Before the
FEDERAL COMMUNICATIONS COMMISSION Washington, D.C. 20554

Federal Communications Commission FCC 13-39

In the Matter of	)	
	)	
Reassessment of Federal Communications Commission Radiofrequency Exposure Limits And Policies	)))	ET Docket No. 13-84
	)	
Proposed Changes in the Commission's Rules Regarding Human Exposure to Radiofrequency Electromagnetic Fields	)))	ET Docket No. 03-137

COMMENTS BY Nokia Corporation

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I - INTRODUCTION AND SUMMARY

About Nokia
Nokia is a global leader in mobile communications whose products have become an integral part of the lives of people around the world. Every day, more than 1.3 billion people use their Nokia device to capture and share experiences, access information, find their way or simply to speak to one another. Nokia's technological and design innovations have made its brand one of the most recognized in the world. For more information, visit http://www.nokia.com/about-nokia.

With regards to the FCC's exposure guidelines, Nokia submits that the scientific basis of these is now more than 20 years old and the rationale for continuing to maintain two separate limit values in a world that has in the main adopted the guidelines set by the International Commission on Non-Ionizing Radiation Protection (ICNIRP) is increasingly difficult to justify. On the contrary, there is very strong policy, practical and scientific grounds to justify an alignment with these international guidelines. The current FCC limits were based on early dosimetry considerations alone, whereas the ICNIRP 1998 or IEEE C95.1- 2005[1] limits of 2.0 W/kg averaged over 10 g of tissue for general public exposure and 10 W/kg averaged over 10 g for occupational exposure are based on a significantly improved understanding of the RF and thermal dosimetry and biological health effects.

Both ICNIRP guidelines and IEEE C95.1- 2005 standard provide a very conservative framework for the protection of persons exposed to RF fields. From the substantial safety margin inherent in the standards themselves, through to the specificity of SAR measurement protocols and how the devices are tested compared to how they typically operate, the result is a very conservative framework suitable for widespread adoption. In fact, the World Health Organization (WHO) recommends that national governments should adopt the exposure guidelines developed by the International Commission on Non-Ionizing Radiation Protection (ICNIRP, 1998) or the Institute of Electrical and Electronics Engineers (IEEE C95.1- 2005), which are for the present purposes, essentially the same and collectively referred to as IEEE/ICNIRP or the 'international standards'.[2]

Most importantly, international and national health authorities and expert bodies continue to maintain the consensus view that there are no established health effects below the levels recommended by ICNIRP and IEEE C95.1-2005.The adoption of consistent science based guidelines increases consumer confidence and reduces community concerns.

[1] The American National Standard Institute ANSI adopted the IEEE standard in 2006 as ANSI/IEEE C95.1-2006
[2] Both adopt a SAR compliance level of 2.0 W/kg averaged over 10 grams of tissue.

Currently, at least 115 countries, territories and regions use the ICNIRP guideline as the basis of national safety standards for mobile. This is in contrast to only thirteen following the FCC's guideline for mobile devices.

Moreover, any arbitrary reduction below existing guidelines can have significant unintended consequences which would make the operation of telecommunication networks difficult and in some cases impossible as we see in in some parts of the world like in India, Belgium and France today. Thus, Nokia submits that the adoption of arbitrary limits below those established by IEEE/ICNIRP and recommended by the WHO, represents a poor policy choice that actually threatens the proven safety, security and economic benefits that mobile communications provides to the community at large.

Nokia remains sensitive to the concerns and questions raised with regards to RF emissions. We provide a range of consumer information including on company websites and publications as well as in user manuals. If some members of the community remain concerned, the best way for them to reduce their exposure from cell phones is to follow the FCC's own advice that is consistent with the WHO's advice to use "hands-free" devices which keep cell phones away from the head and body during calls and to limit the number and length of calls.

It should also be remembered that the telecommunications network is inherently precautionary. Studies of cell phones in everyday use show that when talking on a mobile phone while walking around a major city or inside city buildings, smartphones operate at less than one per cent of the phones maximum power output. This and other technical features such as discontinuous transmission, the existence of exposure standards, continuous research and on-going review as well as the availability of consumer information make the existing environment in which the industry is operating within inherently precautionary.

Nokia also submits that there is strong congressional and executive support for the harmonisation of standards and that the continued retention of the current FCC's limits, especially in the absence of scientific support from relevant standards committees, has resulted in a "government unique standard" ('GUS'), a position directly at odds with existing government policy and one which should be rectified by the adoption of IEEE C95.1-2005.

With the extensive deployment of LTE, the United States currently enjoys a position of considerable technology leadership, but this technological lead can quickly be lost in this rapidly changing environment. Nokia finds the compliance framework established by the FCC for LTE devices exceptionally complicated and time consuming. The harmonization of limits would make the production of new devices much more efficient with only one global standard to design and comply with.

In relation to the evaluation of devices, Nokia submits that the FCC's current LTE testing requirements are unduly onerous, involving in some cases in excess of

100 SAR tests for head and body exposure in only two LTE frequency bands, equating to 4 – 6 weeks of testing for SAR type approval. Alternative approaches based on initial screening of conducted power are being used internationally and have been shown to be as effective as the current FCC specified approach. These alternative processes involve considerably less testing time – an important factor for products that often have a market life cycle of 12 months or so.

Finally, Nokia would also like to see a presumption of adoption operating where the FCC is actively involved in standards committees, rather than have all parties invest considerable time and resources into standards development only to see the FCC fail to adopt them or to mandate contradictory requirements. Nokia believes that this could be achieved through the KDB process and is consistent with the principles and requirements of OMB Circular A-119.

II - FURTHER NOTICE OF PROPOSED RULEMAKING

A - TECHNICAL EVALUATION REFERENCES IN RULES

Nokia notes the FCC's decision to "discontinue use of Supplement C as an informative reference for evaluation of mobile and portable devices" and, instead, to utilize "the Office of Engineering and Technology (OET) Laboratory Division Knowledge Database (KDB) to provide current guidance and policies on acceptable procedures for evaluating wireless devices."[3] KDBs, therefore, will constitute the sole locus of documented requirements for grant authorization testing. As such, KDB requirements will reflect, on a day-to-day basis, the extent of the FCCs commitment to harmonization with international standards and requirements.

In order for the KDB process to effectively supplant the more authoritative – but, concededly less flexible – guidance issued through an OET Bulletin and supplements, Nokia believes that KDBs must have the following qualities:

a. KDBs should be released in draft in order with an adequate notice period during which stakeholders can provide input;
b. KDBs issued in final should provide adequate time for an orderly transition of practices
c. KDBs must provide testing guidance that is consistent, as much as possible, both with current standards and international practices. (Where departure from international standards and practices are called for by a KDB, a rationale for such departure should be provided.)
d. KDBs should provide adequate flexibility to allow for innovation in both testing and technology.

In accordance with the above principles, Nokia urges the FCC to use this opportunity to embrace harmonized requirements through the KDB process. Such an approach will be in line with the FCC's statement that "we fully intend to continue to use the KDB to provide guidance on techniques and methodologies recommended by internationally and domestically accepted expert standards bodies, such as the Institute of Electrical and Electronics Engineers ("IEEE") and the International Electrotechnical Commission ("IEC"), to the extent that their standard procedures ensure compliance with our exposure limits."[4] As items covered by Supplement C are recast through the KDB process, the FCC should avoid developing unique U.S. requirements and work to keep the testing process aligned with international standard processes.

By way of example, Nokia would note the ongoing issue of testing fluids for use with the SAM phantom. In 2001, the FCC initiated its ongoing requirement that simulants for head and body measurements each be unique such that two

[3] Id. at Paragraph 28.
[4] Id. at Paragraph 38.

simulants are required for a complete suite of tests rather than the one simulant formula adopted in other countries, as provided for in IEC standard 62209-2 (2010). As a consequence, testing requirements effectively are doubled for products shipped to both the US and internationally since the approach outlined in the KDB must be followed for US product while product destined for the rest of the world will be tested according to IEC 62209-2 (2010).

Nokia notes that the above proposed KDB principles and our proposal for internationally recognized testing procedures are not only consistent with, but called for by the Office of Management and Budget ('OMB') Circular A-119, which directs Government agencies "to use voluntary consensus standards in lieu of government-unique standards except where inconsistent with law or otherwise impractical."[5]

[5] http://www.whitehouse.gov/omb/circulars_a119

III - NOTICE OF INQUIRY

A - EXPOSURE LIMITS

Nokia notes that the FCC's existing RF exposure guidelines, adopted in 1996, are based on the standards extant at that time: the ANSI/IEEE C95.1-1992 Standard[6], and the NCRP's 1986 report on Biological Effects of RF Fields.[7] The scientific basis of the existing guidelines is therefore more than 20 years old and, as explained further below, resulted in adoption by the FCC of astandard that has now been rejected by the majority of the world's scientists and regulatory bodies in favor of the current science based ICNIRP/IEEE standards. As expressly stated in the IEEE C95.1-2005 Standard:

> *Since publication of ANSI C95.1-1982 significant advances have been made in our knowledge of the biological effects of exposure to RF energy[8].*

As a result of reviews of the RF literature and the state of the science, the World Health Organization (WHO) provides the following advice to national governments with regards to RF exposure standards:

> ***Protection standards***
>
> *International exposure guidelines have been developed to provide protection against established effects from RF fields by the International Commission on Non-Ionizing Radiation Protection (ICNIRP, 1998) and the Institute of Electrical and Electronics Engineers (IEEE, 2005).*
>
> *National authorities should adopt international standards to protect their citizens against adverse levels of RF fields. They should restrict access to areas where exposure limits may be exceeded.[9]*

The WHO advice has been widely followed. A recent paper[10] presented at the

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[6] The IEEE C95.1-1991 standard was adopted by ANSI in 1992 to become ANSI/IEEE C95.1-1992.

[7] 47 CFR 2.1093 (d), "The limits to be used for evaluation are based generally on criteria published by the American National Standards Institute (ANSI) for localized specific absorption rate ("SAR") in Section 4.2 of "IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz," ANSI/IEEE C95.1-1992, Copyright 1992 by the Institute of Electrical and Electronics Engineers, Inc., New York, New York 10017. These criteria for SAR evaluation are similar to those recommended by the National Council on Radiation Protection and Measurements (NCRP) in "Biological Effects and Exposure Criteria for Radiofrequency Electromagnetic Fields," NCRP Report No. 86, Section 17.4.5. Copyright NCRP, 1986, Bethesda, Maryland 20814."

[8] IEEE C95.1-2005, page 35.

[9] http://www.who.int/mediacentre/factsheets/fs304/en/index.html accessed on 04 March 2013

[10] Rowley J., Joyner K., Zollman P. & Larsson LE. Radiofrequency Exposure Policies Relevant to Mobile Communication Devices and Antenna Sites. BioEM 2013, 10-14 June Thessaloniki Greece

Joint Meeting of the Bioelectromagnetics Society and the European BioElectromagnetics Association in June 2013 found there are currently 115 countries, territories, dependencies and sub-national regions using the ICNIRP guidelines as the basis of national exposure standards for mobile devices. This is in contrast to only thirteen countries that follow the FCC guidelines for mobile devices.

It is interesting to note that even China adopted the ICNIRP guidelines in 2007 for devices[11] and several countries, including Australia[12] and Taiwan[13] that previously had indivudual standards have now adopted national standards based on ICNIRP guidelines. The change in the international landscape towards greater harmonization of RF exposure standards based on IEEE C95.1-2005/ICNIRP was recognized in the recent Government Accounting Office (GAO) report:[14]

> *These international organizations have updated their exposure limit recommendation in recent years, based on new research, and this new limit has been widely adopted by other countries, including countries in the European Union.*

For the foregoing reasons, it is evident that the overwhelming view of the scientific community, national experts and the international health agency actively overseeing this field, is that the current science supports the harmonized 2W/kg with 10g averaging for general public exposure and 10W/kg with 10g averaging for occupational exposure standard rather than the older standard still followed by the FCC.

In developing these updated standards, the experts and scientists followed the example of the earlier standards body and built in substantial safety margins.[15] Consequently, there is no basis for continued use of the outdated standard that is no longer supported by the IEEE: it cannot be said to be either safer or more useful than the later standard. More specifically, given that both the 1.6W/kg averaged over 1 g tissue and the 2W/kg averaged over 10 g tissue limits – as well as the MPE values -- are well below the threshold for adverse health effects with large safety margins[16], both limit values must be regarded as being equally safe for consumers.

In a world that is harmonizing around the 2W/kg value, that has a built in substantial safety margin, any rationale for continuing to maintain two separate

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[11] GB 21288-2007: *Limits for Human Local Exposure to Electromagnetic Fields Emitted by Mobile Phones*

[12] *Maximum Exposure Levels to Radiofrequency Fields - 3 kHz to 300 GHz* available at http://www.arpansa.gov.au/pubs/rps/rps3.pdf

[13] CNS 14959 (2005): Limits for exposure to time-varying electric, magnetic and electromagnetic fields (up to 300 GHz)

[14] http://www.gao.gov/products/GAO-12-771

[15] See IEEE C95.1-2005, Annex C.6 Safety factors and uncertainty factors

[16] See ICNIRP's 2009 Statement On The "Guidelines For Limiting Exposure To Time-Varying Electric, Magnetic, And Electromagnetic Fields (Up To 300 GHz) at http://www.icnirp.de/documents/StatementEMF.pdf

guidelines can not be based on the science but must be based on non-sciencepublic policy considerations. The contrary holds true, however: as detailed below there are very strong policies, as well as practical and scientific grounds to justify an alignment with international standards.

B- RATIONALE FOR HARMONIZATION OF FCC'S LIMITS

In addition to the fact that the scientific basis of the FCC's guidelines has become outdated with the original IEEE C95.1-1991 standard having been superseded twice in the intervening years (C95.1-1999 Edition then followed by C95.1-2005), and that the WHO recommends adoption of either the IEEE C95.1-2005 standard or ICNIRP guidelines, there are significant policy reasons to justify the update and harmonization of the FCC's Limits.

1 – CLEAR SCIENTIFIC SUPPORT FOR HARMONIZED LIMITS

While the FCC has made the perfectly correct point that the "[c]ontinued use of present exposure limits is currently supported by statements from significant qualified expert organizations and governmental entities", it is important that the statement be understood as recognition that there clearly is no public health risk from continued use of the standard and not as an endorsement of a standard that has been outdated twice by new science. . Therefore, such a statement should not be construed as support for continuing to use the old standard rather than the updated ones. In fact, there is strong support from international health and government expert agencies for the 2W/kg ICNIRP/IEEE limit.

2 – INTERNATIONAL STANDARDS PROVIDE A BIOLOGICAL BASIS BETTER SUITED TO A HEALTH PROTECTION STANDARD

On the issue of the differences between the averaging of exposures,[17] Nokia notes that the FCCs peak spatial-average SAR limits for localized exposure of the general public (1.6 W/kg averaged over 1 g of tissue) and workers (8 W/kg averaged over 1 g of tissue) are based on the C95.1-1991 (and NCRP Report 86) SAR values and differs significantly from the 2 W/kg and 10 W/kg averaged over 10 g of tissue value found in the ICNIRP guidelines and the IEEE C95.1-2005 standard.

In the revised IEEE C95.1-2005 standard, the recommended peak spatial-average SAR values for the controlled environment and the general public (if no RF safety program is implemented) have been changed and are now harmonized with the WHO-recommended ICNIRP peak SAR limits, i.e., 10 and 2.0 W/kg averaged over 10 g of tissue, respectively. The rationale for the change is

[17] Id. at Paragraph 220

explained in Appendix C, Section C.2.2.2.1 of C95.1-2005. Whereas the 1991 SAR limits were based on early dosimetry considerations alone, the 2005 limits are based on a significantly improved understanding of the RF and thermal dosimetry and biological/health effects considerations.

Therefore considering the FCC's objective to provide adequate protection for human exposure to RF energy, then it makes sense for the FCC to adopt a standard that is both biologically based and one that also takes into account the variety of ways that products can use RF energy.

4 – INTERNATIONAL STANDARDS ARE CONSERVATIVE

Nokia notes that both ICNIRP and IEEE C95.1-2005 provide a very conservative framework for the protection of persons exposed to RF fields. From the substantial safety margin inherent in the standards themselves, through to the specificity of SAR measurement protocols and how the devices are tested compared to how they typically operate, the result is a very conservative framework suitable for widespread adoption.

The following provides details on how conservativeness is built in to various components of the standards:

a) SAM phantom

The combination of higher tissue conductivities, a large head size, a thin ear and the exclusion of a hand holding the handset were all chosen to provide a conservative estimate of the peak spatial-average SAR associated for the operating configurations expected by typical wireless handset users.

The collective impact of the above parameters is to produce a margin such that the SAR values assessed using the test procedures of this standard are expected to be higher than during actual use conditions of a handset.

i. **Head size:** A head geometry that results in overall smaller distances between the handset and the tissue boundary will provide more conservative results because the separation between the equivalent current densities on the device under test and the tissue equivalent liquid will be less. Thus, a larger anthropomorphic head model, with larger local radii of curvature, will satisfy the criterion for minimal distances.
ii. **Phantom shape:** The dimensions and shape of Specific Anthropomorphic Mannequin (SAM), except for the ear protrusions discussed later, were derived from a subset of the 90th percentile dimensions from the survey of the US Army males.
iii. **Head tissue-equivalent liquid:** To fulfil the conservative criteria in SAR assessment, the homogenous liquid parameters must be carefully selected taking into account the energy coupling enhancement due to standing waves that occurs in tissue layers of

the human head. The tissue-equivalent liquids are based on a study of the anatomical variations in the head region behind and above the ear for a cross section of a representative user population. At each frequency, the possible ranges of layered-structure thickness and conductivity of the tissue-equivalent liquid that resulted in the highest peak spatial-average SAR values (1 g and 10 g average) were evaluated. Dielectric properties for homogeneous head tissue-equivalent liquids were determined to produce the same (or slightly higher) peak spatial-average SAR values compared to the highest values occurring in the heterogeneous cases.

iv. **Pinna shape, orientation, and thickness:** In the selection of any phantom for handset SAR testing, a properly designed and positioned pinna (external ear) is necessary in order to achieve correct and repeatable geometrical relationships between the handset and the tissue boundary. For SAM, the pinna orientation and shape were selected to maximize the inductive coupling from a handset. The relevant IEEE standards committee decided to simulate the pinna using a stable, simplified loss-less spacer with a thickness of 6 mm (inclusive of the 2 mm phantom shell thickness). This spacer thickness is considerably less than the typical 19–28 mm spacing between the rear edge of the pinna (when not compressed) and the head shown in the anthropometric data, thereby contributing to the conservative conditions of SAM for SAR assessments.

The conservativeness of SAM has been repeated shown in numerous computational studies using anatomical correct models from MRI scans. The spatial peak SARs in the SAM head model used for compliance evaluation have been shown to be conservative for both adults and children (by the teams of Beard et al[18]., Chris et al.[19] and Hadjem et al.[20]). Their conclusions are summarized in the following statements taken from the abstracts of their papers:

The results show that when the pinna SAR is calculated separately from the head SAR, SAM produced a higher SAR in the head than the anatomically correct head models. Also the larger (adult) head produced a statistically significant higher peak SAR for both the 1- and 10-g averages than did the smaller (child) head for all conditions of frequency and position. [Beard et al.]

The peak spatial specific absorption rate (SAR) assessed with the standardized specific anthropometric mannequin head phantom has been shown to yield a

[18] Beard BB, Kainz W, Onishi T, Iyama T, Watanabe S, Fujiwara O, et al., “Comparisons of computed mobile phone induced SAR in the SAM phantom to that in anatomically correct models of the human head,” *IEEE Trans. Electromagn. Compat.*, vol. 48, no. 2, pp. 397–407, May 2006.

[19] Christ A, Gosselin MC, Christopoulou M, Kuhn S, Kuster N, “Age-dependent tissue-specific exposure of cell phone users,” *Phys. Med. Biol.*, vol. 55, pp. 1767–1783, Mar. 2010.

[20] Hadjem A, Conil E, Gati A, Wong MF and Wiart J, “Analysis of power absorbed by children’s head as a result of new usages of mobile phones,” *IEEE Trans. Electromagn. Compat.*, vol. 52, no. 4, pp. 812–819, Nov. 2010.

conservative exposure estimate for both adults and children using mobile phones. [Chris et al.]

The specific anthropomorphic mannequin (SAM) homogeneous head model has been also used to compare all the results and to confirm that the SAM model always overestimates adult and child head exposure… It was also pointed out that the value of the maximum local peak SAR in the SAM was always higher than in the adult and children models. [Hadjem et al.]

Nokia notes that IEEE 1528-2003 provides additional information about the SAM phantom in Section 5 of the standard.

b) Testing at Maximum Power

During SAR testing, the devices are tested using maximum power. In reality this is rarely experienced by users due to the existence of adaptive power control in the network. Power control is undertaken at the cell site level and serves to adjust the output power only to that level needed to make and maintain a quality connection. Discontinuous transmission is another network efficiency feature by which transmissions are minimised when the user is not talking, but rather listening.

Studies that have been undertaken on devices in real network conditions have shown that devices operate at average power levels of between 1% to 35% of their maximum as a result of power control and discontinuous transmission. A more detailed discussion and their impact can be found in section D2 of this document, however the result though is that by testing the devices at maximum power and without taking into account the impact of power control and discontinuous transmission results in a very conservative SAR result.

The combination of these factors undoubtedly results in a very conservative compliance framework, such that even if one or more elements is shown at a later date to require modification, or the users fails to use the device as intended, the end result in terms of fundamental safety is not in question. As the FCC itself points out in relation to the issue of body-worn usage where a consumer disregards the information contained in product documentation about the correct distance to use the device at, "a use that possibly results in non-compliance with the SAR limit should not be viewed with significantly greater concern than compliant use" as there is "no evidence that this poses any significant health risk"[21].

C - CONSUMER INFORMATION

Nokia supports the FCC's statement that "[s]everal general strategies are available for users of portable devices that want to reduce their exposure."

[21] Id. at Paragraph 251

including “increasing distance from the device and decreasing time of use are obvious actions to reduce exposure”[22]. Information such as that already provided by the FCC is extremely helpful in reminding consumers that they can limit or reduce their exposure should they wish to. This advice is also consistent with the statements made by the WHO[23]:

> *In addition to using "hands-free" devices, which keep mobile phones away from the head and body during phone calls, exposure is also reduced by limiting the number and length of calls…*

Nokia also provides information consistent with the above to consumers within the SAR information section of their user guides and/or their websites. This includes the following statement:

> *Organizations such as the World Health Organization and the US Food and Drug Administration have stated that if people are concerned and want to reduce their exposure they could use a hands-free device to keep the phone away from the head and body during phone calls, or reduce the amount of time spent on the phone.*

In addition to the above information Nokia has also expanded its SAR reporting program – now known as SAR Tick. The SAR Tick initiative incorporates a number of elements:

(a) The introduction of a SAR Tick (see below) to provide a visual confirmation that the phone has been tested for SAR compliance and provides a link to a new consumer-oriented website on SAR issues; and
(b) The inclusion of additional information in the ‘health and safety section/important product information section’ of the user manual; and
(c) The modification of the existing SAR information text to include a clear table of the maximum SAR values for the device and the operating conditions under which they were recorded.

With regards to (a & b) Nokia now includes a new SAR Tick logo in the front section of the user manual or in the short guide that accompanies the phone, similar to the following:

www.sartick.com

This product meets the applicable FCC SAR guideline of 1.6W/kg when held against the head or at a distance of x.x cm or x/x of an inch from the body. The FCC SAR guideline includes a considerable safety margin designed to assure the safety of all persons, regardless of age and health. The specific maximum SAR values for this product can be found in the xxxx section of this user guide.

When using the product next to your body (other than in your hand or against your head), either use an approved accessory such as a holster or maintain a distance of x.x cm

[22] Id. Paragraph 233
[23] http://www.who.int/mediacentre/factsheets/fs193/en/

	or x/x of an inch from the body to ensure your use is consistent with how the device is tested for compliance with FCC RF exposure requirements. Note that the product may be transmitting even if you are not making a phone call.

Figure 1: Example of SARTick logo and accompanying text.

The logo serves to visually reinforce the text, and provides a short summary of the essential compliance information for the device. The text also provides a reference to the full SAR compliance information that is often located elsewhere in the manual. This format meets the key outcomes raised by stakeholders for (a) greater visibility within the manual, and (b) providing key information in the safety or 'important product information' section that appears 'up front'. Such an approach also allows manufacturers the flexibility to provide a full explanation and proper context to SAR in the section of their user manual that best fits with the overall structure/layout of the document.

The SAR-tick logo also includes a link which directs consumers to www.sartick.com - a new comprehensive and dedicated website focussing on SAR which consolidates existing and new SAR resources for the general public.

With regard to element (c) discussed above, NOKIA now includes additional information in the full SAR compliance information section of the user guide. This information includes the maximum SAR recorded for both head and at the body and includes the operating conditions that this maximum was recorded at. The presentation of this information is clearer and again addresses concerns raised by stakeholders. The information is provided with explanatory text that helps consumers know more about what SAR is and how it is measured as well as the practical advice that the FCC and the FDA have provided for those consumers who wish to reduce their exposure – as mentioned above.

Nokia questions the rationale behind the FCC's statement that "there is inconsistency in the supplemental information voluntarily provided in the manuals provided with portable and mobile devices" and that "for a variety of reasons, the maximum SAR value that is normally supplied is not necessarily a reliable indicator of typical exposure and may not be useful for comparing different devices." [24]

Nokia considers that the FCC's own advice to consumers available on its website[25] indicates the purpose of SAR values and that they are not intended to

[24] Id. Paragraph 234
[25] http://www.fcc.gov/guides/specific-absorption-rate-sar-cell-phones-what-it-means-you

show typical exposure:

> *the SAR values collected by the FCC are intended only to ensure that the cell phone does not exceed the FCC's maximum permissible exposure levels even when operating in conditions which result in the device's highest possible – but not its typical - RF energy absorption for a user.*

Nokia considers that this explanation of what SAR is intended for, is important and helps to correct attempts to paint SAR as being some form of 'relative safety indicator', which is clearly wrong and inappropriate. As the FCC itself advises consumers:

> *Consequently, cell phones cannot be reliably compared for their overall exposure characteristics on the basis of a single SAR value for several reasons (each of these examples is based on a reported SAR value for cell phone A that is higher than that for cell phone B):*
>
> *- Cell phone A might have one measurement that was higher than any single measurement for cell phone B. Cell phone A would, therefore, have a higher reported SAR value than cell phone B, even if cell phone B has higher measurements than A in most other locations and/or usage configurations. In such a case, a user generally would receive more RF energy overall from cell phone B.*
>
> *- Cell phone A might communicate more efficiently than cell phone B, so that it operates at lower power than cell phone B would under comparable conditions. Consequently, a user would receive more RF energy overall from cell phone B.*
>
> *- The highest value from cell phone A might come from a position which the user seldom or never employs to hold a phone, whereas that user might usually hold a phone in the position that resulted in the highest value for cell phone B. Therefore, the user would receive the highest RF exposure that cell phone B delivers but would not receive the highest RF exposure that cell phone A delivers.*

Therefore Nokia does not support the FCC's contention of any "inconsistency"[26], as the SAR values provided accurately reflect the conditions under which manufacturers are required to test by the FCC and that the values are not intended to be used for comparison purposes.

With regards to the question posed by the FCC as to whether it should also take actions to better enable consumers to correlate the make and model number of their device to an FCC ID[27] Nokia would support this action in principle. Nokia notes though that the current structure of the FCC's website in this regard reflects its process of granting authorizations and these are not directly related to the model names and numbers that a consumer would typically be searching for. While supporting efforts to improve consumer access to this information Nokia would be concerned if this change resulted in additional burdens or delays for manufacturers in obtaining the necessary authorizations. This would particularly be the case for manufacturers of radio modules. Ultimately Nokia

[26] Id. Paragraph 234
[27] Id. Paragraph 235

prefers the FCC to encourage consumers to access the SAR information directly from manufacturers own sites, since then the information does not need to be duplicated and the FCC database can continue to serve the function that it was intended to.

2 - DEVICES

In relation to the precautionary aspects of devices, Nokia notes that a recent analysis of the FCC's own data has shown that the maximum SAR for approved devices has decreased over time:

> *The FCC data also provide insights regarding some changing RF exposure factors over time. It is noteworthy that maximum SARs decreased over the period from 1999 to 2005, mainly reflecting a trend toward lower maximum power communication systems as well as lower SARs for bar-type phones with internal antennas and lower SARs from slider phones with all types of antennas….To the extent that the types of phones tested over the years approximate the use in the US population, these data would suggest a decrease in population exposures per unit time of use.* [28]

While the trend of decreasing SAR has been influenced by changes in form factors, technology, antenna design and performance, it is worthwhile in the context of the FCC's consideration of RF exposures, that the data shows a decrease in population exposure 'per unit of time of use' over the years.

The impact of power control and discontinuous transmission on the devices also ensures that phones operate well below their maximum for the vast majority of time. The study by Persson et al.[29] for example, found that after assessing output power from more than 800,000 hours of voice calls, the average level for 3G voice calls was below 1mW across all environments including rural, urban, and dedicated indoor networks. These results were consistent with the findings of an earlier study by Wiart et al.[30] of mobile phone use in everyday use, which found that when talking on a mobile phone while walking around a major city or inside city buildings, smartphones typically operate at less than one per cent of the phones maximum power output. This equates to 100 times less emissions than the maximum exposure level measured in SAR compliance tests. The researchers stated:

> *Finally, 90% of all collected measurements (indoor, outdoor) are less than 4dBm (1% under the maximum possible emitted power). The real exposure due to mobile phones in terms of Specific Absorption rate (SAR) is then well below (100 times below) the normative values given at the maximum powers.*

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[28] Kuehn et al., Analysis of mobile phone design features affecting SAR in a human head. *Bioelectromagnetics* 2013

[29] Persson et al. *Output power distributions of terminals in a 3G mobile communication network* Article first published online: 19 OCT 2011 | DOI: 10.1002/bem.20710

[30] Wiart et.al. *Exposure induced by WCDMA Mobile Phones in Operating Networks*, IEEE Trans on wireless communications Vol. 8 No 12 2009

Nokia believes that the adoption of arbitrary limits below those established by ICNIRP and recommended by the WHO represents a poor policy choice, and one that actually threatens the proven safety, security and economic benefits that mobile communications provides to the community at large. However, as has been shown in several cases, the adoption of internationally harmonised standards is also considered by several governments as being an application of precaution and consistent with a precautionary approach to the issue.

E – EVALUATION

Nokia agrees with the comment that "evaluation is a rapidly evolving area…most effectively guided by good engineering practice rather than specific regulations."[31]

Wireless devices have become increasingly complex working over multiple frequency bands and communications technologies and with an ever-increasing demand by consumers for higher capacity and higher speed data services. The current state of the art technology supplied to consumers is LTE and commonly referred to as 4G services. However, the overly conservative FCC testing requirements mean a very significant increase in the number of SAR tests facing manufacturers and the associated time to market delays and costs. According to the current FCC SAR test procedures for LTE devices[32], some handsets are required to undergo in excess of 100 SAR tests for head and body exposure in only two LTE frequency bands, which equates to 4 – 6 weeks (double shifts) for type approval SAR testing and this figure is unreasonably high given that the typical product life cycle is 12 months or so.

Other national approaches[33,34,35] which are based on the international 3GPP standards[36] rely more on the initial screening of conducted power levels to ascertain which combination of channels, channel bandwidth, resource block (RB) allocation and offset, modulation and maximum power reduction will yield the highest SAR, thereby minimizing the amount of SAR testing required to show compliance. In fact the maximum SAR found by comparing the four international approaches have shown an average deviation of 5% or less[37],

[31] Id. Paragraph 244
[32] 941225 D05 SAR for LTE Devices v02r02
[33] ARIB STD-T56 ver. 3.1, 18 Dec. 2012. (in Japanese)
http://www.arib.or.jp/english/html/overview/st_ej.html
[34] ARIB T56 ver. 3.2 In preparation
[35] Notice of National Radio Research Agency (No. 2012-43, December 6, 2012) "Technical details on SAR measurement procedure" Annex 3 Method of measuring SAR for LTE terminals
[36] 3GPP TS 36.521-1 Evolved Universal Terrestrial Radio Access (E-UTRA); User Equipment (UE) conformance specification; Radio transmission and reception; Part 1: Conformance testing
[37] Report to IEC 62209 MT Update of LTE SAR Ad-hoc WG, Newbury May 2013

Research has shown that conducted power results and SAR are linearly related and that other factors (channel bandwidth, modulation, RB allocation and offset) are of lesser significance. Thus, the conducted power measurements are the key for the efficient identification of LTE modes resulting in highest SAR conditions. This principle is already implemented in several FCC KDBs related to other communication systems (CDMA, WLAN etc.), where only certain test mode is required to be SAR tested unless some other modes have significantly higher conducted power. This same approach should be expanded to LTE SAR testing, to avoid the excessive amount of SAR testing described above.

Nokia also notes that there are several standards committees that are constantly monitoring and reviewing the standards and preparing updates. The FCC is actively involved in many of these[38], (including the filing of numerous comments all of which are required to be addressed), yet the FCC does not adopt these standards when they are published[39], or worse, mandates contrary requirements[40]. Nokia believes that where the FCC is actively involved in a standards committee then there should be a presumption of adoption of these standards once published as they do represent, by their consensus approach, best engineering practice by which to ensure and measure compliance. Their formal adoption once published is also consistent with the requirements of the NTTAA and OMB Circular A-119 discussed earlier in this submission. Nokia would further submit that these could be adopted via the KDB process.

[38] Including IEEE C95.1-2005, IEC 62209-1, IEC 62209-2, IEEE 1528.
[39] Such as IEC 62209-2 (2010)
[40] Such as the requirement to test using two fluids contrary to the requirements of IEC 62209-2 (2010)