

Description of GIBC PFD/EIRP Earth Station software for Earth Station notices

(Updated on 04/04/2024)

Description of the main features

A. Application

This module is applicable to the individual notification notices of Earth stations (either typical or specific). Regulatory provisions covered by this module are verified during the Bureau examination under Radio Regulations provision No. 11.31.

It uses as an input either BR IFIC SRS database or individual notice prepared using SpaceCap or AP7 Capture software.

B. Regulatory provisions covered

- i. Examinations of the use of the frequency 14.5 – 14.75 GHz in countries listed in Resolution 163 (WRC-15) and 14.5 – 14.8 GHz in countries listed in resolution 164 (WRC-15) by the fixed-satellite service (Earth-to-space) not for feeder links for the broadcasting-satellite service, with respect to the provisions Nos. 5.509C, 5.509D, 5.509E and 22.40 of the Radio Regulation (WRC-15 decisions).
- ii. Examinations of the use of the frequency band 399.9 – 400.05 MHz and 401 - 403 MHz with respect to the provisions Nos. 5.260A and 5.264A of the Radio Regulation (WRC-19 decisions).
- iii. Examination with respect to the provisions Nos. 5.502, 5.503, 5.364, 5.506A, 5.532B, 5.555C, 21.8, 21.10, 21.13, 21.13A, 21.14, 21.15, 22.26, 22.27, 22.28, 22.31, 22.32, 22.34 and Resolution 902 (WRC-03).

C. Limits verified by the software

Tables 1 and 2 below list all applicable parameters of Earth stations and limits verified by the software.

Table 1. Limits verified by the software under Section B i) and ii) above

Applicable frequency band (MHz)	Applicable Service	RR Provision	stn_type to be examined by the software	Starting applicable date	Limit on minimum applicable antenna diameter (m.)	Limit on maximum power spectral density (dBW/Hz)	Ref. BW (MHz)	PFD Limit in RefBW	Minimum distance from the border (km)
399.9 – 400.02	MSS (TELECOMMAND)	5.260A	S, T				0.004	5	
399.9 – 400.05	MSS, SOS	5.260A	S, T				0.004	5	
401-403	METSAT, EESS, SOS	5.264A	S, T				0.004	7	
401-403	METSAT, EESS, SOS	5.264A	S, T				0.004	22	
401-403	METSAT, EESS, SOS	5.264A	S, T				0.004	12	
14500-14750/14800	FSS	5.509C	S	2015-11-28	6	-44.5			
14500-14750/14800	FSS	5.509E	S	2015-11-28					500
14500-14750/14800	FSS	22.40	S	2015-11-28	6	-44.5	27	-76	

14500-14750/14800	FSS	5.509D	S	2015-11-28	6	0.004	-151.5
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Table 2. Limits verified by the software under Section B iii) above

Provision	Frequency band	Service	stn_type to be examined by the software	Hard Limits	Ref. BW	Findings
5.502	13.75-14 GHz	FSS	S	Ant diameter (min) < 1.2m	-	N-- X/5.502
5.502	13.75-14 GHz	FSS	S	Ant diameter (min) < 4.5m	-	N-- X/5.502
5.503	13.77-13.78 GHz	FSS	S	EIRP density limits > (see 5.503)	40 or 4 kHz	N-- X/5.503
5.503	13.772-13.778 GHz	FSS	S	EIRP density limit > 51 dBW/refBW	6 MHz	N-- X/5.503
5.364	1 610-1 626.5 MHz	MSS	S, T	Mean EIRP density > -3 dBW/refBW	4 kHz	N-- X/5.364
5.364	1 610-1 626.5 MHz	MSS	S, T	Peak EIRP density > -15 dBW/refBW	4 kHz	A--
5.532B	24.65-25.25 GHz (R1) 24.65-24.75 GHz (R3)	FSS	S	Ant diameter (min) < 4.5m	-	N-- X/5.532B
5.555C	51.4-52.4 GHz	FSS	S	Ant diameter (min) < 2.4m	-	N-- X/5.555C
21.8	See Table 21-3	See Table 21-3 in Annex (except SRS (deep space))	S, T	EIRP towards horizon for all except SRS (deep space) (See 21.8 and remarks)	4 kHz or 1 MHz	X/21.8
21.10	See Table 21-3	See Table 21-3 in Annex for SRS (deep space)	S, T	EIRP towards horizon for SRS (deep space)(see 21.10 and remarks)	4 kHz or 1 MHz	X/21.10
21.13	1 610-1 626.5 MHz	RDSS	S, T	EIRP > -3 dBW	4 kHz	X/21.13
21.13A	13.75-14 GHz	FSS	S	If antenna diameter < 4.5m, then apply 21.13A off-axis EIRP limits.	1 MHz	X/21.13A
21.14	Any	Any except SRS	S, T	Elevation < 3 deg	-	X/21.14
21.15	Any SRS non-deep space bands	SRS(non-deep space)	S, T	Elevation < 5 deg	-	X/21.15
21.15	Any SRS deep space bands	SRS(deep space)	S, T	Elevation < 10 deg	-	X/21.15
22.26	12.75-13.25 GHz 13.75-14 GHz 14-14.5 GHz	FSS + non-FMTV	S	Max EIRP (see 22.26)	40 kHz	X/22.26
22.27	12.75-13.25 GHz 13.75-14 GHz 14-14.5 GHz	FSS + FMTV only	S	Max EIRP (may exceed 22.26 by 3 dB but meet 22.27)	-	X/22.27
22.28	12.75-13.25 GHz 13.75-14 GHz 14-14.5 GHz	FSS + FMTV only	S	Max EIRP (see 22.28)	-	X/22.28
22.31	12.75-13.25 GHz 13.75-14 GHz 14-14.5 GHz	Space Operations (TD or TK only)	S	Max EIRP (same as 22.26 but with +16 dB tolerance, see 22.31)	40 kHz	X/22.31
22.32	29.5-30 GHz	FSS, MSS	S	Max EIRP density (see 22.32, 22.38)	40 kHz	X/22.32
22.34	29.5-30 GHz	Space Operations (TD or TK only)	S	Max EIRP (same as 22.32 but with +10 dB tolerance, see 22.34)	40 kHz	X/22.34

No. 5.506A & Res. 902	14 - 14.5 GHz	MMSS	S, T	Ant diameter (min) < 1.2m		X/5.506A
No. 5.506A & Res. 902	14 - 14.5 GHz	MMSS	S, T	Max EIRP (See Res902)	See Res902	X/5.506A

As it can be seen from the table above, a single earth station can be subject to several provisions and limits. In case if any limit is not met a corresponding record will be produced in the output files.

D. Calculation methods

Under provision 5.509C

In the 14.5 – 14.75 GHz in countries listed in Resolution 163 and 14.5 – 14.8 GHz in countries listed in Resolution 164, for FSS:

- minimum antenna diameter of E/S should not be less than 6 meter (antenna diameter is extracted from RR Appendix 4 C.10.d.7 data element);
- maximum power spectral density (C.8.a.2) should not exceed -44.5 dBW/Hz.

In case any of these limits is not met X/5.509C indication will be given in the output report.

Under provision 5.509E

In the 14.5 – 14.75 GHz in countries listed in Resolution 163 and 14.5 – 14.8 GHz in countries listed in Resolution 164, for FSS:

- Earth station should not be located closer than 500 km from the borders of the other administrations.

In case this condition is not met, the list of administrations is produced and indication X/5.509E will be given in the output report.

Under the provision No. 22.40

In the 14.5 – 14.75 GHz in countries listed in Resolution 163 and 14.5 – 14.8 GHz in countries listed in Resolution 164, for FSS:

- Power-flux density at any point on geostationary orbit arc shall not exceed -76 dBW/m² in 27 MHz.

$$PFD = P_t + G - 10\log(4\pi D_L)$$

$$P_t = \text{Min} [\text{pwr_ds_max} + 10 * \log_{10}(27\ 000\ 000); \text{pep_max}]$$

pwr_ds_max: maximum power spectral density of the emission;

pep_max: maximum peak power of the emission;

G - relative gain of the transmitting antenna toward the point under consideration in the GSO arc. It is assumed that feeder-link earth station antennas of the incoming satellite network always track precisely the corresponding feeder-link receiving space station.

D_L (m): Distance between the grid point under consideration and the GSO position where PFD is calculated.

In case pfd-limit is exceeded an indication X/22.40 will be given in the output report.

0.05 dB is considered as tolerable excess in such case.

Under the provision No. 5.509D

In the 14.5 – 14.75 GHz in countries listed in Resolution 163 and 14.5 – 14.8 GHz in countries listed in Resolution 164, for FSS:

- power flux-density produced by Earth station shall not exceed $-151.5 \text{ dB(W/(m}^2 \cdot 4 \text{ kHz))}$ produced at all altitudes from 0 m to 19 000 m above sea level at 22 km seaward from all coasts, defined as the low-water mark.

PFD is calculated at different grid points along 22 km distance from the coast at different altitudes from 0 m to 19 000 m.

$$PFD = P_t + G - 10\log(4\pi D_L)$$

To derive P_t from **pep_max** or **pwr_ds_max**:

For certain PFD examinations there is a choice between using the power density (pd), expressed in W/Hz, multiplied by the reference bandwidth (bref) expressed in Hz or the total peak envelope power (px), expressed in W. The choice for any emission the necessary bandwidth of which is B (Hz) is to be made according to the following rule:

If $B > \text{bref}$ then

*If $\text{pd} * \text{bref} > \text{px}$ then $\text{pused} = \text{px}$*

*else $\text{pused} = \text{pd} * \text{bref}$*

else

if $B \leq \text{bref}$ then

$\text{pused} = \text{px}$

If $\text{PFD} > -151.5 \text{ dB (W/(m}^2 * 4 \text{ kHz))}$ in any of the point or altitude an indication X/5.509D will be given in the output report.

Under the provision No. 5.260A (Frequency bands 399.9 – 400.05 MHz)

Applies to Mobile Satellite Service and space operation functions (except telecommand in 400.02 – 400.05 MHz).

Application date on or after 23.11.2019.

Does not apply to Notification received before or on 22 Nov 2019 and brought into use by that date

Condition 1: Earth Station e.i.r.p limit for any emission					
Frequency band	Notice Type	Max e.i.r.p. of Any emission of Each Earth station (dBW)	Ref. BW	Unfavourable finding	calculation method (for each emission)*
399.9 – 400.05	S	5	4	N X/5.260A	If $\text{pused} = \text{pd} * \text{bref}$, $\text{EIRP}/4 \text{ KHz} = \text{PD (dBW/Hz)} + \text{GainMaxEarthStation (dBi)} + 10\log(4000) \text{ dB.Hz}$

399.9 – 400.02					If pused = px, EIRP/4 KHz = P (dBW) + GainMaxEarthStation (dBi)
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Condition 2: Earth Station e.i.r.p limit in the whole band				
Frequency band	Notice Type	Max e.i.r.p. of Any emission of Each Earth station (dBW)	Unfavourable finding	calculation method (for each emission)*
399.9 – 400.05	S	5	N X/5.260A	P(dBW) + GainMaxEarthStation (dBi)

Under the provision No. 5.264A (Frequency bands 401 – 403 MHz)

Applies to Meteorological-satellite service and Earth exploration-satellite service and space-operation functions.

Does not apply if the Notification of the associated space station is received before or on 22 Nov 2019 and brought into use by that date. Apply to all after 22 November 2029 (No. 5.264A refers).

Does not apply if the NGSO in the meteorological-satellite service and the Earth exploration-satellite service for which complete notification information has been received by the Radiocommunication Bureau “before” 28 April 2007 and different e.i.r.p limit should be applied in the frequency band 401.898-402.522 MHz after 22 November 2029 (No. 5.264B refers)

Condition 1: Earth Station e.i.r.p limit for any emission						
Notice type	Associated Space Station	Apogee (km)	Max e.i.r.p. of Any emission of Each Earth station (dBW)	Ref. BW	Unfav. finding	calculation method (for each emission)*
S	G		22	4	N- X/5. 264A	If pused = pd*bref, EIRP/4 KHz = PD (dBW/Hz)+ GainMaxEarthStation (dBi)+10log(4000)dB.Hz If pused = px, EIRP/4 KHz = P (dBW) + GainMaxEarthStation (dBi)
	N	≥ 35786	22	4		
	N	< 35786	7	4		
Condition 2: Earth Station e.i.r.p limit in the whole band						
Notice type	Associated Space Station	Apogee (km)	Max e.i.r.p. of Any emission of Each Earth station (dBW)	Unfav. finding		calculation method (for each emission)*
S	G		22	N- X/5. 264A		P(dBW) + GainMaxEarthStation (dBi)
	N	≥ 35786	22			
	N	< 35786	7			

Under the provisions Nos. 5.502, 5.503, 5.364, 5.506A, 5.532B, 5.555C, 21.8, 21.10, 21.13, 21.13A, 21.14, 21.15, 22.26, 22.27, 22.28, 22.31, 22.32, 22.34 and Resolution 902 (WRC-03)

See Section B iii) above and the relevant provisions.

Under the provision No. 5.260A 4KHz, 5.264A 4KHz, 5.364, 5.503, 5.506A, 21.8, 21.10, 21.13, 21.13A, 22.26, 22.31, 22.32, 22.34

Rec. ITU-R SF.675 is automatically applied to assignments **from 1 May 2024** (see CR/503) based on the following date fields and using the following method to determine the transmission power used (Pused) in the examination, where applicable.

- When the notice is at Notification(notice.ntf_rsn=N), grp.d_ntf_first it used, if null then use grp.d_rcv, if null then use notice.d_rcv
- When the notice is at Coordination (notice.ntf_rsn=C), grp.d_prot_eff is used, if null then grp.d_rcv, if null then use notice.d_rcv

Bavg = Bref

Pused = pwr_ds_max * Bref

Bavg < Bref

If B >= Bref then

If pwr_ds_max * Bref > pep_max then

Pused = pep_max

else

Pused = pwr_ds_max * Bref

else if B < Bref then

Pused = pep_max

Bavg > Bref

if B < Bref then

Pused = pep_max

else

Pused = pwr_ds_max * Bref

Where

Bavg is the averaging bandwidth in accordance with Recommendation ITU-R SF.675. If the centre frequency of the frequency assignment is below 15 GHz, Bavg = 4 kHz. Otherwise, Bavg = 1 MHz.

Bref is the reference bandwidth (e.g. 4 kHz, 1 MHz, etc.).

pwr_ds_max is the maximum power spectral density of emission.

pep_max is the maximum peak power of emission.

B is the emission bandwidth.

E. Results database

To facilitate analyses of the results, the program generates upon each run a new database containing the calculations results.

Results of calculations are stored under users profile folder ... \TEX_RESULTS\[NOTICE_ID]\ PFD_ES_[CREATION_TIME]\ under filename PFDE2S_RESULTS.mdb

These results database contains the following information:

- Execution summary
- Detailed results of calculations for uplink.

The results database structure is provided in Attachment 1.

F. Report file

In addition to the detailed information provided in the results, a text report is also produced to give basic calculation results.

Users are encouraged to use the results database for queries and analysis.

Brief overview of the interface

PFD/EIRP Earth Station tab can be accessed from the main GIBC interface.

Input SRS database should be selected in Tools/Options tab.

Main screen of this module is shown on figure 1 below.

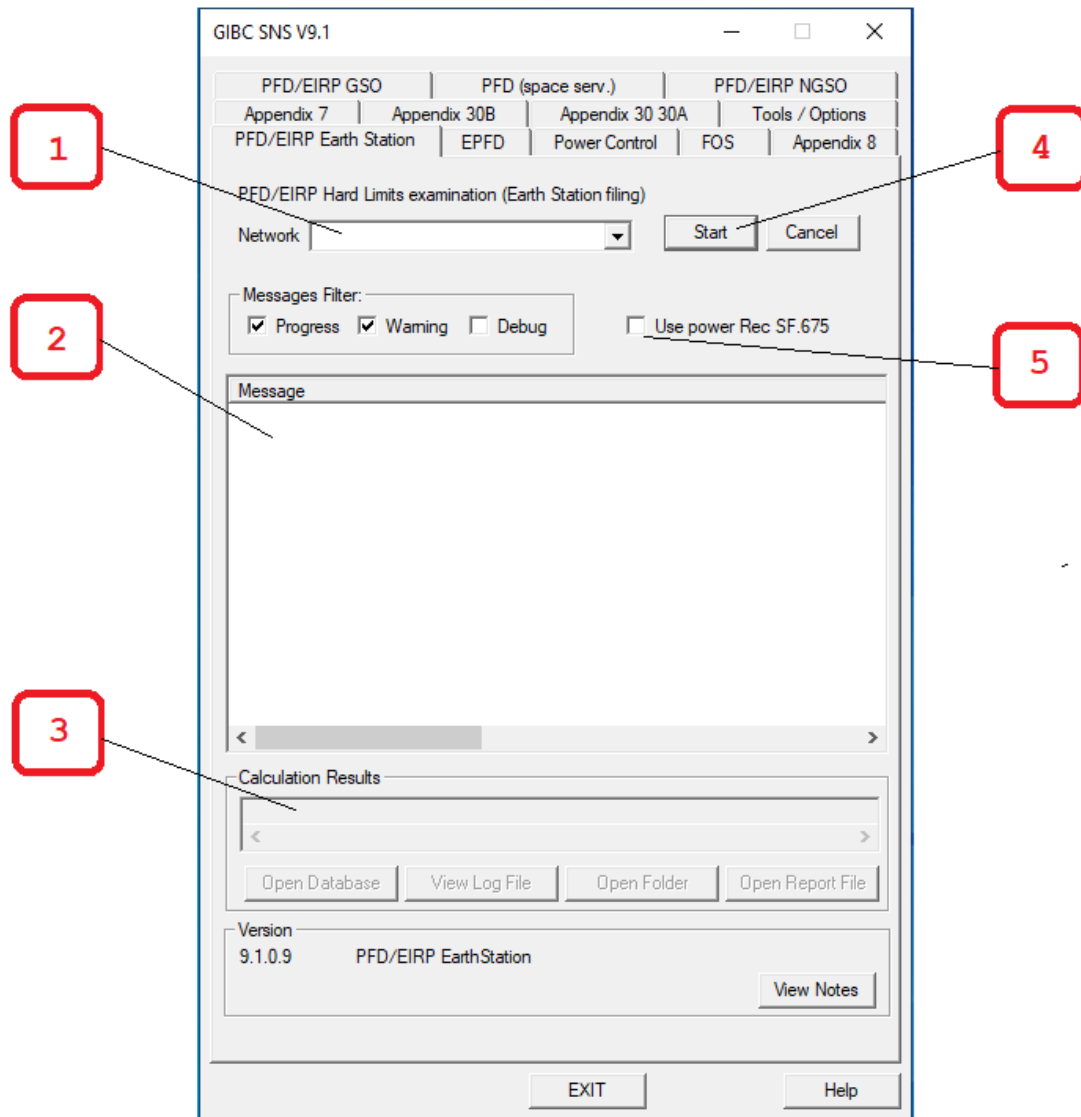


Figure 1. Module main interface window

- (1) Enter notice here
- (2) Progress messages
- (3) Results location
- (4) Start calculations
- (5) Use of power in accordance with Recommendation ITU-R SF.675 option

To report an issue or to send a suggestion, please contact brsas@itu.int

Attachment 2. Description of database PFDE2S_results.mdb

PFDE2S_results.mdb database contains all PFD Earth-to-space analysis results. It includes nine tables: **BR_Internal**, **list_adm_intersected**, **pdf_clc_head**, **test_points**, **uplink_res** and **version**.

1. Table **BR_Internal** contains records of combination of beam, group and emission of the incoming earth station.
2. Table **test_points** contains test points used in the calculation in accordance with no. 5.509D.
3. Table **list_adms_intersected** list of administrations intersected by the line between the earth station and the test point.
4. Table **uplink_res** contains result of uplink calculation results.
5. Table **version** contains the version of the database PFDE2S_Results.mdb.

The results of calculation are stored in the **uplink_res** table. This table include information of notice, station, beam, group, assignment, emission, antenna, provision and result of calculation.

Each data row of **uplink_res** tables is unique and represent the analysis of the assignment under the provision that is in this row. The field **findg_flag** in **uplink_res** indicate that the assignment in record has favorable finding (A-) or unfavorable finding (N-). The PFD calculation are respectively stored in the fields: **pdf_produced**, **pdf_limit** and **pdf_excess**. Other fields provide results with respect to antenna diameter (**min_ant_diam**) and maximum power spectral density (**max_spec_pwr_ds**) limitations.

Table **uplink_res**

Field Name	Description
ntc_id	unique identifier of the notice
adm	country symbol of the notifying administration (Table 1A of the Preface to the BR IFIC)
ntwk_org	symbol of intergovernmental satellite organizations (Table No. 2 of the Preface to the BR IFIC)
stn_name	name of the earth station
d_rcv	date of receipt of the notice
ntf_rsn	code indicating that the notice has been submitted under 9.6 [C], 11.2 [N]
st_cur	current processing status of the notice
sat_name	name of the space station
long_nom	nominal longitude of the space station, give '-' for West '+' for East
beam_name	designation of the satellite antenna beam
emi_rcp	code identifying a beam as either transmitting [E] or receiving [R]
pattern	antenna pattern name
gain	maximum isotropic gain of the antenna expressed in dBi with one decimal position
ant_diam	antenna diameter(metres): in the case of FSS earth stations operating in the frequency band 13.75-14.0 GHz
grp_id	unique identifier of the group
class_of_stn	List of classes of station corresponding to the service(s)
bdwidth	assigned frequency band expressed in kHz OR the bandwidth of the frequency band, in kHz, observed by the radio-astronomy station OR receiver noise bandwidth processor (for active sensors)

d_inuse	date of bringing into use
grp_d_rcv	date of receipt of the list of frequency assignments pertaining to the group
d_prot_eff	the date from which a list of assignments is taken into account according to the provisions of the RR, as appropriate
date_2D	date of protection of group if exists, otherwise date of receipt of the notice
date_2D_ref	DP': date of protection of group, 'DR': date of receive of group, 'DN': date of receive of notice, 'DV' date of first notification
freq_assgn	assigned frequency
freq_sym	symbol indicating kilohertz [K], megahertz [M] or gigahertz [G]
design_emi	designation of emission
pep_max	the maximum value of the peak envelope power, supplied to the input of the antenna for each carrier type [dBW] (C8a1/C8b1/C8b3a)
pwr_ds_max	maximum power density [dBW/Hz] (C8a2/C8b2/C8b3b)
ix_provsn	sequence number of index of provision
provsn	provision reference
applied_reg	applied regulation
service	name of the service(s)
finding	Finding if unfavourable
fndg_flag	A-' if favorable; 'N-' if unfavorable; NULL if warning
min_ant_diam	NOT MET' if the minimum earth station antenna diameter (m) limit defined in the RR 5.509C, 6m, is not met; NULL if it is met
max_spec_pwr_ds	NOT MET' if maximum power spectral density [dBW/Hz] limit defined in the RR 5.509C, -44.5 dBW/Hz, is not met; NULL if it is met
list_adms_500km	List of administrations located closer than 500 km to the earth station. Examination RR5.509E
wc_tp_long_dec	longitude in degrees with four decimals of the worst case test point (for RR5.509D)
wc_tp_lat_dec	latitude in degrees with four decimals of the worst case test point (for RR5.509D)
wc_tp_altitude	altitude of the worst case test point (m) (for RR5.509D)
wc_gso_pos	worst case point in the geostationary satellite orbit (in decimal degrees) (for RR22.40)
pdf_produced	produced pdf value at a worst case test point in the sea (for RR5.509D) or in the geostationary orbit (for RR22.40)
pdf_limit	pdf hard limit value
pdf_excess	pdf_produced - pdf_limit at a worst case point on earth
off_axis_gain	off-axis gain expressed in dB with one decimal position in the direction of worst case test point
off_axis_angle	off-axis angle where the gain is calculated (decimal degrees)
refbw	reference bandwidth (MHz)
ix_list_adms_intersected	pointer to table list_adms_intersected (LIST OF ADMINISTRATIONS INTERSECTED BY THE LINE BETWEEN EARTH STATION AND GRID-POINT. Examination RR5.509D)
eirp_produced	produced eirp value at a worst case test point
eirp_limit	eirp limit value at a worst case test point
eirp_excess	eirp_produced - eirp_limit at a worst case test point
ss_ntc_id	unique identifier of the notice of associated space station

ss_beam_name	designation of the satellite antenna beam of associated space station
ss_grp_id	unique identifier of the group of associated space station
ss_d_inuse	date of bringing into use of group of associated space station
ss_date_2D	date 2D, rule defined in specification and depending on phase coordination or notification
ss_date_2D_ref	DP': date of protection of group, 'DR': date of receive of group, 'DN': date of receive of notice, 'DV' date of first notification
ss_orb_id	identifying sequence number of the orbital plane linked to beam of NGSO associated space station
ss_apog	the farthest altitude of the non-geostationary satellite above the surface of the Earth or other reference body - expressed in kilometers of orbit of linked to beam NGSO associated space station
message	message about the examination
pused_type	'B', 'C', 'D' in case mehod power Rec SF.675. Otherwise is 'A'
pwr_ds_max_used	'Y' if pused is derived from pwr_ds_max. Null otherwise.