



RF Exposure Guidance Updates in New KDB Draft Publication 447498

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Note: The views expressed in this presentation are those of the authors and may not necessarily represent the views of the Federal Communications Commission.



Take-Home Message

- Several, presently “unsettled” issues for RFX related to Equipment Authorization addressed in a new KDB 447498 draft
- New guidance accounts with most recent rulemaking efforts, technology evolution, and improves consistency and uniformity among RF devices
- New draft to be open for comments with posting after the workshop



Contents

- 1. Re-Iterating Present KDB 447498 Transition Policy Modules**
- 2. New KDB 447498 Draft for Comment**
- 3. KDB 447498 “Satellite” Publications Updates**
- 4. Equipment Authorization Policy and §1.1307**
- 5. Improving Guidance Consistency and Uniformity**
- 6. Time-averaging in RFX Evaluations**
- 7. Extension of SPLSR Formula**
- 8. RF Exposure Assessment for Module Integration**
- 9. RF Exposure Test Exemption Below 300 MHz**
- 10. Tolerances in Compliance Data**
- 11. Certification for Fixed Station Equipment**
- 12. Unintentional Radiator Sources (URS)**
- 13. Conclusions**



Re-Iterating Present KDB 447498 Transition Policy

No Changes for KDB 447498 Transition Plans

Notes in KDB 447498 “Main page”

- **Until further notice**, either 447498 D04, or the previous KDB Pub. 447498 D01 v06 may continue to be used:
 - No mix of old and new procedures within application filings
 - A **transition period date** will be announced (with ample advance notice)
- For devices using 447498 v06 and **not subject to PAG**:
 - Form-731s and associated grants must be submitted to FCC by a TCB on or before the end of the transition period (still to be announced)
- For devices using 447498 v06 and **subject to PAG**:
 - TCB must submit PAG KDB inquiry and fully-populated Form-731 application on or before the end of the transition period (still to be announced)



New KDB 447498 Draft for Comments

- Previous KDB 447498 Draft (DR05, 2022) received comments: **all comments reviewed** and, as applicable, accounted for.
- New changes in the **new forthcoming draft** have been inserted to improve consistency of Equipment Authorization compliance guidance, and clarity and uniformity in the present published procedures
- Details are provided in this presentation **to support the review and comment on the new draft**
- As clearly displayed in the pertinent slides, **changes posted for comments** and herein discussed **not yet to be used** for Equipment Authorization purposes until new publication is issued
- No enacting of new procedures via workshop presentations: the **preferred approach** is to provide a **preview**, support **comment phase**, and then **smoothly transition to** new procedures via KDB Publication along with a transition period



KDB 447498 “Satellite” Publications Updates

- Update is in progress for several procedures included in publications related to KDB 447498
- KDB Publications currently under revision to sync with new KDB 447498
 - KDB 616217 “SAR evaluation considerations for laptop, notebook, netbook and tablet computers”
 - KDB 648474 “SAR evaluation for handsets, wireless charging battery covers”
 - KDB 996639 “Modules” (updates published)
 - Published new WPT KDB 680106 provides guidance for all “co-located”, non-modular transmitters that are separately authorized, and this guidance is to be further formalized within topical publications listed above



Equipment Authorization Policy and §1.1307 (I)

- Recent workshop provision ([April 2022 TCB Workshop – 4.1](#)) for Equipment Authorization of § 2.1093-Portable devices operating **below 4 MHz**, is now formalized in **new KFB 680106-v04** (the “WPT one”)
- Summary frequency table (from previous KDB 447498 draft) has been then **in effect** and underlines **differences and alignment** between test procedures Rules and Equipment Authorization

Frequency range ^a	FCC Rules	OET Equipment Authorization Policies
$f \leq 100$ kHz	N/A (under consideration) ^c	All devices assessed case-by-case, with field strength limits of $E = 83$ V/m and $H = 90$ A/m, in all body exposure relevant positions
100 kHz $< f \leq 300$ kHz ^b	SAR limits in § 1.1310 (b), (c)	MPE limits at 300 kHz in Table 1 to § 1.1310(e)(1): $E = 614$ V/m and $H = 1.63$ A/m
300 kHz $< f \leq 4$ MHz ^b	§ 2.1091 Mobile Devices: MPE limits in Table 1 to § 1.1310(e)(1)	MPE limits in Table 1 to § 1.1310(e)(1)
	§ 2.1093 Portable Devices: SAR limits in § 1.1310 (b), (c)	
4 MHz $< f \leq 6$ GHz	§ 2.1091 Mobile Devices: MPE limits in Table 1 to § 1.1310(e)(1)	
	§ 2.1093 Portable Devices: SAR limits in § 1.1310 (b), (c)	
6 GHz $< f \leq 100$ GHz	MPE limits in Table 1 to § 1.1310(e)(1) ^c	
100 GHz $< f \leq 3000$ GHz	N/A (under consideration) ^c	

^a For all $f \leq 6$ GHz, SAR limits in §§ 1.1310 (b), (c) can always be applied where available, in place of MPE limits
^b Policies for 100 kHz $< f \leq 4$ MHz reflect capabilities of available SAR measurement equipment. Numerical simulations may be also acceptable, under PAG
^c NPRM, ET Docket No. 19-226; FCC 19-126, 34 FCC Red 11743

[Next Slide](#)



... from Slide 7

Frequency range ^a	FCC Rules	OET Equipment Authorization Policies
$f \leq 100 \text{ kHz}$	N/A (under consideration) ^c	All devices assessed case-by-case, with field strength limits of $E = 83 \text{ V/m}$ and $H = 90 \text{ A/m}$, in all body exposure relevant positions
$100 \text{ kHz} < f \leq 300 \text{ kHz}$ ^b	SAR limits in § 1.1310 (b), (c)	MPE limits at 300 kHz in Table 1 to § 1.1310(e)(1): $E = 614 \text{ V/m}$ and $H = 1.63 \text{ A/m}$
$300 \text{ kHz} < f \leq 4 \text{ MHz}$ ^b	§ 2.1091 Mobile Devices: MPE limits in Table 1 to § 1.1310(e)(1)	MPE limits in Table 1 to § 1.1310(e)(1)
	§ 2.1093 Portable Devices: SAR limits in § 1.1310 (b), (c)	
$4 \text{ MHz} < f \leq 6 \text{ GHz}$	§ 2.1091 Mobile Devices: MPE limits in Table 1 to § 1.1310(e)(1)	
	§ 2.1093 Portable Devices: SAR limits in § 1.1310 (b), (c)	
$6 \text{ GHz} < f \leq 100 \text{ GHz}$	MPE limits in Table 1 to § 1.1310(e)(1) ^c	
$100 \text{ GHz} < f \leq 3000 \text{ GHz}$	N/A (under consideration) ^c	
^a For all $f \leq 6 \text{ GHz}$, SAR limits in §§ 1.1310 (b), (c) can always be applied where available, in place of MPE limits ^b Policies for $100 \text{ kHz} < f \leq 4 \text{ MHz}$ reflect capabilities of available SAR measurement equipment. Numerical simulations may be also acceptable, under PAG ^c NPRM, ET Docket No. 19-226; FCC 19-126, 34 FCC Rcd 11743		

Synopsis of RF Exposure Limits in FCC Rules and OET Equipment Authorization Policies



Equipment Authorization Policy and §1.1307 (II)

Leveraging Basic Restriction Limits for Compliance

- In principle, the FCC RF exposure **basic restriction limits** may be used for equipment authorization, while measurements show that the reference limits are not met
- Results from **numerical simulations** may be used to support compliance with basic restriction limits
- The simulation needs to show that the data in a simulated tissue model are properly **validated**
- Thorough validation will have to also **show consistency** with the (MPE) data that did not show compliance with the reference limits
- The application will be subject to the **NUMSIM PAG review**



Improving Guidance Consistency and Uniformity (1)

Draft for Comments

- New provisions will be introduced for devices using “hotspot” mode
 - 5 mm maximum test distance compliance (*i.e.*, anywhere from 0 to 5 mm)or
 - only if equipped with body proximity sensors, show compliance at 25 mm with sensors off (consistent with recent KDB 447498-Main Page guidance update), this requires PAG and validation of sensor functionality
- Revised test separations distances will be required for various form factor devices (phones vs. phablets, etc.) and, in general will converge to 5 mm for portable devices
- Well-supported exceptions will be included, with clearly demonstrated use-cases, not based on user choices (e.g., belt holster availability is not sufficient)
- Non-standard test separation distances may be accepted via Equipment Compliance Review (ECR) Inquiry per KDB Pub. 951290 (this item is already in effect)



Reminder Note

951290 D01 Equipment Compliance Review

- ECR and other KDB Inquiry types

<i>KDB Inquiry Type</i>	<i>Submitted by</i>	<i>Purpose</i>
General Inquiry	Anyone	To obtain clarifications on FCC Published Guidance
ECR	Applicants for Equipment Authorization	Only to provide the specific information requested by the FCC in published guidance
NAG	Applicants for Equipment Certification	To gather additional guidance on methodologies related to specific items in the PAG List
PAG/MPAG	TCBs	To address compliance and obtain approval for PAG Items



Improving Guidance Consistency and Uniformity (II)

Assessing § 2.1091-Mobile vs. § 2.1093-Portable Conditions

- New KDB Inquiry categories available in KDB Publication 951290
- KDB to be filed: 1st category “Equipment Compliance Review”, 2nd “Category “Mobile vs. Portable”
- Case description shall include use-case conditions defined in an **objective, defensible** manner.
- For certifications, **grant comments** shall detail situations where there is a **non-standard minimum approach** distance, i.e., *Mobile* device compliant only for distances greater than 20 cm, or *Portable* device compliant only for more than ... cm, but still less than 20 cm.
- The **user’s manual** (or similar documentation) must report the same language as the grant comment (this includes SDoC)



Time-averaging in RFX Evaluations (I)

Clarification on Equipment Authorization Policy

- To evaluate the environmental impact of RF on humans, 47 CFR 1.1310(e)(1) provides limits on SAR and Maximum Permissible Exposure (MPE), specified for an **averaging time** of 30 min., and 6 min., for the general public and occupational exposure, respectively
- Per **OET Equipment Authorization procedure**, the uniform criterion for all RF devices requires demonstrating compliance to limits stated in KDB 447498, and using the time averaging window specified as follows:

Frequency (GHz):	< 3	3–6	6–10	10-16	16-24	24-42	42-95
Max. Averaging Time (s):	100	60	30	14	8	4	2

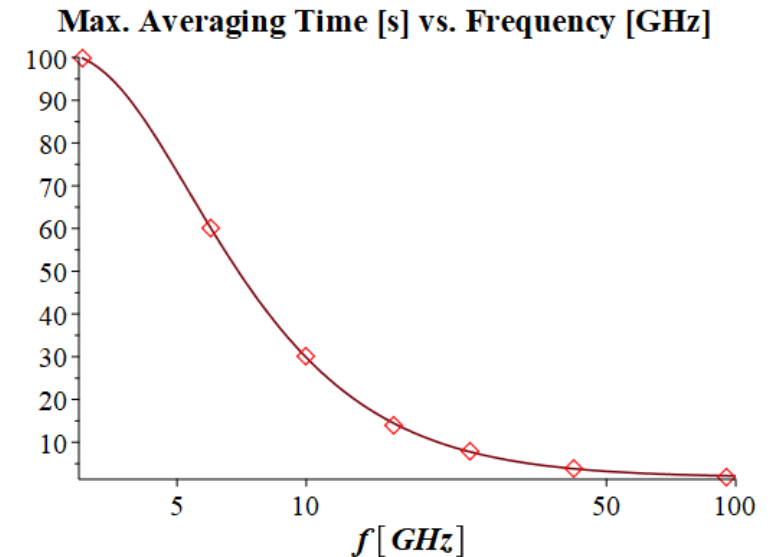
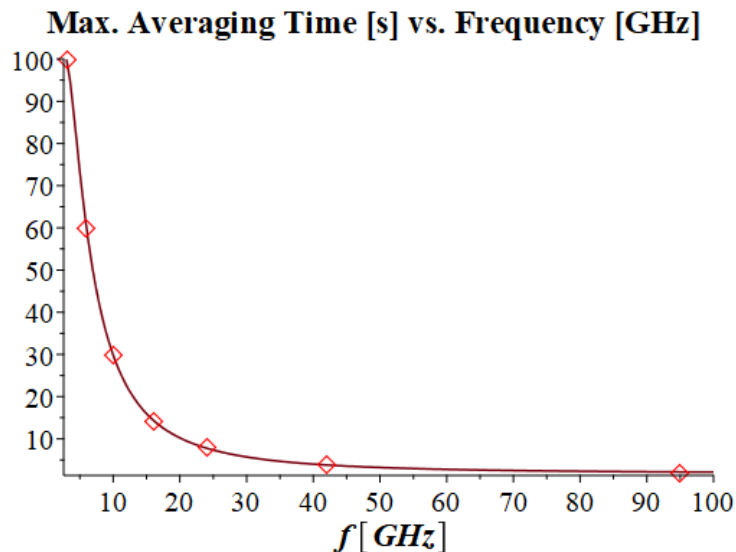
From: Oct. 2018 TCBC Workshop, "[RF Exposure Order/NPRM Issues](#)"



Time-averaging in RFX Evaluations (II)

- For frequencies not listed in the previous Table, maximum averaging time t_{ave} may be evaluated via linear piecewise interpolation, or least-squares fitting, for instance as

$$t_{ave}(f) = \frac{15536}{f^4} - \frac{15171}{f^3} + \frac{4235}{f^2} - \frac{6.889}{f} + 1.769$$





Extension of SPLSR Formula

Draft for Comments

- “Generalized” SPLSR formula: same formula will be presented in terms of TER quantities, i.e., based on normalized SAR and TER contributions for field and power density MPE
- This will allow to include power density contributions and contributions of [MPE below 4 MHz in place of SAR](#) (the latter already allowed for non-SPLSR evaluations per [TCB Workshop Apr. 2022-4.1](#) procedure and now in [KDB 680106v04](#))
- SPLSR will be allowed to include SAR or PD from [validated numerical simulations](#), when allowed for certification of the standalone device in place of direct evaluation
 - Example: SAR_A and SAR_B are used for evaluating SPLSR between two transmitters “A” and “B”. SAR_A can be from lab testing while SAR_B is from a numerical simulation (properly validated and deemed acceptable). [NUMSIM PAG will apply](#).



RF Exposure Assessment for Module Integration (I)

Draft for Comments

- Devices with transmitter modular grant (“*Modules*”) need to account for the host device form factor because in a “crowded environment” (e.g., cell phone handset) the *Module* RF emissions patterns may add up and be re-shaped by nearby materials
- Uniform procedure for integration of modular transmitters all §2.1093-portable host devices is introduced to prevent excessive near-field contributions from nearby transmitters that may lead to incorrect RF exposure evaluations
- The host integrator will be able to apply the (new TER-based) SPLSR formula for all devices to determine module location and applicability to a specific host, regardless of the outer enclosure form factor.



RF Exposure Assessment for Module Integration (II)

Draft for Comments

- Previous “small form factors” restriction will be then now automatically provided in **quantitative terms**
- Module integration in hosts will be then applicable **uniformly** to all devices to guarantee RF exposure compliance.
- Example
 - SPLSR criterion allows a device to be consider compliant for Equipment Authorization if $SPLSR = (SAR_i + SAR_j)^{1.5}/R_{i,j} < 0.04$ for every pair (i,j) of transmitter antennas separated by a distant $R_{i,j}$ expressed in *mm*, and with SAR_i and SAR_j being the stand-alone SAR values.
 - For two antennas i and j at with $SAR_i + SAR_j = 1.6$ W/kg than $R_{i,j} \approx 50.6$ mm
 - Therefore, in this case two *Modules* each characterized by the **maximum SAR permissible for simultaneous transmissions**, cannot be integrated with less than a 50.6 mm distance from each other



RF Exposure Test Exemption Below 300 MHz

Draft for Comments

- Compliance Test exemption criteria for Equipment Authorization will align with the Section 1.1307 of the Rules criteria providing exemptions from the need of performing an Environmental Assessment between 300 MHz and 3– GHz
- For the purpose of Equipment Authorization, compliance test exemptions below 300 MHz, will be introduced in a continuous fashion to meet legacy provisions (from 447498-v06)
- Exemptions criteria extension approach was outlined in previous KDB 447498 draft and will be presented with an enhanced format to simplify the applications.



Tolerances in Compliance Data

- No distinction shall be made between “tune-up tolerance” and **any other tolerance** (production, calibration, or test equipment).
- The “reported SAR” (or MPE) shall be defined in reference to the **device’s overall specification tolerance**, as declared by the manufacturer.
- If a product is fabricated under low accuracy standards, then the manufacturer is implicitly penalized because the product needs to be tested to **comply with the applicable limit minus the tolerance**.
- Example: **±10% tolerance** on power will require using lower a max 1-g SAR:

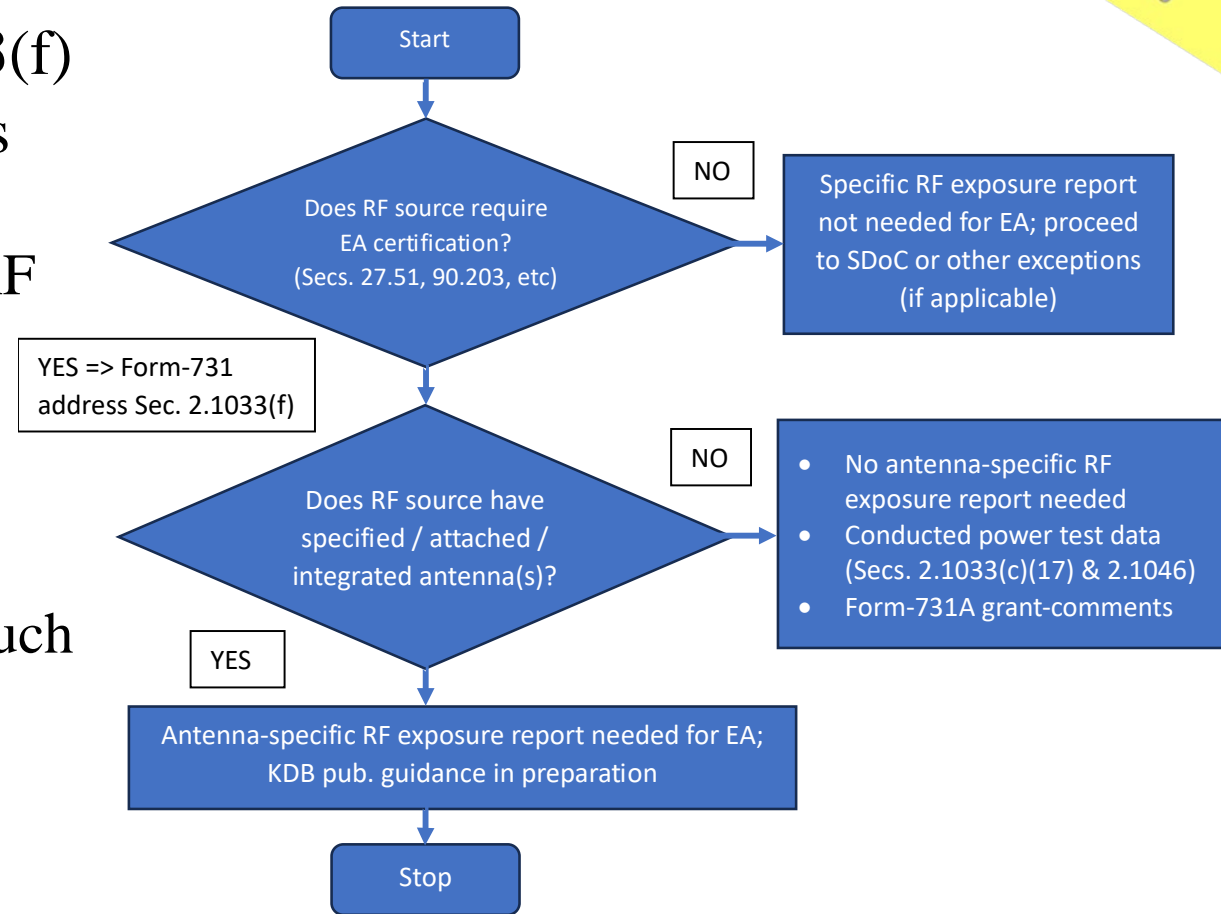
$$\text{SAR}_{\text{max}} = 1.6 - 0.16 = 1.44 \text{ W/Kg}$$



Certification for Fixed Station Equipment

Draft for Comments

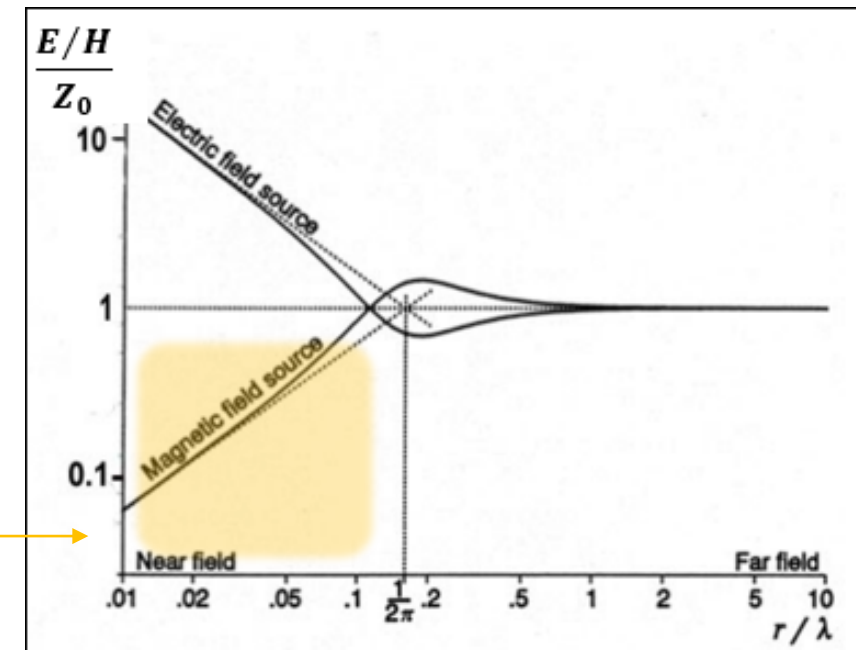
- Updates being prepared for addressing §2.1033(f) in filings for **fixed-mount/fixed-site** RF sources
 - Commercial Mobile Radio Service (**CMRS**, e.g., Parts 27, 96, etc.) base stations or fixed-mount RF sources
 - Consistency in supporting compliance distances
 - Consistency with updates of OET 65 bulletin
- Guidance on RFX **filing requirements**
 - RF sources with integral or specific antennas, such as beamforming arrays
 - RFX conditions with site-dependent and site-licensed RF sources
- Considering new KDB Pub. other than 447498





Unintentional Radiator Sources in RFX Evaluations (I)

- Devising “test compliance friendly” procedure based on Part 15 B test data for equipment authorization of RF devices that include Unintentional Radiator Sources (URS)
- Only special cases will require to account for URS contribution to the RFX evaluation, that is when a Part 15 B testing cannot provide a good measure of the total radiated power.
- This occurs when the Part 15 B measurement is done in the near field and for a “predominantly magnetic” source.



Adapted from [K. McDonald, 2004]



Unintentional Radiator Sources in RFX Evaluations (II)

Draft for Comments

- An RF device that includes **URS exempted** from authorization (per §§ 15.23, 15.103, and 15.113) will be exempted from including the URS contributions in the total RF Exposure evaluation budget.
- For non-exempt URS, in most cases, **leveraging Part 15 B** EMC compliance test data can be used for addressing RFX compliance
- For Part 15-B compliant URS, **in most cases**, the radiated power estimate based on near-field components **does not reach the 1-mW** RFX test exemption level
 - **Exceptions** may be found for emissions in the **tens of kHz** from **magnetic-type sources** (i.e., $E/H = Z_w \ll Z_0 \approx 377 \Omega$)
 - These are cases where Part 15-B test data collected in the **near-field**, may lead to a power estimate that is **less than the actual power radiated** by the device [TCBC Workshop Apr. 2023]



Unintentional Radiator Sources in RFX Evaluations (III)

Draft for Comments

- Example: a power supply/cabling feeding low frequency RF (say, 10 kHz) to an EV charging coil. The power supply/cabling, a source with conducted RF, is the **unintentional** radiator, the EV coil is an **intentional** radiator.
- In general, precise identification of the URS special cases requires:
 - Computing the near field transition boundary based on the URS frequency and size
 - If URS is Part 15 B compliant based on **test distance** in the far field, no further RF Exposure contribution needs to be reported/filed
 - If Part 15 B test distance in the **near field**, measure H field at, if $E/H \geq 377 \Omega$, no further RFX contribution needs to be reported/filed
- **Simplified compliance workflow** developed as a look-up table



Conclusions

- New revision of KDB 447498 to be posted as a **draft for comments**
- **Key updates** provide improved consistency in equipment authorization procedures and streamlined guidance: as simple as it can be, no more complex than it should
- FCC will ensure that provisions are in place to ensure a **smooth transition** between old and new procedures