International Civil Aviation Organization

MIDANPIRG Communication Navigation and Surveillance Sub-Group (CNS SG)

Fifth Meeting
(Cairo, Egypt, 11 – 13 December 2012)

Agenda Item 4:   **Development related to CNS**

FREQUENCY FINDER
A PROGRAM FOR MANAGING, ASSESSING COMPATIBILITY AND PRESENTING ON A MAP FREQUENCY ASSIGNMENTS
FOR AERONAUTICAL COMMUNICATION AND NAVIGATION SYSTEMS

(Presented by the Secretariat)

1.   Introduction

1.1   ICAO is developing the program Frequency Finder that offers a tool to assist ICAO Regional Offices and States to manage and coordinate aeronautical frequency assignments. This program combines the data base management functions for updating the ICAO COM lists, calculation of interference areas and uses a geographical interface for plotting of the coverage of frequency assignments, including predicted interference area, on a map (currently with Google Earth only). The graphical interface can be used to overlay frequency assignments on certain geographical areas such as ACC or FIR sectors, with air-routes and combined with other ICAO databases that are being developed.

1.2   The program has initially been developed to provide support to Regional offices that have a central role in the coordination of frequency assignment with focus on ICAO Regions outside Europe (and in North America: USA and Canada). The program is currently being modified to accommodate frequency assignment planning in Europe as well (in particular the use of 8.33 kHz frequency assignments) and the frequency assignment planning criteria that are contained in the ICAO *Handbook on Radio Frequency Spectrum Requirements for Civil Aviation*, Volume II *Frequency assignment planning criteria for radio communication and navigation systems* (Doc 9718).

1.3   Frequency Finder is being built containing different modules:

- VHF air/ground communications (DSB-AM, VDL Mode 2 and VDL Mode 4)
- VHF navigation (ILS, VOR, GBAS, VDL Mode 4)
- NDB
- HF air/ground communications
- SSR Mode S II code assignments

In addition, Frequency Finder has included applications that will allow for the plotting of FIR sectors and air-routes. Plotting of ACC sectors (as used in Europe) has also been implemented.

1.4   The program is using FileMaker Pro (version 12) for data base management, calculation of interference contours, assessing compatibility between frequency assignments and for generating the files necessary to plot the frequency use and interference areas on a map (with Google Earth). The program is available in a full version (that requires the user to have FileMaker Pro 12 installed on the local computer) and in a runtime version (which does not require FileMaker Pro and can work as a stand-alone program).

1.5   The modules for NDB and HF frequency assignment planning are still to be developed. The module for the coordination of SSR Mode S Interrogator Identifier (II) codes (only for SSR II codes 0 – 15) has been completed. The planning criteria for the coordination of these Mode S II codes that were implemented are in Frequency Finder have been updated by the Aeronautical Surveillance Panel and are being incorporated in Frequency Finder. The module for VHF navigation systems (ILS, VOR and DME has been completed using the limited frequency assignment planning criteria for these systems that are applied in the ICAO Regions outside Europe. This module is being modified to incorporate the planning criteria for ILS, VOR and DME as per Annex 10 (which are expected to become in line with those used in the EUR Region). The module for VHF air/ground communication planning has been completed, using both the current Regional frequency assignment planning criteria. Implementation of the frequency assignment planning criteria as per the ICAO *Handbook on radio frequency spectrum requirements for civil aviation, Volume II, Frequency assignment planning criteria for radio communication and navigation systems* (Doc. 9718) is being completed.

1.5   Frequency Finder has been used to generate the ICAO global frequency assignment plan and has concatenated and harmonized the different ICAO Regional COM lists into a single data base, using a single data format for the registered frequency assignments. This global frequency assignment plan is intended to facilitate interregional coordination of frequency assignment as well as to be used as part of the global eANP. The global frequency assignment plan is also to be used when seeking registration of frequency assignments that have been coordinated through ICAO with the International Telecommunication Union (ITU) in the ITU Master International Frequency Register (MIFR). Special provisions have been implemented in Frequency Finder to assist in developing the relevant notices for electronic submission to the ITU.

1.6   It should be expressly noted that Frequency Finder provides a tool for frequency assignment planning. The program incorporates the agreed frequency assignment planning criteria and assesses compatibility with other frequency assignments in the global plan. The coverage that is being considered is the Designated Operational Coverage. Actual coverage may differ in cases where the propagation of the radio signal is obstructed by buildings or mountains, in particular when receiving signals at a low elevation angle from both the desired or to undesired facility. This is further addressed in the Handbook, Volume II.

2.   Using Frequency Finder.

2.1   For use by the Regional Offices outside the EUR Region, the module for VHF air/ground communications is practically completed. As pointed out in paragraph 1, Frequency Finder is currently

being updated to implement the frequency assignment planning criteria as per the ICAO Handbook, Volume II. In addition Frequency Finder is being updated to implement provisions for the protection of area services (ACC, FIR) and for 8.33 kHz channel spacing. Implementation of the (alternative) protection when using the 14 DB D/U protection ratio (currently only in Europe) is being considered. Frequency Finder incorporates the global database of frequency assignments for VHF air/ground communications and VHF Navaids (including DME). However, certain functionality to accommodate specifics, including those applicable in the EUR Region are currently being implemented.

Note: Frequency Finder currently includes for the VHF Navaids the frequency assignment planning criteria that are applied in Regions outside Europe. Working Group F of the Aeronautical Communications Panel is involved in developing updated harmonized criteria that should be applied on a global basis.

2.2   Management of the database is provided by typical data base functions such as:

- Querying the database – the database can be queried using specific parameters (Region, Country, Location, Frequency, Service or FIR (ACC) sector. The user can also manually select frequency assignments.
- Entering new frequency assignments – entering new frequency assignments can be done through a special window in the program
- Modifying existing frequency assignment - modifying an existing frequency can be done through a special window in the program

    Note: new frequency assignments or modifications to an existing frequency assignment can immediately be tested for compatibility with other frequency assignments; these frequency assignments can be saved as a "draft" or "temporary" assignment

- Exporting the data base (in a FileMaker Pro, Excel or PDF file) in the format of the ICAO COM list

A screenshot of the (global) database is in Figure 1

Figure 1 – Screenshot of the (global) data base.

2.3 Mapping of frequency assignments.

The Designated Operational Coverage of frequency assignments can be plotted on a map, using Google Earth. The user can plot the DOC of a single frequency assignment or a selection (as result of a query) of frequency assignments. In case the frequency is linked to either an FIR sector (or for Europe an ACC sector) the plotted coverage is limited to the boundaries of the relevant sector.

Examples for plotting the coverage on a map are in Figure 2 and Figure 3.

Figure 2 – Designated operational coverage limited to the boundaries of the FIR Accra; the green line shows the coverage of station Tamale (ACC-U on 126.7 MHz)

Figure 3 – Overview of all frequency assignments on the frequency 118.100 MHz in the AFI Region

2.4   Testing existing frequency assignments

2.4.1   Frequency Finder can test compatibility of existing frequency assignments, of proposed modifications to existing frequency assignment as well as of proposed new frequency assignments with other frequency assignments in the global database. Frequency Finder tests compatibility of the selected frequency with all co-frequency and adjacent frequency assignments in a circle with a radius of 1020 NM. When testing these frequency assignments, Frequency Finder calculates the actual geographical separation distance of the station that is being tested with the other stations in the plan (co-frequency and adjacent frequency) and calculates the minimum separation distance that is required, in accordance with the relevant frequency assignment planning criteria. In case the actual separation distance is larger than the minimum distance required, the station being tested is compatible with (one or more) to the stations against which the station is being tested. In cases where the minimum separation distances is not met, Frequency Finder identifies this the station being tested is not compatible. In both cases (compatible or not compatible assignments) Frequency Finder presents the margin with which the separation distance is compatible or no compatible.

2.4.2   The results of each of the co- and adjacent channel calculations can be examined. Figure 4 shows the co-frequency calculation details that are presented.
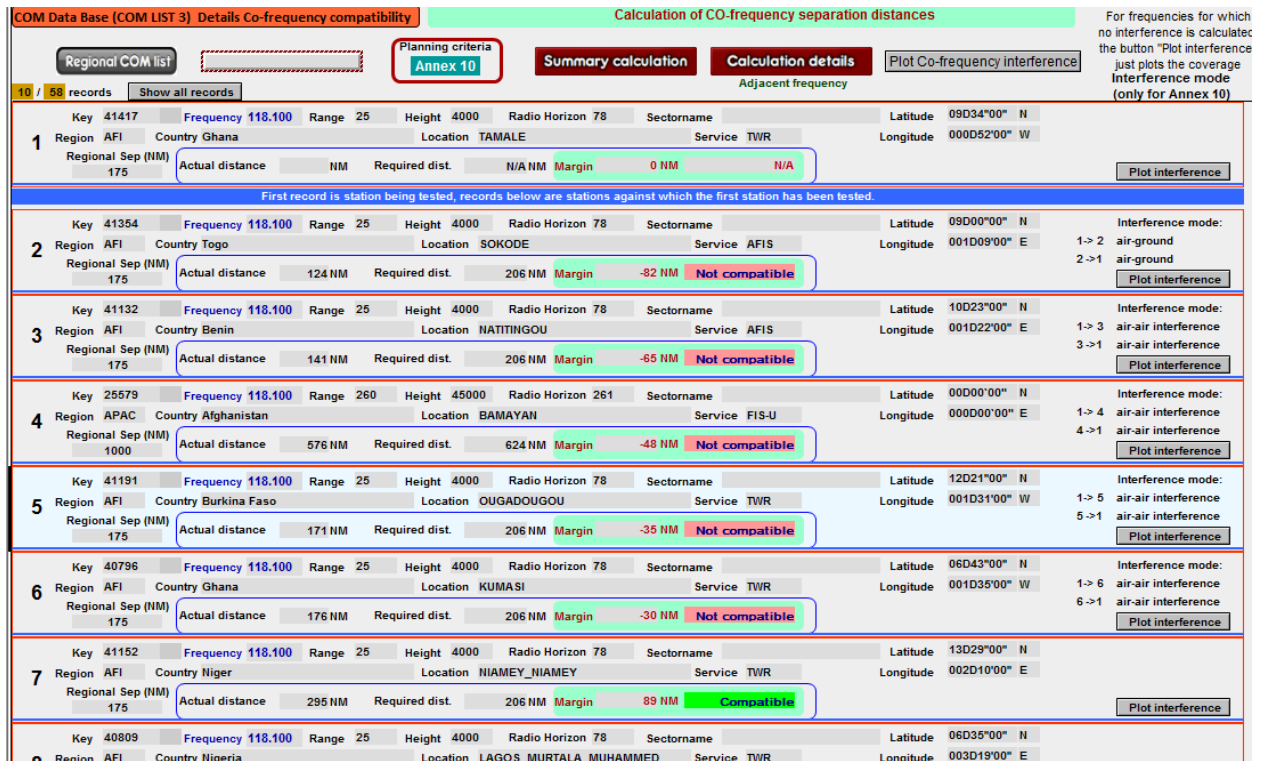
Figure 4 – Screenshot co-frequency calculation details

2.4.3   The calculation details shown in Figure 4 include all potential incompatibilities for station Tamale (TWR on 118.100 MHz) in Ghana that have been identified by Frequency Finder. The areas where the frequency assignment planning criteria are not met (Nos. 2 – 5 in Figure 4) are identified as "not compatible" and the area where interference is predicted can be plotted on a map with Google Earth. This window also identifies if the interference is air-to-air only or if also the desired ground station is interfered (i.e. can communicate with the undesired aircraft).

2.4.4   Figure 5 shows the coverage (DOC) and the interference contours for Tamale and Ouagadougou on 118.100 MHz (Nos. 1 and 5 in Figure 8).

Figure 5 – Interference contours between Tamale (Ghana) and Ouagadougou (Burkina Faso)

Figure 5 shows the frequency assignment that is being tested (Tamale, Ghana; the red circle shows the coverage of Tamale TWR) against the interferer (Ouagadougou, Burkina Faso; the orange circle shows the coverage of Ouagadougou TWR)). The white segments show the interfered area (at 4000 ft. altitude above MSL).

2.4.6   The parameters for the tests are saved in the window "Summary Calculations" as shown in Figure 6. Tests can be re-evaluated later with the button "Redo calculations", taking into account any changes that have been made to the data base of frequency assignments at a later point in time.

Figure 6 – Summary of compatibility calculations.

2.5   New frequency or modified frequency assignments.

2.5.1   In a special window new/mod frequency, the user can modify an existing frequency assignment or introduce a new frequency assignment. Local users (States) can use this feature to test new frequency assignments for submission to ICAO for international coordination, as required. Regional Office can, when introducing modifications to existing or new frequency assignment, in addition update the ICAO global table of frequency assignments that is available on this ICAO website.

2.5.2   Figure 7 shows the box used to enter modifications to an existing frequency assignment (in case a new frequency assignment is to be entered, this box is empty). After the parameters to be modified (or, for a new frequency assignment, the necessary details) are entered, the modified frequency assignment can be tested with regard to compatibility with the frequency assignment plan. The user will be informed if the modifications are compatible.

2.5.3   This box allows for insertion of the uniform designated operational coverage (DOC) of services as well as for tailoring the DOC to specific operational requirements.

2.5.4   After all details for a new or modified frequency assignment have been entered and tested the user can decide to keep the modified (or new) frequency assignment in the data base as a draft entry and start coordination with ICAO and/or States. Keeping the draft entry in the data base is necessary to secure that later modifications to the frequency assignment plan take into account the modified (or draft new) frequency assignment. Alternatively, the user can enter the "draft" frequency assignment permanently in the data base.

Figure 7 – Box to enter modifications to an existing frequency assignment.

2.6   Search for a new (or alternative) frequency.

2.6.1   Frequency Finder offers the user the option to search for either an alternative frequency (in case modifications to an existing frequency assignment shows incompatibility with the frequency plan) or for a new frequency. Figure 8 shows the box that is to be used for searching for a new (or alternative) frequency assignment.

2.6.1.1 In the box Find Frequency the user can select the frequency range within which the search for an alternative (or new) frequency assignment should take place or select from the allotment table which has been established by each Region.

2.6.2.2 The user can select the number (from 1 – 10) of alternative frequencies that Frequency Finder should attempt to find. After the search is completed, Frequency Finder shows the number of compatible frequencies from which the user can select. The margin (distance) to the nearest co-frequency (or adjacent frequency) assignment is also shown. For efficient frequency assignment planning, the user should select the frequency with the smallest margin (*** indicates that within the circle with a radius of 1020 NM around the station that is being tested no co-frequency (or adjacent frequency) assignments are recorded in the frequency assignment plan).
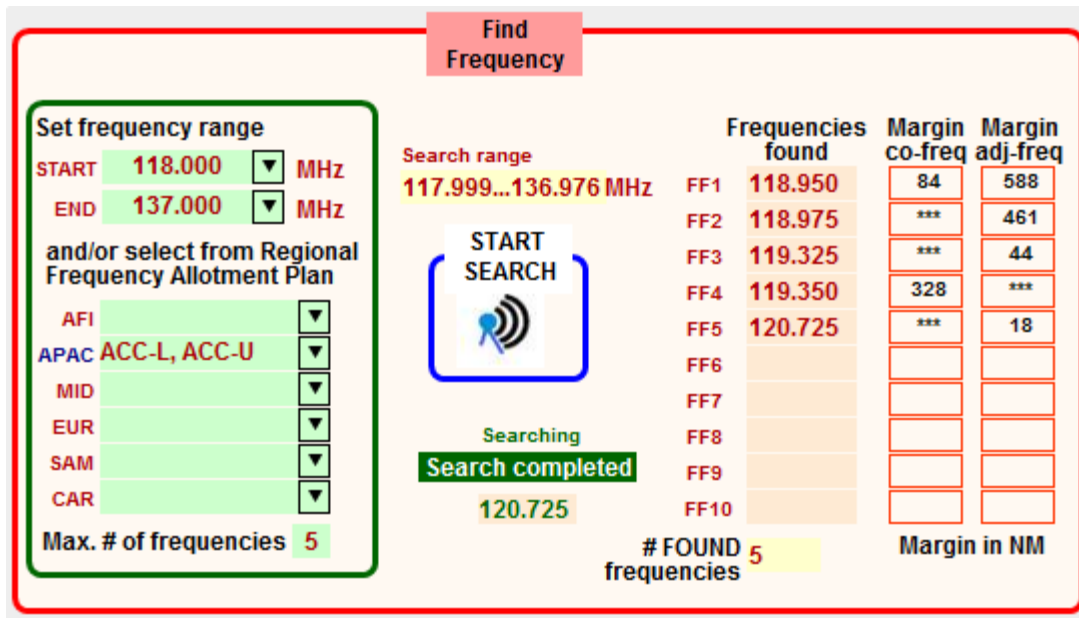

Figure 8 – Box in Frequency Finder to search for a new frequency assignment

3.   Use of Frequency Finder

3.1 In its final format, Frequency Finder is intended to provide a tool for use by ICAO Regional Offices and ICAO Contracting States for the management and coordination of frequency assignments and to generate and update the ICAO global frequency assignment plan. The configuration that is currently foreseen is as follows and summarized in Figure 9:

a) The program resides on the local computer used by States and Regional offices
b) The global data base of frequency assignments resides on the ICAO website (HQ)

c) The global database can be downloaded from the ICAO website and imported in the local version of Frequency Finder to enable the user access to the most current version of the global database.

d) States and Regional Offices can use the global database to assess compatibility between current frequency assignments and with new or modified frequency assignments.

e) The local data base can be updated (either manually or automatically) with the current version of the global database.

f) **Only Regional Offices** can update the global database with modifications to the database.

g) Coordination of new frequency assignments or modifications to existing frequency assignments is to be effected eventually with the Regional Offices for incorporation in the global frequency plan. Such coordination is to take place through regular means of communications (e.g. email). If so desired, a feature can be implemented in Frequency Finder that will automate the generation of these email messages.

Note 1: the European database of frequency assignments, which is developed using different programs, will be imported in the ICAO global data base (and in the format of the global ICAO database) at regular intervals. Such updates can be effected automatically or through manual intervention.
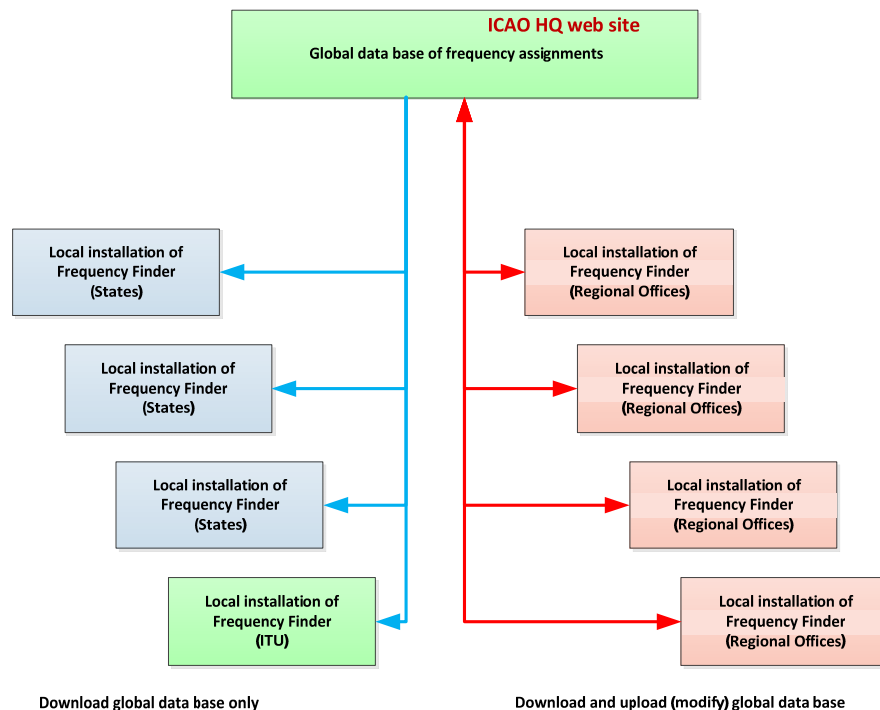
Figure 9 – Configuration for using Frequency Finder

4. **Global database.**

The global database includes a subset of the data contained in Frequency Finder and essentially includes the data currently available in the Regional ICAO com lists, with some extensions. The global database can be browsed with a regular web-browser and is presented as shown in Figure 10.

Include real screenshot of the global database in a web browser.

With the web-browser, the user can query the database. The user can also download the complete global database and insert it in Frequency Finder in order to use in frequency assignment planning the most current version of the global database.

5.   Further developments

5.1   VHF Air/Ground communication

5.1.1   Apart from modifications that may improve the user friendliness of Frequency Finder ongoing work concentrates on introducing the following functionality:

- Frequency planning for 8.33 kHz channel spacing (primarily for use in Europe)
- Coverage of ACC sectors (primarily for use in Europe)
- Identification of extended range stations (review of data base; all Regions)
- Identification of FIR sectors (review of data base; all Regions)
- Identification of errors in current data base (all Regions)

5.1.2   Further work on the calculation of buffer zones for areas services (and for VOR/DME keyhole coverage areas) as well as introducing the use of terrain data to better visualize on the map the

coverage of the VHF stations is necessary but cannot be completed with external resources being available.

5.2   VHF Navigation systems

5.2.1   Frequency Finder currently includes the global data base of frequency assignments for VHF navigation systems (ILS, VOR, DME, GBAS). Frequency assignment planning is based on the planning criteria that are being used in the Regional Offices outside Europe.

5.2.2   In conjunction with developing updated frequency assignment planning criteria for VHF NAV systems (ILS, VOR, GBAS and including also DME and VDL Mode 4) (for incorporation in the ICAO *Handbook on radio frequency spectrum requirements for civil aviation (Volume II)*) Frequency Finder is being updated to include these planning criteria. The use of Frequency Finder for frequency planning for VHF navigation systems will be aligned with the functions that have been introduced for the module for VHF air/ground communication systems.

5.3   LF/MF beacons and aeronautical HF bands

5.3.1   Initially, only the global data base for both LF/MF beacons (NDB and locator) as well as for HF air/ground communication frequencies will be introduced. At a later stage Frequency Finder will be updated with material that would enable using Frequency Finder for frequency assignment planning.

5.4   SSR Mode S Interrogator Identifier codes (SSR Mode S II codes)

5.4.1   Subject to agreement in the Aeronautical Surveillance Panel on planning criteria for SSR Mode S II codes, the module for that would enable Regions to coordinate and assign SSR Mode S II codes will be introduced in Frequency Finder.

5.5   eANP (electronic ANP) GIS Web Server mapping solution

5.5.1   Data from the frequency assignment plans that can be presented on maps is planned to be integrated in the development of the eANP GIS web server mapping solutions which are currently being developed in ICAO. Examples are the presentation of air routes (currently a provisional application for plotting on a map air routes has been inserted in Frequency Finder) and other data from the ICAO Regional Plans.

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