ITU World Radiocommunication Seminar

NGSO- Article 21 Examination

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Space Service Department
Radiocommunication Bureau

2-6 December 2024, Geneva, Switzerland

Outline

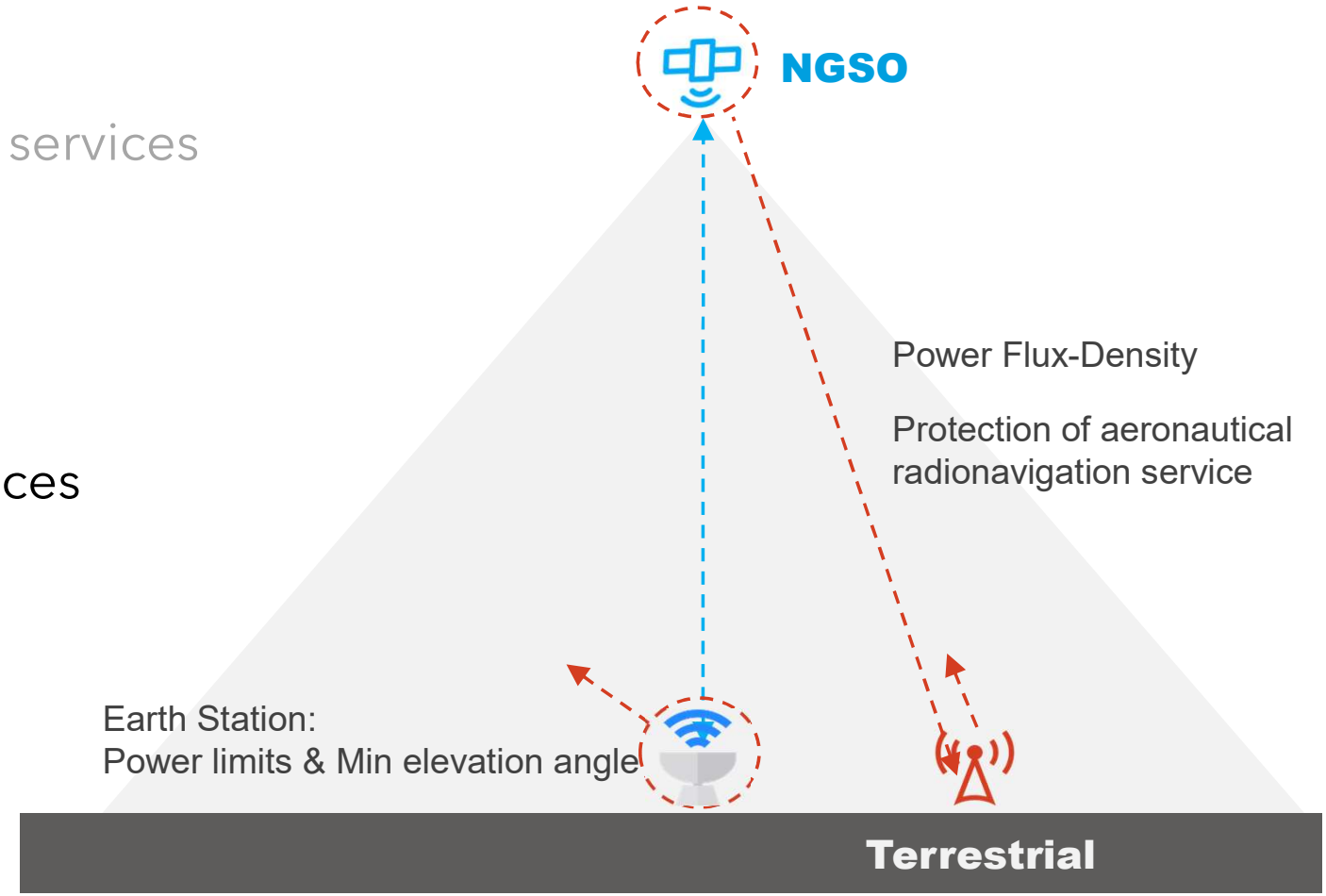
- Article 21
- GIBC PFD/EIRP NGSO
- Exercise

Article 21

Article 21-Terrestrial and space services sharing frequency bands above 1 GHz

Section I
Section II
} Terrestrial services

Section III
Section IV
Section V
Section VI
} Space services



Article 21-Terrestrial and space services sharing frequency bands above 1 GHz

Section III- Power limits for earth stations

Section IV- Minimum angle of elevation of earth station

Section V- Limits of power flux-density from space stations-> Hard limits

Table 21-4 includes Res 679(AI 1.17 WRC-23)

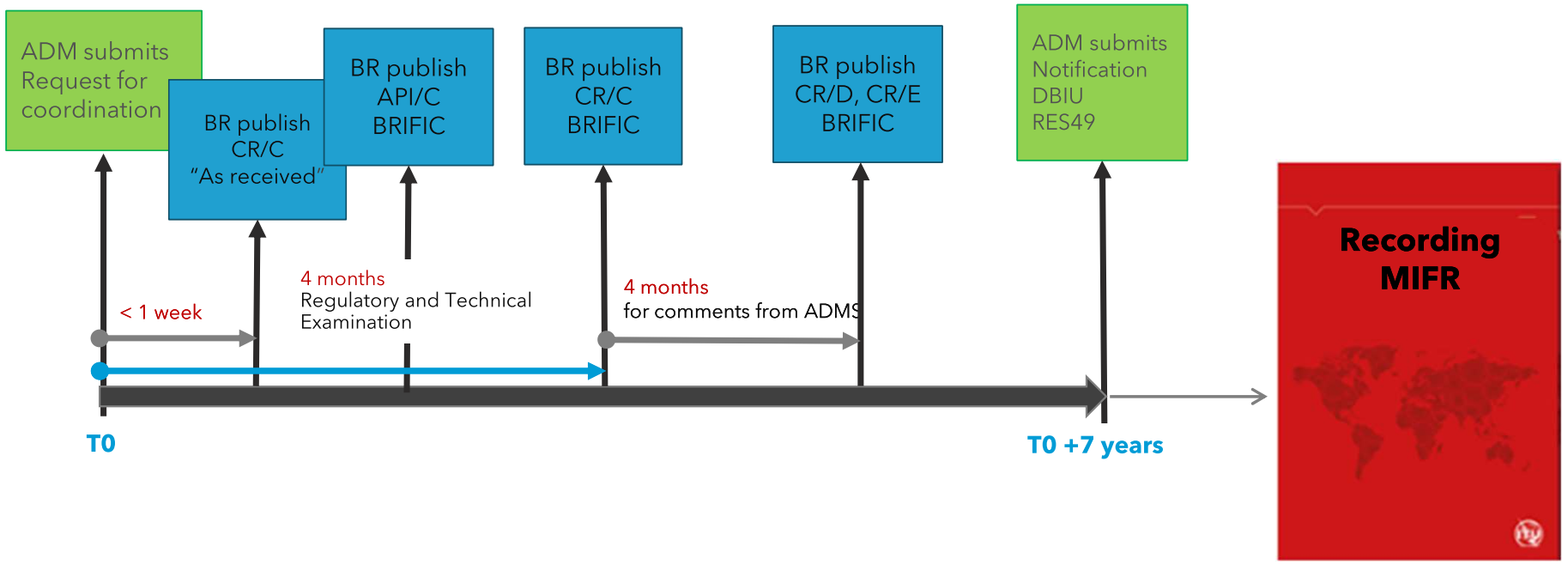
Section VI- Protection of aeronautical radionavigation service systems from aggregate emissions of space stations of RNSS systems in the 1167-1215 MHz band

TABLE 21-4 (*continued*) (Rev.WRC-23)

Frequency band	Service*	Limit in dB(W/m²) for angles of arrival (δ) above the horizontal plane			Reference bandwidth
		0°-5°	5°-25°	25°-90°	
19.3-19.7 GHz 21.4-22 GHz (Regions 1 and 3) 22.55-23.55 GHz 24.45-24.75 GHz 25.25-27.5 GHz	Fixed-satellite (space-to-Earth) Broadcasting-satellite Earth exploration-satellite (space-to-Earth) Inter-satellite Space research (space-to-Earth)	-115 [15]	$-115 + 0.5(\delta - 5)$ [15]	-105 [15]	1 MHz
27.500-27.501 GHz	Fixed-satellite (space-to-Earth)	-115	$-115 + 0.5(\delta - 5)$	-105	1 MHz
27.5-30.0 GHz	Inter-satellite (non-geostationary satellite orbit)[26]	-120	$-120 + 0.5(\delta - 5)$	-110	1 MHz
31.0-31.3 GHz 34.7-35.2 GHz (space-to-Earth transmissions referred to in No. **5.550** on the territories of countries listed in No. **5.549**)	Space research	-115	$-115 + 0.5(\delta - 5)$	-105	1 MHz
31.8-32.3 GHz	Space research	-120 [20]	$-120 + 0.75(\delta - 5)$ [20]	-105	1 MHz
32.3-33 GHz	Inter-satellite	-135	$-135 + (\delta - 5)$	-115	1 MHz
37-38 GHz	Space research (non-geostationary-satellite orbit)	-120 [20]	$-120 + 0.75(\delta - 5)$ [20]	-105	1 MHz
37-38 GHz	Space research (geostationary-satellite orbit)	-125	$-125 + (\delta - 5)$	-105	1 MHz
37.5-40 GHz	Fixed-satellite (non-geostationary-satellite orbit) Mobile-satellite (non-geostationary-satellite orbit)	-120 [11, 21]	$-120 + 0.75(\delta - 5)$ [11, 21]	-105 [11, 21]	1 MHz
37.5-40 GHz	Fixed-satellite (geostationary-satellite orbit) Mobile-satellite (geostationary-satellite orbit)	0°-5°: -127 [21]	5°-20°: $-127 + (4/3)(\delta - 5)$ [21] 20°-25°: $-107 + 0.4(\delta - 20)$ [21]	25°-90°: -105 [21]	1 MHz
40-40.5 GHz	Fixed-satellite Mobile-satellite	-115	$-115 + 0.5(\delta - 5)$	-105	1 MHz
40.5-42 GHz	Fixed-satellite (non-geostationary-satellite orbit) Broadcasting-satellite (non-geostationary-satellite orbit)	-115 [11, 21]	$-115 + 0.5(\delta - 5)$ [11, 21]	-105 [11, 21]	1 MHz

When Art 21 needs to be considered?

Networks subject to coordination in the non planned bands



When Art 21 needs to be considered?

Regulatory Exam

Conformity with Radio Regulations (No. 9.35 of RR)

- Table of Frequency Allocations
- Hard Limits (PFD/EIRP Limits) Nos. 9.35, 11.31 of RR, RoP 11.31

Only frequency assignments with favourable conclusions will pass

Technical Exam

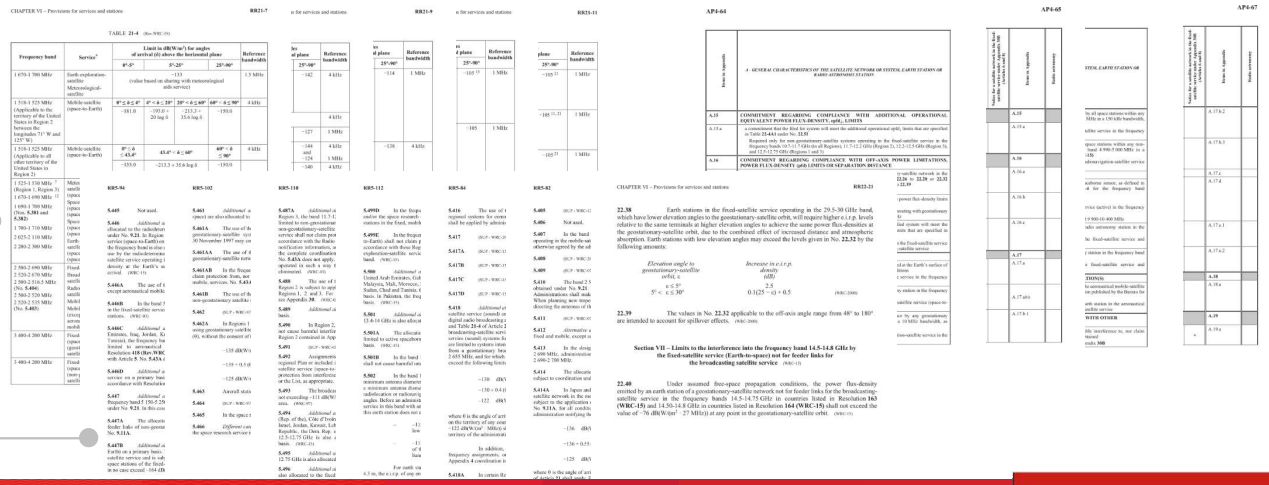
Coordination requirements (No. 9.36 of RR)

- Identify the list of administrations with which coordination may need to be effected

Hard Limits, where in the RR?

PFD Limits (Table 21-4)

Other limits (Art5, 22 etc)



Commitments & Compliances (Ap4)

Different editions of RR

Article 21

Conformity with Radio Regulations (No. 9.35)

Not compliance with the table of frequency allocations

or

Excess in the hard limits

UNFAVOURABLE FINDING

Nos. 9.35 or 11.31

Conformity with Radio Regulations (No. 9.35)

Consequence

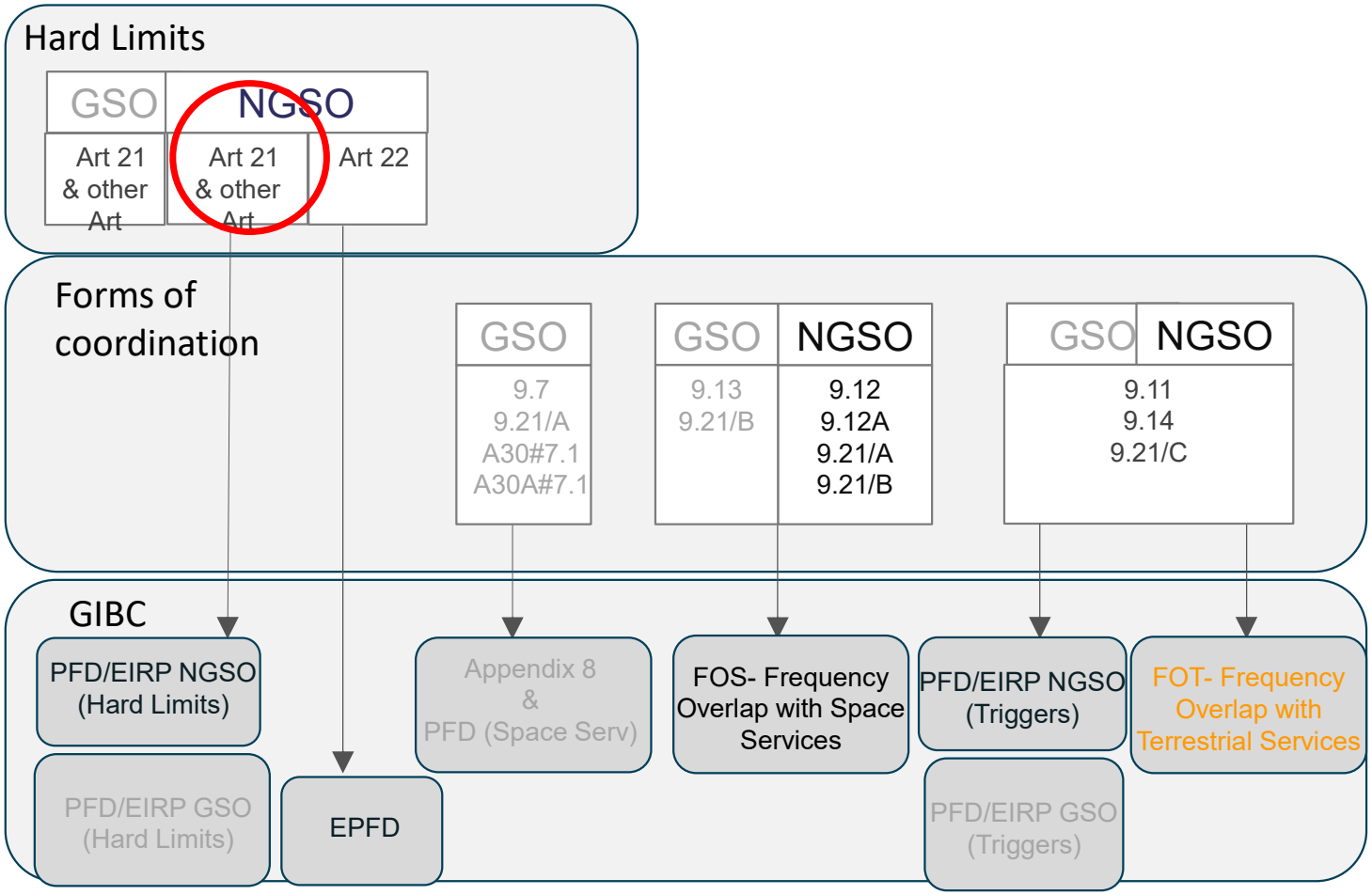
- No date of protection
- Record for info only (No. 8.4)
- No international recognition (No. 8.3)
- Cannot cause or claim protection from harmful interference (No. 4.4)

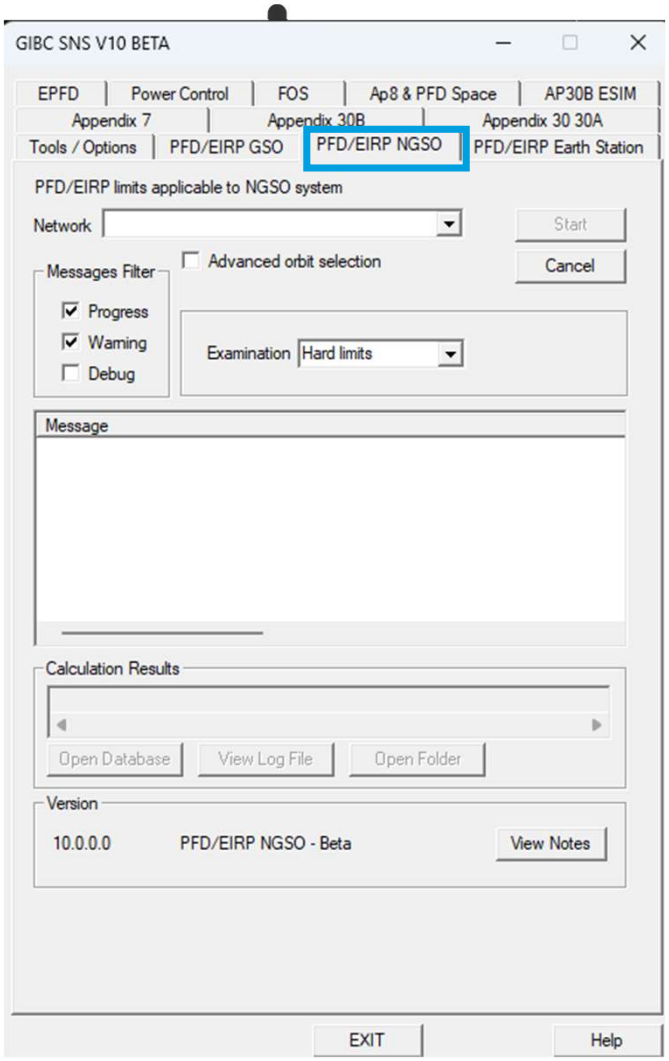
Remedy

- New Submission
- New Date of Receipt
- New Cost Recovery Invoice

GIBC PFD/EIRP NGSO

GIBC


Hard Limits
GSO
NGSO
Art 21 & other Art
Art 21 & other Art
Art 22
Forms of coordination
GSO
9.7
9.21/A
A30#7.1
A30A#7.1
GSO
NGSO
9.13
9.21/B
9.12
9.12A
9.21/A
9.21/B
GSO
NGSO
9.11
9.14
9.21/C
GIBC
PFD/EIRP NGSO (Hard Limits)
PFD/EIRP GSO (Hard Limits)
EPFD
Appendix 8 & PFD (Space Serv)
FOS- Frequency Overlap with Space Services
PFD/EIRP NGSO (Triggers)
PFD/EIRP GSO (Triggers)
FOT- Frequency Overlap with Terrestrial Services


GIBC SNS V10 BETA
EPFD
Power Control
FOS
Ap8 & PFD Space
AP30B ESIM
Appendix 7
Appendix 30B
Appendix 30 30A
Tools / Options
PFD/EIRP GSO
PFD/EIRP NGSO
PFD/EIRP Earth Station
PFD/EIRP limits applicable to NGSO system
Network
Start
Cancel
Advanced orbit selection
Messages Filter
Progress
Warning
Debug
Examination
Hard limits
Message
Calculation Results
Open Database
View Log File
Open Folder
Version
10.0.0.0
PFD/EIRP NGSO - Beta
View Notes
EXIT
Help

PFD/EIRP NGSO

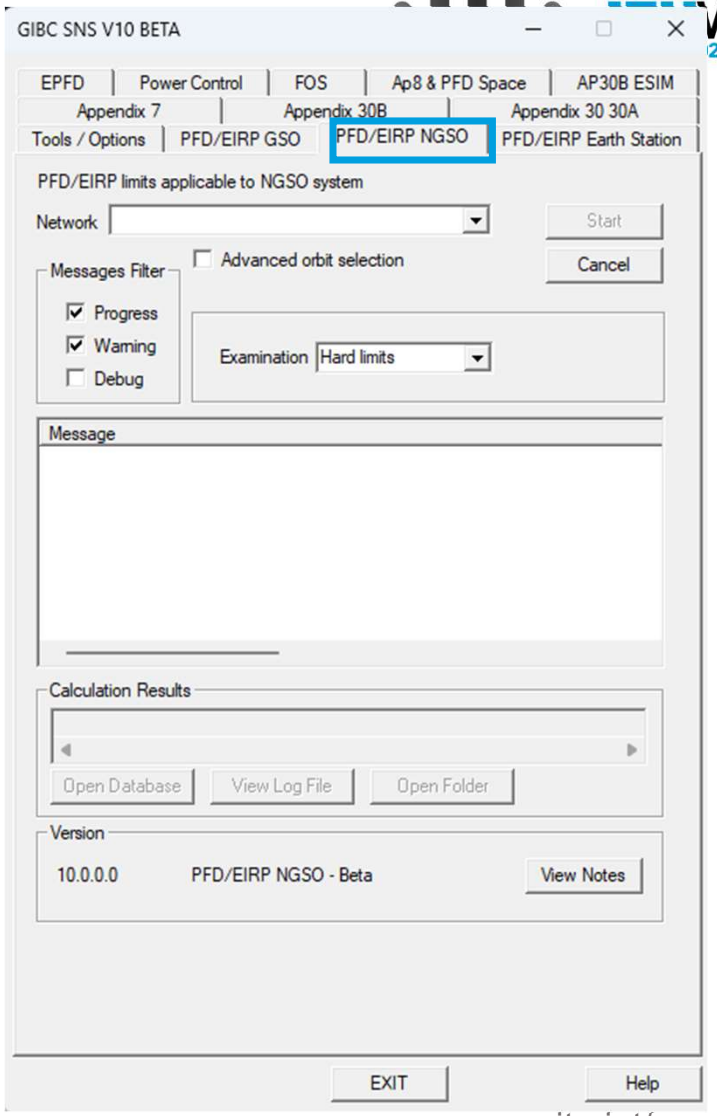
PFD: Power Flux Density at the surface of the Earth produced by emissions of a space station

EIRP: Equivalent Isotropic Radiated Power transmitted in any direction to the horizon by an Earth station

Types of examination:

- Hard limits
- Triggers
- Rec. 608

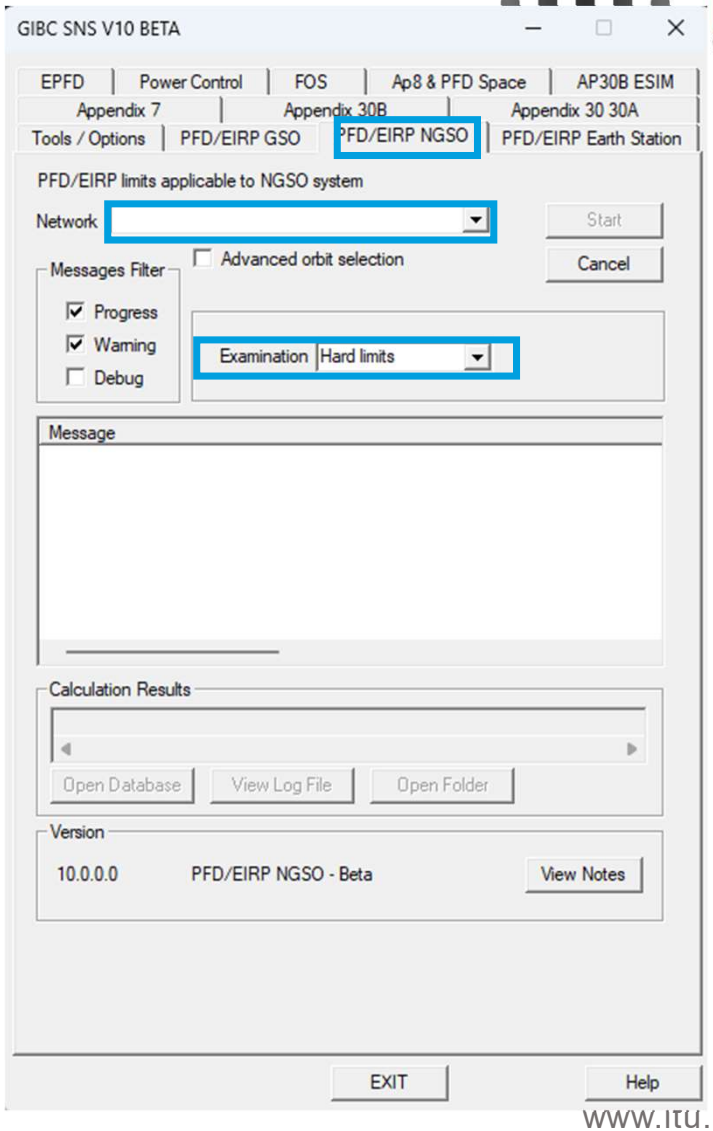
Antenna pattern already inserted in GIMS database



PFD/EIRP NGSO

Hard Limits

- NGSO only
- PFD hard limits[1]
- EIRP density toward horizon[2]
- PFD limit at GSO[3]
- Minimum antenna diameter[4]
- Commitment or Compliance checks[5]
- Minimum elevation angle e checks[6]
- Rule of Procedure on No. 21.16



[1] Table 21-4 of Art. 21, Nos. 5.407, 5.268 , 5.418, 5.446, 5.447B, 5.493, Res903 (REV.WRC-19) & 761 (REV.WRC-19), Res677(WRC-23)
[2] Nos. 5.264A, 5.364, 5.502, 5.503, 5.506A, 5.538, 21.8 (Warning), 5.260A
[3] No. 22.5
[4] Nos. 5.502, 5.532B, 5.509C
[5] Ap4 – A.17.a, A.17.b3, A.17.b2, A.17.d, A.17.e.1, A.17.abs, B.4.b5
[6] Nos 21.14, 21.15

PFD/EIRP NGSO

Triggers

- NGSO only
- No. 9.11 - BSS vs terrestrial stations
- No. 9.14 - NGSO vs terrestrial stations
- No. 9.21/C - Seeking agreement wrt terrestrial stations

Where to find the PFD threshold values in RR:

- Appendix 5 Annex 1 : Method for determination of the need for coordination between MSS and RDSS space stations (space-to-Earth) and other terrestrial services sharing the same frequency band in the 1-3 GHz range
- Footnote 5.348A

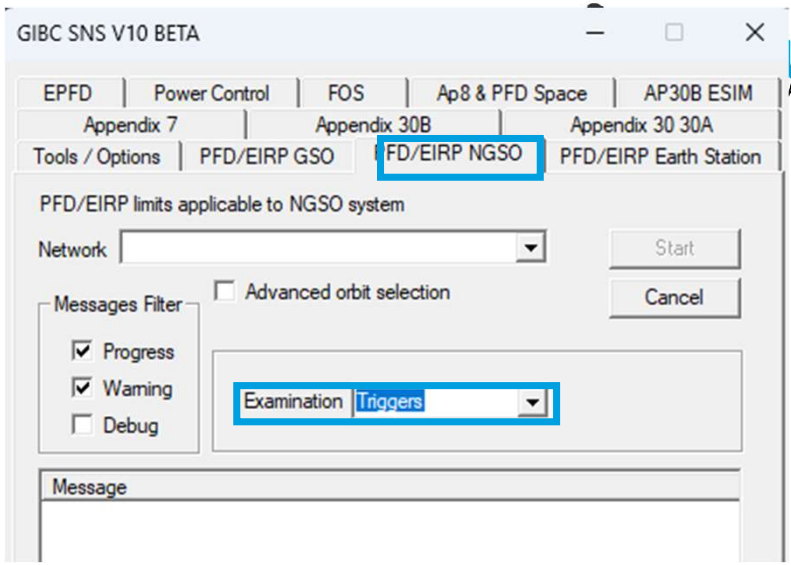


TABLE 5-2 (Rev.WRC-19)

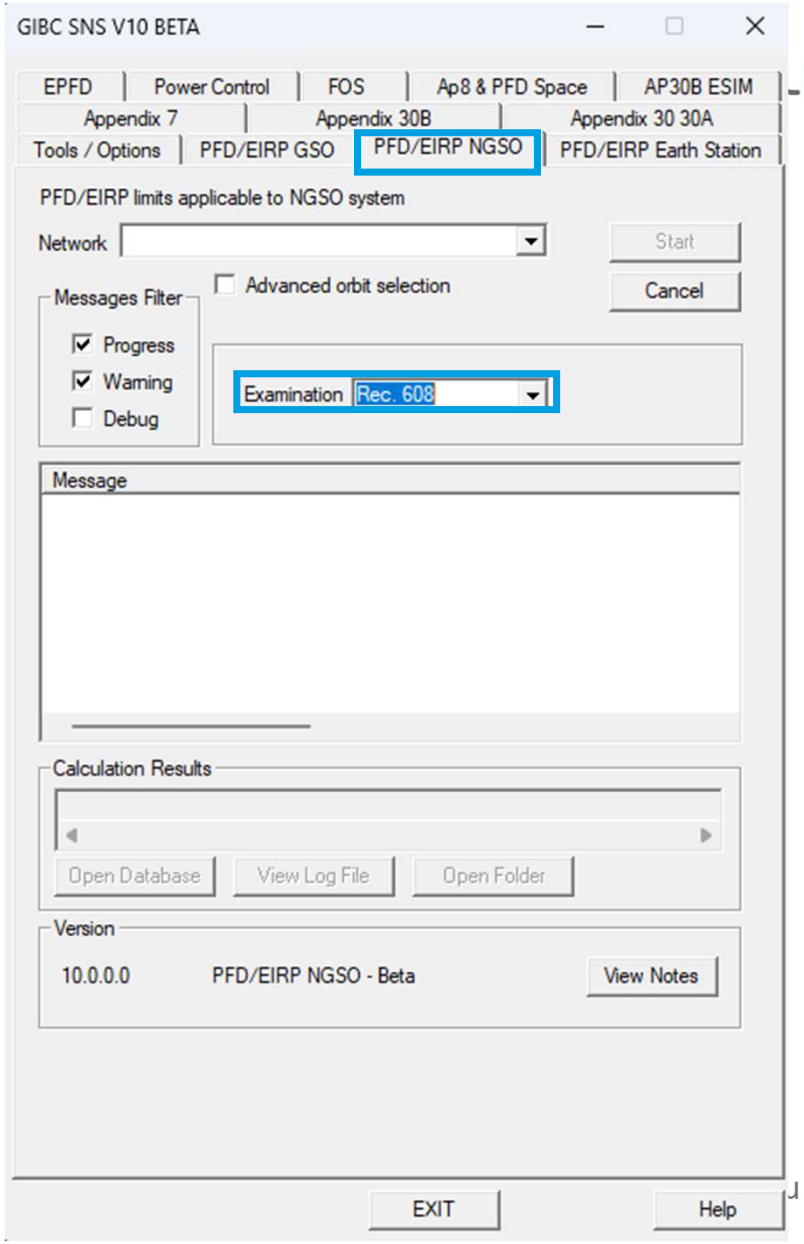
Frequency band (MHz)	Terrestrial service to be protected	Coordination threshold values				
		GSO space stations		Non-GSO space stations		
		pfd (per space station) calculation factors (NOTE 2)		pfd (per space station) calculation factors (NOTE 2)		% FDP (in 1 MHz) (NOTE 1)
		P	*r* dB/ degrees	*P*	*r* dB/ degrees	
1 518-1 525	Analogue FS telephony (NOTE 5)	−146 dB(W/m²) in 4 kHz and −128 dB(W/m²) in 1 MHz	0.5	−146 dB(W/m²) in 4 kHz and −128 dB(W/m²) in 1 MHz	0.5	
	All other cases FS telephony (NOTES 4 and 8)	−128 dB(W/m²) in 1 MHz	0.5	−128 dB(W/m²) in 1 MHz	0.5	25

5.348A In the band 1 518-1 525 MHz, the coordination threshold in terms of the power flux-density levels at the surface of the Earth in application of No. **9.11A** for space stations in the mobile-satellite (space-to-Earth) service, with respect to the land mobile service use for specialized mobile radios or used in conjunction with public switched telecommunication networks (PSTN) operating within the territory of Japan, shall be –150 dB(W/m²) in any 4 kHz band for all angles of arrival, instead of those given in Table 5-2 of Appendix **5**. In the band 1 518-1 525 MHz stations in the mobile-satellite service shall not claim protection from stations in the mobile service in the territory of Japan. No. **5.43A** does not apply. (WRC-03)

PFD/EIRP NGSO

Rec. 608

- NGSO only
- Footnote 5.328A-PFD limit of Rec. 608 (REV.WRC-07) for RNSS in 1164-1215 MHz
- For information to the ADM



PFD/EIRP NGSO

HARD LIMITS vs TRIGGER

GIBC “Hard Limits” option		GIBC “Trigger” option
To establish findings under Nos. 9.35/11.31		To identify coordination requirements under No. 9.36
Excess = Unfavourable		Excess = Coordination may be required, Aff Adm needs to confirm, CR/D
		Provisions: 9.11, 9.14, 9.21/C

PFD/EIRP NGSO

PFD calculations methods:

- Type of orbit: circular, elliptical
- Service area: global, region, list of countries
- Beam: steerable or fixed
- Method in Annex 1 of RoP 21.16 (steerable beams & B.3.b.1)
- Antenna pattern
  - If has to be submitted by the ADM
    - Standard patterns: ITU library(Antenna Patterns (itu.int))
    - GIMS: customize pattern
      - Images will not longer be allowed since 1st January 2025!
      - Option of digitize the images in GIMS!!!

e - EXAMINATION

Online integration of GIBC (Graphical Interface for Batch Calculations) PFD (power flux-density) hard limits software tool for GSO/NGSO and Earth station on e-Submission

Purpose: Assists in verifying compliance with PFD and EIRP limits during satellite network filings

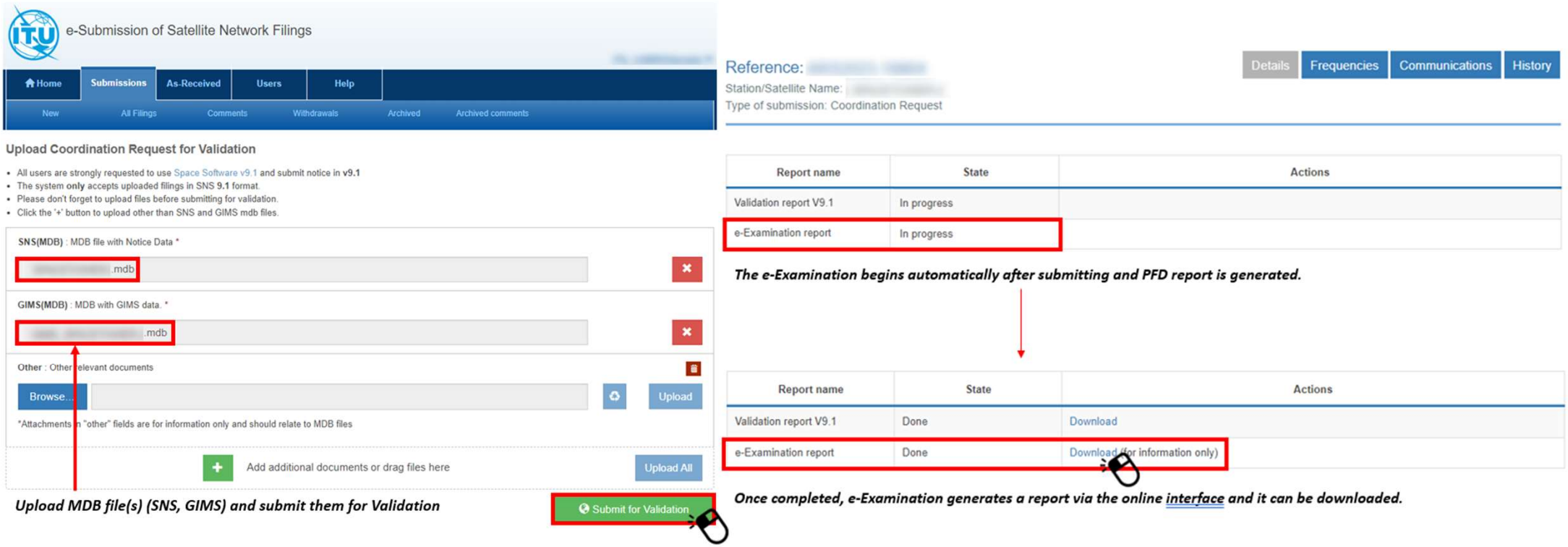
Supports:
GSO/NGSO space stations and Earth stations.
Coordination and notification in non-planned bands.

Automation:
Examinations are conducted automatically on a remote server via e-Submission and Users can easily download the e-Examination results from e-Submission interfaced.

Only for informational purposes !!

A definitive finding will be established by the Bureau during its examination under No. 9.35/11.31 of the Radio Regulations.

e - EXAMINATION



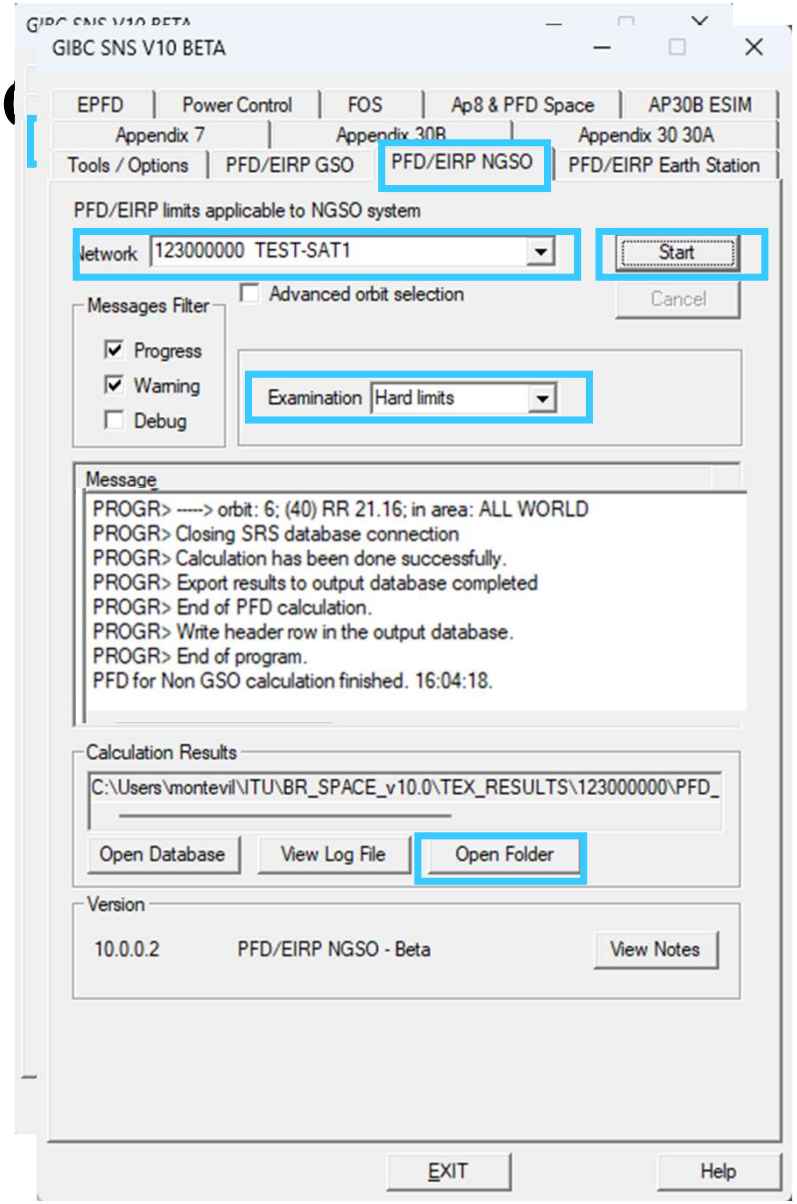
Exceed the limits ? You can withdraw and replace your notice anytime, but cost recovery charges apply after 15 days

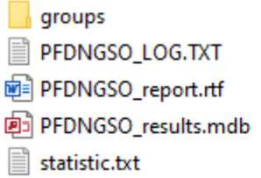
https://www.itu.int/en/ITU-R/space/support/Pages/e-examination-

Example

Example

PFD/EIRP NG





Example

HARD LIMITS Report

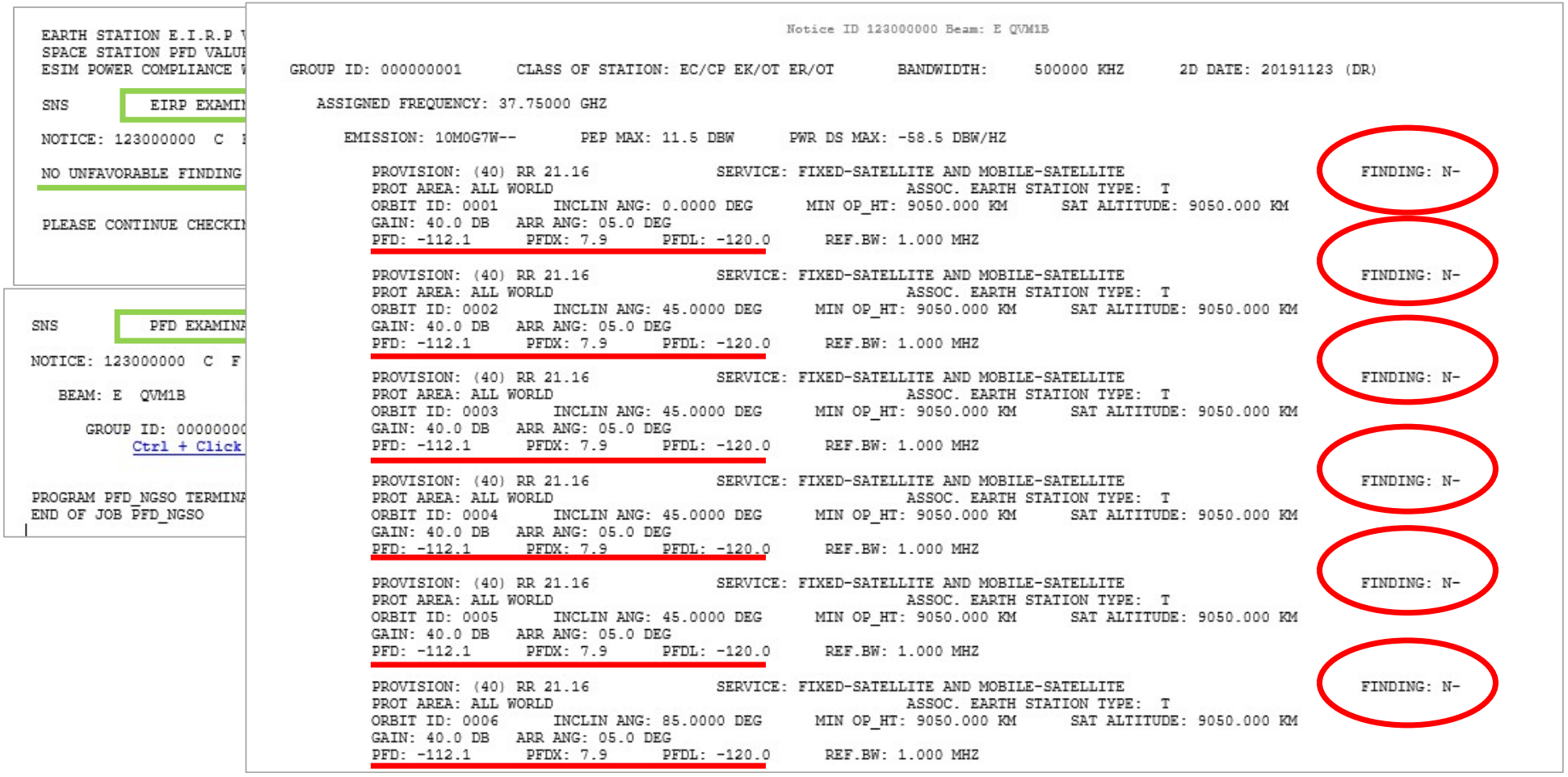
Satellite Network

- Beam(s)
  - Group(s)
    - Frequency assignment(s) & **RESULTS**
      (Frequency & emission)

Contains assignments that **exceeded hard limits**

Example

HARD LIMITS report



```
EARTH STATION E.I.R.P
SPACE STATION PFD VALUE
ESIM POWER COMPLIANCE

SNS          EIRP EXAMI

NOTICE: 123000000  C

NO UNFAVORABLE FINDING

PLEASE CONTINUE CHECKI
```

```
SNS          PFD EXAMINA

NOTICE: 123000000  C  F

   BEAM: E  QVM1B

      GROUP ID: 00000000
           Ctrl + Click

PROGRAM PFD_NGSO TERMINA
END OF JOB PFD_NGSO
```

```
                                Notice ID 123000000 Beam: E QVM1B

GROUP ID: 000000001      CLASS OF STATION: EC/CP EK/OT ER/OT      BANDWIDTH:     500000 KHZ      2D DATE: 20191123 (DR)

   ASSIGNED FREQUENCY: 37.75000 GHZ

      EMISSION: 10M0G7W--       PEP MAX: 11.5 DBW      PWR DS MAX: -58.5 DBW/HZ

         PROVISION: (40) RR 21.16              SERVICE: FIXED-SATELLITE AND MOBILE-SATELLITE                    FINDING: N-
         PROT AREA: ALL WORLD                                   ASSOC. EARTH STATION TYPE:  T
         ORBIT ID: 0001      INCLIN ANG: 0.0000 DEG      MIN OP_HT: 9050.000 KM      SAT ALTITUDE: 9050.000 KM
         GAIN: 40.0 DB   ARR ANG: 05.0 DEG
         PFD: -112.1      PFDX: 7.9      PFDL: -120.0      REF.BW: 1.000 MHZ

         PROVISION: (40) RR 21.16              SERVICE: FIXED-SATELLITE AND MOBILE-SATELLITE                    FINDING: N-
         PROT AREA: ALL WORLD                                   ASSOC. EARTH STATION TYPE:  T
         ORBIT ID: 0002      INCLIN ANG: 45.0000 DEG      MIN OP_HT: 9050.000 KM      SAT ALTITUDE: 9050.000 KM
         GAIN: 40.0 DB   ARR ANG: 05.0 DEG
         PFD: -112.1      PFDX: 7.9      PFDL: -120.0      REF.BW: 1.000 MHZ

         PROVISION: (40) RR 21.16              SERVICE: FIXED-SATELLITE AND MOBILE-SATELLITE                    FINDING: N-
         PROT AREA: ALL WORLD                                   ASSOC. EARTH STATION TYPE:  T
         ORBIT ID: 0003      INCLIN ANG: 45.0000 DEG      MIN OP_HT: 9050.000 KM      SAT ALTITUDE: 9050.000 KM
         GAIN: 40.0 DB   ARR ANG: 05.0 DEG
         PFD: -112.1      PFDX: 7.9      PFDL: -120.0      REF.BW: 1.000 MHZ

         PROVISION: (40) RR 21.16              SERVICE: FIXED-SATELLITE AND MOBILE-SATELLITE                    FINDING: N-
         PROT AREA: ALL WORLD                                   ASSOC. EARTH STATION TYPE:  T
         ORBIT ID: 0004      INCLIN ANG: 45.0000 DEG      MIN OP_HT: 9050.000 KM      SAT ALTITUDE: 9050.000 KM
         GAIN: 40.0 DB   ARR ANG: 05.0 DEG
         PFD: -112.1      PFDX: 7.9      PFDL: -120.0      REF.BW: 1.000 MHZ

         PROVISION: (40) RR 21.16              SERVICE: FIXED-SATELLITE AND MOBILE-SATELLITE                    FINDING: N-
         PROT AREA: ALL WORLD                                   ASSOC. EARTH STATION TYPE:  T
         ORBIT ID: 0005      INCLIN ANG: 45.0000 DEG      MIN OP_HT: 9050.000 KM      SAT ALTITUDE: 9050.000 KM
         GAIN: 40.0 DB   ARR ANG: 05.0 DEG
         PFD: -112.1      PFDX: 7.9      PFDL: -120.0      REF.BW: 1.000 MHZ

         PROVISION: (40) RR 21.16              SERVICE: FIXED-SATELLITE AND MOBILE-SATELLITE                    FINDING: N-
         PROT AREA: ALL WORLD                                   ASSOC. EARTH STATION TYPE:  T
         ORBIT ID: 0006      INCLIN ANG: 85.0000 DEG      MIN OP_HT: 9050.000 KM      SAT ALTITUDE: 9050.000 KM
         GAIN: 40.0 DB   ARR ANG: 05.0 DEG
         PFD: -112.1      PFDX: 7.9      PFDL: -120.0      REF.BW: 1.000 MHZ
```

GIBC PFD/EIRP NGSO

- Hard Limits exceeded -> **Unfavorable finding**
- Triggers Limits exceeded -> **Coordination needed**
- Where to find Hard and Trigger limits in RR
- How to run GIBC/PFD NGSO SW
- Importance of capturing customized antenna pattern in GIMS

Thank you!

ITU Radiocommunication Office

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