EUROPEAN ORGANISATION FOR THE SAFETY OF AIR NAVIGATION

EUROCONTROL

Enclosure 2

SINGLE EUROPEAN SKY
(SES) REGULATION

JUSTIFICATION MATERIAL FOR THE

DRAFT IMPLEMENTING RULE ON THE 2[ND] PHASE OF THE AIR-GROUND VOICE CHANNEL SPACING

31 January 2011
Edition 1.0

DOCUMENT CHANGE RECORD

The following table records the complete history of the successive editions of the present document.

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EXECUTIVE SUMMARY

Radio Frequency Spectrum is a scarce and finite resource. Europe is experiencing increasingly long delays to satisfy frequencies demand in the aeronautical mobile radio communication service band (i.e. 117.975 to 137 MHz). Taking into account the limitations for increasing the allocated spectrum and/or frequency reuse, the main means to overcome this frequency congestion in the medium to long term is to reduce the spacing between channels from 25 kHz to 8.33 kHz, thereby fitting a greater number of channels into the existing frequency band.

The original ICAO decisions concerning the requirement for 8.33 kHz channel spacing were made in 1994 and 1995. The non-binding nature of these decisions meant that certain Stakeholders had only partially committed to the implementation of 8.33 kHz. Therefore in 2005 the European Commission issued a Mandate to EUROCONTROL for the development of a draft Implementing Rule on Air-ground Voice Channel Spacing (A-VCS IR) to support the deployment of 8.33 kHz in Europe.

After consultation with Stakeholders the European Commission decided to adopt a phased approach, first addressing the deployment of 8.33 kHz above FL195. Provisions for 8.33 kHz above FL195 were published in Commission Regulation (EC) No 1265/2007 (the A-VCS IR) on 27 October 2007.

This document represents the justification material for the second phase, addressing the deployment of 8.33 kHz below FL195 in the ICAO EUR Region where Member States are responsible for the provision of air traffic services. It presents the current operational, technical and institutional environments, the issues leading to the need for regulatory action, and the benefits of such action.

The implementing rule will compel Stakeholders to meet their obligations relating to the following three milestones:

- Forward Fit Requirement starting 1 year after the entry into force of the Implementing Rule, to ensure all new radios are 8.33 compliant,
- Interim Implementation for 2014 to ensure a given number of conversions take place in the European States identified in the Implementing Rule,
- Final Implementation for 2018 to ensure 8.33 kHz spacing of all possible European voice channels.

1. INTRODUCTION

The European Organisation for the Safety of Air Navigation (EUROCONTROL) was mandated by the European Commission to prepare a draft Implementing Rule on Air-Ground Voice Channel Spacing, to complement and refine the Essential Requirements as described in the Single European Sky (SES) interoperability Regulation. The main objective is to provide a proper regulatory framework for the deployment of 8.33 kHz channel spacing by including requirements specific to ANSPs, airspace users, airspace of application, Member States; implementation conditions including transitional arrangements, applicable procedures, conformity assessment and safety requirements. Therefore the regulatory framework will ensure the coordinated deployment of reduced channel spacing within the European Air Traffic Management Network.

Following the development of a first edition of the Regulatory Approach (SES/IOP/VCS/REGAP/1.0) released in December 2005 and after a written consultation with the concerned Stakeholders and accepted by the European Commission in January 2006, it was decided to address the scope of the mandate in two phases. The first phase focussed on the deployment of 8.33 kHz channel spacing in the airspace above flight level 195 (FL195). This first phase was completed with the adoption and publication of the Commission Regulation (EC) No 1265/2007 (published in the Official Journal of the European Union on 27 October 2007 and referred to as the A-VCS IR in this document).

In the context of the original mandate, this document provides the justification material for the update of the A-VCS IR to address the second phase of the scope of the mandate, which is the extension of the deployment of 8.33 kHz channel spacing in the airspace below FL195.

2. SCOPE OF THE DOCUMENT

This document represents the justification material for the update of the published interoperability Implementing Rule on Air-Ground Voice Channel Spacing (Commission Regulation (EC) No 1265/2007), addressing the deployment of air-ground voice communications based on 8.33 kHz channel spacing in the airspace below FL195.

Together with the draft Implementing Rule itself, the identification of means of compliance with the draft Implementing Rule and with the identification of EUROCONTROL's actions to support Stakeholders' efforts to implement the Implementing Rule, it represents the final report to be delivered to the European Commission.

The document is structured in four main parts, as follows:

- An introductory section describing the environment in which the Implementing Rule will intervene, in terms of institutional, operational and technical aspects as well as the presentation of the issues giving need to a regulatory action and the benefits of such action;
- A part describing and justifying the main categories of regulatory provisions (e.g. Objective and scope, Interoperability and Performance, Associated procedure, State aircraft, etc) leading to the identification of the structure of the Implementing Rule;
- The assessment of the impact of the Implementing Rule. This part identifies the Stakeholders concerned, addressing also the economic impact including the costs and the benefits and a description of the safety impact as well. It also provides a comparison between the current regulatory situation in the area covered by the mandate and the desired regulatory situation after full exploitation of the scope of the mandate;

- A description of the informal and formal consultation activities associated with the mandate from the initiation of the development work of the mandate deliverables up to date.

3. BACKGROUND

The objective of this section is to put into context the subject of reduced voice channel spacing and explain why it is required. A description of the current VHF communications environment is provided in terms of institutional, operational and technical aspects. It is followed by a high level description of the problems giving rise to the need for regulatory action.

3.1 Operational, technical and institutional environment

3.1.1 Institutional

The frequency band 117.975 - 137 MHz is allocated on a worldwide basis to the Aeronautical Mobile Route Service (AM(R)S) and is used mainly for air/ground voice communications and air/ground data communications.

Each State has its own Telecommunications Administration authority which is normally the responsible for regulating the use of the radio spectrum. For the bands allocated to aeronautical services such as AM(R)S, this responsibility is often delegated to the Civil Aviation Authority of the State. In the European Region, activities relating to frequency co-ordination in the band, including the maintenance of the list of all VHF communications assignments, are handled on behalf of ICAO by EUROCONTROL.

Before a new frequency assignment can be made, it must be co-ordinated in order to give all potentially affected authorities in neighbouring States the opportunity to check that the proposed new assignment is compatible with existing assignments in their State. If an incompatibility is found, an objection can be raised. As a result of congestion in the VHF communications band, the ICAO Frequency Management Group (FMG) hold special meetings every 6 months to address those requirements for which an available channel can only be identified by moving one or more existing assignments to another channel.

3.1.2 Operational

The Aeronautical Mobile Route Service frequencies band (117.975–137 MHz) is the main communications band for line-of-sight air-ground communications and is used at all airports, for en route, approach and landing flight phases and for a variety of short-range tasks for general aviation and recreational flying activities (e.g. gliders and balloons).

To satisfy increased frequencies demand and reduce frequency congestion in high-density traffic areas, the channel width has been reduced on four occasions (from 200 kHz to 100 kHz in the 1950s, to 50 kHz in the 1960s, to 25 kHz in 1972 (Seventh Air Navigation Conference) and finally to 8.33 kHz starting in 1995.

Within this band we can find the following users and services (non-exhaustive list):

- Common air-to-ground frequencies which have been assigned to general aviation operations and sporting use such as the glider frequencies.
- Aeronautical fire station assignments.
- Air/Ground (A/G) – A two way communication between an aircraft and a ground station to pass advisory information regarding the situation local to the aerodrome.

- Aerodrome Flight Information Service (AFIS) – A two way communication between an aircraft and a ground station, in which the ground operator may only pass advisory information regarding the airborne situation local to the aerodrome but can pass instructions to aircraft on the ground at the aerodrome.
- Area Control Centre Service (ACC) - A two way communication between an aircraft and a ground station, in which the ground operator provides control instructions to the aircraft within a defined geographical region or sector.
- Approach (APP) - A two way communication between an aircraft and a ground station, in which the ground operator controls the aircraft in the vicinity of an aerodrome traffic zone when the aircraft is not flying by visual reference to the aerodrome.
- Automatic Terminal Information Service (ATIS) - A broadcast transmission from a ground station to one or more aircraft in which information relating to the aerodrome from which the transmission is being made is conveyed.
- Aerodrome Surface (AS) – A two way communication between an aircraft and a ground station, in which the ground operator provides either control to or information for an aircraft on the ground. This category includes Ground Movement Control (GMC) & Fire.
- Flight Information Service (FIS) - A two way communication between an aircraft and a ground station, in which the ground operator may only pass advisory information as requested by the pilot. This information may include situation awareness and weather information.
- VOLMET - A broadcast transmission from a ground station to one or more aircraft in which meteorological information relating to a number of aerodromes is provided.
- Tower (TWR) - A two way communication between an aircraft and a ground station, in which the ground operator controls the aircraft in the vicinity of an aerodrome traffic zone when the aircraft is flying with visual reference to the aerodrome.
- Operational Control (OPC) - A two way communication between an aircraft and a ground station required for the exercise of authority over the initiation, continuation, diversion or termination of flight for safety, regularity and efficiency reasons.

Frequency 121.5 MHz is the aeronautical emergency frequency and is designated in the Radio Regulations for general distress and safety and Emergency Locator Transmitter (ELT) purposes. Frequency 123.1 MHz is the frequency designated as the auxiliary to 121.5 MHz. This frequency is to be used as a supplementary search and rescue frequency.

Frequency 123.450 MHz is the frequency designated for air-air communications between aircraft engaged in flights over remote and oceanic areas and while out of range of VHF ground stations.

3.1.3 Technical

The technical characteristics of transmissions in the VHF communications band are specified in Annexes 10 and 11 to the Convention on International Civil Aviation. In addition, the equipment, services, systems and facilities must comply with the applicable Radio Regulations of the International Telecommunication Union (ITU).

The equipment and systems should be designed and constructed to operate within the AM(R)S allocation 117.975 MHz to 137.000 MHz, the first and last assignable frequencies being 118.000 MHz and 136.975 MHz. Channel spacing is either 25 kHz or 8.33 kHz using Double Sideband (DSB) Amplitude Modulation (AM).

3.2 Issues giving rise to a need for regulation

The original ICAO decisions concerning the requirement for 8.33 kHz channel spacing were made in 1994 and 1995, and have since been substantiated by numerous subsequent ICAO and EUROCONTROL decisions. In practice, the non-binding nature of these decisions has led to situations where certain Stakeholders have only partially committed to supporting the implementation of 8.33 kHz. In view of the worsening European frequency congestion situation, the need to ensure full commitment has been the main driver for the development of regulation relating to 8.33 kHz channel spacing.

The main issues that have led to the need for regulation are now discussed.

3.2.1 Frequency Congestion and its Consequences

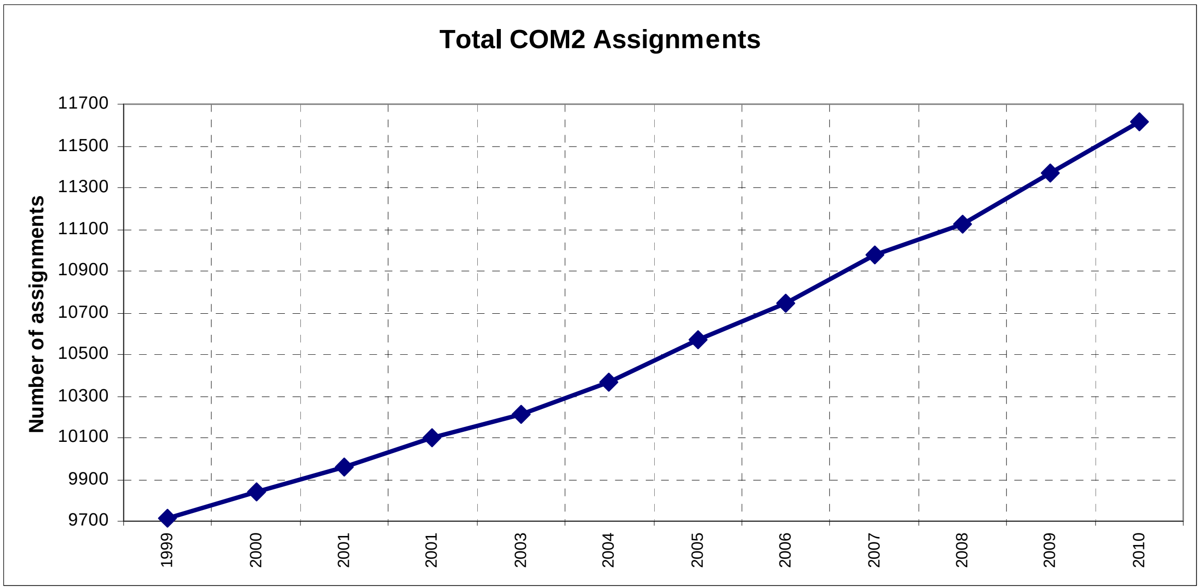
The Aeronautical Mobile Route Service (AM(R)S) band (i.e. from 117.975 MHz to 137 MHz) can support 760 channels in the band with channels spaced by 25 kHz. Those 760 channels are not allocated once, but rather re-used (i.e. assigned) as many times as possible. The same channel can be used again at a different location as long as the distance between them is sufficient to avoid interference. Frequency planning rules have been derived by ICAO to determine when frequency re-use is possible. These rules minimise the risk of a user experiencing interference from other users of the same frequency.

The situation is, therefore, that there are a finite number of channels and fixed planning rules, yet continued demand for new frequency assignments.

The introduction of channels spaced by 8.33 kHz theoretically enables 3 times more channels than using 25 kHz spacing, though in practice the 3-to-1 assignments ratio can not always be achieved because of adjacent 25 kHz assignments and other technical problems.

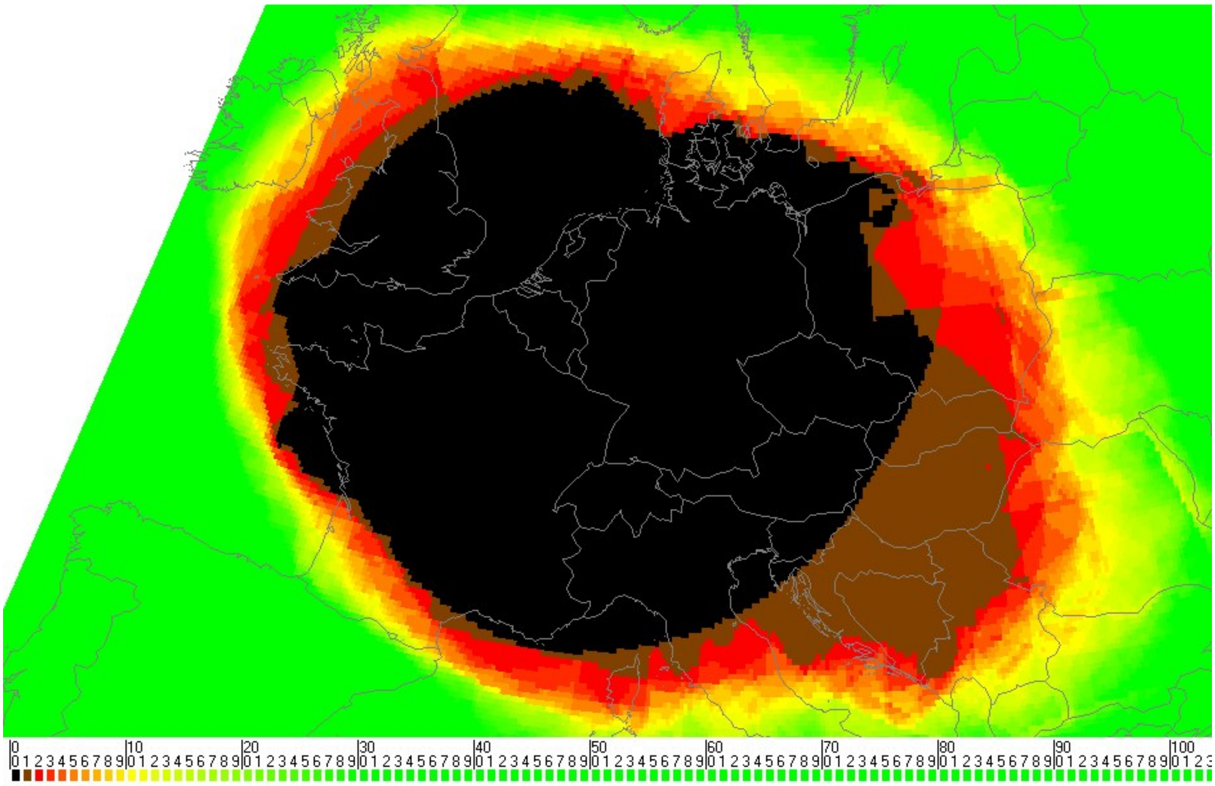
The conversion to 8.33 kHz channel spacing of the European airspace above Flight Level 195 has reduced frequency congestion, however the demand for new assignments has continued and core area States are finding increasing difficulty to satisfy the demand for new frequency assignments.

The chart below shows the evolution of the total number of assignments in the Aeronautical Mobile Route Service band for the past 10 years. Its continuous growth does not seem to be significantly affected by economic crises nor air traffic reductions.



When a State needs a new frequency assignment for voice communications (or to modify the use of an existing one) the relevant authority will check in the ICAO table listing all existing assignments (also known as the COM2 table) and if they can find a frequency available that meets all the requirements (i.e. respects the planning rules) they will publish their intention to use it. If no other State objects to the new assignment in the following 30 days, the assignment will be granted. The frequency congestion in the central European region means that a readily available frequency can rarely be found.

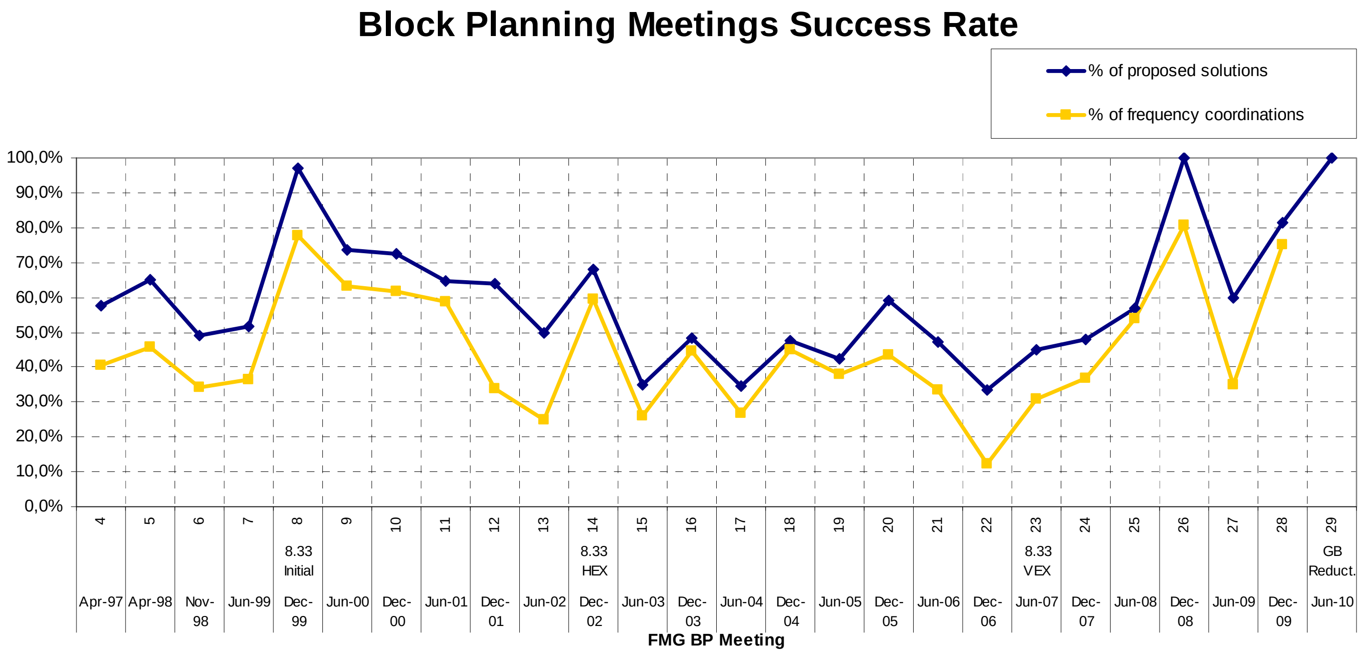
The following diagram depicts the amount of Area Control Centre (ACC) frequencies directly available at any European geographical location. These frequencies require big protection areas as the assignment must protected up to FL450. For the central European States it is impossible to find an ACC frequency directly available.



When the desired frequency can not be found directly, the State (or their designated representative) can introduce a request in an ICAO Frequency Management Group (FMG) Block Planning (BP) meeting. FMG BP meetings take place every six months. At these meetings “frequency shifts” will be attempted in order to satisfy the request. Frequency shifts are changes of existing frequency assignments in order to “make room” for the new assignment. Up to 5 shifts may be proposed to satisfy the new request, and the need for 3 or 4 shifts is not uncommon.

If a solution can be found by proposing shifts, the holders of the frequencies to be shifted (usually neighbouring countries) have up to 6 months to implement the frequency changes and at the following FMG BP meeting the new request will be implemented (i.e. coordinated in the COM2 table). Often some shifts can not be implemented for various technical reasons and at the following FMG BP meeting, if the State re-submits the request, a different solution will be sought for.

The following chart shows the success rate of the BP meetings for all the European States. Its shows the evolution of the percentage of requests for which a solution could be found (% of proposed solutions) and the percentage of those solutions that were actually implemented (% of frequency coordinations).



For more than ten years it has been impossible to quickly satisfy all frequency requests at BP meetings. The chart above shows the dates for the implementation of 8.33 above FL245 in the initial States (8.33 Initial), the horizontal extension to all European States (8.33 HEX), the vertical extension to all airspace above FL195 (8.33 VEX) and the recent reduction of the Emergency Frequency guard band size (GB reduct.). The 8.33 implementation has improved the BP meetings success rate, but the continued demand for new assignments has kept the success rate low.[1] The chart above shows an European average, the success rate is much smaller for the central European countries and much bigger for countries in the periphery.

The forecast produced by the experts at the ICAO Frequency Management Group (FMG) shows that unless something is done the situation is going to worsen gradually and by 2015 less than 50% of the frequency requests will be satisfied (see annex 5).

All proposed solutions to the frequency shortage problem have been analysed. In addition to extending 8.33 kHz spacing the main candidates were optimising frequency usage and making use of new technologies. Improvements can be made in the current management of frequencies, but these will not be enough to meet all the forecasted demand in the next years. The new technologies currently under development by SESAR are not expected to significantly change the usage of voice up to 2030. The only realistic, validated option to solve the medium to long term VHF congestion problems is the further deployment of air-ground voice communications based on 8.33 kHz channel spacing. The Impact Assessment section below provides the details of all analysed options.

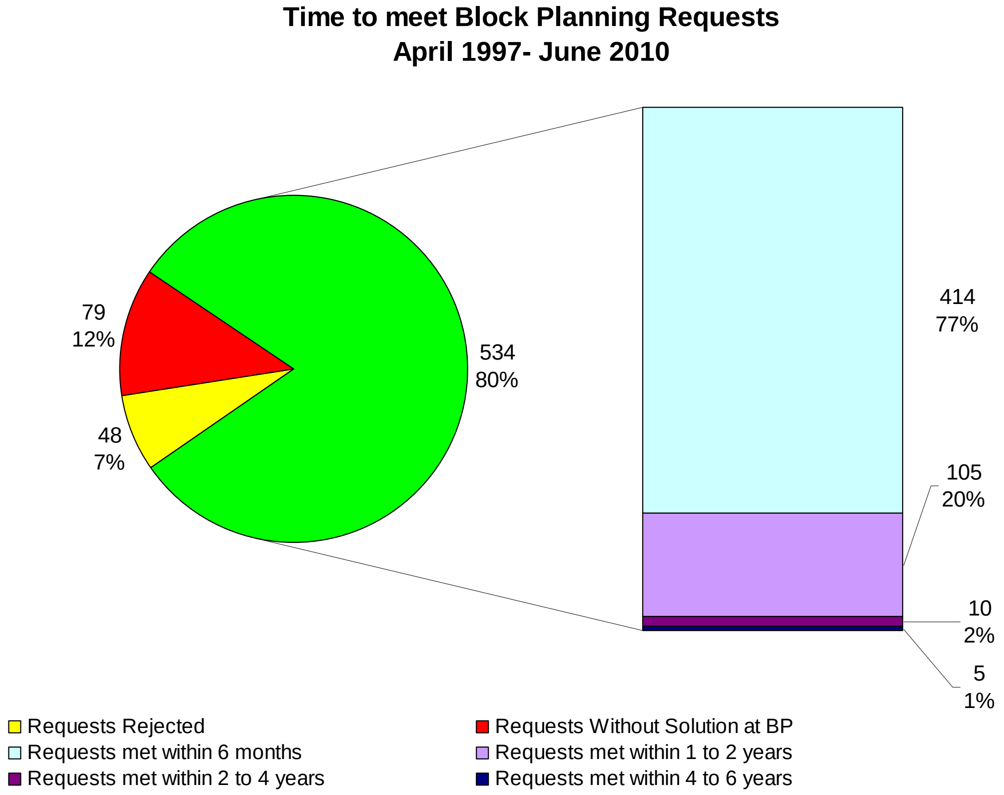
[1] Improvements to the frequency planning approach that have increased the success rate have also been implemented during the last 10 years.

The inability to provide suitable frequency assignments in a timely manner is a constraint to the delivery of operational improvements such as:

- The creation and modification of sectors to better match traffic flows;
- The creation and modification of services like approach, tower, ATIS and OPC;
- The provision of backup services and spare assignments for avoiding interference;
- Satisfying Pan-European requirements such as accommodating VHF Data Link (VDL) services in the band 136.700 to 136.975 MHz.

These operational improvements deliver benefits such as reduced delays and increased capacity that would be postponed if the additional frequencies required are not readily available. An assessment of the potential economic impact of these delays is provided in the Impact Assessment section below.

The following diagram provides a graphical overview of the time required to meet Block Planning frequency requests.



The need to maximise the number of 25 to 8.33 kHz timely conversions to reduce the European frequency congestion is the main issue that has led to the need for regulation.

3.2.2 Coordinated Deployment

The regulatory work will build upon the existing A-VCS IR by enlarging its scope so as to address the airspace below FL195. It will define enforceable obligations on the Member States, ANSPs and airspace users, compelling them to meet their obligations with regard to:

- The ground deployment of 8.33 kHz spaced channels, by addressing the 25 kHz to 8.33 kHz conversions, associated with specific timescales;

- The enforcement of mandatory carriage in order to mitigate against non-8.33 kHz equipped aircraft entering 8.33 airspace and to reduce controller workload in transition zones;
- The handling of non-8.33 kHz equipped State aircraft;
- The requirements specific to ATM systems relating to 8.33 kHz operations.

The need to ensure a coordinated implementation of 8.33 below FL195 to meet the overall European frequencies requirements is an issue that has led to the need for regulation.

3.3 Benefits of the Regulatory Action

The regulatory action will compel Stakeholders to meet their obligations relating to a common and harmonised deployment of 8.33 kHz channel spacing. This is essential in order to maximise frequency planning benefits, whilst minimising any negative impact on operations, and maintaining safety levels. Without this regulatory action, States would aim at maximizing local benefit which would lead to an uncoordinated deployment that could impact safety and may not timely meet the forecasted European demand of new frequencies.

3.4 Basis for regulatory action

3.4.1 Single European Sky Initiative

The Single European Sky initiative aims are to encourage safe, efficient and dynamic use of European airspace. To that end a legislative package including an interoperability Regulation has been put in place. This interoperability Regulation (Regulation (EC) 552/2004 No amended by Regulation (EC) No 1070/2009) addresses the measures to be adopted in relation to constituents, systems and associated procedures with the objective of ensuring the interoperability of the European Air Traffic Management Network (EATMN), in terms of essential requirements applicable to the EATMN.

The interoperability Regulation also specifies that Implementing Rules for interoperability should be drawn up for systems, whenever necessary to complement or further refine the essential requirements. The Implementing Rules should also be drawn up where necessary to facilitate the coordinated introduction of new, agreed and validated concepts of operations or technologies.

3.4.2 Essential Requirements

As described in the above paragraph, the interoperability Regulation specifies that the Implementing Rules are to be developed where necessary in order the refine and complement the essential requirements. Therefore, the draft Implementing Rule on 8.33 kHz channel spacing has to ensure the traceability to the essential requirements it refines and complements. The complete set of essential requirements applicable to the EATMN is described in the Annex II of the SES interoperability Regulation but it is important to note that not all of these requirements are to be reflected in the draft Implementing Rule on 8.33 kHz channel spacing.

It is considered that the essential requirements complemented and refined by the draft Implementing Rule are as follows:

- Seamless operation – the draft Implementing Rule will address the deployment of voice communications based on 8.33 kHz channel spacing in a consistent and coordinated way. This will ensure the achievement of seamless operations with regard to the voice communications within the area of applicability of the Implementing Rule.

- Support for new concepts of operation – the 8.33 kHz channel spacing as defined in the draft Implementing Rule will represent a prerequisite for the availability of VHF frequencies needed for the implementation of several operational improvements (e.g. accommodation of VHF Data Link services in the band 136.700 to 136.975 MHz, creation and modification of sectors to better match traffic flows, provision of backup services, etc).
- Civil-military co-ordination – the draft Implementing Rule will complement this essential requirement by addressing the accommodation of the State aircraft within the applicability area, the associated exemptions and transitional arrangements specific to this type of traffic.

The draft Implementing Rule on 8.33 kHz channel spacing in the airspace below FL195 is not expected to have a direct impact on the other Essential Requirements set out in the Annex II of the SES interoperability Regulation.

4. DETERMINATION OF REGULATORY PROVISIONS

4.1 General

The determination of the regulatory provisions takes fully into account the existence of the Commission Regulation (EC) No 1265/2007 which already includes requirements already applicable in the airspace below Flight Level 195 (e.g. the phraseology) or requirements which are generically applicable to systems or constituents (e.g. requirements for the verification of compliance).

Several practical solutions for the update of the existing Regulation (i.e. an amendment of the Regulation, a new Regulation complementing (EC) No 1265/2007, or a new Regulation addressing the entire airspace and repealing Regulation (EC) No 1265/2007) were analysed and discussed with the European Commission. It was decided to develop a new Regulation consolidating the relevant requirements coming from Regulation (EC) No 1265/2007 supplemented as necessary so as to reflect the phased deployment of 8.33 kHz communications in the entire airspace of applicability. Following this approach, at the entry into force of the new Regulation, the Regulation (EC) No 1265/2007 will be repealed as its requirements will be reflected in the new proposed Regulation.

4.2 Regulatory coverage

The regulatory coverage identifies all subjects to be submitted to regulatory requirements in the draft Implementing Rule so as to ensure interoperability, as well as the nature of these requirements for each subject. These requirements come from Regulation (EC) No 1265/2007, modified where necessary (e.g. requirements which would otherwise have a retroactive applicability at the entry into force of the new implementing rule) or are derived from the enlargement of the scope of Regulation (EC) No 1265/2007 so as to address the airspace below FL 195 and finally the conversion of all the frequency assignments within aeronautical mobile radio communication service band, without prejudice to specific exemptions.

These subjects are as follows*:*

- The scope of the draft Implementing Rule in terms of impacted systems as well as area of applicability including the airspace where the carriage of 8.33 kHz capable radios will be mandatory. The draft Implementing Rule will apply to the airspace of the ICAO EUR region where the EU Member States are responsible for the provision of air traffic services as defined in Article 3 of the SES airspace Regulation (Regulation (EC) No 550/2004 amended by Regulation (EC) No 1070/2009). However it is important to observe that the applicability of the requirements will follow a phased approach in space as well as in time. The carriage and conversion requirements will first apply in specific airspaces of a sub-set of Member States (mainly central European) the scope being enlarged later on to the entire airspace and all assignments (particular exemptions being identified). In terms of systems the draft Implementing Rule applies to all voice communication systems operating in the aeronautical mobile radio communication service band 117.975 – 137 MHz.

  In order to support the deployment of 8.33 kHz the draft rule maintains the requirements coming form Regulation (EC) No 1265/2007 applicable to flight data processing systems, allowing the transmission of information about the 8.33 kHz capability of flights between air traffic control units.

  It should be noted that the requirements relative to the deployment of 8.33 kHz above FL 195 will remain. They will be applicable from the date of entry into force of the implementing rule which will coincide with the date when Regulation (EC) No 1265/2007 will be repealed. As such the continuity in the application of the regulatory requirements will be ensured.

- The obligations of the regulated parties: operators, Air Navigation Service Providers, Member States, manufacturers, in terms of interoperability and performance requirements – these requirements reflect the significant scope enlargement brought by the deployment of 8.33 kHz communications in the airspace below FL 195. While in Regulation (EC) No 1265/2007 the similar requirements were focussing on the Air Navigation Service Providers and operators, the new regulation also brings new requirements on the manufacturers of VHF radios and on the Member States. These requirements reflect the deployment principles of forward fit, of an interim phase in a sub-set of Member States and of a final phase applicable in the entire area of applicability.

  As the definition for “conversion” includes the publication in the ICAO COM2 table of the new 8.33 kHz assignment, which is a State responsibility, the obligations on the Member States also refer to the conversions of the 25 kHz frequencies to 8.33 kHz frequencies whenever this will be feasible. With this regard, the draft Implementing Rule differentiates between the Member States subject to the interim phase and the other Member States. The former will have to implement the interim phase while all the Member States will have to comply with the final phase. It should be noted that the draft Implementing Rule identifies specific situations for which the assignments will not have to be converted. Moreover, for cases not identified in the draft text but which will still preclude the conversion to 8.33 kHz assignments as required by the regulatory requirements, the proposed text defines a mechanism for informing the Commission (for non-compliances with the interim phase) or for requesting exemptions from the Commission (for non-compliance with the final phase). In this later situation the Commission may grant exemptions following a decision taken according with the comitology procedure.

  The ANSPs will have to ensure compliance with the requirements relative to the application of procedures, accommodation on non-equipped State aircraft, safety and verification of compliance as already defined Regulation (EC) No 1265/2007.

  As the regulatory requirements have a broader scope than the Air Navigation Service Providers and the operators (e.g. users of hand-held radios, radios operated by fire-fighters on the airports, etc) it is proposed to address these Stakeholders through the Member States. As such the implementing rule will include within its scope all the “users” of VHF radios operated in the aeronautical mobile radio communication service band accommodating all the local specificities.

  One of the main groups of “users” of VHF radios is the operators therefore they are specifically identified in the draft Implementing Rule. The obligations refer to the carriage of radios having the 8.33 kHz channel spacing capability according with the phased implementation (the interim and the final phase) as well as to the application of specific procedures (e.g. phraseology and flight planning). It should be noted that the requirements applicable to the procedures are reflecting the content of Article 4 of Regulation (EC) No 1265/2007 which was applicable above and below FL 195.

  A specific requirement is put on the manufacturers ensuring that the VHF radios, intended to operate within aeronautical mobile radio communication service band put on the market after 1 year from the entry into force of the Implementing Rule, will have the 8.33 kHz channel spacing capability. This requirement will supplement the requirement on manufacturers already existing in Regulation (EC) No 1265/2007 addressing the obligations relative to the verification of compliance.

Whenever compliance with the applicable requirements of the ICAO Annex 10 is required, the relevant requirements are put on the users of ground/airborne installations of voice communication systems explicitly including portable and handheld 8.33 kHz communication systems in order to maintain the alignment with the text of ICAO Annex 10 and to ensure that all users are included in the scope of the draft Implementing Rule. With this respect the draft text also proposes a definition for "user of voice communication systems".

The draft Implementing Rule is developed along the lines identified above, with requirements covering all these subjects. It should be noted that besides the requirements addressing the subjects mentioned above, the draft Implementing Rule addresses as described in the sections below the handling of the State aircraft, the conformity assessment requirements, and the implementation conditions.

4.3 Conformity assessment

The conformity assessment requirements are directly derived from the "Verification of compliance" requirements of the SES interoperability Regulation (EC) No 552/2004 as amended by Regulation (EC) 1070/2009. It should be noted that the obligations for the issuance of specific EC declarations for constituents and for systems, coming from the SES interoperability Regulation were further detailed in Regulation (EC) No 1265/2007. It is not expected these requirements to change due to the deployment of 8.33 kHz channel spacing in the airspace below FL 195 therefore the requirements already defined in Regulation (EC) No 1265/2007 (its Articles 7 and 8 and Annexes III and IV) are transferred without modification to the draft Implementing Rule.

However it may be possible that the enlargement of scope of the draft Implementing Rule will bring new Stakeholders within the framework of the rule (e.g. manufacturers of hand held radios will have to produce 8.33 kHz capable radios, if not already the case, therefore will have to follow the specific requirements applicable to constituents as defined in the draft Implementing Rule).

It should be noted that according with the changes brought by the second package of the Single European Sky legislation, notably in the field of verification of compliance, a certificate issued by the European Aviation Safety Agency, where it applies to constituents or systems, shall be considered, an appropriate EC declaration, if it includes a demonstration of compliance with the applicable interoperability, performance and safety requirements of the draft implementing rule. Therefore the draft Implementing Rule reflects this alternative process applicable to constituents and/or systems.

4.3.1 *Purpose of conformity assessment requirements*

The purpose of conformity assessment requirements is to mandate the implementation of verification of compliance of EATMN constituents and systems supporting air-ground voice communications based on 8.33 kHz channel spacing with the relevant requirements of the Implementing Rule.

It should be noted that the EC declaration of verification shall be without prejudice to any assessments that the National Supervisory Authority may need to carry out on grounds other than interoperability, as an important aspect of the air-ground voice communications. In this context, in the recitals section of the text, the complementarity of the draft Implementing Rule to Directive 1999/8/EC (the R&TTE Directive) is acknowledged. However the conformity assessment requirements included in the rule will be limited to the compliance with the requirements specific to the draft Implementing Rule for the deployment of air-ground voice communications based on 8.33 kHz channel spacing.

4.3.2 Identification of systems supporting air-ground voice communications

The SES framework Regulation (EC) No 549/2004 amended by Regulation (EC) No 1070/2009 defines "system" as "the aggregation of airborne and ground-based constituents, as well as space-based equipment, that provides support for air navigation services for all phases of flight".

These systems are identified in Annex I of the interoperability Regulation. As already defined in Regulation (EC) No 1265/2007, the systems (and procedures) impacted by the draft Implementing Rule, therefore subject to conformity assessment requirements are as follows:

- Systems for air-ground communications.
- Flight data processing systems.

The determination of conformity assessment requirements must apply to the above list of systems.

4.3.3 *Determination of conformity assessment requirements for EATMN constituents*

The Implementing Rule specifies the requirements to be respected by the applicable manufacturers of constituents, before issuing an EC declaration of conformity or suitability for use.

Beside the end-to-end performance requirements of the voice communication systems, the rule explicitly identifies the transmitter/receiver ground constituent together with the specific performance requirements applicable to it.

In what concerns the conformity assessment procedure for constituents, as already the case in Regulation (EC) No 1265/2007, the Annex IV Parts A and B of the draft Implementing Rule define a minimum acceptable approach, based on the Module A (internal production control) as defined in Annex II of Decision No 768/2008/EC of the European Parliament and of the Council of 9 July 2008 on a common framework for the marketing of products, and repealing Council Decision 93/465/EEC. This will allow the manufacturer (or his authorised representative established within the Community) to declare ("self certify") that the constituents concerned satisfy the requirements of the draft Implementing Rule.

4.3.4 *Determination of conformity assessment requirements for EATMN systems*

The basic principle is to specify conformity assessment requirements for each EATMN system supporting voice communications based on 8.33 kHz channel spacing. Therefore the verification of compliance with requirements that are not specific to 8.33 kHz channel spacing (e.g. requirements related to the voice communications in general, irrespective of the channel spacing) is outside the scope of this Implementing Rule.

As already specified in Regulation (EC) No 1265/2007 the requirements applicable to the verification of systems consider both cases, when a notified body is or is not involved in the verification activities, depending on conditions to be fulfilled by the Air Navigation Service Providers. These conditions are defined in the Annex V of the Implementing Rule.

4.4 Implementation conditions

4.4.1 *Implementation dates*

The requirements relative to the implementation conditions identify the dates when different Stakeholders subject to the draft Implementing Rule will have to comply with the regulatory requirements, taking into account that overall, the draft Implementing Rule will entry into force 20 days after the publication in the Official Journal of the European Union. Therefore, even if the requirements will be applicable 20 days after publication in the Official Journal of the European Union, whenever a specific implementation date is identified in the proposed regulatory requirements, it should be interpreted as the latest date by which the Stakeholders will have to ensure compliance with the applicable requirement.

These requirements address the 8.33 kHz channel spacing capability of radios as well as the conversion of 25 kHz to 8.33 kHz channels. They reflect the phased approach proposed in the draft Implementing Rule in terms of interim and final phase of deployment.

It should be noted that some of the requirements relative to the deployment of 8.33 kHz channel spacing in the airspace above FL 195, coming from the Regulation (EC) No 1265/2007, do not have an implementation date anymore as these requirements now occur in the past (e.g. requirements with implementation dates in 2008 or 2009). These requirements have to be included in the new Implementing Rule due to the fact that Regulation 1265 (EC) No 1265/2007 will be repealed. As these requirements should have already been implemented they will not have a deferred compliance date, being mandatory from the date of entry into force of the new Regulation, the same date when Regulation 1265 (EC) No 1265/2007 will be repealed. Through such a mechanism no gaps will be created in the legal basis for the deployment of 8.33 kHz communications.

4.4.2 *Criteria for exemption*

The Implementing Rule identifies specific criteria allowing the Stakeholders to be exempted from the application of the regulatory requirements in certain cases. With regard to the ground systems, these criteria identify the situations when the ANSPs do not have to make the 25 kHz to 8.33 kHz conversions. These criteria will apply for assignments where 25 kHz offset-carrier system (Climax) is utilised, assignments that have to stay in 25 kHz as a result of a safety requirement or 25 kHz assignments used to accommodate State aircraft. This list is not exhaustive therefore the draft text allows the Member States not to fulfil the conversion requirement for cases other than those identified in the draft Implementing Rule, subject to approval by the European Commission, following the opinion of the Single Sky Committee.

Several criteria for exemption from 8.33 kHz mandatory equipage are also identified for certain categories of State aircraft (see section 4.5) with the observation that these non-8.33 equipped aircraft are to be accommodated in the area of application of the Implementing Rule provided that they can be safely handled within the capacity limits of the ATM system on UHF or 25 kHz VHF assignments therefore in specific instances these aircraft may be refused the provision of service.

4.5 State aircraft

The regulatory requirements concerning the State aircraft address the obligations of the Member States to equip the State aircraft flying GAT with 8.33 capable radios as well as the acceptable exceptions to these obligations and the provisions applicable to the ANSPs for the handling of non-8.33 kHz equipped State aircraft (within the safety and capacity limits). These requirements are following the same principles as those defined in the Regulation (EC) No 1265/2007 (Article 5 on State aircraft).

The carriage requirements are similar with those applicable to “civil” aircraft (e.g. forward fit followed by retrofit) taking also into account the specific constraints applicable to State aircraft (e.g. large fleets, long procurement cycles, etc). The proposed text identifies particular situations when the equipage of State aircraft with 8.33 kHz capable radios cannot take place within the required timeframes, requiring the Member States to provide relevant information to the European Commission for these cases. It should be noted that the proposal provides for a generic exemption for the State aircraft which will be withdrawn from the operational service by 31 December 2025.

The air traffic service providers will have to ensure that non-equipped State aircraft will be accommodated, either on UHF or on 25 kHz assignments. However this accommodation is conditioned by the ability of safely handling these aircraft within the capacity limits of the air traffic management system, therefore it may happen that in particular circumstances the provision of service will be refused to non-equipped aircraft.
In order to ensure the proper transparency of the way the Regulation is implemented, notably the requirements relative to the handling of non-equipped State aircraft, the proposed text maintains the requirements defined in Regulation (EC) 1265/2007, for the air traffic service providers to communicate to the Member States their plans for handling the non-equipped State aircraft.

4.6 Articulation with means of compliance

In accordance with the basic principles of the "New Approach"[2], the Implementing Rule should not unduly mandate detailed technical requirements. These detailed requirements should be left at the level of Community specifications nominated as means of compliance with the Implementing Rule. The Community specifications are voluntary standards developed by EUROCONTROL in the case of operational standards or by the European Standardisation Bodies in cooperation with EUROCAE, in the case of technical standards. With regard to the airborne components, the EASA Certification Specification will also provide acceptable means of compliance.

The draft Implementing Rule having as main objective to enlarge the scope of the existing Regulation (EC) No 1265/2007 it is considered that the means of compliance which were envisaged in the context of the EUROCONTROL Final Report for the Regulation (EC) No 1265/2007 are still relevant. These means of compliance will address:

- Equipment standards for ground and airborne radios.
- Detailed procedures supporting the Regulation with regard to flight planning.
- Message definition and data insertion rules with regard to requirements addressing the flight data processing systems.

Further details will be provided in the associated document part of the Final Report.

4.7 Scope and objective of the draft Implementing Rule

4.7.1 *Scope*

The objective of the draft Implementing Rule on 8.33 kHz channel spacing is to enlarge the scope of the deployment of 8.33 kHz channel spacing in the aeronautical VHF band (117.975 to 137 MHz) to the entire European airspace, in a phased manner, as a means of satisfying the future demand for VHF assignments.

4.7.2 *Objective*

Based on the principles described in the previous sections of this document as well as on the results of the implementation of Regulation (EC) No 1265/2007 in the airspace above FL 195, the scope of the draft Implementing Rule will address:

- Maximisation of the frequency planning benefits arising from the deployment of 8.33 kHz channel spacing;

2 The "New Approach", defined in a Council Resolution of May 1985, represents an innovative way of technical harmonisation. It introduces, among other things, a clear separation of responsibilities between the EC legislator and the European standards bodies CEN, CENELEC and ETSI in the legal framework allowing for the free movement of goods.

- The definition of the airspace in which the airborne carriage and operation of 8.33 kHz channel spacing radio equipment is mandatory, following the phased deployment;

- the requirements for the forward-fit of 8.33 capable radios as well as 8.33 capability of radios put on the EU market after a certain date;

- The requirement for the mandatory airborne carriage and operation of 8.33 kHz channel spacing radio equipment in the defined airspace;

- The requirement for provisions relating to the handling of non-8.33 kHz State aircraft;

- The requirement for the conversion of ground-based systems from 25 kHz channel spacing to 8.33 kHz channel spacing operation;

- The acceptable criteria for non-compliance with the requirement to convert ground based systems from 25 kHz channel spacing to 8.33 kHz channel spacing operation;

- The high level requirements for ATM systems and procedures relating to 8.33 kHz operations;

- The timescales for the above.

5. STRUCTURE OF THE DRAFT IMPLEMENTING RULE

This section presents the Implementing Rule, based on the conclusions of the Regulatory Approach, and on the structure presented in Section 4 above. This overall structure of the proposed rule is defined in terms of preamble, enacting terms and annexes. It is fully aligned with the best practices in drafting of regulatory material, as described in the "Joint Practical Guide for the drafting of Community legislation" and follows the same structure as Regulation (EC) No 1265/2007. Therefore the new text maintains the same organisation in terms of articles as Regulation (EC) No 1265/2007.

The preamble contains the citations and recitals traceable to the articles included in the Implementing Rule, providing the legal basis and statement of reasons for the draft Implementing Rule.

The enacting terms are structured on articles, as follows:

- Objective and scope – the article defines the high level objective of the Implementing Rule (deployment of air-ground voice communications based on 8.33 kHz channel spacing as already mentioned in Regulation (EC) No 1265/2007) as well as the scope, in terms of EATMN systems impacted by the Implementing Rule, the airspace of applicability and the types of flights concerned by the regulatory requirements as well as the assignments which will not have to be converted to 8.33 kHz. .

- Definitions – the article introduces the definitions applicable for the purpose of the Implementing Rule. It only contains those definitions applicable in addition to those defined in the SES framework Regulation (EC) No 549/2004 amended by Regulation (EC) 1070/2009, including those coming from Regulation (EC) No 1265/2007.

- Interoperability and performance requirements – it consolidates the requirements coming from Regulation (EC) No 1265/2007, supplemented with those specific to the enlargement of the scope so as to address the entire airspace. It specifies the obligations of manufacturers, Member States, operators and Air Navigation Service Providers with regard the deployment of 8.33 kHz channel spacing. The article also identifies the applicable ICAO standards, the cases when the conversions of frequency assignments is considered as not being feasible as well as mechanism of informing the European Commission in cases of non-compliance, either in the interim of in the final phase.

- Associated procedures – the article identifies the applicable procedures that have to be respected by the operators and controllers for the air-ground voice communications (phraseology) as well as for the flight planning and the obligation for the inclusion of the procedures applicable to 8.33 kHz and non-8.33 kHz equipped aircraft in the Letters of Agreement between air traffic control units. Its content reflects the fact that the similar article of Regulation (EC) No 1265/2007 (Article 4 on Associated procedures) was already applicable in the airspace below FL 195 therefore the modifications brought to the text in the context of the new draft were minimal. However the new text takes into account the new ICAO flight plan format which will become applicable as from 15 November 2012.

- State aircraft – the article contains the requirements concerning the equipage or the handling of the non-8.33 kHz equipped State aircraft. It is derived from the equivalent article in Regulation (EC) No 1265/2007, reflecting also the scope enlargement of the draft Implementing Rule. It maintains the requirements specific to the deployment of 8.33 kHz channel spacing in the airspace above FL 195 (e.g. the differentiation between "transport-type" and "non-transport-type" State aircraft) supplemented with requirements addressing the forward-fit as well as the widespread deployment of 8.33 kHz channel spacing in the entire airspace of applicability, in the final deployment phase. As in Regulation (EC) No 1265/2007, the article also identify the obligations of the air traffic service providers to develop and communicate plans for handling the non-equipped State aircraft as well as to accommodate non-equipped State aircraft according to these plans, within the safety and capacity limits of the ATM system.

- Safety – the article defines the generic obligation for Member States to ensure that in the context of a safety management process, a safety assessment is conducted prior to the implementation of the Implementing Rule. The requirements that shall be considered in this process are identified in Annex III.

- Conformity or suitability for use of constituents – the article is directly traceable to the equivalent article of Regulation (EC) No 1265/2007 and provides the reference to the Annex (IV – A and B) describing the requirements to be followed before issuing an EC declaration of conformity or suitability for use, based on the Module A (internal production control) as defined in Annex II of Decision No 768/2008/EC of the European Parliament and of the Council of 9 July 2008 on a common framework for the marketing of products, and repealing Council Decision 93/465/EEC. It also provides an equivalent path for the verification of compliance and for the issuance of appropriate certificates, based on the EASA certification process, as defined in the interoperability Regulation amended by the second package of the Single European Sky.

- Verification of systems - the article is directly traceable to the equivalent article of Regulation (EC) No 1265/2007 and refers to the annexes (IV-C and D) containing the requirements that shall be followed for the verification of compliance of the systems identified in the "Objective and scope" article with the regulatory requirements identified in the Implementing Rule and for the issue of the EC declaration of verification. It addresses the case when the verification of systems is conducted entirely by the Air Navigation Service Provider and the case when the verification of systems is subcontracted to a notified body. The criteria based on which an Air Navigation Service Provider can conduct the verification activities without involving a notified body are defined in Annex V to the Implementing Rule. The article also provides an equivalent path for the verification of compliance and for the issuance of appropriate certificate, based on the EASA certification process, as defined in the interoperability Regulation amended by the second package of the Single European Sky.

- Additional Requirements - the article is directly traceable to the equivalent article of Regulation (EC) No 1265/2007 and identifies several requirements that support the compliance of the Stakeholders with the regulatory requirements addressing procedures, without leading to the issue of an EC certificate. The objective is to ensure that the personnel impacted by the Implementing Rule are duly aware about the provisions of the rule through the provision of adequate training, the availability of accessible and up-to-date operations manuals as well as the definition of working methods and operating procedures compliant with the requirements of the implementing rule. These requirements supporting compliance are to be applied by the Air Navigation Service Providers and by operators with regard the procedures to be followed by the controllers and by the personnel operating radio equipment. In what concerns the IFPS, the obligations are defined through the Member States that will have to take the necessary measures to ensure their application. These requirements are further supplemented by a high level requirement on the Member States to take the necessary measures to ensure that all parties within the scope of the Implementing Rule comply with it. Among these measures, the publication of the relevant information in the national aeronautical publications is explicitly identified.

- Repeals – as the new proposed regulatory text will replace the existing Regulation (EC) No 1265/2007, this article provides the legal basis for repealing the abovementioned Regulation. As this repeal will happen at the entry into force of the new text, therefore when this new text will became applicable, the continuity of the legal requirements is ensured. The article also addresses and reflects the changes brought by the new ICAO flight plan format and its applicability as from 15 November 2012.

- Entry into force and application – the article identifies the date of entry into force of the Implementing Rule.

The annexes (referenced in the articles) contain detailed requirements that shall be followed in the context of the implementation of the Implementing Rule:

- Annex I identifies the Member States where the interim deployment phase will have to be implemented.

- Annex II identifies the ICAO documents referenced in the Implementing Rule..

- Annex III provides a minimum set of requirements that shall be considered in the process of the safety assessment.

- Annex IV–A describes the requirements that have to be followed before issuing an EC declaration of conformity or suitability for use by the manufacturers of constituents identifying the Part B of the Annex as an appropriate conformity assessment procedure. Its application is without prejudice to the alternative verification path applicable to constituents, which is based on the EASA certification processes.

- Annex IV-B describes the internal production control module based on the Module A (internal production control) as defined in Annex II of Decision No 768/2008/EC of the European Parliament and of the Council of 9 July 2008 on a common framework for the marketing of products, and repealing Council Decision 93/465/EEC. As for Annex IV-A, its application is without prejudice to the alternative process applicable to constituents.

- Annex IV-C describes the requirements for the verifications of systems, when this verification is conducted by the Air Navigation Service Providers.

- Annex IV-D describes the requirements for the verifications of systems, when relevant parts of this verification are subcontracted to a notified body.

- Annex V describes the conditions that have to be fulfilled by the air traffic service provider so as to be able to conduct the verification activities without involving a notified body.

6. IMPACT ASSESSMENT

6.1 Stakeholders concerned

6.1.1 Air Navigation Service Providers (ANSPs)

ANSPs are public or private entities providing air navigation services for GAT. ANSPs within the ICAO EUR Region, have already installed some 8.33 capable radios serving airspace above FL195 in order to comply with the initial 8.33 kHz regulation, Commission Regulation (EC) No 1265/2007 published on 27 October 2007. This second phase of the 8.33 kHz regulation will require these ANSPs to convert all remaining radios to 8.33 kHz spacing in a phased manner between 2014 and 2018.

6.1.2 Commercial aircraft operators

Commercial aircraft operators are those organisations or individuals who operate aircraft as IFR/GAT for scheduled and charter operations in European airspace for commercial purposes, including executive charter companies. These airspace users comprise airlines, freight carriers and aircraft leasing and charter companies from inside and outside of the EU. This category may also include some commercial pilot training schools.

The initial implementation of 8.33 kHz channel spacing above FL195 means that most commercial aircraft operators will already have equipped their aircraft with 8.33 kHz capable radios and, therefore the impact of this second phase of the 8.33 kHz regulation will be relatively small.

6.1.3 Aerial work

Aerial work encompasses civil flights, generally carried out for commercial purposes, in which the objective is to supply a service other than the carriage of people or goods. A wide range of services are carried out (see Figure 1) but common services include surveys and photography, search and rescue and pilot training. Since most aerial work is carried out below FL195, few of the aircraft used for this work will have been equipped to meet the initial implementation of the 8.33 kHz channel spacing Implementing Rule, but this second phase of the 8.33 kHz regulation will require all aircraft used for aerial work in Europe to be equipped.

6.1.4 Private aircraft operators

Most private aircraft operating in Europe under VFR and many private aircraft operating under IFR/GAT remain below FL195 and were therefore unaffected by the initial implementation of 8.33 kHz channel spacing. However this second phase of the 8.33 kHz regulation will have a major impact on private aircraft operators, as it will apply not only to powered aircraft and helicopters but also to gliders, balloons and microlights. Therefore, there will be a major impact on general aviation. These Stakeholders will receive small direct benefits but could benefit from improved access to airspace, reduced delays for new flight information services and new GA aerodromes and the ability to organise special events.

6.1.5 Military authorities and state aircraft operators

Combat and transport aircraft operated by military authorities in Europe are being equipped with 8.33 kHz capable radios in order to comply with the initial regulation on 8.33 kHz channel spacing above FL195. However, military and state authorities operate large numbers of light aircraft and helicopters, operating below FL195, few of which are equipped with 8.33 kHz capable radios. However the rule takes into account the particular constraints of the State aircraft fleets and provides specific transitional arrangements and an exemption policy.

In addition, some military airfields will need to install 8.33 kHz radios. This will be a requirement for those airfields open to civilian aircraft but it is also likely that military only airfields will install these radios in order to monitor civilian aircraft operating in the area.

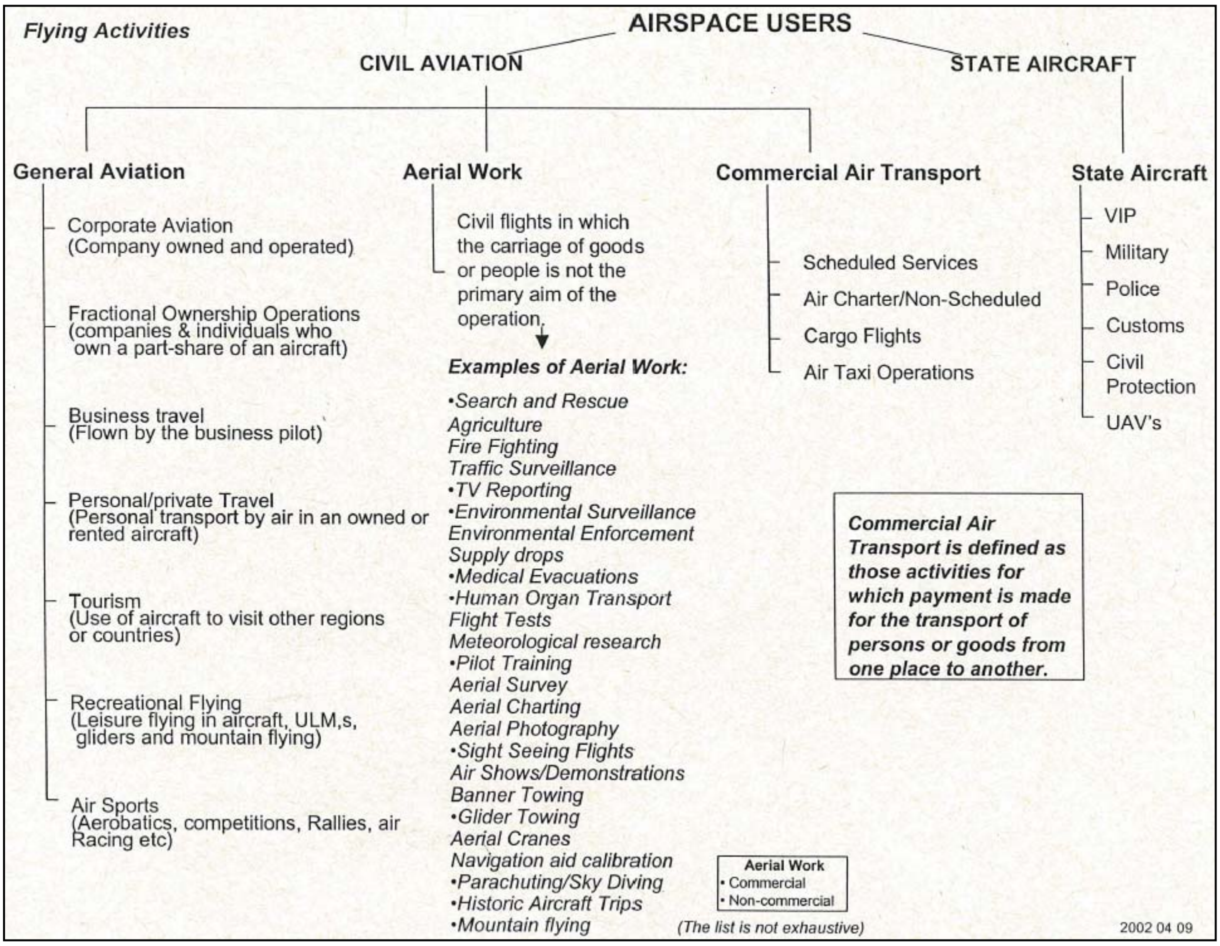


Figure 1 - Airspace users

6.1.6 Supervisory Authorities

Regulatory, supervisory and certification authorities operating within the EU will have responsibilities arising from ensuring compliance with this Implementing Rule. These organisations include the European Aviation Safety Agency (EASA) as well as the National Supervisory Authorities (NSAs).

6.1.7 Aircraft/Equipment Manufacturers

The organisations responsible for manufacturing, supplying, installing and integrating the appropriate radio equipment in aircraft and ATS units include manufacturers, suppliers, aircraft operators, ANSPs and vendors of aircraft, avionics and ATC systems and constituents. They will have to ensure that the equipment manufactured by them complies with the essential requirements and with the associated Implementing Rules including this

Implementing Rule and where applicable to issue the appropriate EC declarations of conformity or suitability for use.

6.2 Economic impact

6.2.1 The Supply and Demand for Frequencies

6.2.1.1 The demand for frequencies

The ICAO COM2 table as of 18 June 2010 indicates that there are 9305 assignments in the ICAO EUR Region (non 8.33 States are excluded), of which 568, or just 6,1%, are 8.33 kHz assignments. About a quarter of all assignments are for Area Control Centre (ACC) and Approach (APP) services which have very large frequency protection volumes and, therefore, have a major influence on spectrum demand.

In January 2008, at the request of the European Commission, EUROCONTROL launched the Frequency Usage Analysis Project to estimate the potential for measures to improve the effective utilisation of the available VHF band and to evaluate the impact of the implementation of 8.33 kHz channel spacing above FL195. Figure 2, taken from the study, shows the density of frequency usage throughout Europe. The higher an area is on the scale, the more overlapping frequencies there are in that area and, hence, the greater difficulty there is in finding a new frequency. The darker area on the map shows where frequency congestion is the most serious.

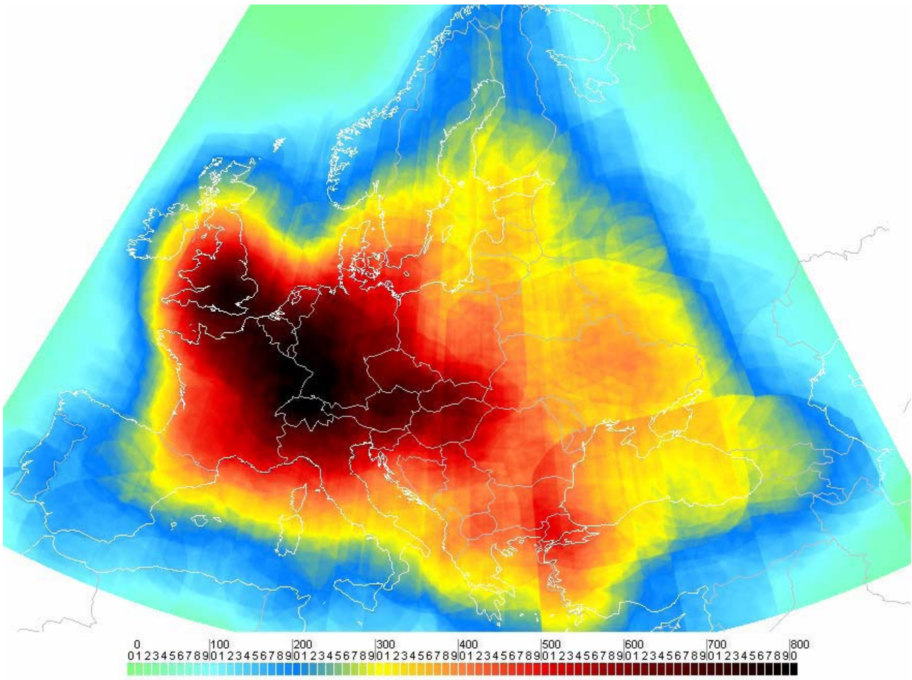


Figure 2 - Surface occupation density

Also as part of the project, EUROCONTROL produced a forecast of frequency demand, based on a linear growth model as this seemed to provide the best fit with the past evolution of frequency demand. According to this model, the total demand for frequency assignments within European and neighbouring states over for the next 15 years would be of the order of 1500 new assignments, of which one third would be for ACC upper airspace usage. Thus additional demand over the next 15 years could be of the order of 17% of the current usage.

The effect of this growth in demand has been evaluated in this business case but, since linear growth in demand cannot be expected to continue indefinitely, the effect of a growth rate of only half the historical value has also been evaluated.

6.2.1.2 The availability of frequencies

At this stage there is insufficient information available to be able to make long term estimates of the number of frequencies which will be required for specific services in specific areas. Therefore, in order to assess the likely availability of frequencies, two sets of simulations have been carried out. These simulations, which are described more fully in Annex 1, have been designed to model the steps in the block planning process and the frequency conversions required by the proposed implementation plan. Since the ability to meet the demand will be different for different services and for different locations, the satisfaction rates may fluctuate from year to year depending on the source of the demand.

In the first set of simulations, the forecast demand has been allocated per service and in time, based on the trends derived from the block planning process, in order to derive the demand that would be generated at 6 month intervals in each State. The simulations attempt to satisfy all demand occurring at six month intervals from 2010 to 2025 and assume that the two phases of 8.33 kHz expansion below FL195 take place as outlined in the proposed amendment to the Implementing Rule.

In order to verify the first set of simulations, a further set has been prepared. For the second set multiple computer runs were carried out with random variability in the location of frequency demand and the services for which the frequencies are required and the results were averaged. The expected value of the annual frequency demand satisfaction rates derived from this second set of simulations is generally within 2 to 3 percentage points of the first set, with a five percentage point gap in 2011 being the largest difference. The results of the first set of simulations have been used as the basis for the estimate of delay costs in the following sections of this document.

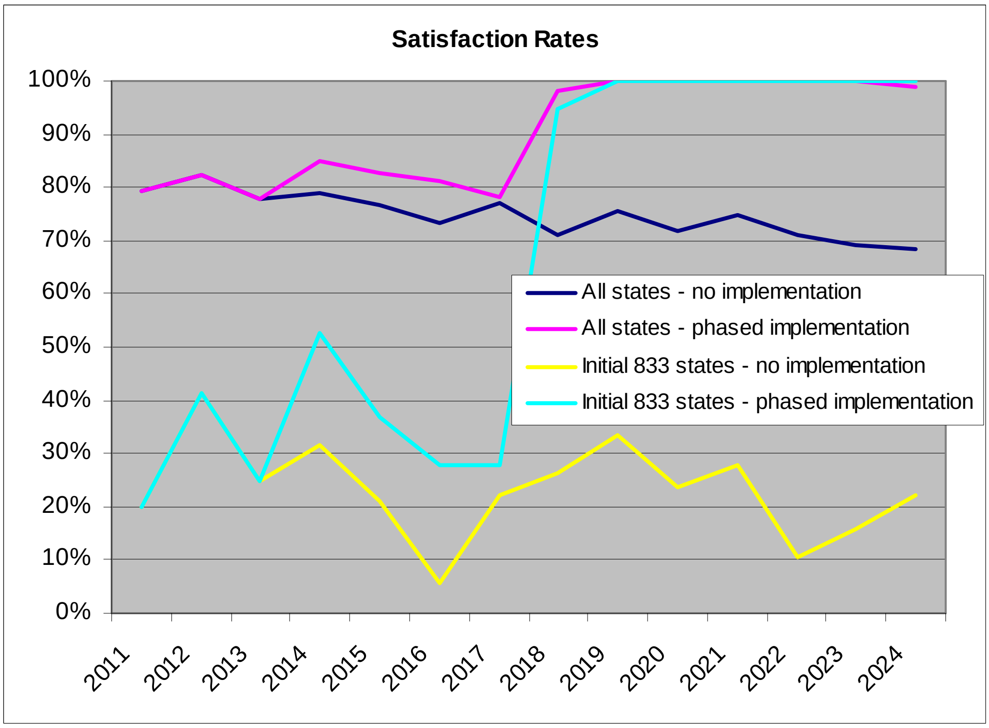


Figure 3 - Satisfaction rates

Figure 3 shows the results of two scenarios from the first set of simulations. One scenario assumes phased implementation of 8.33 kHz channel spacing, as specified by the proposed implementation plan, whilst the second scenario applies no 8.33 kHz conversions. The ability to meet a frequency requirement will depend upon which service requires the frequency and the location of the requirement. Demand at the periphery of Europe will be easier to satisfy than demand in the core area. Similarly, the demand for a tower frequency will be easier to meet than the demand for an ACC frequency with a large protection area. The satisfaction rate will, therefore, tend to fluctuate but, nevertheless, the underlying trends are discernable in Figure 3.

Without any further conversions, the satisfaction rate, which currently stands at about 80% for all States, will decline to around 70% by about 2022. However, in the Initial 8.33 States the position is much more critical. The satisfaction rate, which is only around 30% at present, may well decline to between 10% to 20% by 2022.

With full 8.33 kHz expansion as planned, the situation can be remedied and all demand can be satisfied after 2018. In the intervening period, the interim phase can provide a partial solution, with the decline in satisfaction rates being arrested and maintained at roughly their present level despite the increasing demand.

Further scenarios are presented in Annex 1.

6.2.2 The Options Available

6.2.2.1 The range of options

Potential solutions to the frequency shortage problem may include:

- optimising frequency usage
- making using of new technologies, particularly datalink and the measures envisaged in the Future Communications Infrastructure
- extending 8.33 kHz channel spacing

The following sections evaluate the potential for each of these approaches.

6.2.2.2 Optimising frequency usage

The Frequency Usage Analysis Project used, as a baseline, the COM2 status as of February 2008 and analysed a list of potential measures to increase the capacity of the VHF COM band. The study also considered the effect of extending 8.33 kHz below FL195. A summary of the improvements analysis from Phase 1 of the project is provided below.

Accounting obsolete and reserved assignments

The study identified that about 50 obsolete and reserved ACC assignments could be removed, enabling 43 new assignments, including 18 ACC in the core European Area and 15 ACC in Area II.

Harmonization of National Aerodrome Frequencies and major A/G assignments

Several improvements in the core area were identified, enabling 34 new assignments, including a minimum of 7 ACC in the core European Area. It is considered that at least 50 additional assignments could be made possible, including 20 ACC in Area I (seven Core States) and 20 ACC in Area II.

Full re-planning of COM2 assignments

This will require more spectrum since there are, at present, deviations from and incompatibilities with COM2 planning rules; whereas a re-planning exercise would have to strictly apply the ICAO planning criteria.

Sub-banding

Regrouping services of similar types in a common sub-band was assessed for broadcast services and for 8.33 assignments, but delivers no benefits. Mixing different types of services is, in fact, more efficient since small services may fit between larger ones.

Optimising frequency reuse

Tightening the assignments as much as possible in respect of the ICAO criteria produces moderate results but implementation would require significant effort and, therefore, it was not considered to be a high priority option.

DOC tailoring

Limiting the protected volume to the actual area of VHF communications without excessive margins was evaluated. It should ideally be achieved on each individual assignment but indications of the potential benefits were produced using two simulations, *ACC DOC reduction* and *overlap removal by DOC reduction*. The results were sufficiently promising to recommend extending the study.

Revisiting planning criteria

The volume of deviations from and incompatibilities with planning rules and the results of overlap removal by DOC reduction indicate that it would be worth undertaking further work to refine frequency planning criteria and adapt them to specific operational requirements. Vertical adjacent separation should also be considered.

Reusing 121.5 guard-band channels

Four guard-band channels for the emergency frequency can today be reused for ATS purposes. This was done in June 2010 and, although the gain is not very significant, it has made some contribution to the current congestion situation.

ACC Dynamic Frequency allocation

Frequency assignments are currently allocated to elementary sectors (static allocation). The potential future flexible airspace design will not be achievable without revisiting this static allocation method. However, technical requirements, procedures and coordination means have to be developed to implement dynamic frequency allocation. In the current situation, such a measure would provide important benefits, mainly in France.

Extending 8.33 kHz below FL195

Harmonising 8.33 kHz conversion rates and further progressing 8.33 kHz deployment in ACCs was also considered. The study found that further 8.33 kHz extension in ACC and APP was likely to satisfy the estimated frequency demand until 2020 and possibly beyond.

Conclusions

The analysis identified that some capacity benefits can be produced:

- in the short term through the re-allocation of some unused assignments, by accounting the reserved assignments and through the extension of some of the best practices identified in ACC and National Aerodrome assignments,
- in the medium and long term by implementing several other measures such as DOC tailoring, revisiting separation criteria and dynamic allocation (long term).

However, whilst these improvements will make a useful contribution towards meeting the short term demand, they will not be sufficient to fully satisfy the anticipated demand for VHF assignments in the medium and long term and, therefore, it will be necessary to find additional ways to reduce frequency congestion.

6.2.2.3 The use of data link

The introduction of controller pilot data link communications (CPDLC) has been mandated by European Commission Regulation (EC) No 29/2009. CPDLC is a tool to be used by controllers to reduce their work load and enable them to increase their productivity, thereby increasing peak sector capacity. This increase in capacity will make it possible to defer the addition of extra sectors, with the consequential deferral of the additional frequencies required by these sectors.

However, CPDLC will not become mandatory throughout Europe until 2015, only applies to airspace over FL285 and will only reduce rather than eliminate the rate of increase in sectors. The justification material for the data link regulation[3] suggests that between 2010 and 2020 about 160 additional sectors would be required in upper airspace throughout Europe if data link were not implemented, but that the introduction of data link would reduce this increase to about 110. Thus, whilst data link will make a major contribution to providing the extra capacity required in Europe, there will still be a substantial requirement for extra sectors and the corresponding frequencies.

6.2.2.4 The Future Communications Infrastructure

The definition of the Future Communications Infrastructure (FCI) has been entrusted to the SESAR programme. As part of the Single European Sky initiative, SESAR (Single European Sky ATM Research) will provide Europe with a high-performance air traffic control infrastructure which will enable the safe and environmentally friendly development of air transport.

The mobile communication infrastructure developed under the SESAR programme is composed of 3 segments:

1. A specific airport communication segment to be deployed in some high traffic density airports,
2. A new ground-based communication segment (of the air/ground infrastructure),
3. A satellite-based communication segment.

Currently, voice services are not within the scope of the SESAR development. This infrastructure will support data link services.

The initial operation of data link services (IOC) supported by the SESAR mobile communication infrastructure is scheduled circa 2020. This date corresponds to the initial operation of the first segment (airport communication system). The mobile communication infrastructure will then be extended, based on the availability of and the needs for services supported by the other segments (new ground-based / Satellite-based). Past experiences show that it can take 10 or 15 years for systems of this complexity to deliver full benefits in all phases of flight. Therefore the data link service provided by the new systems is not expected to change significantly the usage of voice up to 2030.

SESAR is planning a study to identify how voice communication will be used and operated beyond 2030 in the context of data link communications as the primary communication

[3] See www.eurocontrol.int/ses/public/standard_page/sk_dls.html

mean. Depending on the result, the scope of the mobile communication infrastructure activities might be extended. A specific activity might be launched to address the definition and development of a new voice communication system. The initial operation of such a system is envisaged circa 2030. Up to this time, voice communications will be supported by VHF.

Conclusions

The overall conclusion from the above analysis is that, although some improvements can, and should, be made in the current management of frequencies, this will not have a major impact on the availability of frequencies. In addition, the new technologies considered within SESAR will not offer significant benefits until around 2025.

Therefore there is no practical alternative to the extension of 8.33 kHz channel spacing below FL195 to provide the required frequencies in the period 2010 to 2025. Nevertheless, improvements in the management of frequencies and the implementation of data link will be extremely useful in enabling demand to be accommodated before the full implementation of 8.33 kHz channel spacing proposed for 2018.

6.2.3 The Penalty for Inaction

6.2.3.1 Approach to the evaluation

The implementation of 8.33 kHz channel spacing below FL195 will make more frequencies available to the ATM community, but will in itself have no immediate impact. It is not until these frequencies are used in some performance improving measure that a tangible benefit will be derived. Thus 8.33 kHz implementation is an enabling project which will allow further measures to be implemented which will improve ATM performance.

Because it is impractical to try to anticipate the benefits and costs of these measures, the approach taken is to assess the penalty of not implementing 8.33 kHz. Since there may not be practical alternatives to the implementation of 8.33 kHz channel spacing before about 2025, the potential costs over the period 2010 to 2025 have been considered. However, the results of this evaluation will provide only guidance as to the order of magnitude of these costs.

6.2.3.2 Principal assumptions

The basic premise underlying the evaluation is that a shortage of frequencies will mean that measures to increase capacity cannot be introduced or can only partially be introduced. The approach assumes that a shortage of frequencies will mean that new sectors cannot be opened and, as a consequence, capacity cannot be increased and a rising level of delays will ensue. These delays will have a cost for airspace users which is taken to be the penalty of not implementing 8.33 kHz channel spacing.

A direct one to one relationship between frequencies and sectors has been assumed. The relationship between sectors and capacity will be different for different locations with different traffic flows. In some situations, a 1% increase in the availability of frequencies (and therefore sectors) has been reported to lead to a 5% increase in capacity. However, such a large gain is likely to be exceptional and, in this analysis, direct proportionality between frequencies and capacity has been assumed.

The level of delay has been estimated using a method published by the EUROCONTROL Performance Review Unit (PRU) in 2002 in its Performance Review Report (PRR) report number 5. The method uses an empirical relationship between traffic levels and delays. The approach assumes that, for a given level of capacity, the relationship between delay and the volume of traffic determined by the PRU remains valid. Thus, if an increase in the level of capacity, or lack of it, is predicted for a future year, the level of delay can be determined for the expected volume of traffic. A description of this approach is provided in Annex 4 section A 4.1.

The delay considered in this analysis is purely that caused by a lack of capacity. The CFMU determined that, in 2009, 58% of ATFM delay was due to ATC causes and, of ATC delay, 37% was due to a lack of capacity[4]. It has been assumed that these proportions will remain fairly constant.

Various estimates have been made for the cost of delay but in 2002, the PRU commissioned the University of Westminster to produce a report on this subject. The report[5] developed a method for assessing the cost of delay and produced a summary value for ground delay, which effectively includes the cost to passengers, of €72 per minute, based on 2002 cost levels. The Westminster method was refined in 2009. Using this method and adjusting the inputs to current cost levels, produces a cost of ground delay of €89.

The evaluation has been carried out for the period up to 2025 and considers the potential levels of delay for a range of scenarios. The full linear growth in demand for frequencies, as described in Annex 1 section A 1.4, is assumed in three of the scenarios but, for two of the scenarios, the effect of reducing the demand for frequencies by half is evaluated. The scenarios are:

- no implementation/full demand – there is no further extension of 8.33 kHz channel spacing
- no implementation/half demand – there is no further extension of 8.33 kHz channel spacing, but the rate of traffic growth and the demand for frequencies is cut by half
- phased implementation/full demand – implementation of the proposed phases (i.e. 2014 and 2018), together with the full demand for frequencies
- phased implementation/half demand – implementation of the proposed phases, but only half of the forecast traffic growth and half the full demand for frequencies
- delayed implementation/full demand – the final implementation phase is delayed to 2020, although the interim phase takes place by 2014 as planned. Full demand is assumed.

Future levels of delay and the cost of this delay have been estimated on the basis of traffic and delay data from the latest published CFMU[6] statistics and the September 2010 edition of the STATFOR[7] baseline traffic growth rates.

6.2.3.3 Cost of delays

Figure 4 shows the annual level of capacity induced delay in 2009 and the estimated level at five yearly intervals in the future for each of the scenarios.

[4] Network Operations Report - 2009, CFMU, May 2010

[5] Evaluating the True Cost to Airlines of One Minute of Airborne or Ground Delay, University of Westminster, May 2004, www.eurocontrol.int/prc/gallery/content/public/Docs/cost_of_delay.pdf

[6] Network Operations Report 2009 , Indicators and analysis of the ATM Network Operations Performance, May 2010, available at www.cfmu.eurocontrol.int/j_nip/cfmu/public/standard_page/data_provision_reporting_yearly.html

[7] EUROCONTROL Medium-Term Forecast, September 2010, Flight Movements 2010 - 2016 , available at www.eurocontrol.int/statfor/public/subsite_homepage/homepage.html

Delay per flight (minutes)	**2009**	**2010**	**2015**	**2020**	**2025**
No implementation/full demand	0.35	0.43	0.76	1.33	2.45
No implementation/half demand		0.38	0.53	0.69	0.93
Phased implementation/full demand		0.43	0.71	0.84	0.84
Phased implementation /half demand		0.38	0.52	0.56	0.56
Delayed implementation/full demand		0.43	0.71	1.03	1.02
Cost of delay (€m)	**2009**	**2010**	**2015**	**2020**	**2025**
No implementation/full demand	294	373	791	1,609	3,426
No implementation/half demand		330	501	698	1,018
Phased implementation/full demand		373	740	1,019	1,174
Phased implementation /half demand		330	486	564	606
Delayed implementation/full demand		373	740	1,240	1,426

Figure 4 - Annual delay

Thus, without implementation, the extent of delay in 2020 may be almost four times the current level and the cost of this delay may be over four times as high. After 2020, delays and the associated cost escalate rapidly.

Figure 5 indicates the present value of the costs of delay over the period up to 2025 discounted at 8%. Values are shown for each scenario and each area, together with the relative reduction in the cost of potential delay for each scenario relative to the baseline *do nothing* situation.

Present value (to 2025 in €m)	Full demand			Half demand	
Implementation	None	Phased	Delayed	None	Phased
All states					
Total delay	10,791	7,356	8,061	5,325	4,621
Reduction relative to baseline	-	3,435	2,730	-	703
Initial 833 states[8]					
Total delay	6,400	3,778	4,318	2,497	1,982
Reduction relative to baseline	-	2,622	2,082	-	515

Figure 5 - Cost of delay

Additional sectorisation can reduce delay but never fully eliminate it. Furthermore, there is a finite limit to the effectiveness of continually reducing sector size. Even with full implementation there are substantial delay costs indicating that, even with the maximum release of frequencies, it will not be possible to fully meet the rising traffic demand using conventional re-sectorisation and network planning. The analysis suggests that the penalty for not introducing measures to fully meet the growing demand could be over €10 billion (or over €5 with the half demand situation). About 60% of the delay occurs in the Initial 8.33 States. These delay figures should be treated with caution since much of the increase in delay occurs in the later years of the analysis and, if delays of this magnitude began to occur, it is unlikely that the traffic would grow at the rate predicted. However, the suppression of

8 The Initial 8.33 States were the original states to implement 8.33 kHz in their upper airspace. See Annex 1 section A 1.5 for a list of the Initial 8.33 States, the HEX (horizontal expansion) states and the other states included.

demand in this way would have a cost for the community, for which the delay cost could stand as a proxy.

Nevertheless, the complete phased implementation makes a major contribution to holding down delay costs, reducing the *no implementation* total by about €3.4 billion, or about a third, in the full demand case. Thus, if the cost of 8.33 kHz extension and the re-sectorisation it enabled were less than this amount, then the extension could be justified on economic grounds.

Delays to the implementation of the programme can have a significant effect on the benefits achievable. If the completion of the programme were delayed to 2020, a delay of two years, the value of the delay savings over the period to 2025 would fall to about €2.7 billion, meaning that 20% of the potential benefits had been lost.

Most of the delay is caused by frequency shortages in the upper airspace of the Initial and Hex (Horizontal Expansion) areas. However, because of the practice of holding aircraft on the ground until their passage is clear, the delay is likely to be incurred at the starting point of the flight which may be in a different area.

6.2.4 The approach to Offset-carrier Climax

6.2.4.1 The purpose of Climax

Offset-carrier or Climax systems allow the extension of the coverage of an assignment when the range of a single ground station is inadequate to cope with the operational area. This is usually because of the size of the sector or terrain constraints, but Climax may also be used for redundancy reasons. Two or more ground stations are deployed in order to cover the desired area. The ground stations operate on the same channel but their carrier is slightly shifted in frequency. The Climax situation is summarised below and further details are provided in Annex 3.

6.2.4.2 The problem posed by Climax

Climax is possible with 8.33 kHz capable radios in accordance with the new ED-23C standard. However, it is not possible with the radios currently deployed based on the ED-23B standard. There would be significant problems associated with including a requirement for 8.33 kHz Climax within the update of the 8.33 kHz implementing rule. These include the following.

- The adoption of a requirement for radios to the ED-23C standard would require the retrofit or upgrade of radios meeting the ED-23B standard which were installed to allow aircraft operating above FL195 to meet the current 8.33 kHz implementing rule (EC No 1265/2007). This would impose an unacceptable cost burden on those aircraft operators who have already equipped their aircraft to meet the current requirements.
- Radios certified to the ED-23C standard are not yet available for all classes of aircraft and it may be three to five years before this is the case. Thus a requirement for ED-23C radios would delay the forward fit phase of 8.33 kHz channel spacing increasing the implementation costs below FL195.
- ED-23C radios are expected to be 10% more expensive than ED-23B compliant radios.

Therefore it is necessary to examine the extent of usage of Climax to determine the number of 25 kHz conversions which would have to be foregone if Climax sectors were to continue to operate with frequencies at 25 kHz channel spacing. It would then be possible to make a judgement as to whether the availability of these conversions would justify mandating the use of ED23C radios.

6.2.4.3 The extent of Climax usage

Simulations have been carried out to assess the full impact of 2-leg Climax throughout Europe. The simulations were based on the COM2 database as of January 2010, considered each type of service (ACC, APP, FIS, TWR, etc) and were run over a 24 year period (to 2034).

The simulations indicate that, over the full period of the analysis, without Climax conversions, 2636 additional assignments can be found within Europe. This represents 83% of the 3180 additional requirements required. With the inclusion of 2-leg Climax conversions, a further 77 assignments can be made, increasing the satisfaction rate to 85%. Thus the inclusion of 2-leg Climax conversions has relatively little effect on the total number of assignments possible.

Figure 6 shows the density of usage of 2-leg Climax (the higher on the scale, the higher is the use of Climax at any point). It illustrates that Climax congestion affects mainly the core area states and this will have an impact on the number of conversions achievable in this region during the interim phase (from 2014 to 2018).

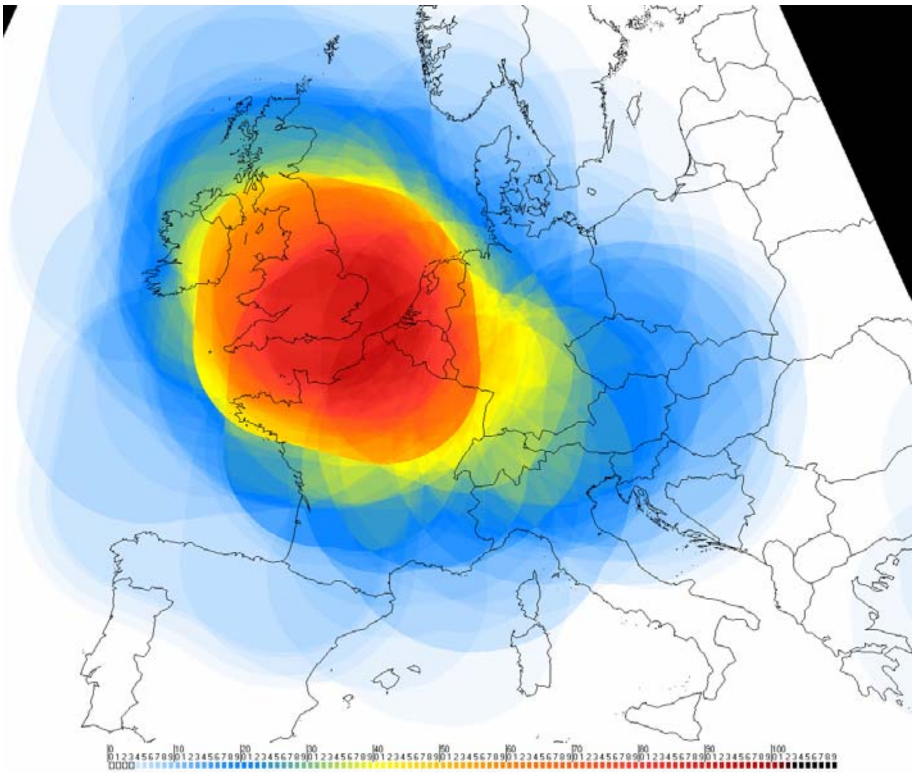


Figure 6 - Density of climax usage

6.2.4.4 The cost of mandating ED-23C standard radios

The principal impact of mandating radios capable of 8.33 kHz Climax operation would be on those aircraft which have already been equipped for 8.33 kHz operation above FL195. The cost of upgrading radios in these aircraft may be of the order of €6,000 and, where upgrade was not feasible and a new radio was required, the cost may be of the order of €35,000.

The cost of implementing an ED-23C retrofit mandate for heavy and medium class IFR aircraft, currently operating above FL195 and which are, as a consequence, already equipped with ED-23B standard radios, has been estimated at about €80m. In total, the additional cost of an ED-23C mandate over and above that of an ED-23B mandate has been estimated at €120m for IFR aircraft and €16m for VFR aircraft.

The possibility of mandating ED-23C radios exclusively as part of the forward fit mandate has also been evaluated. This would increase the cost of all radios by 10% and increase airline costs by increasing the number of spares they have to manage.

6.2.4.5 Conclusions

Expenditure of €136m in order to increase a potential of 2636 frequency assignments by just 77 additional assignments is clearly not feasible, particularly when the final implementation in 2018 will provide enough conversions to satisfy all forecast demand. Thus an ED-23C retrofit mandate is not proposed. On the other hand, forward fit with ED-23C radios is to be recommended because they improve the quality of voice communications.

6.2.5 The Costs of Implementation

6.2.5.1 Ground costs

The conversion of radio equipment on the ground to 8.33 kHz can, in some cases, be achieved by a modification to existing radios. In other cases, radios may need to be replaced and, in certain instances, significant infrastructure changes might be required. Hence, individual costs may vary significantly. Modifications may also be required to ATC displays and flight plan processing systems, principally to assist in the indication of non-8.33 kHz equipped aircraft.

Most Air Navigation Service Providers (ANSP) are currently acquiring 8.33 kHz radios as part of planned radio replacement programmes and a large number of existing ground stations are already 8.33 kHz equipped. The introduction of 8.33 kHz ground radios may coincide with modernisation programmes for air-ground radio systems and, therefore, overall costs for these programmes may be significantly higher, covering items that are not necessarily linked to 8.33 kHz.

The implementation costs shown in Figure 7 below have been compiled from a range of sources. Six ANSPs provided data on the costs of converting ground stations serving en-route and TMA sectors (these have been averaged) and EUROCONTROL estimated the number of such ground stations. The numbers of large medium and small aerodromes, including military airfields, were derived from the EUROCONTROL PRISME database. AOPA provided further information on aerodrome and mobile (handheld) installations. DIRCAM (France) provided information concerning the cost of equipping the ground infrastructure at military aerodromes, including joint civil/military airports.

AOPA categorised the aerodromes as follows:

- Large - international scheduled traffic with equipment maintained by national ANSPs. Communication equipment used for ATC purposes, owned an maintained by ANSPs;
- Regional - national scheduled traffic. Operations only supervised occasionally by ANSPs. COM equipment owned by operator;
- Small - no scheduled traffic, but part-time CTR;
- Mini - AFIS only, 1 to 2 service vehicles and fire trucks only;
- Micro - privately owned, glider and air sports on occasion.

	Number	Unit cost (€k)	Total cost (€m)
ATCC			
En-route	538	86.0	46.3
TMA	547	53.0	29.0
Total ATCC	1,085		75.3
Aerodromes			
Large (international)	100	160.0	16.0
Medium (regional)	300	55.0	16.5
Small (AFIS only)	1,733	26.5	45.9
Military	225	50.0	11.3
Mini+micro	1,500	1.5	2.3
Direction finders	750	20.0	15.0
Test equipment (sport/recreation)	450	11.3	5.1
Total aerodromes	5,058		112.0
Mobile (handheld) installations			
Rescue teams	3,200	0.8	2.6
Ground services	2,500	0.8	2.0
Maintenance shops	2,200	0.5	1.1
Sport/recreation	1,500	0.5	0.8
Total mobile	9,400		6.4
Overall total			193.7

Figure 7 - Ground equipage costs

The total of almost €194m represents an upper limit. In practice some of the radios at large and medium sized airports will already be 8.33 kHz capable and many of the others would be replaced as part of a normal replacement programme regardless of 8.33 kHz implementation.

6.2.5.2 Airborne costs

Approach

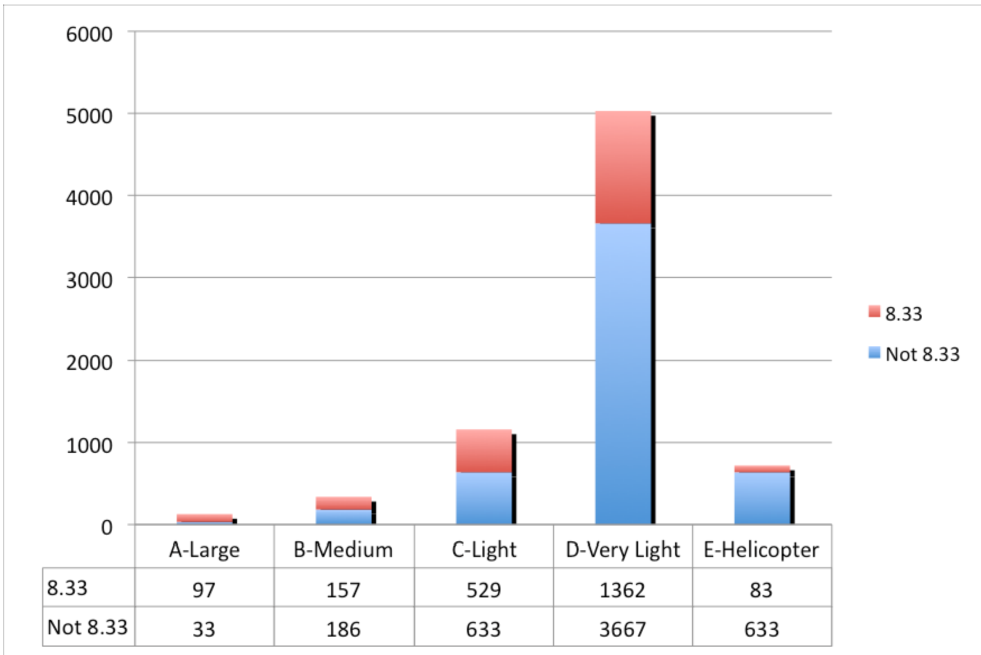
An estimate has been made of the number of civil and state aircraft which will be required to retrofit as a consequence of the implementation of 8.33 kHz channel spacing below FL195. A number of technical solutions have been identified for each aircraft type and the costs of these solutions have been estimated, allowing an overall aircraft retrofit equipage cost has been derived.

In the case of new radios, it has been assumed that 8.33 kHz radios will have a similar cost to that of 25 kHz radios and, therefore, implementation of 8.33 kHz channel spacing will have no incremental effect on the cost of forward fit radios.

Civil aircraft costs

Data on the number of aircraft operating under IFR in European airspace has been derived from flight plans submitted to the EUROCONTROL CFMU, whilst information on aircraft operating under VFR has been derived from the International Register for Civil Aviation Aircraft and data supplied by the recreational aircraft associations. This data has been analysed to determine the numbers of aircraft already equipped with 8.33 kHz capable radios.

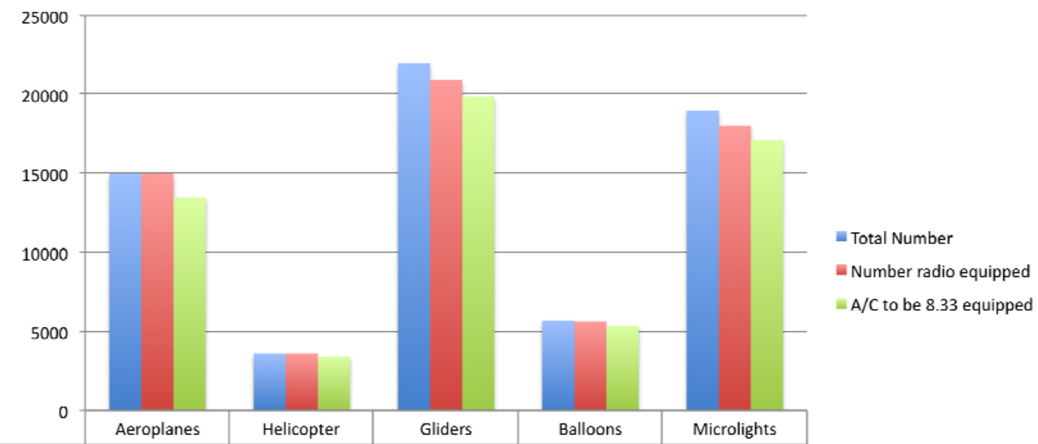
As a consequence of the existing implementing rule on 8.33 kHz equipage, virtually all aircraft operating above FL195 are already equipped with 8.33 kHz capable radios. For aircraft operating as IFR only below FL195, the statistics indicate that about 30% of aircraft are currently equipped with 8.33 kHz capable radios. Most of these aircraft are very light aircraft, as indicated in Figure 8.



	A-Large	B-Medium	C-Light	D-Very Light	E-Helicopter
8.33	97	157	529	1362	83
Not 8.33	33	186	633	3667	633

Figure 8 - IFR aircraft flying below FL195

In the case of VFR traffic, the data is less reliable but estimates have been made based on aircraft registers and data provided by recreational aircraft associations. There was particular difficulty in identifying the number of microlights, since the approach to registering these craft varies considerably from State to State. Thus the figure for this category can only be considered as an approximate guide. As indicated in Figure 9, the downward extension of the 8.33 kHz regulation will have a much larger impact on the smaller VFR aircraft which were largely unaffected by the original implementation. It has been assumed that all remaining non-equipped IFR aircraft will equip during the interim retrofit phase but that all VFR aircraft will equip during the final retrofit phase. Figure 9 also shows that some of the radio equipped VFR aircraft already have 8.33 capable radios and therefore would not need to change their radios.



	Aeroplanes	Helicopter	Gliders	Balloons	Microlights
Total Number	15000	3600	22000	5700	19000
Number radio equipped	15000	3600	20900	5643	18050
A/C to be 8.33 equipped	13500	3420	19855	5361	17148

Figure 9 - VFR aircraft

Proposed equipage solutions have been prepared for the various categories of aircraft and cost estimates made. These are presented in Annex 2. On the basis of these proposals, an estimate of the cost of retrofitting civil aircraft has been made and this is summarised in Figure 10.

State aircraft costs

Estimates of the number of state aircraft impacted by the proposed extension of 8.33 kHz channel spacing have been derived from data provided by the EUROCONTROL Directorate for Civil/Military ATM Coordination[9], CFMU data and information provided by the French, German and Netherlands military authorities.

As with civil aircraft, potential equipage solutions have been developed and costed (see Annex 2). Estimates of the total costs, which are summarised in Figure 10, are subject to considerable uncertainty since the aircraft configurations may differ from state to state and the retrofit programs are, in general, more extensive than just a radio retrofit. Additionally, with military aircraft there are confidentiality constraints. The special provision for state aircraft, which exempts those aircraft which will be taken out of service before 2025, significantly reduces the costs of equipage of state aircraft.

Summary of aircraft costs

Figure 10 provides a summary of the numbers of aircraft affected by the extension of 8.33 kHz channel spacing and the costs of complying with the new requirements.

[9] www.eurocontrol.int/mil/public/site_preferences/display_library_list_public.html#6

	Civil IFR A/C	Civil VFR A/C	State A/C	Total
Aircraft numbers				
Phase 1	5,046	-	-	5,046
Phase 2	-	54,784	6,640	61,424
Total	5,046	54,784	6,640	66,470
Costs (€m)				
Phase 1	49.38	-	-	49.38
Phase 2	-	167.26	226.16	393.42
Total	49.38	167.26	226.16	442.79

Figure 10 - Summary of aircraft equipage costs

Over 66,000 aircraft may be required to retrofit and a large majority of these are small, civil VFR aircraft. However, in terms of cost, the overall total of costs amounts to just over €440m which is divided almost equally between civil and state aircraft.

6.2.6 Economic Evaluation

6.2.6.1 Introduction

An economic evaluation of the extension of 8.33 kHz channel spacing below FL195 has been made using the estimates and assumptions provided earlier in this document. However, it must be emphasised that 8.33 kHz channel spacing is an enabling measure and further costs must be incurred to implement measures which use the extra frequencies, such as re-sectorisation, before operational benefits may be achieved. Thus the *net benefit* of 8.33 kHz channel spacing effectively represents the maximum sum which may be expended on the further measures if the overall activity is to remain beneficial.

6.2.6.2 The cost of implementation

The cost of implementation is derived using the cost estimates for ground infrastructure and aircraft retrofit presented above. Assumptions have been made regarding the phasing of expenditure over the period 2011 to 2017, which are shown in Annex 4 section A 4.2. A summary of the costs is presented in Figure 11.

Implementation costs (€m)	Interim phase	Final phase	Total
Ground	48.4	145.2	193.7
Civil IFR A/C	49.4	-	49.4
Civil VFR A/C	-	167.3	167.3
State A/C	-	226.2	226.2
Total	97.8	538.7	636.4

Figure 11 - Summary of costs

Thus, aircraft retrofit costs are the major constituent of the costs, accounting for 70% of the total for full implementation.

6.2.6.3 Evaluation

Figure 12 provides a summary of the costs of implementation and the potential delay costs which may be avoided. Further details are shown in Annex 4 sections A 4.2 and A 4.3. For all scenarios, the potential reduction in the delay cost is substantially in excess of the cost of implementation, generating a large net present value (NPV) for the period up to 2025. However, as noted above, further expenditure on re-sectorisation, additional controllers and support staff would be required to create the capacity increases necessary to achieve the reductions in delay costs.

Present values (to 2025 in €m)	Phased implementation full demand	Delayed implementation full demand	Phased implementation half demand
Reduction in cost of delay	3,435	2,730	703
Cost of equipage	427	402	427
Net present value	3,008	2,327	276

Figure 12 - Costs and benefits

The adverse effect of a two year delay to full implementation can be clearly seen, with the value of delay savings falling by over €700 million over the period to 2025. On the other hand, even if the growth in the demand for frequencies falls to half its past rate, substantial delay savings are made.

The method of estimating delay costs is fairly rudimentary and the results should therefore be treated with caution and taken as an indication of their order of magnitude. Nevertheless, the analysis does illustrate the way in which delay costs can escalate rapidly if capacity does not keep up with demand.

Clearly, in practice, delays would not increase in the manner shown since, if measures were not taken to increase capacity, the demand would not increase in the manner predicted. However, if STATFOR estimates are accepted as a realistic estimate of future demand then, to meet this demand, major steps will have to be taken to increase capacity. The analysis shows that an 8.33 kHz implementation below FL195 is likely to be an economically viable method of satisfying the demand for new frequencies and thus enabling the required capacity enhancing measures. It also shows the value of achieving earlier partial implementation by means of the interim phase.

6.2.6.4 Other benefits

The initial implementation of 8.33 kHz channel spacing above FL195 means that most commercial aircraft operators will already have equipped their aircraft with 8.33 kHz capable radios. Therefore, the highest economic impact of the implementation of 8.33 kHz below FL195 will be for general aviation and state aircraft. These stakeholders will receive small direct benefits but will receive significant indirect benefits associated with the continued growth of European aviation that 8.33 kHz channel spacing below FL195 will enable.

Even though the direct benefits for general aviation and state aircraft are small it is worth listing them here.

Benefits for State Aircraft

- Increased access to airspace

  Different European countries have chosen different ways to accommodate non-8.33 kHz equipped aircraft above FL195. It is likely that this will happen again for the implementation below FL195. Within a particular state, state aircraft generally find effective working solutions for access to the relevant airspace. This is more difficult for international flights where it is more difficult to understand the airspace access constraints of other countries.

- Increased availability of VHF frequencies for military airfields.

  In general all military airfields have all the frequencies they require to conduct normal operations. In some countries requests for new frequencies to improve the service provided have been delayed because of frequency congestion. This situation will become worse in the future if nothing is done to reduce the congestion.

Benefits for General Aviation:

- Improved Access to Airspace

  Equipping with 8.33 kHz capable radios will allow GA to reduce detours around 8.33 areas. Also as 8.33 spreads below FL195, having an 8.33 radio will significantly increase safety for unexpected diversions.

- Reduced delays for new aerodromes

  The opening of new GA aerodromes has been delayed because of the lack of available frequencies. This situation will get worse unless the frequency congestion problem is addressed.

- Reduced delays for new Flight Information Services

  Some of the new FIS envisaged for class F and G airspace are being delayed because of the lack of available VHF frequencies.

- Better GA frequencies

  In many cases GA frequencies suffer from interference or are shared by several aerodromes because of the unavailability of other options.

- Ability to organise special events

  Some special events such as glider competitions require the availability of many VHF frequencies which are becoming increasingly difficult to be made available.

This is not to imply that the above direct benefits outweigh the cost of the implementation of 8.33 kHz channel spacing below FL195 for those stakeholders. While this may be true in some particular locations, it cannot be said that it is the case everywhere in Europe.

6.2.7 Conclusions of the Economic Impact

Without the extension of 8.33 kHz channel spacing it is likely that only about 70% of the future requirement for frequencies in Europe can be met. The situation in the core area of Europe is much worse and, by the end of the decade, it is likely that only between 10% to 20% of the requirement in the core area will be met.

The inability to meet the future frequency demand will have a very significant impact on:

- Europe's ability to accommodate the predicted increase in traffic in the near future. A lack of available frequencies will delay, or make impossible, airspace improvements to increase capacity. This will lead to increased delays with a significant cost impact for airlines, which may be of the order of €1.6 billion per year by 2020 and rising as high as €3 billion per year by 2025 if no action is taken.

- European economic development, because new airports/airfields and/or new runways may be delayed due to the unavailability of the frequencies required to operate them.
- maintaining Europe's high levels of safety, by not being able to find the best solution to meet voice communication safety requirements.
- the timely deployment of SESAR improvements that require the availability of new VHF voice communications channels.

The above drawbacks will impact firstly the European core area and gradually expand towards the periphery.

The extension of 8.33 kHz channel spacing is the only proven solution to meet the forecast demand for new frequencies in the medium to long term. Although the improvements analysis carried out within the Frequency Usage Analysis Project was able to identify some improvements which could make a useful contribution towards meeting the short term demand, they will not be sufficient to fully satisfy the anticipated demand for VHF assignments in the medium and long term. The measures anticipated in the Future Communications Infrastructure are still in the research and development phase and it is unlikely that any of these measures will be able to deliver practical improvements to the European ATM system before about 2025. Thus no alternative to the extension of 8.33 kHz channel spacing has been identified to meet requirements in the period 2015 to 2025.

The consequences of not extending 8.33 kHz channel spacing are very significant. The average level of delay caused by capacity shortfalls throughout Europe in 2020 may be almost four times as high as the current level and seven times as high by 2025. Although the extension of 8.33 kHz channel spacing will not fully solve capacity problems, it will enable further sectorisation which could reduce future delay costs between now and 2025 by over €3 billion in present value terms.

The costs of implementation, whilst substantial, are not unreasonable in the context of the benefits which may be achieved. The total costs of full implementation, at about €430m in present value terms, are equivalent to about 12% of the delay savings achievable by 2025. Furthermore, the benefits of 8.33 kHz channel spacing will continue to accrue until the full effects of the new measures foreseen in the Future Communications Infrastructure begin to be realised.

However some Stakeholders are impacted more than others. The initial implementation of 8.33 kHz channel spacing above FL195 means that most commercial aircraft operators will already have equipped their aircraft with 8.33 kHz capable radios. Therefore the burden of the downward extension will have a disproportionate impact on general aviation, including recreational aviation, and State aircraft. Although the direct impact delay savings will mainly be of value to commercial operators, measures to reduce the costs of flying will have a generally beneficial impact on the overall economy and, in addition, there are some direct benefits to general aviation and state aircraft in terms of eased access to airspace, reduced delays in the opening of new aerodromes, improved Flight Information Services, increased availability of VHF frequencies for military airfields, better GA frequencies and the ability to organise special events.

The proposed phased implementation approach aims at finding an affordable transition for all stakeholders as well as minimising implementation risks. The final implementation date of 2018 provides over seven years for all parties to complete their conversions. However, if full implementation were delayed until 2020, over 20% of the benefits would be lost and so it is important to ensure that implementation takes place in accordance with the proposed implementing rule.

6.3 Safety Impact Assessment

A generic[10] Safety Impact Assessment has been carried out to address the implementation of the 8.33 kHz below FL195 as defined in the draft Implementing Rule. The safety target was set to demonstrate that

ST#1 the risk of an accident following the complete conversion to 8.33 kHz (i.e. final phase) shall not be significantly greater than before the start of the introduction of 8.33 kHz below FL 195

ST#2 the risk of an accident during the transition to the complete conversion to 8.33 kHz below FL 195 shall be reduced as far as reasonably practicable.

Subject to the identified Assumptions and issues, the overall conclusion is that deployment of 8.33 kHz in the airspace of IR applicability below FL 195 according to the draft Implementing Rule has the potential to satisfy the above Safety Targets.

The specific conclusions of the analysis are:

1. For the airspace addressed in the draft Implementing Rule there are three risks associated with the deployment of 8.33 kHz VCS:
   - an increase in the risk of mistuning an 8.33 kHz channel because of the additional digit that has to be selected and, initially, because of a number of airspace users (e.g. General Aviation) unfamiliar with 8.33 kHz operations as they do not fly above FL 195
   - the risk associated with having to accommodate exempted 25 kHz State aircraft, up to the date by which all such aircraft will have been retrofitted or eventually withdrawn from service; and
   - the risk associated with having two different Voice Communications Systems (i.e. 25 and 8.33 kHz channel spacing) across the border with the airspace of applicability.

   In all three cases, Functional Safety Requirements have been derived to reduce the risk to what is likely to be a low level, though that needs to be confirmed by specific local safety assessments to be carried out by the States concerned.

2. For the States that take part in the Interim Phase, as identified in annex I of the draft Implementing Rule, there will be an additional risk associated with operating 25 kHz non-exempt aircraft in a mix of 25 kHz and 8.33 kHz sectors / airspace.

   Functional Safety Requirements have been derived in order to reduce this risk but, because of the big number of factors involved and the complexity of the relationships between them, it has not been possible to determine quantitatively the magnitude of the risk in the generic safety assessment – this needs to be done by the States / ANSPs concerned in their local safety assessments.

3. For the airspace of applicability of the draft Implementing Rule (IR), the conversion of frequency assignments should not start until after the date by which the IR requires all non-exempted aircraft traversing the airspace to be equipped with 8.33 kHz radios,

[10] By "generic" it is meant that no specific airspace or sectors in any specific country were considered to perform the analysis.

unless a local safety assessment has been carried out to show that such conversion is safe when considering all the airspace users impacted by the change.

4. There will be a slight increase in the risk of mistuning the frequency/channel for ground vehicles operating in the manoeuvring area of aerodromes. Nevertheless this increase will be very small because those vehicles often use a single frequency/channel (e.g. the ground or the tower frequency) and will not change it so frequently. The radio systems (fixed or hand-held) used by vehicle drivers should be compliant at least with the ICAO Annex 10 requirements in order to prevent any harmful interference and to be fully interoperable.
   Functional Safety Requirements have been identified to reduce the risk linked with the vehicles operating on the manoeuvring area of aerodromes.

Annex 6 provides a detailed summary of the Safety Impact Assessment. The tables below summarises the Safety Requirements and Assumptions identified and the way they are addressed in the draft Implementing Rule.

Num.	Safety Requirement	Addressed in
SR#1	State AIPs (supported as necessary by NOTAMs) shall provide up-to-date information to all Aircraft Operators and Flight Crew concerning the VCS requirements of the airspace for which the State is responsible	Article 9(6)
SR# 2	Aircraft Operators and Flight Crew shall be made aware of the consequences of using 25 kHz VCS radios in 8.33 kHz VCS airspace unless specifically authorised (i.e. State aircraft)	Article 9(5)
SR#3	Aircraft Operators and Flight Crew of 25 kHz VCS-equipped, non-exempt aircraft shall <u>not</u> submit Flight Plans that would take the aircraft through any part of 8.33 kHz VCS airspace	Articles 4(4), (5), (6) and (7)
SR#4	Aircraft Operators and Flight Crew shall ensure that the Flight Plan for any flights which pass through any part of the EUR Region indicates the VCS capability and status (exempt / non-exempt) of the aircraft concerned	Article 4(4)
SR#5	Controllers shall <u>not</u> route a 25 kHz VCS-equipped, non-exempt aircraft through 8.33 kHz VCS airspace unless there is an overriding safety reason for so doing and they apply published procedures covering this situation	Articles 3(27) and 9(1)
SR#6	Controllers shall <u>not</u> accept a 25 kHz VCS-equipped, non-exempt aircraft into an 8.33 kHz VCS sector unless there is an overriding safety reason for so doing and they apply published procedures covering this situation	Articles 3(27) and 9(1)

Num.	Safety Requirement	Addressed in
SR#7	Before handing over an aircraft to an 8.33 kHz VCS sector, Controllers shall ensure that the receiving sector is advised of the VCS capability and status (exempt / non-exempt) of the aircraft concerned	Articles 3(27) and 9(1)
SR# 8	ANSPs shall develop and implement strategies to ensure the safe handling of (non-8.33 kHz) exempt aircraft in 8.33 kHz VCS airspace	Articles 5(11), 5(12) and Annex III(7)
SR# 9	State's frequency assignment plan shall comply with EUR Frequency Management Manual – ICAO EUR Doc 011 (2009) in order to ensure that any ATS assigned frequency does not interfere with other assigned frequencies and is free from harmful interference.	Articles 3(25), (26) and Annex III(6)
SR#10	Flight Crew shall be adequately trained in the use of the 8.33 kHz radios	Articles 4(1), (2) and 9(5)
SR#11	In the event that a 25 kHz VCS-equipped aircraft is unable to communicate with ATC, the Flight Crew shall apply the appropriate procedures associated to a loss of comms event.	ICAO Annex 11, PANS-ATM, PANS-OPS and in the Standardised European Rules of the Air (SERA) IR
SR#12	In the event that ATC is unable to communicate with an aircraft in 8.33 kHz VCS airspace, the Controller shall apply the appropriate procedures associated to a loss of comms event.	ICAO Annex 11, PANS-ATM and in the Standardised European Rules of the Air (SERA) IR
SR#13	In the event that a 25 kHz VCS-equipped, non-exempt aircraft has to be routed through 8.33 kHz VCS airspace, the transferring Controller shall instruct the Flight Crew to either switch to a 25 kHz VCS frequency (if available) or to apply the appropriate procedures associated to a loss of comms event (or emergency event).	Annex III(7), ICAO Annex 11, PANS-ATM and in the Standardised European Rules of the Air (SERA) IR
SR#14	In the event that a 25 kHz VCS-equipped, non-exempt aircraft has to be routed through 8.33 kHz VCS airspace, the receiving Controller shall apply the appropriate procedures associated to a loss of comms event (or emergency event).	Annex III(7), ICAO Annex 11, PANS-ATM, PANS-OPS and in the Standardised European Rules of the Air (SERA) IR
SR#15	In case of serious interference to comms with other airspace users by a 25 kHz aircraft that has inadvertently entered an 8.33 kHz sector, the Controller shall apply appropriate procedures in order to try to contact the 25 kHz VCS aircraft on emergency frequency to stop the interfering transmissions	ICAO Annex 11, PANS-ATM and in the Standardised European Rules of the Air (SERA) IR

Num.	Safety Requirement	Addressed in
SR#16	In case of serious interference to comms with other airspace users by a 25 kHz exempt aircraft operating legitimately in an 8.33 kHz sector, the Controller should contact the 25 kHz VCS aircraft to stop the interfering transmissions and apply the procedure associated to a loss of comms event for this aircraft	ICAO Annex 11, PANS-ATM and in the Standardised European Rules of the Air (SERA) IR
SR#17	IFPS shall check each flight plan that is routed through one or more 8.33 kHz VCS sectors to ensure that it indicates that the aircraft is 8.33 kHz VCS capable – otherwise the flight plan shall be rejected	Articles 4(8) and 9(2)
SR#18	If the Flight Crew of a 25 kHz VCS-equipped aircraft is requested to transfer to an 8.33 kHz VCS channel they shall immediately advise ATC that the aircraft is not 8.33 kHz VCS capable	Annex II(3)
SR#19	States shall ensure that all LOAs are updated in accordance with their respective VCS implementation status.	Article 4(3)
SR#20	Aerodrome information/publication (aerodrome manual) shall provide up-to-date information to all vehicle drivers concerning the VCS requirements applicable to the aerodrome manoeuvring areas.	Article 9(6)
SR#21	Vehicle drivers shall be made aware of the consequences of using non-8.33 kHz VCS radios in 8.33 kHz VCS manoeuvring areas unless specifically authorised	Article 9(5)
SR#22	Airport operator/ANSP shall develop and implement strategies to ensure the safe handling of non -8.33 kHz VCS-equipped vehicle in 8.33 kHz VCS airport area.	Annex III(8)
SR#23	State's frequency assignment plan shall comply with EUR Frequency Management Manual – ICAO EUR Doc 011 (2009) in order to ensure that any aerodrome assigned frequency does not interfere with other frequencies assigned in the aerodrome vicinity and is free from harmful interference.	Articles 3(25) and (26)
SR#24	Airport operator shall ensure that vehicle drivers operating on the manoeuvring area are fully conversant with the proper R/T procedures associated to 8.33 kHz VCS	Article 9(5)
SR#25	Airport operator shall ensure that the vehicle radio equipment (including hand-held equipment) used for ATC are compliant with the ICAO Annex 10 standard	Articles 3(21), (22) and (23)

Num.	Safety Requirement	Addressed in
SR#26	In the event that no contact can be established to a vehicle on the manoeuvring area and when situation might lead to taxiway collision or runway incursion the controller shall: • inform other vehicles in the vicinity and taxiing aircraft to immediately stop unless the vehicle has been visually acquired by them • whenever required, ask to a landing aircraft to execute a missed approach due to runway obstruction.	ICAO Annex 11, PANS-ATM and in the Standardised European Rules of the Air (SERA) IR
SR#27	In the event that a vehicle is unable to communicate with ATC and when situation might lead to taxiway collision or runway incursion, the airport operator shall, in liaison with the ATC, intercept and escort the vehicle outside of the manoeuvring area	ICAO Annex 11, PANS-ATM and in the Standardised European Rules of the Air (SERA) IR
SR#28	Airport operator/ANSP shall verify (e.g. through operational trial) that the 8.33 kHz assigned frequency does not generate interference to other already assigned frequencies (ground, tower)	Annex III(5)
SR#29	Airport operator/ANSP shall verify (e.g. through operational trial) that the 8.33 kHz assigned frequency is not impacted by interference	Annex III(5)
SR#30	Vehicle drivers shall receive adequate training on the usage of the 8.33 kHz VCS system	Article 4(1)

Num.	Safety Assumption	Addressed in
A001	Current VHF comms below FL 195 – i.e. using 25 kHz VCS – are acceptably safe.	Not applicable.
A002	The 8.33 kHz VCS comms infrastructure and aircraft equipage will comply with the necessary ICAO standards, as already applicable to the EUR region above FL 195.	Articles 3(21), (22), (23) and (24)
A003	In addition to 8.33 kHz channel spacing capability, the aircraft and mobile equipment is able to tune to 25 kHz spaced channels and to operate in an environment which uses offset-carrier frequencies	Article 3(20)
A004	Individual States / ANSPs must carry out a full safety assessment specific to their areas of responsibility, prior to the deployment of 8.33 kHz VCS comms below FL 195.	Article 6

7. COMPARISON OF EXISTING AND DESIRED SITUATION

	Current Regulatory Situation	**Desired Regulatory Situation**
Comprehensiveness of the regulatory material		
Area of applicability	EU States airspace above FL195	All EU States airspace by 2018
Interoperability and Performance	ICAO performance requirements referenced in the Regulation therefore made mandatory. Legal obligation for the transmission of the information about the 8.33 kHz capability of flights in the Notification and Initial Co-ordination processes between ATC units. Legal obligation for the ANSPs to make the frequency conversions for sectors with a lower limit at or above FL 195, where offset-carrier is not in use.	No change to the performance requirements or the co-ordination requirements. Legal obligation for the States and ANSPs to make the frequency conversions for all feasible frequency assignments.
Safety	Member States are obliged to conduct a safety assessment before the implementation of the Regulation.	Member States are obliged to conduct a safety assessment before the implementation of the Regulation.
Conformity Assessment	CA requirements are to be implemented in accordance with the implementing rule. There will be a formal CA process leading to harmonised practices.	CA requirements are to be implemented in accordance with the implementing rule. There will be a formal CA process leading to harmonised practices.
Implementation Conditions	Dates for the mandatory equipage and for the conversions of the 25 kHz frequencies having mandatory status as they are defined in the implementing rule.	Dates defined for airspace below FL195.
Means of compliance	Formalised through the publication in the Official Journal as means of compliance with the implementing rule and/or identification in the implementing rule.	Formalised through the publication in the Official Journal as means of compliance with the implementing rule.

	Current Regulatory Situation	Desired Regulatory Situation
Impact on stakeholders		
Air Navigation Service Providers	Regulatory obligation to implement the requirements applicable to them.	Regulatory obligation to implement the requirements applicable to them.
Aircraft Operators	Mandatory equipage above FL 195 enforced through the EU legal mechanisms.	Mandatory equipage in All EU States airspace enforced through the EU legal mechanisms.
IFPS	Flight plans checked for 8.33 non-compliance for flights above FL 195	Flight plans checked for 8.33 non-compliance for all flights.
ATM systems manufacturers	8.33 kHz capable ground systems available.	8.33 kHz capable ground systems available
Airborne equipment manufacturers	8.33 kHz capable airborne systems available for most aircraft including all those capable of flying above FL195.	8.33 kHz capable airborne systems available for all aircraft, including VFR aircraft and handhelds
National Authorities	Responsible for the supervision of compliance with the EU Regulation	Responsible for the supervision of compliance with the EU Regulation
Notified Bodies	Formal involvement foreseen in specific cases, where ANSPs cannot comply with relevant requirements described at Annex IV of the rule.	Formal involvement foreseen in specific cases, where ANSPs cannot comply with relevant requirements described at Annex IV of the rule.
Militaries	Regulatory requirements on the Member States regarding the equipage of State aircraft. Constraints of technical or financial nature preventing Member States to equip certain categories of State aircraft with 8.33 kHz capable radios, identified in the Regulation.	Regulatory requirements on the Member States regarding the equipage of State aircraft. Constraints of technical or financial nature preventing Member States to equip certain categories of State aircraft with 8.33 kHz capable radios, identified in the Regulation.
Regulatory Process		
Rule making	EC/SES rule making mechanism.	EC/SES rule making mechanism.
Decision making	European Commission using comitology procedure.	European Commission using comitology procedure.
Enforcement	EU legal mechanisms.	EU legal mechanisms.
Co-ordination with ICAO	EUROCONTROL on behalf of national authorities.	EUROCONTROL on behalf of national authorities.

8. CONSULTATION

8.1 Process

The consultation activities followed the basic mechanisms of the EUROCONTROL Notice of Proposed Rule-Making (ENPRM) process. This requires Stakeholder involvement at all phases of development of regulatory material. Informal consultation concerns all the consultation activities associated with the development of the draft material up to the point it is the considered sufficiently mature for formal, public consultation.

8.2 Consultation on the draft regulatory approach

The proposed draft regulatory approach document was submitted for written informal consultation between 7 May and 3 June 2010. The main objectives of the regulatory approach document were to give an overview of the regulatory provisions and to identify and analyse the topics to be covered by the draft Implementing Rule, taking fully into account the existence of Regulation (EC) No 1265/2007. It also proposed possible scenarios for the development of the draft rule. The two proposed scenarios are summarised as follows:

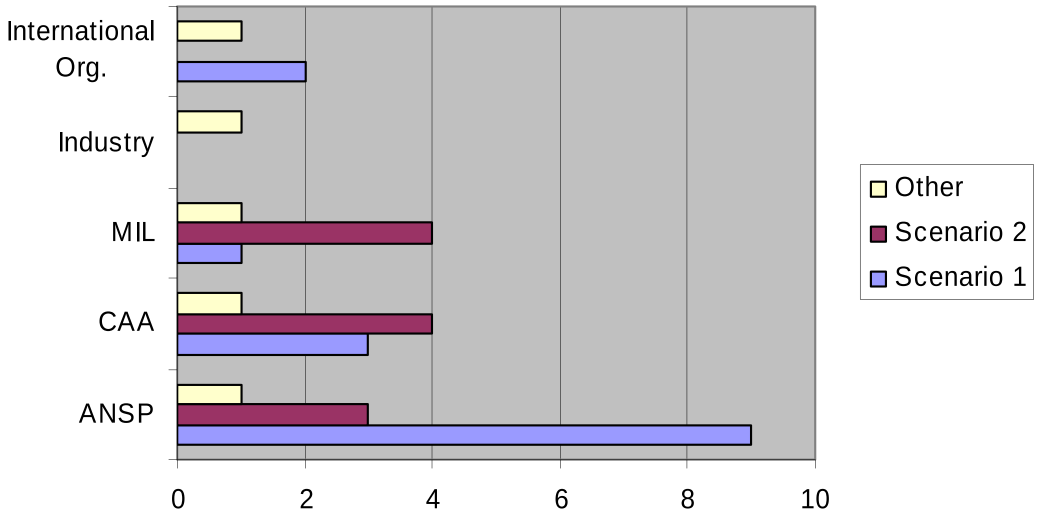
Scenario 1 – Development of regulatory provisions identifying three implementation milestones.

- Forward Fit Phase starting 1 year after the entry into force of the Implementing Rule to ensure all new radios comply.
- Interim Phase for 2014 to ensure a given number of conversions take place.
- Final Phase for 2018 to ensure 8.33 kHz spacing of all possible voice channels.

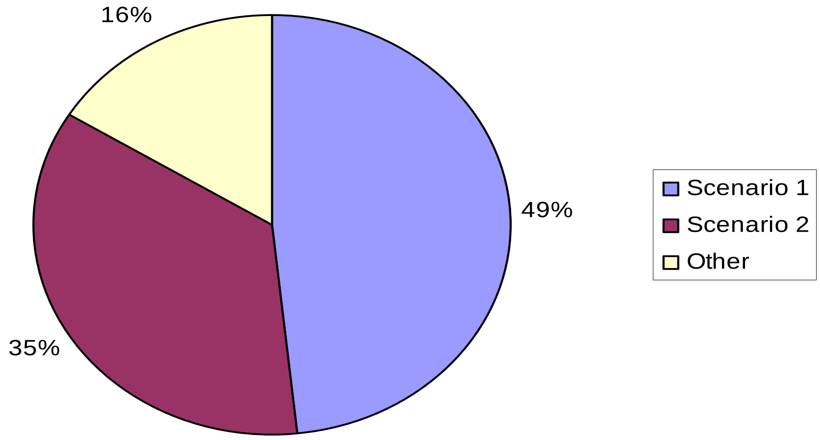
Scenario 2 – Development of regulatory provisions identifying two implementation milestones.

- Forward Fit Phase starting 1 year after the entry into force of the Implementing Rule to ensure all new radios comply.
- Final Phase for 2018 to ensure 8.33 kHz spacing of all possible voice channels.

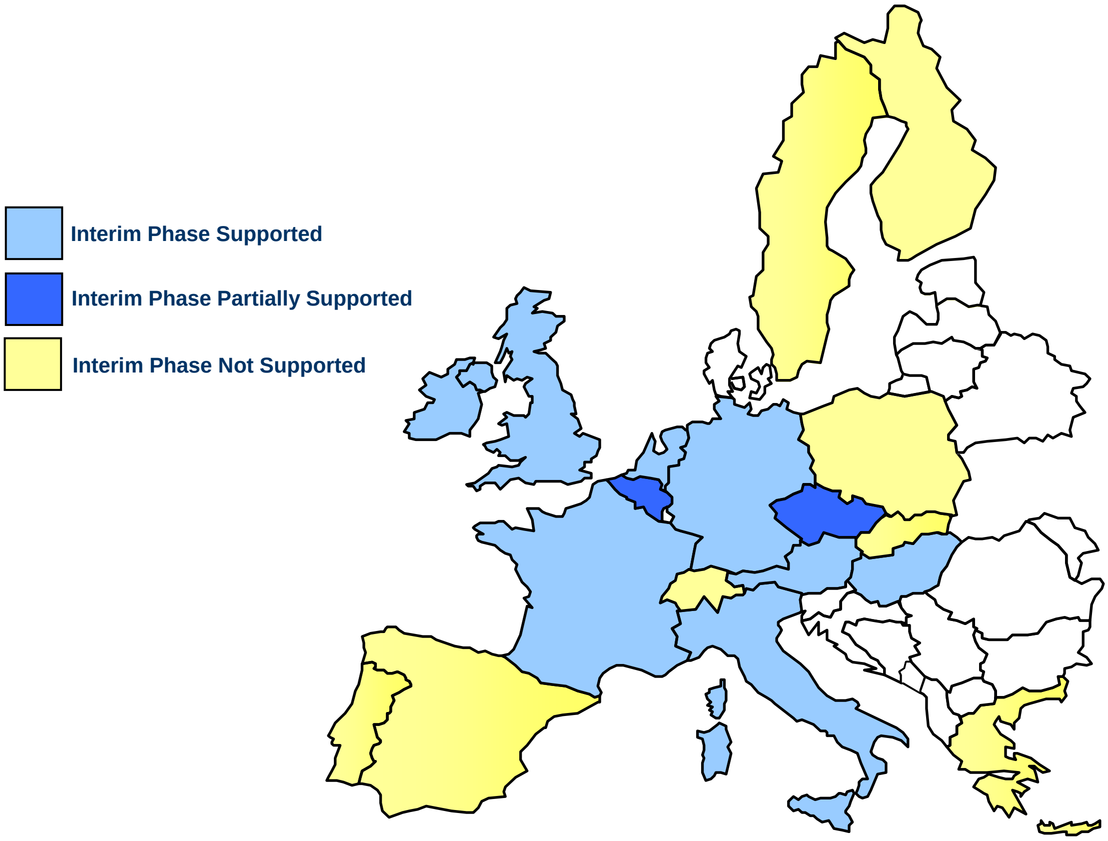
The document was circulated to the members of the 8.33 kHz Programme Steering Group, the Stakeholders Consultation Group and the Civil-Military Interface Standing Committee. The consultation triggered a total of 31 responses, coming mostly from Air Navigation Service Providers and National Supervisory Authorities but also from military authorities, industry as well as from international organisations and associations.



The responses showed a split preference between the two proposed scenarios, neither of them being supported by a majority of Stakeholders.



However, there was a geographical division in the choice of the preferred option, with a clear grouping of the Stakeholders supporting the Scenario 1, in the core area of Europe, while Scenario 2 was supported mostly by Stakeholders situated outside this area.



Following these results it was decided to merge the two proposed scenarios by taking a phased approach based on geographical regions. Therefore the interim phase, as proposed by Scenario 1, only applies to those States which agree to implement it (the States identified in Annex I of the draft Implementing Rule), while Scenario 2 applies to all Member States within the scope of the Implementing Tule.

8.3 Formal consultation on the draft final report

Section to be completed following the formal consultation on the draft IR

9. CONCLUSIONS

The extension of 8.33 kHz channel spacing is the only proven solution to meet the forecast demand for new frequencies in the medium to long term. No alternative to the extension of 8.33 kHz channel spacing has been identified to meet requirements in the period 2015 to 2030.

The consequences of not extending 8.33 kHz channel spacing are very significant, particularly in terms of constraints on capacity and the consequential delay costs. However, the extension of 8.33 kHz channel spacing will enable further sectorisation which would significantly reduce future delay costs between now and 2030. The costs of implementation, whilst substantial, are not unreasonable in the context of the benefits which may be achieved. The total costs of full implementation, at about €430m in present value terms, are equivalent to about 15% of the delay savings achievable by 2025.

However some Stakeholders are impacted more than others. The burden of the downward extension will have a disproportionate impact on general aviation, including recreational aviation, and State aircraft.

The proposed phased implementation approach aims at finding an affordable transition for all Stakeholders as well as minimising implementation risks.

The safety assessment has shown that all identified risks have satisfactory mitigations. However, a local assessment should always be performed in order to validate the effectiveness of those mitigations.

Annex 1 Estimates of Frequency Supply and Demand

A 1.1 Methods of estimation

At this stage there is insufficient information available to be able to make long term estimates of the number of frequencies which will be required for specific services in specific areas. Furthermore, the ability to meet the demand will be different for different services and for different locations. Therefore a probabilistic approach has been developed in two stages.

The first stage derives from earlier work carried out in relation to 8.33 kHz channel spacing. It is based on the overall frequency demand produced as part of the Frequency Usage Analysis Project[11], but uses a random generation of the location of frequency demand together with manual input and professional judgement for estimates of the frequency supply. Only one set of results was produced for each scenario considered.

In order to cross check the results and to refine them when necessary, the second stage uses frequency planning algorithms and multiple simulations to generate a *most likely* set of frequency satisfaction rates. The results of both approaches are presented below. As a consequence of the origin of the two approaches (the first approach was developed from earlier 8.33 work whereas the second derives from work carried out for the Frequency Usage Analysis Project), the approaches use slightly different planning regions which may generate a small difference in the results.

A 1.2 Services evaluated

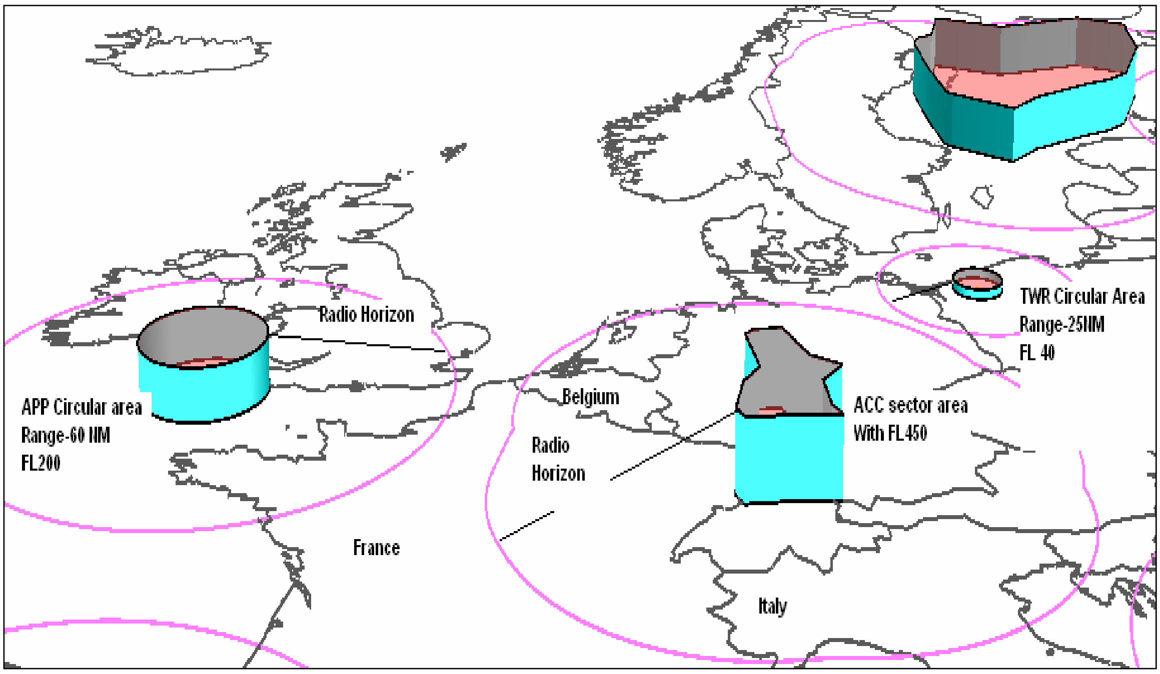


Figure 13 - Protection volumes for ACC, APP and TWR services

Estimates have been made of the future demand for and supply of VHF assignments in the Aeronautical VHF COM Band (118-137 MHz) in the ICAO EUR Region. The stage 1 estimates concentrate on Area Control Centre (ACC) and Approach (APP) services since, as illustrated in Figure 13, these services have very large frequency protection volumes and

[11] FUAE-D3 The Frequency Requirement Forecast, edition 1.0, 24 November 2008

have a major influence on spectrum demand. For example, an ACC service protected to FL450 might require a frequency protection extending to 260 nautical miles[12].

The stage 1 estimates do not assess the demand arising from other ATS services, such as TWR, AFIS and ATIS, and neither do they estimate the demand due to non-ATS services. These additional ATS and non-ATS items will also generate spectrum demand. Thus the estimates present a conservative picture of the likely level of demand. However, these services are included within the stage 2 analysis.

The simulations are based on the ICAO COM2 table as of 18 June 2010 which contains the assignments indicated in Figure 14 (non 8.33 states are excluded).

Service	Number of 25 kHz assignments	Number of 8.33 kHz assignments	Total
A/G	1585	8	1593
ACC	870	427	1297
AFIS	731		731
APP	1273		1273
AS	632	8	640
ATIS	387		387
FIS	114		114
OPC	1703	125	1828
PAR	158		158
TWR	1217		1217
VOLMET	67		67
Total	8737	568	9305

Figure 14 - Current assignments

A 1.3 Scenarios evaluated

Five scenarios have been evaluated in order to assess the effect of extending 8.33 kHz channel spacing, the effect of delay and the consequences of a major fall in demand. The scenarios are:

Scenario 1 – no implementation/full demand

This is a *do nothing* case with no further extension of 8.33 kHz channel spacing and with the demand for frequencies following the linear growth rate projected in the Frequency Usage Analysis Project.

Scenario 2 – no implementation/half demand

This is an additional *do nothing* case with no further extension of 8.33 kHz channel spacing, but with the demand for frequencies at half the linear growth rate projected in the Frequency Usage Analysis Project and traffic growth rates at half the value in the STATFOR forecasts.

[12] The radio horizon protection area is defined as 1.23 x the square root of the maximum flight level (in feet). Thus a sector with a maximum flight level of 450 requires a 260 nautical mile protection ring around the sector boundaries.

Scenario 3 – phased implementation/full demand

This simulation assumes implementation of the measures prescribed in the proposed Implementing Rule, with the full level of growth in the demand for frequencies.

Scenario 4 – phased implementation/half demand

This simulation assumes implementation of the measures prescribed in the proposed Implementing Rule, with only half the anticipated growth in the demand for frequencies and half the forecast growth in traffic.

Scenario 5 – delayed implementation/full demand

In this simulation, completion of the final implementation phase is delayed to 2020, although the interim phase takes place by 2014 as planned. The full level of growth in the demand for frequencies is assumed.

A 1.4 Frequency demand

The forecast of frequency demand is derived from the estimates produced within the Frequency Usage Analysis Project, which proposes a linear growth model for future demand. Based upon this forecast model, estimates of the total demand for frequency assignments within European and neighbouring states over for the next 15 years have been produced, as indicated in Figure 15. Since the linear growth in demand cannot be expected to continue indefinitely, a further set of estimates has been produced assuming that the growth in the demand for frequencies will be only about half the past rate, producing a low demand forecast.

Service	Full Demand Forecast (number of assignments)	Low Demand Forecast (number of assignments)
ACC - upper airspace	435	240
ACC - lower airspace	140	84
APP	390	205
ATIS	106	56
TWR	266	145
Total	1337	730

Figure 15 - Frequency demand forecast

A 1.5 The stage 1 simulations

Simulation areas

The simulations consider the demand of all European states and also the demand from neighbouring states that have an impact on the European spectrum availability. Because frequency congestion is not uniform across Europe, three groups of states have been used in the simulations. These groups comprise:

- **Initial 8.33 States** - Austria, Belgium, Luxembourg, Germany, France, Switzerland, the Netherlands
- **HEX States** - Albania, Belarus, Bulgaria, Bosnia Herzegovina, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, FYROM, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Malta, Norway, Poland, Portugal, Romania, Serbia, Montenegro, Slovak Republic, Slovenia, Spain, Sweden, the United Kingdom
- **Other States** - Algeria, Armenia, Egypt, Georgia, Iraq, Jordan, Island, Israel, Lebanon, Libya, Morocco, Syria, Tunisia, Russia, Turkey, Ukraine.

The simulation process

The simulations cover the period 2010 to 2024. In order to provide realistic results, the simulation process is as follows:

1 At every simulation step (i.e. every 6 months) a number of frequency requests is generated, based on a linear demand model (described above in section A 1.4). In order to generate realistic frequency requests the approach is to pick among the existing assignments and try to find a second frequency for them. For instance, to generate the demand for one ACC/upper frequency in the UK, one of the existing UK ACC/upper airspace assignments in the COM2 is taken and a second frequency for this same airspace with the same DOC is searched for.

2 If a frequency is not directly available, shifts of other frequencies are attempted in order to satisfy the demand.

3 If the request can not be met, it will not be considered again in the subsequent simulation steps.

The forecast demand has been allocated per service and in time using expert judgement in order to derive the demand that would be generated at 6 month intervals in each state (i.e. the simulation step). The simulations attempt to satisfy all demand occurring at six month intervals from 2010 to 2024. (The stage 1 estimates assume no demand in 2010 and first half of 2011.)

The frequency demand includes both 25 kHz assignments and 8.33 kHz assignments. It has been assumed that all ACC/upper demand in the 8.33 area will be for 8.33 kHz assignments. Elsewhere a gradual increase in 8.33 kHz assignments over time has been assumed. Figure 16 shows the evolution of the full demand for 8.33 kHz and 25 KHz frequencies in the 8.33 states at each of the six monthly steps assuming the interim phase in 2014 and full implementation in 2018. Figure 17 shows the evolution of assignments for the low demand case.

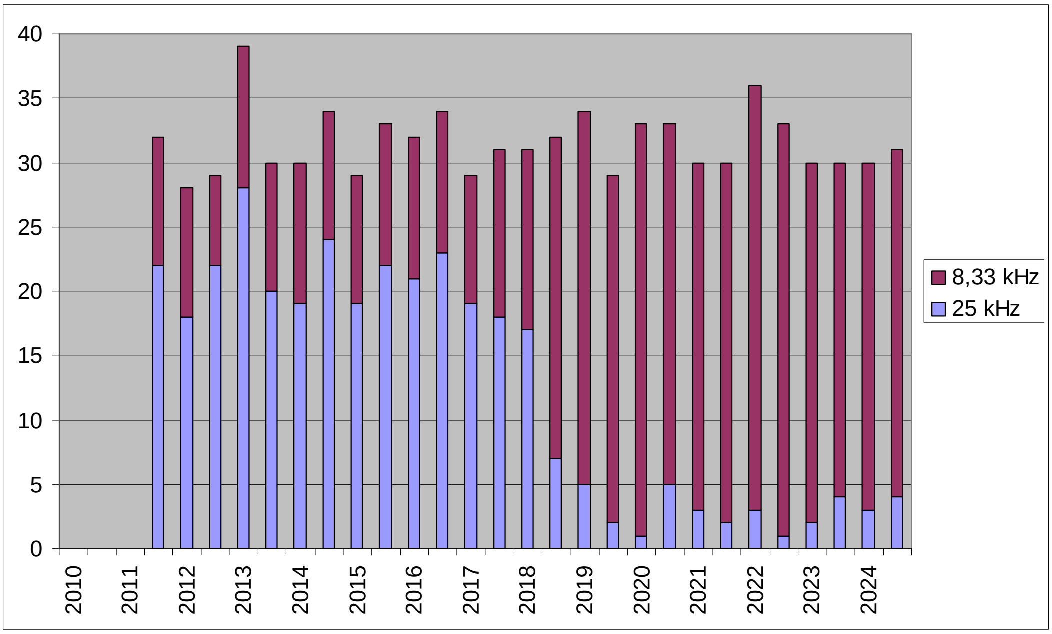


Figure 16 - 8.33 kHz and 25 kHz (full demand)

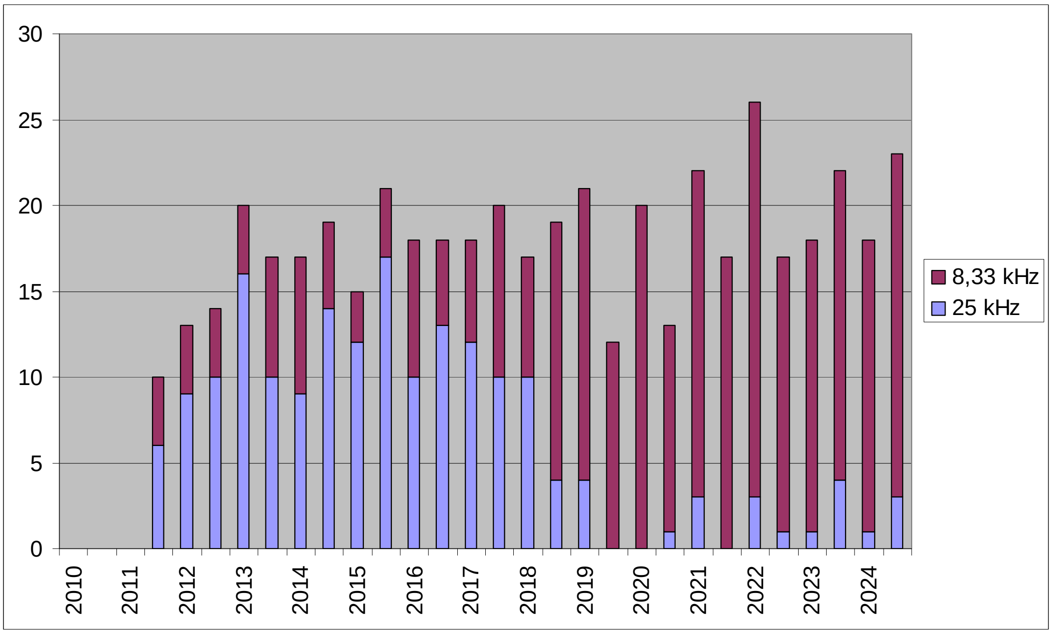


Figure 17 - 8.33 kHz and 25 kHz (low demand)

8.33 kHz conversions

Interim phase conversions have been modelled on the basis of the proposed implementation phases, together with feedback from ANSPs regarding potential conversions. For each state a maximum number of conversions have been set and a distribution of those conversions among services has been assumed, as shown in Figure 18. The conversion forecasts provided by members of the 8.33 kHz Programme Steering Group have also been taken into account. It is also assumed that a third of the anticipated interim phase conversions are made on 1 January 2014 and the rest are made on 1 July 2014.

Number of ACCs on 25 kHz	Number of climax	25% of feasible (maximum)	ACC	APP	TWR
850	241	87	67	16	4

Figure 18 - Interim phase conversions

For the final phase, all feasible assignments will be converted in three steps, one third on 1 January 2018, another third on 1 July 2018 and the last third on 1 January 2019.

Results of the stage 1 simulations

The results of the simulations, in terms of the number of assignments required by 2024 and the number available, are presented in tabular form in Figure 19. The results are also presented graphically in Figure 20 for all states and in Figure 21, which only includes the initial 8.33 states.

Number of assignments	Initial 8.33 states		HEX states		Other states		
	Upper	Lower	Upper	Lower	Upper	Lower	Total
Demand							
Linear growth	87	162	214	388	132	354	1337
Half linear growth	47	95	118	225	74	171	730
Requests satisfied							
No implementation/full demand	10	48	145	319	124	351	997
No implementation/half demand	2	32	86	191	72	169	552
Full implementation/full demand	53	115	198	364	130	353	1213
Full implementation/half demand	27	75	109	212	74	170	667
Delayed implementation/full demand	44	102	188	354	130	353	1171

Figure 19 - Results of the simulations

Without any further conversions, the satisfaction rate, which currently stands at about 80% for all states, will decline to around 70% by 2025. However, in the Initial 8.33 states the position is much more critical. The satisfaction rate, which is only about 30% at present, may well decline to around 20% by 2025.

With full 8.33 kHz expansion as planned, the situation can be remedied and all demand can be satisfied after 2018. In the intervening period, the interim phase can provide a partial solution, with the decline in satisfaction rates being arrested and maintained at roughly their present level despite the increasing demand.

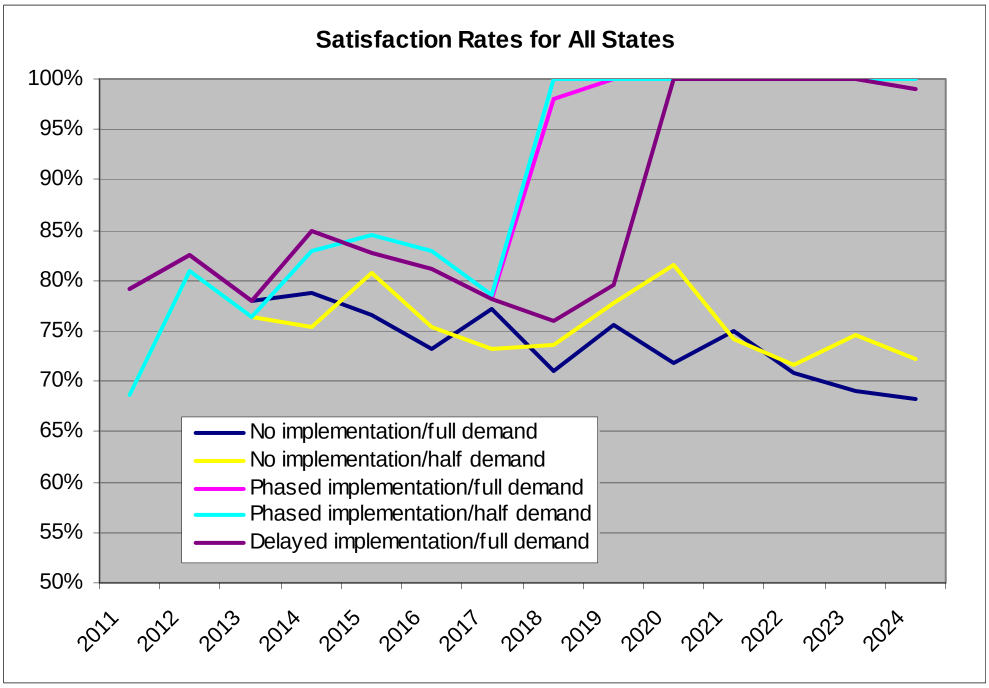


Figure 20 - Satisfaction rates for all states

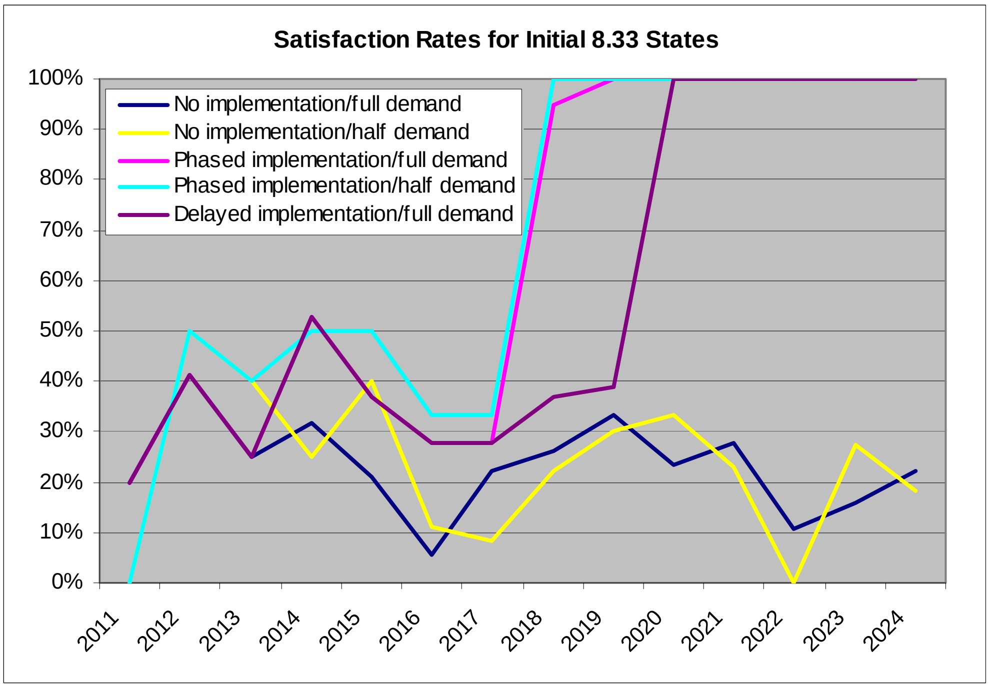


Figure 21 - Satisfaction rates for core states

A 1.6 The stage 2 simulations

The state 2 simulations fully automate the estimating process with the use of mathematical algorithms, including the SENSI frequency planning algorithm and frequency planning tools such as MANIF, currently used for day to day frequency management, and PLANIF used for the ICAO FMG block planning meetings.

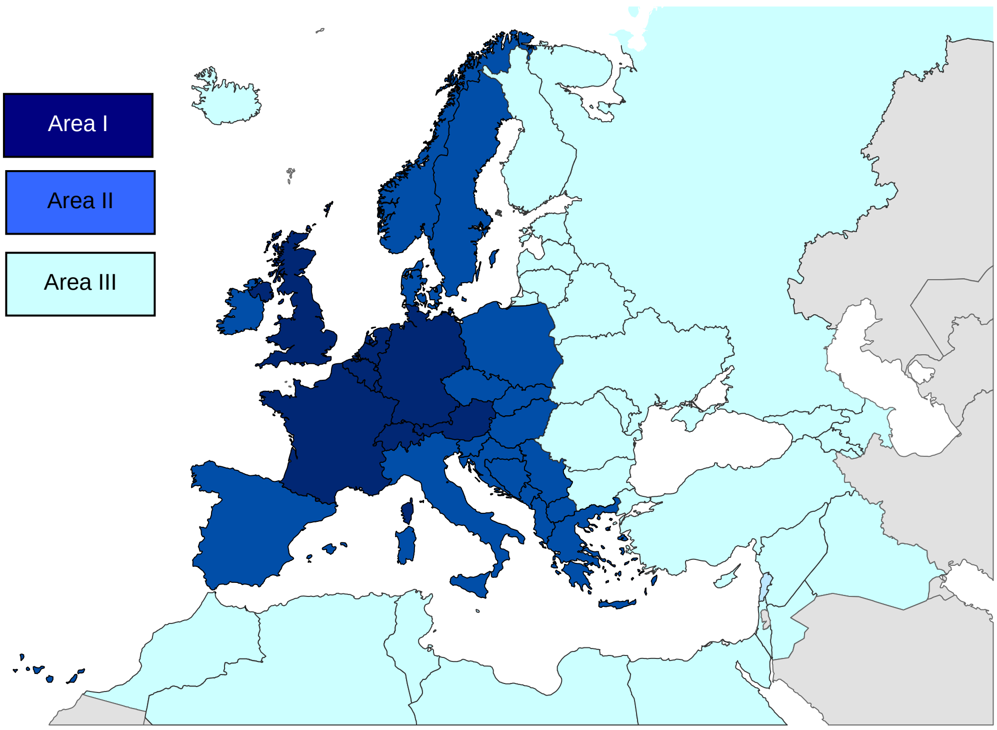


Figure 22 - Stage 2 areas

The analysis is based on the three areas used in the Frequency Usage Analysis Project, which are shown in Figure 22. The areas roughly coincide with the 8.33 planning areas, with Area I corresponding to the Initial area, Area II corresponding to the HEX area and Area III corresponding to the other area. However, seven[13] of the 41 states included are in different areas, of which the one with the largest traffic volume is the UK which is in Area I but is a Hex state.

The demand for frequencies is based on the linear demand forecast derived within the Frequency Usage Analysis Project with the allocation between services being as shown in Figure 23. The values shown are the average annual number of frequencies required for each service within each area. As with the stage 1 simulations, a half demand case has been evaluated, but no delay scenario.

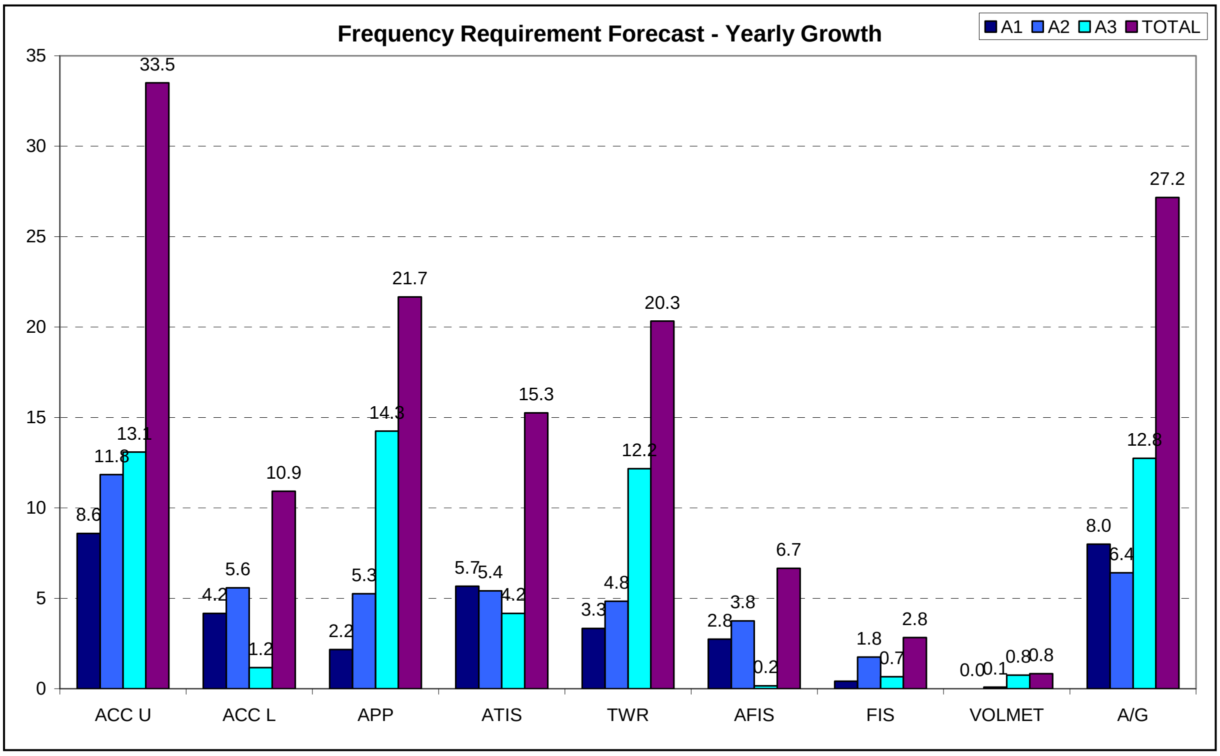


Figure 23 - Stage 2 demand allocation

The stage 2 results are expressed in terms of satisfaction rates for the frequency demand for each service in each area. Figure 24 shows the composite satisfaction rates for all ACC and APP demand across the three areas.

[13] Finland, the Baltic States, Bulgaria, Romania and the UK.

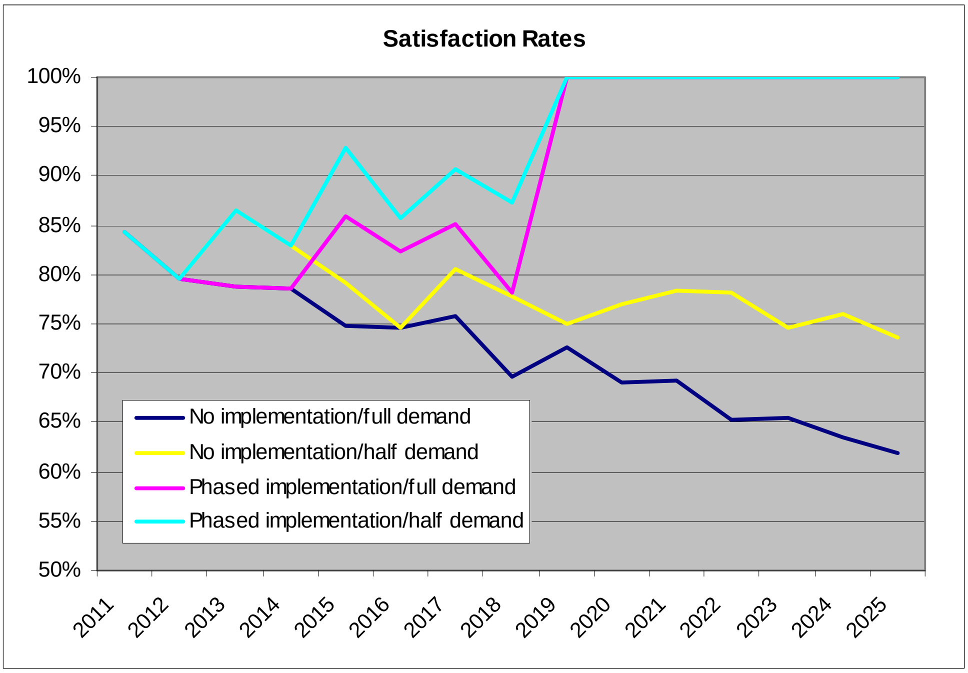


Figure 24 Results of stage 2 simulations

A 1.7 Comparison of methods

Figure 25 compares the overall satisfaction rates for ACC and APP services in all areas produced by the stage 1 and stage 2 methods. Because the stage 1 method is based on the six monthly block planning cycle, implementation benefits appear earlier in 2014 and 2018 than with the stage 2 method, which operates on an annual basis. Other than this anomaly, the results mostly lie within 2 to 3 percentage points of each other, with a five percentage point gap in 2011 being the largest difference. This comparison may be indicative of the confidence limits which may be placed on the results.

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
No implementation/full demand										
Stage 1	79%	82%	78%	79%	77%	73%	77%	71%	76%	72%
Stage 2	84%	80%	79%	79%	75%	75%	76%	70%	73%	69%
Phased implementation/full demand										
Stage 1	79%	82%	78%	85%	83%	81%	78%	98%	100%	100%
Stage 2	84%	80%	79%	79%	86%	82%	85%	78%	100%	100%

Figure 25 - Comparison of satisfaction rates

The stage 1 results have been used in the estimates of delay costs, since this set of results permits an estimate of the effect of a delay to the second phase of implementation.

Annex 2 Aircraft Equipage Costs

A 2.1 Civil aircraft

A 2.1.1 Current levels of equipage

Data on the number of aircraft operating in European airspace has been derived from:

- EUROCONTROL CFMU (data for all flights between January and October 2009)
- the International Register for Civil Aviation Aircraft
- the Recreational Aircraft Associations.

The CFMU data recorded all flights operating as IFR flights in controlled airspace and was used to determine the following for each IFR flight:

- the maximum flight level
- whether the flight was indicated as being by a 8.33 kHz capable aircraft
- whether the flight was a military flight

As a consequence of the existing Implementing Rule on 8.33 kHz equipage, virtually all civil aircraft operating above FL195 are already equipped with 8.33 kHz capable radios. For aircraft operating as IFR below FL195, the statistics indicate that about 30% of aircraft are currently equipped with 8.33 kHz capable radios.

In the case of VFR traffic, the data is less reliable but estimates have been made based on aircraft registers and data provided by recreational aircraft associations. In the case of gliders and balloons, handheld radios are used by instructors, retrieval teams and competition directors and estimates of these have been included.

A proportion of the current fleet will be taken out of service before an updated 8.33 kHz Implementing Rule could come into effect and, therefore, these aircraft will not retrofit with 8.33 kHz capable equipment. Based on studies carried out by Airbus, it has been assumed that large and medium IFR aircraft have an average working life in Europe of 25 years and, therefore, aircraft more than 25 years old in 2014 have not been included in the retrofit cost estimates. Light and very light IFR aircraft, helicopters and VFR aircraft tend to have a longer life and therefore, no reduction has been made in the numbers of these aircraft.

It has been assumed that all remaining non-equipped IFR aircraft will equip during the interim phase but that all VFR aircraft will equip during the final phase.

The estimates of the aircraft numbers and the levels of equipage are presented in Figure 26.

A 2.1.2 Proposed equipage

In order to prepare equipage costs, the following equipage solutions have been assumed.

Large, Medium A/C, Helicopters

- 2 Radios
- Combined Com / Nav solutions
- Transceiver + CP

Light A/C (between 2t and 5.7t) and Helicopters (IFR):

- 2 Radios
- Panel Mounted Equipments

- Possibly Combined COM/NAV solutions

Very Light A/C (<2t), Light Helicopters (VFR):

- 2 radios
- Panel mounted equipment

Gliders

- 1 radio installed onboard
- Low cost panel mounted equipment
- Handheld radios used for instructors, retrieve teams, competition directors.

(Europe Air Sport has estimated that the number of handhelds should be 25 countries x 50 clubs x 20 handhelds per club = 25 000 handheld radios.)

Microlights

- 1 radio,
- Low cost panel mounted equipment

Balloons

- 1 radio installed onboard
- 1 radio for retrieve teams
- Handheld radios

A 2.1.3 Equipment costs

Medium and Large A/C

There are existing solutions proposed by major avionics equipment manufacturers consisting of a transceiver installed in the avionics bay plus a control panel installed in the cockpit. The approximate price of such radio system has been estimated at between $15,000 and $20,000.

Light A/C

For light A/C (below 5.7 tonnes) panel mounted solutions seems to be the most suitable solution in term of price, dimensions and weight. The cost is around $5,800. Combined COM/NAV units are also available and could be used as an alternate solution. Cost range from $10,000 to $21,000.

Helicopters

DZUS mounted radios consist of a transceiver plus a control panel and may cost about $9,000.

Very Light A/C

Low cost radios are already available on the market at an approximate cost of $1,500.

Handheld radios

Within the light aviation community handheld radios are used by retrieval teams, instructors and competition directors (balloons and gliders). Currently there is no 8.33 kHz capable handheld radio.

Non certified radios

Obtaining an ETSO is costly for an avionics manufacturer and it is difficult to find a price below $1,500 for an *ETSOed* radio. For very light A/C (e.g. gliders, ULM/microlight A/C) some users may envisage installing non certified radios. This will be possible in certain countries, such as Italy where ULM/microlights are considered as model A/C (and so do not need certified radios) but not in Germany.

For each aircraft, it has been considered that some engineering customization will be needed in order to adapt the design to each aircraft configuration. It has been assumed that the modification is performed during scheduled aircraft checks. The installation work has been estimated has follows:

- 2 hours approximately for VFR and Very Light IFR A/C
- 3 to 4 hours for light, medium and large IFR A/C

It has been considered that the Supplemental Type Certificate (STC) is *Major Classified* although, in some cases, the STC could be classified as Minor (e.g. for some VFR aircraft). As the proportion of Minor STC is very difficult to estimate and the impact of certification in the overall cost is minor, it has not been considered in the cost calculation.

The retrofit cost assessment has been performed taking into account the following costs:

- a one-off cost per aircraft type that includes the cost of certification of the radio installation by means of an aircraft manufacturer SB or STC and engineering activities (drawings, wiring, etc.)
- one-off costs per aircraft that include the cost of the equipment (VHF 8.33 Radio), the installation kits (wiring, connectors), the installation of the equipment on each aircraft and the engineering dossier customisation for each aircraft
- the costs of handheld radios used by retrieval teams, instructors and competition directors for gliders and balloons.

Some cost issues remain to be resolved; including old equipment disposal costs (see the Waste Electrical and Electronic Equipment Directive published by European Community).

	IFR A/C						VFR A/C						
	Large	**Medium**	**Light**	**Very Light**	**Helicopter**	**Total**	**Aeroplanes**	**Helicopter**	**Glider**	**Balloons**	**Microlights**	**Total**	**Total**
Aircraft numbers													
Number flying only below FL195	130	343	1,162	5,029	716	7,380	10,000	3,600	22,000	5,700	19,000	60,300	67,680
Radio equipped (%)	100%	100%	100%	100%	100%		100%	100%	95%	99%	95%		
Number radio equipped	130	343	1,162	5,029	716	7,380	10,000	3,600	20,900	5,643	18,050	58,193	65,573
8.33 kHz equipped (%)	75%	46%	46%	27%	12%	30%	10%	5%	5%	5%	5%		6%
A/C to be 8.33 kHz equipped	33	185	627	3,671	630	5,146	9,000	3,420	19,855	5,361	17,148	54,784	59,930
A/C < 25 years old in 2014	24	94	n/a	n/a	n/a	118	n/a	n/a	n/a	n/a	n/a	n/a	118
Cost estimates													
Estimated number of aircraft types	10	15	45	65	25	160	100	60	100		100	360	520
One off cost per aircraft type (€)	20,000	20,000	10,000	10,000	15,000		10,000	10,000	4,000		4,000		
Estimated number of aircraft	24	94	627	3,671	630	5,046	9,000	3,420	19,855	5,361	17,148	54,784	59,830
One off cost per aircraft (€)	33,000	33,000	13,000	7,400	13,000		8,000	5,700	1,500	500	1,500		
Cost of additional handhelds radios (€m)									12.50	2.68		15.18	15.18
Total cost (€m)	0.99	3.40	8.60	27.82	8.57	49.38	73.00	20.09	42.68	5.36	26.12	167.26	216.63
Phasing													
Phase 1 - impact (%)	100%	100%	100%	100%	100%		0%	0%	0%	0%	0%		
- cost (€m)	0.99	3.40	8.60	27.82	8.57	49.38	-	-	-	-	-	-	49.38
Phase 2 - impact (%)	0%	0%	0%	0%	0%		100%	100%	100%	100%	100%		
- cost (€m)	-	-	-	-	-	-	73.00	20.09	42.68	5.36	26.12	167.26	167.26

Figure 26 - Implementation costs for civil aircraft

A 2.2 State aircraft

A 2.2.1 Definition of state aircraft

According to the Civil-Military Interface Standing Committee (CMIC), state aircraft are defined as follows:

- For ATM purposes and with reference to article 3(b) of the Chicago Convention, only aircraft used in military, customs and police services shall qualify as state aircraft,
- Aircraft on a military register, or identified as such within a civil register, shall be considered to be used in military service and hence qualify as state aircraft,
- Civil registered aircraft used in military, customs and police service shall qualify as state aircraft,
- Civil registered aircraft used by a state for other than military, customs and police service shall not qualify as state aircraft.

A 2.2.2 Data sources

Two sources of information have been used to assess the number of aircraft affected by the extension of 8.33 kHz below FL195:

- Military Statistics for 2006 and 2008 provided by the EUROCONTROL Directorate Civil-Military ATM Coordination (DCMAC) [14]
- CFMU data for flights from January to October 2009.

The CFMU data have been used as follows:

- The maximum flight level filed in the flight plan has been used to determine if the flight went above FL195.
- The "Y" filed in the equipment field was used to determine if the aircraft was 8.33 kHz capable. It should be noted that using the filing of a "Y" to determine the 8.33 kHz equipage status may be unreliable since the equipment field data is not always available and, even when aircraft are equipped with an 8.33 kHz radio, pilots do not always file the "Y" in the flight plan if the flight will remain below FL195.
- The flight type filed in the flight plan was used to determine if the flight was a military one.

The aircraft families were determined in accordance with the military classification (Directorate Civil-Military ATM Coordination), i.e.:

- combat aircraft
- light aircraft (mainly trainers)
- large aircraft (mainly transport types)
- helicopters
- paramilitary aircraft

[14] www.eurocontrol.int/mil/public/site_preferences/display_library_list_public.html#6

A 2.2.3 Estimate of aircraft numbers

The following assumptions have been used to assess the number of aircraft affected by the proposed Rule:

- Aircraft that are capable of flying above FL195 are not included since it is assumed that they are operated above FL195 and therefore subject to the current 8.33 Rule. Although a small number of such aircraft are only operated below FL195, so as to avoid the need for 8.33 equipage, for the purposes of this estimate it has been assumed that all combat and transport aircraft are operated above FL195 and are already equipped.
- It is assumed that the majority of aircraft flying below FL195 (light aircraft and helicopters) are not currently 8.33 equipped.

The table below presents a first estimate of the potential number of state aircraft flying below FL195 which will be required to equip with 8.33 radios. Most of these belong to ECAC fleets but there are a significant number of US aircraft.

Military statistics for 2008 show that a large proportion (87%) of flights in Europe by military aircraft from States not members of Eurocontrol were carried out by US aircraft. The percentage of the total number of US aircraft which fly in Europe (shown in parentheses in the table below) has been estimated using CFMU data for 2009.

	Combat	Large	Light	Heli-copters	Para-military	Total
ECAC fleets	3332	1124	2282	4487	396	11621
US fleet in Europe (% total US fleet)	574 (15%)	945 (40%)	360 (20%)	799 (15%)	23 (15%)	2701
Total aircraft	3906	2069	2642	5286	419	14322
% flying below FL195	0%	0%	45%	100%	95%	
% not 8.33 equipped	-	-	90%	98%	98%	
Aircraft to be equipped	-	-	1070	5180	390	6640

Figure 27 - Estimate of aircraft numbers

DCMAC military statistics contain the number of aircraft of each type within the major categories used. This indicates that about 45% of light aircraft and 95% of paramilitary aircraft, together with 100% of helicopters, belong to types which are not capable of flying above FL195. Very few of the aircraft not capable of flying above FL195 are equipped with 8.33 radios and, although no comprehensive data is available, it has been assumed that 90% of the light aircraft and 98% of the helicopters and paramilitary aircraft operating below FL195 are not equipped.

A 2.2.4 Installation assumptions

Three retrofit solutions are considered to be possible:

- a new of the shelf V/UHF installation with fit and form replacement
- an equipment upgrade (e.g. ARC 186 to ARC 210)
- installation of an additional civil VHF radio

However, the third solution, additional civil radio installation, will not be feasible for helicopters and small fixed wing aircraft due to a lack of space in the cockpit and avionics bay, the additional maintenance and spare parts management required and interference due to VHF antenna installation in close proximity to the V/UHF antennae, particularly on small aircraft and helicopters.

In order to reduce the retrofit costs, the upgrade of only one of the two radios carried could, in theory, be considered. However, this solution is very unlikely to be chosen because of the additional costs of spare parts, management and maintenance which would be entailed. Accordingly, this approach has not been included in the cost estimates.

A 2.2.5 Exemptions

The current draft of the amended Implementing Rule proposes that state aircraft that operate only below FL195 shall be exempted from the requirement to equip with 8.33 kHz radios if they will be out of service before the end of 2025. The information in the table below, provided by the military authorities in three states, gives an indication of the types of aircraft that could qualify for this exemption.

Country	Aircraft type	Number of aircraft	Out of service date
France	Lynx	28	2019
	Alouette III	25	2017
Germany	Do 224	2	2024
	Bo 105	105	2025
	UH 1D	77	2015
Netherlands	Lynx	21	2009/2010

Figure 28 - Exempted aircraft

For each aircraft type in the military statistics, the date of entry into service has been determined and an estimate of the percentage of aircraft that will be out of service by 2025 has been made on the assumption that:

- all aircraft of types that were first introduced before 1970 will be out of service by 2025
- all aircraft of types that were first introduced after 1970 will still be in service in 2025.

The date of 1970 has been chosen since the average life of state aircraft in the three countries supplying information is about 60 years. (Some very old aircraft are still in service, including 140 Alouette III which entered service in 1960, 390 UH1 which entered service in 1956 and 57 AN2 which entered service in 1942.)

Aircraft family	Aircraft out of service before 2025
Light	30%
Helicopters	55%
Para-military	25%

Figure 29 - Aircraft out of service before 2025

A 2.2.6 Cost estimates

Figure 30 shows the construction of an overall cost estimate for airborne equipage. This is based upon the assumptions previously described, together with:

- a cost per aircraft type for each retrofit solution. This has been estimated at €100,000 in each case.
- an equipage cost for each aircraft, as indicated in the table.

These costs represent an order of magnitude estimate and are subject to significant uncertainty. In particular, equipment costs quoted in US dollars have been converted to euro at a rate of $1.25 to the euro and this rate may be subject to considerable fluctuation.

Before taking account of exemptions, the total cost of retrofit has been estimated at €452 million. Of this amount, only €7.2 million relates to the one-off costs associated with developing a solution for each aircraft type, with the remaining €445 million being the individual aircraft equipage costs.

The effect of the exemptions indicated in section A 2.2.5 has been accounted for by reducing the total equipage cost in proportion to the numbers of the existing fleet still expected to be in service during 2025. To be strictly correct, the cost per aircraft type should be an all or nothing value, depending on whether any aircraft of that type will still be in service in 2025. However, since the proportion of the costs associated with the aircraft type is small (1.6%), this level of precision has not been attempted.

Once the exemptions are taken into account, the total equipage costs fall to €226 million.

Aircraft family	Solution	Number of radios	Number of aircraft types	Cost per aircraft type	Number of aircraft per solution	Cost per aircraft	Total cost	Cost per family	Still in service in 2025	Costs allowing for exemptions
Light	New V/UHF	2	5	€ 100 000	214	€ 100 000	€ 21.9 m	€ 59.8 m	70%	€ 41.8 m
	Equipment upgrade	2	10	€ 100 000	535	€ 50 000	€ 27.8 m			
	Civil VHF radio	1	5	€ 100 000	321	€ 30 000	€ 10.1 m			
Helicopter	New V/UHF	2	20	€ 100 000	2072	€ 100 000	€ 209.2 m	€ 366.6 m	45%	€ 165.0 m
	Equipment upgrade	2	20	€ 100 000	3108	€ 50 000	€ 157.4			
Para-military	New V/UHF	2	4	€ 100 000	117	€ 100 000	€ 12.1 m	€ 25.8 m	75%	€ 19.3 m
	Equipment upgrade	2	6	€ 100 000	234	€ 50 000	€ 12.3 m			
	Civil VHF radio	1	2	€ 100 000	39	€ 30 000	€ 1.3 m			
Totals							**€ 452.2 m**	**€ 452.2 m**		**€ 226.2 m**

Figure 30 - State aircraft equipage costs

Annex 3 Offset-carrier Climax Impact Assessment

A 3.1 The use of Climax

Offset-carrier or Climax systems allow the extension of the coverage of an assignment when the range of a single ground station is inadequate to cope with the operational area. This may be for various reasons such as the size of the sector or terrain constraints.

Two or more ground stations are deployed in order to cover the desired area. The ground stations operate on the same channel but their carrier is slightly shifted in frequency. Climax assignments may have 2, 3 or 4 legs, requiring 2, 3 or 4 ground stations. Climax may also be used for redundancy reasons. Two ground stations cover the operational area and if one fails, the service is maintained by the second.

A 3.2 The current Climax situation

A 3.2.1 The 2004 study

In 2004, a EUROCONTROL study identified Climax frequency assignments in the ECAC region[15]. The values shown on the map in Figure 31 indicate the frequencies used for all services.

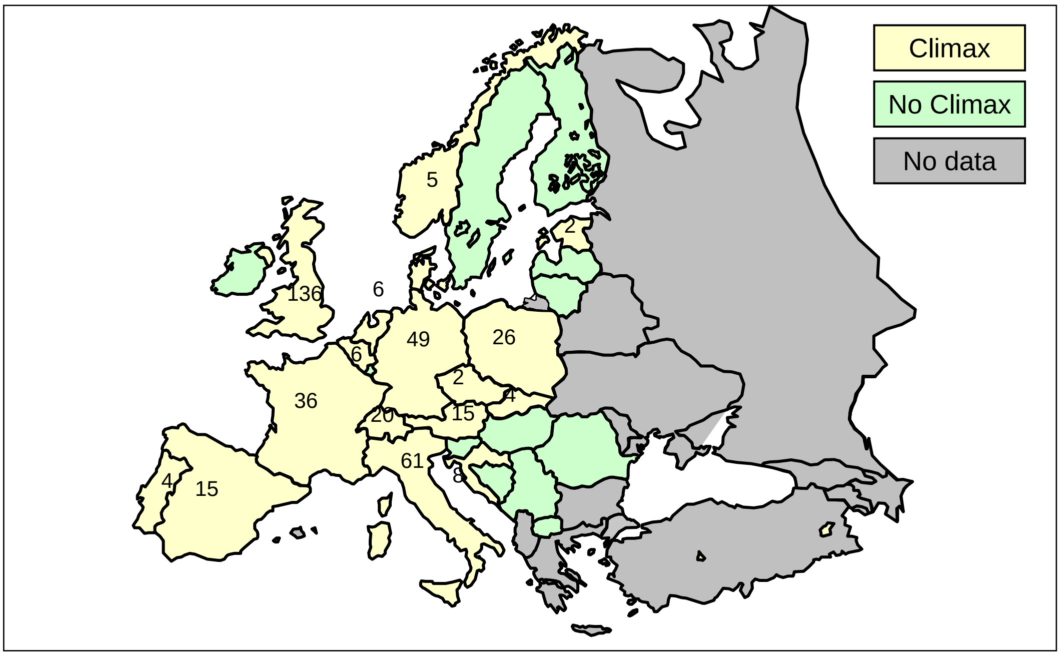


Figure 31 - Location of Climax frequencies

25 kHz frequency assignments

The study considered the 25 kHz assignments remaining in the VHF band and determined that:

- Climax 2-leg frequency assignments represent 4.4% of the 25 kHz assignments
- Climax >2-leg frequency assignments represent 2% of the 25 kHz assignments
- Most of climax frequency assignments are used for ACC purposes

[15] It should be noted that this study is now over six years old and may not precisely reflect the current situation. In particular, there are at present two climax frequencies in use in Ireland.

Although these figures provide a first indication, they are not significant enough to assess potential impact of Climax on 8.33 kHz implementation.

Surface occupation

To better quantify the spectrum consumption, the use of the *surface occupation* concept is preferred to the amount of assignments. The total surface occupation is the sum of the surface areas where one frequency cannot be reused. It includes the co-channel protection area (Co) and the adjacent channel protection area (Ad). Ad can be approximated by the service area and has to be counted twice (for both sides of the main frequency). The total Surface Occupation (Tso) can be written as: Tso = Co+ 2.Ad

Figure 32 below shows the distribution of 25 kHz frequency assignments in terms of surface occupation. This indicates that:

- Climax 2-leg frequency assignments represent 10.2% of the 25 kHz surface occupation
- Climax >2-leg frequency assignments represent 5.9% of the 25 kHz surface occupation

Thus the potential spectrum shortfall due to the non-conversion of the Climax 2-leg frequency assignments could be around 10%.

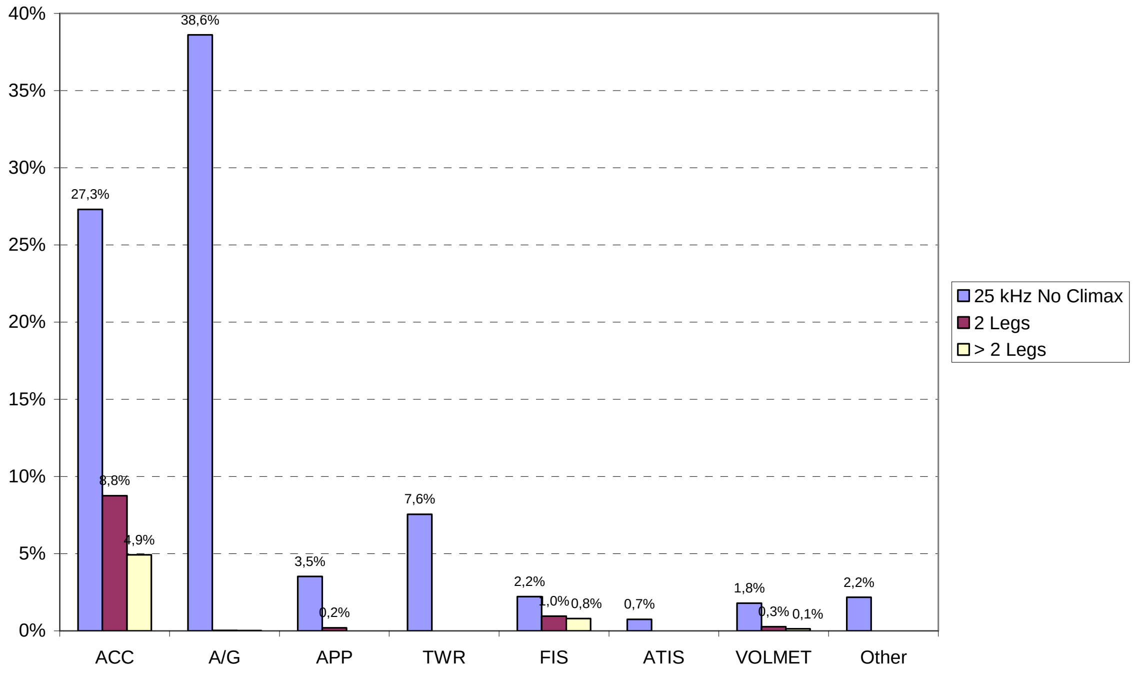


Figure 32 - 25 kHz spectrum consumption

A 3.3 The Frequency Usage Analysis Project

Phase 1 of the Frequency Usage Analysis Project, carried out in 2008, provided information on how Climax was operated in en-route control centres (ACCs) in the core area of Europe. In this area, a total of 374 operational en-route assignments were identified, of which 206 had not been converted to 8.33 kHz channel spacing and thus were still at 25 kHz channel spacing. Amongst these 206 25 kHz assignments there were:

- 106 2-leg Climax assignments
- 13 3-leg Climax assignments
- 1 4-leg Climax assignment

These values are lower than those shown on the map in Figure 31, since the Frequency Usage Analysis Project only considered frequencies used for en-route ATC and not the full range of services.

Figure 33 shows the location of the Climax assignments. The largest user of Climax frequencies is the UK, in which almost all of the remaining 25 kHz en-route operational assignments are Climax. Belgium and the Netherlands (excluding Maastricht) also have a high Climax ratio (over 50%). However, this may be explained by the fact that their centres cover airspace below FL245 (with the upper airspace being controlled from the Maastricht centre). Due to its mountainous terrain, Austria also has a high proportion of Climax frequencies (61%) although, surprisingly, Switzerland only uses 26% of its frequencies as Climax frequencies.

Location	Total	25 kHz	2-leg	2-leg (% of 25kHz)	>2 leg	>2 leg (% of 25 kHz)
Austria	18	10	8	80%	2	20%
Belgium	7	7	4	57%	0	0%
Maastricht	21	0	0	0%	0	0%
France	137	42	14	33%	0	0%
Germany	89	64	8	13%	10	16%
The Netherlands	6	6	3	50%	0	0%
Switzerland	19	10	5	50%	0	0%
United Kingdom	77	67	64	96%	2	3%
Phase 1 States	374	206	106	51%	14	7%

Figure 33 - Operational en-route frequency assignments

Excluding Climax frequencies, 86 assignments are available for conversion to 8.33 kHz channel spacing. This would rise to 192 if 2-leg Climax frequencies were included. In these seven states, their retention for 2-leg Climax purposes would prevent 106, or just over half of the remaining 25 kHz assignments from being converted to 8.33 kHz channel spacing.

A 3.4 Simulations

In order to extend the above analysis of the seven states in the Frequency Usage Analysis Project to the whole of Europe, simulations have been carried out to assess the full impact of 2-leg Climax. The simulations covered the three areas shown in Figure 34, in which Area I corresponds to the area considered in the Frequency Usage Analysis Project. The simulations were based on the COM2 database as of January 2010, considered each type of service (ACC, APP, FIS, TWR, etc) and were run over a 24 year period (to 2034).

Climax data have been extracted from the 2004 Climax study, updated with information from the individual states. Some Climax frequency assignments from the 2004 study have been deleted or shifted since then and, therefore, have not been taken into account in the simulations.

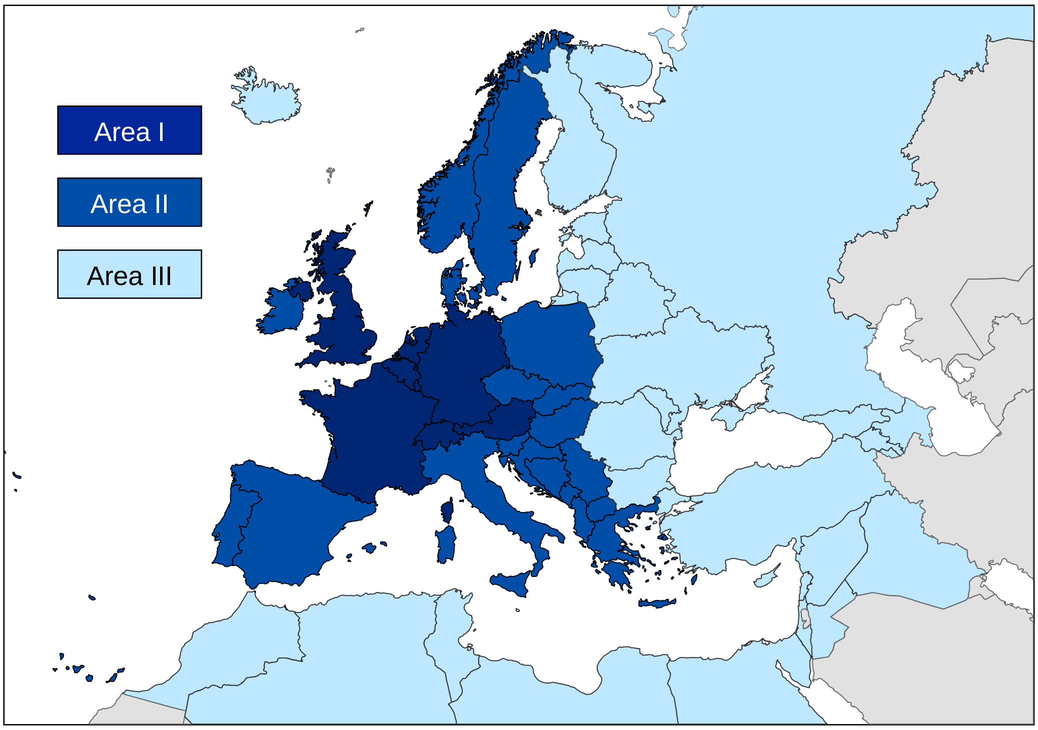


Figure 34 - Reference areas

A summary of the results of the simulations is shown in Figure 35.

	Area I	Area II	Area III	Total
Current number of assignments (January 2010)	2657	1930	2454	7041
Additional assignments required over simulation period	842	916	1422	3180
Additional assignments available without any further 25 kHz conversions	328	656	1286	2270
Additional assignments available without Climax conversion	449	790	1397	2636
Additional assignments available with 2-leg Climax conversion	515	802	1396	2713

Figure 35 - Simulation of Climax conversions

Thus, over the full period of the analysis, the simulations indicate that, without Climax conversions, 2636 additional assignments can be found. This represents 83% of the 3180 additional requirements required. With the inclusion of 2-leg Climax conversions, a further 77 assignments can be made, increasing the satisfaction rate to 85%. Thus the inclusion of 2-leg Climax conversions has relatively little effect on the total number of assignments possible.

A 3.5 Equipage for 8.33 kHz Climax

Existing 8.33 kHz radios, developed to comply with the current 8.33 kHz mandate, are capable of being upgraded to meet the ED-23C requirements which enable their use in an 8.33 kHz multi-carrier system. However, the extent of the modification may vary and existing radios may be categorised as follows.

- Category 1 - 8.33 kHz radios potentially capable of meeting ED-23C requirements with a minor modification (no modification of software and/or hardware). However, this modification will include tests of the radios, updates to the documentation and work with aircraft manufacturers and DOAs to install the revised equipment.
- Category 2 - 8.33 kHz radios needing a software or hardware/software upgrade to meet ED-23C requirements.
- Category 3 - 25 kHz radios that will not be capable of meeting ED-23C requirements.

The number of aircraft falling into each of these categories has been estimated, together with the costs of the modifications required to enable compliance with the ED-23C standard. These are presented in Figure 36, which also shows the incremental cost of meeting the ED-23C standard over and above the cost for meeting the ED-23B standard.

	IFR aircraft					VFR aircraft			
	Large	**Medium**	**Light**	**Very Light**	**Helicopter**	**Aeroplanes**	**Helicopter**	**Glider**	**Balloons**
Aircraft numbers									
Number of aircraft (above and below FL195)	11132	3528	2430	5170	720	10000	3600	22000	5700
% radio equipped	100%	100%	100%	100%	100%	100%	100%	95%	99%
Number radio equipped	11132	3528	2430	5170	720	10000	3600	20900	5643
Number < 21 years old	10235	2742							
Retrofit options									
Radio Cat 1	5%	5%	3%						
Estimated number of aircraft types	20	10	5						
One-off cost per aircraft type (€)	12,000	12,000	8,000						
Number of aircraft	512	137	73						
One-off cost per aircraft (€)	2,500	2,500	2,500						
Total cost (€m)	1.52	0.46	0.22						
Radio Cat 2	94%	85%	70%	28%		10%			
Estimated number of aircraft types	80	50	40	25	Cost of new radio lower than SB	40	Cost of new radio lower than SB	Cost of new radio lower than SB	
One-off cost per aircraft type (€)	20,000	20,000	10,000	10,000		10,000			
Number of aircraft	9621	2331	1701	1448		1000			
One-off cost per aircraft (€)	6,000	6,000	7,000	9,000		7,000			
Total cost (€m)	59.33	14.98	12.31	13.28		7.40			
Radio Cat 3	1%	10%	27%	72%	100%	90%	100%	100%	100%
Estimated number of aircraft types	10	15	20	40	25	150	60	200	
One-off cost per aircraft type (€)	20,000	20,000	10,000	10,000	15,000	10,000	10,000	4,000	
Number of aircraft	102	274	656	3722	720	9000	3600	20900	5643
One-off cost per aircraft (€)	35,000	35,000	16,000	9,000	16,000	8,000	6,000	1,500	500
Total cost (€m)	3.78	9.90	10.70	33.90	11.90	73.50	22.20	32.15	2.82
Costs of handheld radios (€m)								15.00	2.82
Total costs (€m)									
Total cost per aircraft family	64.63	25.34	23.23	47.18	11.90	80.90	22.20	47.15	5.64
Total cost for ED 23C H1 mandate			172.27					183.57	
Cost per aircraft family for ED 23B	0.99	3.40	8.68	27.79	8.60	73.00	20.09	42.68	5.36
Cost increase per aircraft family	63.64	21.94	14.55	19.39	3.29	7.90	2.11	4.47	0.28
Cost of ED 23B mandate below FL195			49.46					167.26	
Total incremental cost of ED 23C H1 mandate			122.81					16.31	

Figure 36 - Cost of 8.33 kHz Climax equipage

Annex 4 Financial Evaluation

A 4.1 Delay-demand relationships

The Performance Review Unit (PRU) has developed an empirical relationship between delays and traffic levels for each of the years 1998 to 2001. This was illustrated in figure 11 of Annex 6 to the Performance Review Report for 2002 (PRR5), which is reproduced below as Figure 37.

The combination of delay thresholds and slope profiles among all ACCs results in a power function relationship between delays and traffic at ECAC level (see Figure 11). The relationship is given by $D \propto T^k$, where the power k is the elasticity factor, D is delay and T is traffic. For 2001, the elasticity factor for en-route delay[8] was shown to be 7, which means that a 1% variation in traffic will result in a 7% variation in en-route delay, or $D \propto T^7$ (see also Figure 14).

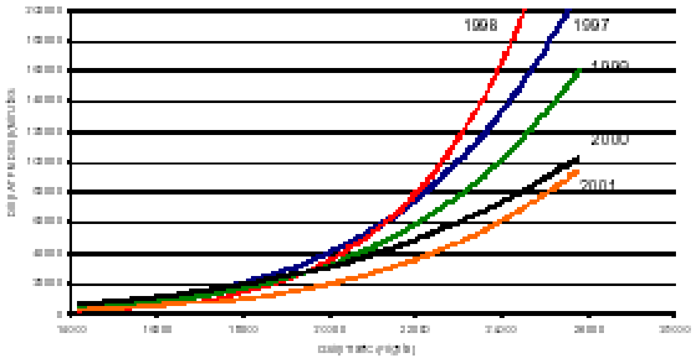


Figure 11: Relationship between Traffic and En-route Delays

Figure 37 - Traffic and delay curves

The curves show exponential growth in delay as the volume of traffic increases. Stated simply, this indicates that, with a low volume of aircraft in a block of airspace, the probability of any two wanting to be 'in the same place at the same time' and thus causing one to be delayed is low. However, with a large volume of traffic, the probability becomes much higher and the level of delays grows rapidly.

The curves also show that, as the capacity of the ATM system has increased over the years, higher levels of traffic have been accommodated without increasing the level of delay and the curves have moved to the right.

If we assume that a capacity increase of 1% means that 1% more traffic can be handled without an increase in delay, then we can construct delay-demand curves for future years, as illustrated below in Figure 38. The curves can then be used to predict future levels of delay, given the anticipated growth in traffic and the planned increase in capacity.

In the example shown below, an initial delay-demand curve was produced, based on 2008 actual European data, and a second curve was produced assuming that measures were to be introduced in 2009 to provide a 2% capacity increase over 2008, to match an anticipated growth in the volume of traffic.

In 2009, there was an average of 26,103 flights per day and the average delay per flight was 0.96 minutes. If the traffic level in 2010 were to grow by 2% to 26,265 flights per day, without a capacity increase the average delay would increase to 1.10 minutes per flight. However, if measures increasing capacity by 2% were introduced, then delays could be held at about the

2009 level of 0.96 minutes per flight and the benefit of the capacity measures would be a reduction in delay of over 4,300 minutes per day. Over the whole year, this could be worth about €140m to airspace users. The financial value placed upon the value of this delay saving, it may be compared with the cost of implementing the capacity enhancement measures in order to determine whether the measures can be justified.

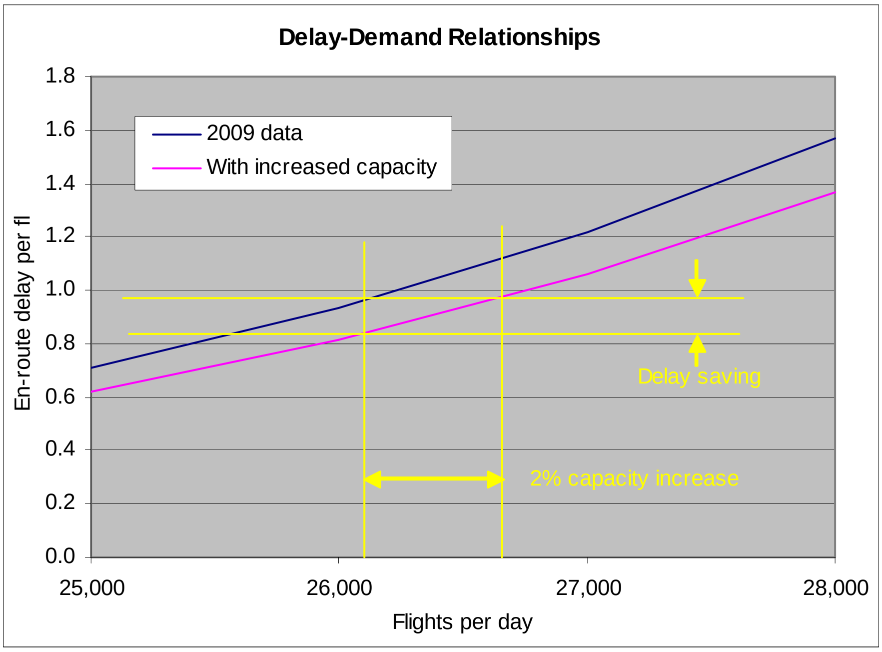


Figure 38 - The effect of increased capacity

A 4.2 Annual expenditure

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Total
Phase 1												
Rate of expenditure												
Ground costs			10%	15%								25%
Civil IFR A/C costs		25%	25%	50%								100%
Civil VFR A/C costs												0%
State A/C costs		25%	25%	50%								100%
Costs of phase												
Ground	-	-	19.37	29.05	-	-	-	-	-	-	-	48.41
Civil IFR A/C	-	12.34	12.34	24.69	-	-	-	-	-	-	-	49.38
Civil VFR A/C	-	-	-	-	-	-	-	-	-	-	-	-
State A/C	-	-	-	-	-	-	-	-	-	-	-	-
Total	-	12.34	31.71	53.74	-	-	-	-	-	-	-	97.79
Phase 2												
Rate of expenditure												
Ground costs					15%	20%	20%	20%				75%
Civil IFR A/C costs												0%
Civil VFR A/C costs					10%	20%	45%	25%				100%
State A/C costs					10%	20%	45%	25%				100%
Costs of phase												
Ground	-	-	-	-	29.05	38.73	38.73	38.73	-	-	-	145.24
Civil IFR A/C	-	-	-	-	-	-	-	-	-	-	-	-
Civil VFR A/C	-	-	-	-	16.73	33.45	75.27	41.81	-	-	-	167.26
State A/C	-	-	-	-	22.62	45.23	101.77	56.54	-	-	-	226.16
Total	-	-	-	-	68.39	117.41	215.77	137.09	-	-	-	538.66
Scenario costs												
No implementation	-	-	-	-	-	-	-	-	-	-	-	-
No implementation	-	-	-	-	-	-	-	-	-	-	-	-
Core area in 2014 - elsewhere in 2018	-	12.34	31.71	53.74	68.39	117.41	215.77	137.09	-	-	-	636.45
Core area in 2014 - elsewhere in 2018	-	12.34	31.71	53.74	68.39	117.41	215.77	137.09	-	-	-	636.45
Core area in 2014 - elsewhere in 2020	-	12.34	31.71	53.74	22.80	61.93	133.86	156.76	117.62	45.70	-	636.45

A 4.3 Delay projections

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	PV
Summary of scenarios																	
No implementation/full demand																	
Average delay/flight (min)	0.38	0.42	0.48	0.53	0.58	0.66	0.74	0.82	0.93	1.05	1.19	1.37	1.55	1.80	2.03	2.27	
Total delay (m min)	3.62	4.18	5.01	5.72	6.45	7.53	8.77	10.00	11.71	13.65	16.04	18.97	22.14	26.65	30.88	35.78	
Cost of delay (€m)	322	372	446	509	574	670	781	890	1,042	1,215	1,428	1,689	1,970	2,372	2,748	3,184	9,493
No implementation/half demand																	
Average delay/flight (min)	0.36	0.39	0.42	0.44	0.46	0.49	0.51	0.54	0.58	0.61	0.65	0.69	0.72	0.78	0.83	0.89	
Total delay (m min)	3.46	3.80	4.16	4.46	4.77	5.12	5.45	5.84	6.33	6.79	7.31	7.91	8.46	9.28	10.07	10.93	
Cost of delay (€m)	308	338	370	397	424	456	485	520	564	604	651	704	753	826	896	973	4,909
Interim 2014, final 2018/full demand																	
Average delay/flight (min)	0.38	0.42	0.48	0.53	0.56	0.61	0.67	0.74	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	
Total delay (m min)	3.62	4.18	5.01	5.72	6.24	7.00	7.90	8.99	9.27	9.55	9.83	10.13	10.43	10.75	11.08	11.43	
Cost of delay (€m)	322	372	446	509	555	623	703	800	825	850	875	901	929	957	987	1,017	6,235
Interim 2014, final 2018/half demand																	
Average delay/flight (min)	0.36	0.39	0.42	0.44	0.45	0.47	0.49	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	
Total delay (m min)	3.46	3.80	4.16	4.46	4.68	4.96	5.19	5.56	5.64	5.73	5.82	5.91	6.00	6.09	6.18	6.28	
Cost of delay (€m)	308	338	370	397	416	441	462	495	502	510	518	526	534	542	550	559	4,205
Interim 2014, final 2020/full demand																	
Average delay/flight (min)	0.38	0.42	0.48	0.53	0.56	0.61	0.67	0.74	0.82	0.90	0.90	0.90	0.90	0.90	0.89	0.89	
Total delay (m min)	3.62	4.18	5.01	5.72	6.24	7.00	7.90	8.99	10.34	11.77	12.12	12.48	12.85	13.23	13.64	14.06	
Cost of delay (€m)	322	372	446	509	555	623	703	800	920	1,047	1,078	1,110	1,143	1,177	1,214	1,251	6,887

A 4.4 Comparison of equipage and delay costs

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	PV
Summary of scenarios																	
No implementation/full demand																	
Cost of delay (€m)	322	372	446	509	574	670	781	890	1,042	1,215	1,428	1,689	1,970	2,372	2,748	3,184	9,493
Cost of equipage (€m)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
No implementation/half demand																	
Cost of delay (€m)	308	338	370	397	424	456	485	520	564	604	651	704	753	826	896	973	4,909
Cost of equipage (€m)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Interim 2014, final 2018/full demand																	
Cost of delay (€m)	322	372	446	509	555	623	703	800	825	850	875	901	929	957	987	1,017	6,235
Cost of equipage (€m)	-	12	32	54	68	117	216	137	-	-	-	-	-	-	-	-	427
Interim 2014, final 2018/half demand																	
Cost of delay (€m)	308	338	370	397	416	441	462	495	502	510	518	526	534	542	550	559	4,205
Cost of equipage (€m)	-	12	32	54	68	117	216	137	-	-	-	-	-	-	-	-	427
Interim 2014, final 2020/full demand																	
Cost of delay (€m)	322	372	446	509	555	623	703	800	920	1,047	1,078	1,110	1,143	1,177	1,214	1,251	6,887
Cost of equipage (€m)	-	12	32	54	23	62	134	157	118	46	-	-	-	-	-	-	402

Annex 5 The ICAO Frequency Management Group position on 8.33 kHz

The Fourteenth Meeting of the Frequency Management Group (FMG/14) of the International Civil Aviation Organisation (ICAO) European Air Navigation Planning Group (EANPG) was held on 13-17th of September 2010 in the European and North Atlantic Office of ICAO.

FMG/14 was provided with a chart providing a visual indication of the degree to which aeronautical frequency spectrum requirements can be satisfied in each aeronautical frequency band for each year until 2025 (see the chart below). The information provided in the chart was based on historical data contained in the ICAO EUR Air Navigation Plan Tables and the satisfaction ratio of the FMG BPMs.

The chart indicated that congestion in the VHF COM and NAV bands persists and is particularly acute in the areas with the highest density of flights in the EUR Region. It is projected that more than 50% of the VHF COM frequency requirements will not be satisfied in the high traffic density parts of the EUR Region in the coming years. Spectrum access problems, although to a lesser degree and caused by different reasons, also exist in other frequency bands, including HF, SSR and AMS(R)S.

FMG/14 reviewed the progress of various ongoing activities aimed at alleviating the current and future forecasted frequency spectrum congestion. It was recalled that in regard to the VHF COM band, it was demonstrated that only the full implementation of 8.33 kHz VHF COM channel spacing will permit all VHF COM frequency demand to be met in the EUR Region until at least 2025. However, the current EC rule making proposal is to mandate the full implementation of 8.33 kHz below FL195 by 2018 at the latest with an interim phase by 2014. Therefore, FMG/14 felt that the States and airspace users should be urged to commit to the interim phase and to proceed to the full 8.33 kHz implementation as soon as possible.

FMG/14 recalled that work is being undertaken within ICAO to develop future communication systems to address the future operational needs in the 2025+ timeframe. It was noted that taking into account the usual timeframes for the design, standardisation, certification and equipage of any aviation equipment, it is questionable whether the future communication systems will be available to equip a sufficient number of aircraft by 2025.

In addition, it was noted that the main thrust of this work up to now was on meeting the future operational requirements in datalink communications. However, as illustrated by the chart, the most urgent issue for the EUR area is located in the VHF COM band. Therefore, FMG/14 felt that there is an urgent need to accelerate the work undertaken on the development of the future communication systems and specifically target them on meeting the future VHF voice requirements.

ICAO Paris - Capacity Projection for Aeronautical Frequency Bands in the EUR/NAT Regions

last update 19/08/2010 by EANPG Frequency Management Group

Legend

no information available
all requirements are satisfied
requirements are satisfied with difficulty,90%
requirements are satisfied with difficulty,80%
requirements are satisfied with difficulty,70%
requirements are satisfied with difficulty,50%
requirements are satisfied,less than 50%

Sources:
Data in COM and CNS Tables is used to determine congestion in 108-117.975MHz and 950-1215MHz bands
The ratio of coordinated BPM proposals is used to determine congestion in VHF COM band
FMG MLS task force materials

				Previous years									Projection																
	Band	**Service**	***Notes***	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
1	90 -110 kHz	LORAN-C																										
2	130 – 526.5 kHz	NDB																										
3	2850 – 22000 kHz	HF COM	1																									
4	74.8 – 75.2 MHz	Marker Beacon																										
5	108 – 111.975 MHz	ILS LOC/VOR + [GBAS]	*2*																									
6	111.975 - 117.975	VOR + [GBAS]	*2*																									
7	117.975 – 137 MHz	VHF COM	*3*	59,6	44,4	45	43	12	37	80	75																	
8	328.6 – 335.4 MHz	ILS GP																										
9	406 – 406.1 MHz	ELT																										
10	960 – 1215 MHz	DME/GNSS	*2*																									
11	1030 - 1031 MHz	SSR GA/ACAS	4																									
12	1088 - 1093 MHz	SSR AG/ACAS	4																									
13	1215 – 1260 MHz	GNSS																										
14	1260 – 1400 MHz	Pri RADAR																										
15	1525 – 1559 MHz	SAT COM	*5*																									
16	1559 – 1626.5 MHz	GNSS																										
17	1626.5 – 1660.5 MHz	SAT COM	*5*																									
18	2700 – 3300 MHz	Radar (Pri Surviellance)																										
19	4200 – 4400 MHz	RadioAlt																										
20	5000 – 5250 MHz	MLS	*6*																									
21	5350 – 5470 MHz	Radar (weather)																										
22	8750 – 8850 MHz	Radar (doppler)																										
23	9000 – 9500 MHz	ASDE																										
24	13.25 – 13.4 GHz	Radar (doppler)																										
25	15.4 – 16.6 GHz	ASDE																										
26	31.8 – 33.4 GHz	ASDE																										

Note 1 Additional HF allocations and data link implementation is anticipated to gradually reduce congestion (NAT Region)
Note 2 With gradual removal of VORs the congestion is anticipated to ease.However, implementation and associated transition period for the deployement of future comm systems will exacerbate congestion
Note 3 Under assumption that 8.33 kHz is not implemented below FL195. In the long run there is a need to speed up the roll out of future comm systems to carry digital voice
Note 4 Growing number of SSRs, implementation of Mode-S, ADS-B, MLAT increases the spectrum use
Note 5 Problems in getting more access due to non aviation users operating in the band
Note 6 Congestion will grow with implementation of future AMRS and UAS in the band

Annex 6 Safety Impact Assessment Summary

The safety impact assessment performed addresses the implementation of 8.33 kHz below FL195 in the ICAO EUR Region. This safety assessment is addressing the safety impact of such implementation on the air traffic services which are supported by the air-ground VHF voice communication. Furthermore it addresses also the potential safety impact on the control of the movement of ground vehicles on the manoeuvring areas of aerodromes.

Considering this scope, the safety assessment does address the impact on:

- Air Traffic services delivered to pilots in controlled/uncontrolled airspace and for aerodrome operation where two way radio communication is required
- The control of the movement of ground vehicles in controlled aerodromes where two way radio communication is required

The safety assessment does not address the safety impact on:

- the performance of airline communications[16] which are supported by the air-ground VHF voice communication even if OPC (OPerational Control) frequencies have to be converted in 8.33 kHz.
- Apron management services because air traffic control has normally no responsibility for control of vehicles on apron areas (ICAO Doc 9137 Part 8) and VHF voice communication might not be used (e.g. use of digital radio communication system)

This annex provides a summary of the Safety Assessment. The complete assessment can be downloaded from the documents section of the website: www.eurocontrol.int/833

A 6.1 General Approach to the Safety Assessment of 8.33 KHz below FL 195

Hypothetically, it could be said that if a homogeneous channel spacing (i.e. either 8.33 kHz or 25 kHz) were to exist in the airspace, and there were to be a corresponding homogeneous aircraft fit, then any hazards associated with air-ground and ground-ground Radio Telephony (RT) communications would be the same whichever channel spacing was deployed - i.e.

- loss of communication - due to voice-communications equipment failure or incorrect frequency selection by an aircraft or ground vehicle
- distortion of communication - due to interference caused by incorrect frequency selection by an aircraft or ground vehicle, by inappropriate frequency assignments to proximate sectors, or by external[17] events such as natural phenomena or man-made interference.

For the purposes of this safety impact assessment, it is assumed that the likelihood and consequences of any of the following are not affected by the change from 25 kHz Voice Communications System (VCS) to 8.33 kHz VCS:

- voice-communications equipment failure
- external interference events
- Controller transmitting a wrong frequency to the pilot.

[16] Airline Operational Communication (AOC) and/or Airline Administrative Communication (AAC)
[17] "External" here means from outside of the aviation VHF RT communications system

Therefore, any risk associated with these three hazard causes does not change and can, therefore, be excluded from this safety assessment, which is concerned specifically with the effects of the introduction of 8.33 kHz VCS below FL 195.

Furthermore, it has already been established, from the previous deployment of 8.33 kHz VCS above FL 195, that:

- an 8.33 kHz VCS-equipped aircraft is fully able to communicate with a ground station that is equipped with either 25 kHz or 8.33 kHz VCS
- a 25 kHz VCS-equipped aircraft can communicate only with a 25 kHz VCS ground station
- The VHF air-ground communication frequency assignment planning criteria (ICAO EUR Doc 011) are properly addressing the 8.33 kHz spaced channels and no specific assignment criteria are relative to the altitude (implementation above or below FL 195).

Thus a hazardous situation related to the introduction of 8.33 kHz VCS below FL 195 would exist if:

- an 8.33 kHz VCS-equipped aircraft was to mistune a (correct) 8.33 kHz VCS frequency
- a 25 kHz VCS-equipped, non-exempt aircraft was to enter, or attempt to enter, a sector that uses primarily 8.33 kHz VCS - for example, by selecting an old 25 kHz VCS frequency or by trying to select a 25 kHz channel close to the 8.33 kHz VCS frequency assigned to the sector.
- a 25 kHz VCS-equipped, exempt aircraft was to enter, or attempt to enter, a sector that uses primarily 8.33 kHz VCS, unless facilities / procedures for handling such aircraft had already been put in place.

Therefore, the safety assessment has to address the above from three perspectives:

- the specification of Safety Objectives, and then Safety Requirements, to avoid hazardous situations occurring, wherever possible
- the specification of Safety Objectives, and then Safety Requirements, such that if hazardous situations do occur, for whatever reason, then their effects in terms of safety are reduced as much as possible
- an estimation of the likely risk associated with the occurrence of hazardous situations, taking account of the above mitigations.

The first perspective is known as the ***success approach***; the other two together are known as the ***failure approach***.

Note: This safety assessment summary is not describing the Safety Objectives but directly the Safety requirements. Safety objectives are described in the complete report.

The safety assessment assumes the following:

ID	Assumption	Rationale
A001	Current VHF comms below FL 195 – i.e. using 25 kHz VCS – are acceptably safe.	There is no historical evidence to suggest otherwise. Any risks inherent in VHF air-ground comms are therefore deemed to be outside the scope of this safety assessment.
A002	The 8.33 kHz VCS comms infrastructure and aircraft equipage will comply with the necessary ICAO standards, as already applicable to the EUR region above FL 195.	The operational use of a primarily homogeneous 8.33 kHz VCS comms infrastructure /aircraft fit has already been demonstrated above FL 195 and is therefore deemed to be outside the scope of this safety assessment.
A003	In addition to 8.33 kHz channel spacing capability, the aircraft and mobile equipment is able to tune to 25 kHz spaced channels and to operate in an environment which uses offset-carrier frequencies	This is part of the design requirements for the aircraft 8.33 kHz VCS radios and is reinforced by article 3(20) of the draft Implementing Rule

A 6.2 Safety Targets

Two Safety Targets for which the Safety Objectives/Safety Requirements are to be derived:

ST1 the risk of an accident following the completion of the Final Phase of conversion to 8.33 kHz VCS below FL 195 shall not be significantly greater than before the start of the Interim Phase

ST2 the risk of an accident during the period between the start of the Interim Phase and completion of the Final Phase, of conversion to 8.33 kHz VCS below FL 195 shall be reduced as far as reasonably practicable.

A 6.3 Safety Assessment Results for Aircraft Operation

A 6.3.1 Introduction

This safety impact assessment is addressing the impact of the 8.33 kHz implementation below FL 195 on air traffic services delivered to aircraft operation in Enroute, Terminal airspace and during landing and taxiing.

The implementation of 8.33 kHz below FL195 in the ICAO EUR Region where EU Member States are responsible for the provision of air traffic services is characterised by:

- the Interim Implementation for 2014 to ensure a given number of conversions take place in the European States area defined in the Implementing Rule[18],
- the final Implementation for 2018 to ensure 8.33 kHz spacing of all possible voice channels in the EU member States airspace.

[18] This area is called in the rest of the document “area of applicability defined in IR Annex I”

A 6.3.2 Risk Assessment

Overview

As it is not practicable for a generic safety assessment such as this to address the factors specific to local operational environments, it is not possible to assign meaningful quantified Safety Objectives / Safety Requirements for 8.33 kHz VCS or to draw quantitative conclusions regarding the risk of its deployment below FL 195.

That said, however, it is possible for the safety assessment to draw some qualitative conclusions, as follows.

In the long term, when all aircraft operating in Europe are 8.33 kHz VCS equipped, then, for flights that originate in the airspace of IR applicability (and for 8.33 kHz VCS-equipped flights originating outside this airspace) the only increased risk of an accident, compared with today's 25 kHz VCS communications, arises from incorrect selection (mistuning) of a 8.33 VCS frequency as explained in Safety Scenario #1.

Risk increases arising in the shorter-term and/or from equipage exceptions are discussed in Safety Scenarios #2 and #3.

Note: References to Hazard (Haz#) and Safety Requirements (SR#) appears in this safety impact assessment summary in a non incremental way, as opposed to the complete report.

Safety Scenario #1 - 8.33 kHz VCS-equipped aircraft operating in a 8.33 kHz airspace -

Safety Scenario #1 describes the normal operation in the 8.33 environment and applies indefinitely from the beginning of the airspace conversion to 8.33 kHz VCS, in the area of applicability defined in IR annex I. It is used to address the problem (identified in section A 6.1) that an 8.33 kHz equipped aircraft could encounter in an 8.33 kHz sector due to the mistuning of the assigned frequency.

In addition to Assumptions A002 and A003 (described in section A 6.1 above), the following Safety Functional Requirements, to avoid hazardous situations occurring, shall be implemented:

SR#10	Flight Crew shall be adequately trained in the use of the 8.33 kHz radios
SR# 9	State's frequency assignment plan shall comply with EUR Frequency Management Manual – ICAO EUR Doc 011 (2009) in order to ensure that any ATS assigned frequency does not interfere with other assigned frequencies and is free from harmful interference.

The following hazard associated to this scenario has been identified:

Haz#4: Incorrect frequency selection by the Flight Crew of a 8.33 VCS-equipped aircraft

Haz#4 addresses in general mistuning of the correct frequency - in human factors terms this would be a "slip", that is correct intention but incorrect execution[19]. This has been assessed as a Cat 3 hazard (possibly Cat 2, depending on the specific local circumstances).

It should be noted that below FL 195 the airspace users will range from General Aviation to Commercial Air Transport and State aircraft and some risk increase is likely to occur because of:

- an increase of one in the number of digits to be selected for 8.33 kHz VCS frequencies - this is already the case above FL 195

- part of the airspace user population, who have limited or no experience of 8.33 kHz VCS operations above FL 195 - that was of course the case for all airspace users when 8.33 kHz VCS was first introduced above FL 195.

For Haz#4, satisfaction of Functional Safety Requirements SR#10 identified above and SR#1 identified below should ensure that any risk involved is reduced significantly.

SR#1	State AIPs (supported as necessary by NOTAMs) shall provide up-to-date information to all Aircraft Operators and Flight Crew concerning the VCS requirements of the airspace for which the State is responsible

Safety Scenario #2 - 25 kHz VCS-equipped, <u>exempt</u> aircraft operating in 8.33 kHz VCS airspace-

Safety Scenario #2 addresses the (legitimate) presence of 25 kHz VCS-equipped, exempt aircraft in 8.33 kHz VCS airspace. Such aircraft are likely to exist for many years, even after 31 December 2018[20]. Therefore, this Safety Scenario applies:

- to 8.33 kHz VCS airspace in the area of applicability defined in IR Annex I;

- to 8.33 kHz VCS airspace in the IR applicability area[21], from the start of the transition period of the Final Phase;

- thereafter, in the IR applicability area, until all non-8.33 kHz VCS, exempt aircraft have been either retrofitted to 8.33 kHz VCS or eventually withdrawn from service.

The following Safety Functional Requirements, to <u>avoid</u> hazardous situations occurring, shall be implemented:

SR# 8	ANSPs shall develop and implement strategies to ensure the safe handling of (non-8.33 kHz) exempt aircraft in 8.33 kHz VCS airspace
SR# 9	State's frequency assignment plan shall comply with EUR Frequency Management Manual – ICAO EUR Doc 011 (2009) in order to ensure that any ATS assigned frequency does not interfere with other assigned frequencies and is free from harmful interference.

There are two hazards associated with Safety Scenario #2:

[19] In contrast, selection of an <u>incorrect</u> frequency - in human factors terms a "mistake" (i.e. incorrect intention) - is out of scope of this safety assessment as explained in section A 6.1 above.
[20] Articles 5(9) and 5(10) of the IR allows this situation to exist even after 2025 as some exemptions are open.
[21] ICAO EUR Region where EU Member States are responsible for the provision of air traffic services.

Haz#2: inadequate provision of facilities / procedures for handling of 25 kHz VCS-equipped, exempt aircraft in 8.33 kHz VCS sectors.

Haz#3: Electromagnetic incompatibility between 25 kHz VCS and 8.33 kHz VCS frequencies.

These two hazards have been assessed as Cat 3 (possibly Cat 2, depending on the specific local circumstances); however, they are entirely avoidable by satisfaction of Functional Safety Requirements SR# 8 and SR# 9 respectively which are identified above.

However, if such hazardous situations do occur, for whatever reason, satisfaction of the following Safety Requirements will reduce as much as possible their effects in terms of safety;

- For Haz#2

SR#11	In the event that a 25 kHz VCS-equipped aircraft is unable to communicate with ATC, the Flight Crew shall apply the appropriate procedures associated to a loss of comms event.
SR#12	In the event that ATC is unable to communicate with an aircraft in 8.33 kHz VCS airspace, the Controller shall apply the appropriate procedures associated to a loss of comms event.

- For Haz#3

SR#16	In case of serious interference to comms with other airspace users by a 25 kHz exempt aircraft operating legitimately in a 8.33 kHz sector, the Controller should contact the 25 kHz VCS aircraft to stop the interfering transmissions and apply the procedure associated to a loss of comms event for this aircraft

Safety Scenario #3 -25 kHz VCS-equipped, non-exempt aircraft operating in 25 kHz VCS airspace close to the boundary with 8.33 kHz VCS airspace-

Safety Scenario #3 applies in the IR applicability area due to some airspace and/or individual sectors being converted to 8.33 kHz VCS before 31 December 2018. It applies therefore:

- in the area of applicability defined in IR Annex I during the Interim Phase
- in the IR applicability area, due to the fact that States with a particular serious frequency congestion problem are permitted to convert sectors to 8.33 kHz before the 1 January 2018 (target date for conversion of all installed ground and aircraft radios to 8.33 kHz VCS).

Safety Scenario #3 applies also at the boundary of the IR applicability area, as follows:

- as soon as any airspace /sector close to the boundary is converted to 8.33 kHz VCS
- indefinitely thereafter, because conversion to 8.33 kHz VCS in neighbouring States is outside the scope of the implementation

The following Safety Functional Requirements, to avoid hazardous situations occurring, shall be implemented:

SR#1	State AIPs (supported as necessary by NOTAMs) shall provide up-to-date information to all Aircraft Operators and Flight Crew concerning the VCS requirements of the airspace for which the State is responsible
SR# 2	Aircraft Operators and Flight Crew shall be made aware of the consequences of using 25 kHz VCS radios in 8.33 kHz VCS airspace unless specifically authorised (i.e. State aircraft)
SR#3	Aircraft Operators and Flight Crew of 25 kHz VCS-equipped, non-exempt aircraft shall not submit Flight Plans that would take the aircraft through any part of 8.33 kHz VCS airspace
SR#4	Aircraft Operators and Flight Crew shall ensure that the Flight Plan for any flights which pass through any part of the EUR Region indicates the VCS capability and status (exempt / non-exempt) of the aircraft concerned
SR#5	Controllers shall not route a 25 kHz VCS-equipped, non-exempt aircraft through 8.33 kHz VCS airspace unless there is an overriding safety reason for so doing and they apply published procedures covering this situation
SR#6	Controllers shall not accept a 25 kHz VCS-equipped, non-exempt aircraft into a 8.33 kHz VCS sector unless there is an overriding safety reason for so doing and they apply published procedures covering this situation
SR#7	Before handing over an aircraft to a 8.33 kHz VCS sector, Controllers shall ensure that the receiving sector is advised of the VCS capability and status (exempt / non-exempt) of the aircraft concerned
SR# 19	States shall ensure that all LOAs are updated in accordance with their respective VCS implementation status.

There are two hazards associated with Safety Scenario #3:

Haz#1: a 25 kHz VCS-equipped, non-exempt aircraft enters 8.33 kHz VCS airspace – this has been assessed as a Severity Category (Cat) 3 hazard and may be due to an operational error or as a result of the need to divert an aircraft into 8.33 kHz VCS airspace for some reason

Haz#3: Electromagnetic incompatibility between 8.33 kHz VCS and 25 kHz VCS frequencies – Such incompatibility might occur close to a boundary between 8.33 kHz VCS and 25 kHz VCS airspace - this has been assessed as a Cat 3 (possibly Cat 2) hazard:

For Haz#1, the satisfaction of Functional Safety Requirements SR#1 to SR#7 identified above and satisfaction of SR#11 to SR#18 identified below should ensure that any risk involved is reduced substantially. However, what it would **not ensure** is that the risk is reduced as far as reasonably practicable. For that purpose several requirements have been added to Annex of the draft Implementing Rule.

SR#11	In the event that a 25 kHz VCS-equipped aircraft is unable to communicate with ATC, the Flight Crew shall apply the appropriate procedures associated to a loss of comms event.
SR#12	In the event that ATC is unable to communicate with an aircraft in 8.33 kHz VCS airspace, the Controller shall apply the appropriate procedures associated to a loss of comms event.

SR#13	In the event that a 25 kHz VCS-equipped, non-exempt aircraft has to be routed through 8.33 kHz VCS airspace, the transferring Controller shall instruct the Flight Crew to either switch to a 25 kHz VCS frequency (if available) or to apply the appropriate procedures associated to a loss of comms event (or emergency event).
SR#14	In the event that a 25 kHz VCS-equipped, non-exempt aircraft has to be routed through 8.33 kHz VCS airspace, the receiving Controller shall apply the appropriate procedures associated to a loss of comms event (or emergency event).
SR#15	In case of serious interference to comms with other airspace users by a 25 kHz aircraft that has inadvertently entered a 8.33 kHz sector, the Controller shall apply appropriate procedures in order to try to contact the 25 kHz VCS aircraft on emergency frequency to stop the interfering transmissions
SR#16	In case of serious interference to comms with other airspace users by a 25 kHz exempt aircraft operating legitimately in a 8.33 kHz sector, the Controller should contact the 25 kHz VCS aircraft to stop the interfering transmissions and apply the procedure associated to a loss of comms event for this aircraft
SR#17	IFPS shall check each flight plan that is routed through one or more 8.33 kHz VCS sectors to ensure that it indicates that the aircraft is 8.33 kHz VCS capable – otherwise the flight plan shall be rejected
SR#18	If the Flight Crew of a 25 kHz VCS-equipped aircraft is requested to transfer to an 8.33 kHz VCS channel they shall immediately advise ATC that the aircraft is not 8.33 kHz VCS capable

The risk associated with Haz#3 would be reduced substantially, probably to a very low level, by satisfaction of Functional Safety Requirement SR# 9.

SR# 9	State's frequency assignment plan shall comply with EUR Frequency Management Manual – ICAO EUR Doc 011 (2009) in order to ensure that any ATS assigned frequency does not interfere with other assigned frequencies and is free from harmful interference.

A 6.3.3 Risk Quantification

The absolute assessment of risk for Haz#1 ("a 25 kHz VCS-equipped, non-exempt aircraft enters 8.33 kHz VCS airspace") is very difficult at a generic level because it will depend on the number of opportunities for the hazard to arise – i.e. on the number of interfaces between 8.33 kHz VCS and 25 kHz VCS sectors – which, in turn, will depend on local factors including the number and distribution of sectors to be converted and the actual rate of 8.33 kHz VCS aircraft equipage.

It is necessary, therefore for individual States to carry out a full safety assessment, specific to their areas of responsibility, prior to the deployment of 8.33 kHz VCS comms - which is captured as an Assumption A004.

A004	Individual States / ANSPs must carry out a full safety assessment specific to their areas of	The safety assessment covered herein is necessarily generic and cannot therefore cover the factors specific to local

	responsibility, prior to the deployment of 8.33 kHz VCS comms below FL 195.	operational environments many of which have a direct bearing on the safety risks involved – this is addressed by Article 6 of the draft Implementing Rule.

For Haz#4 ("Incorrect frequency selection by the Flight Crew of an 8.33 VCS-equipped aircraft"), a similar conclusion can be raised even it applies to a different topic. Indeed local factors like category of airspace users (GA, VFR, Gliders…) in the converted airspace, their training, their experience, the level of information provided to them by States will impact the number of opportunities for the hazard to arise. A proper satisfaction of SR#10 is essential.

For Hazards #2 ("inadequate provision of facilities / procedures for handling of 25 kHz VCS-equipped, exempt aircraft in 8.33 kHz VCS sectors") and #3 ("Electromagnetic incompatibility between 25 kHz VCS and 8.33 kHz VCS frequencies"), it has been assessed that proper implementation of the identified SRs will prevent the occurrence of the Hazards. However for Haz#2, it is important that the service provider determine very precisely the amount of exempted aircraft they have to handle in their airspace. Indeed a large amount of exempted aircraft in a given airspace could lead to an unachievable SR#8.

A 6.4 Safety Assessment Results for Ground Vehicle Operation

A 6.4.1 Introduction

The movement of vehicles on the manoeuvring area of an aerodrome shall be controlled by the relevant air traffic services. When so prescribed by the service provider continuous two way radiotelephony is necessary. It must be noted that the rules for the control of the vehicles on ground may be different from one airport to another one.

Air Traffic control is responsible for the control of the movement of vehicles on the manoeuvring area. To maintain such control and if so prescribed, vehicles operating on the manoeuvring area should be fitted with VHF-Com R/T on the appropriate channel (Ground or tower frequency), or closely escorted by an R/T equipped vehicle. The Airport operator is responsible for ensuring that operational R/T equipment is provided on vehicles being operated on the manoeuvring area and drivers are fully conversant with proper R/T procedures.

On apron areas, ATS has normally no responsibility for control of vehicles. The airport operator is responsible for regulating vehicular traffic movement on the apron in order to reduce to a minimum the risk of aircraft/vehicle and vehicle/vehicle conflict and to promote the safety of pedestrians. The Apron Control service can be exercised by regulating the vehicles that can enter the apron and by instruction of driver.

The implementation of 8.33 kHz below FL 195 will impact any vehicle equipped with a radio operating on the manoeuvring area where the ATC is supported by 8.33 kHz VCS. Indeed each vehicle shall be equipped with 8.33 kHz VCS (or the driver shall have an appropriate hand-held equipment) for e.g. movement instructions and/or for crossing runways or if not-equipped should be guided/escorted by an 8.33 kHz equipped vehicle in order to operate in the aerodrome.

The Safety Targets described in section A 6.2are fully applicable to the ground vehicle operation.

Note: when the term "VCS-equipped vehicle" is used, it means either a fix installation onboard the vehicle or the use of hand-held equipment by the vehicle driver.

A 6.4.2 Risk Assessment

Overview

The generic safety assessment cannot address factors linked with the local aerodrome environment (runway, manoeuvring and apron physical layout, traffic density).Therefore it is not possible to assign meaningful quantified Safety Objectives / Safety Requirements for 8.33 kHz VCS in the airport area or to draw quantitative conclusions regarding the risk of its deployment at aerodrome level. That said, however, it is possible for the safety assessment to draw some qualitative conclusions.

Note: References to Hazard (Haz#) and Safety Requirements (SR#) appears in this safety impact assessment summary in a non incremental way, as opposed to the complete report, to help the reading of this document.

Safety Scenario #4 - Non 8.33 kHz capable vehicle operating near the manoeuvring area where ATC is supported by 8.33 kHz VCS-

This scenario covers a non-8.33 kHz vehicle because either non-equipped, or equipped with wrong radio.

Safety Scenario #4 applies in the IR applicability area due to some tower and/or ground frequency being converted to 8.33 kHz VCS before 31 December 2018. It applies therefore:

- in the area of applicability defined in IR Annex I during the Interim Phase
- in the IR applicability area, due to the fact that States with a particular serious frequency congestion problem are permitted to convert tower/ground frequencies into 8.33 kHz before the 1 January 2018.

The following Safety Functional Requirements, to avoid hazardous situations occurring, shall be implemented:

SR#20	Aerodrome information/publication (aerodrome manual) shall provide up-to-date information to all vehicle drivers concerning the VCS requirements applicable to the aerodrome manoeuvring areas.
SR# 21	Vehicle drivers shall be made aware of the consequences of using non-8.33 kHz VCS radios in 8.33 kHz VCS manoeuvring areas unless specifically authorised
SR#22	Airport operator/ANSP shall develop and implement strategies to ensure the safe handling of non 8.33 kHz VCS-equipped vehicle in 8.33 kHz VCS airport area.

The following hazards are associated with Safety Scenario #4:

Haz#5: A non 8.33 kHz VCS-equipped vehicles enters in the 8.33 kHz VCS manoeuvring area

Haz#6: Inadequate provision of facilities / procedures for handling non-8.33 kHz equipped vehicle (exempted)

Haz#5 addresses in general the non correct application of the procedures for driving in the manoeuvring area or the lack of knowledge of the airport surface.
This hazard is avoidable by satisfaction of Functional Safety Requirements SR# 20 and SR# 21 identified above. However, if such hazardous situations do occur, for whatever reason, satisfaction of SR#26 and SR#27 described below will reduce as much as possible their effects in terms of safety.

Haz#6 addresses the problem linked with unclear definition of procedure for driving in the aerodrome and lack of resource to guide “non 8.33 VCS equipped vehicle” in the aerodrome manoeuvring area (i.e. maintenance vehicles, ambulances, fire brigade …).
This hazard is avoidable by satisfaction of Functional Safety Requirements SR# 20, SR#21 and SR# 22 identified above. However, if such hazardous situations do occur, for whatever reason, satisfaction of SR#26 and SR#27 described below will reduce as much as possible their effects in terms of safety.

SR#26	In the event that no contact can be established to a vehicle on the manoeuvring area and when situation might lead to taxiway collision or runway incursion the controller shall: • inform other vehicles in the vicinity and taxiing aircraft to immediately stop unless the vehicle has been visually acquired by them • whenever required, ask to a landing aircraft to execute a missed approach due to runway obstruction.
SR#27	In the event that a vehicle is unable to communicate with ATC and when situation might lead to taxiway collision or runway incursion, the airport operator shall, in liaison with the ATC, intercept and escort the vehicle outside of the manoeuvring area

Safety Scenario #5 - 8.33 kHz capable vehicle operating in a manoeuvring area where ATC is supported by 8.33 kHz VCS-

This scenario covers 8.33 KHz VCS-equipped vehicles operating in 8.33 kHz VCS manoeuvring area. It reflects what will be normal operations in an aerodrome environment where ground and/or tower frequencies have been converted into 8.33 kHz and such scenario applies indefinitely.

The following Safety Functional Requirements, to avoid hazardous situations occurring, shall be implemented:

SR#23	State’s frequency assignment plan shall comply with EUR Frequency Management Manual – ICAO EUR Doc 011 (2009) in order to ensure that any aerodrome assigned frequency does not interfere with other frequencies assigned in the aerodrome vicinity and is free from harmful interference.
SR#24	Airport operator shall ensure that vehicle drivers operating on the manoeuvring area are fully conversant with the proper R/T procedures associated to 8.33 kHz VCS
SR# 25	Airport operator shall ensure that the vehicle radio equipment (including hand-held equipment) used for ATC are compliant with the ICAO Annex 10 standard

There are three hazards associated with Safety Scenario #5:

Haz#7: The 8.33 kHz assigned frequency generates interference

Haz#8: The 8.33 kHz assigned frequency is impacted by interference

Haz#9: Wrong selection of the 8.33 kHz channel by the vehicle driver

Haz#7 and Haz#8 address the problem linked with the correct assignment and use of the frequencies in the airport area.
The risk associated with Haz#7 and Haz #8 would be reduced substantially, probably to a very low level, by satisfaction of Functional Safety Requirements SR# 28 and SR#29 respectively in addition to SR#23 and #25 identified above. However, if such hazardous situations do occur, for whatever reason, satisfaction of SR#27 will reduce as much as possible their effects in terms of safety.

SR#28	Airport operator/ANSP shall verify (e.g. through operational trial) that the 8.33 kHz assigned frequency does not generate interference to other already assigned frequencies (ground, tower)
SR#29	Airport operator/ANSP shall verify (e.g. through operational trial) that the 8.33 kHz assigned frequency is not impacted by interference
SR#27	In the event that a vehicle is unable to communicate with ATC and when situation might lead to taxiway collision or runway incursion, the airport operator shall, in liaison with the ATC, intercept and escort the vehicle outside of the manoeuvring area

Haz#9 addresses the mistuning of the correct frequency by the vehicle drivers due to the increase number of digit to be set. The increase in risk linked with this hazard is very limited because vehicles operating in the airport area are use a limited number of frequencies/channels (e.g. the ground or the tower frequency only) as opposed to pilots changing frequency/channels frequently (e.g. at each sector).

The risk associated with Haz#9 would be reduced substantially by satisfaction of the Functional Safety Requirement SR# 30 identified below in addition to SR#24 and SR#25 identified above. However, if such hazardous situations do occur, for whatever reason, satisfaction of SR#27 will reduce as much as possible their effects in terms of safety.

SR#30	Vehicle drivers shall receive adequate training on the usage of the 8.33 kHz VCS system
SR#27	In the event that a vehicle is unable to communicate with ATC and when situation might lead to taxiway collision or runway incursion, the airport operator shall, in liaison with the ATC, intercept and escort the vehicle outside of the manoeuvring area

A 6.4.3 Risk Quantification

The absolute assessment of risk for the hazards identified for the airport operation when considering ground vehicle operations is very difficult at a generic level because it will depend on the number of opportunities for the hazards to arise that is linked with local aerodrome environment (runway, manoeuvring and apron physical layout, electromagnetic environment,…) and the possible different actors delivering services to vehicles (i.e. ANSPs, Airport operator).
It is necessary, therefore for individual States to carry out a full safety assessment, specific to their areas of responsibility, prior to the deployment of 8.33 kHz VCS comms in the airport area - which is captured as an Assumption A004.

A004	Individual States / ANSPs must carry out a full safety assessment specific to their areas of responsibility, prior to the deployment of 8.33 kHz VCS comms below FL 195.	The safety assessment covered herein is necessarily generic and cannot therefore cover the factors specific to local operational environments many of which have a direct bearing on the safety risks involved – this is addressed by Article 6 of the draft Implementing Rule

A 6.5 Conclusions

The summary of the conclusions and the Safety Requirements and Assumptions is presented in Section 6.3 of this document.