Request for clarifications on Supplement C – 0101

(Note: Page numbers for the "Word" version of Supplement C may vary with the page margins allowed by specific printers selected for a Word document.)

Received from a specific group on July 16, 2001

1. Under the section "Devices Operating Next to a Person's Ear" (page 41): if the IEEE SAM phantom is used would the two device positions described in IEEE, CENELEC or IEC be acceptable?

   The alternative "Ear/Tilt" position described in Supplement C is intended for use with interim phantoms until the IEEE phantom is commercially available. When the IEEE head phantom is available, the device test positions defined by the IEEE may be used. Currently, there are no test results available for the IEEE head model. The Commission will evaluate the performance of this head phantom as soon as it is commercially available. The FCC may provide further clarifications according to the Commission's test results and other information or test results available at the time when the IEEE SAR document is approved for final release.

   Note: Supplement C only addresses devices authorized for use in the United States. The SAR limits adopted by the FCC and certain other countries are different; therefore, the test requirements could vary. The Commission has not reviewed the test procedures described in the IEC and CENELEC draft documents.

2. Under the section "Output Power" (page 49): would other procedures, such as drift measurements, be acceptable alternatives for conducted power measurements before and after each scan?

   A conducted output power measurement either before or after the SAR test is needed to quantify the output power level supported by the SAR test results. SAR drift measurements, as described in Supplement C, may be used to verify the output power stability of a device during the SAR measurement.

   Follow up questions - Is measuring conducted output power before or after the entire sequence of SAR scans (instead of each individual SAR scan) acceptable? For some handsets it is not possible to measure conducted output power without opening the unit. This can risk damaging the handset, as some are not designed to be opened.

   When SAR drift measurements are used to verify the output power stability of a test device during SAR measurements, the conducted output power levels of the test sample(s) at the frequency channels tested for SAR may be measured before, after or during the SAR measurements. When conducted output power

measurements require the device to be disassembled, such measurements should be performed after all SAR tests are completed.

3. In the section "Determining Total System Measurement Uncertainty" (page 54) and in "Specific Information for SAR Measurements" item 9c (page 31), is this the correct interpretation on how to treat measurement uncertainty: uncertainty should not be scored against the standard (i.e., subtracted to lower the standard) unless the uncertainty measurement is higher than the state of the art values. In such a case, the FCC may require either that the uncertainty be either reduced or that the uncertainty value -- or a portion thereof -- be scored against the limit with the effect of lowering the limit for that application.

   Page 54: Compliance should be determined based on the measured 1-g SAR values without including the uncertainty. The last paragraph of this section (page 55) explains how uncertainty is handled. The issue on how SAR measurement uncertainty should be handled to ensure compliance for production units is currently under discussion between the FCC and the FDA. Additional clarifications will be provided when recommendations are received from the FDA.

   Page 31: This is on page 33. When the measured SAR values are very close to the limit with a larger than normally anticipated measurement uncertainty and there is insufficient or no explanation, test samples are likely to be called in for determining compliance according to the Commission's measurements.

4. System verification (page 46): is "system verification" the same as "performance check" used in IEEE-P1528?

   They are the same. It had been called "system verification" before the IEEE began calling it "system performance check". The procedures are used to verify system measurement accuracy before performing compliance testing; therefore, Supplement C identifies the procedures as "system verification".

5. Under the section "Test Site Ambient Conditions" (page 48): is extensive monitoring of the laboratory (including SAR measurement with the device turned off) necessary when the laboratory environment is well controlled?

   Supplement C recommends ambient RF conditions to be check daily. The effects of ambient RF on the measurement system can generally be detected during the system verification procedures, which should be performed daily. The effects of ambient RF on the measurement itself may be monitored during the SAR measurement or checked daily if the ambient conditions are relatively quiet. How ambient RF conditions may change during SAR tests due to nearby mobile RF sources and reconfiguration of objects near the SAR measurement location was discussed during the June 2001 SCC-34 meeting. The committee recommends RF conditions be monitored during each SAR test to ensure the test results are not

affected by unwanted RF. This can be easily achieved by observing the ambient conditions on a spectrum analyzer and is a rather simple process. When adverse RF conditions are identified during the monitoring process, a no-power SAR test may be performed to evaluate the impact of external RF conditions on the SAR measurements. In special situations where SAR tests are performed, for example, in a fully enclosed RF shielded environment, routine monitoring of ambient fields is unnecessary if there are no setup changes. However, periodic monitoring or evaluation would still be necessary to ensure that the RF energy from the test devices is not interfering with the measurement equipment.

6. Dielectrics on page 37: how are the body tissue dielectric parameters derived? Would the body dielectric parameters in Supplement C be updated when new parameters are available from standards organizations (e.g. IEC, IEEE)?

   Standardized tissue dielectric parameters for testing body (non-head) regions using homogeneous phantoms, similar to the head parameters developed by SCC-34, are currently unavailable. The IEC has been planning to address body-worn SAR test procedures, but has not yet started on an initial or preliminary draft. When standardized body dielectric parameters are available from standards organizations for testing SAR using homogeneous body phantoms and the parameters are applicable to the SAR requirements in the United States, the Commission will update Supplement C with such parameters.

   The following have been considered in developing the body parameters indicated in Supplement C –

   i) SCC-34/SC-2 has head tissue parameters for 300 MHz – 3000 MHz only.
   ii) The SCC-34/SC-2 head parameters have been derived with numerical simulations using the various 4-Cole-Cole head tissue parameters in planar models to determine the appropriate parameters for testing in homogeneous phantoms.
   iii) Head parameters for 150 MHz and 5800 MHz have been extrapolated using the SCC-34/SC-2 homogeneous head parameters, with respect to the slope of the 4-Cole-Cole parameters for average white and gray matters (brain) in AL/OE-TR-1996-0037 (Reference [12] in Supplement C).
   iv) The curves for the dielectric parameters derived from the 4-Cole-Cole average white and gray matters are similar to the curves for the new SCC-34/SC-2 head parameters. These curves differ by a scale factor because the SCC-34/SC-2 parameters have been derived (selected) for use in a homogeneous phantom to estimate the exposure conditions in the heterogeneous tissues of the users, with little overestimation and no underestimation.
   v) The conductivity values of the SCC-34/SC2 head parameters (for homogeneous phantoms) are higher than the average muscle conductivity derived from the 4-Cole-Cole parameters. However, it has been known that muscle has higher conductivity than brain. Therefore, adjustments are needed for the muscle parameters to maintain the correct ratio of conductivity between the head and body parameters for making SAR measurements in

homogeneous phantoms. A similar rationale used to derive the SCC-34 head parameters has been applied to establish the conductivity values of body tissues in Supplement C. The ratio of average brain (white and gray matters) to average muscle conductivity obtained using the 4-Cole-Cole equations has been applied to scale the SCC-34 head conductivity to obtain appropriate body conductivity values for homogeneous phantoms. Other than being scaled by this ratio, the shape and slope of the resulting body conductivity curves are similar to the 4-Cole-Cole average muscle curves.

vi) The average permittivity of different head tissues has been used, through computational modeling, to compute the highest conductivity required by the SCC-34 head phantom to make conservative SAR measurements. The average dielectric constant for parallel and transverse muscle parameters from the 4-Cole-Cole equation is about 2% lower than the higher of these two values. Since it is not clear what types of tissues should be included to derive body tissue parameters, the higher of the two muscle dielectric constant values (2% difference) has been used for body tissue.

vii) Relevant plots are attached at the end of this document.

7. Dielectric properties should be within 5% of the target values indicated in the table on page 37. There appears to be a conflict between this and the recommendation that the parameters be within 5% of the values used in the dipole reference measurement.

   Language clarification: "The dielectric parameters of the tissue medium used to verify the SAR system should be within 5% of those used to obtain the reference data (target SAR values) ~~and~~ , which should also satisfy the requirements specified in Appendix C." The word "and" should be changed to "which". The tissue parameters used to verify the system measurement accuracy should be within 5% of the values used to obtain the target values. The tissue parameters used to obtain the target values should satisfy the requirements of Appendix C. These two requirements are independent of each other. The tissue parameters used in the system verification are not required to satisfy the requirements of Appendix C provided the above two conditions are satisfied independently.

8. In item 10a on page 33, it is not clear how many plots are sufficient for the test reporting.

   The number of SAR plots is dependent on the SAR distribution for the different test positions (left, right, cheek, tilt, antenna extended and antenna retracted). Different SAR distributions could result due to different device and tissue loading conditions in the various test positions. The purpose of the SAR plots is to identify the peak SAR location with respect to the test device and the phantom in the test setup to support the test procedures used to demonstrate compliance. It is the applicant's responsibility to justify if fewer plots may be used.

   Follow up questions - Please provide additional guidance specifying which of the 24 plots need to be submitted. Is it only the ones that demonstrate a change in

location or intensity of the "hot spot" or are all of the SAR plots required or, is the worst case SAR plot adequate?

For each operating mode, the plots that show changes in peak SAR location or changes in intensity at that peak location (typically 10-15% difference in 1-g SAR) should be included in the SAR report; otherwise, the plot showing the highest peak SAR for each group of similar plots may be submitted provided it is clearly explained in the test report.

9. Temperature range (Page 45): why are the figures different from those in the IEEE draft?

   The temperature range of 15–25ºC (59-77ºF) specified in P1528 is substantially lower than those normally expected in typical laboratory measurement conditions. SAR is an indoor measurement and most indoor laboratory conditions are typically around 20-26ºC (68-79ºF). Therefore, this is the recommended temperature range indicated in Supplement C for minimizing measurement errors due to temperature effects on the test device and test procedures.

   Follow-up questions - P1528 indicates a degree range of 18°- 25° (not 15° to 25° as stated in the answer above) for laboratory conditions, whereas Supplement C indicates a range of 20°- 26°. Is the IEEE range acceptable?

   A temperature range of 15–25ºC was stated in the original question provided to us. A temperature range of 18–25ºC has been recommended by P1528, which corresponds to 64.4-77.0ºF. This is still several degrees lower than the low temperature expected for most indoor laboratory conditions. Out original response still applies.

10. On page 56, B 2 and 3: what is meant by production tolerance and performance tolerance?

    This is in the "Documenting the Measurement Uncertainty of SAR Evaluations" Section of Appendix D.

    B-II: SAR Variation due to Performance Tolerance of the Test Sample –an estimate of the SAR variation with respect to the electrical performance of the test sample and its maximum rated performance for normal use. These may include, but not limited to, considering the maximum conducted and radiated output power levels in the various operating modes and test configurations etc. Other relevant performance parameters that could affect SAR should be identified according to the design of each device.

    B-III: SAR Variation due to Tolerance of Production Units – an estimate of the SAR variation with respect to the test parameters applied to the test sample and the range of parameters expected in production units.

The information is needed to determine if the test sample used is appropriate for demonstrating compliance of the product to be marketed. (See §2.908)

11. Page 46, the meaning of "with and without compensation" is unclear here. Since it refers to probe calibration, the sentence should be moved from the system verification section to the probe calibration section.

    These compensations are typically implemented in the system software. If the system hardware fails, one may not discover such failure due to system offsets; therefore, systems should be periodically checked without the compensation procedures activated. Since not all compensation parameters are related to probe calibration, there could be compensations for other electronic components within the measurement system. The system verification procedures are typically used to check the system with and without the compensation procedures activated; therefore, it is described in the "system verification" section.

12. Page 49-50, the issue of TDMA scaling was not answered to clarify how to perform this test on devices not intended to be operated continuously in transmit mode for 20 - 30 minutes at the highest TDMA duty factor.

    Handsets are generally designed to operate continuously until the battery runs out. The generic procedures developed for testing most handsets may not apply to non-standard devices and operating configurations. Commission staff has already discussed the issues relating to a specific product from this manufacturer.

    Follow-up questions - Please clarify the issue of TDMA scaling and how it applies to devices not intended to be continuously operated in the transmit mode. (This situation does not necessarily apply only to PTT, it can apply to some phone models as well.)

    It is stated in the "**DEVICE OPERATING MODES**" paragraph that TDMA devices should be tested with a TDMA signal. Such devices should not be tested with a CW equivalent signal, which would require the SAR to be scaled. If the design of a handset does not allow it to sustain continuous operations due to battery capacity or other hardware limitations, the recommendations in the preceding paragraph, "**DEVICE OPERATING CAPABILITIES**", should be followed.

13. Page 47, why are there dipole & flat phantom requirement differences between IEEE P1528 and Supplement C?

    The SCC-34 made some last minute changes during its June 2001 meeting because its members did not provide the supporting test data for its earlier decided specifications. Supplement C has taken into consideration such evolving changes. In anticipation of more changes and other discrepancies before SCC-34 finalizes its draft document, the parameters specified in Supplement C have provided more flexibility.

Follow-up questions - Can the flat phantom as defined in P1528 be used? There are differences between the flat phantom dimensions in the IEEE document and Supplement C that do not apparently take into account the reasoning behind the flat phantom measurements as defined in P1528.

As stated in item 4 of the "**SYSTEM VERIFICATION**" section – "Small phantom dimensions may be acceptable if it can be demonstrated that the measured one-gram SAR is within ±1% of that produced by a phantom with the required phantom dimensions."

Note: The supporting information for the flat phantom recommended by P1528 has been verified by means of numerical modeling at only one frequency, 840 MHz, with the SAR averaged over a 10-g volume. There are some unclear issues on whether this data is applicable to all frequencies with substantially different tissue dielectric parameter requirements for a 1-g averaging volume; therefore, two flat phantom alternatives have been included in Supplement C to address these issues and to provide flexibility.

14. Page 43, devices with a headset output should be tested with a headset connected to the device. How should the leads be positioned?

    The headset leads are intended for loading the headset jack, which may change the RF current distribution on the device; therefore, changing the SAR distribution. Headset leads should not be coiled next to the device or the antenna. Letting the leads hang down toward the floor would be acceptable.

15. Page 40, the low frequency (<300 MHz) flat phantom box is too large to be practical. Need to define a maximum size.

    This is on page 46-47. We are aware of the problem and it has been stated in Supplement C that "systems may be verified at 300 MHz until standard dipoles below 300 MHz are available." The IEEE does not provide any recommendation for devices operating below 300 MHz. This revision of Supplement C is intended to address procedures for cellular and PCS handsets, which do not operate below 300 MHz.

16. Page 50, more clarification is needed on battery configuration for tests.

    This is on page 49. Supplement C has provided an alternative method to determine if the number of tests may be reduced by checking changes in radiated output with respect to battery options. If the procedures are not applicable to the specific battery or handset design, a manufacturer should test all battery options available for the handset to ensure compliance.

17. Page 53, the separation distance between adjacent measurement points should be **less than or** = 5.0mm. Also, in other parts of the document there are inconsistencies between IEEE P1528 and Supplement C (e.g. "less than" Vs "no greater than").

    The latest IEEE draft has "no more than 5 mm". This is also acceptable. Since P1528 does not provide any field probe positioning accuracy requirements for the area and zoom scan procedures, the difference between "less than 5 mm" and "no more than 5 mm" could be difficult to determine during probe positioning. Similar situations may apply to differences between "less than" and "no greater than". There are also similar discrepancies found in the latest IEEE draft document. It would not be possible for us to revise Supplement C according to everything in an evolving draft document, word by word, without additional considerations. We may reconsider these minor issues after the IEEE document has been approved for final release.

18. A maximum limit of 5% scaling to max power will require that the transmit power be artificially adjusted to the upper limit of the production transmit power specification window. This may not be possible for some products wherein the normal distribution is significantly below the upper limit which is based on a worst case unit. Other designs do not have factory adjustable power and instead rely on the design and component tolerances to provide a high yield to the transmit power specification window. How should these products be handled?

    The handsets manufactured today typically require rather tight tolerance to meet network and design requirements. We anticipate a very small number of products to be in this category. When the SAR is close to the limit and the output variations among production units are high, testing at output levels significantly below the upper limit may not demonstrate compliance. The described situations are more likely to appear in unlicensed transmitters.

    Follow-up questions - The response provided does not clarify the issue. Would the question please be re-addressed?

    It is the manufacturer's responsibility to ensure the sample tested for demonstrating compliance is in accordance with §§2.907, 2.908 and 2.909(a) of Commission rules. The test data for a number of handsets submitted for equipment approval has shown nonlinear relationship between SAR and output power. When SAR scaling is used to demonstrating compliance, Supplement C recommends the scaling to be within 5% of the measured SAR to ensure the reported numbers are valid for demonstrating compliance. When production units are expected to have substantial variation in output power or performance characteristics, the manufacturer may have to consider rigorous quality control requirements to ensure its products comply with Commission rules.

19. Page 11, it is suggested that computer modeling use heterogeneous models while measurements should use homogeneous (SAM) models. This is not consistent.

FCC rules do not specify SAR evaluations must be performed using heterogeneous or homogeneous models and heterogeneous models have always been allowed. Although it may not be feasible to perform routine SAR measurements using heterogeneous phantoms for compliance testing, this should not restrict such use in numerical computations where the actual human anatomy is modeled. Supplement C has provided addition guidance in the SAR Computation Section for numerical simulations to use either homogeneous or heterogeneous models.

20. Page 40, "Tissue liquid should be at least 15cm deep" conflicts with 15 +/- 0.5cm elsewhere.

    The first appearance of 15 cm at the top of page 40 is related to a general discussion. The second appearance of 15.0 +/- 0.5cm at the bottom of page 40 is a specification; therefore, the tolerance is included.

21. Page 51, the following sentence is inconsistent with IEEE P1528: "For most probes, a separation of at least half a probe diameter should be maintained between the probe tip and the phantom surface to avoid requiring complex compensation procedures to further reduce probe boundary-effects errors." IEEE P1528 allows for compensation algorithms.

    P1528 allows the use of additional compensation for probe boundary effects error but it does not provide any guidance or procedures on how to perform the additional compensation. This is not acceptable for Supplement C.

22. Page 46, it is stated that: "Thickness of dipole must not exceed the separation distance between the outer surfaces of the dipole and the phantom shell by 20%" Why? This statement does not appear in IEEE P1528. Please clarify.

    See response to item #13 above. The SCC-34 made some last minute changes because its members did not provide the supporting test data for its earlier decided specifications. Supplement C has taken into consideration such evolving changes. In anticipation of more changes and other discrepancies before SCC-34 finalizes its draft document, the parameters specified in Supplement C have provided more flexibility.

23. On page 47, step 9 of the System Verification: We suggest the sentence "The SAR distribution must be identical to the reference data" be changed to read "The SAR distribution should be similar to the reference data". The reason is that "identical" is a very exacting word and could be interpreted to require a rigorous mathematical comparison of the two plots, which is not, we believe, the intent.

    There is no reason for the SAR distribution of a dipole source that meets the specifications in Supplement C to show visually discernible differences from its

reference data. "Identical" means no visually discernible differences in the SAR distribution plots. We have seen SAR distributions submitted in equipment approval filings that are distorted due to improper positioning procedures. Although the 1-g SAR values may still be within 10% of the target values, the results are invalid when the dipole is improperly positioned.

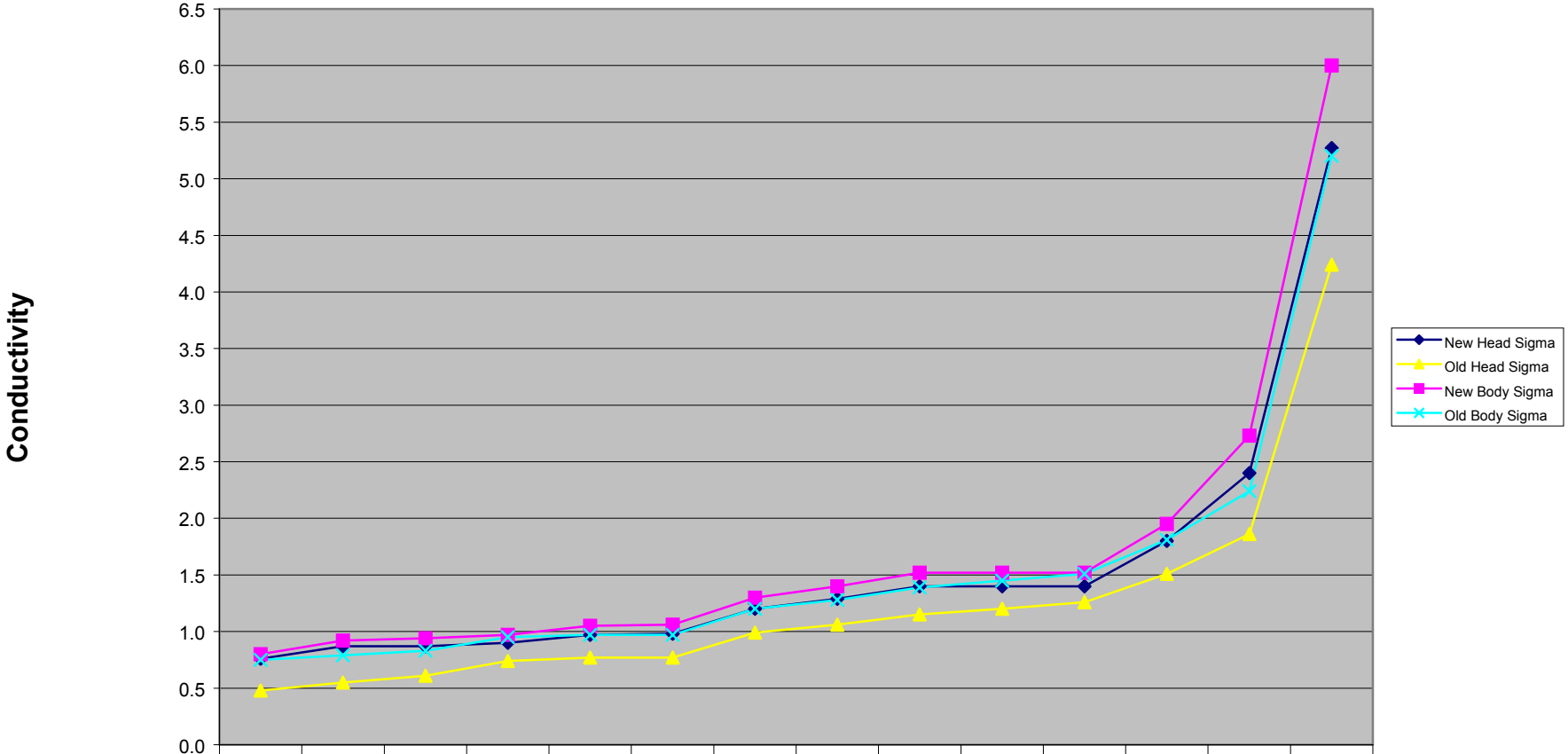
24. If the revised Supplement C does not address push to talk radios, why are there specific instructions regarding PTT radios in at least one instance (page 44, the paragraph beginning with "Transmitters that are designed…")?

This revision of Supplement C addresses cellular and PCS handset test procedures. In additional to next to the ear and body-worn configurations, some handsets may also operate in PTT mode. These procedures may be applicable for testing certain PTT 2-way radios; however, it should not be interpreted as the specific test procedures for testing 2-way radios.

Follow-up questions - Please confirm that Supplement C is not applicable to push-to-talk radios.

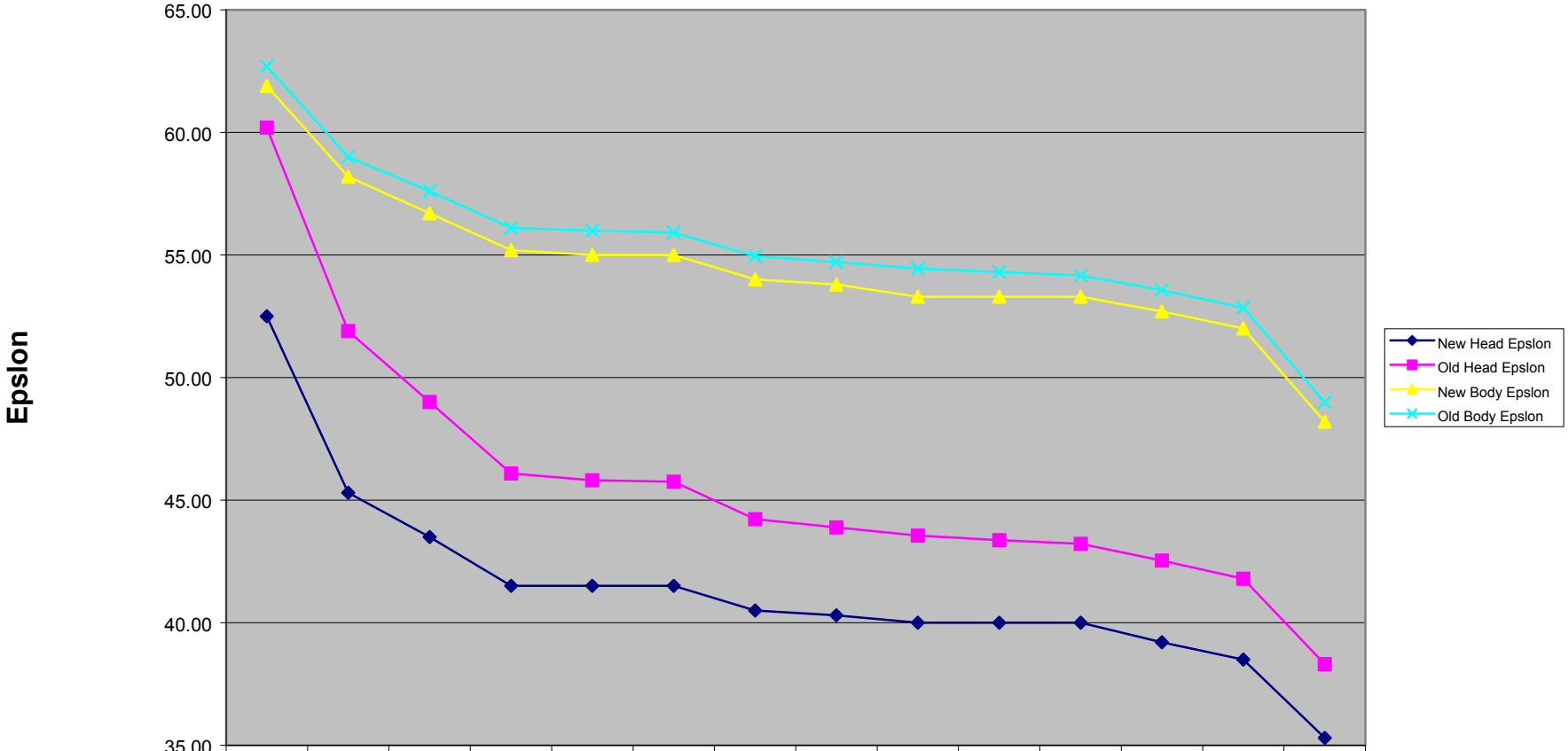
Our earlier response has already stated that "These procedures may be applicable for testing certain PTT 2-way radios; however, it should not be interpreted as the specific test procedures for testing 2-way radios." While the "touch" and "tilt" device test positions are only intended for cellular and PCS phones, the body-worn SAR configurations and tissue dielectric parameters can certainly be used for testing most 2-way radios.

Supplement C - Conductivity



	150	300	450	835	900	915	1450	1610	1800	1900	2000	2450	3000	5800
New Head Sigma	0.76	0.87	0.87	0.90	0.97	0.98	1.20	1.29	1.40	1.40	1.40	1.80	2.40	5.27
Old Head Sigma	0.48	0.55	0.61	0.74	0.77	0.77	0.99	1.06	1.15	1.20	1.26	1.51	1.86	4.24
New Body Sigma	0.80	0.92	0.94	0.97	1.05	1.06	1.30	1.40	1.52	1.52	1.52	1.95	2.73	6.00
Old Body Sigma	0.75	0.79	0.83	0.95	0.97	0.97	1.20	1.28	1.39	1.45	1.51	1.81	2.24	5.20

Supplement C - Dielectric Constants



	150	300	450	835	900	915	1450	1610	1800	1900	2000	2450	3000	5800
New Head Epslon	52.50	45.30	43.50	41.50	41.50	41.50	40.50	40.30	40.00	40.00	40.00	39.20	38.50	35.30
Old Head Epslon	60.20	51.90	49.00	46.09	45.81	45.75	44.22	43.89	43.55	43.37	43.22	42.54	41.79	38.31
New Body Epslon	61.90	58.20	56.70	55.20	55.00	55.00	54.00	53.80	53.30	53.30	53.30	52.70	52.00	48.20
Old Body Epslon	62.70	59.00	57.60	56.10	56.00	55.92	54.95	54.71	54.44	54.30	54.17	53.57	52.85	48.99