conditions</strong></td>
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</tbody>
</table>
| Risk matrix | Express the tolerability of a failure of the service provided by the ANSP with those rates:

- Effects of hazards of Severity 1 are extremely exceptional.
- Effect of Severity 2 to 5 remains within tolerable rates. |
| **Need for Advisory Material** | |
|  | Development of the quantitative values of RCS at EU level apportionment to different levels of service
- Expression of “tolerable rates” according to different risk models
- Verification process of the NSA |
| **Regulatory Coverage Relating to Implementation Conditions** | |
| Implementation timescales. | The regulation and the advisory material dealing with the Establishment of the rates of RCS at EU level and for different types of service provision, with specific rule for apportionment at NSA level and ANSP level

Should be implemented consistently with the entry to force of the Commission Regulation Establishing a Safety Oversight Function by National Supervisory Authorities (the transposed ESARR 1). |

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12. REFERENCES

Primary References Influencing the RCS


[7] Mandate to EUROCONTROL to assist the European Commission in the development of a risk classification scheme in ATM,

[8] Initial plan on the Development of a Risk Classification Scheme for the Design of ATM, approved by the EC the 12th July 2006


[10] ICAO Annex 11 to the Convention on International Civil Aviation,


[12] EUROCAE ED-125

Other Background Documents & and Documents


[16] EUROCONTROL Safety Regulatory Requirement (ESARR) 2 –(April 2002)

[17] SRC POL DOC 1

[18] ICAO Doc. 4444.
[19] EU Single European Sky website
http://europa.eu.int/comm/transport/air/single_sky/index_en.htm

[20] EUROCONTROL Integrated Risk Picture

[21] EUROCONTROL Safety Assessment Methodology (SAM)
## 13. TERMS AND ABBREVIATIONS

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Term</th>
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<tbody>
<tr>
<td>a/c</td>
<td>Aircraft</td>
</tr>
<tr>
<td>ACC</td>
<td>Air Control Center</td>
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<tr>
<td>AIP</td>
<td>Aeronautical Information Publication</td>
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<tr>
<td>AL</td>
<td>Assurance Level</td>
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<tr>
<td>ALARP</td>
<td>As Low As Reasonably Practicable</td>
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<tr>
<td>AF</td>
<td>Ambition Factor (ground components)</td>
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<tr>
<td>ANSP</td>
<td>Air Navigation Service Provider</td>
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<tr>
<td>AO</td>
<td>Aircraft Operator</td>
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<tr>
<td>APP</td>
<td>Approach</td>
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<tr>
<td>ASM</td>
<td>Air Space Management</td>
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<tr>
<td>ATC</td>
<td>Air Traffic Control</td>
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<tr>
<td>ATFM</td>
<td>Air Traffic Flow Management</td>
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<tr>
<td>ATM</td>
<td>Air Traffic Management</td>
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<tr>
<td>ATS</td>
<td>Air Traffic Services</td>
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<tr>
<td>CAA</td>
<td>Civil Aviation Authority</td>
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<tr>
<td>CNS</td>
<td>Communications, Navigation and Surveillance</td>
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<tr>
<td>EATMN</td>
<td>European Air Traffic Management Network</td>
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<tr>
<td>EASA</td>
<td>European Agency for Safety In Aviation</td>
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<tr>
<td>EC</td>
<td>European Community</td>
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<tr>
<td>ECAC</td>
<td>European Civil Aviation Conference</td>
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<td>ED</td>
<td>EUROCAE Document</td>
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<tr>
<td>ESARR</td>
<td>EUROCONTROL Safety Regulatory Requirement</td>
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<tr>
<td>EUROCAE</td>
<td>The European Organization for Civil Aviation Equipment</td>
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<tr>
<td>FPG</td>
<td>Focal Point Group</td>
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<td>GA</td>
<td>General Aviation</td>
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<tr>
<td>GAT</td>
<td>General Air Traffic</td>
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<tr>
<td>ICAO</td>
<td>International Civil Aviation Organisation</td>
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<tr>
<td>IR</td>
<td>Implementing rule</td>
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<td>MTOM</td>
<td>Maximum Take-Off Mass</td>
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<tr>
<td>NSA</td>
<td>National Supervisory Authority</td>
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<td>RCS</td>
<td>Risk Classification Scheme</td>
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<tr>
<td>SES</td>
<td>Single European Sky</td>
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<tr>
<td>SRC</td>
<td>Safety Regulation Commission (EUROCONTROL)</td>
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