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Title: RF Exposure Evaluation Considerations for Occupational Push-to-Talk Two-Way Radios

Short Title: SAR Test for PTT Radios

Reason: Revision of Attachment

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Keyword/Subject: Occupational PTT Radios

First Category: Radio Frequency (RF) Exposure

Second Category: SAR Evaluation

Third Category:

Question: What are the Specific Absorption Rate (SAR) test requirements for occupational push-to-talk (PTT) radios?

Answer: The attached document below- 643646 D01 SAR Test for PTT Radios v02 - provides test reduction guidance for occupational push-to-talk (PTT) radios pending the development and publication of final procedures

Attachment List:

643646 D01 SAR Test for PTT Radios v02

Attachment 643646 D01 SAR Test for PTT Radios v02

RF Exposure Evaluation Considerations
for
Occupational Push-to-Talk Two-Way Radios

I. Introduction

This document provides the SAR test reduction and MPE evaluation guidance for occupational push-to-talk (PTT) two-way radios. The SAR test reduction applies to handheld PTT radios and associated accessories. Handheld PTT two-way radios intended for occupational use typically have multiple options for antennas, batteries, body-worn and audio accessories. For some radios, the number of SAR test configurations introduced by large varieties of accessories can be substantial. The resulting combinations can number in the thousands. The MPE procedures are applicable for testing PTT two-way radios operating with vehicle-**mounted antennas, for passengers and bystander exposure conditions.**

II. Occupational handheld PTT Radios

Handheld PTT radios often require multiple antenna options to cover overlapping frequency bands or subsets of frequency bands. Multiple battery options along with a variety of body-worn accessories may be available to support different operational requirements. In some cases, a large number of different audio accessories may also be available to support law enforcement, fire and rescue or other public safety operations. In addition, some of the accessories are designed to operate only in specific combinations of configurations. When the number of possible combinations is large, there is a need to reduce the number of SAR tests to streamline test requirements. However, it can be difficult to determine appropriate test reduction combinations for large number of accessories, whether it is based on measured SAR levels or subsets of higher exposure test configurations.

The test reduction considerations described for handheld PTT radios can be applied to minimize test concerns. When the combinations of accessories are large and complex, it is usually difficult to optimize the test reduction procedures based only on experiences and assumptions. The test guidance enables manufacturers and test laboratories to apply consistent test reduction procedures for equipment certification and to facilitate TCB review and approval. As potential issues are identified, they can be rectified through subsequent revisions of this document.

It is recommended that a KDB inquiry be submitted to the FCC when it is unclear if these procedures are applicable for testing specific product and accessory combinations. A KDB inquiry must be submitted when there is a large number of accessories, requiring substantial test reductions; or for products and circumstances where other test reduction considerations are applied; or if this document is not sufficient to address the SAR test concerns.

III. Head SAR test considerations

Passive body-worn and audio accessories generally do not apply to the head SAR of PTT radios. Head SAR is measured with the front surface of the radio positioned at 2.5 cm parallel to a flat phantom. A phantom shell thickness of 2 mm is required. When the front of the radio has a contour or non-uniform surface with a variation of 1.0 cm or more, the average distance of such variations is used to establish the 2.5 cm test separation from the phantom.

A. Testing antennas with the default battery

1. Start by testing a PTT radio with a standard battery (default battery) that is supplied with the radio to measure the head SAR of each antenna on the highest output power channel, according to the test channels required by KDB 447498 and in the frequency range covered by each antenna within the operating frequency bands of the radio.[1] When multiple standard batteries are supplied with a radio, the battery with the highest capacity is considered the default battery for making head SAR measurements.

   When the head SAR of an antenna tested in III.A.1. is:

   (i) ≤ 3.5 W/kg, testing of all other required channels is not necessary for that antenna

   (ii) 3.5 W/kg and ≤ 4.0 W/kg, testing of the required immediately adjacent channel(s) is not necessary;[2] testing of the other required channels may still be required

   (iii) 4.0 W/kg and ≤ 6.0 W/kg, head SAR should be measured for that antenna on the required immediately adjacent channels; testing of the other required channels still needs consideration

   (iv) 6.0 W/kg, test all required channels for that antenna

   (v) for the remaining channels that cannot be excluded in III.A.1.(ii) and III.A.1.(iii), which still require consideration, the 3.5 W/kg exclusion in III.A.1.(i) and 4.0 W/kg exclusion in III.A.1.(ii) may be applied recursively with respect to the highest output power channel among the remaining channels; measure the SAR for the remaining channels that cannot be excluded

      (a) if an immediately adjacent channel measured in III.A.1.(iii) or a remaining channel measured in III.A.1.(v) is > 6.0 W/kg, test all required channels for that antenna

2. Testing antennas with additional batteries:

   (i) Based on the SAR distributions measured in III.A.1., for antennas of the same type and construction operating within the same device frequency band, if the frequency range of an antenna (A) is fully within the frequency range of another antenna (B) and the highest SAR for antenna (A) is either ≤ 4.0 W/kg or ≤ 6.0 W/kg and it is at least 25% lower than the highest SAR measured for antenna (B)[3] within the device operating frequency band, further head SAR tests with additional batteries for antenna (A) are not necessary. Justifications for antenna similarities must be clearly explained in the SAR report.[4]

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[1] The test channel selection criteria in IEEE Std 1528-2003 may be considered when the number of channels required is greater than or equal to that required by KDB 447498 and the measured maximum output power for the closest channels between these two methods of channel selection are within ½ dB.

[2] "Required immediately adjacent channels" are those defined in KDB 447498 next to the highest output power channel; or, if applicable, according to the channel selection criteria in IEEE Std 1528-2003.

[3] The highest SAR is determined according to the SAR measured on the highest output power channel and all required adjacent and remaining channels. The same applies to other sections of this document.

[4] Similar antennas must be of the same type and construction, including the same antenna dimensions, similar SAR distribution and radiating characteristics. The measured 1-g SAR for the antennas should be within the combined standard uncertainty of the SAR measurements.

(ii) When the SAR for all antennas tested using the default battery in III.A.1. are ≤ 4.0 W/kg, test additional batteries using the antenna and channel configuration that resulted in the highest SAR among all antennas tested in III.A.1. Testing of additional batteries in combination with the remaining antennas is unnecessary.

(a) When the SAR measured with an additional battery in III.A.2.(ii) is > 6.0 W/kg, test that additional battery on the highest SAR channel of each antenna measured in III.A.1.[5]

(i) if the SAR measured in III.A.2.(ii)(a) is > 6.0 W/kg, test that additional battery and antenna combination(s) on the required immediately adjacent channels

1. if the SAR measured in III.A.2.(ii)(a) or III.A.2.(ii)(a)(i) is > 7.0 W/kg, test all required channels for the antenna and battery combination(s)

(iii) When the SAR for at least one of the antennas tested in III.A.1. with the default battery is > 4.0 W/kg:[6]

(a) An antenna tested in III.A.1. with highest SAR ≤ 4.0 W/kg does not need to be tested for additional batteries.[7]

(b) When the highest SAR of an antenna tested in III.A.1. is > 4.0 W/kg and ≤ 6.0 W/kg, test additional batteries on the channel that resulted in the highest SAR for that antenna in III.A.1.

(c) When the SAR of an antenna tested in III.A.1. or in III.A.2.(iii)(b) is > 6.0 W/kg, test that battery and antenna combination on the required immediately adjacent channels

(i) if the SAR measured in III.A.2.(iii)(c) is > 7.0 W/kg, test that battery and antenna combination on all required channels

[5] See footnote 4. Also take III.A.2.(i) into consideration.

[6] See footnote 4.

[7] All SAR must be ≤ 4.0 W/kg for III.A.2.(ii) to apply. The SAR for some antennas could be ≤ 4.0 W/kg with others > 4.0 W/kg in III.A.2.(iii).

3. Report the measured head SAR in formats similar to the following:

Example for Illustration Only					
Head SAR – in front of the face					
Antenna (MHz)	Measured	Ch. Freq. (MHz)	Battery		
			Default	I: *Model #*	II: *Model #*
A (470 – 490)	Power (W)	470.5			
		480.0			
		489.5			
	SAR (W/kg)	470.5			
		480.0			
		489.5			
B (420 – 450)	Power (W)	420.5			
		430.0			
		440.0			
		449.5			
	SAR (W/kg)	420.5			
		430.0			
		440.0			
		449.5			
C (450 – 465)	Power (W)	450.5			
		464.5			
	SAR (W/kg)	450.5			
		464.5			
D (465 – 470)	Power (W)	467.5			
	SAR (W/kg)	467.5			

Reported SAR values have already been scaled by the applicable duty factor
Antenna, battery and accessory specifications are explained in the product descriptions section in the SAR report
When test reduction applies, SAR are not reported for such configurations in the above Table
(Note: Modify table layout to present the test results of actual product and accessories)

B. Body SAR test considerations for body-worn accessories

Body SAR is measured with the radio placed in a body-worn accessory, positioned against a flat phantom, representative of the normal operating conditions expected by users and typically with a standard default audio accessory supplied with the radio. Since audio accessories, including any default audio accessories supplied with a radio, may be designed to operate with a subset of the combinations of antennas, batteries and body-worn accessories, when a default audio accessory does not fully support all the test configurations required in this section for body-worn accessories testing an alternative audio accessory must be selected to be the default audio accessory for body-worn accessories testing.[8] If an alternative audio accessory cannot be identified, body-worn accessories should be tested without any

[8] The applicable audio accessory that is expected to result in the most conservative SAR must be used. The selection criteria must be clearly explained in the SAR report to support the test results.

audio accessory.[9] In general, all sides of the radio that may be positioned facing the user when using a body-worn accessory must be considered for SAR compliance.

1. Testing antennas with the default battery and body-worn accessory:

   (i) Start by testing a PTT radio with the thinnest battery and a standard (default) body-worn accessory that are both supplied with the radio and, if applicable, a default audio accessory, to measure the body SAR of each antenna on the highest output power channel, according to the test channels required by KDB 447498 and in the frequency range covered by each antenna within the operating frequency bands of the radio.[10] When multiple default body-worn accessories are supplied with a radio, the standard body-worn accessory expected to result in the highest SAR based on its construction and exposure conditions is considered the default body-worn accessory for making body-worn SAR measurements.

      (a) When the body SAR of an antenna tested in III.B.1.(i) is:

         (i) ≤ 3.5 W/kg, testing of all other required channels is not necessary for that antenna

         (ii) 3.5 W/kg and ≤ 4.0 W/kg, testing of the required immediately adjacent channel(s) is not necessary; testing of the other required channels may still be required

         (iii) 4.0 W/kg and ≤ 6.0 W/kg, body SAR should be measured for that antenna on the required immediately adjacent channels; testing of the other required channels still needs consideration

         (iv) 6.0 W/kg, test all required channels for that antenna

         (v) for the remaining channels that cannot been excluded in III.B.1.(i)(a)(ii) and III.B.1.(i)(a)(iii), which still require consideration, the 3.5 W/kg exclusion in III.B.1.(i)(a)(i) and 4.0 W/kg exclusion in b) may be applied recursively with respect to the highest output power channel among the remaining channels; measure the SAR of the remaining channels that cannot be excluded

            1. if an immediately adjacent channel measured in III.B.1.(i)(a)(iii) or a remaining channel measured in III.B.1.(i)(a)(v) is > 6.0 W/kg, test all required channels for that antenna

2. Testing antennas and default body-worn accessory with additional batteries:

   (i) For batteries with similar construction, test only the battery that is expected to result in the highest SAR. This is generally determined by the smallest antenna separation distance provided by the battery and body-worn accessory, between the radio and the user, with the applicable side(s) of the radio facing the user.[11]

[9] A KDB inquiry may be submitted to determine other possible testing alternatives.

[10] See footnote 2.

[11] If a battery tested for head SAR is showing abnormally higher SAR than a similar battery, additional considerations may be necessary to determine if that battery should be excluded for body-worn SAR testing. A KDB inquiry with applicable SAR results should be submitted to make the determination.

(ii) Based on the SAR distributions measured in III.B.1., for antennas of the same type and construction operating within the same device frequency band, if the frequency range of an antenna (A) is fully within the frequency range of another antenna (B) and the highest SAR for antenna (A) is either ≤ 4.0 W/kg or ≤ 6.0 W/kg and it is at least 25% lower than the highest SAR measured for antenna (B) within the device operating frequency band, further body SAR tests for the default body-worn accessory with additional batteries for antenna (A) are not necessary. Justifications for antenna similarities must be clearly explained in the SAR report.

(iii) When the SAR for all antennas tested using the thinnest battery in III.B.1. is ≤ 4.0 W/kg, test additional batteries using the antenna and channel configuration that resulted in the highest SAR among all antennas tested in III.B.1. Testing of additional batteries in combination with the default body-worn and audio accessory and remaining antennas is unnecessary.

(a) When the SAR measured with an additional battery in III.B.2.(iii) is > 6.0 W/kg, test that additional battery with the default body-worn and audio accessory on the highest SAR channel for each antenna measured in III.B.1.

(i) if the SAR measured in III.B.2.(iii)(a) is > 6.0 W/kg, test that additional battery and antenna combination(s) with the default body-worn and audio accessory on the required immediately adjacent channels

1. if the SAR measured in III.B.2.(iii)(a) or III.B.2.(iii)(a)(i) is > 7.0 W/kg, test all required channels for the configuration(s)

(iv) When the SAR for at least one of the antennas tested in III.B.1. with the thinnest battery using the default body-worn and audio accessory is > 4.0 W/kg:

(a) An antenna tested in III.B.1. with highest SAR ≤ 4.0 W/kg does not need to be tested for additional batteries.[12]

(b) When the highest SAR of an antenna tested in III.B.1. is > 4.0 W/kg and ≤ 6.0 W/kg, test additional batteries with the default body-worn and audio accessory on the channel that resulted in the highest SAR for that antenna in III.B.1.

(c) When the SAR of an antenna tested in III.B.1. or in 2) d) ii) is > 6.0 W/kg, test that battery and antenna combination with the default body-worn and audio accessory on the required immediately adjacent channels

(i) if the SAR measured in III.B.2.(iv)(c) is > 7.0 W/kg, test that battery, antenna, body-worn and audio accessory combination on all required channels

[12] See footnote 8.

3. Report the measured body SAR for the default body-worn and audio accessory in formats similar to the following:

Example for Illustration Only									
Body-worn Accessory #			*Model1*			*Model 2*		*Model 3*	
Antenna (MHz)	Measured	Ch. Freq. (MHz)	Battery						
			Standard	I	II	I	II	I	
A (470 – 490)	Power (W)	470.5							
		480.0							
		489.5							
	SAR (W/kg)	470.5							
		480.0							
		489.5							
B (420 – 450)	Power (W)	420.5							
		430.0							
		440.0							
		449.5							
	SAR (W/kg)	420.5							
		430.0							
		440.0							
		449.5							
C (450 – 465)	Power (W)	450.5							
		464.5							
	SAR (W/kg)	450.5							
		464.5							
D (465 – 470)	Power (W)	467.5							
	SAR (W/kg)	467.5							

Reported SAR values have already been scaled by the applicable duty factor
Antenna, battery and accessory specifications are explained in the product descriptions section
When test reduction applies, SAR are not reported for such configurations in the above Table
Default audio accessory *Model ###* used for body-worn accessories testing
(Note: Modify table layout to present the test results of actual product and accessories)

4. Repeat the above test sequence for additional body-worn accessories by replacing "default body-worn" accessory with each "additional body-worn" accessory. For body-worn accessories with similar construction and operating configurations, test only the body-worn accessory within the group that is expected to result in the highest SAR. This is typically determined by the smallest antenna separation distance provided by the body-worn accessory, between the radio and the user, with the applicable side(s) of the radio facing the user. Similarities in construction and operating configurations for batteries and body-worn accessories must be clearly explained in the SAR report.

C. Body SAR test considerations for audio accessories with integral antenna

Audio accessories with an integral antenna or radiating element must be tested separately from those without any primary radiating element. An audio accessory with a built-in antenna that enables the antenna on a PTT radio to be disconnected from its output while the audio accessory is in use should be tested using the highest capacity default battery. When transmission from the antenna on the PTT radio

is disabled while the audio accessory is transmitting using its integral antenna, the normal body-worn accessories for the radio are not expected to influence the SAR of the audio accessory. In addition, special body-worn attachments are generally used for audio accessories with an integral antenna; the audio accessory must be tested according to how it is attached to the user during normal operation. Body SAR is measured with the audio accessory positioned against a flat phantom representative of the normal operating and exposure conditions expected by users. All sides of the audio accessory that may be positioned against the user must be considered for SAR compliance.

1. An audio accessory is tested on the highest output power channel, according to the test channels required by KDB 447498 and in the frequency range covered by the antenna on the audio accessory within the operating frequency bands of the radio to measure body SAR.[13]

   (i) Based on the SAR distributions measured in 1), for audio accessories of the same type and construction operating within the same device frequency band, if the (antenna) frequency range of an audio accessory (A) is fully within the (antenna) frequency range of another audio accessory (B) and the highest SAR for accessory (A) is either ≤ 4.0 W/kg or ≤ 6.0 W/kg and it is at least 25% lower than the highest SAR measured for accessory (B) within the device operating frequency band, further body SAR tests are not necessary for audio accessory (A). Justifications for antenna and audio accessory similarities must be clearly explained in the SAR report.

   When the body SAR of an audio accessory tested in III.C.1. is:

   (a) ≤ 3.5 W/kg, testing of all other required channels is not necessary for that audio accessory

   (b) 3.5 W/kg and ≤ 4.0 W/kg, testing of the required immediately adjacent channel(s) is not necessary; testing of the other required channels may still be required

   (c) 4.0 W/kg and ≤ 6.0 W/kg, body SAR should be measured for that audio accessory and antenna on the required immediately adjacent channels; testing of the other required channels still needs consideration

   (d) 7.0 W/kg, test all required channels for that audio accessory

   (e) for the remaining channels that cannot be excluded in III.C.1.(i)(b) and III.C.1.(i)(c), which still require consideration, the 3.5 W/kg exclusion in III.C.1.(a) and 4.0 W/kg exclusion III.C.1.(i)(b) may be applied recursively with respect to the highest output power channel among the remaining channels that cannot be excluded; measure the SAR for the remaining channels that cannot be excluded

      (i) if an immediately adjacent channel in III.C.1.(i)(c) or a remain channel measured in III.C.(i)(e) is > 7.0 W/kg, test all required channels for that audio accessory

[13] See footnote 2.

2. Report the measured body SAR for audio accessories in formats similar to the following:

Example for Illustration Only			
Body SAR – audio accessories with integral antenna			
Audio Accessory (MHz)	Measured	Ch. Freq. (MHz)	SAR (W/kg)
A: *Model #* (470 – 490)	Power (W)	470.5	
		480.0	
		489.5	
	SAR (W/kg)	470.5	
		480.0	
		489.5	
B: *Model #* (450 – 465)	Power (W)	450.5	
		464.5	
	SAR (W/kg)	450.5	
		464.5	
Reported SAR values have already been scaled by the applicable duty factor Antenna, battery and accessory specifications are explained in the product descriptions section When test reduction applies, SAR are not reported for such configurations in the above Table *(Note: Modify table layout to present the test results of actual product and accessories)*			

D. Body SAR test considerations for audio accessories without built-in antenna

For audio accessories that do not have any built-in radiating element, the antenna, battery and body-worn accessory combinations that are applicable to each audio accessory and have not been tested with body-worn accessories must be clearly identified in a format similar to the following, with the applicable combinations require testing highlighted to facilitate reviewing the results.

Example for Illustration Only

Antenna (A – D)	Battery											
	a				b				c			
	Body-worn				Body-worn				Body-worn			
Audio Accessory	1	2	3	4	1	2	3	4	1	2	3	4
I	A, B, C, D	N/A	A, B, D	N/A	C, D	A, B, C, D	B, C	N/A	N/A	B, D	A, B, C, D	A, D
II	A, B, C, D	A, B, C, D	N/A	A, B, C, D	N/A	N/A	A, B, C, D	B, D	C	A, B, C, D	N/A	N/A
III	B, C, D	N/A	B, C, D	B, D	A, C, D	A, B, D	N/A	A, B, C, D	A, B, C, D	N/A	B, C, D	A, B, C, D

In this example, audio accessories (I – III) only work with the subset of antenna (A - D), battery (a – c) and body-worn accessory (1 – 4) combinations identified in the table, where N/A indicates the audio accessory and/or the battery is not supported or applicable to the body-worn accessory. The antennas listed for each body-worn accessory and battery combination identify the antennas supported or applicable to that body-worn accessory.

The possible combinations are dependent on the design and implementation of an individual radio, applicable antenna and accessory combinations. This table must be adapted for the actual product accessory combinations.

The combinations require testing should be highlighted.

(Note: Modify table layout to present test configurations required for the actual product and accessories)

For audio accessories with similar construction and operating requirements, test only the audio accessory within the group that is expected to result in the highest SAR, with respect to changes in RF characteristics and exposure conditions for the combination. If it is unclear which audio accessory within a group of similar accessories is expected to result in the highest SAR, good engineering judgment and preliminary testing should be applied to select the accessory that is expected to result in the highest SAR. Similarities in construction and operating configurations must be clearly explained in the SAR report.

1. For the audio accessories that have not been tested in the body-worn accessories test sequences in the previous section, , the highest SAR for an antenna, body-worn accessory and battery combination tested in the body-worn accessories sequences applicable to an audio accessory is used to determine SAR test requirements according to the following:

   (i) ≤ 4.0 W/kg, SAR tests for that audio accessory is not necessary

   (ii) 4.0 W/kg and ≤ 6.0 W/kg test that audio accessory using the highest body-worn SAR combination (antenna, battery and body-worn accessory) and channel configuration identified in III.D.1. that is applicable to the audio accessory. Due to the complexity of body-worn and audio accessory combinations, the applicable test combinations must be clearly described and identified in the SAR report

(iii) 6.0 W/kg, test on all required channels for that audio accessory

(iv) When the SAR measured in III.D.1.(ii) is > 6.0 W/kg, test that audio accessory on the required immediately adjacent channels; testing of the other required channels still needs consideration

(a) if the SAR measured in III.D.1.(iv) is > 7.0 W/kg and it is one of the accessories within a group of similar audio accessories, test all other audio accessories within that group of similar audio accessories using the highest body-worn SAR combination (antenna, battery and body-worn accessory) and channel configuration identified in III.D.1. that is applicable to the audio accessory

(i) when the SAR for a similar audio accessory in III.D.1.(iv)(a) is > 7.0 W/kg, test that audio accessory on all required channels using the combination in III.D.(iv)(a)

2. Report the measured body SAR for audio accessories in formats similar to as shown in the following table:

Example for Illustration Only								
Audio Accessory I: *Model Number…*								
Antenna (MHz)	Measured	Ch. Freq. (MHz)	Battery (a – c) & Body-Worn (1 – 4) Combinations					
			b/2	b/4	c/1	c/2	c/3	
A (470 – 490)	Power (W)	470.5						
		480.0						
		489.5						
	SAR (W/kg)	470.5						
		480.0						
		489.5						
B (420 – 450)	Power (W)	420.5						
		430.0						
		440.0						
		449.5						
	SAR (W/kg)	420.5						
		430.0						
		440.0						
		449.5						
C (450 – 465)	Power (W)	450.5						
		464.5						
	SAR (W/kg)	450.5						
		464.5						
D (465 – 470)	Power (W)	467.5						
	SAR (W/kg)	467.5						

Reported SAR values have already been scaled by the applicable duty factor
Antenna, battery and accessory specifications are explained in the product descriptions section
When test reduction applies, SAR are not reported for such configurations in the above Table
(Note: Modify table layout to present the test results of actual product and accessories)

IV. Occupational mobile PTT radios operating with vehicle-mounted antennas

Both occupational and general population exposure conditions must be addressed for PTT two-way radios transmitting with antennas mounted on law enforcement, public safety and similar vehicles to demonstrate RF exposure compliance. Occupational exposure conditions may be applied to qualified workers who have received RF exposure training and for work related exposure only. General population exposure conditions must be applied to passengers, bystanders and all other circumstances. The following must be considered to determine RF exposure compliance.

A. Standalone transmission

1. The operating duty factor requirements in KDB 447498 for portable two-way PTT radios must be applied to PTT radios operating with vehicle-mounted antennas.

2. Occupational exposure conditions can only be applied to a qualified radio operator in work-related conditions. The required minimum separation distance between a transmitting antenna and the radio operator may vary with the duration and conditions of exposure. The radio operator is required to have the knowledge to determine how to apply occupational exposure limits with respect to his or her exposure time and distance considerations, and also apply general population exposure requirements to mitigate exposure concerns for passengers and bystanders.

3. The minimum separation distance required for passengers and bystanders to comply with RF exposure limits can vary with the antenna installation location and the type of vehicle.

   (i) The antenna mounting locations are usually centered on the roof or trunk of a vehicle to provide the most optimal antenna-to-passenger and antenna-to-bystander separation distances.

   (ii) For testing purposes, the antenna mounting conditions on a large vehicle may not always produce the most conservative exposure conditions for installation on smaller vehicles. If the antenna-to-passenger or antenna-to-bystander test separation distances established by the test vehicle is larger than those required in the actual installation on smaller vehicles, different antenna mounting locations should be considered for testing, to ensure that the minimum separation distances for back seat passengers and outside bystanders used in the tests are sufficiently conservative to allow the results for a larger vehicle to be applied to actual installations in smaller vehicles that require smaller separation distances.

   (iii) The minimum separation distances required to install an antenna on a vehicle must be larger than those tested for compliance and must be disclosed separately to antenna installers and radio operators to ensure compliance.

4. The MPE evaluation procedures required in KDB 447498 must be applied.

   (i) Passenger exposure must be evaluated at ≤ 10 cm from the surface of the seats.

   (ii) Bystander exposure should be evaluated at a distance ≥ 20 from the edge of the vehicle, at the required locations, and must be ≤ 90 cm from the antenna. The test separation distance from the antenna must be in multiples of 15 cm or 6”.

(a) The evaluation should be along the 0°, ± 45° and, if applicable ± 90° radials of the antenna, where 0° should correspond to the location with the shortest distance between the antenna and the exposed person at a fixed distance parallel to the edge or boundary of the vehicle.

5. The antenna must be installed with separation distances larger than those tested for passenger and bystander exposure compliance. The closest distance between a person and the antenna should be used to determine the minimum distances; for example, back of the head for passengers and surface of the body for bystanders.

6. When more than 60 cm separation is required between the antenna and bystanders outside of the vehicle to maintain compliance, a caution label is required to alert the radio operator about his or her obligations to maintain bystander RF exposure requirements.

   (i) This must be implemented as a permanent label on the microphone or at the end of the cord next to the microphone; for example, "Caution: Persons outside of the vehicle must be kept x cm, or x.x ft, away from the antenna to comply with FCC RF exposure requirements during radio transmission".

   (ii) The required bystander separation distance should be rounded up to the next 15 cm or 6 inches to facilitate applying the instructions.

B. Simultaneous transmission

1. If an antenna transmits in multiple frequency bands, the most conservative test separation distance among all frequency bands must be used to determine compliance for all frequency bands.

2. When the transmitters or antenna(s) installed on a vehicle support simultaneous transmission, RF exposure compliance must be addressed; typically through Class II permissive change approval for the transmitter with the highest maximum output power, or for the most recently added simultaneous transmitting transmitter.

3. When simultaneous transmission applies, the minimum antenna-to-passenger and antenna-to-bystander separation distances must satisfy the conditions required when all simultaneous transmitting antennas are operating. The minimum antenna-to-passenger and antenna-to-bystander separation distances for the approved simultaneous transmission operations must be clearly specified in the antenna installation and radio operator instructions.

4. All prohibited configurations must also be clearly identified in the antenna installation requirements and radio operator instructions.

C. Numerical SAR simulation

When MPE limits are exceeded in some mobile exposure conditions, it may be acceptable to demonstrate compliance with respect to SAR limits using FDTD simulations, by applying the procedures required in KDB 447498 and other *published KDB procedures*.[14].

1. The test configurations, including the human body and vehicle models, antenna modeling details and mounting conditions, must be fully described in a standalone SAR report for the SAR simulations to

[14] See KDB 447498 for *published KDB procedures.*

be acceptable. The requirements of draft standard IEEE P1528.1 and P1528.2 (draft IEC 62704-1 and 62704-2) must be fulfilled and clearly described in the report.[15]

2. When the source-based time-averaged maximum conducted output power is > 25 W or the calculated 1-g SAR is > 0.8 W/kg, free-space simulated E and H field strengths must be verified against field strengths or plane wave equivalent power density measurement results to confirm the accuracy and validity of the simulated results.

   (i) The same spatial locations required for MPE evaluations should be used in this verification to compare the modeled and measured results.

   (ii) The computed power density (or E^2 and H^2) at each spatial point must be within 25% of those measured, and the spatially averaged results must be within 20% of those measured.

   (iii) When the computed spatially averaged results are lower than those measured, the reported 1-g SAR must be scaled up by the E^2 and H^2 differences to determine compliance.

V. General reporting procedures

The SAR reporting requirements in KDB 865664 should be applied to document SAR and MPE compliance according to the test setup and results. The procedures in KDB 447498 should be applied to report SAR compliance according to numerical simulations.

Change Notice:

04/04/2011 643646 D01 SAR Test for PTT Radios v01r01 has replaced 643646 D01 SAR Test for PTT Radios v01 footnote 1 Added

05/tbd/ 2012 643646 D01 SAR Test for PTT Radios v02 has replaced 643646 D01 SAR Test for PTT Radios v01r01. v02 represents a major revision.

[15] These are join projects between IEEE and IEC, the IEEE drafts are expected to be replaced by draft IEC 62704-1 and 62704-2.