# TCB RF Exposure Training

## RF Exposure (RFx) Coming Attractions

Goals for Exclusion List Handoff

Exposure Categories and Considerations

Collocated Devices

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# TCB Exclusion List April '02 Handoff Target

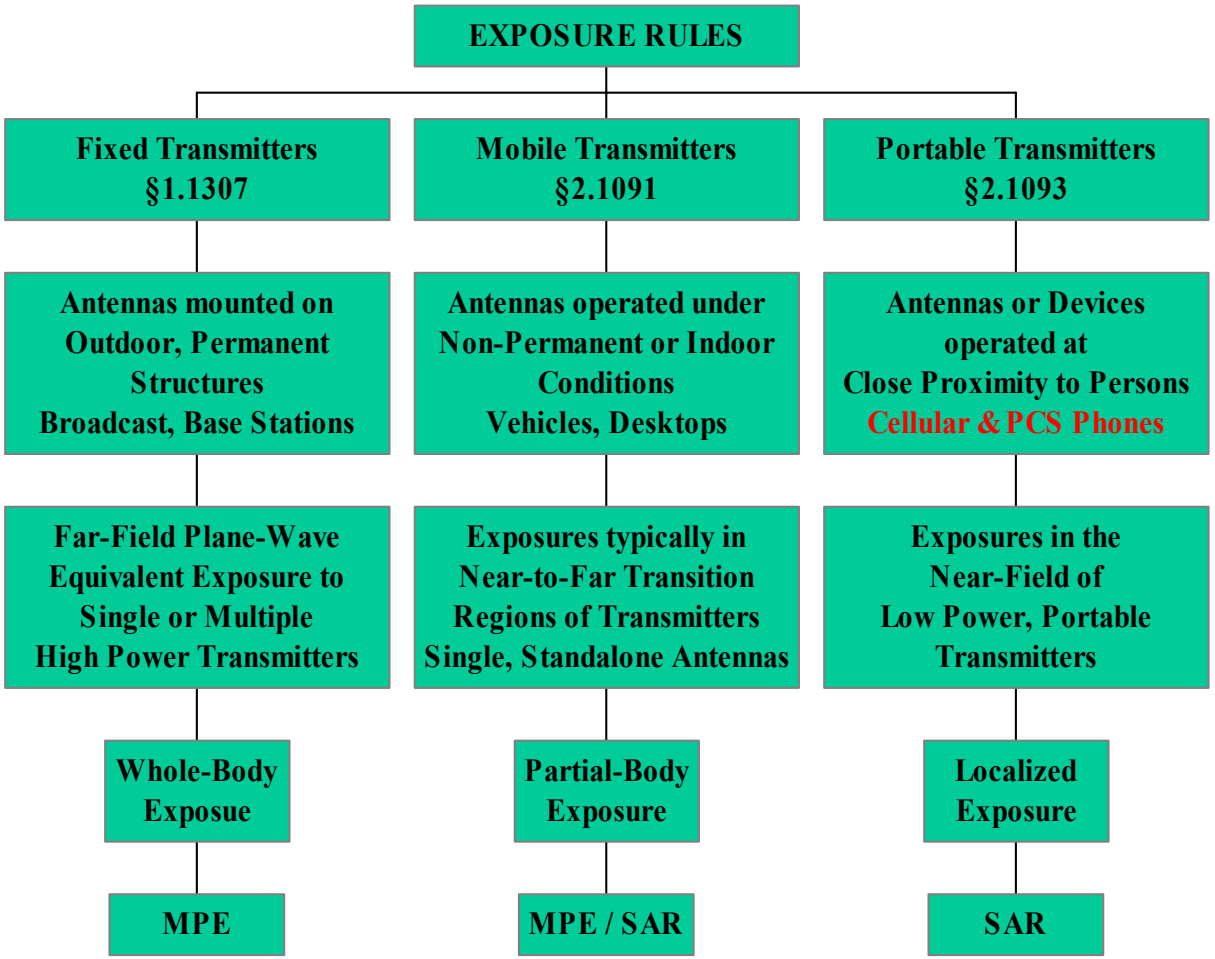
- **TCB LIST STILL IN EFFECT NOW**

- Handoff Prerequisites:
  - Updated power and distance exclusion thresholds
  - PTT test procedures and power thresholds
  - MPE test procedures; partial-body MPE procedures under review and development (e.g., R. Tell IEEE SCC28)
  - Possible collocation procedures
- Other audience suggestions? - group discussion at end of this presentation and/or during meeting

# Device Categories & Exposure Conditions

- Fixed: $d$ >> 20 cm, outdoor, permanent-mount, high power, multiple Tx; intended tower- or roof-mount
- Mobile: $d \geq 20$ cm, indoor, moveable, single Tx; meant for vehicle-mounted or transportable, relocatable, indoor-wall-mount
- Portable: $d < 20$ cm, relatively low power, single Tx; SAR limits apply 0 cm to 20 cm
- For palmtop, extremity limit may apply for portable condition of user's hand, while mobile condition applies for user's head/body
- For high power PTT, controlled limit may apply to user while uncontrolled limit applies to bystander

# Device Categories & Exposure Conditions




From: August 2001 FCC - TCB Training on SAR Review

# MPE Basic Considerations

- Far-field power density equation can be used for MPE estimation only for $d \geq 20$ cm
- MPE *estimation* equation typically does not apply in near-field $d < 20$ cm (portable *exposure condition*)
- SAR limits apply for all distances less than 20 cm
  $\therefore$ MPE *estimation* for $d < 20$ cm is immaterial by rules
- MPE *estimation* cannot be used for *routine evaluation* of mobile devices in lieu of measurement or computer simulation of equivalent geometry
- Be careful about allowing unsupported compliance claims in users manuals and elsewhere in filing, especially anything based on MPE *estimation*
- Example: PCMCIA in laptop is not mobile - see below

# SAR Testing for MPE Compliance

- 2.1091(d)(3): compliance with exposure guidelines for devices in this section can be accomplished by the use of warning labels and by providing users with information concerning minimum separation distances from transmitting structures and proper installation of antennas.
- For consideration under mobile conditions, must demonstrate that 20 cm spacing will be maintained
- SAR data for specific distance(s) and device configuration(s) reviewed to evaluate compliance as a mobile device per 2.1091(d)(4). SAR data for limited configurations may not support all portable *exposure conditions*, so device will not be designated as "portable"
- SAR data and specific test configurations may be listed in the users manual to inform end-users of compliance at the specific distance(s), in lieu of other mobile device exposure statements normally required under 2.1091(d)(3).
- "Limited portable" criteria based on SAR tested at *d* may receive sanction; filing should show reasonable expectation/proof that *d* will be maintained

# Part 15 RFx Review

- 47 CFR 15.247(b)(4): “Systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy levels in excess of the Commission’s guidelines.”
- Suppl C Sect. 3 RFx for SS Tx:
  - “If a transmitter is designed to operate next to the body of its user or at close proximity to persons, a RF evaluation may be requested according to 47 CFR §1.1307(c) and (d).”
  - “If a device, its antenna or other radiating structures are operating at closer than 2.5 cm from a person’s body or in contact with the body, SAR evaluation may be necessary when the output is more than 50 – 100 mW, depending on the device operating configurations and exposure conditions.”
  - “It should be emphasized that categorical exclusion from routine environmental evaluation must not be interpreted as an exemption from compliance with the RF exposure requirements in §15.247(b)(4).”

# Laptop Considerations

- For antennas internal or external to lid/LCD, compliance typically evaluated assuming mobile conditions
- If device has capability to be used on lap, warning labels or manual statements are not sufficient to stop people from lapheld use
- Card slots or external and internal antennas mounted in the keyboard section are usually less than 20 cm from user's body $\Rightarrow$ lapheld use necessitates compliance with SAR limits; MPE *estimation* does not apply
- When power and/or SAR is relatively low, will consider approval concept for device families – similar size and shape cases; card slot and internal or external antennas in same relative location for each model; nearby shielding and grounding structure topologies substantially similar; direct-contact SAR tested

# Draft - Palmtop and Laptop Positions

- At flat phantom:
  - Back/bottom in direct contact
  - Front/top – keyboard near contacting, lid opened back
  - Edge with card/antenna face broadside
  - Laptop edge containing card facing phantom
  - For antenna near corner of side, maybe do nearest side
  - Direct-contact configurations may reduce SAR $\Rightarrow$ may also need small-gap position, e.g., 2 or 3 mm
- Flip-up antenna test positions: 1) handheld or lapheld back-panel on flat phantom with antenna a) up, b) down, 2) bystander antenna up parallel to flat phantom a) edge containing antenna, b) next closest edge/corner

# Draft - Palmtop - Hand SAR Concepts

- Hand typically does not contact or enclose antenna, many palmtop devices unlikely to exceed 4 W/kg 10-g extremity limit, for antenna approximately 1-2 cm from hand
- Appropriate hand-held/-operated instructions = mobile possible
- Recent trend to designate as hand SAR that position with device in direct contact with flat phantom; by that logic, may need direct contact of at least case side/edge closest to antenna also
- Such positions present incorrect loading and proximity for normally unobstructed antennas
- To avoid misrepresentation, call this for example “direct-contact SAR,” not hand SAR
- To better simulate hand loading with flat phantom, place device near edge with antenna sticking out; however, this may lead to probe boundary effect or special probe cal. issues

# RFx Considerations for Mobile Part 15 Modules

- No portable modules - operating configurations and exposure conditions for final product must be defined
- Because of near-field conditions, SAR tested in one specific host is unlikely to represent SAR patterns in other host devices
- Module compliance evaluated for mobile conditions, preferably for specific host devices (LMA), or OEM installation
- SAR compliance shown means compliance for MPE limit
- SAR test distance not listed on grant (unless body-worn); test distance and configurations should be shown in user manual
- Must specify antenna/connector options, details
- Detailed installation and operating instructions included to ensure 20 cm separation
- PCMCIA is not module

# Draft - Collocated SAR Evaluation

- Oct '01 IEC 62209 Proposal: For devices that can transmit on more than one frequency band at the same time (multiple transmitters), the maximum exposure is obtained by the following process: the zoom scan volume is extended to cover the entire area of exposure. The SAR distribution is assessed on exactly the same grid at all frequencies which can transmit simultaneously. For each point of this extended zoom scan the SAR values of those frequencies which can transmit simultaneously are summed and the post-processing is applied to this extended zoom scan. The maximum exposure is the highest spatial peak SAR determined for the single and combined frequency exposures.
- IEC draft seems to sidestep the issues of frequency-dependent liquids and probe cal
- Possible SAR test protocol for TxAB with 2 center frequencies:

| TxA | TxB | probe cal. @ | liquid @ |
|---|---|---|---|
| On | Off | *f* (TxA) | *f* (TxA) |
| On | On | *f* (TxA) | *f* (TxA) |
| Off | On | *f* (TxB) | *f* (TxB) |
| On | On | *f* (TxB) | *f* (TxB) |

# Draft - Collocated RFx Evaluation

- Options for evaluating compliance:
  - 1. Report max SAR from matrix of test combinations for each band and device mode
  - 2. Sum up single-Tx SAR values in each band, independent of SAR field patterns
  - 3. Spatial superposition of SAR distributions for each band
- May consider free-space near-field *H*-field mapping – removes tissue-equivalence and tissue-specific probe cal. issues
- Maybe pursue single liquid for all frequencies, and apply probe "shaped-response" design and cal. principles

# Draft – Bluetooth Threshold Powers

- BT power exclusion-rule-of-thumb: 1.6mW/g $\times$ 1g $\Rightarrow$ 1.6mW-conducted needed to hit limit assuming all power transferred to ideal 1g of tissue
- General collocation conditions:
  - 1) A 1mW device can be collocated with another mobile device
  - 2) For portable configurations with antenna in direct-contact, 1mW device can be collocated when the aggregate power does not exceed 5mW
  - 3) For other portable configurations (no contact and distances to 20 cm), the 1mW device can be collocated when aggregate does not exceed 10mW
- A handset with Bluetooth has single FCC ID but two separate filings for Parts 15 and 22/24; each filing must refer to the other application number
- If SAR is to be done:
  - SAR should be done with BT ON at host-device band for usual Suppl C procedures
  - SAR should be repeated with BT OFF for the previous simultaneous-Tx configuration (position, antenna, frequency) with highest SAR

# Draft - Collocated RFx Considerations

- Define TxA+TxB ≡ TxAB as TxA and TxB collocated and simultaneous-on; if either TxA or TxB needs routine evaluation, routine evaluation needed for TxAB
- Given separate exclusion power thresholds $T_A$ and $T_B$, below which separate evaluation not needed, e.g., $T_A$=8W and $T_B$=4W, if $P_A/T_A + P_B/T_B \leq 1$, composite (aggregate) evaluation not needed
- If TxA, TxB each have separate existing grants, and sum $P_{AB}$ is within threshold, Class II may be used on each to collocate with other
- Threshold levels $T_i(f)$ to be determined; CENELEC product standard EN 50360:2001 uses 20mW

# Draft - Collocated RFx Considerations

- Example: TxAB has been approved without RFx evaluation for collocation within threshold $T_{AB}$
- Example1: Add TxC, where C requires routine evaluation. Now exclusion no longer applies $\Rightarrow$TxABC requires routine evaluation
- Example2: Add TxC. If composite power now exceeds threshold, i.e., $P_A/T_A + P_B/T_B + P_C/T_C > 1$ (cf., OET65, C95.1 Annex D) C is responsible for composite RFx evaluation of all
- Multiple Tx: may need new FCC ID on composite as soon as $Tx_k$ added such that $\Sigma P_i/T_i > 1$

# Other Collocation Considerations

- Hot-key or other software control for simultaneous or not; software controls to detect plug-in, other Tx conditions
- TxA/B mutual effects and mutual perturbations expected to change SAR distributions
- Experience with dual-mode Part 22/24 handsets shows that small layout changes re-directs RF current flow and changes SAR
- If antennas are separated far enough apart on host device, e.g., 20 cm or as determined by appropriate near-field analysis, RFx evaluation of each Tx as individual may be possible
- Example: if documentation indicates 802.11b (2.4GHz) and 802.11a (5GHz) capability $\Rightarrow$ check for collocation

# Recent TCB PCMCIA W-LAN Grant

- Device is PCMCIA card with built-in antenna
- If exposure at closer than 20 cm can occur, compliance with SAR limits must be evaluated
- EMC report was done with typical host laptop, means 20 cm spacing from lap cannot be expected to be normal use position
- Exh. 11: “The antenna of the product, under normal use condition, is at least 20 cm away from the body of the user. Warning statement for keeping 20 cm separation distance and the prohibition of operating next to a person has been printed on the users manual. So, this product is classified as the Mobile Device.”
- Exh. 8: “IMPORTANT NOTE: Federal Communications Commission (FCC) Radiation Exposure Statement
  - This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment.
  - This equipment should be installed and operated with minimum distance 20cm between the radiator & your body.
  - This transmitter must not be co-located or operation in conjunction with any other antenna or transmitter.”

# Laptop 80mW LAN PCMCIA and Excl. List

- Part 15 Portable Transmitter Category VI): The following portable transmitters authorized under Part 15 do not qualify for TCB approval: e) §15.247 spread spectrum transmitters that v) operate with the device and its antenna at 5 cm or more from a person's body; by design, the antenna provides a separation distance of less than 2.5 cm from a person's hands, wrists, feet and ankles, and either the peak conducted or peak radiated (EIRP) output power exceeds 1) 100 mW for the 2.4 GHz band
- Section L: §15.247 Spread Spectrum Portable Transmitter operating with the device and its antenna at a separation distance of at least 5 cm from all persons:
  - Grant Conditions[2] – This device and its antenna(s) must operate with a separation distance of at least 5 cm from all persons and must not be co-located or operating in conjunction with any other antenna or transmitter. [This device must transmit with a source-based time-averaging duty factor not exceeding -- %.][3] End-users must be provided with specific operating instructions for satisfying RF exposure compliance requirements.
  - TCB must verify the device does not operate in the 5.7 GHz band; by design, the antenna operates with a separation distance of at least 2.5 cm from a person's hands, wrists, feet and ankles, and the peak conducted and peak radiated (EIRP) output power does not exceed 100 mW for 2.4 GHz band

# See y’all in April !

Questions?

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