



**INTERNATIONAL CIVIL AVIATION ORGANIZATION**  
**Western and Central African Office**  
**Workshop on the Interconnection of Aeronautical Surveillance Systems**  
**(Dakar, 14 – 16 April 2014)**

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**Agenda Item 5: Interconnection of Aeronautical surveillance systems in the AFI Region**

**SSR Mode S assignment ICAO program for calculating and assignment SSR Mode S II-codes**

*(Presented by the Secretariat)*

**Summary**

This Information Paper presents a brief introduction to the ICAO programme for calculating and assignment SSR Mode S Interrogator Identifier (II) in order to minimize the interference which may occur in the operation of SSR Mode S stations.

**Action by the meeting is at Paragraph 3.**

**Reference:**

- Report on the 12<sup>th</sup> Meeting of the ICAO Aeronautical Surveillance Panel (ASP)
- ICAO Annex X Volume IV: Surveillance and anti-collision avoidance systems;
- ICAO Aeronautical Surveillance Manual (Doc 9924)
- ICAO Manual on the Secondary Surveillance Radar (SSR) Systems (Doc. 9684)

**Related ICAO Strategic Objectives: A: Safety; B: Air Navigation Capacity and Efficiency**

**Related ASBU Bloc 0 Modules, Performance Improvement Area:**

*PIA 2 - Globally Interoperable Systems and Data: BO FICE*

*PIA 3 - Optimum Capacity and Flexible Flights: BO ASEP; BO ASUR; BO OPFL; BO SNET*

*PIA4 - Efficient Flight Path: BO TBO*

**1. Introduction**

1.1 ICAO is in the process of completing the development of a program that can assist States and Regional Offices with for managing, coordinating and assigning SSR Mode S II-codes for SSR Mode S ground stations. Principles for the Mode S II-code utilization and the II-code assignment planning criteria, to be used in (international) coordination are presented in a separate paper. These planning criteria are based on the methodology that coverage areas for SSR ground stations, to which the same Mode S II code has been assigned, do not overlap.

*Note: the assumed coverage area used in the current program is 260 NM/45000 ft. (circular) for all SSR Mode S ground stations which is the maximum distance to the radio horizon for aircraft at an altitude of 450.000 ft. unless specified in the Regional ANP. The Aeronautical Surveillance Panel has developed criteria that would allow for the planning of SSR II codes based on the actual designated operational coverage as implemented in the ground radar stations. These criteria are generally less restrictive and are being implemented in the program.*

1.2 The program is using a draft global data base. This database has been extracted from information contained in the ICAO Regional Plans. However, not all States have submitted to ICAO the actual radar stations that are in operation or planned to operate or in a number of cases the required data is incomplete. This means that the use of the draft database in the current program *can only be used for demonstration purposes*.

1.2.1 The final format of the ICAO Global database with SSR Mode S II-code assignments will reside on the ICAO website, accessible to all ICAO Contracting States. Updating of the Global database will take place through the ICAO Regional Offices. States can access the information in the data base for planning and coordination activities. The SSR Mode S II-code assignment database is provisionally combined with Table CNS 4A (surveillance Systems) of the (electronic) Air Navigation Plan (eANP)

*Note: The data base (and in particular the coordinates and the height of the Mode S ground station) used in this program needs to be verified, corrected and completed by States, through the Regional Offices of ICAO.*

## 2 Principles of operation of the program

2.1 The program, when searching for compatible II codes at a specific location, first determines all SSR Mode S stations within a distance of 2040 NM from the [desired] SSR Mode S station. In the next step, the program calculates the separation distance between the desired station and each of the found stations. When the separation distance is less than 532 NM, the found station is not compatible with the desired station as at coverage areas (261 NM for each station) overlap. The II codes used by these [incompatible] stations are stored.

2.1.1 The distance of 532 NM is based on the need to secure proper operation of the SSR Mode S stations for aircraft at an [assumed] maximum altitude of 45000ft (FL 450) and includes a buffer of 10 NM as shown in Figure 1.

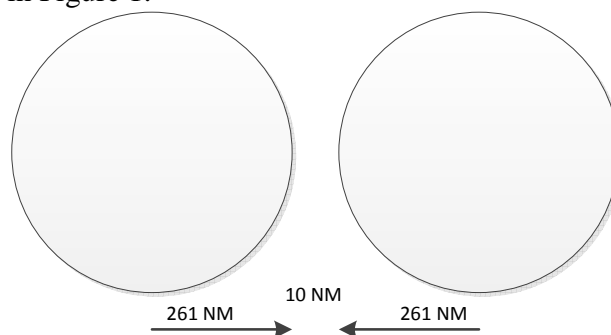


Figure 1

*Note: The minimum separation distance used is hard coded in the program. This is being modified to reflect the planning criteria as developed by the Aeronautical Surveillance Panel.*

2.2 In the next step, the program will look, from the available II-codes 1-15 for SSR Mode S II codes that have been assigned to stations within the range of 2040 NM from the desired radar station. From the calculated list of available and compatible SSR II codes, Frequency Finder selects the code that has already been assigned to the nearest [compatible] SSR Mode S station to improve the efficiency of the Mode S II code assignment plan.

## **Main functions of the program.**

### **3.1 Data base management.**

3.1.1 The program allows the user to query (search) the database, select (manually) SSR Mode S II-code assignments and check if these are compatible with other already assigned SSR II-codes. The program can also assign, automatically, SSR II-codes. Querying the database can be performed for individual countries, Regions, locations, and II codes. The results of the query can be printed, in the format of a [future] ICAO COM list, directly from the program or exported to Microsoft Excel or Adobe PDF files. A mechanism that would allow for the uploading of modifications to the Global database by the ICAO Regional Offices is in preparation.

### **3.2 Calculation and assignment of Mode S II codes.**

3.2.1 The program provides for the calculation of Mode S II-codes, taking into account the need to protect already assigned Mode S II-codes from harmful interference using the methodology that has been determined by the Aeronautical Surveillance Panel.

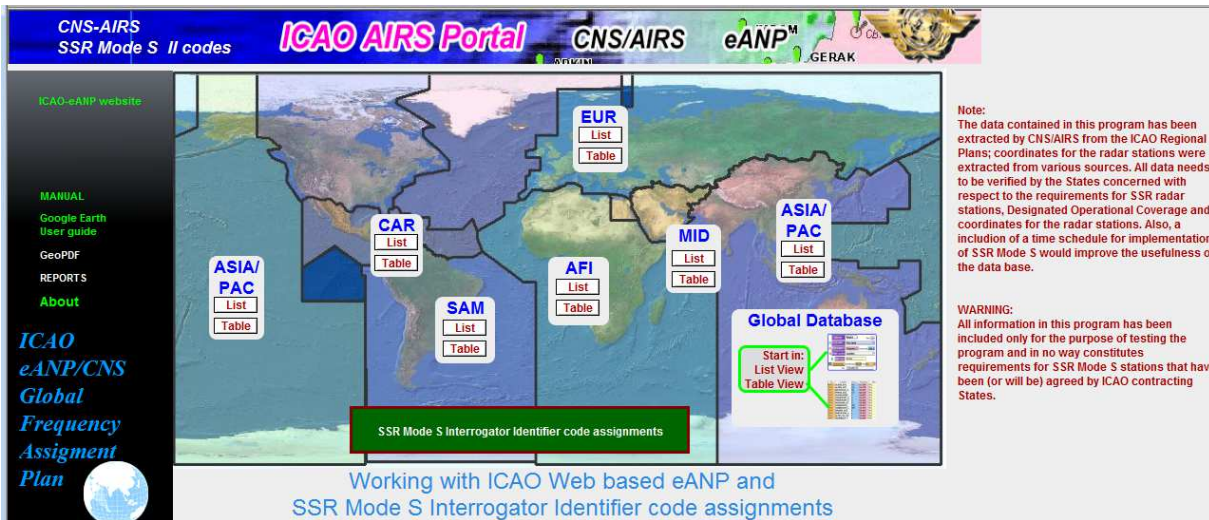
3.2.1 The program provides to the user the option to introduce (manually) a user selected Mode S II code. This is necessary for instance in the case that two (or more) SSR Mode S stations with overlapping coverage areas share the same II code and these stations use the ground linking mechanism that allows for using the same II-code in special cases.

### **3.3 Presentation of II codes on a map with Google Earth.**

3.2.1 The results of the query, calculation results and individual II-code assignments can be plotted on a map. Current provisions include the use of Google Earth. Presentation on the map provides for the plotting of the Designated Operation Coverage (DOC) for the Secondary Surveillance Radar only. In addition, on the basis of maximum and minimum flight levels applicable to the SSR Mode S service that is being provided, coverage contours representing the distance to the radio horizon around the SSR Mode S station at these flight levels can be plotted. These flight levels are user selectable.

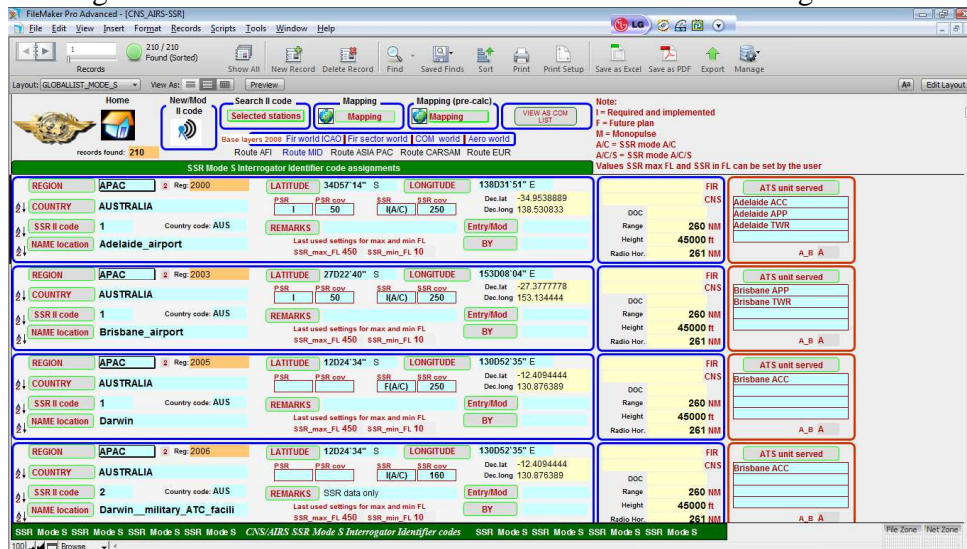
## **4. Operation of the program.**

4.1 When starting the program the following screen is displayed as the home page of the program.



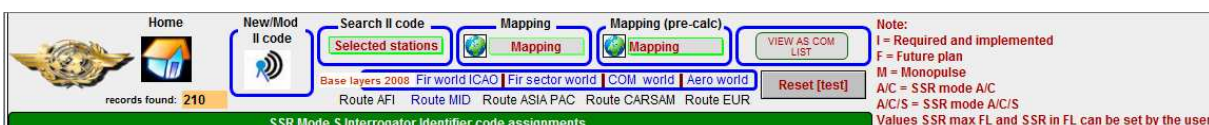
4.2 From this screen the user can select which group of records in the global database that contain radar data is to be presented.

4.3 Using one of the buttons AFI, ASIA/PAC, CAR, EUR, MID or SAM opens a new window where all radar data from the Regional Air Navigation Plans is being displayed. This includes SSR Mode S II code assignments that have been coordinated for each of these Regions.



4.4 Toolbar

4.4.1 The toolbar contains specific buttons / drop down menus specific for the functions of the program. These buttons allow the user to add a new SSR Mode S II code assignment, plot the details of the SSR code assignment on a map and export the queried database in a COM list style format. Below is an overview of this toolbar:

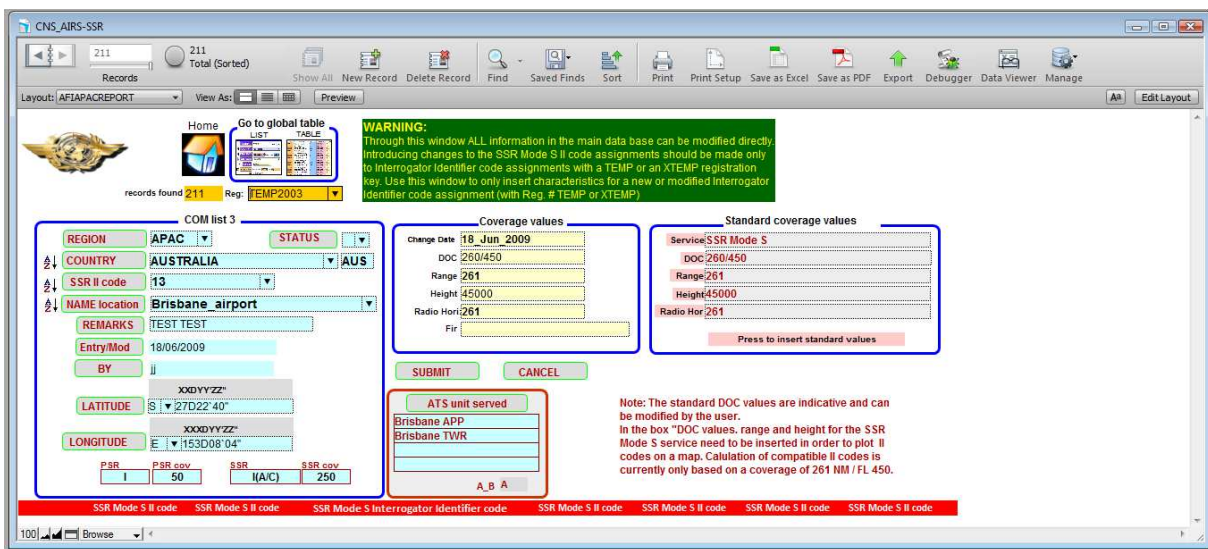


4.4.2 With the button Search II code, the user can search for a new II-code or modify an existing II-code for a single radar station or for a group of radar stations.

When the button Search II code is clicked, the relevant characteristics for the radar station can be entered or modified in a new window. Particularly relevant for the calculation of compatible II-code assignments is the designated operational coverage of the SSR Mode S system.

When the characteristics have been entered, the data can be submitted to the program that calculates or searches for a compatible II-code that can be assigned to the SSR Mode S station.

Alternatively, the user can select an II-code that can be tested for compatibility with other II-codes in the database.



#### 4.4.3 Calculation results

4.4.3.1 The calculation results are presented in the format as shown below is displayed:

Key	4011	II_code5	Range	260	Height	45000	Radio_Horizon	261	frdeglat	35.611666666666667	frdeglong	-6.655
Region	AFI	Full_name	ALGERIA	Location	Oran	Service			Sectorname			
Actual distance		N/A NM	Required dist.		N/A NM	Margin		0 NM		N/A		
Key	4039	II_code1	Range	260	Height	45000	Radio_Horizon	261	frdeglat	28.6	frdeglong	-17.755
Region	AFI	Full_name	CANARY ISLANDS (Spain)	Location	La Palma	Service			Sectorname			
Actual distance		964 NM	Required dist.		602 NM	Margin		362 NM		Compatible		
Key	4041	II_code3	Range	260	Height	45000	Radio_Horizon	261	frdeglat	28.535	frdeglong	-16.266666666666667
Region	AFI	Full_name	CANARY ISLANDS (Spain)	Location	Tenerife	Service			Sectorname			
Actual distance		899 NM	Required dist.		602 NM	Margin		297 NM		Compatible		
Key	4033	II_code5	Range	260	Height	45000	Radio_Horizon	261	frdeglat	27.855	frdeglong	-15.418333333333333
Region	AFI	Full_name	CANARY ISLANDS (Spain)	Location	Gran Canaria	Service			Sectorname			
Actual distance		884 NM	Required dist.		602 NM	Margin		282 NM		Compatible		



4.4.3.2 This window shows all SSR Mode S stations that were considered in the compatibility calculations which are all stations within the range of 2040 (only a selection is shown in Figure 4).

4.4.3.3 The window lists the minimum required separation distance between the desired station and the other stations in the list (which are all SSR Mode S stations within the range of 2040 NM with the desired station in the middle), the actual separation distance which is calculated by the program, the margin of the actual separation distance (a negative margin means that the station is not compatible with the desired station) and an indication whether or not the II-code of the station is compatible or not compatible with the desired station.

From this list, the program selects the compatible SSR Mode S II code with the shortest margin

## 5. Mapping

5.1 With the button *Mapping* (re. §4.4.1) the user can print on a map with Google Earth the coverage of the SSR station.

5.2 The final format of the presentation of this information is based on the SSR Mode S station being assumed as an isotropic radiator and does not take into account the specific vertical diagram (near cosecant squared) of typical radar antennas. As such, it presents coverage with is more optimistic than in practice and in terms of compatibility calculations for SSR II code, these are more conservative.

Example:

REGION	AFI	2 Reg: 4117	LATITUDE	09D33'00" N	LONGITUDE	000D51'00" W	FIR	Accra ACC
COUNTRY	GHANA		Status	Function Coverage	Status	Function Coverage	CNS	ATS unit served
SSR II code	15	Country code: GHA	PSR		SSR	II(A/C)	250	
NAME location	Tamale		REMARKS		Entry/Mod			
			Last used settings for max and min FL: SSR_max_FL 450 SSR_min_FL 250			BY		
							DOC	
							Range	260 NM
							Height	45000 ft
							Radio Hor.	261 NM

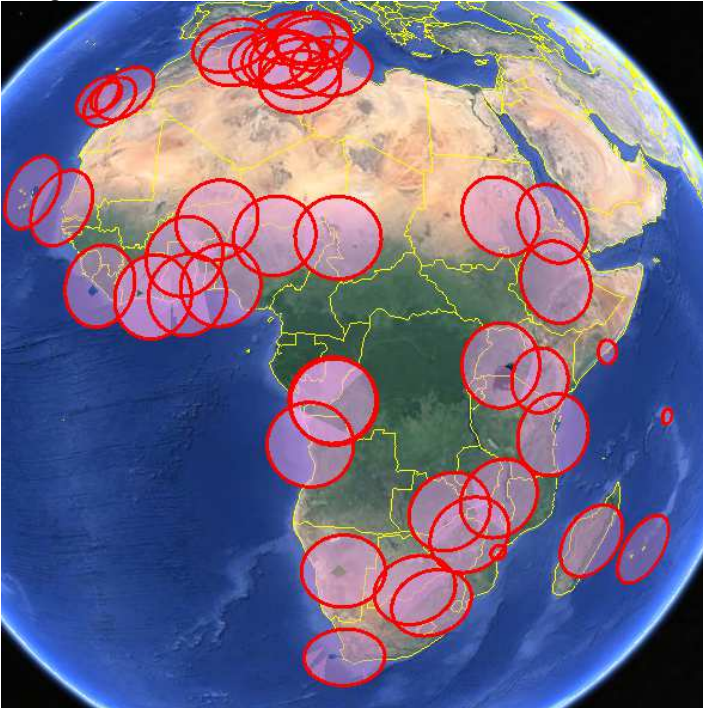
For the radar station in Ghana, Tamale, the designated operational coverage in the AFI Air Navigation Plan for the SSR has been promulgated at 250 NM.



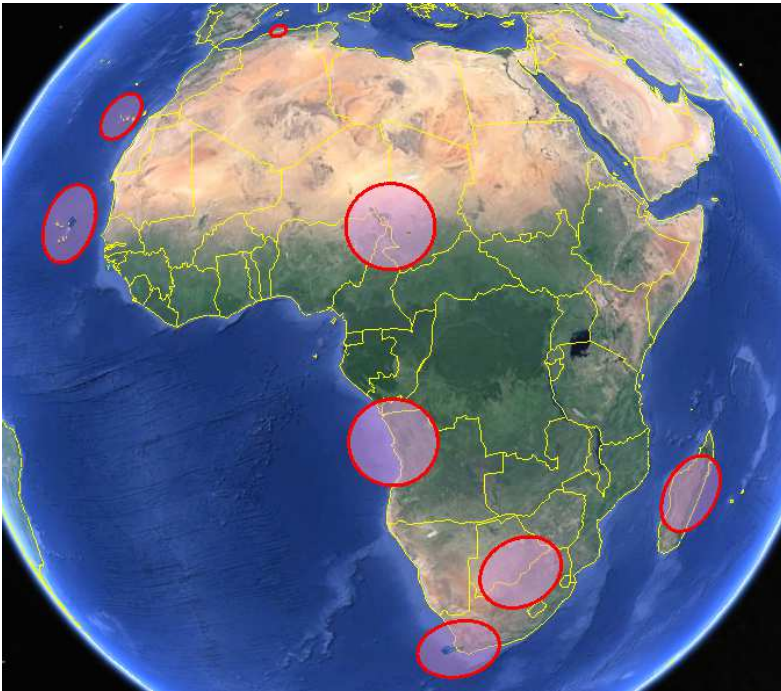
In the coverage of the SSR station is printed on the map in a red circle. The yellow circle presents the coverage of the primary radar at the maximum (assumed) flight level while the green circle presents the coverage at the (assumed) flight level 250. This provides a rough indication on the operational use that can be expected from this radar station.

*Note: The coverage of a primary radar station and a co-located (or associated) SSR Mode S station may be (significantly) different.*

An overview of all radar stations that are in the AFI Regional Plan and for which the program has assigned a **draft II-code** is presented below:



The Figure below presents an overview of all Mode S radar stations with the II-code 1 (one).



The absence of non-overlapping coverage areas for these stations indicates that the II-code assignments are compatible.

## **6. Present the radar data as COM list**

6.1 With the button “VIEW AS COM LIST” on the toolbar (re. §4.4.1) selected information from the database can be shown in COM list format as shown in the list below.

The list can be sorted in the order Country/Location/II code, Location/II code and II code/Country/Location

*Note: the information to be included in the final SSR Mode S II code list is still to be determined.*

*Currently, the PSR/SSR coverage areas and the “ATS Unites served” are not included. This information is contained in the ANP.*



Country	Abbr. Location	II code	Latitude	NS Longitude	WE Cat.	Status	Remarks	Key
CHINA	CHN Beijing_1	1	40004'08" N	116035'04" E			Mode S when	2059
CHINA	CHN Beijing_2	2	40004'08" N	116035'04" E				2062
CHINA	CHN Beijing_3	3	40004'08" N	116035'04" E				2063
CHINA	CHN Changsha	1	28011'48" N	113013'15" E				2068
CHINA	CHN Chengdu	2	30034'42" N	103056'49" E				2070
CHINA	CHN Chongqing	3	29043'09" N	106038'30" E				2072
CHINA	CHN Dalian	4	38057'56" N	121032'18" E				2074
CHINA	CHN Enshi	4	30016'59" N	109019'00" E				2076
CHINA	CHN Fuzhou	4	25056'06" N	119039'47" E				2078
CHINA	CHN Guangzhou_1	2	23023'33" N	113017'56" E				2080
CHINA	CHN Guangzhou_2	5	23023'33" N	113017'56" E				2083
CHINA	CHN Gullin_1	6	25013'05" N	110002'21" E				2086
CHINA	CHN Gullin_2	7	25013'05" N	110002'21" E				2088
CHINA	CHN Guiyang_1	8	26032'19" N	106048'03" E				2090
CHINA	CHN Guiyang_2	9	26032'19" N	106048'03" E				2092
CHINA	CHN Haikou	3	20001'00" N	110022'59" E				2094
CHINA	CHN Harbin	1	45037'24" N	126015'01" E				2096
CHINA	CHN Hefei	5	31046'48" N	117017'54" E				2098
CHINA	CHN Hohhot	5	40051'05" N	111049'26" E				2100
CHINA	CHN Jinan	6	36051'26" N	117012'59" E				2102
CHINA	CHN Kunming	5	24059'32" N	102044'36" E				2104
CHINA	CHN Lanzhou	8	36030'54" N	103337'12" E				2106

## 7 Action by the meeting

The meeting is invited to:

- a) Take not of the information given above
- b) Encourage ICAO to pursue the effort in the development and implementation of the programme for assignment of SSR Mode S II-codes for SSR Mode S ground stations.
- c) Recommend Sates to formally submit their query for assignment of SSR Mode S II-codes for SSR Mode S ground stations.

END