

**ESARR ADVISORY MATERIAL/GUIDANCE MATERIAL
(EAM/GUI)**

EAM 4 / GUI 6

**EXPLANATORY MATERIAL ON
GROUND BASED SAFETY NETS**

Edition	1.0
Edition Date	15 April 2010
Status	Released Issue
Distribution	General Public
Category	ESARR Advisory Material

F.2 DOCUMENT CHARACTERISTICS

TITLE		
EAM 4 / GUI 6 Explanatory Material on Ground Based Safety Nets		
Document Identifier	Reference	EAM 4 / GUI 6
eam4gui6_e1.0_ri_web	Edition Number	1.0
	Edition Date	15.04.2010
Abstract		
<p>This document aims at assisting EUROCONTROL Member States, National Supervisory Authorities (NSAs) and Air Navigation Services Providers (ANSPs) in adequately addressing the relevant requirements during the development, implementation and operational use of ground based safety nets.</p>		
Keywords		
Safety Oversight	Supervision	Safety Oversight of Changes
Monitoring of Safety	Verification of Compliance	ESARR
Safety Regulatory Audit	National Supervisory Authorities	Single European Sky
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DOCUMENT INFORMATION					
Status		Distribution		Category	
Working Draft	<input type="checkbox"/>	General Public	<input checked="" type="checkbox"/>	Safety Regulatory Requirement	<input type="checkbox"/>
Draft Issue	<input type="checkbox"/>	Restricted EUROCONTROL	<input type="checkbox"/>	Requirement Application Document	<input type="checkbox"/>
Proposed Issue	<input type="checkbox"/>	Restricted SRC	<input type="checkbox"/>	ESARR Advisory Material	<input checked="" type="checkbox"/>
Released Issue	<input checked="" type="checkbox"/>	Restricted SRC Commissioners	<input type="checkbox"/>	SRC Policy Document	<input type="checkbox"/>
		Restricted SRCCG	<input type="checkbox"/>	SRC Document	<input type="checkbox"/>
		Restricted SRU	<input type="checkbox"/>	Comment / Response Document	<input type="checkbox"/>

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F.3 DOCUMENT APPROVAL

The following table identifies all management authorities who have approved this document.

Authority	Name & Signature	Date
Quality Control (SRU)	« <i>signed by Daniel Hartin</i> » (Daniel HARTIN)	15.04.2010
Head of Unit (SRU)	« <i>signed by Juan Vazquez-Sanz</i> » (Juan VAZQUEZ-SANZ)	15.04.2010
Chairman, Safety Regulation Commission (SRC)	« <i>signed by Jos Wilbrink</i> » (Jos WILBRINK)	15.04.2010

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F.4 AMENDMENT RECORD

The following table records the complete history of this document.

Edition No.	Date	Reason for Change	Pages Affected
0.01	31-Aug-07	Initial draft.	All
0.02	15-Sep-08	Revised version sent to EUROCONTROL experts.	All
0.03	15-Oct-08	Comments included.	All
0.04	18-Mar-09	Revised version sent to the Safety Nets Task Force.	All
0.05	15-Apr-09	Comments of the task force included.	All
0.06	24-Apr-09	Additional comments from the task force members. SRU quality review.	All
0.07	18-May-09	Additional comments from task force members after meeting of 18-May-09.	All
0.1	15-Oct-09	Draft Issue sent to SRC and Safety Team for formal consultation	-
0.2	26-Oct-09	SRU quality review.	All
0.3	10-Feb-10	Incorporation of Stakeholder's comments arising from RFC No. 0914.	All
0.4	11-Apr-10	SRU quality review.	All
1.0	15-Apr-10	Document formally released.	-

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F.6 EXECUTIVE SUMMARY

Questions raised by various parts of the ATM industry have identified the need to modify SRC Policy Document 2 ‘Use of Safety Nets in Risk Assessment & Mitigation in ATM’. As such, the ATM safety regulatory policy on the use of ground-based “safety nets” was accepted at SRC28. This document aims to improve the understanding and implementation of this policy on ground based safety nets and replaces SRC Policy Document 2.

In summary, the SRC policy:

- Defines the ground based safety nets;
- Introduces a so-called “assignment” process to ensure transparency and traceability in decision making process on the development and use of ground based safety nets, whilst establishing accountability for its use;
- Provides recommendations with regard to several objectives, such as the:
 - impact of ground based safety nets on safety,
 - risk assessment and mitigation process applied to ground based safety nets,
 - training and awareness of users in order to ensure correct and effective use of ground based safety nets,
 - availability of ground based safety nets in case of reduced modes of operation,
 - contribution of ground based safety nets to achieved levels of safety.

In this context, this document aims to assist EUROCONTROL Member States, National Supervisory Authorities (NSAs) and Air Navigation Services Providers (ANSPs) in adequately addressing the relevant requirements during the development, implementation and operational use of ground based safety nets.

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1. INTRODUCTION

The demand of the aviation industry for the increased performance of the ATM functional system has led stakeholders to better define the role of ground-based safety nets and their contribution to safety.

The Safety Regulation Commission (SRC), through the SRC Coordination Group (SRCCG), established the 'Safety Net (SNET) Task Force' to review the current SRC policy with respect to ground based safety nets in ATM. This task force issued a policy which has been adopted by the SRC. It provides a framework for the identification, operational use and design of ground-based safety nets.

The SRC's policy:

- Defines the ground-based safety nets;
- Introduces a so-called "assignment" process to ensure transparency and traceability in decision-making on the use of ground-based safety nets, while establishing accountability for its use;
- Provides recommendations with regard to several area of concerns:
 - Addresses their impact on safety,
 - Underlines the risk assessment and mitigation process applied to ground based-safety nets,
 - Addresses the training and awareness of users in order to ensure their correct and effective use,
 - Addresses their availability in cases of reduced modes of operation,
 - Addresses their contribution to achieved levels of safety.

The objectives of the SRC's policy have an impact on different safety regulatory requirements. The statements of the SRC's ground-based safety nets policy which addresses ESARR 2 and the measurement of achieved safety level are not addressed by this document.

The entire document provides advices and recommendations which may also be understood within the SES regulatory framework. Whilst it addresses ESARR 4 and ESARR 1 (Edition 2.0, Articles 8 and 9), it also deals with the application of the EC Regulations of the Single European Sky (SES); Commission Regulation (EC) No. 2096/2005 (Common Requirements) and Commission Regulation (EC) No. 1315/2007 (ATM Safety Oversight), for those EUROCONTROL Members States where EC legislation is directly applicable.

The SRC policy highlights the impacts of ground-based safety nets on the ATM functional system architecture and the operational procedures and gives advices for their implementation within existing or new ATM functional systems. As they are changes to the ATM functional system, the safety requirements of ESARRs 1 and 4¹ apply.

¹ In the Single European Sky regulatory context, the safety requirements of ESARRs 1 and 4 transposed by Commission Regulation (EC) No. 1315/2007 – Safety Oversight in ATM (ESARR 1) and Commission Regulation (EC) No. 2096/2005 – Common Requirements (ESARR 4).

In addition, the safety assessment and mitigation of the ATM functional system should take into account the impact of ground-based safety nets in the design of ATM functional system since it is recommended that their operational use should be, to the maximum extend feasible, available in reduced modes of operation while maintaining tolerable safety levels.

In this context, this document aims at helping EUROCONTROL Member States, NSAs, ANSPs and all other stakeholders or authorities when they are involved in the development, implementation or operational use of ground-based safety nets.

1.1 Background

The regulatory aspects of ground-based safety nets are of importance to future EUROCONTROL developments and the on-going safety of programmes. Accordingly, this guidance material provides:

- Support to the SPIN (Safety Nets: Planning Implementation & eNhancements) Task Force in the development of harmonised standards and guidance material for the further development of ground-based safety nets;
- A contribution to the European Safety Plan (ESP) launched by EUROCONTROL in order to enhance the maturity of the safety frameworks of the ECAC States. Within the ESP, Activity Field 4 has the objective of providing clarification on the role of ground based safety nets with regard to ESARR 4 implementation. This document providing guidance material for ESARR 4 on ground based safety net achieves this recommendation.
- A contribution to the achievement of the Essential Requirements established in Annex II, Section 3, of Regulation (EC) No. 552/2004 of the European Parliament and of the Council of 10 March 2004 on the interoperability of the European Air Traffic Management network: *“In respect of appropriate ground-based systems, or parts thereof, these high levels of safety shall be enhanced by safety nets which shall be subject to agreed common performance characteristics”*. It should be noted that this guidance material **does not address** the parts of the SRC ground-based safety net policy which are out of the scope of ESARRs 1 and 4;
- EAM 1 / GUI 4, which is advisory material applying to the “safety oversight of changes” as established by ESARR 1, Edition 2.0, will contribute to the policy by addressing the notion of “assignment”, which is a pre-requisite to the development and implementation of ground-based safety nets in ATM functional systems.

1.2 Purpose of the Document

This document provides advice on how to apply the relevant requirements to ensure the development of a safe design, implementation and use of ground-based safety nets. More specifically, it:

1. Does not replace or extend the requirements of ESARRs 1 and 4, or any existing safety requirement of the domain,

2. Identifies the parts of the Policy which are connected to ESARR 4 and ESARR 1², Edition 2.0 processes,
3. Provides minimum criteria on which NSAs should judge if the safety arguments, provided in accordance with the relevant requirements, would be acceptable when ground based safety nets are part of the changes to the ATM functional system.

2. HIGH LEVEL PRINCIPLES

Ground-based safety nets are considered components of the ATM functional system and therefore have to comply with the relevant requirements. In addition, they have to be submitted to the safety oversight of changes process as per ESARR 1, Edition 2.0 and, where applicable, Commission Regulation (EC) No. 1315/2007.

It is assumed that Member States and any stakeholders using this guidance material have absorbed the requirements of ESARRs 1 and 4 into their national regulatory systems (or apply the SES regulations) and have appropriate requirements and guidance material in place.

Throughout the document, the expression '*relevant requirements*' has been used to mean the safety regulatory requirements contained in ESARR 4, Edition 1.0 and Commission Regulation (EC) No. 2096/2005, for those EUROCONTROL Member States where EC legislation is directly applicable. In addition, it is also assumed that, for those States where EC legislation applies, appropriate national regulations have been put into place to address those requirements of ESARR 4 not transposed by Commission Regulation (EC) No. 2096/2005.

3. STRUCTURE OF THE DOCUMENT

This document includes (*verbatim*) in Appendix A, the ground-based safety net policy adopted by the SRC.

For each statement, or group of statements addressing the same topic, the **Rationale** gives explanations and/or interpretations of the policy in the context of the relevant requirements and the **Rationale addressing the safety oversight by the NSA** gives explanations and interpretations of the policy in the context of the safety oversight of changes when it applies to the development of ground-based safety nets.

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² Cf. supra, for all references to ESARRs 1 and 4 see note 1, page 7.

APPENDIX A – SRC POLICY ON GROUND BASED SAFETY NETS

1. PURPOSE OF THE DOCUMENT

This document aims to support NSAs and ANSPs in their national discussions on the use and implementation of ground based safety nets by defining a policy. Application of this policy should assist in ensuring a harmonised approach by both EUROCONTROL Member States and non-EUROCONTROL ECAC Member States.

The SRC commits itself to the policy statements (numbered) and their supporting rationale in this document and regards them as minimum requirements for the use of ground based safety nets as they are defined within this document.

The term “**should**” in this document implies a strong recommendation by the SRC.

Within this document, ground based safety nets are considered as components of the ATM system and therefore have to comply with the relevant requirements. It is assumed that states using this policy/guidance have absorbed the relevant requirements into their regulatory systems and have appropriate requirements and guidance material in place. Application of the States’ regulatory requirements will therefore ensure appropriate development and safe use of ground-based safety nets.

2. BACKGROUND

Launched by EUROCONTROL, the European Safety Plan (ESP) aims to build on the success of its predecessor, the European Strategic Safety Action Plan (SSAP) by continuing to enhance the maturity of the safety frameworks of the European ATM network across the 42 ECAC states. The ESP contains five Activity Fields. ESP Activity Field 4 concentrates on supporting controllers with system safety defences in a more complex traffic environment with demanding traffic increases.

In ESP Activity Field 4, the SRC has been tasked with providing clarification on the role of safety nets with regard to ESARR 4 implementation (Ref: Rec. no. 4.1.1). In order to achieve this recommendation the envisaged deliverables are;

- Guidance Material for ESARR 4 on safety nets; and
- Regulatory policy on the use of safety nets.

This document encapsulates both envisaged deliverables in an iterative approach in parallel to the ongoing developments in and outside ESP. To enable the development of a final policy that is consistent with these developments, this document will be reviewed and if necessary amended through the SRC work programme in line with the following activities and their subsequent deliverables;

- ESP Rec. no. 4.2.4 “Establish concepts, strategies and road-maps for further evolution of ground-based safety nets.”
- Mandate to EUROCONTROL to assist the European Commission in the development of a risk classification scheme in ATM [RCS Mandate].

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3. DEFINITION OF GROUND BASED SAFETY NETS

The principal difference between the ground based safety net functions and other ATM functions is that, whilst the other ATM functions have the objective of supporting a mix of safety, capacity and efficiency, the ground based safety net function has the sole objective of contributing to safety.

The following list of characteristics for ground based safety nets apply. They:

- cater for unplanned events,
- make use of information from ground-based and airborne components of the ATM system to automatically generate alerts that require immediate attention,
- have the sole purpose of alerting users² to increased safety risks for aircraft in their environment of operations.

Putting these characteristics, the underlying rationale of this document and the purpose of ground based safety nets together leads to the following definition:

A ground based safety net is a functionality within the ATM system that is assigned by the ANSP with the sole purpose of monitoring the environment of operations³ in order to provide timely alerts⁴ of an increased risk to flight safety which may include resolution advice

For the assignment and use of parts of the ATM system as a ground based safety net, the policy statements in the sections below apply.

Footnotes of the policy:

1. Safety nets can provide alerts that are anticipated by the controller. This may be caused by e.g. a combination of the parameter setting of the function in combination with the airspace design or aircraft performance. Alerts generated by ground based safety nets under these conditions would be considered nuisance alerts and should be addressed in the respective technical specifications of ground based safety nets.
2. Users in this context refers to controllers and maintainers of the ATM system and, depending on the application assigned as a ground based safety net, pilots.
3. Environment of operations - The environment of operations consists of the physical and institutional characteristics of the airspace within which operations occur. The environment includes ATM services being provided, technologies used, airspace organisation, ambient conditions and people (ESARR 4³).
4. Timeliness of the alert is set by the ANSP to ensure sufficient time to allow for intervention and is subject to regulatory agreement.

A – Rationale

The Strategic Conflict Management and the Separation Provision functions of the ATM system must be able to maintain a very high level of safety, but they do not contribute to the sole objective of safety.

In accordance with existing regulations, to maintain the required high level of safety, a risk-based approach is applied to Strategic Conflict Management and the Separation Provision functions. When implementing those functions, ANSPs should identify the safety objectives to be applied for normal and reduced modes of operation, and for planned and unplanned operations which satisfy the relevant requirements.

As defined in the SRC's policy, the ground-based safety net functionalities have the **sole objective of contributing to safety**. As they provide warnings that separation may be reduced below acceptable levels, they play a part in collision avoidance. It is recognised that they provide safety benefits in alleviating the potential consequences of human errors or equipment failures in ATM operations. **However, because they are part of the ATM functional system and because of their specific role towards safety, specific conditions apply to them.**

Justification of the Necessity to Apply Specific Conditions to Safety Nets Implementation

In the future, the number of different ground based safety nets to the ATM system should increase. This is justified by the improvement in the technical capabilities and the automation of ATM systems. Therefore, ATM would make available for the controllers and pilots more information which would be used to improve the overall efficiency of the ATM system.

Designed on the basis of the availability of such information, the ground based safety nets are functionalities which should be implemented in order to increase the awareness of the controller. This characteristic deals with a very important part of the controllers' work: their perception of the air situation and their capability to anticipate the traffic. It is commonplace to claim that controllers should keep in mind an image of the air situation which is the closest to the real one and that they should have an adequate perception of the risk at any time when they handle the traffic. Because the tools used by the controllers might have an influence on their perception of the air traffic by providing better information, it is considered that these tools should improve the safety of ATM operations. Therefore, it is logical to claim that an increase of the situational awareness of the controllers would make a positive contribution toward safety.

However, when the controller becomes more confident in the tool, some "board effects" might appear. As the severity of these potential effects should have serious impacts on safety, special care should be taken when implementing ground based safety nets. It should be ensured that they are implemented for safety purposes and that they maintain this objective during their use.

Safety nets positively contribute to the overall safety of the ATM system and their use should be encouraged. However specific conditions should be applied to safety nets as a priority in order to maintain their role towards safety. These conditions are presented in this advisory material.

The specific conditions for the implementation of safety nets come from the results in research in risk perception and the requirement to impose high standards while implementing ground based safety nets in the ATM functional system. Therefore, for the implementation, design and operation of ATM ground based safety nets, the following elements should be taken into consideration:

- *The phenomenon of risk compensation⁴;*
- *The effect of inappropriate operational use of safety nets;*
- *The availability of the safety nets (information to controllers and degraded modes);*
- *The appropriate time given to controllers to handle the situation;*
- *The integrity of the information provided by safety nets;*
- *The robustness of the design of the safety nets within the ATM functional system in which they are implemented;*

The risk compensation

The risk compensation is an effect whereby individuals may tend to adjust their behaviour in response to perceived changes in risk. Another way of stating this is that individuals will behave less cautiously in situations where they feel "safer" or more protected. The risk compensation theory relies on the idea that individuals will tend to behave in a more cautious manner if their perception of risk or danger increases. When the individuals feel better protected, unwillingly they may act less cautiously, for instance they may imagine that they have more time to perform a task or they may have a wrong perception of the priority of the actions to achieve a goal.

Air traffic controllers are professionals who handle daily the risk in actual air traffic under a strict regulatory framework which maintains a high level of safety. A possible behavioural change could result from unconscious over-reliance on ground based safety nets, especially when the traffic pressure becomes more demanding.

When controllers have the benefit of a tool which increases their awareness or capacity to anticipate the air situation, and, more generally, any tool that could modify their perception of the risk, design of these tools and their operational use should take into account the risk compensation phenomenon. Specific information and training should be considered and the tool itself should be developed in accordance with the highest standards in safety.

³ Cf. supra, for all references to ESARRs 1 and 4 see note 1, page 7.

⁴ The scientific name of risk compensation is "risk homeostasis"; studies have been developed by ethologists and psychologists. Several publications are available in different domains where the individuals have to estimate risk of injury

The inappropriate operational use of safety nets

The use of the safety net should be defined by the ground safety net specifications and their agreed modes of operation. The controllers should be informed of the use and the limitations of the use of ground based safety net.

When using ground based safety nets, it should be ensured that in the active traffic, the situation is appropriately handled by the operators. An inappropriate use of the ground based safety net would be direct application of the tools with the objectives to improve capacity purpose or to ensure separation.

The availability of safety nets (information to controllers and degraded modes)

The undetected failure of a ground safety net or a lack of information on their mode of operation can lead to a discrepancy between the risk perceived by the controller and the actual risk. This implies an increase in workload when the controller realises this discrepancy, and in the worst case scenario, it can lead to inappropriate actions. Therefore:

- The availability of ground safety nets should be unambiguously known by the controller, with the shortest possible delay;
- In the same conditions as above, the controller should be aware if the safety net is available in normal or degraded modes of operation;
- The complete failure of ground based safety nets should not have an impact on the availability of the rest of the system. All usual efficient means of separation should remain available;
- As reasonably feasible, a failure of any part of the ATM functional system should not have an impact on ground based safety nets. Nevertheless, if the failure has an impact on the ground based safety nets, timely notification should be provided to the controller.
- Those failures, or any other conditions of the ATM functional system which require the application of contingency plans, should include the provision for safety nets availability.

The appropriate time given to controllers to handle the situation when a ground based safety net alert occurs

When an alert from a ground based safety nets occurs, ATCOs may give instructions that may require pilots to undertake specific manoeuvres, or they may react to instructions by controllers in a way that leads to drastic movements of aircraft that may endanger aircrew and passengers. The effects on controllers and pilots when such an occurrence takes place and the consequent effects on their handling of the active traffic should be analysed.

The use of ground based safety net should not impact the overall performance of the system, the controllers (and the pilots as well) should have sufficient time to safely handle the actions to undertake after the occurrences of the alerts provided by the ground based safety net without causing safety effect for the aircraft.

The integrity of the information provided by the ground based safety nets

It is known that ground based safety nets can have shortcomings or limitations e.g. do not function optimally under certain conflict geometries. The limitation of the safety nets should be known by the controllers, the false alarms should be reduced to a minimum.

The robustness of the design of the safety nets

Because safety is incorporated into their mode of operation, the design of safety nets should anticipate the maximum potential safety issues for all components of the ATM functional system which may interfere with them.

and/or accident on the basis of their perception (road, sport, etc.) on the University Web site, more specifically by Pr. Wilde at the Department of Psychology, Queen's University, Kingston, Ontario, Canada. (the reader can refer to the book : Gerald J.S Wilde, Risk homeostasis theory: an overview, in Injury prevention 1998; 4 pp 89 – 91.) Several publications are available in different domain of transport and also in the current life on the University website.

As any part of the ATM functional system, the ground based safety nets in a real time process can have unintended negative effects and they can induce new hazards with effects to this system.

This includes the identification of the hazards and their effects at every stages of their life cycle from the concept of operation to their decommissioning. This includes all off-line activities as maintenance or definition of the parameters which should be done with care and kept under ANSP's control.

Therefore:

- The ground based safety nets are part of the ATM functional system in operation,
- They should be implemented and justified in strict accordance with the relevant requirements,
- The **specific conditions** which should apply to safety nets are presented in the SRC policy.

B – Rationale Addressing the Safety Oversight by the NSA

When considering the material provided by the ANSP addressing, or having an impact on safety nets, the NSA should have a rigorous focus on the safety arguments provided by the ANSP.

When the NSA applies the requirements of ESARR 1, Edition 2.0 or where applicable, Commission Regulation (EC) No. 1315/2007, and when the NSA judges necessary to give a formal acceptance⁵, it should be ensured that the change implemented by the ANSP achieves the **specific conditions** expressed in the safety nets policy.

The formal acceptance for ground based safety implementation should be required because the NSA should:

- consider that the implementation of a ground based safety net requires the introduction of a **new aviation standard** according to ESARR 1, Edition 2.0 or where applicable, Commission Regulation (EC) No. 1315/2007;
- consider that severity classification of the change, introduced by the implementation of the ground based safety net, is dealing with **severity 1 or 2**;
- **in accordance with Article 9 of ESARR 1, Edition 2.0 or, where applicable, Commission Regulation (EC) No. 1315/2007, the NSA should judge it is necessary** to give a formal acceptance before putting the change to ground based safety into operation, because specific conditions should apply *de facto* to ground based safety nets. Specifically, when changes to ground based safety nets are dealing with severity 3 or 4, the assignment by the ANSP to NSA should be also required. The agreement on the final decision to give acceptance through a review process relies on the NSA's decision. **In Accordance with Article 9 of ESARR 1, Edition 2.0 or, where applicable, Commission Regulation (EC) No. 1315/2007, the NSA should inform the ANSP of his intention to receive an assignment and to review the specific conditions which applies to safety nets.**

⁵ As per Article 9 of ESARR 1, Edition 2.0 and Commission Regulation (EC) No. 1315/2007.

4. ASSIGNMENT OF GROUND BASED SAFETY NETS

In the discharge of their accountability for safety, an ANSP must have the freedom to utilise all appropriate means to enhance safety, including: functionality to enhance the presentation of information, and systems to provide appropriate flight safety warnings, in a manner that integrates with all other necessary elements of the environment of operations whilst providing scope for innovative and continual improvement of safety.

The SRC acknowledges that the increasing demands placed on ANSPs to provide increased capacity and efficiency may result in the inappropriate use of ground based safety nets. This policy introduces a process (assignment) that aims to ensure sufficient transparency and traceability in the decision making process on the use of a ground based safety net while establishing accountability for its use. Therefore;

1. In the context of the assignment of ground based safety nets, the ANSP **should** provide a declaration of assignment to the NSA if so requested by the NSA.

The SRC recognises that assigned ground based safety net functions may be technically part of sub-systems of the ATM functional system that are also used for other purposes. In this case the declaration of assignment as described above should clearly specify which element of the sub-system is assigned to function as a ground based safety net. The requirements for ground based safety nets, in this document, would then be applicable to the part of the sub system that is assigned as such.

A – Rationale

The use of ground based safety nets should be justified with appropriate safety arguments before their implementation in ATM functional systems.

All relevant requirements dealing with the implementation and the management of changes to the ATM functional system are fully applicable to safety nets.

Those changes to ground based safety nets could be; a new ground based safety net, a modification to an existing ground based safety net, or a modification to any part of the ATM functional system which could have an impact on one, or several, ground based safety nets.

As soon as the early stages of life cycle of the implementation of ground based safety net started, it should be highly recommended to the ANSP to perform an Initial Safety Argument of the ground based safety net.

The objective of the Initial Safety Argument is to identify the safety impact of the safety nets themselves, but, as well, the impact of the safety nets on all the parts of the ATM functional system that interact with them.

As the Initial Safety Argument is made available by the NSA, it should complement the Assignment made by the ANSP.

The Initial Safety Arguments are not necessarily comprehensive safety arguments. They should be provided at early stages of the safety assessment and mitigation process as per ESARR4/Commission Regulation (EC) No. 2096/2005. However, they should provide the NSA with sufficient information to have a clear mind of the safe implementation of the ground based safety nets within the ATM functional system.

The type of an Initial Safety Argument is agreed between the NSA and the ANSP in compliance with implemented procedures and recognized methodology.

In accordance with certified methodologies and with SAM V2 (which is a mean of compliance to ESARR 4 which may be used by the ANSP), this **initial safety assessment** may be: a detailed safety plan, a first stage of safety arguments as a success approach complemented by a FHA, or an Operational Hazard Analysis (OHA).

The initial safety arguments will be completed progressively in order to provide a complete safety argument which should be compliant with the relevant requirements and which should take into account the specific conditions applicable to ground based safety nets implementation.

In accordance with the **specific phase of the life cycle, of the specific on-going stage of the safety net's development** (new development or change to existing ground based safety nets already implemented) and in accordance with the available information, the ***Initial Safety Arguments*** should provide arguments with regard to the:

- Development of the ground based safety net in accordance **with known or recognised specifications available at that time** (e.g. national specifications, EUROCONTROL Specifications or Community Specifications);
- Independence of the ground based safety net with regard to the capacity and the separation provision;
- Details of the intended use of ground based safety nets which should include unambiguously their operational parameters and their limitations in operational use;
- Identification of the safety impact of this change on the remaining parts of the local ATM functional system for every stage of the life cycle (including provisions for maintenance and decommissioning) ;
- Effects of potential hazards occurring to ground based safety nets and their possible mitigations;
- Capability of ground based safety nets to have reduced mode of operations;
- Demonstration that safe separation should be maintained within tolerable safety levels, with and without available safety nets;
- Demonstration that ground based safety net remain available, to the maximum extend feasible, under reduced mode of operation (degraded modes and failure mode of operation);

B – Rationale Addressing the Safety Oversight by the NSA

As required by ESARR 1, Edition 2.0 or, where applicable, Commission Regulation (EC) No. 1315/2007, the ANSP should inform the NSA of all planned changes made to the ATM functional system.

Therefore, changes related to the development, implementation, maintenance and operation of ground based safety nets should be submitted to the safety oversight of changes process. Articles 8 and 9 of ESARR 1, Edition 2.0 / Commission Regulation (EC) No. 1315/2007 should apply to the introduction of ground based safety nets.

However, due to agreed specific conditions identified in the safety net policy for ground based safety nets, their introduction should be always notified to NSA by the ANSP. **The NSA should inform the ANSP of its intention.**

Even if the safety net development is not started, whatever the result of the severity assessment made by the ANSP is, the ANSP should send an assignment to the NSA when the ANSP :

- Foresees or plans the implementation of a ground based safety nets
- Implements new ground based safety net;
- Changes ground based safety nets;
- Implements any change which has an impact on ground based safety net.

It is advised that the Assignment should be issued for each change to the ground based safety net. When the change is of a severity 3/4/5, the justification for such a classification should be presented to the NSA.

By receiving the Assignment from the ANSP (or the organisation), the NSA should be aware of the ANSP's intention to implement a change which impacts ground based safety nets. Depending on the stage of the development of the ground based safety net, the process should take into account the following:

- a. When the **ANSP has the intention to implement** a ground based safety net or a change which has an impact on safety nets, **but the development has not yet started**, the NSA should:
 - Receive the Assignment of the ANSP's intention to implement a ground based safety net and that implementation is planned
 - Be informed of the intention of the ANSP to ensure the compliance of this ground based safety net with an approved specification (national, EUROCONTROL, or eventually, Community Specification).
- b. When the early stages of the implementation are started, the NSA should receive an **Initial Safety Argument** of the ground based safety nets which would complement the information about the ground based safety nets.
- c. **On the basis of the Initial Safety Argument**, considering the specific measures identified in A) above, the NSA may or may not decide to ensure the review the change to ground based safety net. **The implementation on the ground based safety nets and their impacts on the ATM functional system relies on NSA's decision.**

The Assignment should be part of the overall safety arguments recorded within the safety assessment and mitigation documentation addressing the ground based safety nets development and implementation. They should be available for any type of NSA safety oversight activity.

The assignment should be integrated into the existing respective procedures (ANSP and NSA).

The Initial Safety Arguments identified in A) should provide the justifications of the severity assessment, the safety benefits and the imitations of the considered ground based safety nets.

5. THE USE OF GROUND BASED SAFETY NETS

The SRC acknowledges that ground based safety nets are part of the ATM system and contribute positively to its safety. The following recommendations clarify the specific role that ground based safety nets have within the ATM system.

5.1 Capacity and Efficiency

For the use of ground based safety nets the two following requirements form the basic principles:

2. Ground based safety nets by themselves **should** have the sole objective to contribute to safety.
3. Ground based safety nets **should** not be relied upon for separation assurance in the provision of Air Traffic Services

A – Rationale

The ground based safety nets provide alerts when there is a need to urgently recover a situation related to the separation of an aircraft with other aircraft or obstacles.

When the safety net alert occurs, an increase of the exposure of the aircraft to the conflict is not tolerable.

Therefore all the other means available to ensure a safe separation of aircrafts should be used by the controller in normal conditions and reduced mode (degraded modes and failure modes) of operation.

The use of ground based safety nets in operation should be consistent with their *Assignment*, therefore:

- **The operational documents** of the ground based safety nets **should be consistent with their Assignment.**
- **Procedures should be established, documented and used in accordance with the relevant requirements and the specific conditions applicable to safety nets**, in order to ensure their appropriate use in accordance with their *Assignment*. At operational level this should include the:
 - procedure to use the safety nets in normal and reduced mode of operations (degraded modes and failure modes) ;
 - knowledge of their parameters and their limitation;
 - procedure related to the non availability of safety nets;

Specific monitoring of the inappropriate use of ground safety nets should be put in place (for instance, occurrences which reveal relationships to the capacity or to the use of ground safety net for separation assurance/provision should be systematically recorded and analysed). When it occurs, feedback to the ATCO should be ensured systematically as part of the recurrent or refreshing training, under the shortest delays.

B – Rationale Addressing the Safety Oversight by the NSA

The introduction into service of a ground based safety net should be subject to acceptance by the NSA.

The NSA should ensure that adequate procedures and process documentation are available and used at operational level, including technical aspects for installation, supervision and maintenance, in order to ensure adequate operational use of safety nets.

When applying the processes for the audit of changes, the NSA should have a specific focus on the measures undertaken by the ANSP to ensure that the use of ground based safety nets is consistent with the Assignment and the safety net policy agreed by the SRC.

5.2 Risk Assessment and Mitigation

The real-time use of ground based safety nets can have unintended negative effects. Controllers may give instructions, based on alerts from ground based safety nets, that may require pilots to undertake manoeuvres outside normal operating envelopes, or pilots may react to instructions by controllers in a way leading to drastic movements of aircraft, that may endanger aircrew and passengers. There are also open questions about the effects on controllers and pilots when such an occurrence has taken place and the consequent effects on the handling of the active traffic. It is also known that functions which can be assigned as ground based safety nets can have shortcomings or limitations e.g. do not function optimally under certain conflict geometries.

Taking these issues into account, safety nets should not be relied upon as a sole potential mitigation for identified hazards in the ATM system, but it should be acknowledged that they have a positive contribution to preventing accidents and incidents. Therefore, in the application of the relevant requirements;

4. Ground based safety nets **should not** be designed nor relied upon as a sole means of potential mitigation for identified hazards in the ATM system but can, as a maximum, be part of a combination of mitigations for identified hazards in the ATM system.
5. If an ANSP requires a ground based safety net as part of a combination of mitigations for identified hazards in the ATM system, the safety argument for the change (as required by ESARR 4) **should** consider but should not be limited to:
 - 5.1 a rationale that clarifies the role of the ground based safety net as part of the combination of mitigations, which includes assurance that no undue reliance is placed on ground based safety nets,
 - 5.2 a rationale that clarifies the effect on the proposed change when the ground based safety net fails,
 - 5.3 verification and validation of the change (e.g. using simulations, testing, etc.),
 - 5.4 validation and acceptance of the change by the users, and be formally accepted by the responsible regulatory authority (e.g. NSA)

Additionally, ground based safety nets may themselves introduce new hazards or modify existing hazards. Therefore, implementation of ground based safety nets, or changes to ground based safety nets, are subject to hazard identification, risk assessment and mitigation as required by the relevant requirements.

6. The risk assessment and mitigation process for ground based safety nets **should** consider but should not be limited to the:
 - 6.1 interaction between ground-based safety nets and similar airborne functions,

- 6.2 interaction between ground based safety nets and all other elements of the environment of operation,
- 6.3 effects of reduced system functionality on the availability of ground based safety nets,
- 6.4 impact of the introduction of ground based safety nets on the users,
- 6.5 impact of ground based safety nets on the training requirements for users,
- 6.6 recording and analysis of data needed to show that users and ground based safety nets continue to meet their safety obligations.

A – Rationale

The design, development and implementation of ground based safety nets should rely on recognised safety assessment and mitigation methodologies. The methodologies should provide enough support and advices to ensure that the safety net policy, the specific conditions applicable to safety nets development. They should facilitate the implementation of the safety objectives.

More specifically the Safety arguments, the demonstration and the testing activities applicable to the change dealing with ground based safety nets should identify and provide evidences with regard to:

A1) The role of the ground based safety nets

It is advised that the safety arguments developed by the ANSP should not provide inappropriate arguments (safety objectives, implementation, practices and procedures) addressing the safety nets for their development and their operation. More specifically, the ANSP should design the safety net, or changes which have impact on safety nets, in a way that all aspects of the design (people, equipments and procedures) have no relationships with **the capacity of the ATM functional system and with the separation provision and the safety nets should not be mitigation means**.

As the establishment of adequate procedures are part of the design of the system, the correct handling by users of the alert provided by the ground safety net should be designed in order that other efficient functions and technical resources of the ATM functional system in operation remain always available for air traffic control actions to recover conflicting situation in a timely manner.

The ANSP should design the ground based safety net in order that:

- An unambiguous awareness of the conflicting situation and its progress should be provided to the controller.
- The availability of the other ATM functions should be ensured while a safety net alert occurs;
- The use of safety nets should not be compromised by unacceptable rate of undesirable alerts to Air Traffic Controllers.

A2) Simulations and User Validation of Safety Nets

When a ground based safety net is specified, it should be recommended to perform simulations in order to ensure that the specifications are consistent with the foreseen operational use and that the controllers involved in the simulation have a clear mind of operational best practices dealing with the use of ground based safety nets.

The different exercises computed by the simulations should show that the functionalities of ground based safety nets remain available, eventually in degraded or failure modes of operation.

It should also show the limitations of the ground based safety nets. More specifically, the safety net should be demonstrated to positively contribute to safety by not triggering too many spurious-like alerts that would make a stressful situation for the controllers or for the pilots.

The simulation should show that the alerts are provided by ground based safety nets in a timely manner. The controller should have sufficient time to handle the situation up to a certain degree of complexity which should be identified by the simulation.

The simulation should show that enough resources (availability of system, time, procedures, possible redundancies, etc.) should remain in the ATM functional system to ensure that the controller can decide the appropriate actions to handle the situation.

An appropriate, in depth, users' validation of the ground based safety nets should contribute to establish the ground based success approaches⁶.

A3) Mitigation and Part of the Combinations of Mitigation

It should be inappropriate to consider that ground based safety nets as mitigation means for failures of the ATM functional system. However, they should be part of combinations of mitigations, but they should only be considered as additional helps for improving the awareness of the controller.

The ANSP should argue that the alerts provided by safety nets contribute positively to satisfy the safety objectives of the ATM functional system by developing and augmenting by using a success approach. Nevertheless, this approach should be supported by sound safety arguments.

More specifically, the implementation in the ATM functional system of ground based safety nets should be supported by evidence that the ATM functional system complies with the required safety levels (success approaches, or arguments provided in success cases⁷) in normal mode of operations and that the ground based safety nets should not be used as mitigations when ATM is operated in degraded or failure modes of operation.

The ANSP should make the demonstration of the safety benefits of the alerts provided by ground based safety nets by using appropriate standards, specifications and regulations and by demonstrating that the local implementation of ground based safety nets:

- Is supported by a success approach, and,
- By arguments which demonstrate that the:
 - System remains tolerably safe when the ground based safety nets fail, and,

⁶ A success approach is a way to assess the safety levels when the ATM functional system in question is working as intended – i.e. in the absence of failure.

⁷ A success case is the documents provided the arguments and the reference to evidences that the success approach has been analysed and provide assurance of compliances with required safety levels. (i.e. in the absence of failure for the system).

- Failures of the ATM functional system have no spurious impact on safety nets.

In any case, the ANSP should develop safety arguments with regard to the alerts provided by safety nets which should demonstrate that:

- The controllers should be systematically informed that the safety nets are in reduced mode of operations;
- The implementation of safety nets should not be used as an argument to reduce the severity of any outcomes of hazards of ATM functional system;
- The safety nets should not be mitigation means;
- When safety cases are in operation, independent and efficient mitigation means⁸ of the ATM functional system should be always available for all foreseen conditions of operation (normal, degraded and failure modes of operation) ,
- The changes to any parts of the ATM functional system **in interaction** with the ground based safety nets under consideration should have no impact on its safe implementation and use,
- The system should remain tolerably safe without safety nets. As safety nets are essentially alerts to ATCOs, when using a quantitative approach, the safety nets functions should not bear an important part of the overall ATM safety risk. The apportioned risk given to safety nets functions should remain balanced regarding the apportioned risk given to other functions in ATM.

A4) Common Modes of Failure

- The safety assessment and mitigation material of the ground based safety nets, and of any other part of the ATM functional system in interaction with the safety nets, should clearly show how the common modes of failure are handled (i.e. designed, implemented and operated) in any phase of the life cycle.

A5) The failures of the ground based safety nets should have limited impacts on the performances⁹ of the ATM functional system

The other parts of the ATM functional system should not be compromised in terms of performance for any failures of the safety nets.

Ground-based safety sets, as functionalities which belong to the ATM functional system, can themselves introduce new hazards with serious effects. These should be taken into consideration within their design, implementation and operation;

- Ground based safety nets are part of the ATM functional system, therefore they should be implemented in accordance with the agreed ATM safety targets.

⁸ The efficiency of the mitigations should be demonstrated by the experience or by sound arguments.

⁹ e.g. functionality, robustness, timeliness, integrity.

- As the independence of ground based safety nets from all information coming from other parts of the ATM functional system is not necessarily ensured, specific attention with regard the ESARR 4¹⁰ requirement should focus:
 - a. On the integrity of the data used by the ground based safety nets and which are shared with other parts of the ATM functional system,
 - b. More generally, that the integration of safety nets with the other parts of the ATM functional system is safe,
- The resources (people, equipments and procedures) required by the implementation and operation of ground based safety nets should be anticipated during the design phase of the system's development;
- The introduction of a ground based safety net within existing ATM functional systems should not degrade the overall performance of the system;
- The impact of degraded or failure modes of operations on the performance of the ground based safety nets, including HMI effects, should not be ambiguous for ATCOs. The ATCO should be aware of any situation dealing with the mode of operation of the safety nets.

A6) The failures of the ATM functional system should have limited impact on ground based safety nets

Safety nets could fail or be removed and the system should remain tolerably safe.

For instance, when a failure of parts of the system occurs, the system will need to be reconfigured in order that it remains tolerably safe. The reconfiguration cannot instantly repair the failure, but, via procedural means (e.g. an increase in separation), the ANSP should constrain the operation to remain tolerably safe.

- It is advisable to identify the potential dependence of the implementation of (people, equipment and specifically software, procedure) the safety nets from the rest of the system,
- Safety arguments should be provided with regard to the interactions with the rest of the ATM system,
- The degree of independence with other separation and alerting functions (inc. airborne aspects) should be addressed.
- The impact analysis of the ground based safety nets on the safety of the overall ATM functional system should provide evidence that the interactions with the rest of the ATM functional system remain tolerably safe,
- The changes to any parts of the ATM functional system **in interaction** with safety nets should demonstrate that there is no impact on their safe implementation and use,
- The failure of ground based safety nets should not affect the required safety targets of the system and the airborne part should not be considered as a mitigation for the effects of ground based safety nets;

¹⁰ Cf. supra, for all references to ESARRs 1 and 4 see note 1, page 7.

A7) Verification and test of the safety nets

When the ground based safety nets are developed, comprehensive testing activities should be undertaken by ANSPs which **should demonstrate in accordance with the testing activities of the life cycle of the change and within a representative testing environment** that:

- All safety arguments (assumptions and claims) should be verified;
- Ground based safety nets fulfil their requirements and the safety net policy in normal, reduced and failures modes of operation;
- The failure cases (single and combination of failures cases) are part of testing activities and tolerable safety levels should be maintained;
- All mitigations means, and combination of mitigation means, are verified when a ground based safety net fails.

A8) Validation and acceptance of safety nets by the users

Specific stages of testing should imply the users in an operational environment in order to ensure that the safety of the change which implies a safety net are acceptable by the users and that all the operational procedures in relation with the implementation of the safety net have been tested and validated by the users.

A9) Recording and Traceability

All arguments, evidences and assumptions, results of tests phases should be documented and recorded. The safety assessment and mitigation of safety nets should follow the relevant requirements and safety arguments, and evidences should be available for the NSA.

The traceability of the safety net functionalities with regard to the interfaces in the rest of the system should be available in the documentation.

Complete traceability of the safety nets' development, tests, integration, validation and acceptance by the users should be kept, supported by documents and evidences.

B – Rationale Addressing the Safety Oversight by the NSA

According to the criteria defined in ESARR 1, Edition 2.0 and, where applicable, Commission Regulation (EC) No. 1315/2007, and taking into account the assignment process or any other criteria that the NSA should consider of importance, the NSA should decide to perform a review of the change.

It should be demonstrated that the specific conditions described in the safety net policy are taken into account by the ANSP.

In any case, it should be demonstrated that, with or without the ground safety nets, the ATM functional system should remain tolerably safe.

5.3 Training and Awareness

In order to ensure correct and effective use of ground based safety nets, it is required that users understand the purpose and functioning of ground based safety nets and are aware of the technical availability and operational status of the ground based safety nets they use. Therefore;

7. Users **should** be appropriately trained in, as a minimum, the purpose, operational limitations and functioning of the ground based safety nets they use,
8. Users **should** be aware of the availability and operational status of ground based safety nets in real time.

There is a possibility that because the ground based safety net apparently always gives a timely indication of increased safety risk to aircraft, the users may become reliant on it. Consequently, the user's safety objectives of: seeking to ensure separations regardless of the ground based safety net, will not be met.

9. Users **should** be aware that the safety of the service is predicated on their continuing to ensure separation without relying on the ground based safety net.

The identification of the need for such training and awareness should result from using ESARR 4¹¹.

A – Rationale Addressing the Application of ESARRs 2, 4 and 5

The identification of the need for training and awareness should result of the application of ESARR 5, Edition 2.0.

The procedures should be designed to avoid inappropriate the use of safety nets and to take into consideration the specific conditions applying to safety nets. The best practices and the conditions of potential inappropriate use of ground based safety nets should be well understood by the users.

The users should be informed and adequately trained in order that they should not progressively take more risks, increasing their reliance on ground based safety nets. For instance, the human factors phenomenon of risk compensation should be explained to ATCOs.

The ATCO should be fully trained in all possible situations with the ground based safety nets they use, in normal mode of operation and as well reduced modes of operation.

In addition to the ESARR 5-related processes, information gained from safety analysis of ground based safety nets (ESARR 2) about their implementation and their use should be disseminated and shared between the controllers.

Finally, as per ESARR 1, Edition 2.0 and, where applicable, Commission Regulation (EC) No. 1315/2007, **users should be aware of all safety related conditions which have been decided by the NSA** with regard to the use of safety nets. As this information could lead to **the identification of safety directives** when the experience gained shows the need of a reinforcement of the best practices.

ESARR4 applies to the safety directives as they are new safety requirements for the ATM system.

¹¹ Cf. supra, for all references to ESARRs 1 and 4 see note 1, page 7.

B – Rationale Addressing the Safety Oversight by the NSA

According to ESARR 1, Edition 2.0 and, where applicable, Commission Regulation (EC) No. 1315/2007, when reviewing material related to safety nets development, change and implementation, and before accepting them prior to going into operation, the NSA should verify, as a minimum, that:

- a. All users are adequately trained and aware of all safety related conditions when they use safety nets,
- b. The training process (course content and/or syllabus for initial and refreshment training) about safety nets should be identified as early as possible before their implementation,
- c. The training should, as a minimum, encompass the use of ground based safety nets in normal operations, reduced operations, the limitations of their use and the risks of their misuse,
- d. The training process should take into account the lessons learnt about the use of ground based safety nets,
- e. The users should be informed of the status and availability of ground based safety nets,
- f. The operational conditions and procedures should be modified in accordance with the status and the availability of safety nets,
- g. Controllers should be systematically and formally informed of modifications, availability or any specific condition of operation with regard to safety nets (via information distribution, briefings or in real time via the system supervision),
- h. The design of the safety nets and their interactions with the rest of the system should be tolerably safe and should achieve its safety objectives.

5.4 Reduced Modes of Operation

Ground based safety nets in ATM rely on the availability of components of the technical infrastructure of the ATM system. However, the importance on a ground based safety net may increase in the case of partial failures of that infrastructure (i.e. system degradation leading to reduced modes of operation of the ATM system). Transition to reduced modes of operation, especially when this occurs unexpectedly, may pose a threat to safety.

Ground based safety nets have features that may be supported by different equipment elements of the ATM system. When features are lost due to partial loss of the technical infrastructure of the ATM system it should still be possible to have an effective ground based safety net in place, even with a reduced capability. The design of the ground-based safety nets, and their interfaces with other elements of the ATM system, should therefore offer maximum protection against failures in other parts of the ATM system.

10. Ground based safety nets **should**, to the maximum extent feasible, be available and continue to operate in reduced modes of operation of the technical infrastructure of the ATM system
11. Ground based safety nets **should** themselves have reduced modes of operation subject to the availability of parts of the ATM system required for performance of the ground based safety net

A – Rationale

The importance of ground based safety nets may increase in the case of failures of the infrastructure (i.e. system degradation leading to reduced modes of operation of the ATM functional system). Transition to reduced modes of operation, especially when this occurs unexpectedly, may pose a threat to safety.

The robustness of the ground based safety nets should withstand the failures of the ATM functional system should be specified, designed and demonstrated through safety arguments. Therefore, safety nets should themselves have **safe reduced modes of operation**, subject to the availability of parts of the ATM functional system.

The safety nets are dependent of the availability of several parts of the ATM system. When the ATM system is operating in reduced modes of operations, it should still have sufficient resources and performances available to satisfy Safety nets functionalities.

The design of the system which includes safety nets functionalities should take into account that the:

- Safety nets are maintained and available in reduced mode of operation,
- **Mitigation to the failure conditions of ground based safety nets** and the system implementing them are tolerably safe (i.e. achieve and maintain the required safety requirements).
- ATCO should be aware of all possible situations: normal mode and reduced modes.

B – Rationale Addressing the Safety Oversight by the NSA

The design of parts of the ATM functional system, other than the ground based safety nets function, should offer defences against the failures of the ground based safety nets. Specific attention should be given to the interfaces between ground based safety nets and other elements of the ATM functional system.

- i) The safety arguments and evidences that ground based safety nets should be safely operated in reduced mode of operation should be available to the NSA.
- ii) Appropriate operational procedures should take into account the reduced mode operations of ground based safety nets and the impact on safety nets of the reduced mode of operation of the technical infrastructures.

5.5 Achieved Level of Safety

Ground based safety nets do have an impact on the achieved level of safety of the total ATM system.

12. The effect and contribution of ground based safety nets may be taken into account when an ANSP determines the achieved level of safety

A – Rationale

ESARR 4 does not address achieved levels of safety.

However, the RCS value for the design of the ATM functional system which is used by the State should include the role of safety nets in ATM functional system.

The safety nets should have quantitative safety objectives when the ANSP decides to perform a quantitative assessment for the design of the change to ATM functional system.

B – Rationale Addressing the Safety Oversight by the NSA

The safety occurrences related the use of ground based safety nets should be analysed by the ANSP and should be part of the safety oversight of the system (ESARR 2 requirement).

With regard to safety monitoring, it is advised to keep a close monitoring of the operational use of safety nets and of all occurrences which have impacts on safety nets functions, availability and performances. The occurrences dealing with safety nets are included in the calculation of the achieved level of safety of the State.

The feedback on the use of safety net may lead the NSA to issue safety directives. The safety directives therefore become new safety requirements.

(***)