User Guide

Equivalent Power Flux-Density Limits Validation Software
Test Version

BR ITU, January 2019

User Guide Version 2.0

Table of Contents

1 INTRODUCTION

Resolution **85 (WRC-03)** deals with the application of Article 22 of the Radio Regulations to the protection of geostationary fixed-satellite service and broadcasting-satellite service networks from non-geostationary fixed-satellite service systems.

Resolution **85 (WRC-03)** requires the Bureau to examine if the frequency assignments to:

a) FSS non-GSO satellite systems comply with the EPFD limits contained in Tables **22-1A**, **22-1B, 22-1C, 22-1D, 22-1E, 22-2 and 22-3** of RR Article **22**;

b) specific 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**; or

c) 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**.

Application of these provisions is based of verification of the EPFD produced by non-GSO satellite systems.

2 BACKGROUND FOR EPFD VALIDATION SOFTWARE TEST VERSION

This EPFD Validation Test package can be used by administrations to evaluate their filings with respect to the compliance with Article 22 EPFD limits and Nos. 9.7A/9.7B with respect to the non-geostationary satellites systems and/or prepare required data to be used for regulatory examination.

This package includes GIBC module to be used as an interface to launch EPFD-validation, two implementations of EPFD validation software, two test cases and this user guide.

2.1 Technical Approach

The EPFD engine is integrated into the ITU BR's software so it can be run as part of the checks on a filed network. The architecture is shown in the figure below:

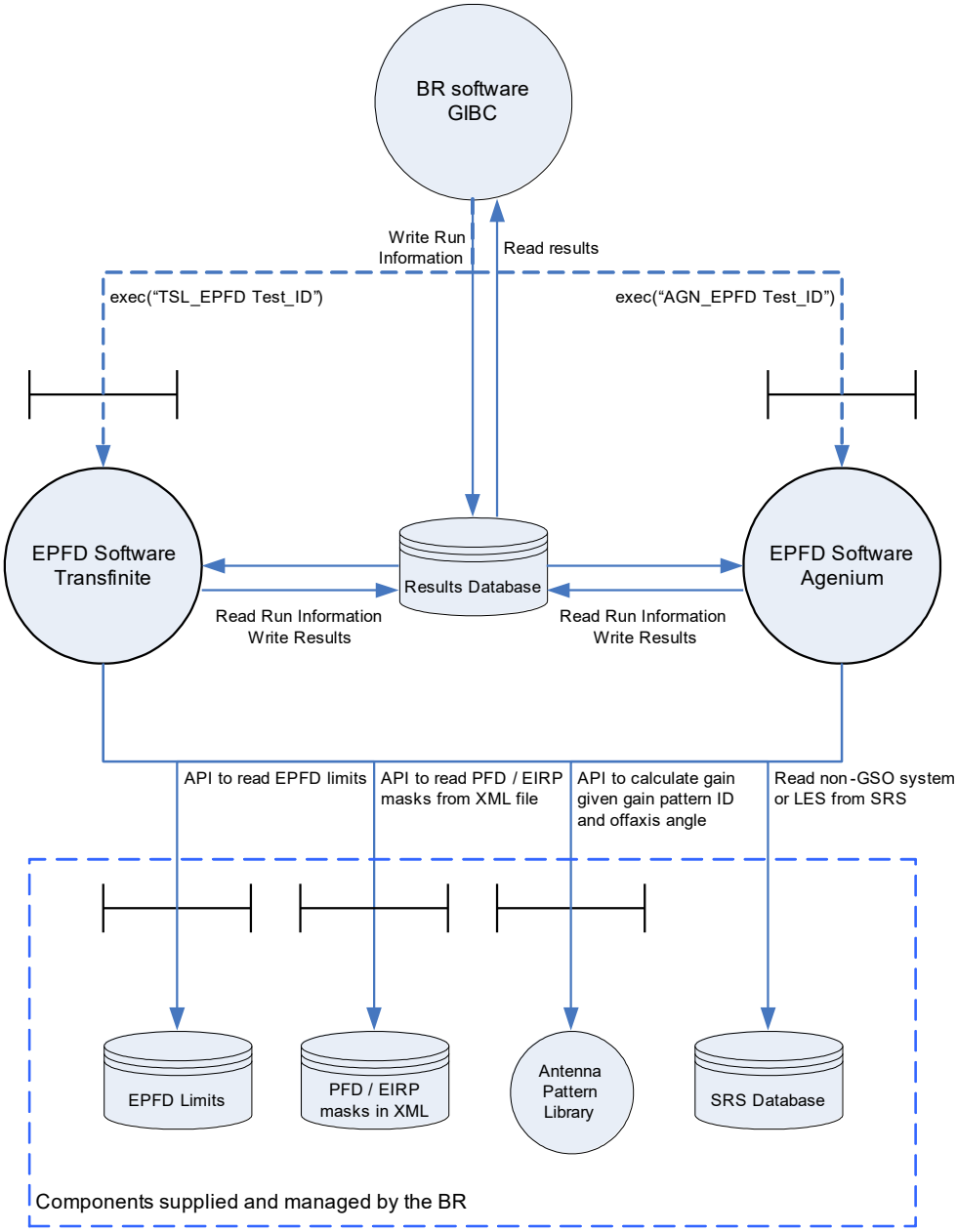

Figure 1: Software Architecture

2.2 Application of current EPFD Validation Software

EPFD validation software has been developed in accordance with Recommendation ITU-R S. 1503-2.

In a previous phase of development, a pair of implementations were developed that implemented the algorithm in S.1503-1.

The key changes between Recommendation ITU-R S.1503-1 and the revision in S.1503-2 were as follows:

Worst Case Geometry

- New WCG(down) algorithm

- New WCG(up) algorithm
- New WCG(IS) algorithm

Data Read Updates

- Read additional parameters from SRS
- Ensure match process to convert SRS database fields into orbit parameters
- Ensure can read new format of PFD and EIRP masks
- Ensure can read specific ES locations from SRS

Calculation Engine Updates

- Introduce ability to have ES EIRP masks vary by latitude
- Introduce ability to have satellite EIRP mask vary by latitude
- Introduce ability to handle PFD / EIRP mask bandwidth calculations
- Introduce ability to use specific ESs
- Updated algorithm for deployment of ES by density
- Other updates to the algorithm including selection of non-GSO satellite for EPFD(up)
- Set orbit model for equatorial non-GSO networks
- Ensure able to handle non-GSO systems using elliptical orbits
- Define resolution for alpha calculation
- Time step calculation update
- Run duration calculation update

These represented significant modifications, in particular the worst case geometry (WCG) was a highly complex algorithm involving separate procedures for different types of constellation.

The following five sets of systems were the basis for the testing and development:

Table 1: Test Cases considered under development

Type	Orbit shape	Equatorial ?	Repeating ?	ES locations
A	Circular	No	Yes	Typical (via density)
B	Circular	No	No	Typical (via density)
C	Circular	Yes	n/a	Typical (via density)
D	Elliptical	No	No	n/a
E	Elliptical	No	Yes	Typical (via density)
F	Polar Limited Coverage	No	Yes	Specific (exact location)

3 INPUT DATA USED IN THE PACKAGE

EPFD Validation Package is supplied with the test SRS database containing two non-geostationary networks and a number of very large earth station to run all types of examinations including Article 22, 9.7A, 9.7B.

It should be noted that the test-data contained in the package may not correspond to the data currently contained in SRS-database.

3.1 System Requirements

EPFD Validation Software Test Version should run on most newer PCs but the following table represents what is considered to be the minimum and recommended system specifications.

	Minimum	**Recommended**
CPU	2.0+ GHz Dual-Core	Intel Core i7+
RAM	2 GB	8+ GB
Operating System	Microsoft Windows Vista/7/8/10	Microsoft Windows 7 64 Bit
Hard Disk Space	500 MB	500+ MB

You will require “Administrator” privileges to install **EPFD Validation Software Test Version** and either “Standard User” or “Administrator” privileges to run GIBC and EPFD Tools.

3.2 Contents of the package and installation

The test-package contains:

1. Radiocommunication Bureau **GIBC** program containing an interface to EPFD Validation.
2. Data validation and manipulation tool **EPFDPrepare**
3. Results visualisation tool **EPFDResultsView**
4. Two separate EPFD Validation programs.

GIBC program is used by administrations and the Bureau to conduct technical/regulatory examinations of the satellite networks and/or earth stations. This includes but not limited to PFD calculation, coordination requirements examination, earth station AP7 contours calculation etc.

In order to install the package the following procedure should be followed:

1. Download **epfdpackage.exe** from the web-page:
   http://www.itu.int/ITU-R/go/space-epfd/en
2. Run **epfdpackage.exe** to extract contents and start global setup program. Follow setup instructions.
3. Global setup will run individual installations of Transfinite S1503-2 Analysis, Agenium EPFDvalidation Tool and GIBC. All three are required for the proper software functioning. Please note the location of installed executable files of Agenium EPFD and Transfinite S1503-2 Analysis. This may need to be indicated in GIBC interface.
4. Before running installation of **Transfinite S1503-2 Analysis** and **Agenium EPFDvalidation Tool**, please make sure that previous versions are uninstalled first.
   Go to Start -> Control Panel -> Program and Features -> Uninstall **EPFDvalidation** and Uninstall **S1503-2 Analysis 5.XX.XX**
5. Depending the version of the Windows Operating System, by default, EPFD tools are installed into the following folders.

   For Agenium EPFD the default location is:

   Running on **32 bit** Windows -
   c:\Program Files\Agenium\EPFDvalidation\EPFDvalidation.exe
   Running on **64 bit** Windows -
   c:\Program Files (x86)\Agenium\EPFDvalidation\EPFDvalidation.exe

   For Transfinite S1503-2 Analysis the default location is:

   Running on **32 bit** Windows –
   c:\Program Files\S1503_2Analysis\Program\S1503_2.exe
   Running on **64 bit** Windows –
   c:\Program Files (x86)\S1503_2Analysis\Program\S1503_2.exe

6. Step-by-step installation:

Select installation modules:

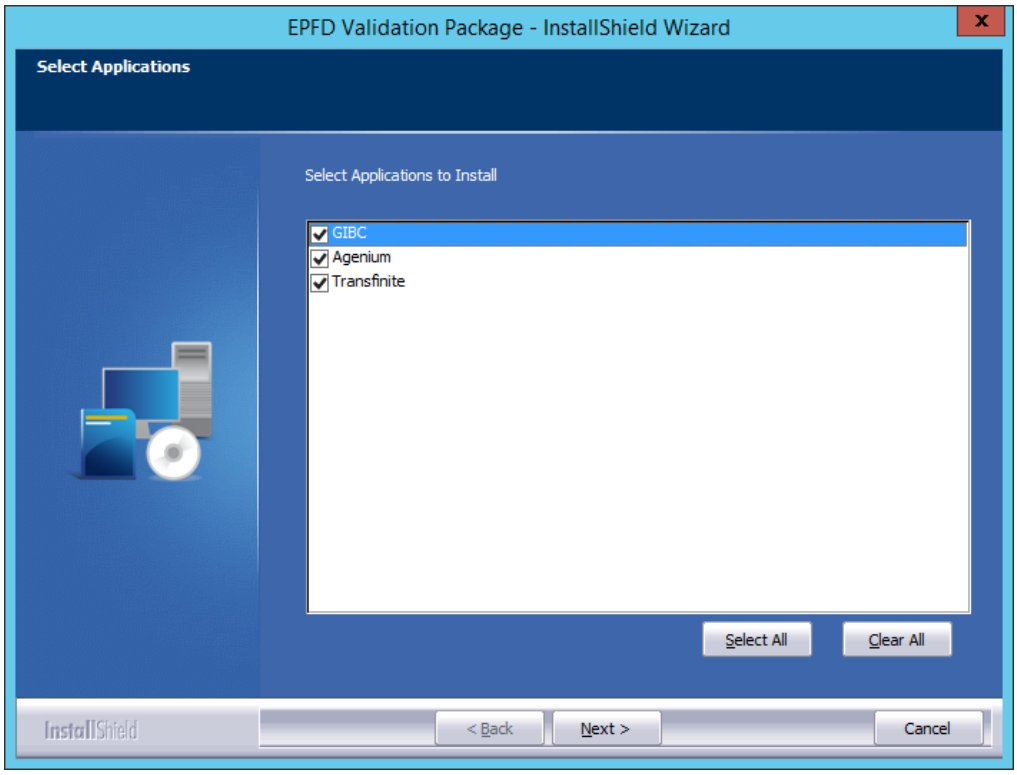

Figure 2: Selecting modules to install

Advance to GIBC installation:

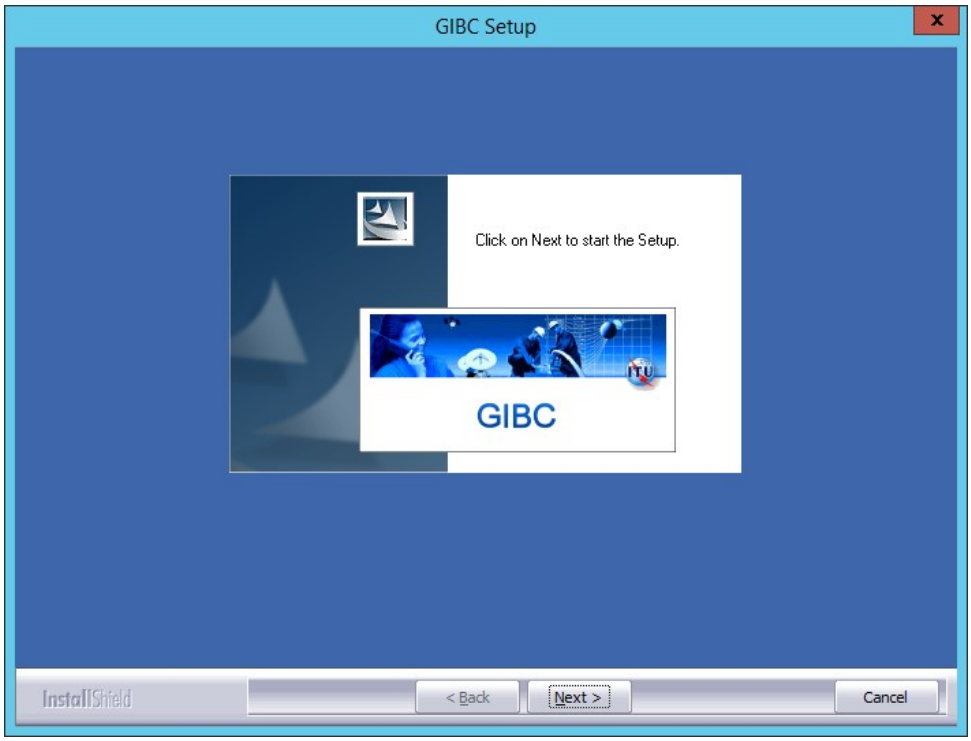

Figure 3: Install GIBC

Advance to Agenium EPFDvalidation setup:

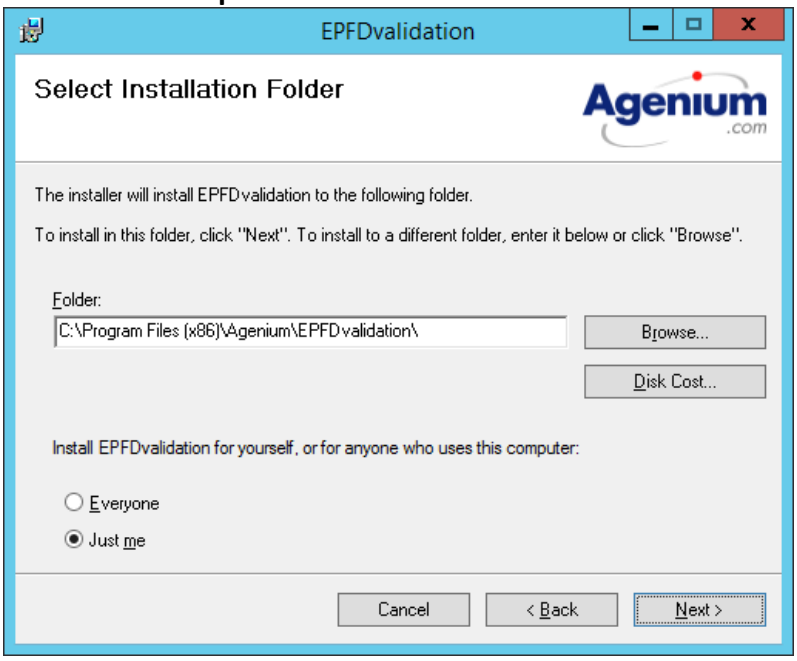

Figure 4: Install Agenium EPFDvalidation

Advance to Transfinite S1503-2 Analysis setup:

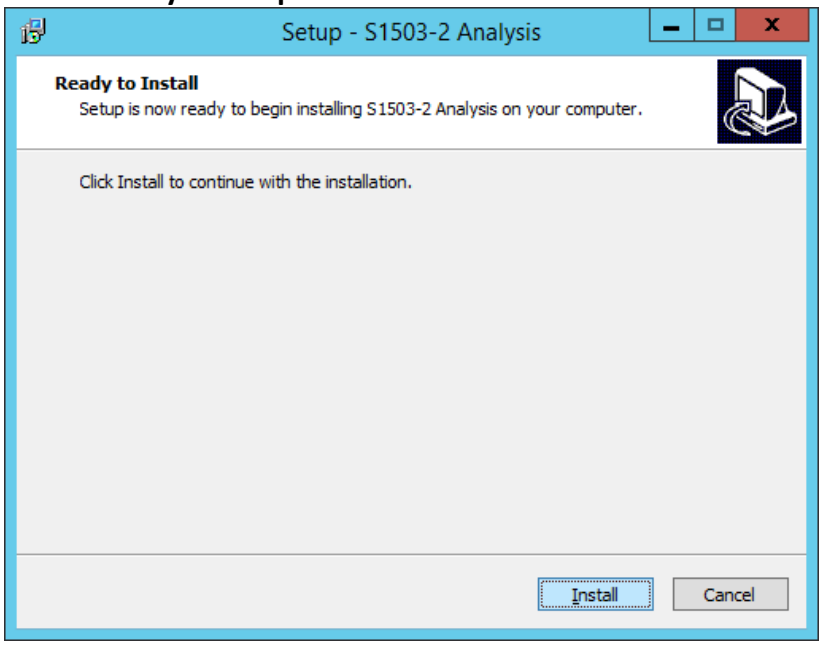

Figure 5: Install Transfinite S1503-2 Analysis

7. After the setup is finished, the following instruments could be located on the client machine:

   C:\BR_SOFT\EPFDTest

   This folder contains the following:

   EPFD_Test_Data.mdb - test SRS-data.

   EPFD_Test_Masks.mdb - PFD/EIRP mask data packed in database.

   C:\BR_SOFT\EPFD

   This folder contains the following:

   EPFD_limits_RES85.mdb - EPFD Limits Database containing information on applicable regulatory limits.

   EPFDPrepare.exe - Data validation and manipulation tool EPFDPrepare is launched through GIBC or could be launched as stand-alone tool from Start Menu:

   Start -> Programs -> BR Space Applications -> GIBC -> EPFDPrepare

   EPFDResultsView.exe - Results visualisation tool EPFDResultsView is launched through GIBC or could be launched as stand-alone tool from Start Menu.

   Start -> Programs -> BR Space Applications -> GIBC -> EPFDResultsView

8. **Agenium EPFDvalidation tool** and **Transfinite S1503-2 Analysis** can be run individually without using common GIBC interface. For the information on user interface of these tools please refer to their respective manuals:

   For Agenium EPFDvalidation Tool:

   c:\Program Files\Agenium\EPFDvalidation\Documents\UserManual.pdf

   or

   c:\Program Files (x86)\Agenium\EPFDvalidation\Documents\UserManual.pdf

   For Transfinite S1503_2 Analysis:

   c:\Program Files\S1503_2Analysis\Program\S1503_2_Software_Installation_and_User_Guide.pdf

   or

   c:\Program Files (x86)\S1503_2Analysis\Program\S1503_2_Software_Installation_and_User_Guide.pdf

4 RUNNING EPFD VALIDATION PACKAGE

Run GIBC: **Start -> Programs -> BR Space Applications -> GIBC -> GIBC**

Switch to tab EPFD to open the main interface of EPFD Validation Package. All the tools can be launched from here.

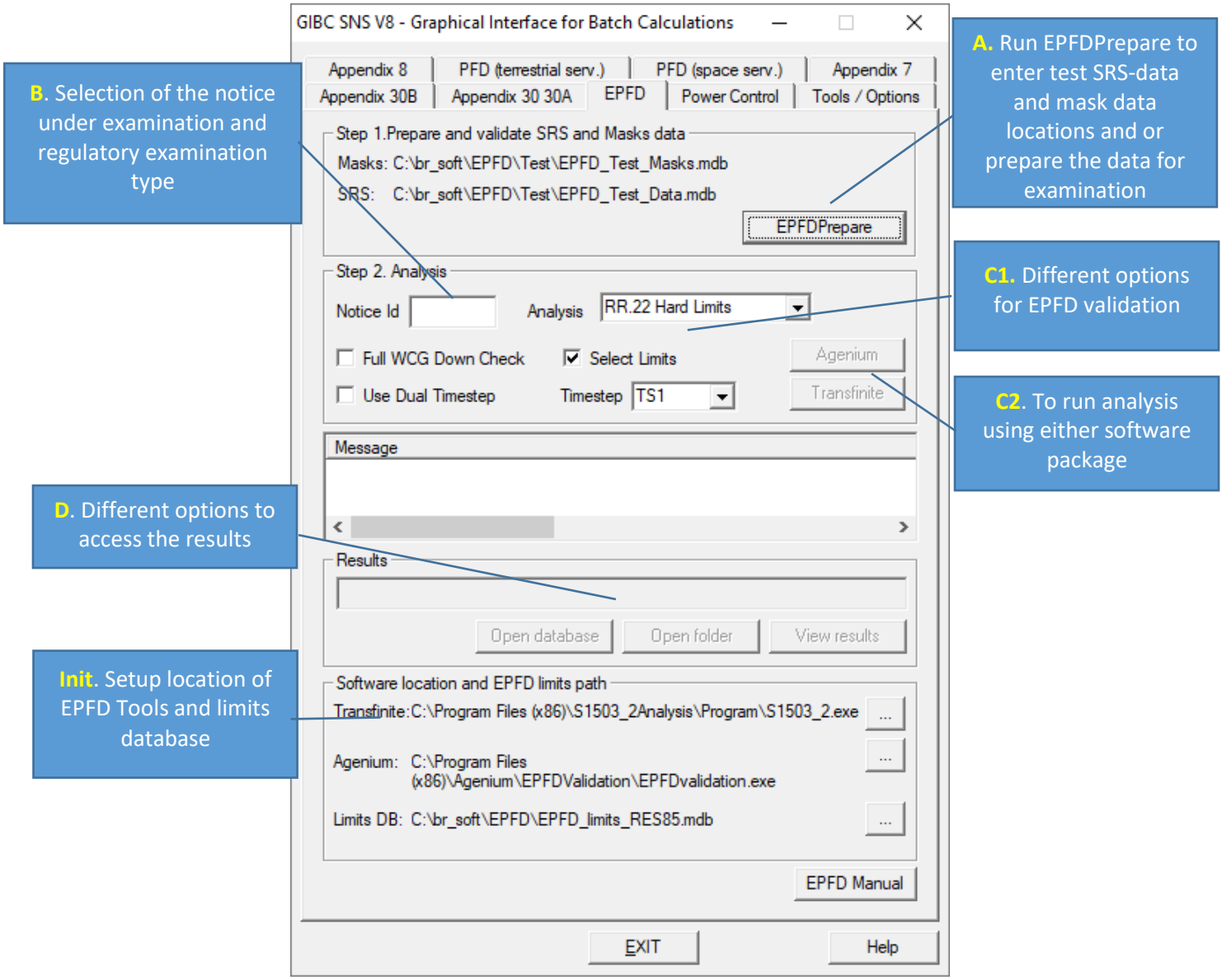

Figure 6: GIBC EPFD Start Screen

Setting up options

Before running any examination, all the options indicated in the block **Init** needs to be properly set:

- Setup location to EPFD Tools executable ***EPFDvalidation.exe*** for Agenium, ***S1503_2.exe*** for Transfinite, if needed.
- Setup location EPFD Limits database.

Selecting Input Databases

Next step is to select input databases containing:

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

Press ***EPFDPrepare*** button. ***EPFDPrepare*** will launch:

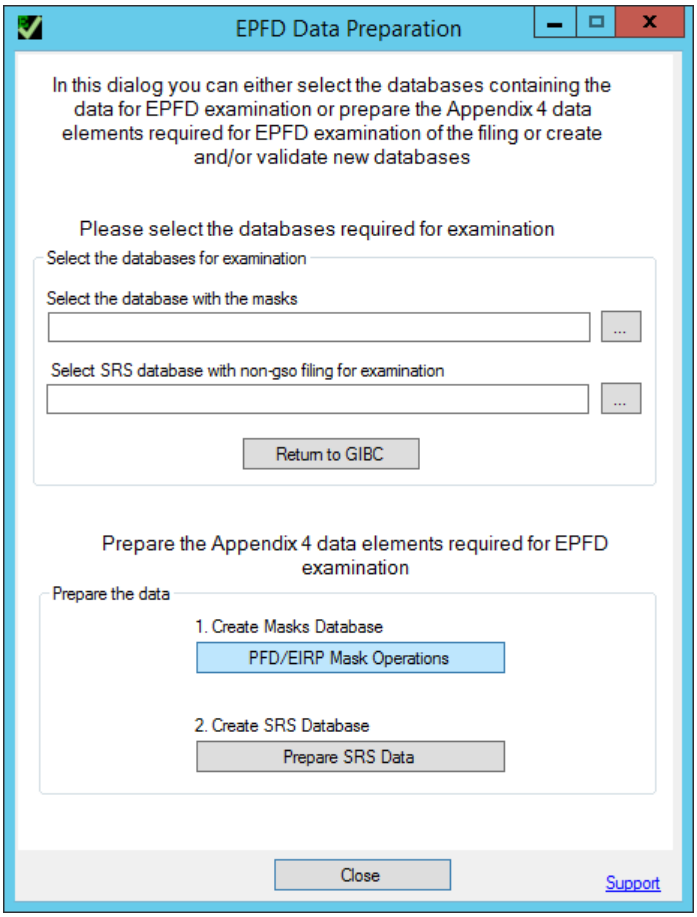

Figure 7: EPFDPrepare Start Screen

Select required databases and press ***Return to GIBC***:

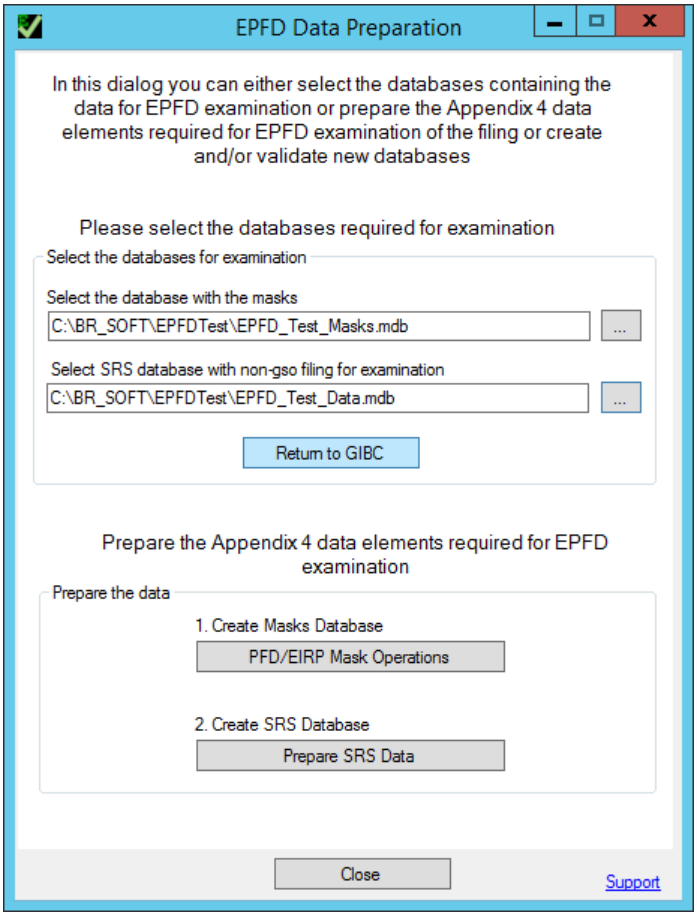

Figure 8: EPFDPrepare database selection dialog

For other functions of ***EPFDPrepare*** see section **5** below.

Selecting Scenario

Examination scenario can be chosen in block **B**.

- For Article 22 and No. 9.7B examination the following notices could be examined using test-database:
  - 101
  - 102
- For No. 9.7A examination the following notices (very large earth stations) could be indicated:

ntc_id	stn_name	ntc_id	stn_name
96520567	JDFPG-A3	100520518	BUCKLEY1-KA2
96520568	JDFPG-A4	100520519	BUCKLEY2-KA2
96520569	JDFPG-A5	100520527	DCEETA-KH2
96520570	JDFPG-A6	100520533	DCEETA-KA2
96520571	BUCKLEY1-W1	102520593	SPECIFIC UK KU-2B

ntc_id	stn_name
96520572	BUCKLEY1-W2
96520573	BUCKLEY2-W1
96520574	BUCKLEY2-W2
96520575	DCEETA-E1
96520576	DCEETA-E2
96520577	DCEETA-E3
96520578	DCEETA-E4
96520579	DCEETA-W1
96520580	MENWITH HILL-A1
96520581	MENWITH HILL-A2
96520582	MENWITH HILL-E1
96520583	MENWITH HILL-E2
96520584	MENWITH HILL-E3
96520585	MENWITH HILL-E4
96520586	DCEETA-W2
99520563	JDFPG-1A
99520564	JDFPG-2A
99520565	JDFPG-3A

ntc_id	stn_name
102520594	SPECIFIC UK KU-1B
107520322	JDFPG-4BKA
107520323	JDFPG-4BKU
108520079	NHTS-A1
108520080	KAU-W1
108520081	KAU-W2
108520082	FTIRWIN-W1
108520083	FTIRWIN-W2
108520084	NHTS-E1
108520085	NHTS-E2
108520086	NHTS-E3
108520087	NHTS-E4
108520088	NHTS-W1
108520089	NHTS-W2
108520090	NHTS-H2
99520566	MENWITH HILL-2A
99520567	MENWITH HILL-1A

Selecting additional options

Setup additional options for examination in block B1.

- ***Use Dual Timestep*** option to improve simulation performance (see Section 4.7, Part D, ITU-R Recommendation S.1503-2).
- ***Full WCG Down Check***. The Worst-case geometry on downlink (WCG Down) calculation can take a significant amount of time to complete. To increase calculation performance, by default, the latitude step size of 1 degree will be used, if it less than PFD mask step size.
- ***Select Limits*** option to preselect Article 22 limits, which are to be examined.
- ***Timestep*** Normal or TS1. Use TS1 to reduce simulation time steps.

Running examination

After everything is ready, press ‘Agenium’ or ‘Transfinite’ in block C2 to run corresponding EPFD Tool.

Calculations are started automatically and once EPFD validation finishes, it may be required to close the dialog by pressing ‘Ok’ or ‘Close’ in EPFD validation tools dialog window.

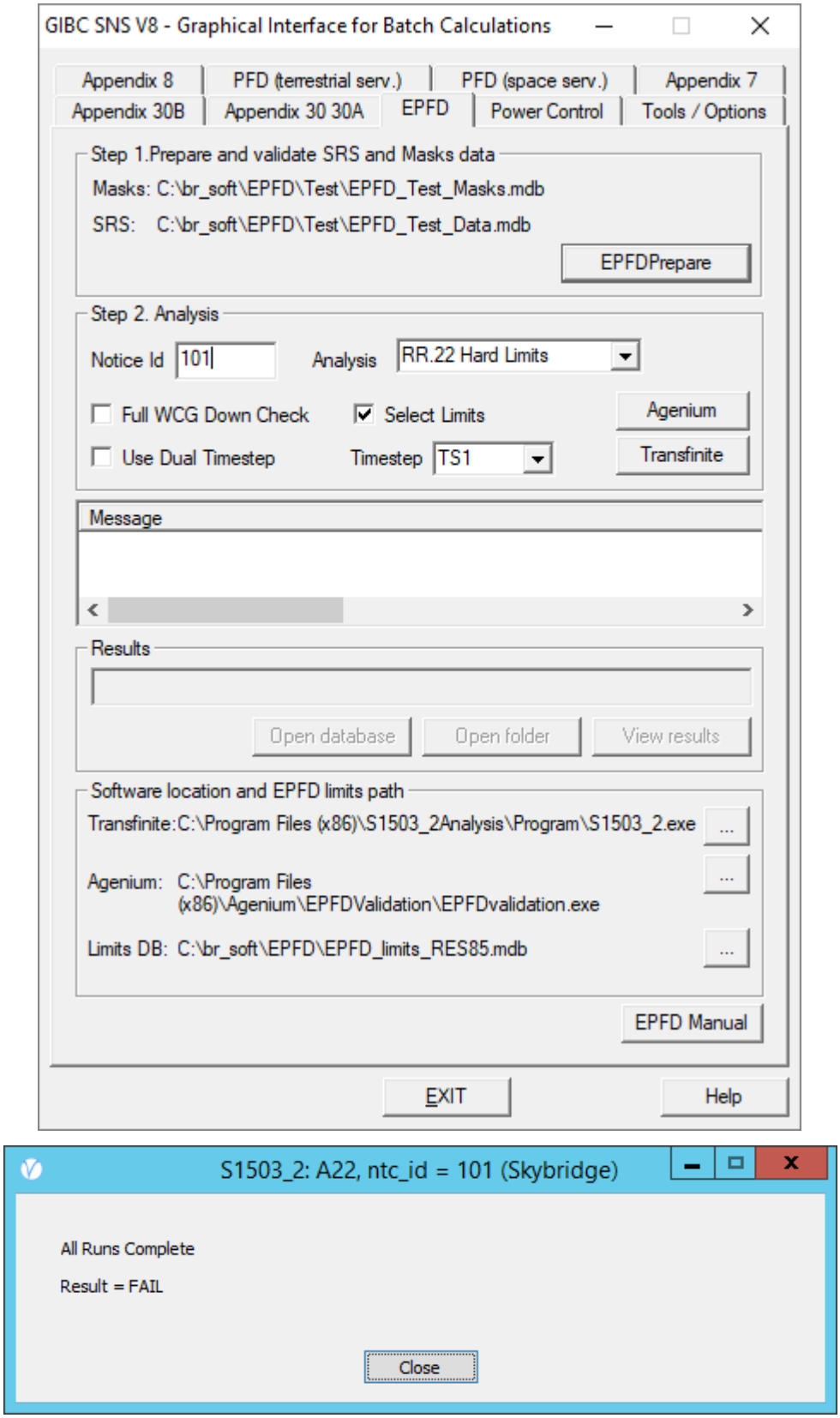

Figure 9: Start and completion of examination

For each examination run, GIBC generates results database located in the following folder:

C:\BR_TEX_RESULTS\EPFD\[NOTICE_ID]\[DATE_TIME_STAMP]\EPFDRESULTS.MDB

Results database contains the definition of the runs as well as the results returned by the two software tools.

Description of the format is contained in Annex 1.

Viewing the results

After the analysis is finished, user is presented with several options to review the results:

1. Open the database containing the results
2. Open a folder containing a database with the results.
3. Launch ***EPFDResultsView*** utility to review results in details by clicking View results in block **D**.

Viewing the results in EPFDResultsView utility

Once the utility is launched through GIBC interface, a list of results corresponding to each of the applicable limits is presented.

For Article 22 examination, every results in this list may be characterized by direction of transmission, service, frequency band, reference GSO earth station antenna pattern, antenna diameter and reference bandwidth.

Each of the results can be reviewed to check **Pass/Fail** status, check cumulative distribution function or details of examination.

Pass/**Fail** status is established both for Article 22 calculations and 9.7A/9.7B coordination triggers. For Article 22 '**Fail**' status means that EPFD hard-limits are exceeded; in 9.7A/9.7B examination it would indicate that there is an affected non-GSO network or earth station.

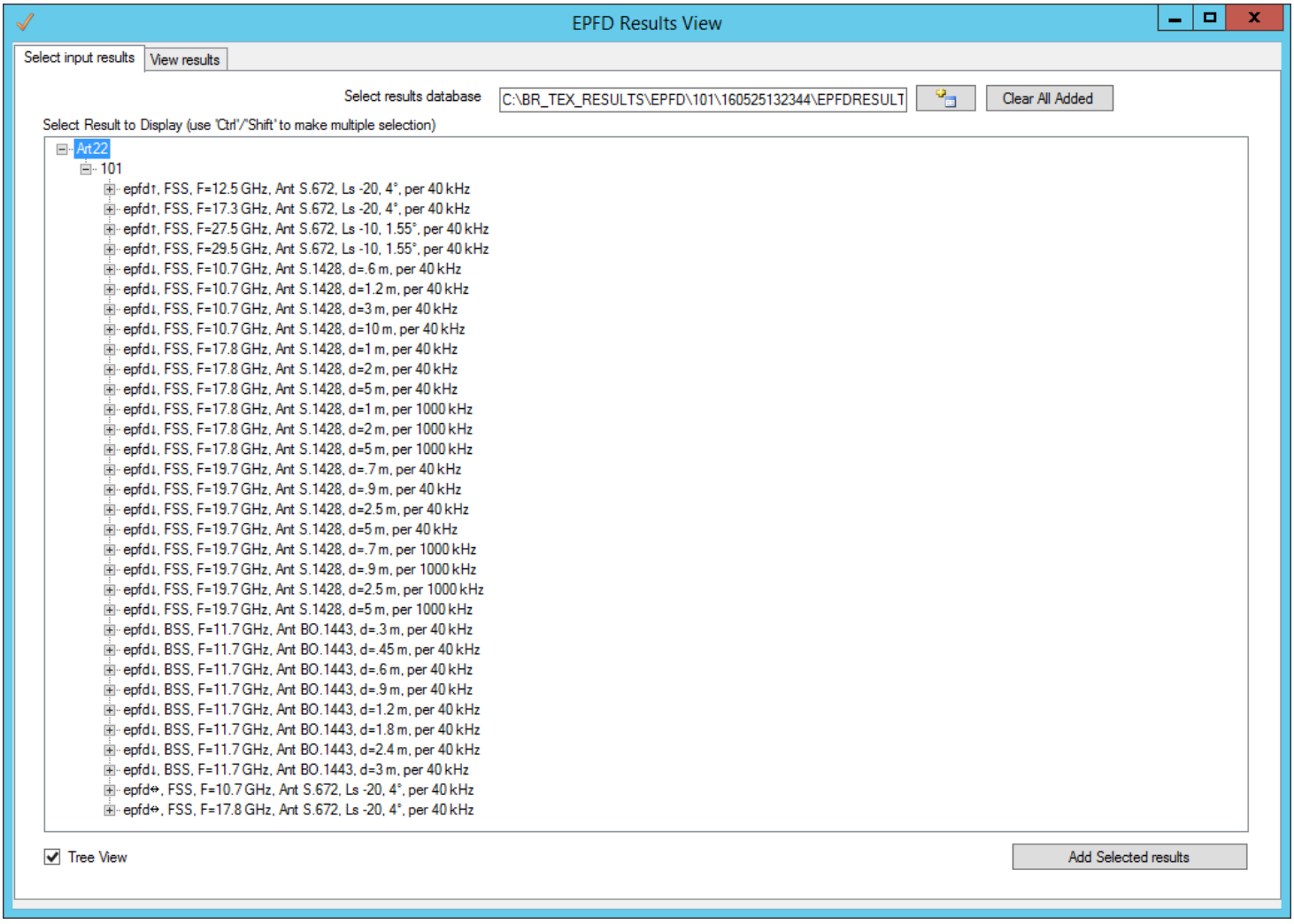

Figure 10: Selecting results review

To get more detailed overview, one or several results under the interest can be selected. To select multiple results make a selection of different entries using Control key and clicking each of the results. To proceed with the review after the selection, press the button **Add Selected results** and navigate to **View results** tab.
The dialog on **View results** tab allows more detailed examination of each of the results.

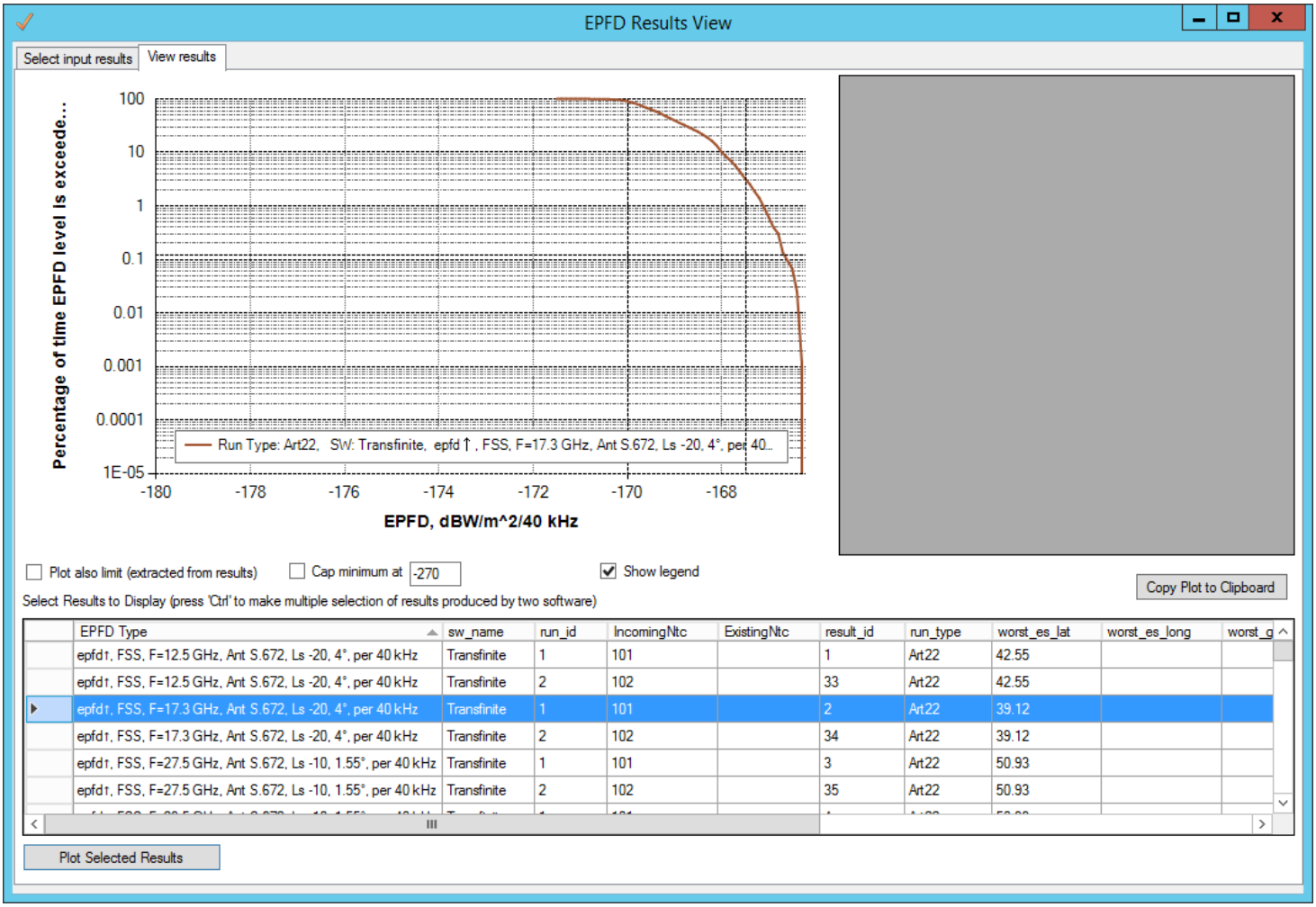

Figure 11: Displaying resulting CCDF

Complementary Cumulative distribution function[1] (CCDF) for each of the results could be plotted individually or combined with other results.

EPFDResultsView can be launched separately from Start Menu.

It is possible to open results files one by one and select the results of different runs and then compare the results coming from different databases by plotting them together. This could be used to compare the results obtained using two different EPFD validation tools.

[1] CCDF computes the power complementary cumulative distribution (CCDF) function from a time domain signal. The CCDF curve shows the amount of time a signal spends above the power level of the calculate signal, or equivalently, the probability that the signal power will be above the given power level.

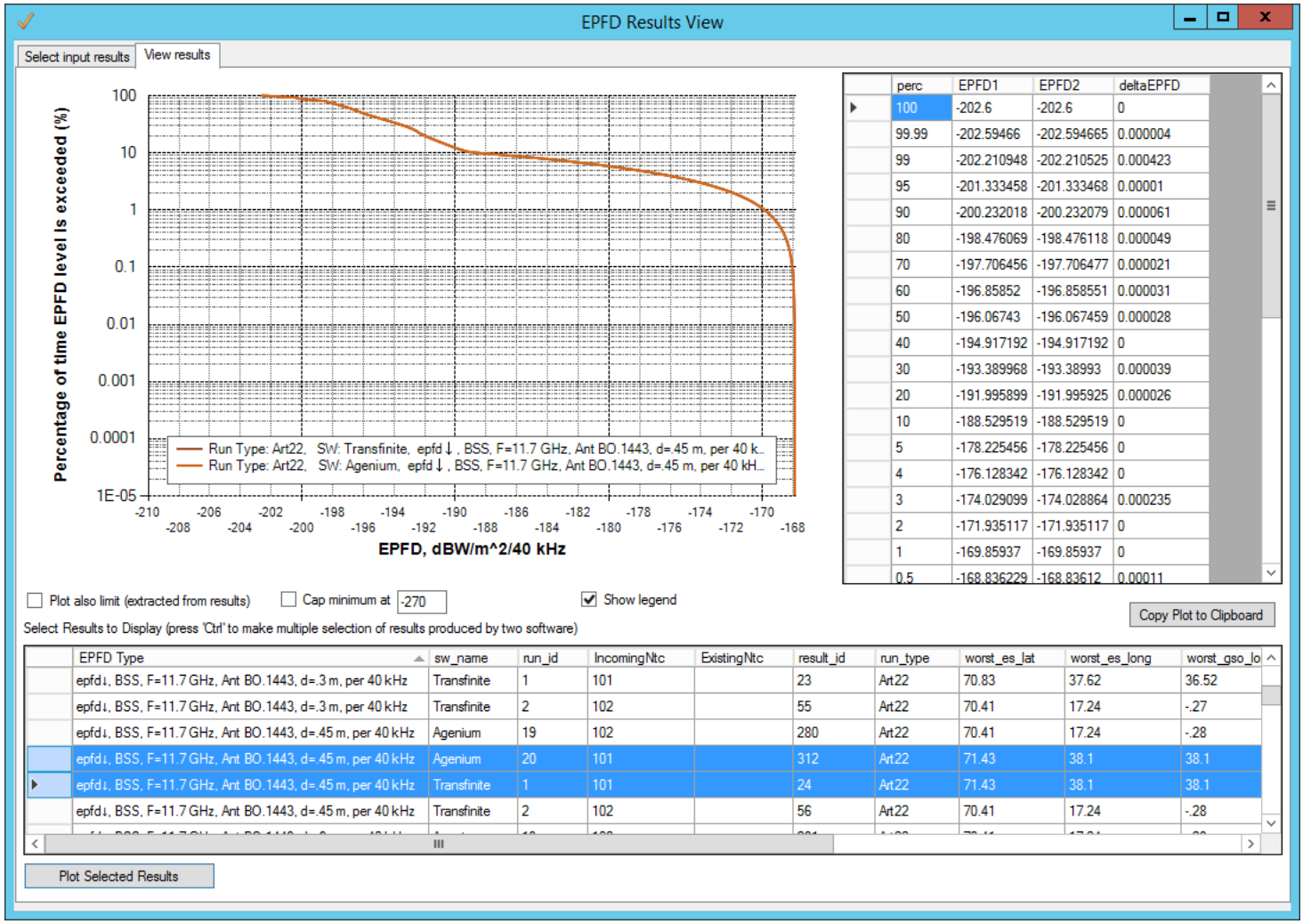

Figure 12: Displaying resulting CCDF from two databases in comparison mode

Interface options:

- Checking 'Show legend' will display graphs legend.
- Double clicking a result on chart legend displays color selection dialog which can be used to change the color of result graph.
- Double clicking on any horizontal or vertical grid line displays color selection dialog which can be used to change the color of horizontal/vertical grid lines.
- If several results are plotted with different reference bandwidths, the X-axis title will display all the references bandwidths, e.g. EPFD, dBW/m^2/40,1000 kHz.
- Data points can be viewed by hovering mouse along the result curve.
- Clicking and dragging the mouse in chart area would allow zoom in to specific chart region. To return to full view right click anywhere on chart.

5 DATA REQUIRED FOR EPFD VALIDATION

5.1 Data and Database Structure

Information on the fields in the SRS required by the algorithm in Rec. ITU-R S.1503-2 is given in Annex 2.

5.2 Submitted Data

A number of potential issues with data submitted in actual non-GSO filings are observed. These include:

- *A.4.b.7.d.1: the type of zone (based on topocentric angle, satellite-based angle or other method for establishing the exclusion zone)*
  - The option "other" is not implementable
  - When the field contains characters different from Y or N, no exclusion method is assumed in the software which corresponds to value Y for the method and 0 degrees for the exclusion angle.
- Lack of understanding of use of non-GSO ES average density and separation distance, as described in Section 5.3
- Fields were not always set – for example elevation angle specified in some groups but left undefined in others
- Repetition between groups, for example specifying the PFD mask multiple times, resulting in multiple runs or requirement to filter out duplicates
- PFD masks submitted for ascending / descending nodes and by satellite longitude, neither of which is consistent with the format defined in Rec. S.1503-2
- Reference bandwidth not set in the PFD or EIRP masks.

5.3 Non-GSO ES Deployment

The use of ***avg_dist*** and ***density*** elements:

- **density** (ES_DENSITY) - Average number of associated earth stations transmitting with overlapping frequencies per km^2 in a cell
- **avg_dist** (ES_DISTANCE) – Average distance between co-frequency cells in kilometers

These are required for uplink EPFD analysis to calculate the number of earth stations be populated:

NUM_ES = ES_DISTANCE * ES_DISTANCE * ES_DENSITY

One issue raised was how these should be defined for the different cases of the access method being FDMA, TDMA or CDMA. In addition, there was the special case where there would only be a single ES within the field of view active on any specific frequency at any one time.

If the supplied ES_DISTANCE is zero then set NUM_ES = 1 and at Step 4 locate a single non_GSO ES at the boresight of the GSO satellite

The NUM_ES is typically 1 for TDMA and FDMA systems and for CDMA systems equal to the number of co-frequency ES all operating on the same frequency at the same time and location. The ES_DISTANCE relates to the smallest distance between co-frequency beams.

5.4 Multiple Non-GSO Orbit Parameters

Recommendation ITU-R S.1503-2 was developed on the basis of the non-GSO FSS system under evaluation having a single set of semi-major axis (a), orbit inclination angle (i) and eccentricity (e). These parameters were used to calculate the worst case geometry plus the time step and duration in addition to the orbit prediction in the EPFD calculations.

In particular, the {a, e, i} elements were used to derive run times such that the constellation would repeat and return to its original configuration. This ensured that the statistics were consistent and complete i.e. all configurations of the constellation were considered an equal number of times to avoid biases.

However with multiple {a, e, i} each sub-set is likely to have different repeat times and S.1503-2 does not include a methodology to calculate the appropriate run time and, where necessary, adjust the orbit model.

For networks having different non-homogenous orbits which are not to be used simultaneously earth stations with its own eirp-mask in the same frequency band, , it is recommended to define separate examination scenarios for each individual type orbit by creating several runs with only one type of orbit to be used.

5.5 Multiple Non-GSO ES EIRP Masks

Rec. ITU-R S.1503 was written on the basis of a single non-GSO ES EIRP mask per frequency band but it was noted during development that there was no reason that multiple non-GSO ES could not be filed and analysed by the verification software.

For networks having different earth stations with its own eirp-mask in the same frequency band, it is recommended to define separate examination scenarios for each individual eirp mask by creating several runs with only one type of eirp mask to be used.

5.6 Defining examination scenario

To run properly EPFD examination, it is important to establish correct relationship between frequency assignments groups and PFD/EIRP masks of the non-GSO filing under examination.

There are two tables in SNS structure establishing this link:

mask_lnk1 table establishes the link for transmitting space station PFD/EIRP mask and corresponding group of frequency assignments

Data Item	Description
grp_id	Unique identifier of the group
ntc_id	Unique identifier of the notice
mask_id	Unique identifier of the mask
orb_id	Sequence number of the orbital plane If -1 or empty applies to all orbital planes.
sat_orb_id	Satellite sequence number in the orbital plane If empty, applies to all the satellites in orbital plane.

mask_lnk2 table establishes the link for transmitting earth station EIRP mask and corresponding group of frequency assignments

Data Item	Description
grp_id	Unique identifier of the group
seq_e_as	Sequence number of the associated earth station. -1 if mask applies to typical ES, otherwise equal to seq_no of specific ES in e_as_stn for given grp_id
ntc_id	Unique identifier of the notice
mask_id	Unique identifier of the mask
orb_id	Sequence number of the orbital plane If -1 or empty applies to all orbital planes.
sat_orb_id	Satellite sequence number in the orbital plane If empty applies to all the satellites in orbital plane.

Each network could have several different combinations of frequency assignments and transmission characteristics.

Frequency assignments groups are defined in SNS group table and include combinations of one or several central frequencies, associated earth stations, emissions and power characteristics.

When it concerns Article 22 examination, each Article 22 limit cover specific band for which specific EPFD limit would apply.

It is common scenario when several frequency assignments, not necessarily overlapping with each other, could fall into the same limit band.

For example, Table 22-1B of Article 22 covers the whole 17.8-18.6 GHz band. If non-GSO filing has separate frequency assignments groups - group 1 (17.8-18.1 GHz), group 2 (18.1-18.3 GHz), group 3 (18.4-18.6 GHz), it is sufficient to run examination only for one group 1. And then use the results of this examination for group 2 and 3.

For, No. 9.7A and 9.7B, however, it is important to include into examination all non-repeating frequency band assignments to make sure all the affected stations/networks are identified.

Let's consider more complex scenario. In scenario described below, a network has several combinations of satellite footprint gain/earth station gain and assigned frequency.

Satellite beam	Assigned Frequency Band	Associated Earth Station	Emission Power Spectral Density	GroupID
TYPE SA (GAIN SX)	F1 - F2	TYPE A (GAIN EX)	PSD_VALUE 1	GROUP1
			PSD_VALUE 2	GROUP2
		TYPE B (GAIN EY)	PSD_VALUE 1	GROUP3
			PSD_VALUE 2	GROUP4
	F2 - F3	TYPE A (GAIN EX)	PSD_VALUE 1	GROUP5
			PSD_VALUE 2	GROUP6
		TYPE B (GAIN EY)	PSD_VALUE 1	GROUP7
			PSD_VALUE 2	GROUP8
TYPE SB (GAIN SY)	F1 - F2	TYPE A (GAIN EX)	PSD_VALUE 1	GROUP9
			PSD_VALUE 2	GROUP10
		TYPE B (GAIN EY)	PSD_VALUE 1	GROUP11
			PSD_VALUE 2	GROUP12
	F2 - F3	TYPE A (GAIN EX)	PSD_VALUE 1	GROUP13
			PSD_VALUE 2	GROUP14
		TYPE B (GAIN EY)	PSD_VALUE 1	GROUP15
			PSD_VALUE 2	GROUP16

For each of this combination different PFD/EIRP mask could be defined:

PFD MASK 1: Satellite beam **SA** – frequency band **F1-F2** - PSD Value **1:**

Satellite beam	Assigned Frequency Band	Associated Earth Station	Emission Power Spectral Density	GroupID
TYPE SA (GAIN SX)	F1-F2	TYPE A (GAIN EX)	PSD_VALUE 1	GROUP1
		TYPE B (GAIN EY)	PSD_VALUE 1	GROUP3

Similarly, for other configurations mask links can be defined

PFD MASK **2**: Satellite beam **SA** – frequency band **F1-F2** - PSD Value **2**

PFD MASK **3**: Satellite beam **SB** – frequency band **F1-F2** - PSD Value **1**

PFD MASK **4**: Satellite beam **SB** – frequency band **F1-F2** - PSD Value **2**

Since all these mask are covering the same frequency band and to be transmitted at unknown time intervals, including them altogether into examination is not possible.

However, it would be possible to define several different runs to be executed separately.

Run 1. Only includes MASK 1 linked to group 1 or 3.

Run 2. Only includes MASK 2 linked to group 2 or 4.

Run 3. Only includes MASK 3 linked to group 9 or 11.

Run 4. Only includes MASK 4 linked to group 10 or 12.

For each of this run, it will be possible also to add groups selected in similar manner for the frequency band F2-F3 provided that F1-F2 and F2-F3 are not covering the same frequency band.

To achieve such separation of data, several ways could be considered:

1. Simplest approach is to split the filing into several filings each corresponding to its own examination scenario
2. To change the link in mask_lnk tables so it would only point to the groups to be run individually.

More complex situations would involve adding one more layer describing different orbital configurations when filing contains different type of orbits. Although there are several orbital constellations in the filing, only one of the satellite orbits will be subject to transmission.

For each run, only specific orbital planes can be extracted or alternatively indicated in mask_lnk tables.

EPFDPrepare allows both approaches to be taken. The user should favour most simple approach as seen from the perspective of particular network configuration.

It is highly recommended whenever possible to define PFD/EIRP mask which would cover all the possible scenarios and run examination only once for single frequency assignment group covering specific EPFD limit.

It should be mentioned, however, that there are exceptions, which allow application of several masks to one frequency assignments group or the limit:

1. Limit contains two values of reference bandwidth (e.g. 40 and 1000 kHz). In this case, only mask for lowest reference bandwidth should be provided. When limit is calculated having higher reference bandwidth PFD-level will be adjusted to 1 MHz bandwidth.
2. Different PFD mask are applicable for different orbits and these different orbits are transmitting simultaneously. In this case, it is possible to indicate individual combinations of pfd masks and orbital planes for the frequency assignment group.

6 USING EPFDPREPARE

Non-GSO system may consist of very complex configurations which may include non-homogenous orbits, different combinations of transmission characteristics and earth stations parameters.

Moreover, existing SRS_ALL does not contain information which establishes the link between PFD/EIRP masks and associated frequency assignments, simply because PFD/EIRP-masks are submitted mostly after the publication of non-GSO system.

There are some other specific issues (see section 5.2) with already provided data which require its adjustment before running EPFD validation.

All these factors indicate that running EPFD validation using directly SRS_ALL database is not feasible, and it is of critical importance to make sure first that all necessary data elements are present and validated. For that purpose, a separate utility ***EPFDPrepare*** was created which would facilitate creation of custom examination scenarios.

Disclaimer: ***EPFDPrepare*** is not mandatory software to be used when preparing filing for submission to ITU. Its purpose purely to facilitate EPFD examination. All the elements (except mask tables) required for EPFD examination could be prepared using SpaceCap. However, ***EPFDPrepare*** would help to correctly establish the links between the masks and SRS data as well to provide validation of the elements required for EPFD examination.

EPFDPrepare can be launched from GIBC or executed separately through Start Menu.

Starting EPFDPrepare from GIBC

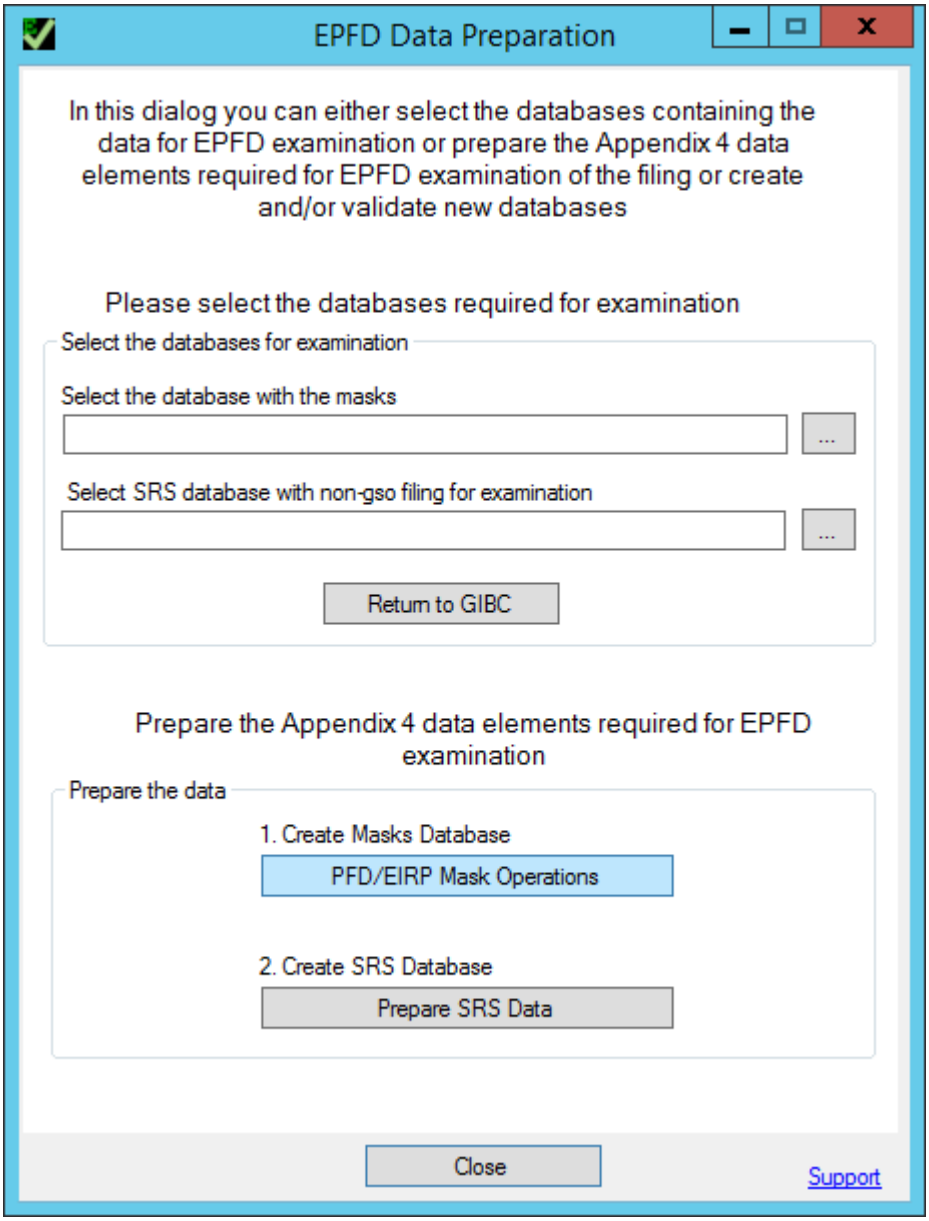

Figure 13: EPFDPrepare start screen

Preparing Mask Data

If mask database needs to be created, press ***PFD/EIRP Mask Operations*** to start Mask Data Dialog.

On this screen user can start creating new mask database or open existing one to continue manipulations with the mask data.

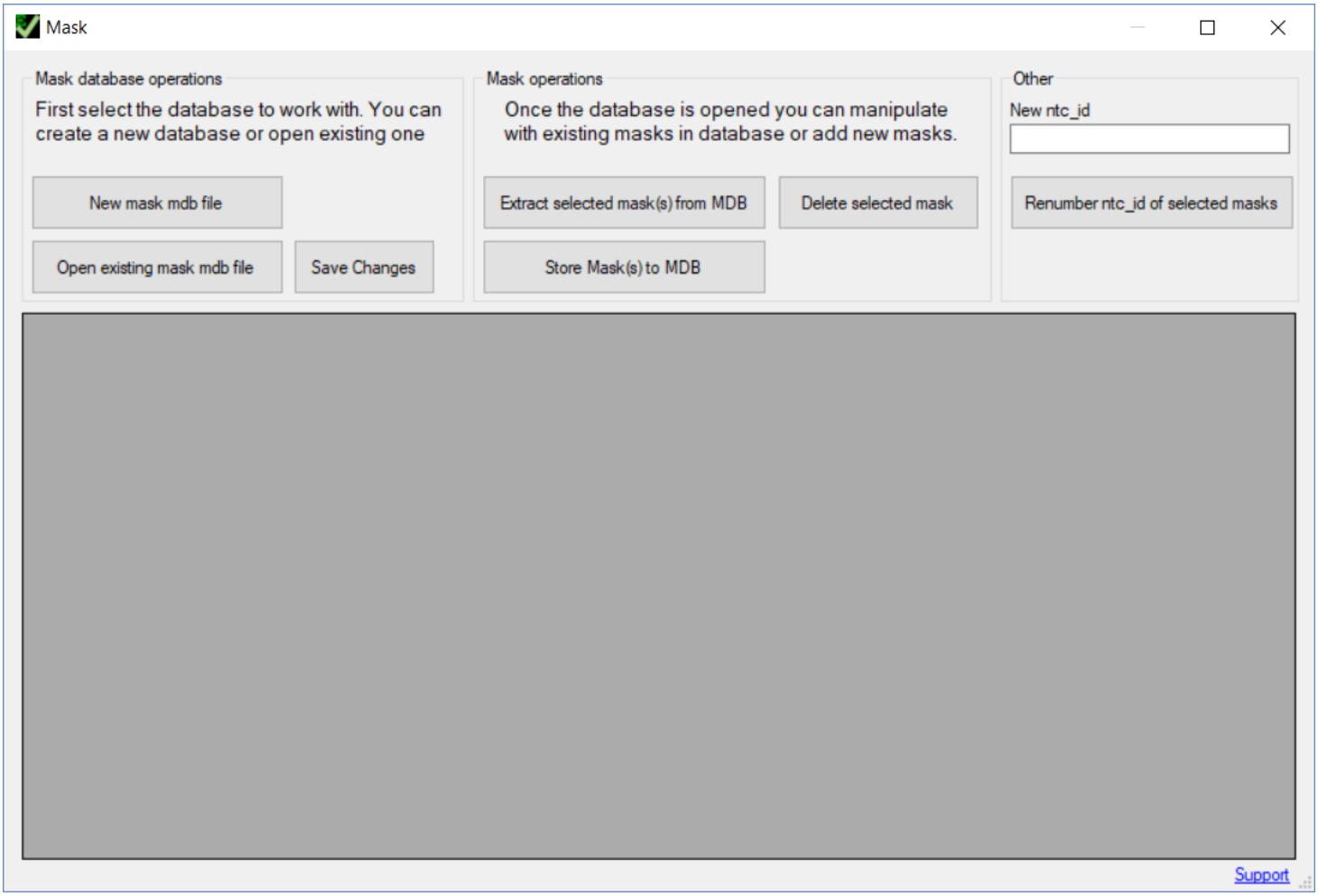

Figure 14: Running mask operation dialog

Start by creating new mask database by pressing ***New mask mdb file***.

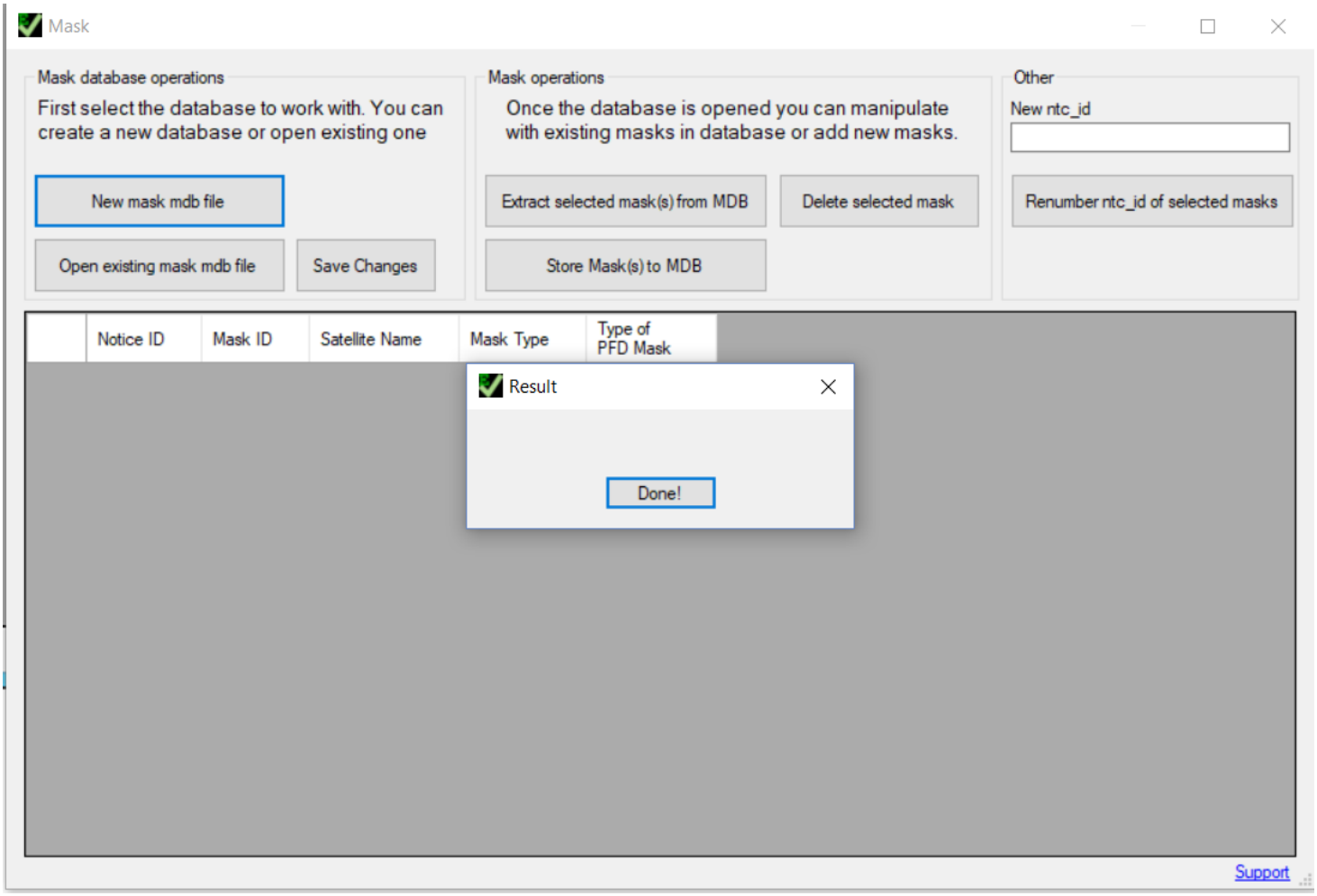

Figure 15: Creating new mask file database

Next step is to add XML-format mask to newly created database. Press ***Store Mask(s) to MDB***.

In the following dialog user can add one or several XML-format masks.

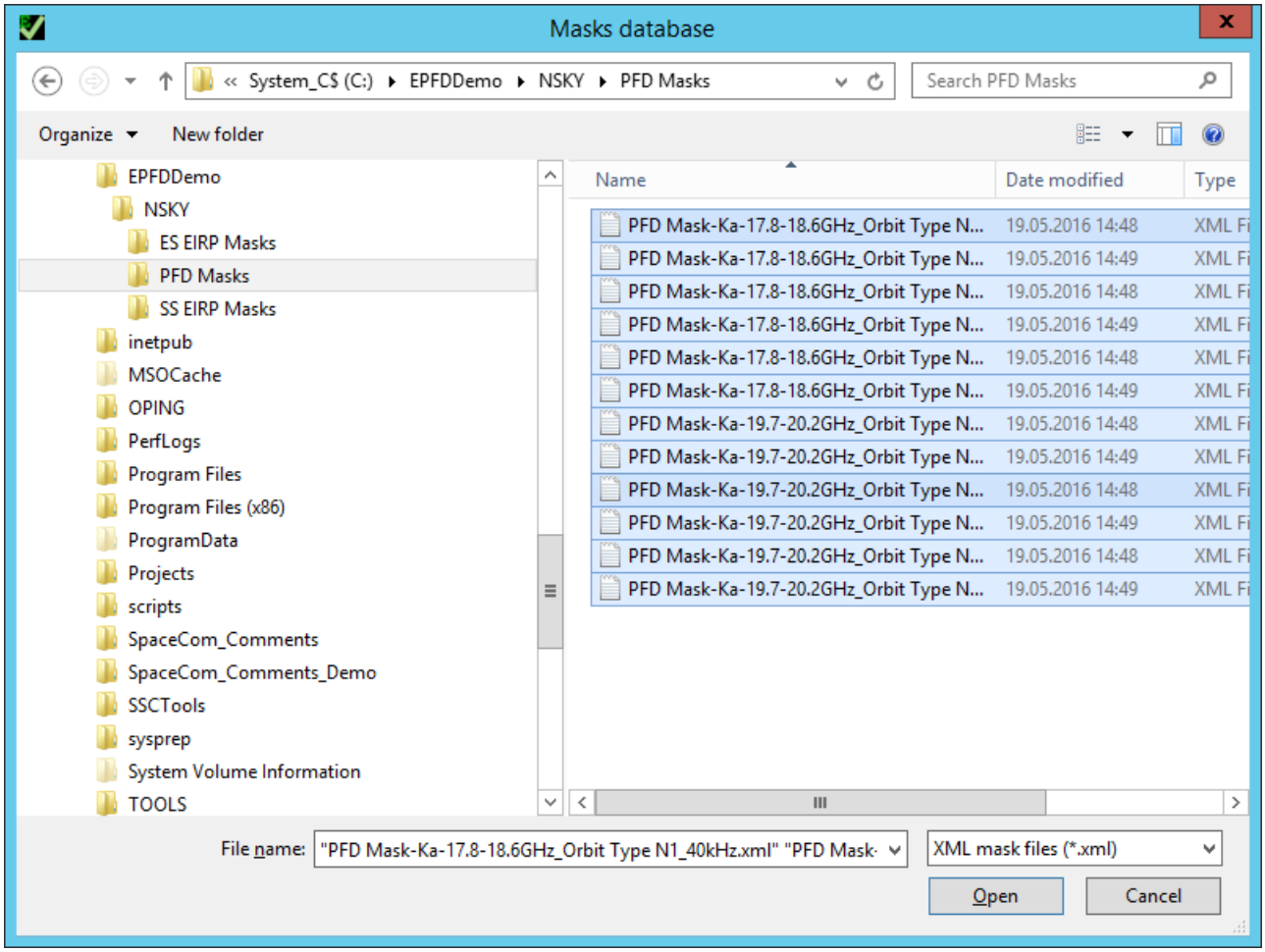

Figure 16: Adding XML-format masks to the database

For each mask selected, the program will validate the mask and provide the list of identified issues with the mask.

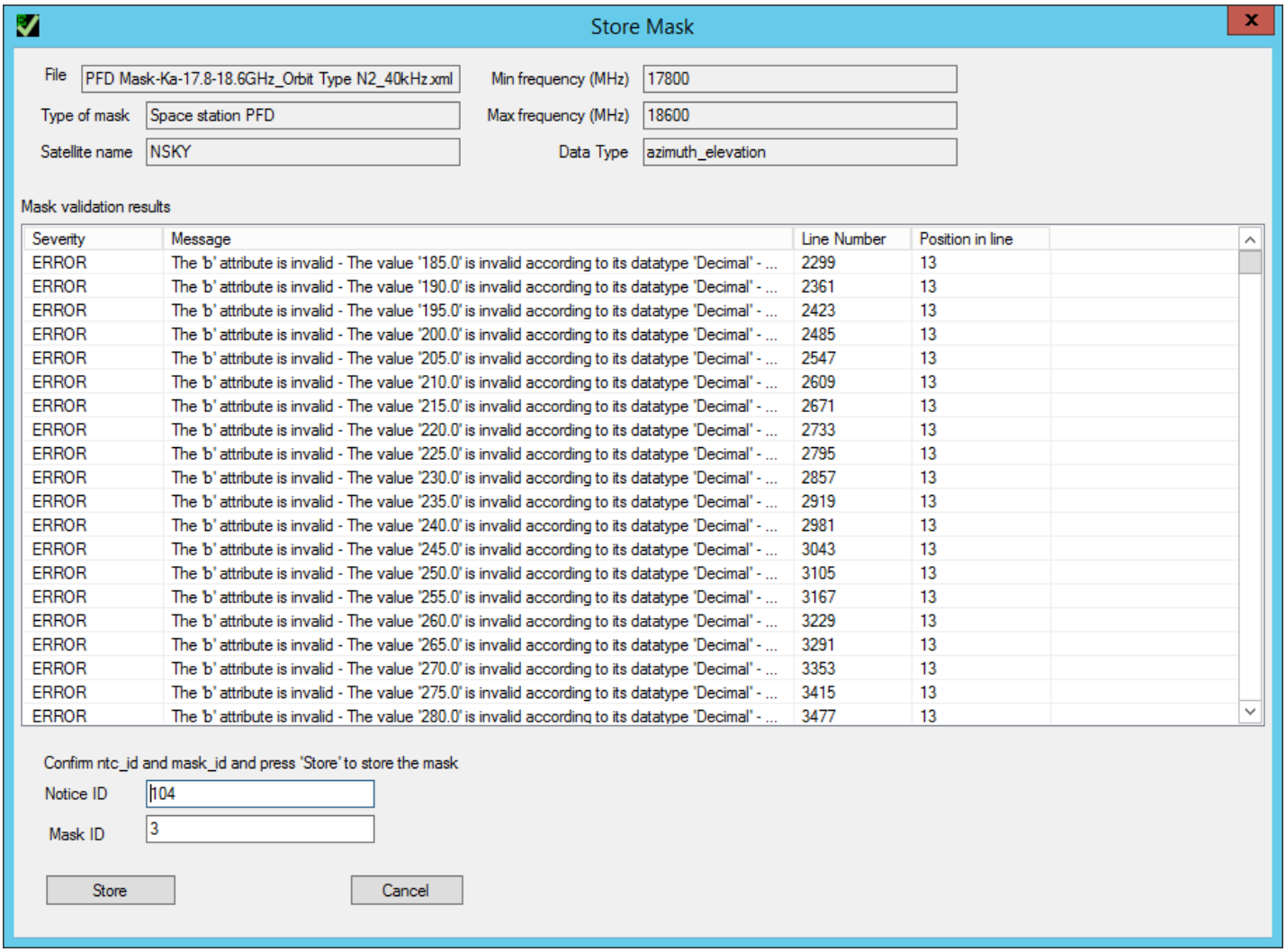

Figure 17: Mask validation dialog

Some basic information is also given for the mask to be added. If needed, mask Notice ID and Mask ID could be changed on the same screen. After the review of this information, press ***Store*** button.

If errors are present in the mask the user is presented with the following dialog.

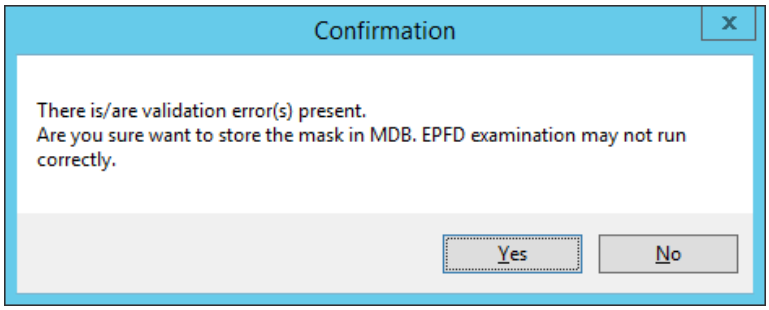

Figure 18: Storing the masks

Also, if the mask with the same Notice ID and Mask ID is already present in the database, a confirmation is requested to overwrite the mask.

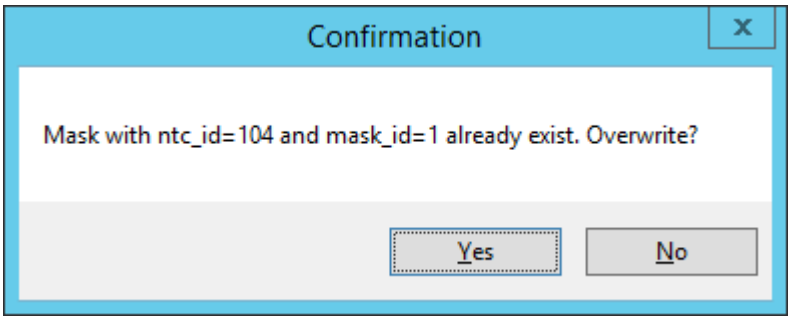

Figure 19: Overwriting the mask

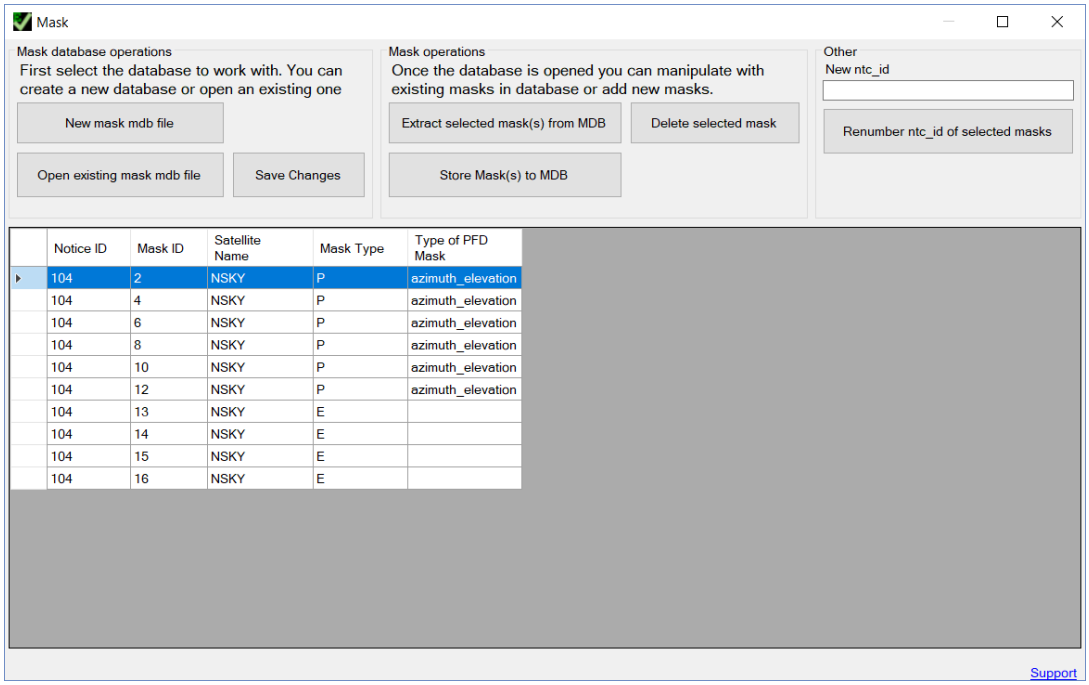

Figure 20: List of stored masks

After the masks are added they are displayed in the main window.

In this user interface, mask from the database could be deleted or extracted in XML-format from the database.

Once all masks operations are complete press ***Save Changes*** to save mask database file.

Starting SRS data preparation

Next step is to complete the SRS data for validation. Press ***Prepare SRS Data***.

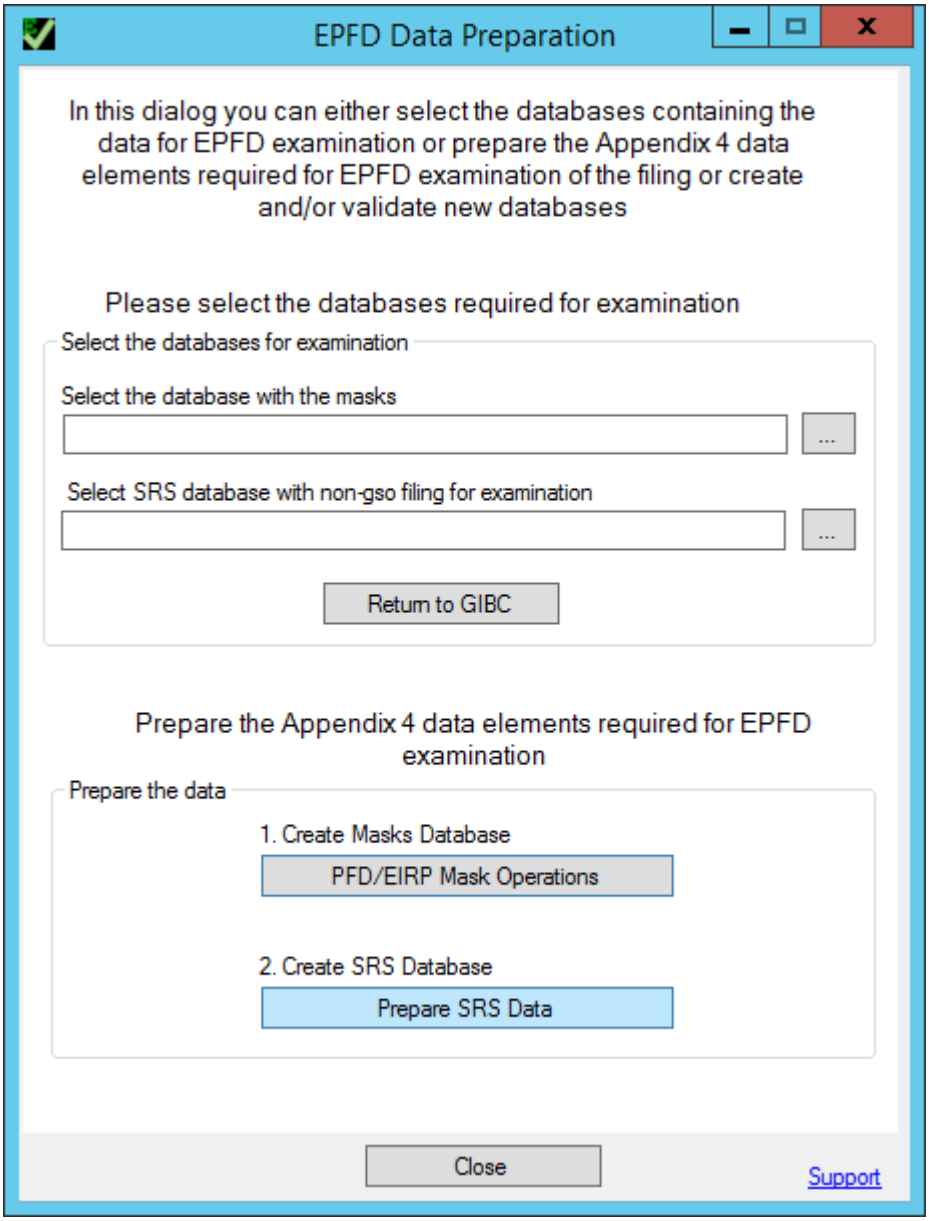

Figure 21: Advancing to SRS data manipulation

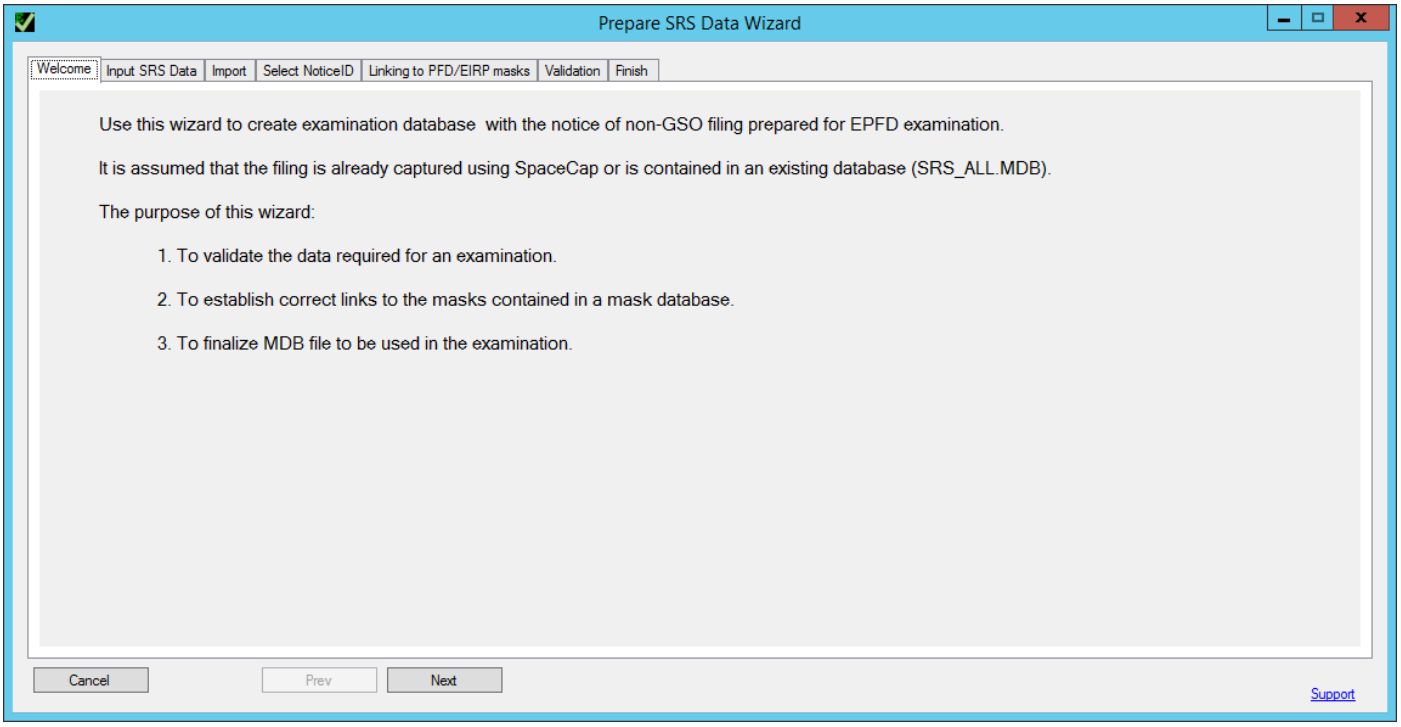

Figure 22: Prepare SRS data start screen

A dialog in form of step-by-step wizard is opened. To advance to the next step press ***Next***.

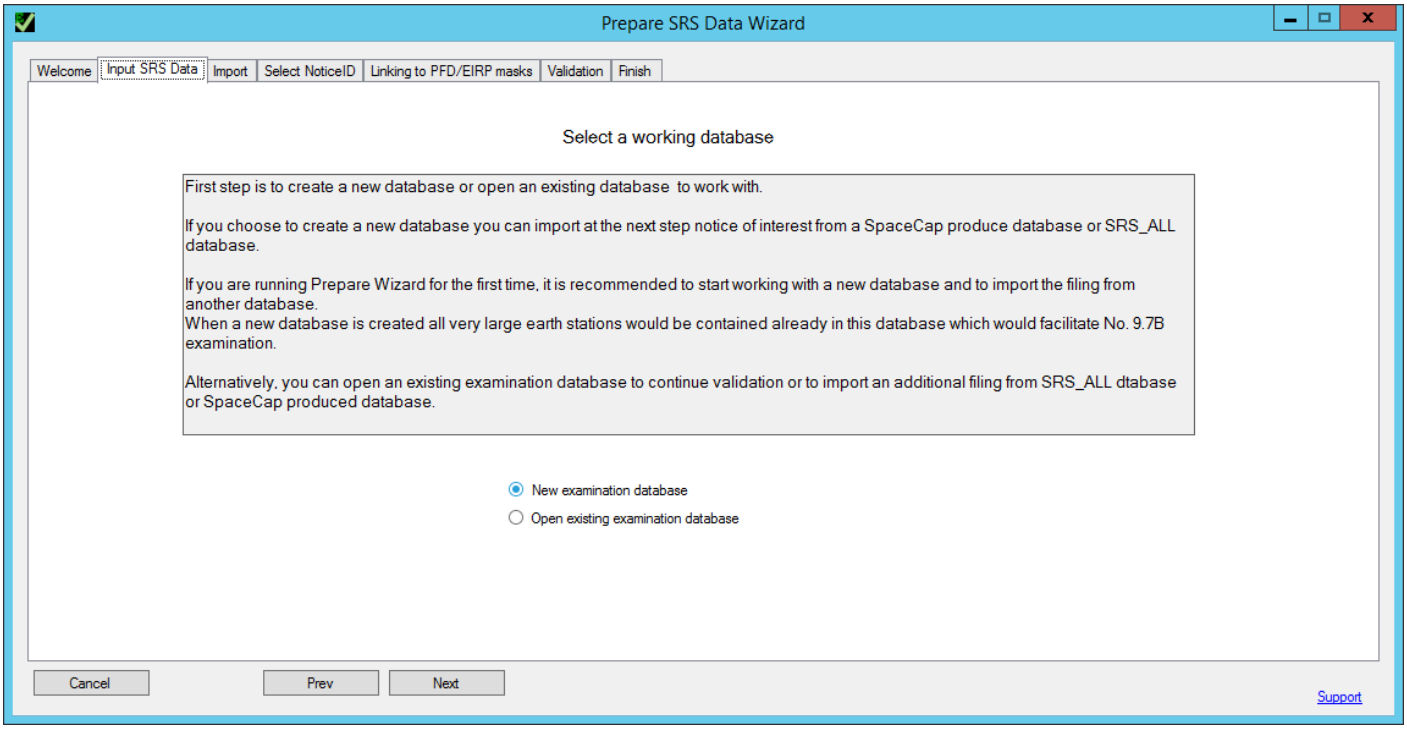

Figure 23: Creating new SRS data database

Similarly, we start from creating a new database. ***Open existing examination database*** could be selected alternatively to continue the working with already created database.

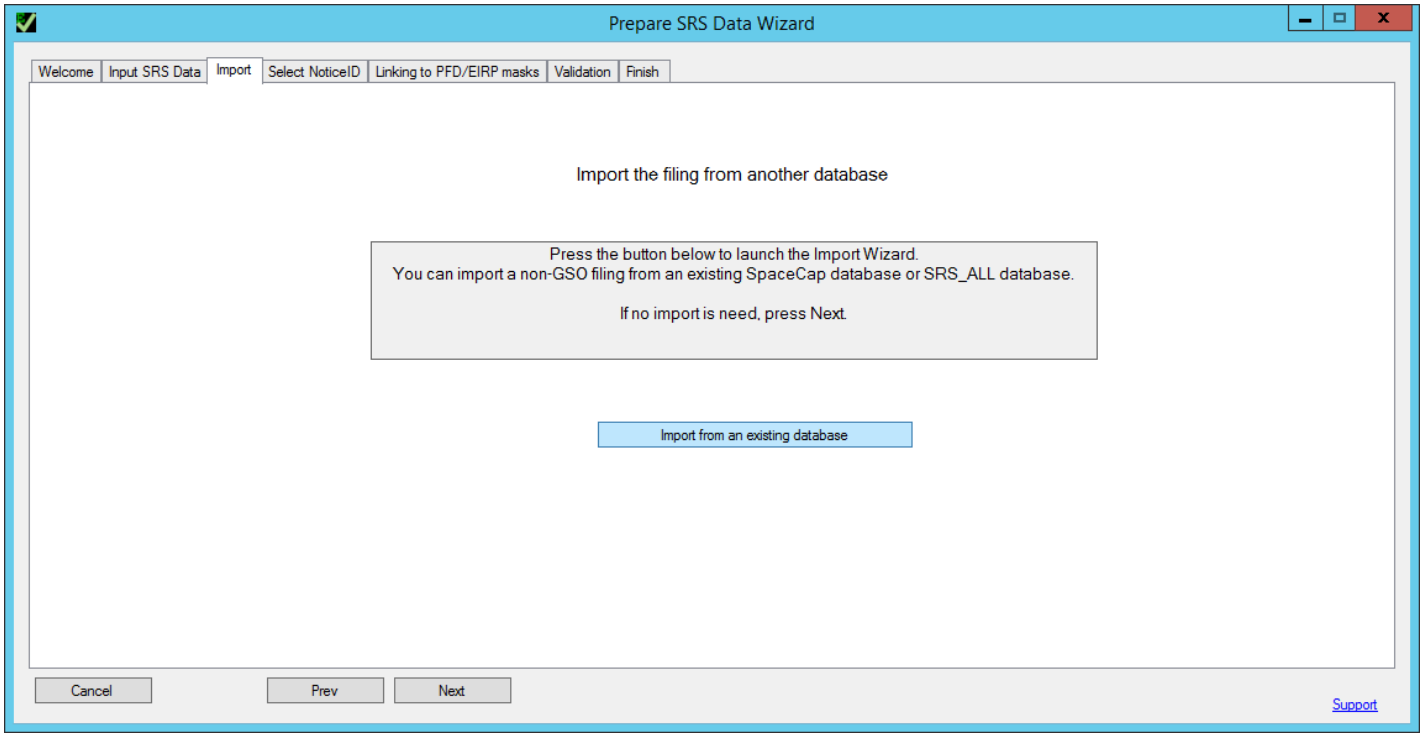

Figure 24: Importing filing to SRS database used for EPFD validation

After a new database is created, we can import existing filing from another database (for example, SRS_ALL).

Press ***Import from an existing database***.

Importing filing from another database

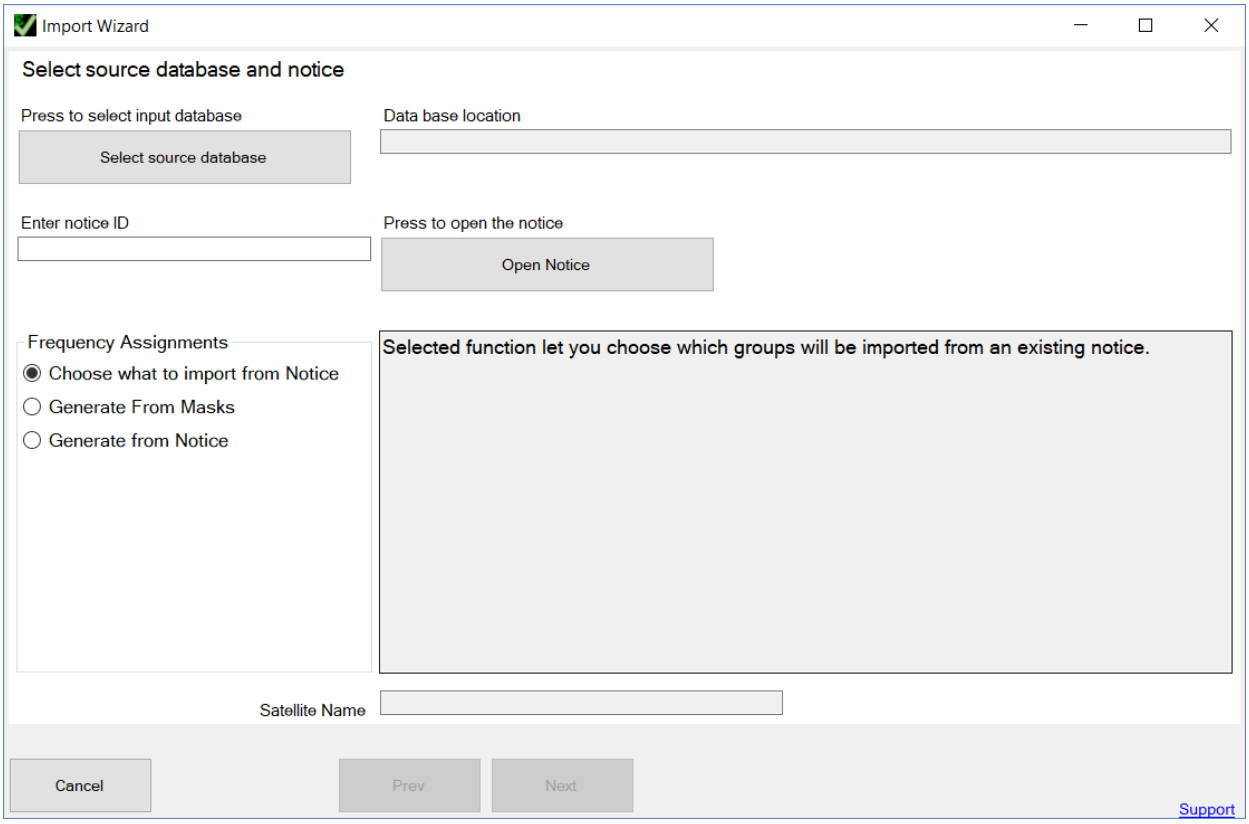

Figure 25: Selecting source database

On this page, the source database and corresponding Notice ID for the notice which is to be imported to a new database need to be indicated.

'Frequency Assignments' box gives 3 options for importing frequency assignments groups.

1. Choose what to import from Notice
2. Generate from Masks
3. Generate from Notice

First option is a default method of selecting frequency assignments groups which can be imported from source databased. Under this option, program looks for frequency assignments groups which are subject to Article 22 or No. 9.7B coordination provision and lets user to select which are the groups need to be imported from.

Second option is using information provided in the masks regarding minimum and maximum frequency of the frequency range to which particular PFD/EIRP mask is applicable. Provided that only single PFD or EIRP mask is applicable to specific frequency range only one new group will be generated.

The advantage of this option is that user don't have to decide which exact frequency groups needs to be imported – program will generate new groups for the user.

Third option, like in the case of the first uses information on Article 22 EPFD limit applicable frequency band and frequency assignments used in the mask. But unlike first option, this option generates completely new groups, while avoiding having multiple groups operating in overlapping frequency band.

This can be illustrated as follows:

- Notice has frequency assignment groups:

  Group ID No. 1 – frequency band 10950-11200 MHz

  Group ID No. 2 – frequency band 11200-11450 MHz

  Group ID No. 3 – frequency band 11200-11400 MHz

- These frequency assignments groups are subject to the same EPFD limits in Article 22 applicable to the frequency bands:
  10.7-11.7 GHz
  11.2-12.2 GHz
  12.2-12.5 GHz
  12.5-12.75 GHz
- Under option 1, user must select carefully 3 different groups. However, under option 3 – program would automatically create one group with combined frequency range 10.95-11.4 GHz.

Like in case of the option 2, the advantage of this option is that user don't have to decide which exact frequency groups needs to be imported – program will generate new groups for the user.

Example of using this interface is given below.

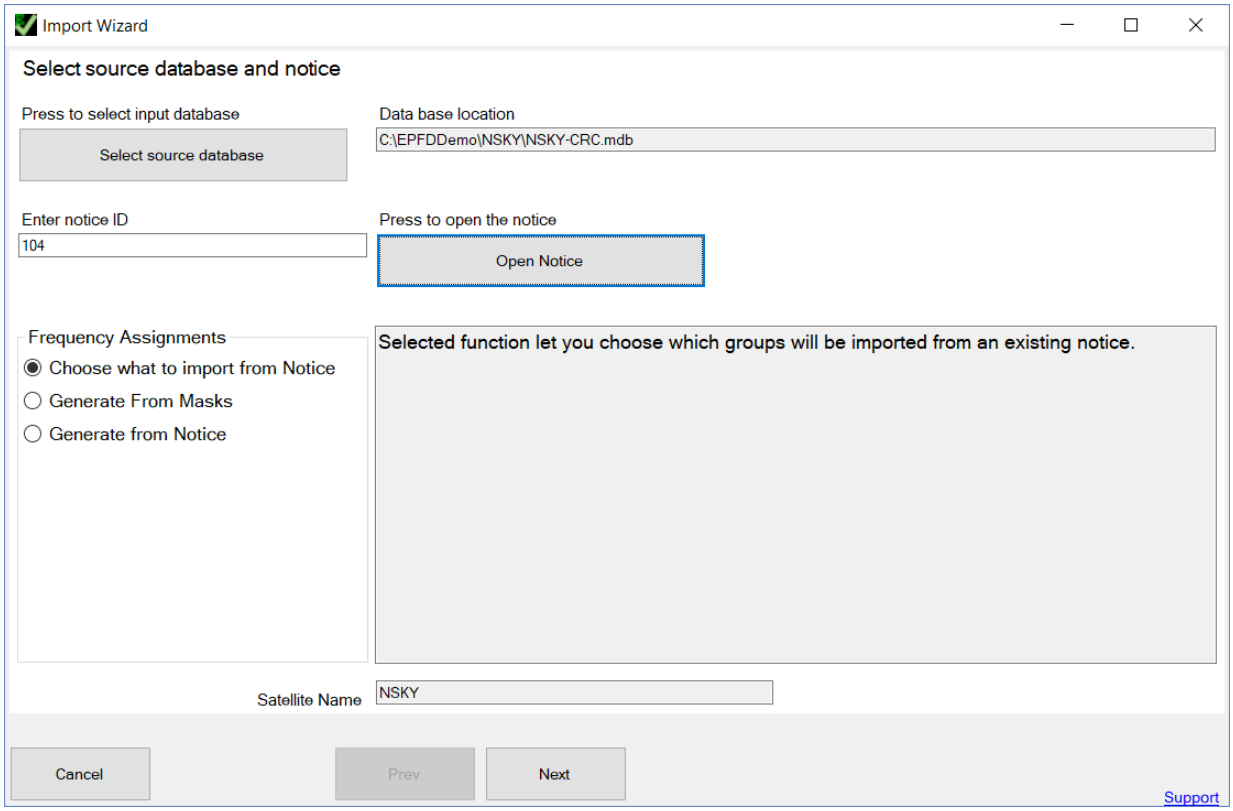

Figure 26: Selecting notice to import

Select a source database and input the Notice ID in the text box and press ***Open Notice***.

Here we start with the Option 'Choose what to import from Notice'.

If notice is found by its Notice ID number, satellite name would appear below, and you may continue to the next step.

Next step is to select orbital planes for import.

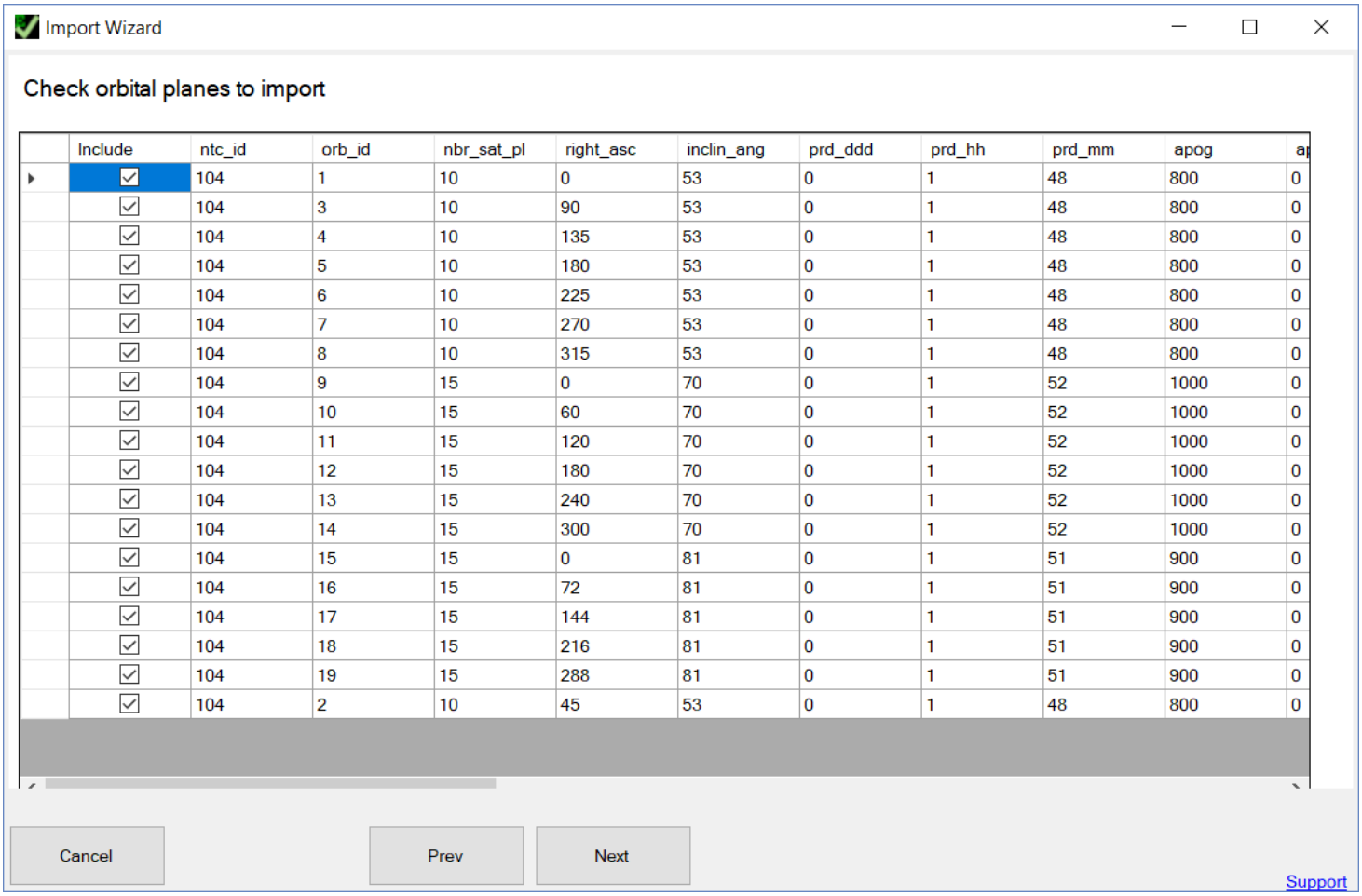

Figure 27: Selecting orbital planes to import

On this page user need to check all the orbital planes which will be used in EPFD Examination. Select orbital planes by checking 'Include' field in the table.

Next step is to select frequency groups to import.

This dialog is provided for the first option of importing groups.

On the left the list of applicable EPFD limits band is extracted. When clicking any of those limits the user is presented with the list of the groups which are subject to the limit selected. In the group list to import the group check **Import** in the left-most column**.**

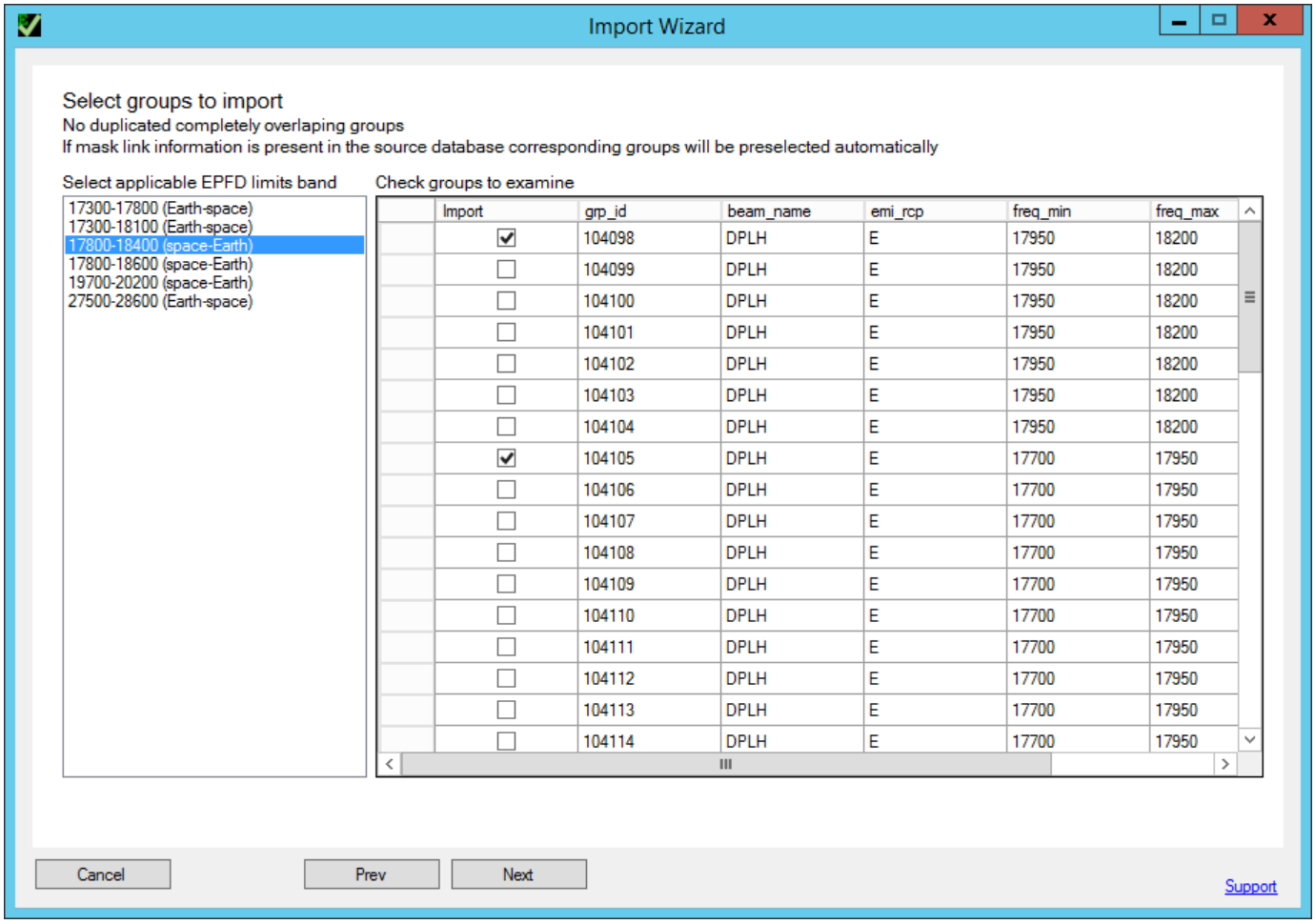

Figure 28: Selecting groups to import

Next step is to select corresponding associated earth station for each frequency assignment group selected at the previous step. This is needed since groups may contain several associated earth stations. Program preselects first station in the list in each group.

The choice of the earth station does not affect the results of EPFD Examination, except the case when group contain both two different types of earth stations – typical and specific.

Typical earth station (stn_type=T) is an earth station which does not have specific geographical coordinates.

Specific earth station (stn_type=S) is an earth station which is located at given geographical coordinates.

In case group has both types, user need to carefully select type of earth station to be imported. Please note, that only 1 type of earth station maybe used in calculation at the same time.

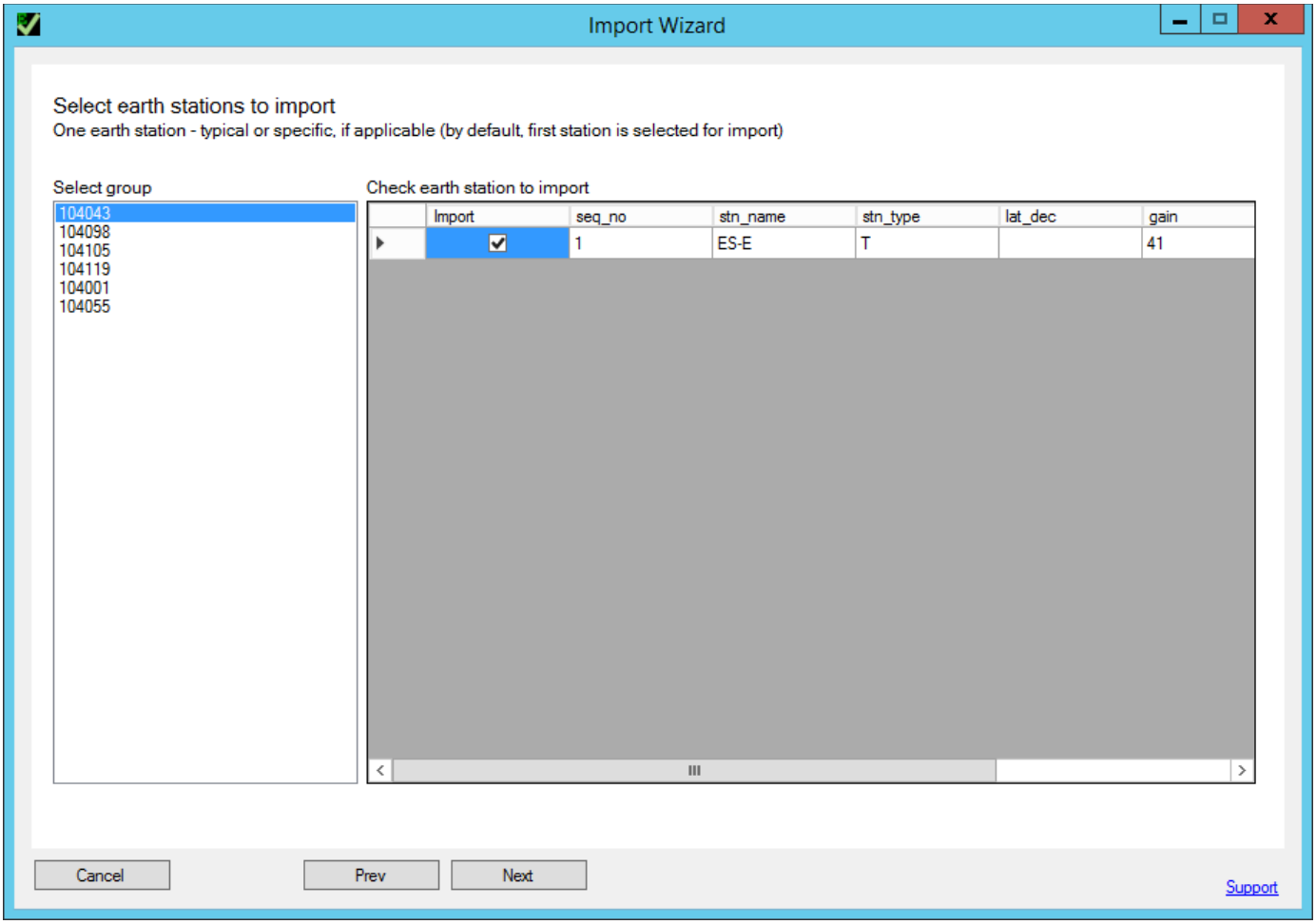

Figure 29: Selecting associated earth stations to import

For each of the selected groups, which are present in a left-side box, it is necessary to choose associated earth station to import.

Finally, the wizard provides a summary of elements to import. Press ***Finish*** to close the wizard.

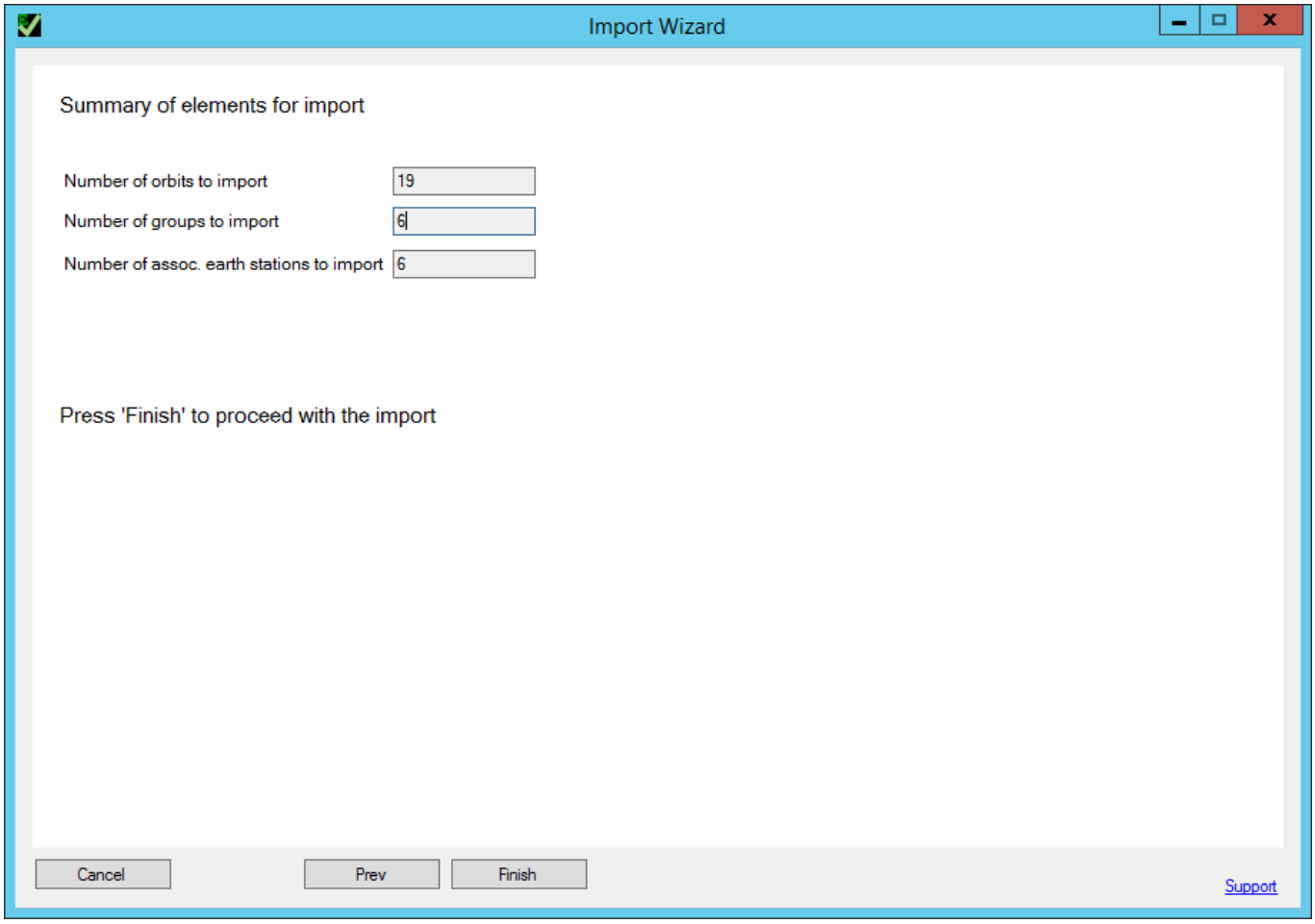

Figure 30: Import summary

Once Import Wizard finishes, the program will with SRS Data wizard.

In case user selected the import option ‘Generate from Masks’, process will be very similar.

Instead of selecting groups, on the screen below the program requests the user to indicate Mask Database file.

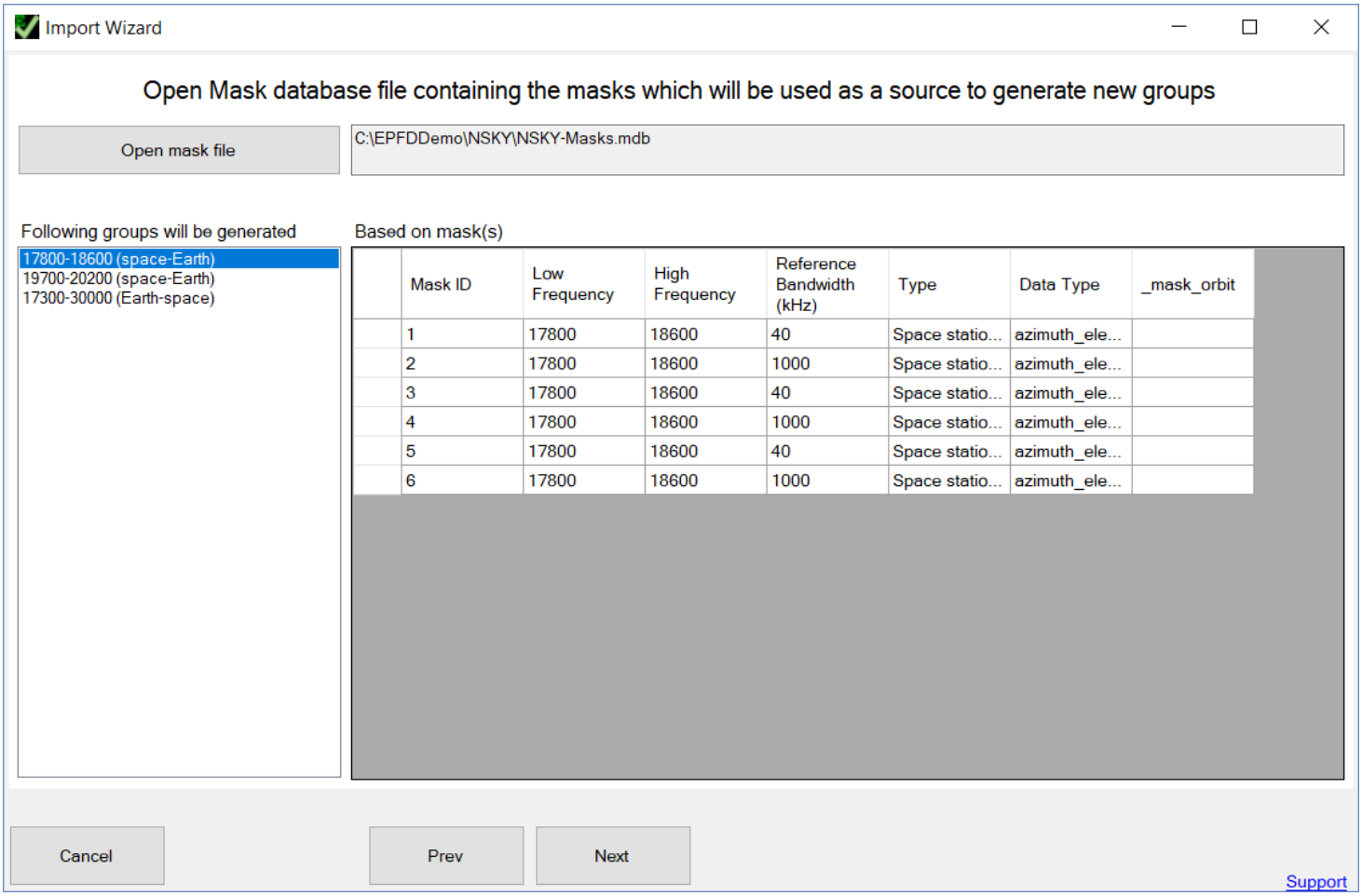

Figure 31

Here user included mask database file. Program identified that 3 groups may be generated based on mask information.

Similar process is found in case of the import option ‘Generate from Notice’.

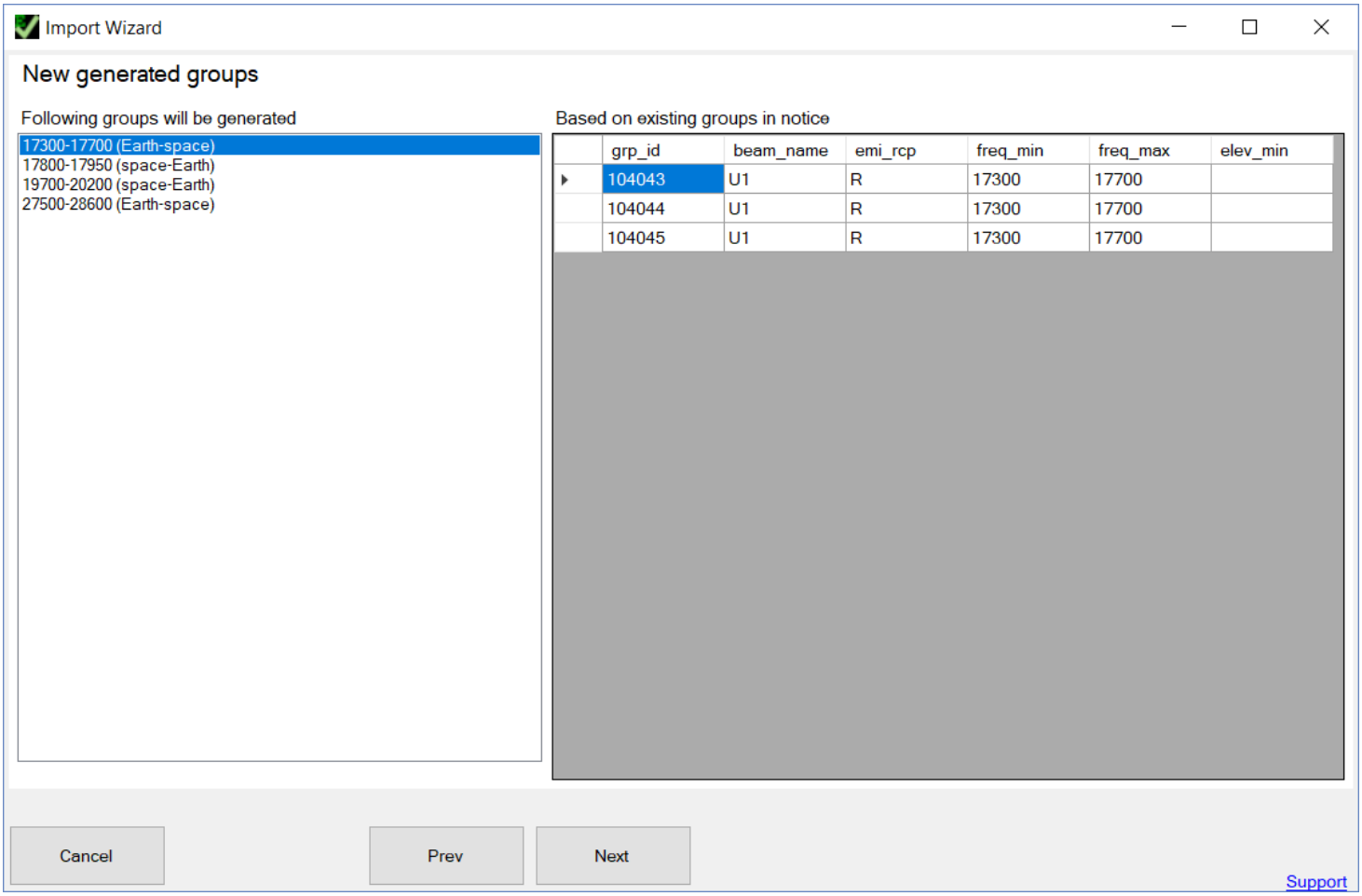

Figure 32

In given example program identified that 4 groups may be generated using frequency assignment groups in the notice and Article 22 limits. These 4 groups ultimately substitute around 50 groups present in the notice.

Once import is completed, user is invited to continue operations with the newly imported notice.

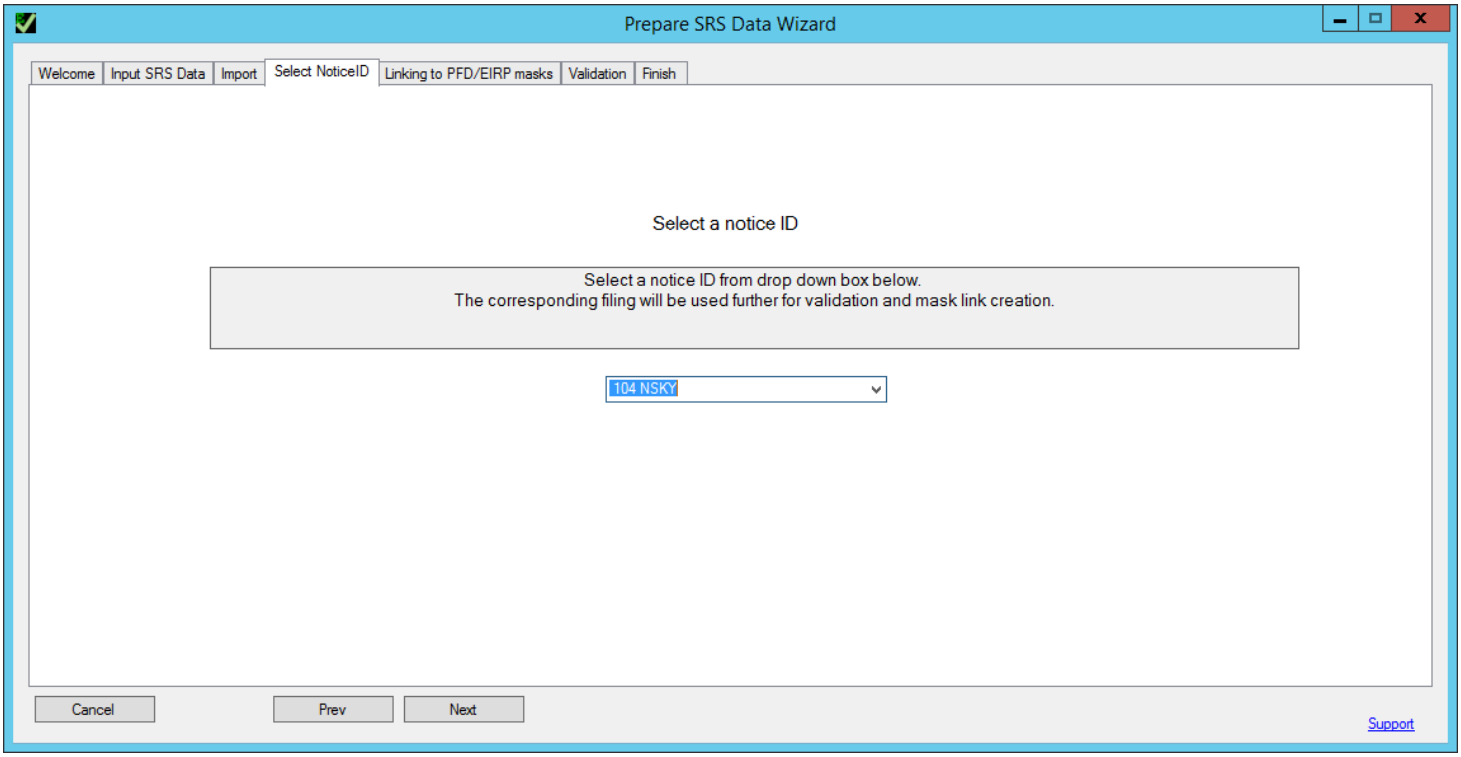

Figure 33: Selecting notice ID

On this page, the Notice ID of the notice is selected.

Establishing mask links

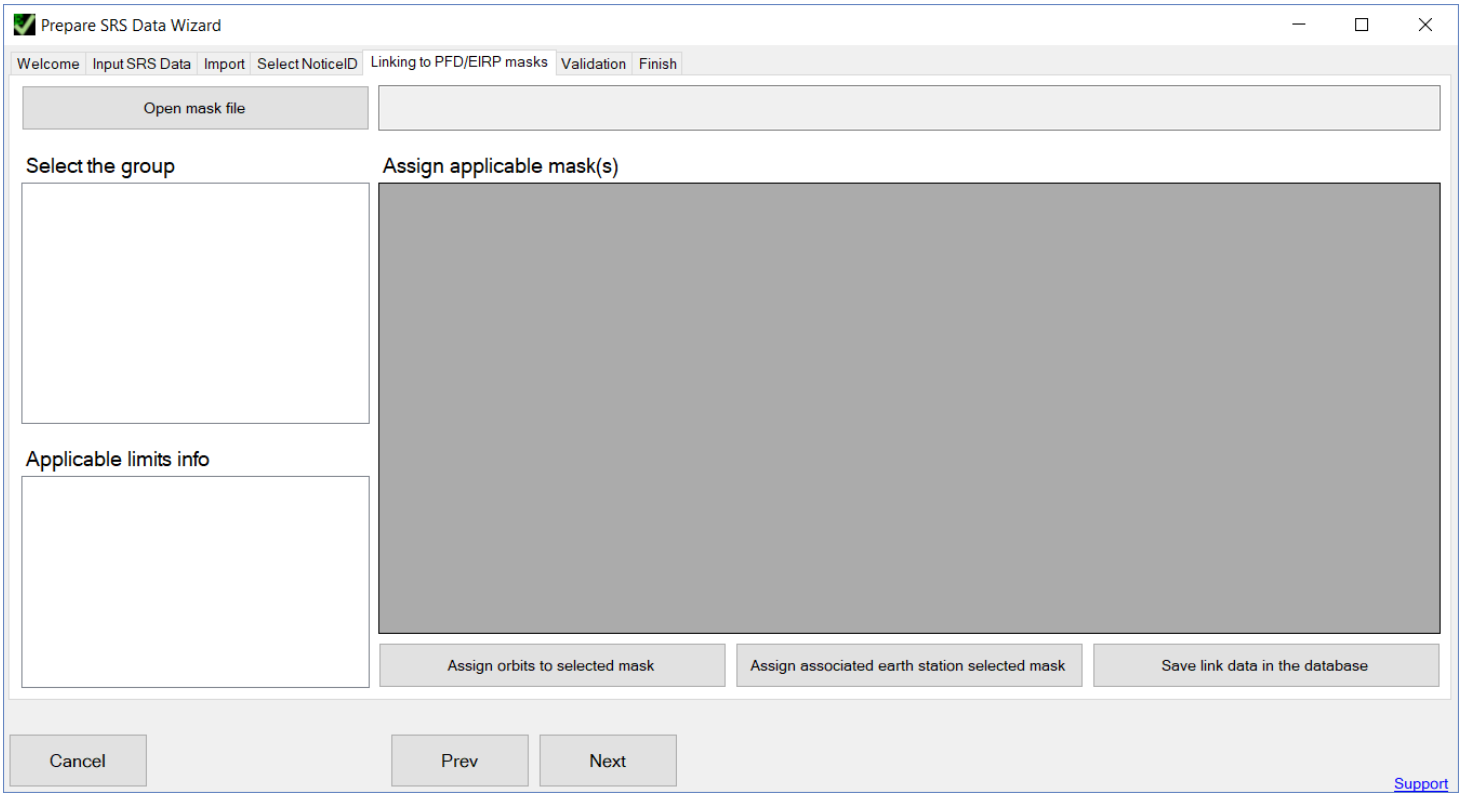

Figure 34: Mask linking starting dialog

One of the main features of ***EPFDPrepare*** is helping to create the mask link tables in SRS database that are needed to link each mask to specific examination frequency assignment group.

Process starts by clicking “Open mask file”.

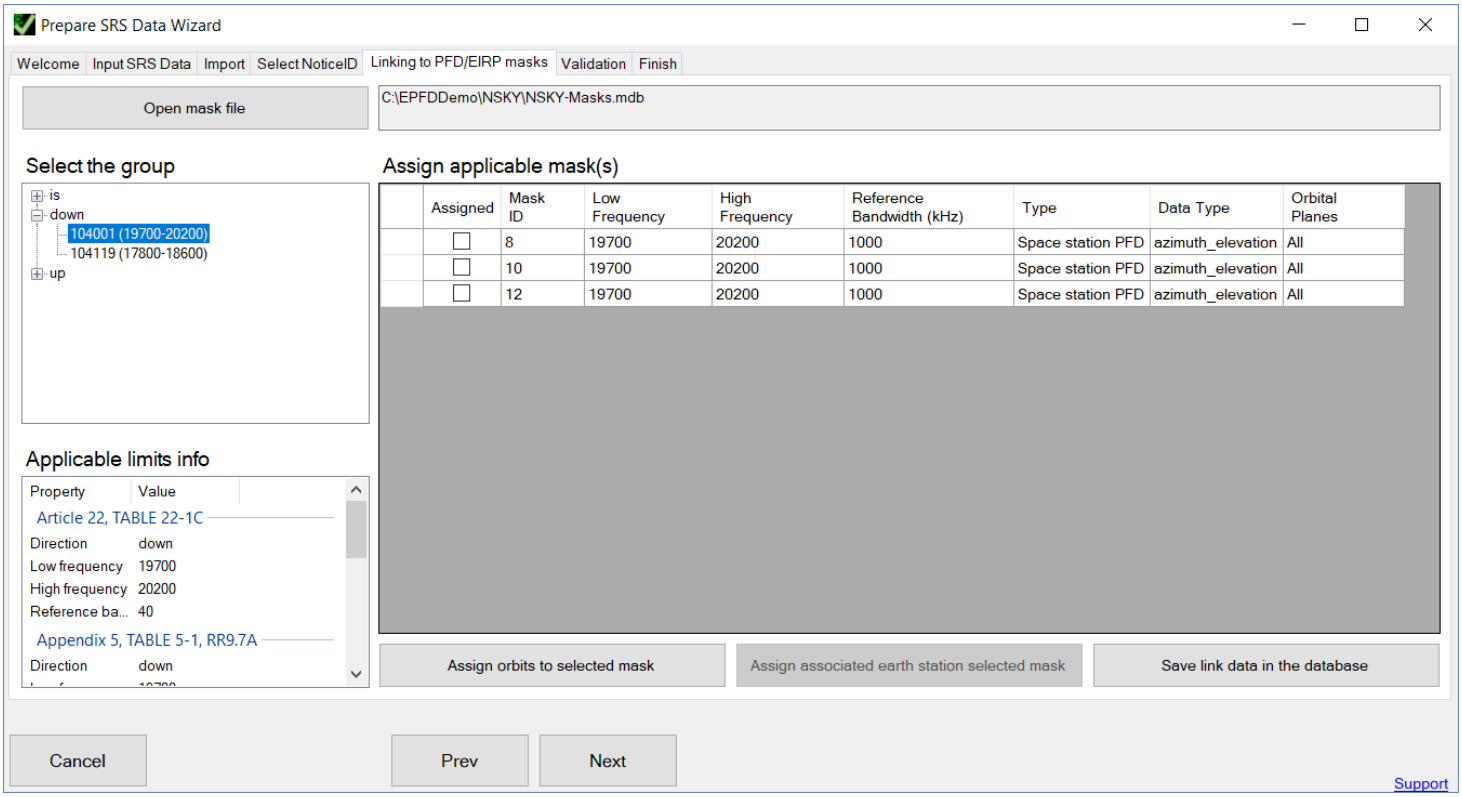

Figure 35: Opening mask database

First, we need to open mask database containing all the masks in XML-format.

After the database is opened, the list of groups is generated which are overlapping with the masks present in the database.

The list is split into three categories – groups subject to EPFD on downlink (down), EPFD on uplink (up) and EPFD on inter-satellite link (is). Clicking any of these categories expands the list of associated groups that are subject to the corresponding limits.

When the user clicks group, the list of applicable masks is displayed in the table ***Assign applicable mask(s)***.

Applicable limits info is provided in the box of the bottom of the page that displays the list of RR Article 22 and 9.7A/B applicable limits for the currently selected group.

Using this information, the user can check the overlap between group and applicable limit, determine the requirement for the reference bandwidth (40 kHz, 1000 kHz or both) and accordingly assign the mask to the group.

To assign specific mask the selected group, ***Assigned*** field in the table should be checked.

Moreover, it is possible to assign each mask to different orbits. For this, select the mask and press ***Assign orbit to selected mask***.

In this example, we have three different masks, which we would like to assign to different sets of orbital planes 1-8, 9-14, 15-19.

Example below is given applying the mask to orbits 1-8.

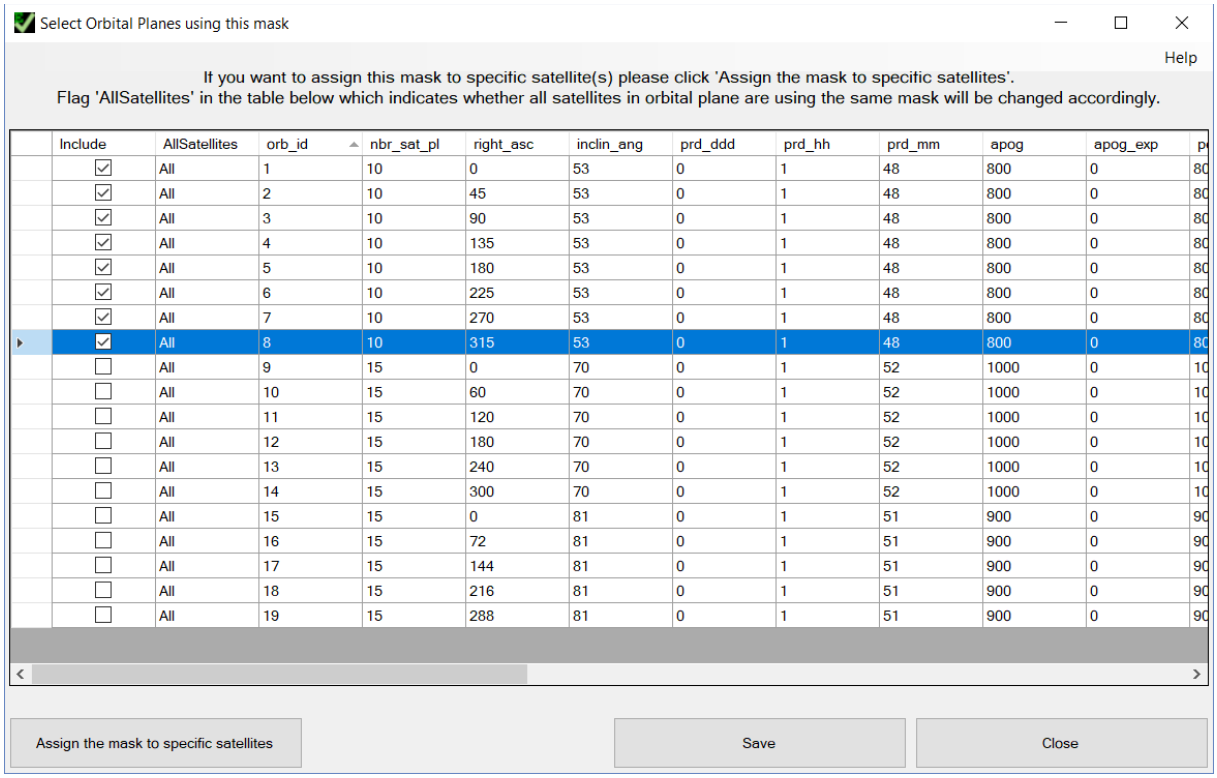

Figure 36: Assigning orbits to specific mask

Under certain circumstances user may require applying different masks to different satellites.

This can be done by clicking ‘Assign the mask to specific satellites.

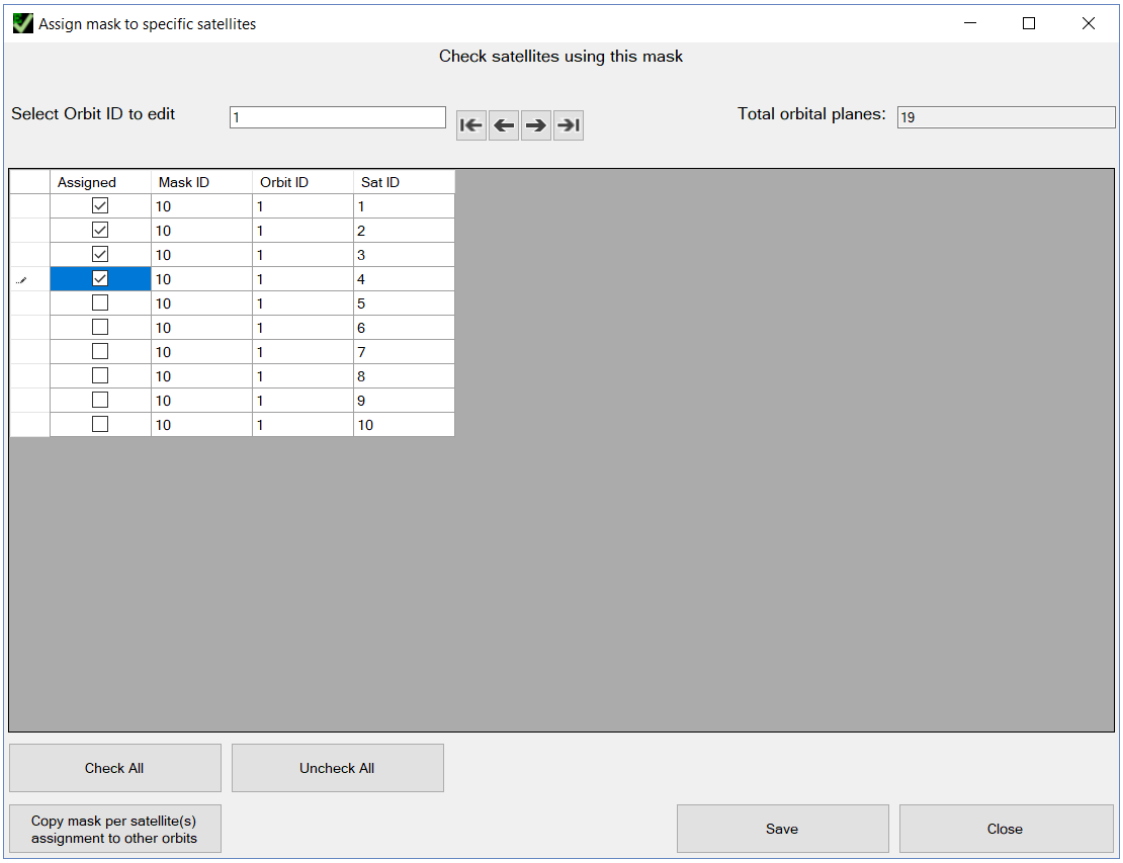

Figure 37. Assigning the mask to satellites

After selection of satellites is done, click ‘Save’.

Now window shows that only satellites 1 to 4 in orbital plane 1 will be using this mask.

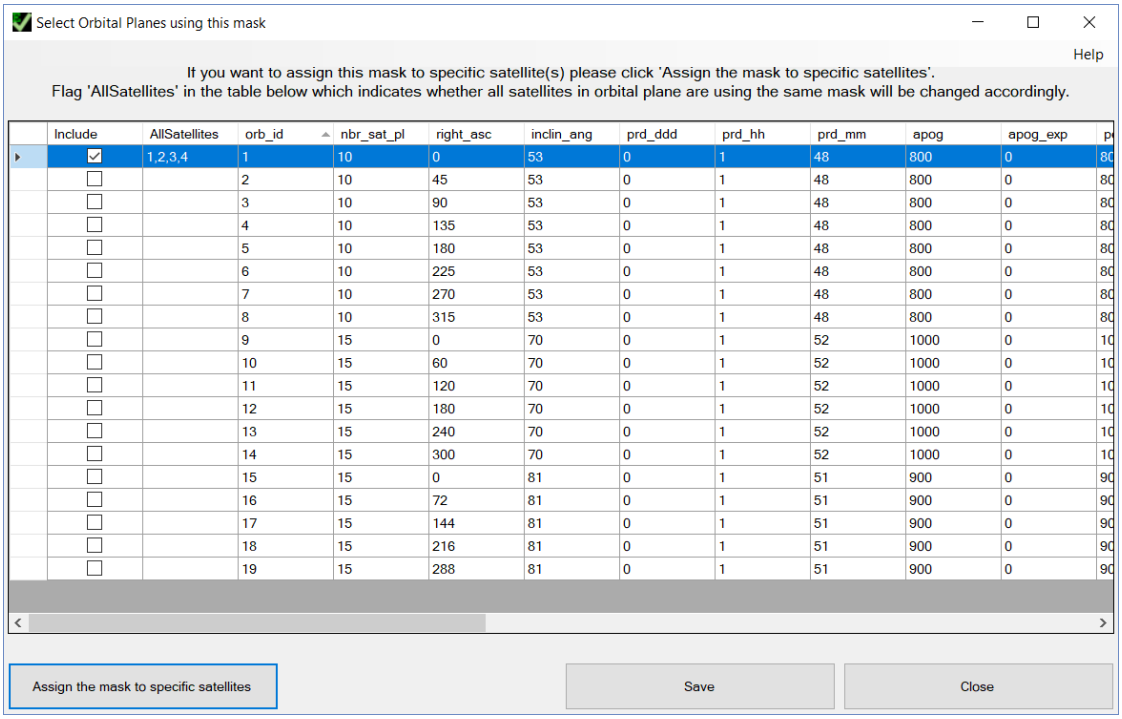

Figure 38.

Please note, that normally it may be enough to apply single mask to all orbital planes.

Possibility to assign masks to different satellites and orbits is given to address complex scenarios.

This step is repeated in case there are different applicable reference bandwidths of the limit and we have different masks for each of the reference bandwidth.

As it was already mentioned it is not necessary to assign the same masks to different groups, it is enough to define scenario for single group covering specific applicable limit. If there are several groups operating in the same frequency band using the same mask, the software will select only one group for validation.

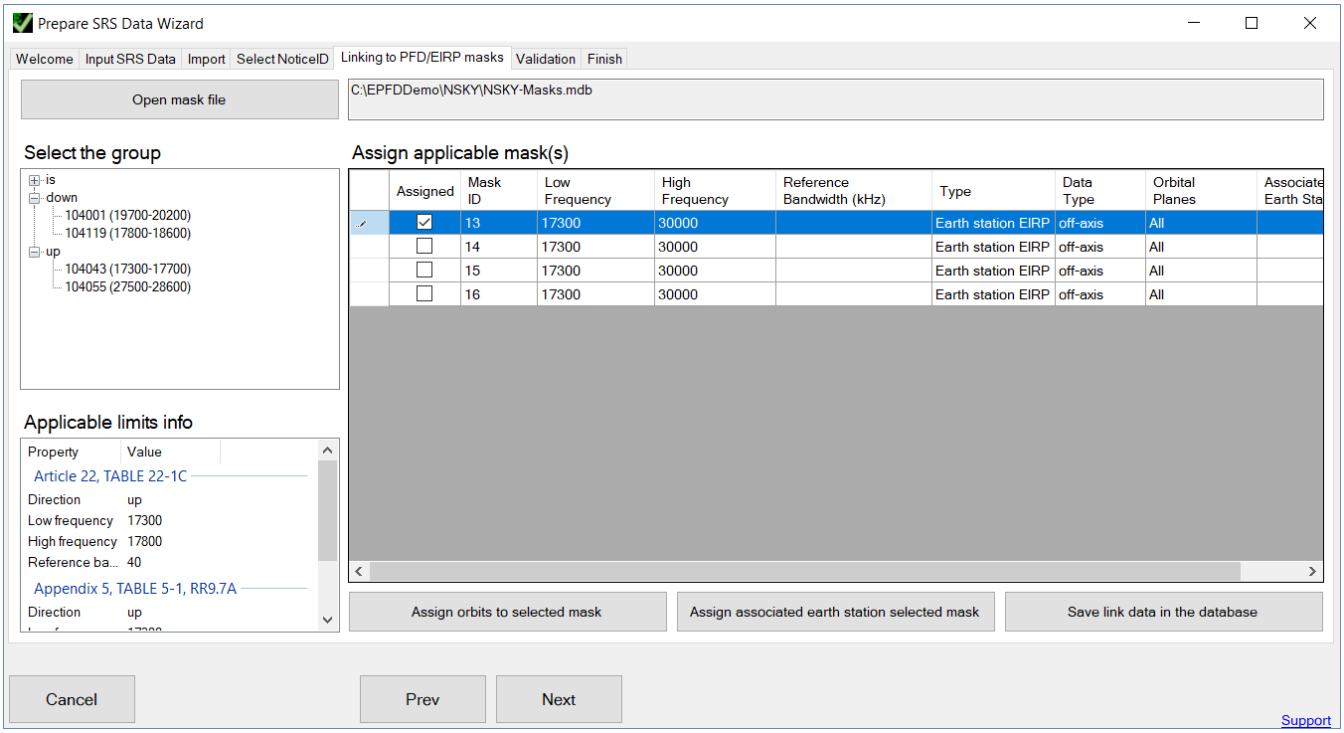

Figure 39: Assigning EIRP masks to specific group

For the uplink, we need to assign earth station EIRP mask.

The procedure is like the previous case, but in addition, of assigning orbits it is possible to assign also type of earth station – whether it is typical or specific (having exact location).

To assign specific mask to the associated earth station, select the mask and press ***Assign associated earth station for selected mask***.

In the dialog below user can select earth station to be considered for selected group and mask. Choosing different typical earth stations would not change the results since transmission characteristics of the earth station are represented by EIRP mask under consideration. However, if there are different types of earth stations – typical or specific, changing from typical to specific will affect the results. For specific earth station the worst-case geometry algorithm takes the coordinates of specific earth station as worst-case coordinates.

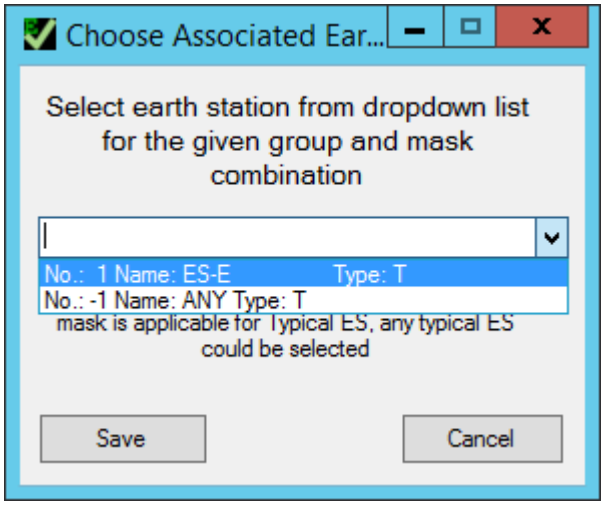

Figure 40: Assigning mask to associated earth station

In addition, in this dialog the user can select earth station No. -1 which signifies that any typical earth station is considered as associated to selected mask.

After the mask link data is established save it by pressing ***Save link data in the database***.

You may continue to the next step of data validation.

Validating the filing

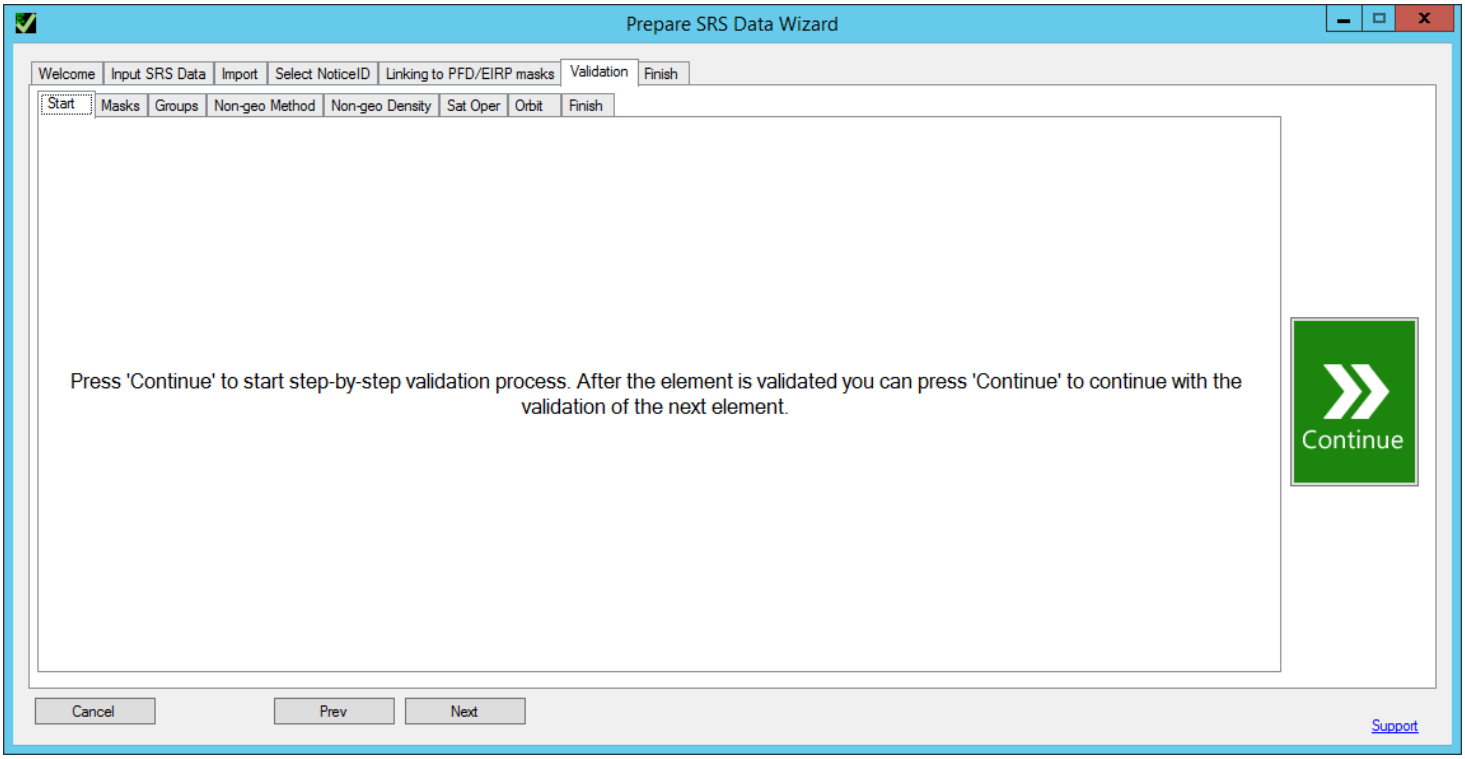

Figure 41: Validation process start screen

Next step is to continue with validation of the filing.

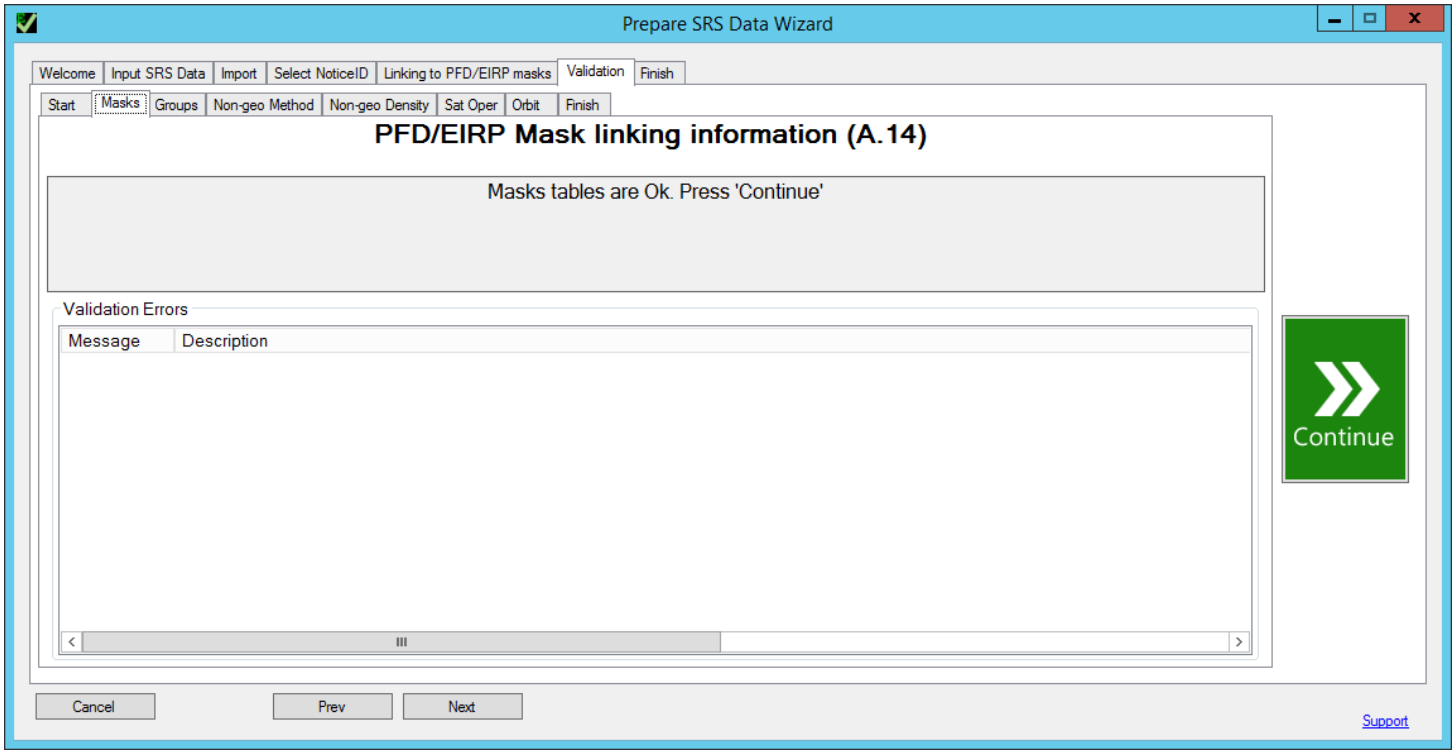

Figure 42: Validating mask link information

The wizard starts with checking of PFD/EIRP mask linking information.

This check includes verification of the data elements in the tables **mask_info**, **mask_lnk1**, **mask_lnk2**. Also, it checks whether all the applicable limits are covered by combination of masks linked to the group.

Possible error messages:

- Mask_info table has missing values in some of the fields
- Mask_info table has no mask type defined or wrong mask type
- Mask_lnk1/Mask_lnk2 table has missing grp_id.
- Mask_lnk1/Mask_lnk2 table contains record(s) with grp_id=X for which no record is present in grp table.
- Mask_lnk1/Mask_lnk2 table has missing mask_id.
- Mask_lnk1/Mask_lnk2 table contains record(s) with Mask_id=X for which no record is present in mask_info.
- Mask_lnk1/Mask_lnk2 table contains record(s) with for grp_id=X referring to mask_id=Y having non-overlapping applicable frequency range in mask_info table.
- Mask_lnk1/Mask_lnk2 table contains record(s) with orb_id=X which are not present in the filing.
- Direction: down/up/is, Limit: X, Low freq: Y, High Freq: Z is not covered by mask_lnk tables for all the orbits in the filing

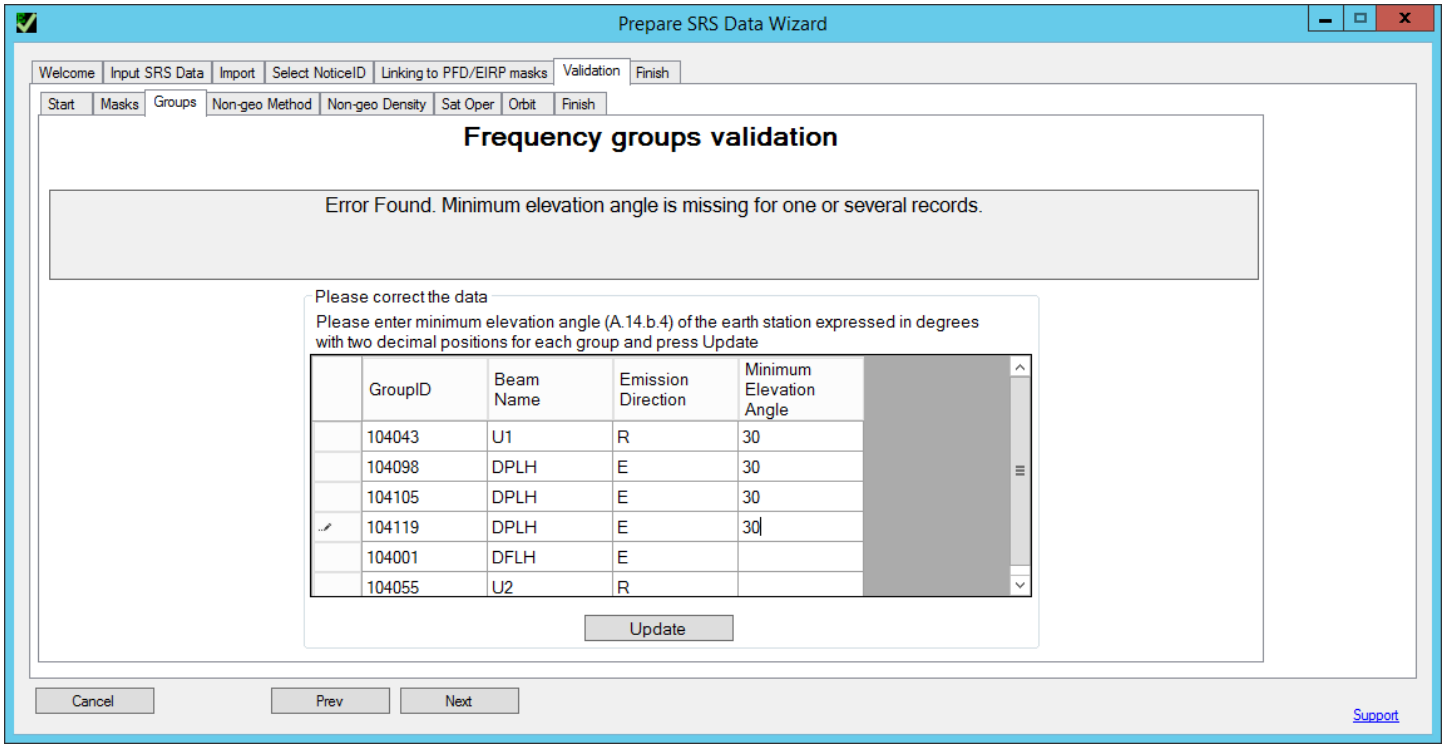

Figure 43: Validation frequency groups

This check includes verification of the data elements in the **grp** table. It checks whether the element A.14.b.4 (elev_min) is given for all the groups subject to examination.

If it is not present, the user can enter it for each group in the same table. After entering missing data, press ***Update***.

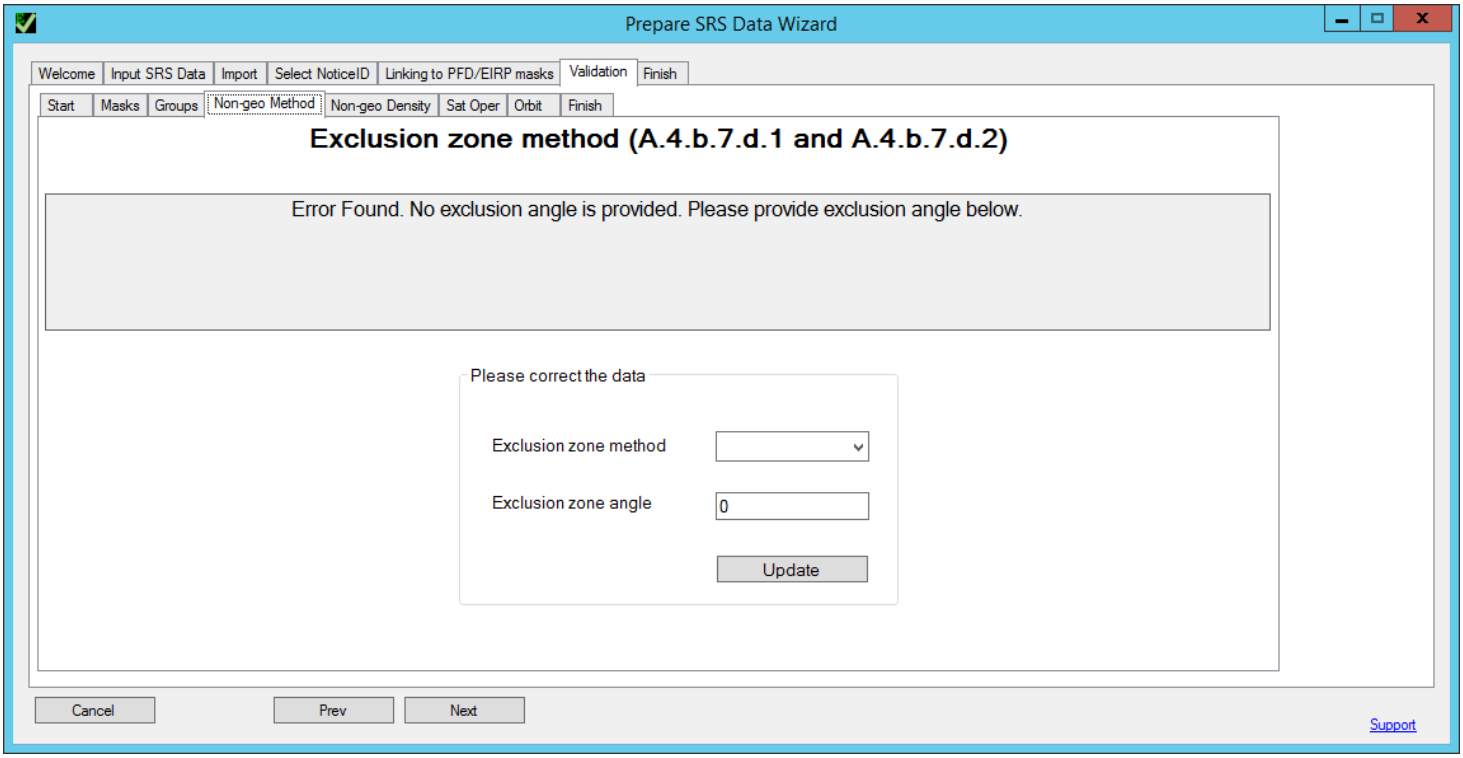

Figure 44: Validating exclusion zone method

This check includes verification of the data elements in the **non_geo** table. It checks exclusion zone method data elements.

If some data is missing or wrongly defined, the user can enter it. After entering missing data, press ***Update***.

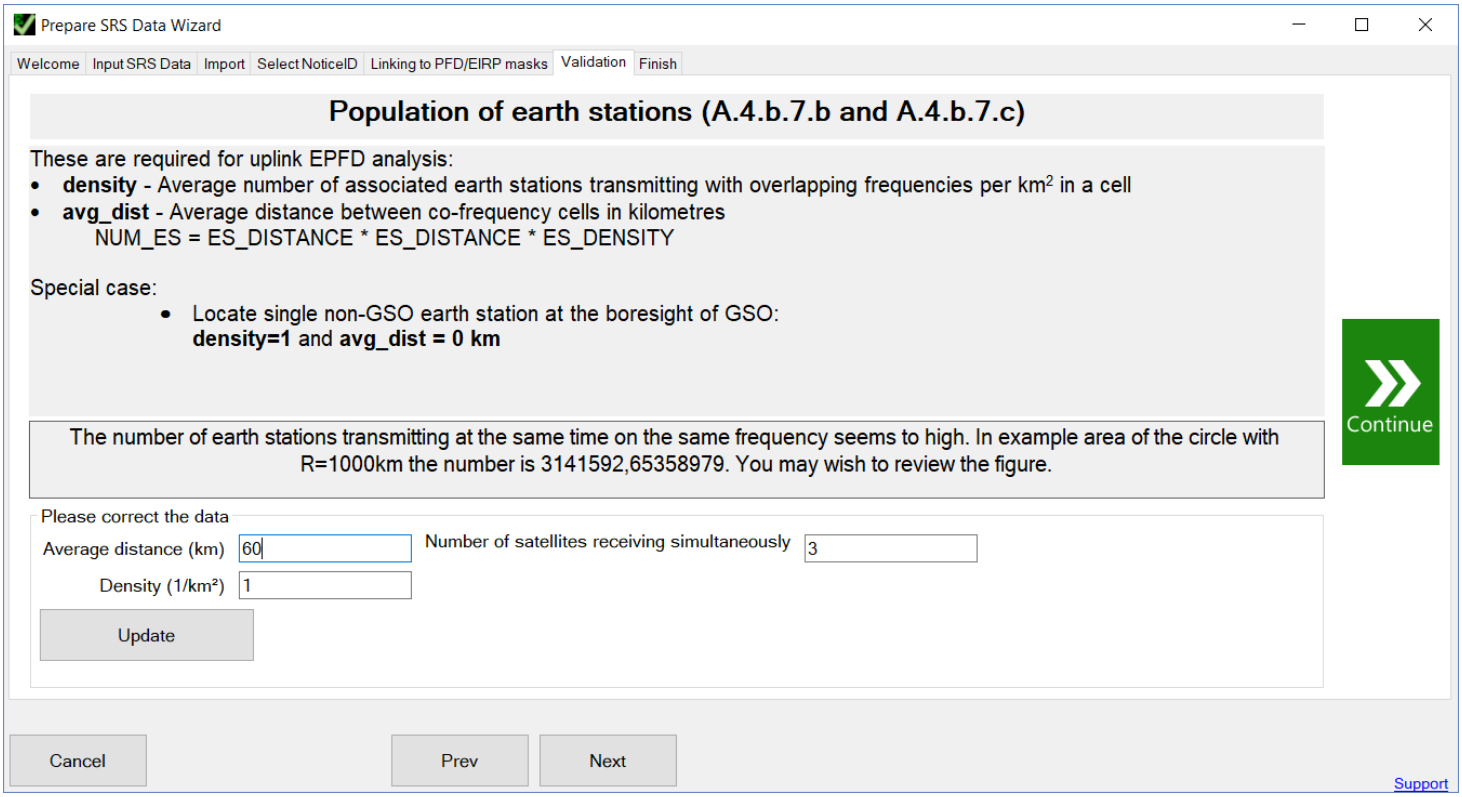

Figure 45: Validating earth station distribution

This check includes verification of the data elements in the **non_geo** table relating to earth station distribution parameters.

If calculated value of earth stations within an example circle is very high (more than 1000) it would give an error - the number of earth stations, transmitting at the same time on the same frequency seems to be high.

If some elements are missing or data looks unrealistic, the user can change it on the same page. After the entering missing data, press ***Update***.

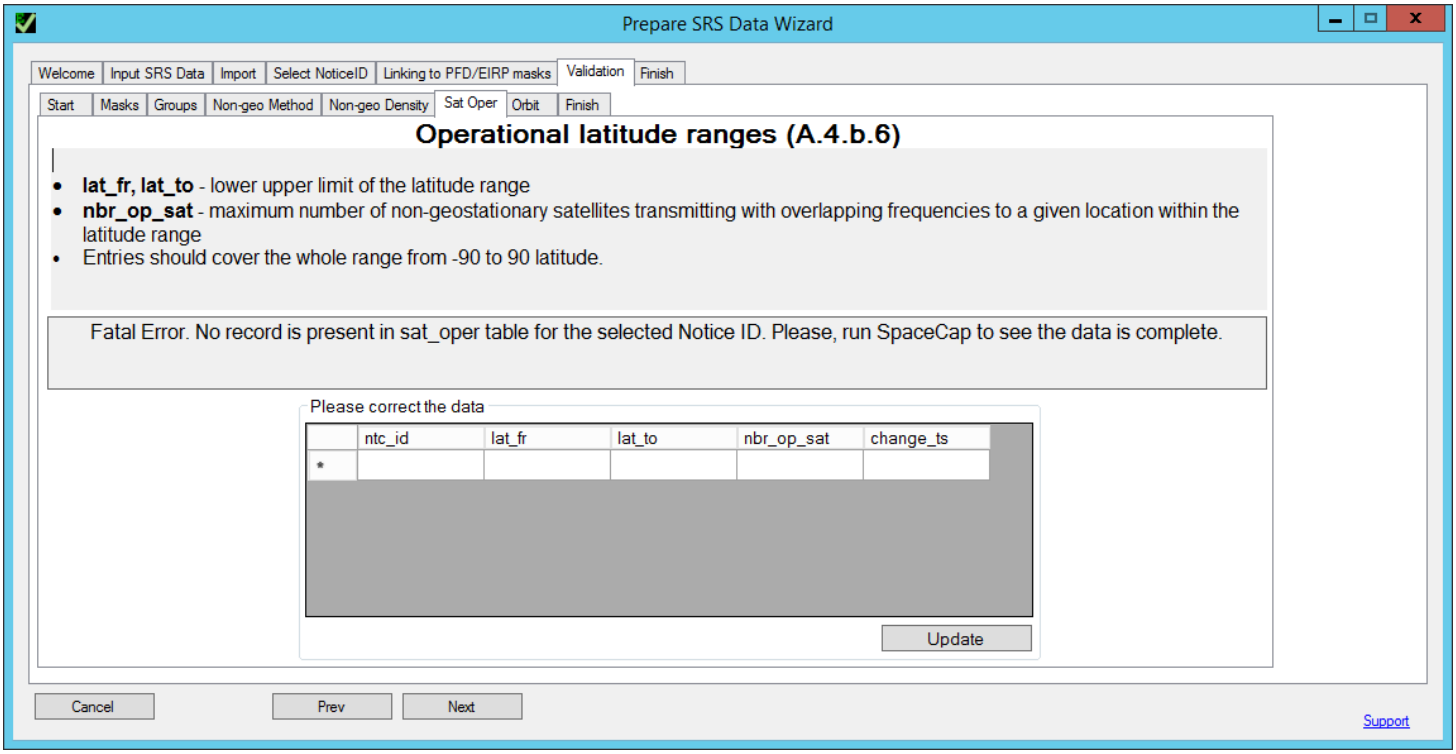

Figure 46: Validating operational latitude ranges

This check includes verification of the data elements in the **sat_oper** table relating to operational latitude range of the system.

Some filings in SRS do not have this data captured. When the filing is imported from SRS, this table stays empty and it is necessary to provide the data for the whole range -90 to 90 latitude.

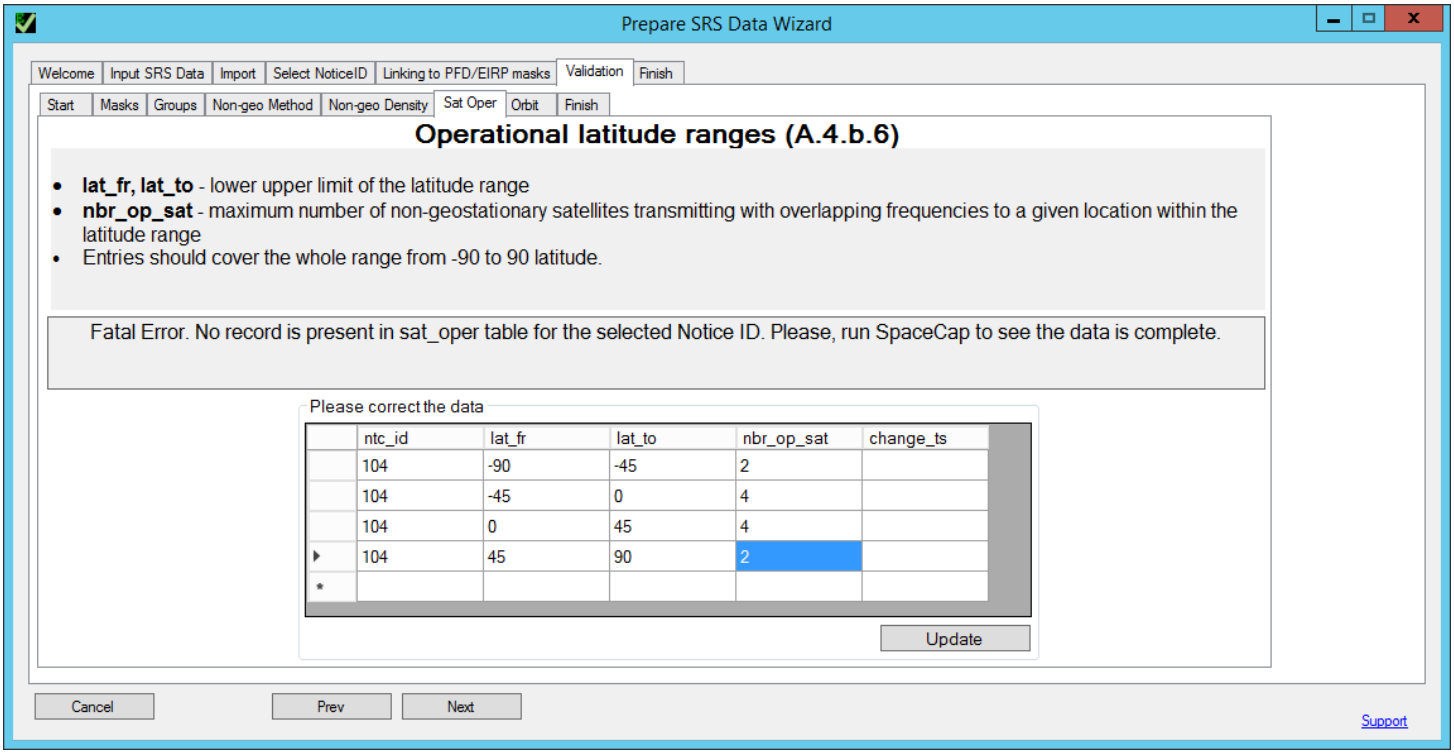

Figure 47: Entering operational latitude ranges

If data is missing, the user can enter it on the same page.

Start entering data from -90 and finish with 90-degree latitude. In the given example, we are populating the table with different ranges, such as -90 to -45, -45 to 0, 0 to 45, 45 to 90.

After the entering missing data, press ***Update***.

Possible error messages:

- White spaces found in latitude range -90 to 90. Table should cover whole latitude range.
- lat_fr should be less than Lat_to.
- Overlapping latitude ranges found. Latitude ranges should not overlap.
- No number of satellites are given for one or several records.
- No record is present in sat_oper table for the selected Notice ID. Please, run SpaceCap to see the data is complete.

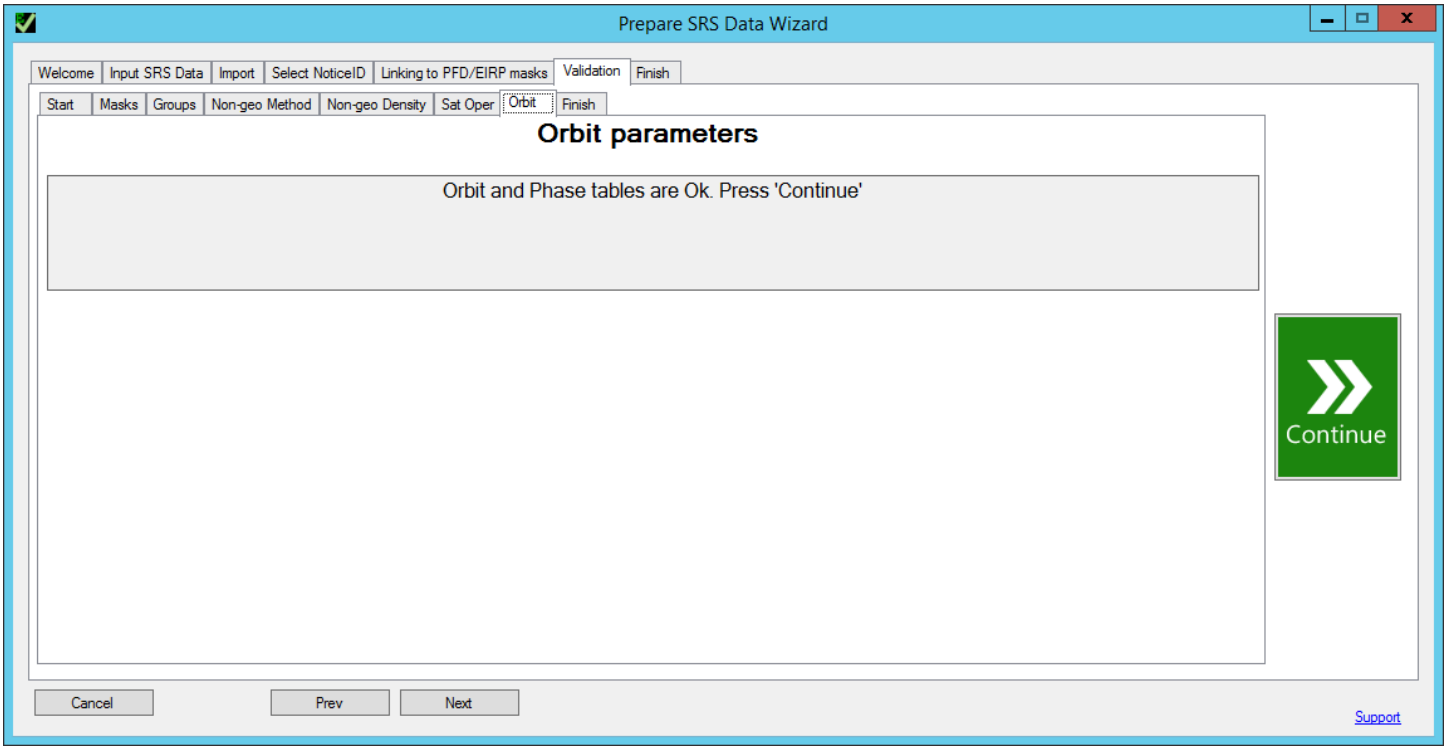

Figure 48: Validating orbit parameters

This check includes verification of the data elements in the **orbit** and **phase** tables.

If some elements are missing or wrongly captured it would suggest running SpaceCap to correct the data.

Possible error messages:

- f_stn_keep (station keeping flag, A.4.b.6.c) is not given or not equal to Y or N
- op_ht or op_ht_exp (minimum transmitting altitude, A.4.b.4.f) is not given or not equal to Y or N
- Station keeping (A.4.b.6.c) is used but station keeping period value is not fully defined.
- f_precess (precession flag, A.4.b.6.e) is not given or not equal to Y or N
- Precession is used (A.4.b.6.e) but precession value is not defined.
- Phase table does not contain phase angles for all the satellites in the plane.

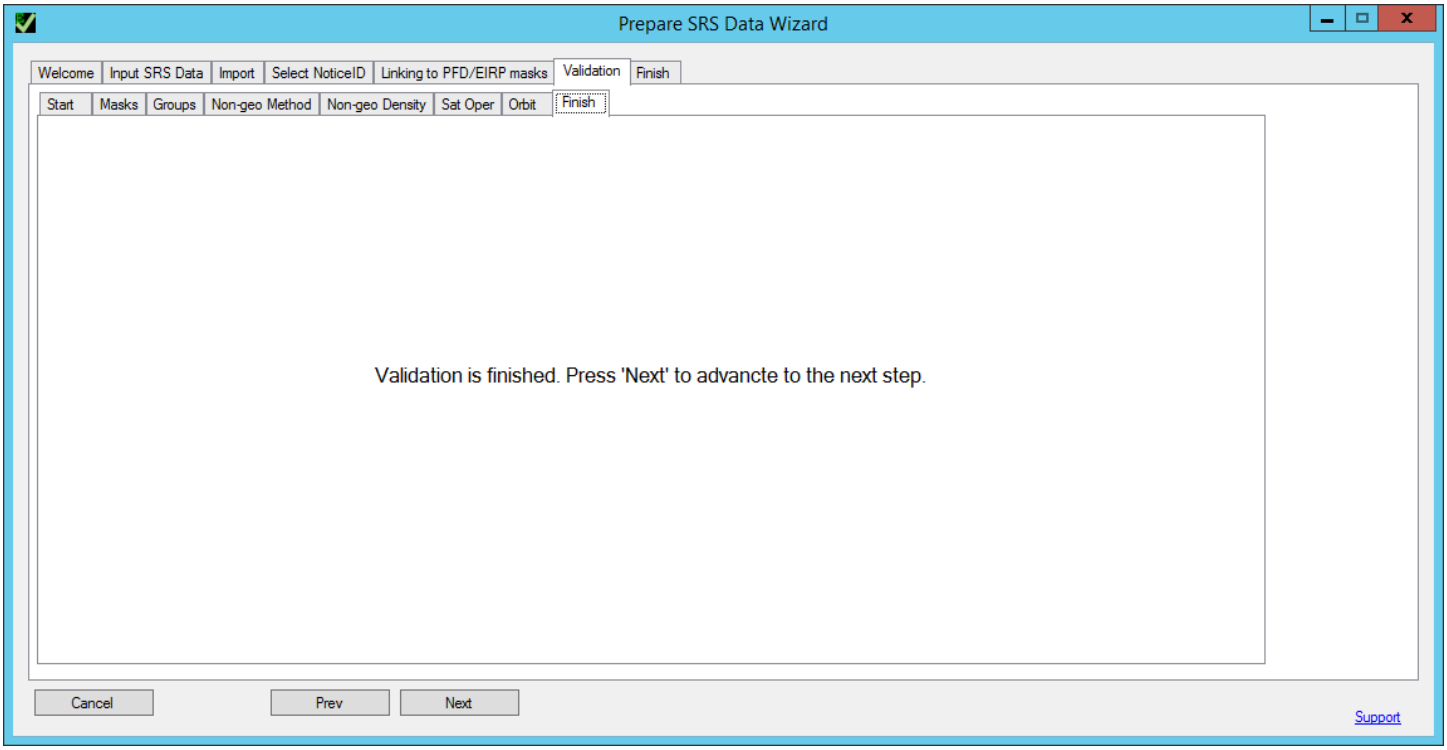

Figure 49: Finishing validation

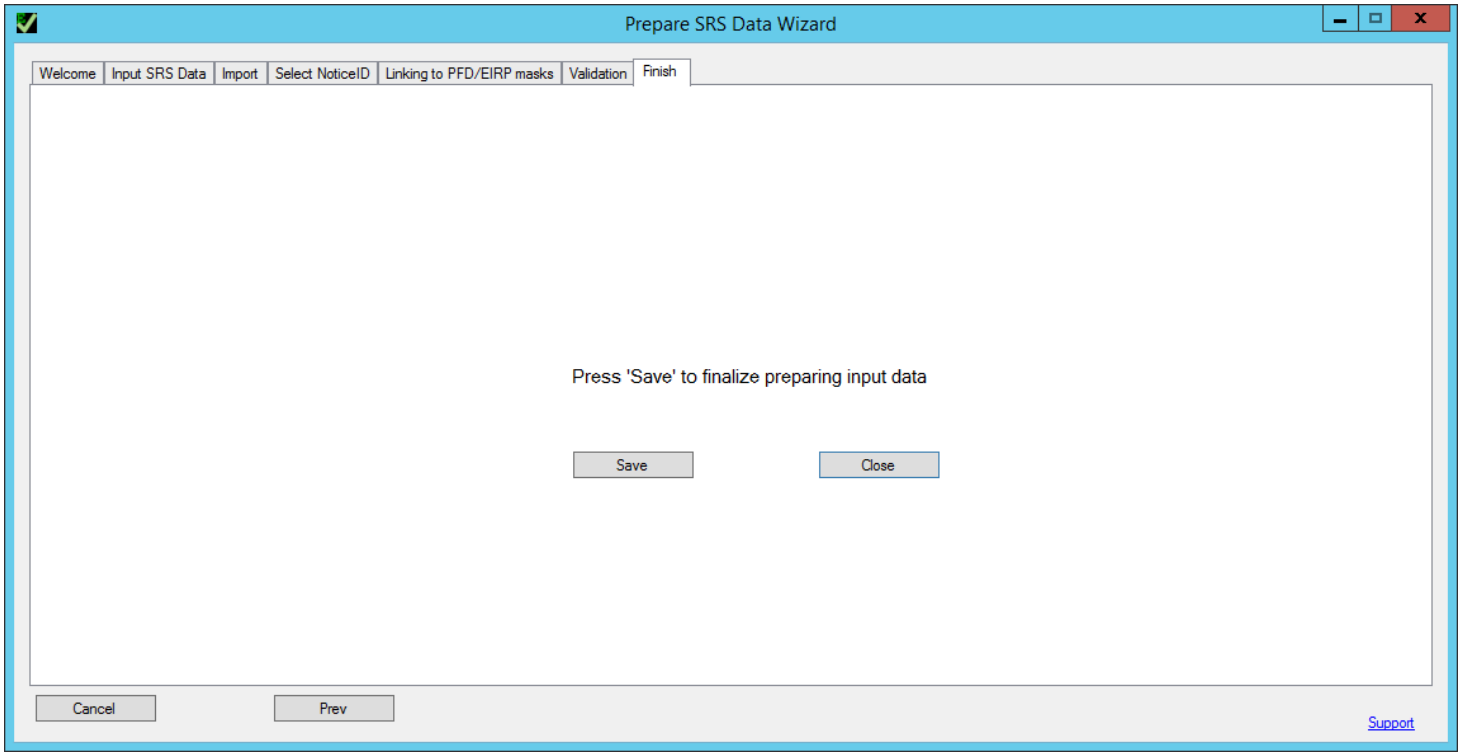

Figure 50: Saving SRS-database

After the validation is finished press ***Save*** to save the final database. Resulting database can be provided as an input to validation tools on the main screen of ***EPFDPrepare***.

Running EPFDPrepare as a stand-alone tool

When ***EPFDPrepare*** is launched from Start Menu (not from GIBC interface), the starting screen will be different.

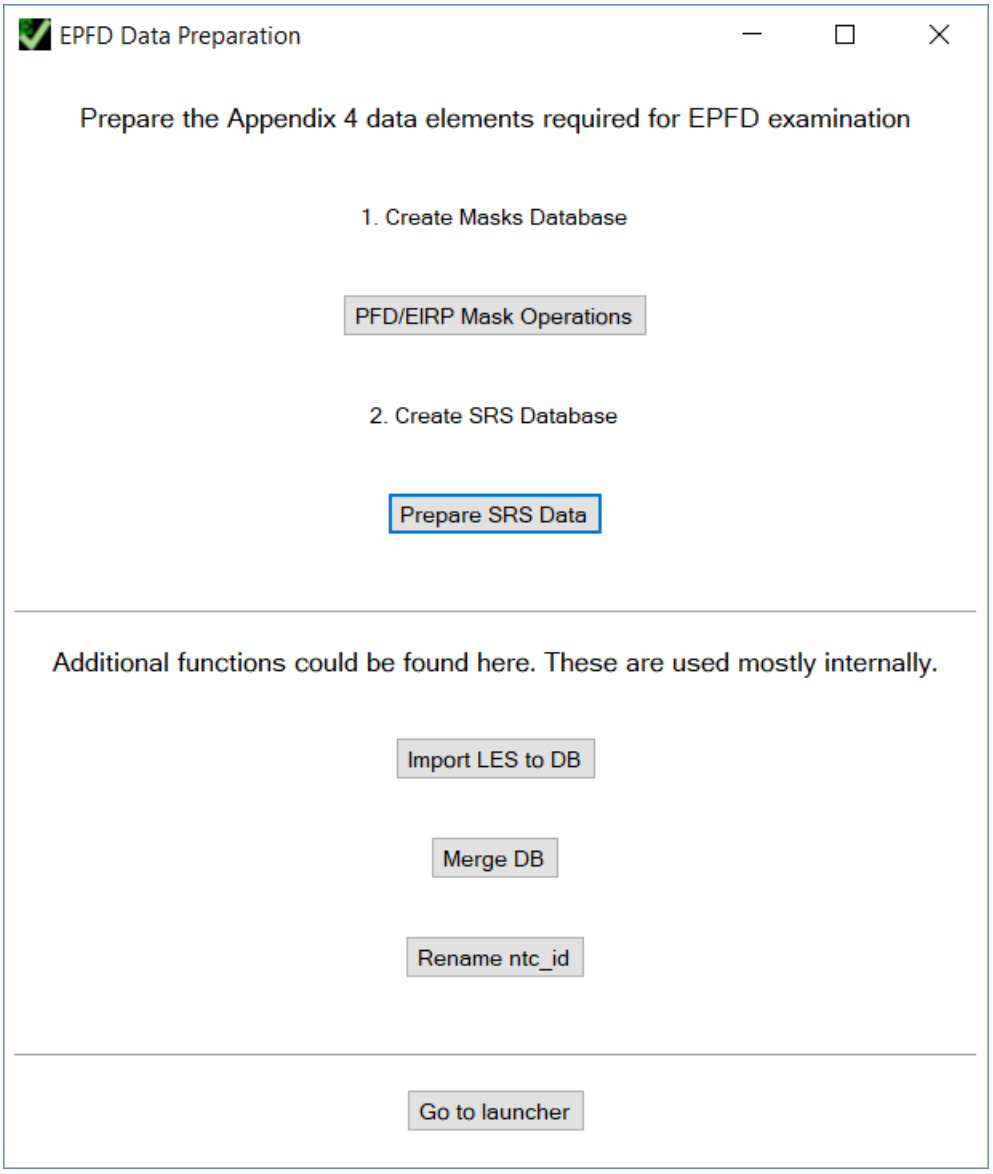

Figure 51: EPFDPrepare start screen

Three additional functions are appearing –***Rename ntc_id***, ***Merge DB*** and ***Rename ntc_id***.

These are functions are used mostly internally in BR.

You can also start stand-alone EPFD validation launcher by clicking ***Go to launcher***.

Stand-alone launcher is an alternative to GIBC interface.

It gives more control in terms of output database locations, possibility to review log-files, hardware options (number of CPU threads to use).

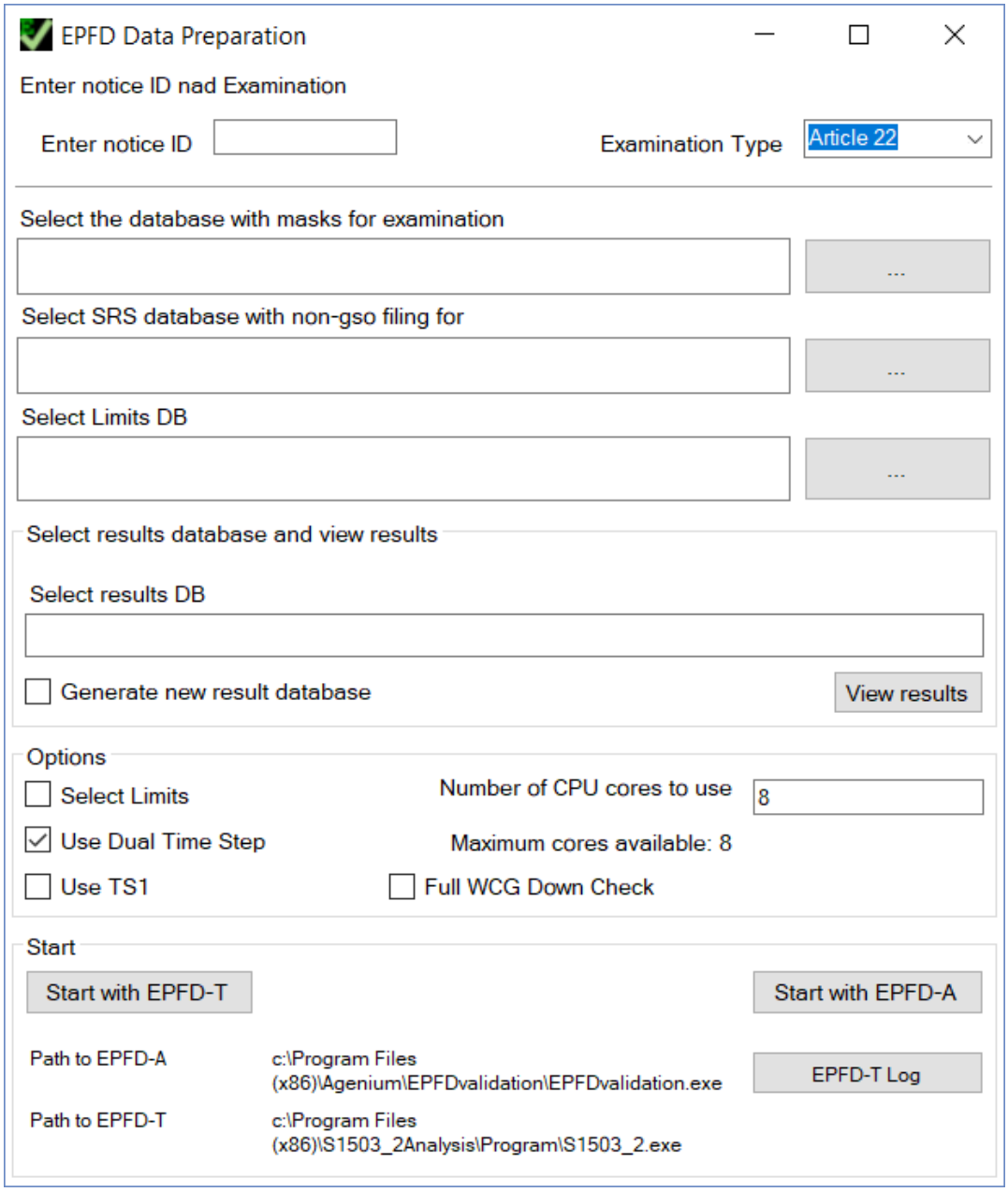

Figure 52: Stand-alone launcher

ANNEX 1. EPFD RUN DEFINITION / RESULTS DATABASE

This section contains the definition of the runs as well as the results returned by the two software tools.

The GIBC (Graphical Interface for Batch Calculation) software uses the ***epfd_results.MDB*** database and stores in table ***run_def*** the parameters specifying the run options including the identifier (ntc_id) of the notice to be examined, either the ntc_id of the non-geostationary system or the ntc_id of the large earth station.

run_def TABLE				INPUT table
Data item	**Data Type**	**Field Size**	**Description**	**Validation**
run_def_id	Number	Long Integer	Unique identifier of the run definition	Primary key [Identity]
run_date_time	Date/Time		Date/Time stamp when the run is requested	
ntc_id	Number	Long Integer	Unique identifier of the SRS notice to be examined	Foreign key (SRS)
run_type	Text	3	Art22 [A22], Art97A [97A], Art97B [97B]	
sw_name	Text	1	Software selected, Agenium [A] or Transfinite [T], to perform the examination	
srs_location	Text	255	Location of the SRS database file (MDB)	
masks_location	Text	255	Location of the PFD and EIRP MASKS database file (MDB)	
epfd_limits_location	Text	255	Location of the EPFD LIMITS reference database file (MDB)	
epfd_runs_location	Text	255	Location of the EPFD RUNS database file (MDB)	

result_def TABLE				OUTPUT table
Data item	**Data Type**	**Format**	**Description**	**Validation**
run_def_id	Number	Long Integer	Unique identifier of the run definition	Foreign key
sw_name	Text	1	Software used, Agenium [A] or Transfinite [T], to perform this run	
sw_version	Text	10	Version number of the software used	
ntc_id	Number	Long Integer	Unique identifier of the SRS notice examined	Foreign key (SRS)
class	Text	1	NON-GSO system [N] or Large Earth Station [L]	
name	Text	30	Name of the NON-GSO system or Large Earth Station examined	
status	Text	1	Pass [P], Fail [F], Error [E]	
feedback	Text	255	Error information	
completed_date_time	Date/Time		Date/Time stamp when the run is completed	

results TABLE				OUTPUT table
Data item	**Data Type**	**Format**	**Description**	**Validation**
run_def_id	Number	Long Integer	Unique identifier of the run definition	Foreign key
result_id	Number	Long Integer	Unique ID of the result data (Identity)	
epfd_type	Text	1	Up [U], Down [D], IS [I]	
freq_used	Number	Double	Frequency in MHz	
ntc_id	Number	Long Integer	The unique id of the notice used along with run_def.ntc_id to define this run (9.7A/B only)	
dish_size	Number	Double	Dish size in metres	
service	Text	1	FSS [F] or BSS [B]	
beamwidth	Number	Double	Beamwidth in degrees	
gain_pattern	Text	50	Gain pattern used	
reference_bandwidth	Number	Double	Reference bandwidth in MHz	
course_timestep_used	Number	Double	Course time step in seconds	
fine_timestep_used	Number	Double	Fine time step in seconds	
number_timesteps	Number	Double	Number of time steps	
worst_es_lat	Number	Double	Worst Earth Station location latitude (Degrees)	
worst_es_long	Number	Double	Worst Earth Station location latitude (Degrees)	
worst_gso_long	Number	Double	Worst GSO longitude (Degrees)	
pass	Yes/No		Has this check passed?	
percentage_complete	Number	Double	How far this check has progressed?	

cdf TABLE				OUTPUT table
Data item	**Data Type**	**Format**	**Description**	**Validation**
result_id	Number	Long Integer	Unique ID of the result set	Foreign key
epfd	Number	Double	In dB(W/m^2)·reference bandwidth	
limit_percentage	Number	Double	The limit percentage value	
calc_percentage	Number	Double	The calculated percentage value	
sequence	Number	Long Integer	Sequence number	

ANNEX 2. SRS DATABASE REQUIRED PARAMETERS

This section details the parameters that the EPFD software uses from the SRS database.

Format Description

Value	Description
X	Used to describe alphanumeric data. e.g. X(9) specifies a 9 character field containing alphanumeric data XXX is equivalent to X(3).
9	Used to describe digits
'.'	Shows the position of a decimal point
S	Implies a sign (sign leading separate) e.g. S999.99 implies a numeric field with a range of values from -999.99 to +999.99 99 implies a numeric field with a range of values from 0 to 99

notice

Data Item	Data Type	Format	Description	Validation
ntc_id	Number	9(9)	Unique identifier of the notice	Primary Key
ntc_type	Text	X	code indicating if the notice is of a geostationary satellite [G], non-geostationary satellite [N], specific earth station [S] or typical earth station [T]	value != NULL
d_rcv	Date/Time	9(8)	date of receipt of the notice	
ntf_rsn	Text	X	code indicating that the notice has been submitted under RR1488 [N], RR1060 [C], RR1107 [D], 9.1 [A], 9.6 [C], 9.7A [D], 9.17 [D], 11.2 [N], 11.12 [N] , AP30/30A-Articles 2A, 4 & 5 [B], AP30B-Articles 6 & 7 [P] , AP30B-Article 8 [N] or Res49 [U]	The software looks a value that is 'C' or 'N'
st_cur	Text	XX	current processing status of the notice	The software looks for a value that is '50' in the Article 9.7A check

non_geo

Data Item	Data Type	Format	Description	Validation
ntc_id	Number	9(9)	Unique identifier of the notice	Primary Key
sat_name	Text	X(20)	Name of the satellite	
nbr_sat_td	Number	9(4)	Maximum number of co-frequency tracked non-geostationary satellites receiving simultaneously	value != NULL && value > 0
avg_dist	Number	9(3).9	Average distance between co-frequency cells in kilometres	value != NULL && value > 0
density	Number	9(6).99	Average number of associated earth stations transmitting with overlapping frequencies per km2 in a cell	value != NULL && value > 0
f_x_zone	Text	X	Flag indicating the type of zone: if the exclusion zone angle is the angle alpha [Y] or the angle X [N]	value != NULL && (value == 'Y' || 'N')
x_zone	Number	99.9	Width of the exclusion zone in degrees	value != NULL && value > 0

orbit

Data Item	Data Type	Format	Description	Validation
ntc_id	Number	9(9)	Unique identifier of the notice	Foreign Key
orb_id	Number	99	Sequence number of the orbital plane	Primary Key
nbr_sat_pl	Number	99	Number of satellites per non-geostationary orbital plane	value != NULL && value > 0
right_asc	Number	999.99	Angular separation in degrees between the ascending node and the vernal equinox	value != NULL
inclin_ang	Number	999.9	Inclination angle of the satellite orbit with respect to the plane of the Equator	value != NULL
apog	Number	9(5).99	The farthest altitude of the non-geostationary satellite above the surface of the Earth or other reference body – expressed in kilometres Distances > 99999 km are expressed as a product of the values of the fields “apog” and “apog_exp” (see below) e.g.: 125 000 = 1.25 x 10^5	value != NULL && value > 0
apog_exp	Number	99	Exponent part of the apogee expressed in power of 10 To indicate the exponent; give 0 for 10^0, 1 for 10^1, 2 for 10^2, etc.	value != NULL && value >= 0
perig	Number	9(5).99	The nearest altitude of the non-geostationary satellite above the surface of the Earth or other reference body – expressed in kilometres Distances > 99 999 km are expressed as a product of the values of the fields “perigee” and “perig_exp” (see `below) e.g.: 125 000 = 1.25 x 10^5	value != NULL && value > 0
perig_exp	Number	99	Exponent part of the perigee expressed in power of 10 To indicate the exponent; give 0 for 10^0, 1 for 10^1, 2 for 10^2, etc.	value != NULL && value >= 0
perig_arg	Number	999.9	Angular separation (degrees) between the ascending node and the perigee of an elliptical orbit. If RR No. 9.11A applies	

orbit (continued)

Data Item	Data Type	Format	Description	Validation
op_ht	Number	99.99	Minimum operating height of the non-geostationary satellite above the surface of the Earth or other reference body – expressed in kilometres Distances > 99 km are expressed as a product of the values of the fields “op_ht” and “op_ht_exp” (see below) e.g.: 250 = 2.5 x 10^2	value != NULL && value > 0
op_ht_exp	Number	99	Exponent part of the operating height expressed in power of 10 To indicate the exponent; give 0 for 10^0, 1 for 10^1, 2 for 10^2, etc.	value != NULL && value >= 0
f_stn_keep	Text	X	Flag indicating if the space station uses [Y] or does not use [N] station-keeping to maintain a repeating ground track	value != NULL && (value == ‘Y’ || ‘N’)
rpt_prd_dd	Number	999	Day part of constellation repeat period (s)	
rpt_prd_hh	Number	99	Hour part of constellation repeat period (s)	
rpt_prd_mm	Number	99	Minute part of constellation repeat period (s)	
rpt_prd_ss	Number	99	Second part of constellation repeat period (s)	
f_precess	Text	X	Flag indicating if the space station should [Y] or should not [N] be modelled with specific precession rate of the ascending node of the orbit instead of the J2 term	value != NULL && (value == ‘Y’ || ‘N’)
precession	Number	999.99	For a space station that is to be modelled with specific precession rate of the ascending node of the orbit instead of the J2 term, the precession rate in degrees/day measured counter-clockwise in the equatorial plane	If f_precess == ‘Y’ then value != NULL && value >= 0
long_asc	Number	999.99	Longitude of the ascending node for the j th orbital plane measured counter-clockwise in the equatorial plane from the Greenwich meridian to the point where the satellite orbit makes its south-north crossing of the equatorial plane (0° =j < 360°)	value != NULL && value >= 0
keep_rnge	Number	99.9	Longitudinal tolerance of the longitude of the ascending node	If f_stn_keep == ‘Y’ then value != NULL && value >= 0

phase

Data Item	Data Type	Format	Description	Validation
ntc_id	Number	9(9)	Unique identifier of the notice	Foreign Key
orb_id	Number	99	Sequence number of the orbital plane	Foreign Key
orb_sat_id	Number	99	Satellite sequence number in the orbital plane	value != NULL && value >= 0
phase_ang	Number	999.9	Initial phase angle of the satellite in the orbital plane If RR No. 9.11A applies	value != NULL && value >= 0

freq

Data Item	Data Type	Format	Description	Validation
grp_id	Number	9(9)	Unique identifier of the group	Foreign Key
freq_max	Number	9(6).9(6)	Maximum frequency in MHz (assigned frequency + half bandwidth)	value != NULL && value >0
freq_min	Number	9(6).9(6	Minimum frequency in MHz (assigned frequency - half bandwidth)	value != NULL && value >0

grp

Data Item	Data Type	Format	Description	Validation
ntc_id	Number	9(9)	Unique identifier of the notice	Foreign Key
grp_id	Number	9(9)	Unique identifier of the group	Primary Key
emi_rcp	Text	X	Code identifying a beam as either transmitting [E] or receiving [R]	value != NULL && (value == 'E' || 'R')
beam_name	Text	X(8)	Designation of the satellite antenna beam	
elev_min	Number	S9(3).99	Minimum elevation angle at which any associated earth station can transmit to a non-geostationary satellite or minimum elevation angle at which the radio astronomy station conducts single-dish or VLBI observations	value != NULL && value >= 0
freq_min	Number	9(6).9(6)	Minimum frequency in MHz (assigned frequency – half bandwidth) (of all frequencies for this group)	value != NULL && value > 0
freq_max	Number	9(6).9(6)	Maximum frequency in MHz (assigned frequency + half bandwidth) (of all frequencies for this group)	value != NULL && value > 0
d_prot_eff	Date/Time	9(8)	date of protection of the frequency group	
d_rcv	Date/Time	9(8)	date of receipt of the list of frequency assignments pertaining to the group	
noise_t	Number	9(6)	receiving system noise temperature	Only validated for 9.7A/B checks

srv_cls

Data Item	Data Type	Format	Description	Validation
grp_id	Number	9(9)	Unique identifier of the group	Foreign Key
seq_no	Number	9(4)	Sequence number	value != NULL && value >= 0
stn_cls	Text	XX	class of station	

e_as_stn

Data Item	Data Type	Format	Description	Validation
grp_id	Number	9(9)	Unique identifier of the group	Foreign Key
seq_no	Number	9(4)	Sequence number	value != NULL && value >= 0
stn_name	Text	X(20)	Name of the transmitting or receiving station	
stn_type	Text	X	Code indicating if the earth station is specific [S] or typical [T]	value != NULL && (value == 'S' || 'T')
bmwdth	Number	999.99	Angular width of radiation main lobe expressed in degrees with two decimal positions	value != NULL && value > 0
lat_dec	Number	S9(3).9(4)	latitude in degrees with four decimals	value != NULL
long_dec	Number	S9(3).9(4)	longitude in degrees with four decimals	value != NULL

sat_oper

Data Item	Data Type	Format	Description	Validation
ntc_id	Number	9(9)	Unique identifier of the notice	Foreign Key
lat_fr	Number	S99.999	Lower limit of the latitude range	value != NULL
lat_to	Number	S99.999	Upper limit of the latitude range	value != NULL
nbr_op_sat	Number	9(4)	Maximum number of non-geostationary satellites transmitting with overlapping frequencies to a given location within the latitude range	value != NULL

mask_info

Data Item	Data Type	Format	Description	Validation
ntc_id	Number	9(9)	Unique identifier of the notice	Foreign Key
mask_id	Number	9(9)	Unique identifier of the mask	Primary Key
freq_min	Number	9(6).9(6)	The lowest frequency for which the mask is valid [GHz]	value != NULL
freq_max	Number	9(6).9(6)	The highest frequency for which the mask is valid [GHz]	value != NULL
f_mask	Text	X	Flag indicating if the mask type is eirp for the space station [S], eirp for the associated earth station [E] or pfd at the space station [P]	value != NULL
f_mask_type	Text	X	Flag indicating the type of the mask. [A], alpha_deltaLongitude [X], X_deltaLongitude [Z], azimuth_elevation [O], EIRP masks	value != NULL

mask_lnk1

Data Item	Data Type	Format	Description	Validation
grp_id	Number	9(9)	Unique identifier of the group	Foreign Key
seq_no	Number	9(4)	Sequence number	value != NULL
ntc_id	Number	9(9)	Unique identifier of the notice	Foreign Key
orb_id	Number	9(4)	Sequence number of the orbital plane	value == NULL means all orbits for that ntc_id
sat_orb_id	Number	9(4)	Satellite sequence number in the non-geostationary orbital plane	value == NULL means all satellites for that orb_id
mask_id	Number	9(4)	Unique identifier of the group	Foreign Key

mask_lnk2

Data Item	Data Type	Format	Description	Validation
grp_id	Number	9(9)	Unique identifier of the group	Foreign Key
seq_no	Number	9(4)	Sequence number	value != NULL
seq_e_as	Number	9(4)	Sequence number of the associated earth station	value != NULL
ntc_id	Number	9(9)	Unique identifier of the notice	Foreign Key
orb_id	Number	9(4)	Sequence number of the orbital plane	Not Used
sat_orb_id	Number	9(4)	Satellite sequence number in the non-geostationary orbital plane	Not Used
mask_id	Number	9(4)	Unique identifier of the group	Foreign Key

Tables used in the Article 9.7A/9.7B calculations

e_stn

Data Item	Data Type	Format	Description	Validation
ntc_id	Number	9(9)	Unique identifier of the notice	Foreign Key
stn_name	Text	X(20)	Name of the earth station	value != NULL
sat_name	Text	X(20)	Name of the associated space station	value != NULL
lat_dec	Number	S9(2).9(4)	Latitude in degrees with four decimals	value != NULL
long_dec	Number	S9(2).9(4)	Longitude in degrees with four decimals	value != NULL
long_nom	Number	S999.99	nominal longitude of the associated space station, give'-' for West, '+' for East	value != NULL

e_ant

Data Item	Data Type	Format	Description	Validation
ntc_id	Number	9(9)	Unique identifier of the notice	Foreign Key
emi_rcp	Text	X	code identifying a beam as either transmitting [E] or receiving [R]	value != NULL
bmwdth	Number	999.99	beamwidth of the earth station antenna	
gain	Number	S99.9	maximum isotropic gain of the earth station antenna	
ant_diam	Number	999.99	antenna diameter (meters): for FSS earth stations operating in the frequency band 13.75 – 14.0 GHz	