Selected Mobile and Portable Device RF Exposure Policies and Procedures

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NOTE Corrections made after the presentation are shown in green font.

Overview

- Summary and status of rule changes per FCC-19-126 Order and Notice of Proposed Rulemaking (NPRM)
- Key concepts and usage guidance of Draft-for-Review KDB 447498 DR04 with new RF exposure rules
- Summary and status of interim RF exposure test procedures for U-NII 6-7 GHz portable devices
- Summary and status of continuing development for other RF exposure policies and procedures

Review and Status of RF Exposure Rules per FCC-19-126 Order and NPRM

RF Exposure Proceedings Status

- Second Report and Order portion of FCC-19-126
  - docket no. 03-137; 34 FCCR 11697 etc.
    - paragraphs 17 through 118, and Appendix A
  - June 1, 2020 effective date for some FCC-19-126 rule changes:
    - Based on Federal Register publication of FCC 19-126
    - 1.1310; 2.1033(f); 15.212(a)(vii); 18.313; 90.223; numerous others not listed here
  - May 3, 2021 effective date for remaining rule changes:
    - 1.1307(b); 2.1091 (b), (c), (d)(1), (d)(2); 2.1093 (b), (c), (d)
    - Announced in Public Notice FCC DA-21-363 (April 2, 2021)
    - DA-21-363 published in Federal Register April 20, 2021
      - 86 FR 20456-20458, no change to effective date of rules

85 FR 18131-18151, Apr. 1, 2020; (https://www.federalregister.gov/documents/2020/04/01/2020-02745/human-exposure-to-radiofrequency-electromagnetic-fields-and-reassessment-of-fcc-radiofrequency)

RF Exposure Proceedings Status

- Notice of Proposed Rulemaking portion of FCC-19-126
  - docket no. 19-226; 34 FCCR 11697 etc.
    - paragraphs 119 through 147, and Appendix B
  - NPRM key topics include:
    - Extending exposure limits below 100 kHz and above 100 GHz, and associated matters on limit quantities and parameters
    - Transmitter-based time-averaging for exposure compliance
    - Spectrum and rule part matters and RF exposure considerations for wireless power transfer (WPT) devices
- Comments received and final rules still under review and development
  - Final rules under docket no. 19-226 not adopted nor in effect yet
    - *Except* Nov. 2018 TCB guidance (https://www.fcc.gov/general/equipment-authorization-presentations) has requirements for transmitter-based time-averaging periods and above-6 GHz averaging area requirements in equipment filings

85 FR 19117-19126, Apr. 6, 2020; (https://www.federalregister.gov/documents/2020/04/06/2020-06966/human-exposure-to-radiofrequency-electromagnetic-fields)

DA-21-363 Eqpt. Auth. Aspects

- Existing equipment authorizations remain valid and do not require modifications
- Certification applications for new and modified equipment must follow the equipment authorization policies and procedures in effect at the time of the application
- Rule changes for equipment authorization primarily affect methods of determining exemption
  - New set of simple, generally-applicable formulas for test exemption replaces the previous rule-part based categorical exclusions
  - Most equipment that was exempt under the old criteria are generally expected to still be exempt under the new criteria
  - Basic exposure limits remain unchanged
- Associated changes for equipment authorization RF exposure evaluation policies and procedures starting with KDB Pub. 447498 are discussed below

Transition Considerations (1)

- Draft Publication for Review KDB 447498 D01 (v07) DR04-44307 is being published* in April 2021
  - Title: *RF Exposure Procedures and Equipment Authorization Policies for Mobile and Portable Devices*
  - Draft is based on the existing policies and procedures of KDB Publication 447498 D01 v06 – with modifications and updates following from the rules adopted in the FCC-19-126 Order
  - Part of a set of KDB RF exposure procedures and policies documents being revised in 2021
- KDB 447498 v07 can be used starting immediately after review process completes and the final version is published
  - The policies and procedures in KDB 447498 v07 must be used in their entirety along with any other associated revised KDB RF exposure procedures and policies (including FCC-TCB conference presentation materials)

* FCC e-filing OET Draft Laboratory Div. Pubs., (https://apps.fcc.gov/oetcf/kdb/reports/PublishedDocumentList.cfm)

Transition Considerations (2)

- The previous version of the policies and procedures, KDB Publication 447498 D01 v06 (including the test exemption power thresholds therein) may continue to be used until Dec. 31, 2021
  - 447498 DR04-44307 is going through draft review process
  - Policies and procedures of 447498 D01 v06 must be used in their entirety when used – no mix of old and new procedures within each application filing
  - During this transition period some of the old procedures still require FCC review through the pre-approval guidance procedure
- All equipment authorization applications must use the new procedures (and new §1.1307 test exemptions) starting Jan. 1, 2022

Draft for Review
KDB 447498 v07 DR04:
General Updates and Concepts per Revised RF Exposure Rules

Editorial Revisions and Restructuring

- In addition to basic changes following from the FCC-19-126 Order, with this revision draft KDB 447498 DR04-44307:
  - Many of the underlying specific requirements and conditions and procedures of 447498 D01 v06 remain unchanged
  - Existing main body sections are extensively re-organized and re-worded intending to improve readability thus usability
    - Numerous descriptive subheadings added and some like-topics grouped together
    - Some sub-topics moved to appendices

Routine Evaluation (1)

- Sec. 2.1033 at new paragraph (f) now has the following customary exposure compliance text as part of the required contents for certification application filings:
  - RF devices operating under the provisions of this part are subject to the RF radiation exposure requirements specified in §§1.1307(b), 1.1310, 2.1091, and 2.1093 of this chapter, as appropriate. Applications for equipment authorization of RF sources under this section must contain a statement confirming compliance with these requirements. Technical information showing the basis for this statement must be submitted to the Commission upon request.
- Routine evaluation generally means a determination of compliance with the exposure limits in §1.1310 or §2.1093
- Further to §1.1307(b)(1)(i), with respect to the limits on human exposure to RF radiation provided in §1.1310, applicants to FCC for the grant or modification of equipment authorizations or any other authorizations for RF sources must either:
  - Determine that a device qualifies for test exemption pursuant to §1.1307(b)(3), or
  - Prepare an evaluation of the human exposure to RF radiation pursuant to §1.1310 (i.e., routine evaluation)

Routine Evaluation (2)

- Under the preceding exposure rules
  - specific radio services and conditions were identified where routine evaluation for RF exposure compliance demonstration was required
  - any services and operations not specifically identified were exempt from routine evaluations
- Under the new exposure rules
  - all radio services and operations (including equipment) are subject to routine evaluation for RF exposure compliance demonstration
  - unless shown to qualify under the exemptions provided in the rules or OET Lab policies for equipment authorization or both
- Per §1.1307(b)(2) definitions, exemption for (an) RF source(s) is solely from routine evaluation for RF exposure compliance demonstration, but is not exemption from Part 2 equipment authorization procedures nor exemption from compliance with the §1.1310 FCC RF exposure limits

Single RF Source Exemptions (1)

I) 1 mW Blanket Exemption – §1.1307(b)(3)(i)(A):

Available maximum time-averaged power is no more than 1 mW, regardless of separation distance. This exemption may not be used in conjunction with other exemption criteria other than those for multiple RF sources in paragraph §1.1307(b)(3)(ii)(A).

II) SAR-based Exemption – §1.1307(b)(3)(i)(B):

$$P_{\text{th}}\,(\text{mW}) = \begin{cases} ERP_{20\,\text{cm}}(d/20\,\text{cm})^{x} & d \le 20\ \text{cm} \\ ERP_{20\,\text{cm}} & 20\ \text{cm} < d \le 40\ \text{cm} \end{cases} \quad (1)$$

with $x = -\log_{10}\left(\frac{60}{ERP_{20\,\text{cm}}\sqrt{f}}\right)$, (2)

f in GHz, separation distance d in cm

$ERP_{20\,\text{cm}}$ per Formula (3)

III) MPE-based Exemption – §1.1307(b)(3)(i)(C):

TABLE 1 TO § 1.1307(b)(3)(i)(C)—SINGLE RF SOURCES SUBJECT TO ROUTINE ENVIRONMENTAL EVALUATION (modified)

RF Source Frequency			Minimum Distance			Threshold ERP
fL MHz		fH MHz	λL / 2π		λH / 2π	W
0.3	–	1.34	159 m	–	35.6 m	1,920 R^2.
1.34	–	30	35.6 m	–	1.6 m	3,450 R^2/f^2.
30	–	300	1.6 m	–	159 mm	3.83 R^2.
300	–	1,500	159 mm	–	31.8 mm	0.0128 R^2f.
1,500	–	100,000	31.8 mm	–	0.5 mm	19.2R^2.

separation distance R in m

IV) MPE-based Exemption – §2.1091(c) ¶1 [also §1.1307(b)(3)(i)(B)]:

$$P_{\text{th}}\,(\text{mW}) = ERP_{20\,cm}\,(\text{mW}) \quad (3)$$

$$= \begin{cases} 2040f & 0.3\ \text{GHz} \le f < 1.5\ \text{GHz} \\ 3060 & 1.5\ \text{GHz} \le f \le 6\ \text{GHz} \end{cases}$$

$20\ \text{cm} < d \le 40\ \text{cm}$

- An RF source is exempt if it meets any of these criteria, regardless of radio service, rule part, or classification as fixed device, mobile device, or portable device
- Notes view of this slide provides other details, further to FCC-19-126
  - same info is in Appendix B of 447498 DR04-44307

Single RF Source Exemptions (2)

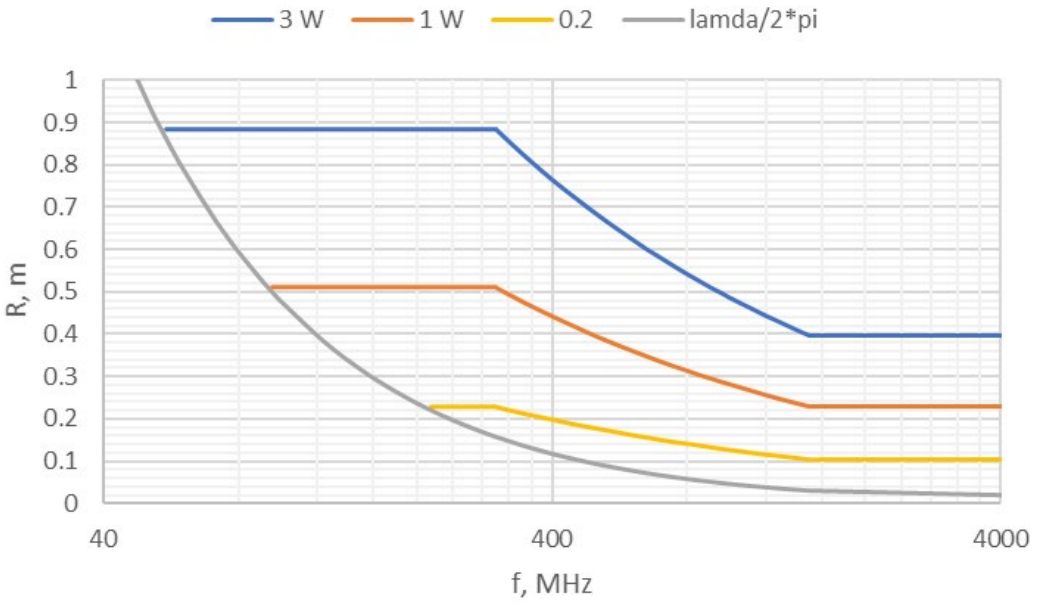
- Generally the sequence for determining exemption for single mobile and portable RF sources includes:
  a) determination of 1 mW blanket exemption under §1.1307(b)(3)(i)(A)
  b) determination of exemption under MPE-based §1.1307(b)(3)(i)(C) if a) is not met
  c) determination of exemption under SAR-based §1.1307(b)(3)(i)(B) if both a) and b) are not met
  d) test reduction procedures for evaluation from FCC Laboratory if a), b) and c) are not met
  e) evaluation by SAR measurement or computation if a), b), c), and d) are not met

Threshold P_{th} Examples

SAR-based, P_{th} in mW

MHz \ mm	5	10	15	20	25	30	35	40	45	50
300	39	65	88	110	129	148	166	184	201	217
450	22	44	67	89	112	135	158	180	203	226
835	9	25	44	66	90	116	145	175	207	240
1900	3	12	26	44	66	92	122	157	195	236
2450	3	10	22	38	59	83	111	143	179	219
3600	2	8	18	32	49	71	96	125	158	195
5800	1	6	14	25	40	58	80	106	136	169

MPE-based, distance R for exemption at example power levels



Multi-RF Sources Exemption

- §1.1307(b)(3)(ii)(A) End product is exempt if
  - each source is 1 mW or less, and any portions of radiating structures of each are 2 cm or more apart, or
  - sum of power of the multiple sources is less than 1 mW (separation is not required)
- §1.1307(b)(3)(ii)(B) Multiple mobile or portable RF sources within an end product are exempt from routine evaluation per Formula (4)

$$\sum_{i=1}^{a} \frac{P_i}{P_{\text{th},i}} + \sum_{j=1}^{b} \frac{ERP_j}{ERP_{\text{th},j}} + \sum_{k=1}^{c} \frac{Evaluated_k}{Exposure\ Limit_k} \leq 1 \qquad (4)$$

  - *P* and *ERP* summation terms are basic exemption criteria
  - *Evaluated*/*Exposure Limit* sum accounts for preexisting exposure levels
- Formula (4) applies as follows:
  - sum the normalized contributions to the exemption threshold for each antenna by calculating the ratio of the maximum time-averaged P_i or ERP_j for the antenna to the corresponding exemption threshold $P_{\text{th},i}$ or $ERP_{\text{th},j}$, and sum these ratios
  - add any normalized contributions from RF sources with known exposure, (i.e., the percentage of the relevant exposure limit that exists prior to considering the subject source(s)) at a specific location
  - the configuration is exempt if the total does not exceed 1

Items Under Consideration

- Blanket exemptions for *unintentional radiators* under Part 15 Subpart B and Part 18 (e.g., consumer microwave ovens)
- Uniform guidance for records retention of exposure compliance supporting technical information of commercially-marketed Part 97 amateur equipment
- Discretion to continue previous KDB 447498 v06 SAR-based exemption thresholds for $f < 300$ MHz

Summary and Status of Interim RF Exposure Test Procedures for U-NII 6-7 GHz Portable Devices

U-NII 6-7 GHz Interim Procedures (1)

- As discussed in Oct. 2020 FCC-TCB slides
  - typical widely deployed millimeter-wave (mmw-) band power density (PD) evaluation methods are optimized for and have lowest measurement uncertainties at frequencies above about 24 GHz
  - Similar low-perturbing low-measurement-uncertainty solutions for near-field incident PD testing of 6-7 GHz portable devices are not known to be commercially available
- SAR test data, along with other measured and derived PD results, has been accepted for the interim for compliance purposes
- These interim procedures for testing and reporting SAR and PD data should continue to be used until further notice
- Industry R&D is progressing towards single-probe field-reconstruction-based PD test methods and test systems with reduced measurement uncertainties

U-NII 6-7 GHz Interim Procedures (2)

- Summary of interim procedures for U-NII 6-7 GHz band portable devices
  - SAR evaluation using 6-7 GHz parameters of IEC/IEEE 62209-1528:2020
    - Apply KDBs 447498, 248227, 648474, 616217, 941225 as applicable for product
    - Report also estimated absorbed PD (for reference purposes only, not specifically for compliance) and estimated incident PD (both derived from measured SAR)
  - For the highest SAR test configurations also measure incident PD (total) using mmw near-field probe and total-field/power-density reconstruction method
    - 2 mm closest measurement plane, e.g., with handsets
    - Using system-manufacturer specified procedures
    - In addition to tune-up tolerance scaling, adjust measured results per amount that measurement uncertainty exceeds 30 % (e.g., per methods of IEC 62479:2010)
- Start with minimum of 5 test channels across full 5925-7125 MHz band and adapt conducted power and SAR test reduction procedures of KDB 248227 v02r02
- SAR tests have been accepted for modules with standalone antennas per KDB 447498 and KDB 616217 SAR-based provisions
  - Supporting data generally needed for consideration before developing similar test procedures and conditions for PD testing

Continuing Developments on Various RF Exposure Policies and Procedures

Interim and Developing Policies

- Development and preparation is continuing for several mobile and portable device RF exposure evaluation procedures, and review and approval uniform policies and procedures
  - RF exposure policies and procedures generally overlap with and are impacted by topics and activities in ~~the exposure rulemaking release,~~ measurement standards projects and working groups, and evolving device technologies in KDB inquiries and PAG reviews
  - Some highlights in following pages
- Along with information of this session, preceding evaluation and review and approval policies and procedures guidance continue to apply

$f > 6$ GHz MPE for Other Portable Devices

- General guidance for portable devices transmitting at $f > 6$ GHz (e.g., UWB, 60 GHz, Part 30) has been provided in previous FCC-TCB conference notes (especially since 2017)
- Former 5 cm MPE evaluation distance of §2.1093(d) is omitted in new rules
  - evaluations shall use minimum separation distance applicable to operating configurations and exposure conditions of device
- Portable devices operating above 6 GHz generally remain addressed on case-by-case basis
  - FCC ID records do include numerous $f > 6$ GHz portable device MPE evaluations since 2017, using measurements, simulations, and analyses

Portable Device MPE Test Exemption

- 1 mW test exemption [§1.1307(b)(3)(i)(A)] may be used with the portable device $f > 6$ GHz FCC MPE power density limits
  - Available maximum time-averaged matched conducted power, irrespective of distance from body
  - Analysis exhibit required where test exemption qualifies
  - Evaluation distance emulating normal use conditions
  - Where test exemption does not qualify, PD measurement can be appropriate for operations across mmw-bands (e.g., 24 GHz, 28 GHz, 39 GHz, 60 GHz)

Development Topics (1)

- Continued OET staff participation in IEC and IEEE exposure measurement standards working groups
  - IEC 63195-1 (mmw measurements); IEC 63195-2 (mmw simulations)
    - FDIS circulation expected soon (Final Draft Intl Std); may be published 2021
  - IEC TC 106 JWG 13 AHGs: time-averaging, 5G-NR-sub-6 GHz
    - draft TR documents might be available in later 2021
  - Maintenance revision project for IEC 62209-3 commenced Apr. 2021
- After standards are finalized, in general selected provisions and procedures will be identified and qualified as acceptable in FCC guidance documents
  - KDB system is the reference for basic test procedures ~~in~~ per §§ 1.1310(d)(4) and 2.1093(d)(2)
- Ongoing KDB pub. change considerations for various SAR measurement procedures and measurement systems topics
  - See other presentation (Novicky)

Development Topics (2)

- Among other exposure KDB update efforts, update of KDB 941225 is still intended
- Work towards uniform guidance for 5G-NR sub-6 GHz SAR evaluations ongoing
  - Considering device-setup and test-exemption considerations
  - Considering information from application-specific evaluations in existing FCC IDs
  - Considering information under discussion in IEC TC 106 project for 5G NR SAR draft technical report (candidate amendment to IEC/IEEE 62209-1528:2020)
  - Industry inputs may be helpful
    - e.g., whether / how reference measurement channels maybe could be leveraged (A.2 and Clause 6 of 3GPP TS 38.521-1 V16.3.0, etc.), and/or other 3GPP provisions

Building 5G Compliance Guidelines

Policies considered in preceding Oct 2020 TCB Workshop

- Antenna Tuning
- Carrier Aggregation
- Power Configuration Algorithm for SAR
- Adding DSS to Base Stations

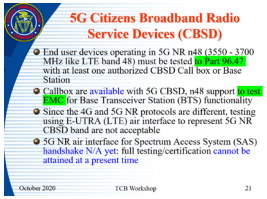
} ***Confirming Oct 2020 TCBW Guidance***

- Simultaneous Transmission SAR Evaluation for EN-DC =>

$$\sum_{i=1}^{a}\frac{P_i}{P_{th,i}}+\sum_{j=1}^{b}\frac{ERP_j}{ERP_{th,j}}+\sum_{k=1}^{c}\frac{Evaluated_k}{Exposure\ Limit_k}\leq 1$$

(Per revised KDB Pub. 447498)

- Testing for 5G NR CBSD => ***Clarification in revised Oct 2020 TCBW Guidance***



- Indoor 5G NR FR2 Femtocell
- NR in the Upper Microwave Flexible Use Service:

} ***Part 30 => Biazaran Apr 2021***
6-7 GHz => Harrington Apr 2021

Thanks for attention !