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EUROCONTROL Guidelines

**EUROCONTROL Guidelines
on the Use of UHF for
Air Traffic Control (ATC)**

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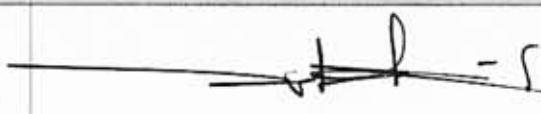
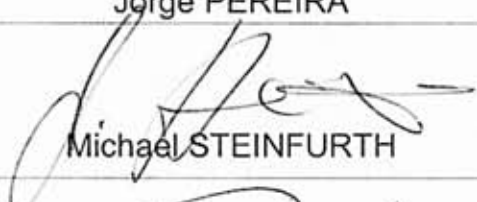


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Abstract			
<p>This EUROCONTROL document describes operating procedures and best practices and summarises implementation options that are required to ensure the harmonisation of the provision of Air Traffic Control using UHF as envisaged in the EC Regulation on Air-Ground Voice Channel Spacing. This guidance is essential to reach a determined level of ATC service when using UHF resources.</p> <p>This document supports the harmonisation of the ATC service using UHF to be provided to military aircraft operating as OAT and to non-8.33 kHz State aircraft flying as GAT/IFR within the airspace where the carriage of 8.33 kHz radios is mandatory. When used in the GAT/IFR environment it shall be considered as a transitional means and within the capacity and safety limits of the ATM system.</p>			
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EXECUTIVE SUMMARY

UHF radio communications are an essential capability to support Air Traffic Control (ATC) air-ground voice exchanges for military aircraft conducting Operational Air Traffic (OAT) flights. Similarly, the majority of civil European ANSPs is presently providing UHF support for the handling of non-8.33 kHz State aircraft occasionally operating as General Air Traffic/Instrument Flight Rules (GAT/IFR) in the airspace designated for 8.33 kHz operations.

The use of UHF for the provision of ATC services is limited by a number of factors. These include:

- limited coverage in some regions;
- specific configurations and utilization practices based on local conditions;
- lack of globally harmonised operating procedures.

This guidance document is developed in response to the recommendations formulated by the Civil-Military Interface Standing Committee (CMIC) and support the provisions contained in the European Commission Regulation (EC) No 1265/2007 on Air Ground Voice Channel Spacing, to provide guidance to ANSPs and airspace users for an efficient use of UHF air-ground ATC communications.

On the basis of available safety assessment results, previously published in the context of the EUROCONTROL 8.33 kHz Programme, together with inputs from some civil and military Air Navigation Service Providers (ANSPs), a number of UHF for ATC operating procedures was defined as required to:

- ensure an appropriate ATC workload, in particular with respect to notification, coordination and transfer between sectors, when handling traffic using simultaneously VHF and UHF in the same sector or when sharing the same UHF frequency in multiple sectors;
- consider the need to change sector configurations when facing intensive military traffic;
- prevent safety hazards related to the handling of non-8.33 kHz equipped State aircraft operating in a sector with limited UHF coverage;
- provide details on the use of VHF 25 kHz channels, as an alternative to UHF, to handle non-8.33 kHz equipped State aircraft.

The users of this guidelines document are advised to undertake local safety assessments before implementing the proposed procedures.

1. INTRODUCTION

1.1 RESPONSIBLE UNIT

1.1.1 This EUROCONTROL Guidelines document was initially developed by a drafting team comprising several Agency Units and representatives from the NATO Spectrum Management Branch (SMB). This activity was part of the 8.33 kHz support measures agreed by the Civil-Military Interface Standing Committee (CMIC). Subsequent consultation took place within EUROCONTROL working arrangements including the Civil-Military CNS Focus Group, the 8.33 kHz Programme Steering Group (PSG) and the ATC Procedures Development Sub Group (APDSG). This document is maintained by the Directorate Civil-Military ATM Coordination (DCMAC) of the European Organisation for the safety of Air Navigation (EUROCONTROL).

1.2 BACKGROUND

1.2.1 The ultra-high frequency (UHF) radio infrastructure is an essential capability for establishing and maintaining air-ground voice communications with military aircraft conducting operational air traffic (OAT) flights. Similarly, UHF communications are an alternative for communicating with non-8.33 kHz equipped State aircraft¹ occasionally conducting flights as GAT/IFR.

1.2.2 Today, these ATC-related UHF services are provided by civil and military air navigation service providers (ANSPs). Depending on the State's local arrangements, military ANSPs normally provide UHF support for OAT whilst civil ANSPs can offer this service for State aircraft operating as either GAT or OAT.

1.2.3 The regulatory provisions regarding State aircraft were defined in the Commission Regulation (EC) No 1265/2007 of 26 October 2007 laying down requirements on air-ground voice channel spacing (AGVCS) for the Single European Sky (SES). This Regulation states that non-8.33 kHz equipped State aircraft that cannot be retrofitted for a justified compelling reason will be accommodated on UHF or 25 kHz VHF assignments.

1.2.4 This document supports the Single European Sky ATM Research (SESAR) infrastructure work programme since in its Target Concept (Milestone Deliverable D3) it is stated that in order to enable a transition for non-VHF 8.33 kHz General Aviation (GA) and State aircraft, and to cater for the situation where retrofit or upgrade is not practicable, VHF 25 kHz and UHF will need to be maintained.

1.2.5 The maintenance of a certain level of UHF communications, in parallel with a continuous effort to retrofit military aircraft with VHF 8.33 kHz capable radios, is

¹ State aircraft encompasses military, police and customs aircraft.

considered the most efficient process to minimise the impact on State aircraft when expanding the airspace where the carriage of 8.33 kHz channel spacing equipment is mandatory. It will constitute an important facilitator for the upcoming phases of 8.33 kHz implementation below FL195 and for OAT Transit Service (OATTS) implementation.

1.2.6 A number of factors constrain today's level of UHF provision by civil and military ANSPs.

Such factors include:

- non-existent or limited UHF coverage
- absence of commonly agreed operating procedures
- lack of recognised standard harmonising technical characteristics
- difficult system integration and lack of cross-coupling with VHF channels
- need to improve frequency management coordination when allocating UHF frequencies.

1.2.7 In order to ensure an adequate handling of non-8.33 kHz equipped State aircraft by using UHF, common provisions need to be developed for specifying, implementing and using UHF by ATC.

1.2.8 The guidelines contained in this document describe the usage of UHF to:

- reduce ATC workload, including coordination between sectors and handovers, when handling traffic using VHF and UHF simultaneously in the same sector and when sharing the same UHF frequency in multiple sectors;
- identify the need to change sector configurations when facing intensive military traffic;
- prevent safety hazards related to the handling of non-8.33 kHz equipped State aircraft operating in a sector with limited UHF geographical coverage.

1.3 OBJECTIVE

1.3.1 These EUROCONTROL guidelines establish a set of harmonised usage procedures necessary for the provision of ground-based single channel UHF radio communications used for ATC air-ground voice communications. It contributes to enable the OAT Transit Service (OATTS) and to support the EC Regulation on AGVCS by ensuring a transitional enabler for 8.33 kHz expansion supporting legacy State aircraft that will not be fitted in time with 8.33 kHz radios.

1.4 SCOPE

1.4.1 This document is applicable to civil and military Air Traffic Service (ATS) units. It applies where UHF ATC radio communications are used to handle State aircraft, either flying as OAT or GAT. Military non-ATM requirements are outside the scope of this document.

1.4.2 Most procedures and best practises are derived from the 8.33 kHz Programme safety-related work and, consequently, are directly applicable to State aircraft operating as GAT/IFR in the en-route environment. The vast majority of the

above-mentioned procedures are also easily transposable to the OAT environment.

- 1.4.4 The content of this document does not replace or override contents of National Aeronautical Information Publications (AIPs).
- 1.4.5 To cope with local conditions, ANSPs that decide to use this guidelines document are advised to undertake local safety assessments before implementing the proposed procedures.

1.5 CONVENTIONS

- 1.5.1 The procedures and requirements described in this document have a voluntary nature and will be applied when compatible with the local conditions and configuration of ATC provision to ensure that the expected results are achieved.
- 1.5.2 Throughout this document conventions for denoting requirements are as follows:
- the word “shall” (or “must”) indicates a mandatory requirement, which must be satisfied by all procedures or practices claiming conformity to this guidelines
 - “should” indicates a recommendation or best practice, which may or may not be satisfied by all procedures or practices claiming conformity to this guidelines
 - “may” refers to a “nice to have” requirement which will not significantly impact the results to be attained.

1.6 GLOSSARY

- 1.6.1 A glossary containing Abbreviations and Definitions is included in Annex A.

2. CONTEXT OF UHF FOR ATC PROVISION

2.1 STATUS OF THE UHF BAND USED FOR MILITARY COMMUNICATIONS (225 MHz - 400 MHz)

- 2.1.1 Military communication requirements rely heavily on the use of the UHF band (225 MHz - 400 MHz), including the needs of deployable forces, Command and Control (C2) requirements and advanced weapon system technologies.
- 2.1.2 The 225-400 MHz band is historically known as the “NATO UHF Band”. This UHF band supports basically military UHF communications. It is used primarily for line-of-sight tactical ground, satellite and maritime communications, air-ground, air-air voice and data transmission.
- 2.1.3 The band 225-400 MHz is recognised in Europe as a harmonised military band. UHF frequencies are used by military Air Defence to control aircraft flying within segregated airspace and when performing military air operations (e.g. air policing, air interception) and by military ATC to control military traffic as OAT. UHF frequencies

have been provided by the NATO Spectrum Management Branch (SMB) or National Military Authorities to civil ANSPs to support ATC services provided to State aircraft, flying GAT/IFR, when they are not VHF capable.

- 2.1.4 In each NATO Member State, the management of this UHF band is delegated by spectrum regulators to military frequency management agencies designated National Allied Radio Frequency Agencies (NARFA). NATO Member States have delegated the coordination/management activities for this portion of the frequency spectrum to the NATO Civil/Military Frequency Management Sub-Committee (FMSC).
- 2.1.5 NATO Spectrum Management Branch (SMB), at NATO Headquarters responds to frequency requests and coordinates the Air-Ground and Air-Air frequency assignments given to civil and military ANSPs. The SMB supports the FMSC during the periodic reorganisations of the UHF band leading to a more efficient utilisation. This is a prerequisite to be able to meet the UHF usage demand since the band is already relatively congested.
- 2.1.6 The procedures for the implementers to request UHF frequencies, coordinated with other existing assignments, are described in the ICAO Frequency Management Manual.

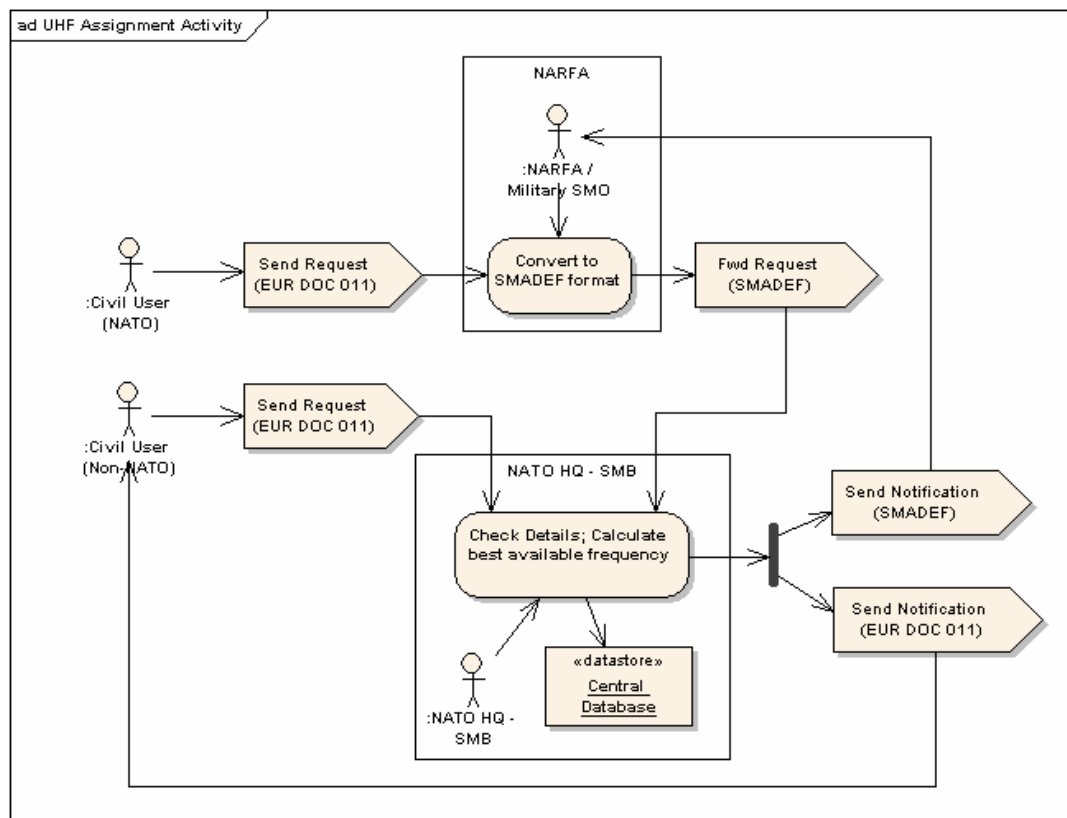


Figure 1: UHF frequency assignment process

2.2 UHF COVERAGE CONSIDERATIONS

- 2.2.1 UHF infrastructure was implemented in the initial NATO Western Europe member States to respond to specific NATO military requirements. Eastern and Central European States that joined NATO at a later stage did not have immediately UHF facilities in place. The implementation of such capabilities is not yet finalised in the entire ECAC area.
- 2.2.2 In States where a UHF infrastructure is not available in civil ANSPs, or where the coverage is insufficient, the alternative is to retain a residual number of VHF 25 kHz channels. As a consequence, these frequencies cannot be converted into 8.33 kHz channels and realise the needed frequency benefits. Hence, the lack of UHF is an indirect obstacle to 8.33 kHz implementation.

2.3 SES REGULATION ON AIR-GROUND VOICE CHANNEL SPACING (AGVCS)

- 2.3.1 Air-ground voice radio communication systems for civil aircraft are used primarily for the purpose of ATC relying on the ICAO VHF COM band (118 - 137 MHz). Within this band, the same frequency can be reassigned many times provided that there are no interference problems. At the time of writing, there are about 11,000 VHF assignments in this band.
- 2.3.2 In 1994, it was decided to face VHF congestion in Europe by changing the channel spacing from 25 to 8.33 kHz. The use of VHF with 8.33 kHz channel spacing was introduced above FL245 in the International Civil Aviation Organization (ICAO) European (EUR) Region from October 1999 and above FL195 from March 2007. In all the phases of 8.33 kHz expansion there were provisions to accommodate State aircraft on UHF or on VHF 25 KHz.
- 2.3.3 More recently, in the context of the Single European Sky, the Commission Regulation (EC) No 1265/2007 of 26 October 2007 was published laying down requirements on Air-Ground Voice Channel Spacing (AGVCS) where provisions for State aircraft are included.
- 2.3.4 This regulation applies to State aircraft conducting IFR flights as GAT in the airspace with 8.33 kHz mandatory carriage in the ICAO EUR Region (i.e. above FL195 since 15 March 2007). It covers the need to equip State aircraft with 8.33 kHz radios with the main focus on 'transport-type' aircraft.
- 2.3.5 The AGVCS Regulation states that the flights of remaining non-8.33 kHz equipped State aircraft that cannot be retrofitted for a justified compelling reason will be accommodated by the civil ACCs, provided that they can be safely handled within the capacity limits of the ATM system on UHF or 25 kHz VHF assignments.
- 2.3.6 Further phases of vertical expansion below FL195 are also under consideration, which adds to the incentive for State aircraft to be equipped with 8.33 kHz radios. This will be subject to where, when and how the vertical expansion extends downwards with a phased approach being considered.

2.4 AIR-GROUND UHF COMMUNICATIONS

2.4.1 Operational Air Traffic (OAT)

2.4.1.1 Military air operations (training and exercises) linked to National Defence and Security are mainly conducted as OAT

2.4.1.2 The ATC services available to support OAT operations vary considerably from State to State depending on the type of arrangements in place. Civil and military ATC can be integrated, co-located or separated. In certain States OAT traffic is handled by civil air traffic controllers (ATCOs) using the civil ANSPs' infrastructure whilst in other countries military controllers operate a military infrastructure.

2.4.1.3 However, the common practice is to handle OAT flights by military ATCOs whether within controlled zone, terminal area or in the control area. When within temporary segregated airspace/temporary reserved airspace (TSA/TRA) or when performing air interceptions, such flights might have to be handled by the Air Defence.

2.4.1.4 Military UHF communications support a wide variety of requirements associated with military Command and Control (C2) functions as well as ATC voice communications between the pilots and ATCOs, either in ATC Centres or in the aerodrome/terminal area.

2.4.1.5 VHF 25 kHz channels in the military band 138-144 MHz are also available for off-route OAT operations and to support military aerodrome services in most NATO States and additionally in the band 145-156 MHz in some Eastern European States.

2.4.2 General Air Traffic (GAT)

2.4.2.1 The current practice, consistent with EC AGVCS regulation, and described in the majority of national AIPs is that, State aircraft (aircraft used in Military / Police / Customs services) which are not equipped with an 8.33 kHz capable radio, are allowed to operate in the airspace designated for 8.33 kHz channel spacing operations, provided that they are UHF equipped. This applies only to UHF equipped aircraft in order to ensure consistent operations in the whole 8.33 kHz airspace of Europe.

Note: It is considered important to note that these aircraft must also be VHF 25 kHz equipped in addition to UHF.

2.4.2.2 In general, non-8.33 kHz equipped State aircraft are handled on UHF frequencies. However some States have chosen to use VHF 25 kHz for air-ground communications.

2.4.2.3 The handling of non-8.33 kHz equipped State aircraft is summarised in the individual State AIP and may be further detailed in other local procedures.

2.5 EQUIPAGE CONSIDERATIONS

- 2.5.1 Civil aircraft operating above FL195 in the ICAO EUR region must be equipped with at least two independent sets of 8.33 kHz capable radios to meet the relevant provisions of existing EC regulation, ICAO provisions laid down in Annex 10 and EUROCAE Minimum Operational Performance Specification for Airborne VHF Receiver-Transmitter operating in the frequency range 117,975-137,000 MHz, Document ED-23B
- 2.5.2 For State aircraft, specific VHF 8.33 kHz equipage aspects like the required number of independent radio sets for fighters are not yet clearly harmonised at international level.
- 2.5.3 One example is a combat aircraft with a single VHF 8.33 kHz transceiver and one independent UHF radio that could be sufficient for the aircraft to be declared as VHF 8.33 kHz equipped. State regulators have the competency to decide on this matter which might impact some of the applicable procedures.
- 2.5.4 Modern military airborne transceivers are multi-band and integrate normally VHF and UHF capabilities (voice and data), provide 121.5 MHz and 243.0 MHz guard channels, have modular upgradeable construction with remote control and may also be multimode and programmable.

3. PROCEDURES FOR ATC WHEN USING UHF

3.1 SAFETY CONSIDERATIONS

- 3.1.1 It is the individual States that ultimately hold the legal responsibility for safety in their national airspace. Therefore, States will need to develop their own detailed safety documentation to govern the implementation and safety monitoring of the system.
- 3.1.2 The guidance given in this document is based on the findings of several safety studies and other work conducted in the frame of the EUROCONTROL 8.33 kHz Programme as well as some contributions from civil and military ANSPs identifying existing practices.
- 3.1.3 The safety hazards that could result directly from 8.33 kHz implementation were determined, and the mitigation measures necessary to reduce such hazards to as low as reasonably practicable levels, were identified within the frame of the EUROCONTROL 8.33 kHz Programme.
- 3.1.4 However, the safety considerations in paragraphs 3.4 and 3.5 are not intended to supersede and have no precedence over the original safety materials. The present text shall not be revised retrospectively. Any fundamental concerns about the original 8.33 kHz safety studies should be fed back to the EUROCONTROL 8.33 kHz Programme.

3.2 FLIGHT PLANNING PROCEDURES FOR GAT/IFR

- 3.2.1 If the State aircraft is equipped with 8.33 kHz capable radio: the letter ‘Y’ shall be inserted in Item 10 of the filed flight plan, regardless of the requested flight level.
- 3.2.2 If the aircraft is NOT equipped with 8.33 kHz capable radio but it is a State aircraft equipped with UHF: the letter M shall be inserted in Item 8, the letter “U” in Item 10 and the indicator ‘STS/EXM833’ in Item 18 of the filed flight plan.
- 3.2.3 The EUROCONTROL Initial Flight Plan Processing System (IFPS) will accept flight plans for non-8.33 kHz but UHF equipped State flights that are planned to enter the airspace above FL195 of an 8.33 kHz State where means to handle such flight are provided.
- 3.2.4 In addition to the current processing IFPS shall include in the acknowledgement message (ACK) transmitted to the flight originator the following comment:

- COMMENT: THIS FLIGHT MAY REQUIRE SPECIAL HANDLING BY ATC DUE TO 8.33 KHZ CARRIAGE REQUIREMENTS
- 3.2.5 The aircraft operator shall ensure that the information provided in the flight plan (i.e. 8.33 kHz equipage information or the presence of the exemption indicator) is consistent with the aircraft to be used, the route to be flown and the requested cruising levels.

3.2.6 The pilot-in-command is ultimately responsible for ensuring that the radio communication equipment appropriate for the flight to be conducted is available and operational on board the aircraft.

3.3 GENERAL SCENARIOS

3.3.1 The ideal UHF configuration would be to have one UHF frequency for each VHF assignment appropriately cross-coupled so that the system becomes a single one from the ATCO perspective.

3.3.2 However, due to the limited resources available and heavy demands for air/ground and air/air assignments in UHF, NATO SMB may not be in a position to answer favourably to all civil ANSP requests for UHF frequencies.

3.3.3 Cross-coupling (sometimes referred as cross-banding) is also useful for all pilots to be able to listen (party line) all the voice communications of adjacent traffic.

3.3.4 A common configuration is to share UHF channels through multiple sectors as illustrated by Figures 1 and 2:

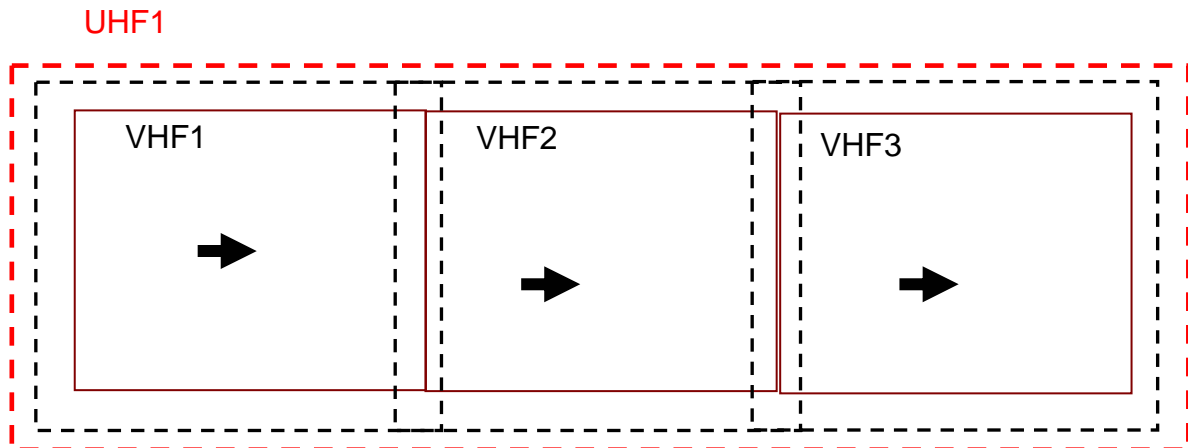


Figure 1 – One UHF assignment shared with multiple VHF sectors

3.3.5 The shortcomings of this configuration have an impact on the need to maintain safety levels. Therefore it serves as the basis to discuss some potential hazards and the associated mitigating actions.

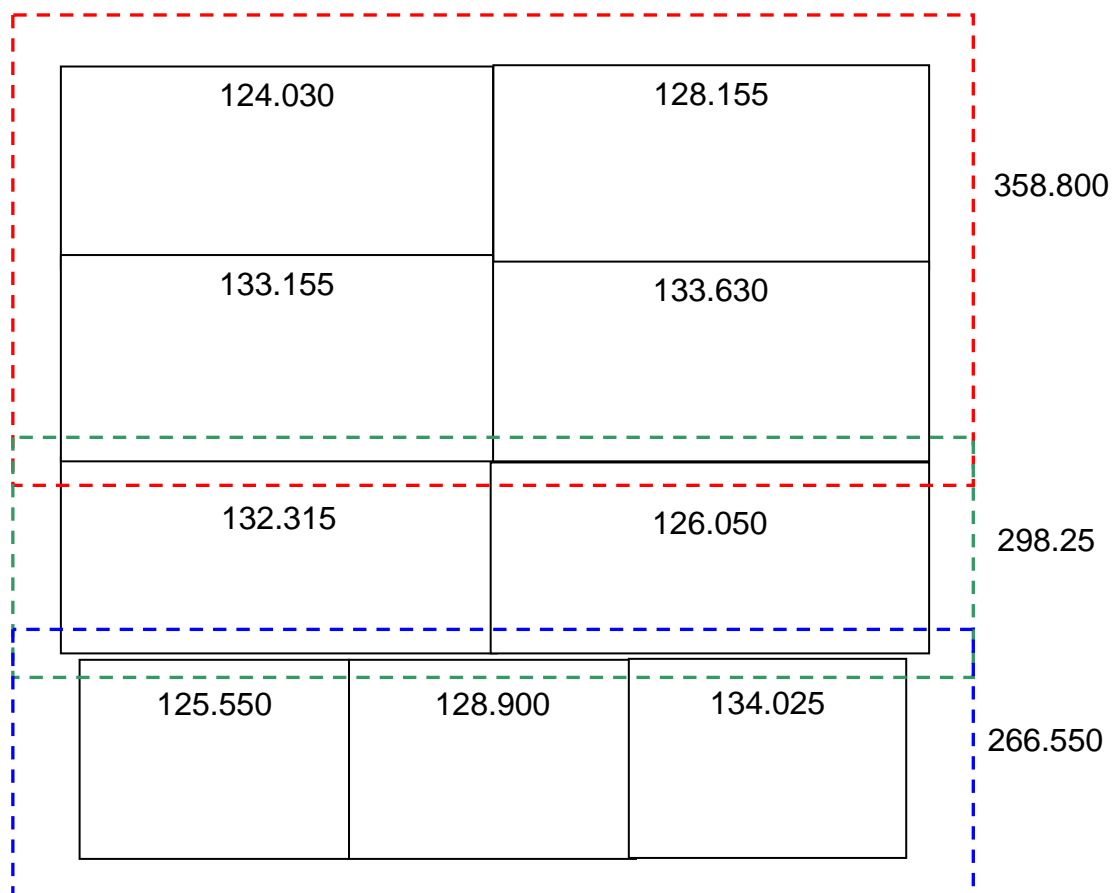


Figure 2 – Multiple UHF assignments shared with multiple VHF sectors

3.3.6 Limited UHF assignments shared with many VHF assignments – sometimes dynamically – may lead to increased controller workload especially where multiple non-8.33 kHz State aircraft have to be handled simultaneously with civil traffic.

3.3.7 The following example related with limited military traffic in 3 sectors sharing one UHF channel shows the complexity of situations that might be derived from the usage of UHF in the abovementioned type of configurations.

One military aircraft (MIL A/C) on UHF1 during ALL crossing time of Sector 1 to Sector 3 (evolution over time is represented by T1, T2 and T3):



[UHF1 coverage, for the 3 VHF sectors]

(At Time1 (T1), the area of usage of UHF1 is Sector1 **ONLY** from T1 to T2)

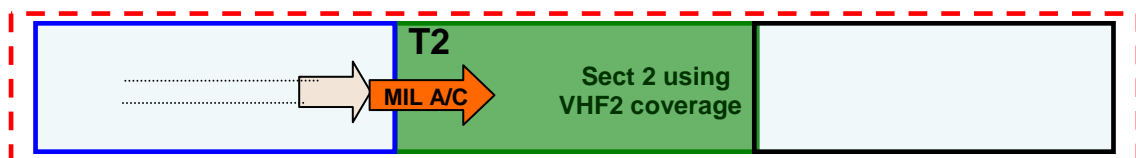
At T1 Mil A/C enters Sector 1 of Controller 1:

- Controller1 selects «UHF1» on its Controller Working Position (CWP) as a means of communication additional to VHF1 (primary means)

Controller1 cross-couples VHF1 and UHF1, thus “party line” (everybody hears everybody in Sector 1) is established between:

- All Civil A/C on VHF 1, and the MIL A/C on UHF 1 and the Controller 1 of Sector 1

MIL A/C progresses to Sector 2.



(At T2, the area of usage of UHF1 is Sector 2 **ONLY** from T2 to T3)

At T2, Mil A/C is about to enter Sector 2:

- Controller 1 hands over MIL A/C to Controller 2
- Controller 1 deselects UHF1 (keep VHF1) and decouples UHF1 from VHF1
- Controller 2 selects UHF1 and couples with VHF2

Controller 2 is now in position to communicate with MIL AC on UHF1

Party line is established in Sector 2.

3.3.8 Additional complexity for this example with multiple aircraft is introduced in the discussion of Hazard 1.

3.4 HAZARDS RELATED TO HANDLING OF NON-8.33 KHZ EQUIPPED STATE AIRCRAFT

3.4.1 HAZARD 01 Too many non-8.33 kHz equipped State aircraft in an ACC with limited UHF coverage

3.4.1.1 This hazard may occur if there are too many non-8.33 kHz equipped State Aircraft entering in airspace with limited UHF coverage (exercises, crisis). This situation may lead to an increase in controller workload.

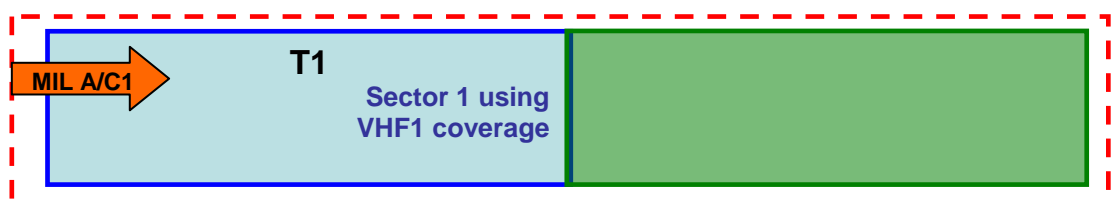
3.4.1.2 The main problem might be related with State aircraft subject to communication transfers (“handovers”) on UHF-assignments, e.g. initial coordination on UHF assignment is unsuccessful and a request is then made to be handled on 25 kHz VHF. (Note: the problem will be minimised for a reduced number of flights when it is a standard procedure to keep backup UHF frequencies available.)

3.4.1.3 An additional complexity arises when one aircraft is being handled in UHF1 in one sector while a second (or more) aircraft enters in a preceding sector for handling on the same UHF1 channel.

3.4.1.4 This could cause the need to handle two aircraft in two different sectors using the same UHF frequency. Military OAT practises may cause a need to combine sectors to cope with this situation. Enhanced coordination is possible in some military centres due to the fact that sectors are defined by airspace areas and not by specific radio frequencies.

3.4.1.5 Building upon the example presented in 3.3.6 the following scenario illustrates the present potential hazard:

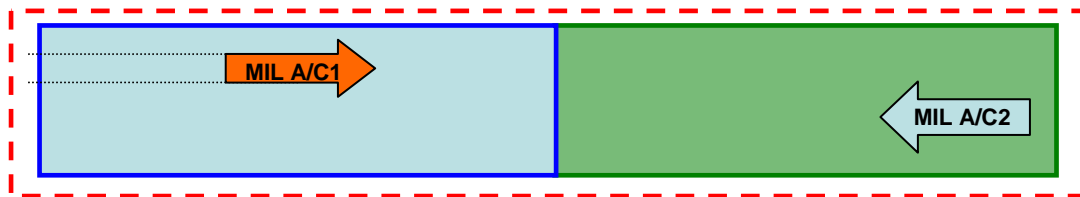
More than one MIL A/C on UHF1 during crossing time of Sector 1 to Sector 2



UHF1 coverage, for 2 VHF sectors

At time **T1** the area of usage of UHF1 is Sector1 **ONLY** from T1 to T2

If another military aircraft (MIL A/C2) enters in Sector 2, it is problematic for Controller2 enter in communication with MIL A/C2 using also UHF1.



UHF1 coverage, for 2 VHF sectors

At **T1** plus a delay **delta T**:

- Resource is already reserved/booked by Controller1 for within Sector 1 usage only, party line is established in Sector 1 (by cross coupling of UHF1 with VHF1), precluding usage and further cross coupling in Sector2

Apparently it seems very challenging to resolve this situation. To cancel the cross-coupling between VHF1 and UHF1 will not solve the problem, in such a case party line would be lost in sector 1 resulting in potential clash of air-ground communications between aircraft on VHF1 and Mil A/C1 on UHF1 for Controller1 reception.

Mitigation

3.4.1.6 Mitigation for this hazard consists in:

- the ratio of UHF to VHF assignments should be improved (1 to 1 ideally). This could be mitigated with dynamic allocation of frequencies to sectors. A different UHF frequency could be made available to the 2nd sector if available dynamically
- sectors may be combined to cope with the situation (if resulting capacity limits can be respected)
- flow management mechanisms like the Central Flow Management Unit (CFMU) shall be used to detect conflicts in UHF1 Area and ensure the simultaneous handling of a reduced number of flights
- specific procedures shall be put in place for the ATCOs to apply special handling of non-8.33 kHz equipped State aircraft in accordance with local conditions
- 8.33 kHz equipage levels should be increased.

3.4.1.7 States have published procedures for handling non-8.33 equipped State aircraft in their AIP.

3.4.2 HAZARD 02 A non-8.33 kHz equipped State aircraft within an 8.33 kHz sector without UHF coverage

3.4.2.1 The entry of a non-8.33 kHz equipped State aircraft into an 8.33 kHz sector where UHF coverage does not exist entails the need to use VHF 25 kHz channels.

3.4.2.2 The pilot attempting to communicate on a 25 kHz, channel instead of an 8.33 kHz channel, potentially leading to frequency blocking and/or interference with communications to other aircraft.

Mitigation

3.4.2.3 Mitigation for this hazard should be based on improving UHF coverage or retention of VHF 25 kHz assignments.

3.4.3 HAZARD 03 Inability to communicate resulting in potential loss of separation during Air Defence (AD) Interceptions or Formation Flights

3.4.3.1 During AD interceptions military aircraft might not be able to communicate with the civil ACC if UHF is not available, and might be unable to establish air-to-air communications if the civil aircraft (intercepted) is not monitoring the VHF emergency frequency (121.5 MHz).

3.4.3.2 There is a potential risk that this results in loss of separation if tactical coordination is not possible.

3.4.3.3 A similar situation can happen during military formation flights when there is heterogeneous equipage between the formation leader and other formation aircraft. In case of an unplanned formation split a loss of communications can occur with aircraft with limited or no VHF capability.

Mitigation

3.4.3.4 Mitigation for this hazard should be based on improving UHF coverage and compulsory monitoring of the emergency frequency by civil aircraft.

3.4.4 HAZARD 04 Lack of information available to ATCOs on 8.33 kHz equipage status of State aircraft

3.4.4.1 Flight plan information might not be enough to fully describe 8.33 kHz equipage status of State aircraft (e.g. number of independent sets of radios, backup, etc).

Mitigation

3.4.4.2 ANSPs shall ensure that the 8.33 kHz equipage status of aircraft, including State aircraft, is available to ATCOs via flight progress strips and/or radar track labels.

3.4.5 HAZARD 05 Airspace constraints and OAT/GAT transfers using UHF and VHF 25 kHz

3.4.5.1 Different arrangements in different States might dictate the need to perform handovers of multiple aircraft using different communication enablers.

3.4.5.2 Different sectorisation, sector capacity limits, airspace structures and airspace

classes might also create some difficulties for handling mixed traffic in VHF and UHF.

3.4.5.3 Mitigation

3.4.5.3 Training and bilateral agreements. States shall ensure that the Letters of Agreement (LoAs) between neighbouring ACCs foresee contingency procedures.

3.5 HAZARDS RELATED WITH UHF CONFIGURATION

3.5.1 HAZARD 06 Selection of wrong frequency by the pilot

3.5.1.1 The selection of the wrong channel or “mistuning” is a potential hazard for any channel. For 8.33 kHz channels, the addition of an extra digit and uncertainty about phraseology, may increase the hazard and may lead to communication problems, including additional pilot and controller workload. The identified hazard effects are interference/frequency blocking, inability to communicate and increased workload.

3.5.1.2 Frequency selection on combat aircraft might involve additional difficulties. Performing frequency changes in some aircraft types might be difficult due to control panel location, rapid ascents/descents, pilot workload etc. In some places a procedure is in place whereby fighter aircraft were handled on a single frequency when transiting a number of sectors², in order to reduce the number of frequency changes.

Mitigation

3.5.1.3 Data link may be used, special handling procedures shall cover the use of a single frequency to transit multiple sectors, better Human-Machine Interface (HMI) shall be made available and training shall be ensured.

3.5.2 HAZARD 07 Low performance of cross-coupled UHF/VHF configurations

3.5.2.1 There are some technical problems when cross-coupling VHF to UHF in certain Voice COM Systems (VCS). The expected performance or Quality of Service parameters of voice communications might be reduced.

Mitigation

3.5.2.2 Apply correct installation procedures and respect technical specifications.

3.5.3 HAZARD 08 Lack of consistency in route structure above/below FL195

3.5.3.1 Problems may occur due to lack of consistency in the route structure. For example,

² There are situations where, to avoid frequency changes, a specific method for fighters to exit TMA has been introduced (exit by the top).

non-equipped aircraft may have to be descended below the 8.33 kHz sector and may thereby end up off route or in uncontrolled airspace as the airspace below may have a totally different structure and a different airspace classification. This may, in addition, jeopardize other aircraft in the particular area.

Mitigation

3.5.3.2 An assessment shall be made on the impact of descending non-8.33 kHz equipped aircraft below FL195, taking into account factors such as transition altitudes, fuel consumption, etc., and determine whether modifications to sector capacity or airspace design/structures are required.

3.5.4 HAZARD 9 Borrow UHF frequencies from military on a tactical basis

3.5.4.1 The practise of obtaining military frequencies to handle traffic on a tactical basis has a risk of using frequencies that are subject of possible harmful UHF interferences. In this case it will be difficult to respond to a sudden increase of traffic or to handle formation flights.

Mitigation

3.5.4.2 The control should be transferred to military ACC or improve UHF provision.

3.5.5 Annex B contains a list of the potential effects caused by the hazards.

3.6 SUMMARY OF MITIGATING PROCEDURES AND BEST PRACTISES

3.6.1 Annex C includes a summary of the mitigating procedures associated with the hazards described above and adds some other practices that are more of a generic nature.

3.6.2 To mitigate against the hazard of a non-8.33 kHz compliant State aircraft, air traffic controllers shall be informed of the 8.33 kHz equipage status of aircraft under their control. In the event that an aircraft is not 8.33 kHz compliant, this will usually be indicated on the flight progress strip and/or the radar track label. Should the ATCO be uncertain about the 8.33 kHz equipage status of any aircraft or the UHF status of a State aircraft, then the phraseology contained in the ICAO *Procedures for Air Navigation Services – Air Traffic Management* (PANS-ATM, Doc 4444), shall be applied.

3.7 PHRASEOLOGY

3.7.1 Consistent use of the correct radiotelephony phraseology procedures shall be observed in all cases as contained in the ICAO Annex 10, Volume II, Chapter 5 as well as relevant phraseology described in the PANS-ATM, Chapter 12.

3.7.2 The table below illustrates some relevant phraseology procedures.

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Circumstance	Phraseology
To request confirmation of 8.33 kHz capability	CONFIRM EIGHT POINT THREE THREE
To indicate 8.33 kHz capability	* AFFIRM EIGHT POINT THREE THREE
To indicate lack of 8.33 kHz capability	* NEGATIVE EIGHT POINT THREE THREE
To request UHF capability	CONFIRM UHF
To indicate UHF capability	* AFFIRM UHF
To indicate lack of UHF capability	* NEGATIVE UHF
To request status in respect of 8.33 kHz exemption	CONFIRM EIGHT POINT THREE THREE EXEMPTED
To indicate 8.33 kHz exempted status	*AFFIRM EIGHT POINT THREE THREE EXEMPTED
To indicate 8.33 kHz non-exempted status	* NEGATIVE EIGHT POINT THREE THREE EXEMPTED
To indicate that a certain clearance is given because otherwise a non-8.33 equipped and/or non-exempted aircraft would enter the airspace of mandatory carriage	DUE EIGHT POINT THREE THREE REQUIREMENT

* Denotes pilot transmission.

4. UHF INTEGRATION IN VOICE COMMUNICATION SYSTEMS (VCS)

4.1 GENERAL

- 4.1.1 The purpose of this section is to cover some installation options to ensure that the configuration available facilitates the application of correct operating procedures and best practices. It can be considered as an additional element influencing the selected technical set up of the UHF system.
- 4.1.2 Full technical details applicable for UHF installations used by ATC are available in European Telecommunications Standards Institute (ETSI) Specification “ETSI EN 302 617 V1.1.1 (2009-01) Electromagnetic compatibility and Radio spectrum Matters (ERM); Ground-based UHF radio transmitters, receivers and transceivers for the UHF aeronautical mobile service using amplitude modulation; Part 1: Technical characteristics and methods of measurement”. NATO STANAG 4205 also includes relevant technical details.
- 4.1.3 Most hazards associated with hazard 01 on the handling of too many non-8.33 kHz State aircraft entering a sector can be mitigated if UHF and VHF channels are appropriately cross-coupled. This section includes only some high level considerations to respond to the variety of options available to ANSPs and to the wide variety of VCS models which might constrain the implementation of cross-coupling solutions.
- 4.1.4 The provision of an ATC service using UHF is significantly enhanced when, at the level of the CWP, the co-existence with VHF communications is transparent to the controller through a perfect integration in the underlying VCS. This is achieved through the cross-coupling (or cross-banding) of VHF and UHF transmissions.
- 4.1.5 The cross-coupling technique requires a similar approach as when multiple transmitters (Tx) and receivers (Rx) equipment to control the extent of radio coverage are used e.g. due to airspace size, geography (mountains), and backup coverage. In many cases Tx/Rx stations are remote from the main VCS equipment and some form of Remote Control Equipment (RCE) is required.

4.2 RADIO ACCESS CROSS-COUPLED

- 4.2.1 Radio access enables a user to transmit and receive voice communications on selected radio frequencies. Cross-coupling is one of the modes of CWP radio access.
- 4.2.2 There are HMI issues that need to be safeguarded in terms of safety to ensure that selection of audio in a particular configuration does not compromise frequencies selected. Besides that, a CWP may have radio access to several frequencies, each of which can be set individually or cross-coupled. Thus, simultaneous transmission and reception on more than one frequency is possible by operation of a common PTT key. The total number of frequencies that can be accessed simultaneously at a CWP will

be specified by the ANSP. Naturally, the selection of a UHF channel is desirable from a safety perspective.

- 4.2.3 ANSPs should require that the extent of radio coverage for each frequency can be controlled by transmitter and/or receiver selection; several options are available including that the user can select at the CWP, which transmitter and receiver combinations that are in use on each frequency. The number of transmitters and receivers and permissible combinations – including default settings - should be specified by the ANSP.

4.3 FREQUENCY CROSS-COUPLING

- 4.3.1 Cross-coupling may be applied to two or more frequencies but the principles may be illustrated with reference to two cross-coupled frequencies 'A' (VHF) and 'B' (UHF) as follows. If an aircraft transmits on frequency 'A' it is received on the ground and 'cross-coupled' to be re-transmitted on frequency 'B'. For the User on the ground when they transmit on either frequency 'A' or 'B' both transmitters will be activated at the same time.
- 4.3.2 How cross-coupling is implemented depends of the vendor specifications of each VCS. However, the extent of the cross-coupling (two or more frequencies) will be specified by the implementer (ANSP). Also, the means of selection and control of cross-coupling will be specified by the ANSP but the following are typical options: 1) at any CWP, 2) at a specified supervisor working position, 3) by means of a system management terminal.
- 4.3.3 Whatever means of cross-coupling that is selected it is extremely important that the user (or users) are given clear indications as to which frequencies are in a cross-coupled mode.
- 4.3.4 Operational safety hazards, particularly during busy/heavy traffic situations, may arise due to cross-coupling where the chance of missed or disturbed radio transmissions increases significantly. These operational safety hazard considerations are discussed in the deliverables dealing with operational aspects of UHF usage.
- 4.3.5 In view of the safety hazards outlined above consideration should be given to restricting the extent of cross-coupling as follows:

- limiting the number of frequencies that can be cross-coupled
- limiting the number of cross-coupling sessions at a CWP
- limiting the number of cross-coupling sessions for the whole VCS

It is also important, in order to prevent coupling chains, to ensure that a particular frequency can only be included in one cross-coupling session.

4.4 HUMAN-MACHINE INTERFACE (HMI)

- 4.4.1 Each user interface with the VCS through a CWP provides a means of communication for both direct speech circuits and Air- Ground applications. The

features and attributes of the HMI are perhaps the most critical part of the VCS design since they have a direct impact upon the efficiency and safe working of users.

- 4.4.2 Important aspects constraining the HMI configuration are the option for integration between direct speech circuits and air-ground communication, the type and design of the activation devices (touch-sensitive screens, mouse/track ball, push button switches, keyboard, mechanical PTT keys), the presentation devices (CRT, plasma, LCD, LED, illuminated keys) and audio devices (headsets, desk microphones, hand microphones, loudspeakers). Particular configurations may vary with the type of VCS considered but for the future there may also be a trend towards total integration of the CWP to include all services – radar, radio, telephone etc – for which computer graphic displays and on-screen selection via mouse-type input devices or touch-screen are likely solutions.
- 4.4.3 The most common problem with cross-coupling needs to be solved with operational procedures if the technical implementation is not adequate. It is when the use of the audio devices is subject to ANSP and local preferences with the Tactical Controller in an ACC who uses both air-ground VHF and air-ground UHF communication non cross-coupled. It might occur also with the simultaneous use of direct speech circuit facilities. The main problem in this type of situation is that a pilot has no knowledge of how the controller he/she is about to contact may be engaged in other air-ground communications.
- 4.4.4 The following guidelines identify some important human engineering aspects that shall be considered for Human Machine Interfaces. Irrespective of cross-coupling being present or not it shall be guaranteed that:
- The interaction between a controller and the HMI should leave the controller in no doubt about the next action to be taken in performing the current function.
 - The indicator associated with the aircraft call should be distinctive to enable active frequencies to be easily identified.
 - A distinctive and clear indicator showing any frequencies that have been cross-coupled should be provided.

ANNEX A: GLOSSARY

Abbreviations

ACC	Area Control Centre
AGVCS	Air-Ground Voice Channel Spacing
ANSP	Air Navigation Service Provider
ATC	Air Traffic Control
ATCO	Air Traffic Controller
ATM	Air Traffic Management
CFMU	Central Flow Management Unit
CMIC	Civil Military Interface standing Committee
COM	Communications
CRT	Cathode Ray Tube
CWP	Controller Working Position
C2	Command and Control
EC	European Commission
ETSI	European Telecommunications Standards Institute
GAT	General Air Traffic
HMI	Human-Machine Interface
Hz	Hertz
ICAO	International Civil Aviation Organization
IFPS	Initial Flight Plan Processing System (CFMU)
IFR	Instrument Flight Rules
IR	Implementing Rule (SES)
LCD	Liquid Crystal Display
LED	Light Emitting Diode
NARFA	National Allied Radio Frequency Agencies
NATO	North Atlantic Treaty Organization
OAT	Operational Air Traffic
OATTS	OAT Transit Service
PTT	Push To Talk

RCE	Remote Control Equipment
SES	Single European Sky
SMB	Spectrum Management Branch (NATO)
STANAG	NATO Standardisation Agreement
UHF	Ultra-High Frequency
VCS	Voice Communications System
VHF	Very High Frequency

Definitions

Coverage	The coverage provided by a radio-navigation system is that surface area or space volume in which the signals are adequate to permit the user to determine position to a specified level of accuracy. Coverage is influenced by system geometry, signal power levels, receiver sensitivity, atmospheric noise conditions and other factors which affect signal availability.
General Air Traffic	Encompasses all flights conducted in accordance with the rules and procedures of ICAO.
Operational Air Traffic	Encompasses all flights which do not comply with the provisions stated for GAT and for which rules and procedures have been specified by appropriate national authorities.
State aircraft	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. Accordingly: 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. (PC/11 12/07/2001)

ANNEX B

HAZARD POTENTIAL EFFECTS

Nr	Hazard	Hazard effect
1	Too many non-8.33 kHz State aircraft in 8.33 kHz sectors with limited UHF capacity	increased pilot and ATCO workload sector overload inability to communicate frequency blocking descending aircraft to lower airspace resulting in higher fuel consumption for aircraft involved application of contingency procedure increased number of conflicts to be resolved aircraft due to re-routing ending up in uncontrolled airspace
2	A non-8.33 kHz equipped State aircraft within an 8.33 kHz sector without UHF coverage	inability to communicate resulting in potential loss of separation interference/freq blocking application of contingency procedure increased pilot and ATCO workload loss of separation (worst case when in a non-radar environment and no flight plan nor traffic information is available for the entering non-8.33 kHz aircraft)
3	Inability to communicate resulting in potential loss of separation during Air Defence (AD) Interceptions or Formation Flights	separation infringement increased pilot workload increased ATCO workload (e.g. due to increased coordination) Reduced ability to provide emergency / life critical flights Loss of separation More complicated diversions / decreased diversion options
4	Lack of information available to ATCOs on 8.33 kHz equipage status of State aircraft	Increased ATCO workload Increased pilot workload Airspace infringement
5	Airspace constraints and OAT/GAT transfers using UHF and VHF 25 kHz	increased number of conflicts to be solved
6	Selection of wrong frequency by pilot	inability to communicate resulting in potential loss of separation interference/frequency blocking increased ATCO workload application of contingency procedure increased pilot workload loss of separation

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7	Low performance of cross-coupled UHF/VHF configurations	Loss of COM performance
8	Lack of consistency in route structure above/below FL195	increased ATCO workload increased pilot workload/increased number of conflicts to be solved
9	Borrow UHF frequencies from military on a tactical basis	interference/frequency blocking increased ATCO workload

ANNEX C

SUMMARY OF MITIGATING PROCEDURES AND BEST PRACTISES

PROCEDURE/PRACTISE	IMPACTED HAZARDS
Collapsing sectors to cope with too many State aircraft	1
Improving the ratio of UHF to VHF assignments (better UHF coverage)	1, 2, 3, 9
Increasing the 8.33 kHz equipage levels	1
Retention of VHF 25 kHz assignments	2
Monitoring of emergency frequency	3
Information on aircraft 8.33 kHz equipage status available to ATCOs	4
Use of data link communications	6
Training	5, 6
Special handling with use of single frequency to transit multiple sectors	6
Ensure that HMI displays information facilitating the use of correct VHF R/T phraseology	6
Apply correct installation procedures and respect technical specifications	7
Assess a priori the impact of descending non-8.33 kHz equipped aircraft below FL195	8
Transfer the control to military ACC	9
Ensure that the LoAs between neighbouring ACCs define contingency procedures for handling non-8.33 kHz compliant State aircraft, taking into account coordination procedures, airspace structures and airspace classes	5, 6
Consistent use of the correct phraseology radiotelephony procedures contained in ICAO Annex 10	6
Aircraft operators shall ensure that clear instructions are available in the cockpit (including on how to use the equipment)	3, 8
Clear read-back by pilots	3
Ensure that ATC units with sectors operating in the 8.33 kHz channel spacing, and the ATC units adjacent to them cooperate effectively	1, 2, 5
Use unplanned diversion as a last resort, particularly where the route network below FL195 is different from that at higher levels	1,
Military aircraft operators shall provide military pilots with training/briefings on the UHF and 8.33 kHz requirements including those relating to flight planning	4, 5, 6
Controller – controller coordination shall be made before transfer of a non-8.33 kHz State aircraft, indicating the exemption status of the aircraft concerned	1, 2, 4
The 8.33 kHz or UHF capability of any aircraft confirmed by the preceding sectors	1, 2



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