ITU World Radiocommunication Seminar

Additional Software tools

2-6 December 2024, Geneva, Switzerland

Additional software tools

EPFD Static

Coordination provisions under No. 9.7A and No. 9.7B

✓What are Very Large Earth Stations (VLES)?

Operating in space-to-Earth at 10.7-11.7 GHz, 11.7-12.2 GHz in Region 2, 12.2-12.75 GHz in Region 3, 12.5-12.75 GHz in Region 1, 17.8-18.6 GHz, and 19.7-20.2 GHz

And having

a) maximum isotropic gain greater than or equal to 64 dBi for the frequency bands 10.7-12.75 GHz or 68 dBi for the frequency bands 17.8-18.6 GHz and 19.7-20.2 GHz;

b) G/T of 44 dB/K or higher;

c) emission bandwidth of 250 MHz or higher for the frequency bands below 12.75 GHz or 800 MHz or higher for the frequency bands above 17.8 GHz

✓Specific very large earth station (under certain conditions) requires coordination under RR No. 9.7A with respect to any existing non-GSO satellite systems using the coordination triggers in RR Appendix 5.

✓Also, FSS non-GSO satellite systems requires coordination under RR No. 9.7B with respect to any large earth station (under certain conditions) using the coordination triggers in RR Appendix 5.

✓Coordination thresholds under Nos. 9.7A and 9.7B are using EPFD (equivalent-power flux density) levels produced by non-GSO FSS system to measure whether coordination between specific very large earth stations and non-GSO FSS is required.

Status of recording of very large earth stations under No. 9.7A

✓To date, there are 42 VLES from 3 administrations whose assignments are notified and recorded in the MIFR following coordination under RR No. **9.7A**. There are additional earth stations whose assignments are currently under RR No. **9.7A** coordination. These earth stations have assignments in either 12.2-12.75 GHz or 17.8-21.2 GHz (space-to-Earth) at limited number of geographical locations

✓All these earth stations are operating with GSO satellites having inclination up-to 8 degrees

✓The algorithm in Recommendation ITU-R S.1503-2 was developed based upon a reference GSO satellite in equatorial orbit with zero inclination angle. A GSO satellite system operating at other inclination angles is not modelled by the algorithm in the Recommendation.

✓The analysis under RR No. **9.7B**, is to determine if coordination is required by comparing against the trigger epfd value at 100% of the time when the antenna is pointed toward the wanted GSO satellite as indicated in RR Appendix 5. Therefore, other methodologies assuming non-zero GSO satellite inclination, e.g. the static calculation recommended in Recommendation ITU-R S.1714, can be used.

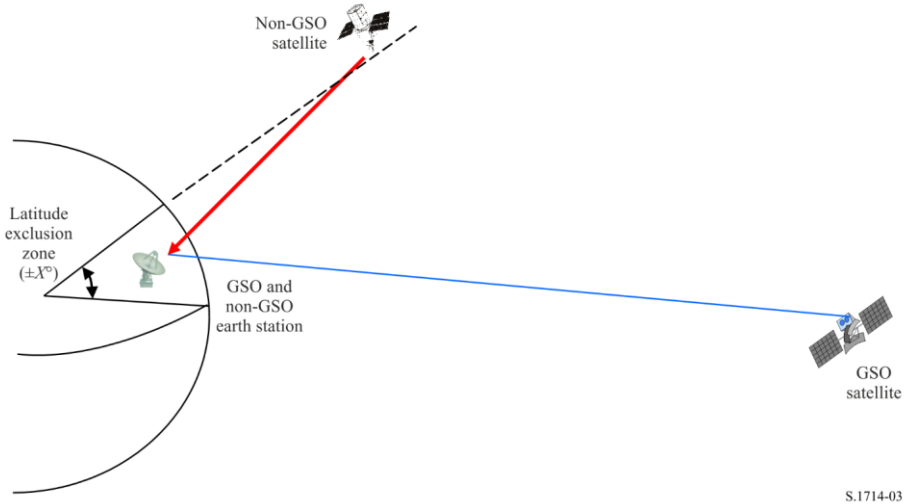
✓The Bureau uses the methodology of Recommendation ITU-R S.1714-1 to identify whether earth stations are affected under No. **9.7B** by the means of static calculations

Static geometries

Recommendation ITU-R S.1714-1 consider different geometries to calculate EPFD during in-line events or where EPFD can be at maximum

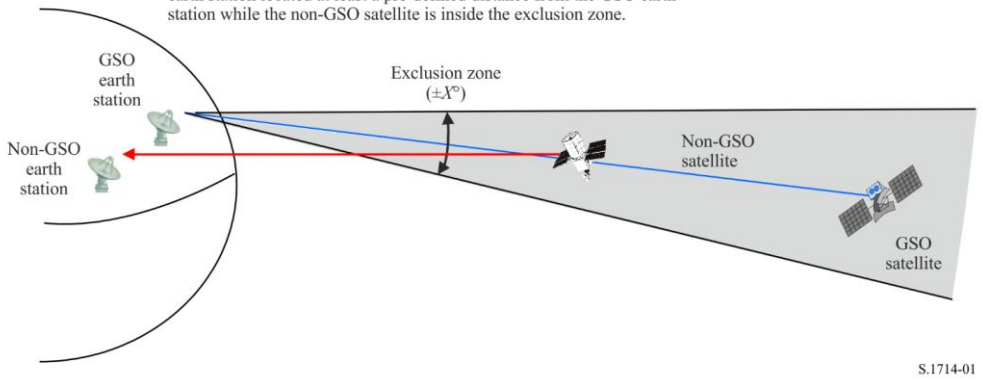
For HEO-type systems

Case 3: The non-GSO satellite cannot transmit when the sub-satellite latitudes is between a certain latitude range. For example, a medium earth orbit (MEO) would not transmit between + and – X^o latitude. A high earth orbit (HEO) would not transmit below + X^o latitude or above – X^o latitude depending on the hemisphere of the apogee.

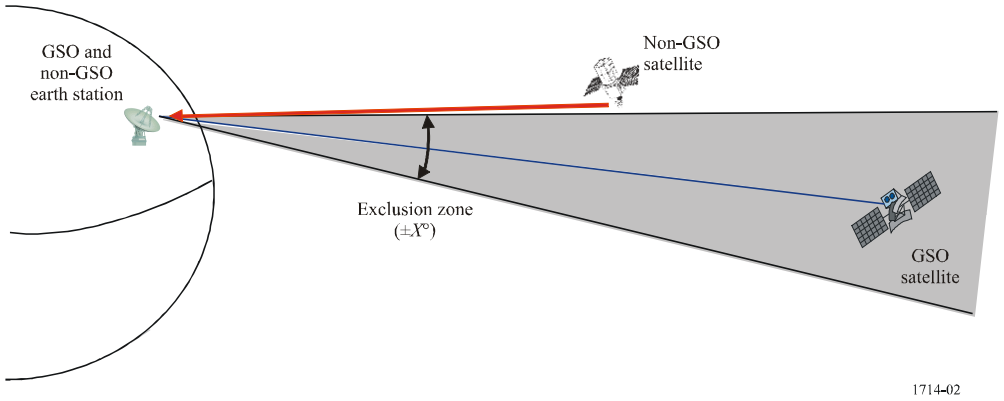


For LEO-type systems

Case 1: The exclusion zone is defined from the GSO earth station to ±X^o to the GSO arc and the non-GSO satellite **can** transmit to a non-GSO earth station located at least a pre-defined distance from the GSO earth station while the non-GSO satellite is inside the exclusion zone.



Case 2: The exclusion zone defined from the GSO earth station to ±X^o to the GSO arc. Non-GSO satellite **cannot** transmit while inside exclusion zone.



EPFD Static Software

EPFD Static software is implementing Recommendation ITU-R S.1714-1 to assess whether any VLES maybe potentially affected by a non-GSO FSS system.

Input data

The software is using the same data required for examination under Article **22** using EPFD validation software. This data comprises of two databases:

- PFD/EIRP mask data stored in MS-Access MDB format.
- Examination SRS-Data

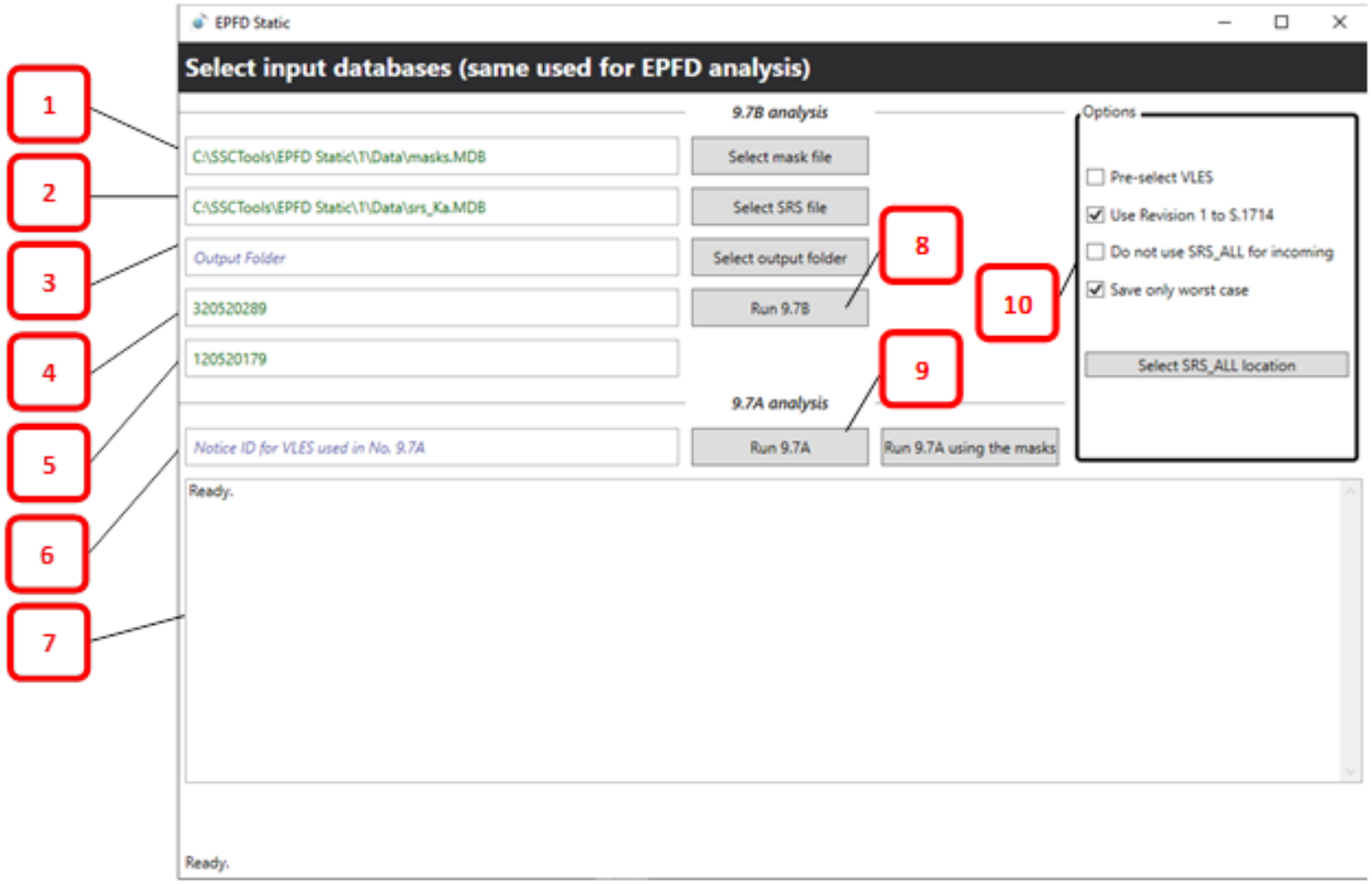
Same steps used to prepare the data for EPFD validation are applicable to prepare the data for EPFD Static software.

EPFD Prepare software could be used to prepare required databases.

In addition to these two databases ***EPFD Static*** software may need access to BR IFIC SRS database.

Overview of the interface

1. Input for mask database. Mask database can be selected by clicking **Select mask file.**
2. Input for examination SRS database. Examination SRS database can be selected by clicking **Select SRS file.**
3. Output folder for results. Can be selected by clicking **Select output folder**. If no selection is made, output files are saved in the same folder where input files are contained.
4. Notice ID of non-GSO FSS as contained Examination SRS Database
5. Notice ID of non-GSO FSS as contained BR IFIC SRS Database
6. Notice ID of VLES as contained BR IFIC SRS Database
7. Status window
8. Click to run 9.7B analysis.
9. Click to run 9.7A analysis.
10. Different optional settings



Additional Notes

Software offers two run scenarios.

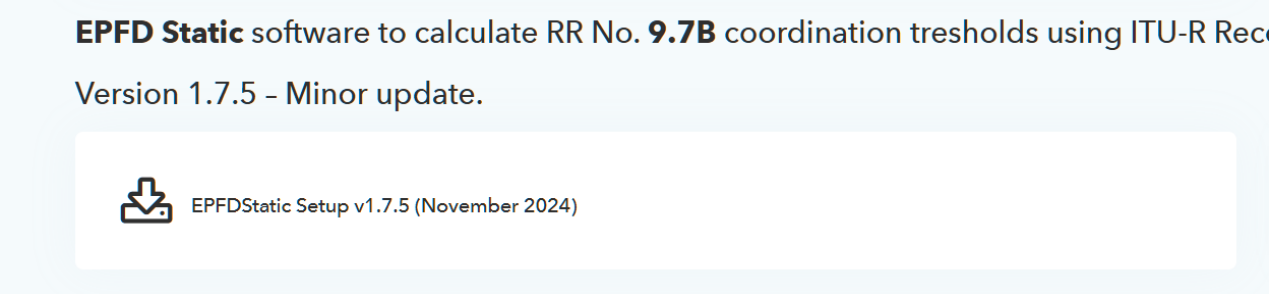
1. After specifying input databases, No. **9.7B** analysis can be conducted by clicking **Run 9.7B**.
2. It should be noted that notice Id of non-GSO FSS system specified in Examination SRS database (4) may be different from actual non-GSO FSS system if the system is already recorded and published in BR IFIC. In such case user need to specify actual notice ID in field (5).
3. No. **9.7A** can be conducted by clicking **Run 9.7A**. No input databases except BR IFIC SRS ALL is required for this analysis. Only frequency overlap is used in the analysis.

There are several options available:

1. Pre-select VLES. When checked, before running No. 9.7B analysis, the software will ask which VLES to be used in the analysis.
2. Use Revision 1 to S.1714. Checked by default and methodology described in Recommendation ITU-R S.1714-1 is used for calculations. If unchecked, the software will use the methodology presented in Recommendation ITU-R S.1714-0.
3. Do not use SRS_ALL for incoming. If checked BR IFIC SRS_ALL will not be used to extract incoming assignments.
4. Save only worst case. For each potentially affected VLES, the resulting Excel report would contain only the worst calculation pair and Recommendation ITU-R S.1714-1 Case. If unchecked, Excel report will include each applicable Case calculation and incoming assignment overlapping VLES frequency band.
5. Select SRS_ALL location – is used to specify location of BR IFIC SRS database. If location is not specified, upon running **No. 9.7B** analysis the software will ask for BR IFIC SRS database anyway.

Demo exercise

1. Extract demo files from **EPFD Static Exercise.zip**
2. You should have **srs.mdb and mask.mdb** files
3. Download EPFD Static from https://www.itu.int/epfdsupport/resources/



4. Run EPFDStatic Setup v.1.7.5.exe to install it.
5. Run EPFD Static from Start Menu

Demo exercise

1. Press '**Select mask file**' and choose mask.mdb
2. Select '**Select SRS file**' and choose srs.mdb
3. Check the option '**Do not use SRS_ALL for incoming**'
4. Run calculations by clicking '**Run 9.7B**'
5. Successful calculation should finish with information in status window:

```
141 stations taken for analysis
16 stations remain after the frequency overlap
Doing Rec. S.1714 analysis.
Analysis is done - results are written to E:\SkyDrive\_Mission\WRS2024\EPFD Static\124520024_97B(Calc).xlsx
Writing provn/tr_aff_ntw tables into E:\SkyDrive\_Mission\WRS2024\EPFD Static\124520024_97B.mdb
        Writing provision table...
        Writing affected network table...
        Writing affected network table for each group...
Remaining affected VLES using S.1714  -  16
Finished.
```

Demo exercise - Report

Two report files are created by default in the same folder where **mask.mdb** and **srs.mdb** reside.

EPFD_DEMO_Note.docx – indicates if any VLES was identified as unaffected, if any.

124520024_97B(Calc).xlsx – Excel spreadsheet containing results of the calculations.

Example:

E14

	A	B	C	D	E	F
26		Calculate long difference between non-GSO and Earth Station (degrees)	Δλn	-39.1490075	-39.14900748	If Δλ/φ>0 then acos[(cos(γn) - sin(φ) * sin(δ)) / (cos(φ) * cos(δ))] else -1*acos[(cos(γn) - sin(φ) * sin(δ)) / (cos(φ) * cos(δ))]
27		Calculate the sub-satellite longitude of the non-GSO at this az and el (degrees)	nGSO Long	94.58399423	94.58399423	earth Long + Δλn
28	**If satellite pfd masks are presented in Alpha vs Delta Longitude form**					
29	**Determine the resulting Alpha as measured from the geostationary orbital arc when the non-GSO is in conjunction with the inclined GSO at maximum inclination**					
30		GSO Arc Latitude (degrees)	GSO Lat	0	0	
31	Calculate the x,y,z components of the VLA latitude in ECF					
32		VLA x value (km)	VLA x	-4034.77422	-4034.774219	Re * cos(φ) * cos(earth Long)
33		VLA y value (km)	VLA y	4217.284143	4217.284143	Re * cos(φ) * sin(earth Long)
34		VLA z value (km)	VLA z	-2572.14091	-2572.140913	Re * sin(φ)
35	Calculate the x,y,z components of the GSO Arc in ECF					
36		GSOarc x value (km)	GSOarc x	5868.094629	5868.094625	Rg * cos(GSO Lat) * cos(GSO Long)
37		GSOarc y value (km)	GSOarc y	41753.66285	41753.66285	Rg * cos(GSO Lat) * sin(GSO Long)
38		GSOarc z value (km)	GSOarc z	0	0	Rg * sin(φ)
39	Calculate the x,y,z components of the non-GSO satellite at the latitude at which in-line conjunction with inclined GSO at maximum inclination occurs in ECF					
40		Non-GSO x value (km)	nGSO x	-1196.35552	-1196.355521	Rn * cos(δ) * cos(nGSO Long)
41		Non-GSO y value (km)	nGSO y	14921.44261	14921.44261	Rn * cos(δ) * sin(nGSO Long)
42		Non-GSO z value (km)	nGSO z	-3522.32615	-3522.326145	Rn * sin(δ)
43	Calculate Vectors needed to calculate Alpha as seen from GSO at maximum inclination					
44		VLA to GSOarc Vector (km)	VLA-GSOarc	38905.81508	38905.81508	Sqrt[(GSOarc x - VLA x)^2 +(GSOarc y - VLA y)^2+(GSOarc z - VLA zx)^2]
45		VLA to non-GSO Vector(km)	VLA-nGSO	11114.7866	11114.78659	Sqrt[(nGSO x - VLA x)^2 +(nGSO y - VLA y)^2+(nGSO z - VLA zx)^2]
46		GSOarc to non-GSO Vector (km)	GSOarc-nG	27969.29174	27969.29174	Sqrt[(nGSO x - GSOarc x)^2 +(nGSO y - GSOarc y)^2+(nGSO z - GSOarc zx)^2]
47		Alpha	Alpha	8.695112342	8.695112342	acos[((VLA to GSOarc Vector)^2 + (VLA to nGSO Vector)^2 - (GSOarc to nGSO Vector)^2)/(2*VLA to GSOarc Vector * VLA to nGSO Vector)]
48		Calculate the Delta Longitude between GSO and non-GSO (degrees)	delta	-12.5839942	-12.58399423	GSO Long - nGSO Long
49	Choose pfd from mask for latitude nearest to sub-satellite latitude of non-GSO, because the GSO VLA frequency bandwith					
50	is vary large there may be several sets of masks with overlapping frequencies, all of these should be added in					
51	Since this is an in line event the Gr(theta)/Gr(max) portion of epfd calculation is equal to 1 (numerical) or 0 dB.					
52		freq 1 pfd of non-GSO with Alpha = Alphai or X = 0 and delta	pfd1		-155.9097753	
53		Mask bandwidth (kHz)	BW		40	
54		Calculate Worst Case epfd (dBW/m^2/RefBW)	epfd		-155.9097753	
55		EPFD Threshold	Ap5		-202	
56		Threshold Reference bandwidth	refBW		40	
57		Excess (dB)			46.09022468	
58						
59						

Result indicate Excess of >46 dB. This particular VLES is affected.