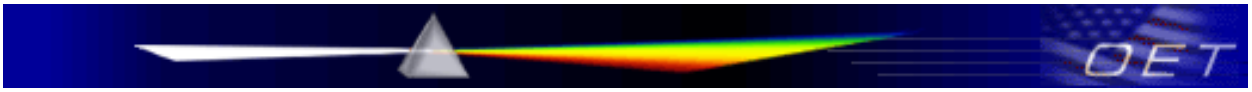

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Office of Engineering and Technology
Laboratory Division

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RF EXPOSURE COMPLIANCE REPORTING AND DOCUMENTATION CONSIDERATIONS

1. INTRODUCTION

This document provides general guidance for manufacturers and test labs to prepare RF exposure test reports to document compliance for mobile and portable transmitting devices. While there is no requirement for test reports to be in a specific format, the reports should include all relevant information and test results in a structured manner as standalone documents, according to the device descriptions, test setup, equipment configurations, test procedures and supporting data, required for equipment approval. The following reporting and documentation guidelines should be considered to ensure reporting consistency and to avoid unnecessary delays in the equipment approval process.

2 REPORTING RF EXPOSURE COMPLIANCE

2.1 Information for all test reports

The following are generally required in all RF exposure measurement, numerical simulation and analysis reports.

a) A test report must include the applicable device information, operating configurations and test setup descriptions to support the results as a standalone document.

b) A statement of compliance is required and should be included at the beginning of the test report to identify the applicable FCC RF exposure rules, transmitter operating requirements and exposure conditions.

c) The information and test data required to demonstrate compliance for FCC equipment authorization must be included in the test report. Information and test results that are not relevant to the equipment approval, when included should have prior FCC confirmation to avoid issues and must be clearly identified at the beginning of the test report as inapplicable for FCC equipment approval.[1]

d) The operating modes and exposure conditions of all wireless technologies applicable to the equipment approval must be clearly described in a separate section of the report, near the beginning, to support the test setup. The information should include at least the following.

   1) The nominal and maximum output power of all wireless modes and frequency bands of production units should be specified. Tune-up tolerances should also be included when it is required for equipment authorization; otherwise, the maximum power allowed for production

[1] For example, "This report contains results that are immaterial for FCC equipment approval, which are clearly identified within the report." Inclusion of this type of information and results in test reports often makes it more difficult to review the test results for FCC equipment approval; therefore, it should be minimized to avoid confusion and unnecessary approval delays. To expedite the review and approval process, a copy of the FCC confirmation should be provided to the TCB.

units should be identified. When multiple maximum output power levels are specified for a wireless or operating mode; for example, different time slots, data rates or modulation requirements, such as GPRS, EDGE, 802.11, WiMax and various 3GPP implementations, the maximum output power of each configuration should be identified separately.

2) Antenna dimensions and separation distances should be illustrated in photos and/or diagrams, according to the wireless technologies, frequency bands and transmit diversity requirements to support the test configurations. The information required to support the test setup and results typically does not qualify for confidentiality. When necessary, specific dimensions and distances may be identified using representative diagrams and illustrations with further reference to detailed photos and descriptions in qualified confidential information in the technical descriptions exhibit.
3) Voice and data mode transmission requirements in all supported operating configurations and exposure conditions for standalone and simultaneous transmission operations should be clearly identified.
4) Device implementation and operating requirements that can influence the RF exposure evaluation; for example, MPR, testing duty factor for TDD systems, power reduction requirements and multiple transmission configurations, such as data rate, data mode, channel bandwidth and modulation etc. should be described with sufficient details to support the required test configurations.
5) Accessories supplied with the device or available as options from the device manufacturer or provisions for supporting other after-market accessories that can influence the RF exposure evaluation; for example, body-worn accessories, wireless charging and NFC battery covers etc. should be identified to support the required test configurations or to qualify for test exclusion.
6) Optional antennas for supporting additional mobile and portable exposure conditions should be clearly described to identify and support the required test configurations.
7) Other device operating capabilities that can influence the RF exposure evaluation but do not require RF exposure evaluation should also be identified.
8) Justifications for device operations and implementation restrictions to obviate RF exposure evaluation are required for test reports to support compliance.

e) The device test setup and operating configurations used to establish transmission in various wireless modes should be documented in a separate section of the test report. The information should include at least the following.

1) The test setup, measurement, numerical simulation or analysis procedures and KDB numbers of *published RF exposure KDB procedures* applied to test the device, include latest applicable TCB workshop guidance, should be clearly identified. Information for test codes and commands that qualify for confidentiality, when included in confidential exhibits must be clearly referenced in the test reports. Other information and descriptions that are unrelated or irrelevant to the actual tests applied to the device should not be included in test reports.
2) Test guidance and other considerations provided through specific KDB inquiries to manufacturers and test labs should be fully described in test reports to support the test results. KDB tracking numbers should not be identified in test reports (see KDB Publication 388624 D01). Test procedures generally do not qualify for confidentiality.
3) Source-based time-averaging duty factors that are inherent to device transmissions or applied separately to the measured results must be clearly explained in the test reports.
4) When test reduction and exclusion are applied, justifications according to the *published RF exposure KDB procedures* or KDB inquiries are required; for example, the relevant power and distance data etc.
5) Except for generic test setup photos, other diagrams and illustrations should include proper explanations and descriptions to support the test setup and measurement results.

f) The test and supporting equipment or numerical simulation tools used to test the device should be uniquely identified in test reports, including actual calibration dates, required calibration interval and calibration status or software release versions. Equipment and apparatuses that are not used in the tests, except when clearly noted, should not be listed.

2.2 Information for MPE reports

The following are generally required in test reports to document MPE compliance according to measurement, numerical simulation or analysis.

a) The test setups used to evaluate and demonstrate compliance should be clearly explained in the test report and must be equivalent to the RF exposure conditions expected for normal operations. When multiple or varying exposure conditions exist, the most conservative conditions must be considered to determine compliance.

b) The maximum output power available at the transmitter and delivered to the antenna must be determined and reported to support the RF exposure results. Cable losses and other attenuations must be accounted for and clearly identified for the test setup and results to demonstrate compliance.

c) The measurement or evaluation points and separation distances from the antenna and radiating structures of the transmitter should be clearly identified in test reports, if applicable, using figures and illustrations. The results should be reported in accordance with the required test configurations. Either peak or spatially averaged results can be used to demonstrate compliance; however, it must be clearly explained in the test report.

d) Compliance for simultaneous transmission from multiple antennas must also be evaluated to confirm that MPE limits are not exceeded due to higher aggregated exposures in overlapping regions of adjacent antennas.

   1) The sum of the ratios of the peak or spatially averaged results to the applicable frequency dependent MPE limits must be ≤ 1 at all locations where users and bystanders can be exposed.

   2) For complex antenna configurations, the results should be illustrated graphically according to antenna installation locations and separation distances to demonstrate compliance.

e) When occupational exposure limits apply, the use conditions must satisfy occupational exposure requirements. This must be fully documented in the test report and all relevant documents, such as installation and operating instructions, to substantiate the RF exposure training required for the radio operators. The antenna installation and operating restrictions must also be identified in the required documentation to ensure compliance.

2.3 Information for SAR reports

The following are generally required in measurement reports to document SAR compliance.

a) SAR system validation status and system verification results should be documented in a separate section of the SAR report, or as an attachment, to confirm measurement accuracy.

   1) SAR measurement systems are validated according to procedures in KDB Publication 865664 D01. While detailed system validation results are not required in the SAR report, the validation status should be documented according to the validation date(s), measurement frequencies, SAR probes, calibrated signal type(s) and tissue dielectric parameters. When multiple SAR systems are used to test a device, the validation status of each SAR system must be documented separately according to the associated system components. System validation status should be documented in a tabulated summary.

   2) System verification is required for the probe calibration points used to measure the SAR of a device. Separate system verifications are required for head and body tissue-equivalent media, multiple SAR probes used with single or multiple systems and multiple probe calibration points used for different frequency bands etc. The tissue dielectric parameters measurement results and

deviations from required target values should be reported in a tabulated summary. The measured 1-g SAR must be compared to the 1-g SAR reported in the calibration certificate of the specific dipole or acceptable source used in each measurement.[2] The results should be tabulated according to the probe calibration points, SAR system and dipole or qualified source used for the measurements. Return loss and impedance results are required for dipoles to qualify for extended calibration interval, which should be tabulated for comparison with the original calibration data.[3]

b) Conducted output power measurements are required to support the SAR results and for scaling results to the maximum tune-up tolerance or production limit.[4] The *published RF exposure KDB procedures* and guidance in KDB inquiries may require additional power measurements to qualify for SAR test reduction and exclusion; for example, 1x Advanced, DC-HSDPA etc. All these should be tabulated in the SAR report to support the device test conditions. When multiple maximum output power levels are applied to different transmission configurations; for example, due to time slot, data rate, transmission protocol or signal modulation requirements, such as GMSK vs. 8-PSK in EDGE and different MPR or RB configurations in WCDMA or LTE, separate maximum output power measurements are required to support the SAR test configurations and results. When power reduction is implemented, the maximum output power levels and triggering conditions for activating the power reduction and returning to normal full power conditions must be verified and reported according to *published RF exposure KDB procedures* or procedures determined through KDB inquiries. The test setup for verifying power reduction triggering should be clearly described in the SAR report. When proximity or other sensors are used, power reduction, distance sensing, triggering and coverage must be verified and documented according to *published RF exposure KDB procedures* for the specific host platform or guidance provided through KDB inquiries. The normally required and any additional measurements of maximum output power should be listed along side the SAR results to support each test configuration.

c) The measured SAR results should be tabulated separately according to the test configurations documented in the test setup descriptions section of the test report, for the required test positions such as head, body-worn accessories, other use conditions (e.g. hotspot mode) and other host device specific exposure configurations. Information relating to duty factors, TDMA time-slots and maximum output power of the various operating modes and conditions are also required to support the SAR results. When *area scan based 1-g SAR estimation* procedures are applied, the measurements must be clearly identified in the tabulated SAR results and associated plots to distinguish these from measurements requiring zoom scans. The qualifying conditions for applying the *area scan based 1-g SAR* must also be explained in the SAR report to support the results.

d) When SAR scaling is required to determine compliance for duty factors that are neither source-based nor inherent to the measurements, the scaling procedures and scaled results should be included after the tabulated SAR summary. If the same scaling factor is applied to a group of SAR results; for example, a frequency band or operating mode, scaling the highest measured SAR within the group should generally be sufficient to demonstrate compliance. The SAR scaling procedures required by the *published RF exposure KDB procedures*, specific KDB inquiries or other FCC requirements must be correctly applied to qualify for equipment approval.

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[2] Waveguide and current loop sources are also defined for selected frequency ranges in SAR measurement standards.

[3] Only dipoles may qualify for extended calibration interval. All other sources must follow manufacturer recommended calibration schedule, which is typically one year.

[4] When conducted power measurement is not feasible, a KDB inquiry should be submitted to determine if alternative requirements may be acceptable. Also see KDB Publication 447498 D01.

e) When required, the SAR measurement variability and measurement uncertainty analysis results should be included after the tabulated SAR summary, according to procedures in KDB Publication 865664 D01. It should be clearly explained in the test report when SAR measurement uncertainty analysis is not required, but included for other purposes (e.g. ISO 17025 accreditation).

f) The analysis required to qualify for simultaneous transmission SAR test exclusion should be documented separately according to the head, body-worn accessory, other use conditions and host specific configurations described in the test setup section of the SAR report. When applying SAR peak location separation ratio test exclusion, the peak location coordinates of each test configuration must be identified according to procedures in KDB Publication 447498 D01. The measured and estimated peak locations must be clearly identified, on SAR plots and illustrations as appropriate, to support the test exclusion. When simultaneous transmission SAR measurement is required, the enlarged zoom scan measurement and volume scan post-processing procedures must be applied to determine the aggregate SAR distribution. SAR plots for the enlarged zoom scans and post-processed volume scan, showing the peak SAR locations, are required to support the measurement configurations. When operation or implementation restrictions are required to limit certain simultaneous transmission operations and testing is not required to show compliance, these configurations must be clearly justified in the SAR report.

g) The SAR distribution plots should be included in a separate attachment or appendix to the SAR report. The plots should be numbered sequentially and referenced in the tabulated SAR summary to facilitate review. Information on test date, wireless mode, exposure configuration and test position, test channel & frequency, SAR probe serial number, probe conversion factors, transmission duty factor, tissue dielectric parameters, area and zoom scan measurement resolutions and dimensions, measurement drifts, 1-g or 10-g SAR and highest extrapolated SAR must be included on each SAR plot, with the peak location(s) clearly identified. When the *area scan based 1-g SAR estimation* provision in KDB Publication 447498 D01 is applied, all information, except for the zoom scan, must be included on the plots. Information on measurement point to phantom surface distance and extrapolated peak SAR at the phantom surface must be included for the *area scan based 1-g SAR estimation* to be acceptable.

h) SAR plot is required for the highest measured SAR in each exposure configuration, wireless mode and frequency band combination; for example, WCDMA head SAR at 1900 MHz. Plots are also required when the measured SAR is > 1.5 W/kg, or > 7.0 W/kg for occupational exposure. The *published RF exposure KDB procedures* may require additional plots; for example, to support SAR to peak location separation ratio test exclusion and/or volume scan post-processing. The relevant boundaries of the test device should be correctly illustrated on SAR plots with peak SAR location(s) identified on the SAR distribution. Z-axis plots are generally optional; these are included to address certain specific concerns, as determined by the test laboratory and measurement results. When Z-axis plots are included, the results should be extrapolated to the phantom surface and the purpose of the plots must be clearly explained in the SAR report.

i) The SAR numbers listed on the grant(s) of equipment authorization must be identified at the beginning of the SAR report, for each equipment class, according to procedures in KDB Publication 690783 D01. These *reported* SAR numbers should be highlighted in the SAR summary results for easy reference and to ensure the proper numbers are listed on the grant(s).[5] The *reported* SAR number for simultaneous transmission is generally the same for all equipment classes (PCE, DTS, NII etc.) involved in the simultaneous transmission. The estimated SAR used to determine simultaneous transmission SAR test exclusion should not be reported as standalone SAR. When simultaneous transmission SAR test exclusion is applied, the estimated SAR can become a component of the highest *reported* SAR for simultaneous transmission on grants of equipment approval. Under no

[5] The *reported* numbers are based on measured SAR adjusted for maximum tune-up tolerance.

circumstances should any SAR reported on a grant of equipment authorization be higher than the SAR limit.

j) General specifications of the SAR system, SAR probe and dipole calibration certificates and results, tissue-equivalent media recipes, SAR system verification (dipole) plots, generic test setup photos and SAR system validation status information etc. should be included in a separate attachment or appendix to the SAR report. All scanned black and white copies of calibration certificates or other related documentation must be legible. Including only one SAR system verification plot, with the largest deviation from the dipole or qualified source SAR target, for each dipole or qualified source, SAR probe calibration point and SAR system combination is generally sufficient. When it is required by KDB Publication 865664 D01 or requested during equipment authorization, certain SAR system validation information may be required; for example, due to SAR probe linearity concerns. These should be included as attachments to the SAR report.

2.4 Information for analysis reports

The following are generally required in analysis reports to document RF exposure compliance.

a) Details of the device operating configurations and exposure conditions, maximum output power, maximum duty factor, and other relevant information are required to support the RF exposure analysis required for test exclusion. Devices that qualify for low duty factor SAR test exclusion must clearly identify the contributing factors in the report. When the duty factor is not source-based, only operational-based duty factors approved through KDB inquiries and those allowed by the *published RF exposure KDB procedures* are acceptable. The maximum average conducted output power, including tune-up tolerance, adjusted by the most conservative duty factor, must satisfy the *SAR Exclusion Threshol*d requirements in KDB Publication 447498 D01 to qualify for low duty test exclusion. Calculations and clear explanations must be included in the analysis to demonstrate the device qualifies for the exclusion.

b) When SAR test exclusion for low exposure potential due to a sufficiently large separation distance between the device and nearby persons, either built-in by design or provided through acceptable installation requirements, is confirmed through a KDB inquiry, the exposure analysis must be prepared according to the guidance provided through the KDB inquiry.

c) When RF exposure limits or evaluation requirements are not fully established, the provisions of §1.1307(c) and (d) are generally applied. Limits are not established for mobile exposure conditions below 300 kHz and portable exposure conditions below 100 kHz. SAR measurement procedures are generally unavailable below 100 MHz. A KDB inquiry is required to determine the RF exposure evaluation requirements for these situations. When applicable, test exclusion may be considered for situations with low exposure potentials. An RF exposure analysis report is generally required to document compliance and must be prepared according to the specific guidance provided through the KDB inquiry for these circumstances.

2.5 Information for numerical SAR simulation reports[6]

The following should be considered in conjunction with the requirements in KDB Publication 447498 D01 and adapted accordingly to document SAR compliance based on FDTD simulations or other acceptable numerical modeling techniques.[7]

a) Computational resources

[6] The *Report & Order* in ET Docket No. 03-137 has discontinued Supplement C. This information has been imported from Supplement C 01-01.

[7] The guidance in KDB Publication 447498 D01 references IEC draft 62704-1, which is applicable to FDTD for 30 MHz to 6 GHz. When applying numerical simulations outside of the scope of IEC 62704-1, a KDB inquiry is highly recommended to determine the applicable simulation and reporting requirements.

1) a summary of the computational resource required to perform the SAR computations for the test transmitter and phantom configurations
2) a summary of the computational requirements with respect to modeling and computing parameters for determining the highest exposure expected for normal device operation, such as minimal computational requirements and those used in the computation

b) FDTD or other numerical modeling algorithm implementation and validation
1) a summary of the basic algorithm implementation applicable to the particular SAR evaluation, including absorbing boundary conditions, source excitation methods, certain standard algorithms for handling thin metallic wires, sheets or dielectric materials etc.
2) descriptions of the procedures used to validate the basic computing algorithms described in a) and analysis of the computing accuracy based on these algorithms for the particular SAR evaluation

c) Computational parameters
1) a tabulated list of computational parameters such as cell/voxel size, domain size, time step size, tissue and device model separation from the absorbing boundaries and other essential parameters relating to the computational setup requirements for the SAR evaluation
2) a description of the procedures used to handle computation efficiency and modeling accuracy for the phantom and the test device

d) Phantom model implementation and validation
1) identify the source of the phantom model, its original resolution and the procedures used to code and assign tissue dielectric parameters for the SAR evaluation
2) verify the phantom model is appropriate for determining the highest exposure expected for normal device operation
3) describe procedures used to verify the particular phantom model has been correctly constructed for making SAR computations, such as comparing computed and measured SAR results of a dipole or a reference source

e) Tissue dielectric parameters
1) a description of the types of tissues used in the phantom models and the sources of tissue dielectric parameters used in the computations
2) verify the tissue types and dielectric parameters used in the SAR computation are appropriate for determining the highest exposure expected for normal device operation
3) a tabulated list of the dielectric parameters used in the device and phantom models

f) Transmitter model implementation and validation
1) a description of the essential features that must be modeled correctly for the particular test device model to be valid
2) descriptions and illustrations showing the correspondence between the modeled test device and the actual device, with respect to shape, size, dimensions and near-field radiating characteristics
3) verify that the test device model is equivalent to the actual device for predicting the SAR distributions for satisfying 47 CFR §§2.907 and 2.908 of Commission rules
4) verify the SAR distribution for high, middle and low channels, similar to those considered in SAR measurements for determining the highest SAR

g) Test device positioning
1) a description of the device test positions (left, right, cheek, tilt, surface, edge etc.) used in the SAR computations
2) illustrations showing the separation distances between the test device and the phantom for the tested configurations, similar to the reporting procedures used in SAR measurements

h) Steady state termination procedures
1) a description of the criteria and procedures used to determine sinusoidal or equivalent steady state conditions have been reached throughout the computational domain for terminating the computations
2) reporting the number of time steps or sinusoidal cycles executed to reach steady state
3) a description of the expected error margin provided by the termination procedures

i) Computing peak SAR from field components
   1) a description of the procedures used to compute the sinusoidal steady total electric field with the required field components at each tissue location
   2) a description of the expected error margin provided by algorithms used to compute the SAR at each tissue location according to the required field components and tissue dielectric parameters
j) 1-g averaged SAR procedures
   1) a description of the procedures used to search for the highest 1-g averaged SAR, if applicable, including the procedures for handling inhomogeneous tissues within the 1-g cube
   2) the 1-g cube tolerance should be determined according to (draft) IEC 62704-1 requirements
   3) a description of the expected error margin provided by algorithms used to compute the one-gram SAR
k) Total computational uncertainty – a description of the expected error and computational uncertainty for the test device and tissue models, test configurations and numerical algorithms etc.
l) Test results for determining SAR compliance
   1) illustrations showing the SAR distribution of dominant peak locations produced by the test transmitter, with respect to the phantom and test device, similar to those reported in SAR measurements
   2) a description of how the maximum device output rating is determined and used to normalized the SAR values for each test configuration
   3) if applicable, a description of the procedures used to compute source-based time-averaged SAR

Change Notice

5/28/2013: 865664 D02 RF Exposure Reporting v01 has been changed to 865664 D02 RF Exposure Reporting v01r01:

- Relevant comments for 05/04/2013 draft have been taken into consideration.
- Identify in the results or plots when *area scan based 1-g SAR estimation* is used.
- Allowing SAR measurement uncertainty analysis to be included in test reports when it is not required by the KDB procedures, but test accreditation requirements.
- In addition to dipoles, other sources defined in SAR measurement standards at selected frequencies are also acceptable for SAR system validation and verification.
- Imported the numerical simulation reporting requirements from Supplement C 01-01.

10/23/2015: 865664 D02 RF Exposure Reporting v01r02 replaces 865664 D02 RF Exposure Reporting v01r01. Included various editorial updates to synchronize document format with other KDB publications and clarified the applicable scope and frequency range of IEC 62704-1.