

MOBILE & WIRELESS FORUM

Comments of the Mobile & Wireless Forum

In Response to the
U.S. Department of Health and Human Services
Request for Information on Electromagnetic Fields (EMFs),
Radiofrequency (RF) Radiation, and Wireless Radiation Exposure

Docket No. HHS-OASH-2026-0397
FR Doc. 2026-19252

I. RESPONSES TO HHS QUESTIONS

Questions 1 and 2: Identity, Credentials and Perspective of the Respondent

The Mobile & Wireless Forum (MWF) is an international trade association whose members are leading global manufacturers of mobile wireless devices. The MWF has long been engaged in sponsoring peer-reviewed research on radiofrequency (RF) health and safety and on the measurement of Specific Absorption Rate (SAR). The MWF website describes the numerous studies and research programs the MWF has sponsored in partnership with independent academic and scientific institutions.¹ The MWF is also a co-sponsor, with the GSM Association (GSMA) and the Australian Mobile Telecommunications Association (AMTA), of the EMF Explained information series.²

The MWF respectfully submits these comments in response to the Request for Information (RFI) published by the U.S. Department of Health and Human Services (HHS) on Electromagnetic Fields (EMFs), Radiofrequency (RF) Radiation, and Wireless Radiation Exposure.³ The MWF welcomes the opportunity to provide scientifically grounded information drawn from the substantial body of peer-reviewed literature on RF health and safety.

¹ See www.mwfai.org.

² See www.emfexplained.info.

³ U.S. Department of Health and Human Services, *Request for Information on Electromagnetic Fields (EMFs), Radiofrequency (RF) Radiation, and Wireless Radiation Exposure*, FR Doc. 2026-19252, Docket No. HHS-OASH-2026-0397 (published Sept. 21, 2026) (“RFI”).

Consistent with the RFI's instruction that respondents identify the basis of their submissions, the MWF states that these comments are based on peer-reviewed research, government reports, international scientific assessments, consensus standards documents, and industry data. Where the MWF relies on an existing exposure guideline, regulatory framework, or scientific assessment, that framework is identified specifically and the citation is provided. In submitting this scientific evidence, MWF recognizes that HHS's evaluation of this docket will be governed by federal data quality and scientific integrity mandates, including the HHS Scientific Integrity Policy⁴, the Information Quality Act⁵, OMB Information Quality Guidelines (67 FR 8452)⁶, and President Trump's Executive Order 14303⁷ ("Restoring Gold Standard Science"). Under E.O. 14303, federal agencies must ensure that regulatory decision-making is informed by research that is reproducible, transparent, structured for falsifiability of hypotheses, communicative of uncertainty, and subjected to unbiased peer review.⁸ As HHS reviews this record, these binding standards require the Department to distinguish verifiable empirical research from subjective sentiment and to evaluate evidence strictly through a disciplined "weight-of-the-evidence" framework. MWF is confident that the studies and other evidence presented in this submission meet this high standard.

The MWF submits these comments as an industry group representing equipment and product manufacturers of mobile wireless devices. The MWF also serves as a sponsor of independent research on RF health and safety and on SAR measurement methodology. These comments accordingly reflect the perspective of an international trade association and research-sponsoring organization with extensive knowledge of and experience with RF/EMF emissions, exposure assessment, and the relevant scientific literature.

Question 3: Public Experiences and Reported Potential Adverse Health Effects

Question 3 invites individuals, families, caregivers, healthcare professionals, and organizations to share personal health experiences. As an industry group and research entity rather than an individual consumer or healthcare provider, the MWF is not positioned to report personal health experiences.

⁴ *Final Scientific Integrity Policy of the U.S. Department of Health and Human Services*, 89 Fed. Reg. 106,526 (Dec. 30, 2024).

⁵ 44 U.S.C. § 3516 note (2012).

⁶ Guidelines for Ensuring and Maximizing the Quality, Objectivity, Utility, and Integrity of Information Disseminated by Federal Agencies, 67 Fed. Reg. 8452 (Feb. 22, 2002).

⁷ Exec. Order No. 14,303, 90 FR 22601 (2025).

⁸ *Id.*

The MWF respects the personal health experiences shared by individuals in this docket and does not question the reality or severity of the symptoms reported by individuals. The MWF strongly supports continued clinical research to identify the true cause of these conditions so that patients can receive effective medical management. However, the scientific literature provides essential context for evaluating the cause of these reports. The World Health Organization (WHO) has extensively reviewed the evidence and concluded that “EHS [Electromagnetic Hypersensitivity] has no clear diagnostic criteria and there is no scientific basis to link EHS symptoms to EMF exposure. Further, EHS is not a medical diagnosis, nor is it clear that it represents a single medical problem.”⁹ Double-blind provocation studies consistently have demonstrated that individuals reporting such sensitivity are unable to detect the presence or absence of RF fields better than chance at levels below exposure limits.¹⁰

While these symptoms are real, the established scientific record does not support RF exposure as their cause.

Question 4: Clinical and Research Observations

Question 4 invites healthcare professionals, researchers, and public health practitioners to describe clinical observations. The MWF is not a healthcare or clinical research institution and therefore does not offer observations of individual patients, nor does it respond to subparts 4(a) through 4(g), which call for information the MWF is not positioned to provide. The MWF does address below the broader research record bearing on (A) the systematic evaluation of the scientific literature undertaken by the two principal standards-setting bodies, and (B) whether any pattern of adverse health effects has been identified through the epidemiological research.

A. The Two Principal Exposure Standards and the Scientific Literature Each Evaluated

Two main exposure standards are used around the world: the IEEE exposure guidelines and the ICNIRP guidelines. Although there is some variation in how these are adopted at the national level, both are largely applied as promulgated by the standards bodies themselves. Each rests on a systematic evaluation of the published scientific literature,

⁹ See World Health Organization *Electromagnetic fields and public health: Electromagnetic hypersensitivity*, Backgrounder (2005, December) <https://www.who.int/teams/environment-climate-change-and-health/radiation-and-health/non-ionizing/hypersensitivity>; see also Fact Sheet No 296 at <https://www.elettra2000.it/phocadownload/fs296.pdf>.

¹⁰ See Rubin GJ, Nieto-Hernandez R, Wessely S, “Idiopathic environmental intolerance attributed to electromagnetic fields (formerly ‘electromagnetic hypersensitivity’): An updated systematic review of provocation studies,” *Bioelectromagnetics* 31(1):1–11 (2010); ICNIRP, “Guidelines for Limiting Exposure to Electromagnetic Fields (100 kHz to 300 GHz),” *Health Physics* 118(5):483–524 (2020) (“ICNIRP (2020)”), at 494 (reviewing the provocation study literature).

and the studies evaluated are identified within the standards documents. The scale of those evaluations is itself significant evidence bearing on Question 4, because it reflects a structured, repeated review of the entire research record for any reproducible pattern of adverse effect.

IEEE Exposure Guidelines. The IEEE Standards Association develops standards under a strict set of procedures administered by the IEEE Standards Board and accredited by the American National Standards Institute (ANSI). For the exposure guidelines, those procedures required the responsible committee — the IEEE International Committee on Electromagnetic Safety (ICES), Technical Committee 95 — to investigate the body of extant scientific studies in order to determine the exposure levels that would be safe for both the general public and occupationally exposed persons.¹¹ The studies evaluated are identified within the standards documents themselves:

IEEE Std C95.1-2005 (approved 2005; published 2006) identifies 1,143 papers in Annex F, its Literature Database, drawn from the International EMF Project (IEEE/WHO) database and cited in the standard, together with a further 144 bibliographic references in Annex G. Annex F expressly notes that the IEEE/WHO database contains additional papers that were reviewed and categorized as peripheral, and therefore not carried into the annex.¹²

IEEE Std C95.1-2019 identifies 1,550 references in Annex E, its Bibliography, with the supporting scientific analysis set out across Annex B (Rationale) and Annex C (Identification of levels of RF exposure responsible for adverse effects: Summary of the literature). Annex C addresses established effects, non-cancer-related studies, cancer-related studies, and reviews of the literature between 6 GHz and 300 GHz.¹³

The committee that prepared IEEE Std C95.1-2019 comprised more than one hundred named scientific and engineering participants drawn from academia, government, and industry across multiple countries, and the standard was subject to individual balloting and approval by the IEEE SA Standards Board on 8 February 2019.¹⁴ This is a transparent, multi-disciplinary, consensus-based process of a kind rarely matched in an environmental health standard setting.

¹¹ IEEE Std C95.1-2019, *IEEE Standard for Safety Levels with Respect to Human Exposure to Electric, Magnetic, and Electromagnetic Fields, 0 Hz to 300 GHz* (approved Feb. 8, 2019) (“IEEE Std C95.1-2019”), Introduction and Annex A (Approach to revision process).

¹² IEEE Std C95.1-2005, *IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz* (2006) (“IEEE Std C95.1-2005”), Annexes B, F and G.

¹³ *IEEE Std C95.1-2019*, Annexes B, C and E.

¹⁴ IEEE SA Standards Board, *Minutes of the IEEE SA Standards Board Meeting (Feb. 8, 2019)*.

ICNIRP Guidelines. ICNIRP is a non-governmental organization formally recognized by the WHO, and its guidelines are developed through a comparable process of systematic literature review followed by public consultation. The 2020 RF guidelines were accompanied by two appendices: Appendix A addressing dosimetry, and Appendix B addressing the biological and health effects reported in the literature, including cancer, reproductive and developmental effects, cognitive and neurological effects, cardiovascular effects, and electromagnetic hypersensitivity.¹⁵

B. The Epidemiological Record

The accumulated epidemiological literature on RF radiation and human health encompasses occupational cohort studies, general population case-control studies, and large prospective cohort studies. No study has established a causal association between RF exposure within current limits and an adverse health outcome. The principal studies include the following.

Motorola Employee Cohort Study (2000). Among the most carefully designed occupational investigations is the study of mortality from cancer of the brain and lymphatic/hematopoietic systems among workers at a major mobile phone manufacturer with potential occupational RF exposure. The study found no significant association between estimated RF exposure and mortality from either brain cancer or lymphatic/hematopoietic cancer.¹⁶

Interphone Study (2010). The multinational Interphone study, the largest case-control investigation of its kind, involved approximately 2,708 glioma cases, 2,409 meningioma cases, and matched controls across 13 countries. It found no overall increased risk of glioma or meningioma associated with mobile phone use.¹⁷

Danish Cohort Study (2011). A nationwide cohort of 358,403 Danish mobile phone subscribers followed for up to 18 years found no association between mobile phone subscription and the incidence of glioma, meningioma, or acoustic neuroma, including among individuals with mobile phone subscriptions for durations of 13 years or more.¹⁸

¹⁵ ICNIRP (2020), *Health Physics* 118(5):483–524, Appendices A and B.

¹⁶ Morgan RW, Kelsh MA, Zhao K, Exuzides KA, Heringer S, Negrete W, “Radiofrequency Exposure and Mortality from Cancer of the Brain and Lymphatic/Hematopoietic Systems,” *Epidemiology* 11(2):118–127 (Mar. 2000).

¹⁷ The Interphone Study Group, “Brain tumour risk in relation to mobile telephone use: results of the INTERPHONE international case-control study,” *International Journal of Epidemiology* 39(3):675–694 (2010).

¹⁸ Frei P, Poulsen AH, Johansen C, Olsen JH, Steding-Jessen M, Schüz J, “Use of mobile phones and risk of brain tumours: update of Danish cohort study,” *BMJ* 343:d6387 (2011).

Million Women Study (2013). This United Kingdom cohort of approximately 791,710 women found no elevated risk of glioma, meningioma, or non-central nervous system cancers associated with mobile phone use.¹⁹

COSMOS Prospective Cohort Study (2024). The COSMOS study enrolled 264,574 participants across multiple European countries and followed them prospectively for a median of over seven years, with exposure characterized in part through objective network operator records rather than participant recall. The study found no association between cumulative mobile phone call time and the risk of glioma, meningioma, or acoustic neuroma.²⁰

In addition to the epidemiological studies cited above, there is also a **WHO-Commissioned Systematic Review (2024–2025)**. Most recently, a systematic review commissioned by the WHO as part of its ongoing RF health risk assessment screened more than 5,000 publications spanning 1994 to 2022 and included 63 studies in its final analysis. The review found no association between mobile phone use and cancers of the head, including glioma, meningioma, and acoustic neuroma, and no association with leukemia or brain cancer from exposure to transmitters or occupational sources.²¹

Consistent with these individual findings, national cancer surveillance data in countries with decades of widespread mobile phone use have not shown the increases in brain tumor incidence that would be expected if mobile phone RF exposure were causally associated with cancer.²² The U.S. National Cancer Institute reports that “incidence rates

¹⁹ Benson VS, Pirie K, Schüz J, Reeves GK, Beral V, Green J, “Mobile phone use and risk of brain neoplasms and other cancers: prospective study,” *International Journal of Epidemiology* 42(3):792–802 (2013).

²⁰ Feychting M, Schüz J, Toledano MB, et al., “Mobile phone use and brain tumour risk — COSMOS, a prospective cohort study,” *Environment International* 185:108552 (Mar. 2024).

²¹ Karipidis K, Baaken D, Loney T, et al., “The effect of exposure to radiofrequency fields on cancer risk in the general and working population: A systematic review of human observational studies — Part I: Most researched outcomes,” *Environment International* 191:108983 (2024); Part II: Less researched outcomes, *Environment International* 196:109274 (2025).

²² See Little MP, Rajaraman P, Curtis RE, Devesa SS, Inskip PD, Check DP, Linet MS, “Mobile phone use and glioma risk: comparison of epidemiological study results with incidence trends in the United States,” *BMJ* 344:e1147 (2012), doi:10.1136/bmj.e1147 (projecting expected glioma rates in 12 U.S. SEER registries for 1992–2008 from U.S. per-capita mobile phone subscription data and reported relative risks, and finding observed rates stable and inconsistent with the higher risk estimates reported in the Swedish case-control series); Inskip PD, Hoover RN, Devesa SS, “Brain cancer incidence trends in relation to cellular telephone use in the United States,” *Neuro-Oncology* 12(11):1147–1151 (2010), doi:10.1093/neuonc/noq077; Zhang L, Muscat JE, “Trends in Malignant and Benign Brain Tumor Incidence and Mobile Phone Use in the U.S. (2000–2021): A SEER-Based Study,” *International Journal of Environmental Research and Public Health* 22(6):933 (2025), doi:10.3390/ijerph22060933 (SEER 22 data for 2000–2021, against an approximately 1,200-fold increase in mobile phone subscriptions); Deltour I, Auvinen A, Feychting M, Johansen C, Klaeboe L, Sankila R, Schüz J, “Mobile phone use and incidence of glioma in the Nordic countries 1979–2008: consistency check,” *Epidemiology* 23(2):301–307 (2012), doi:10.1097/EDE.0b013e3182448295; Deltour I, Poulsen AH, Johansen C, Feychting M, Johannesen TB,

of brain and other central nervous system cancers have remained stable” despite the increase in cell phone use and concludes that “evidence to date suggests that cell phone use does not cause brain or other kinds of cancer in humans.”²³

In response to subpart 4(m), which asks for recommendations regarding future research or surveillance, the MWF's recommendations are set out in its responses to Questions 16 and 17 below.

Question 5: Existing National and International Exposure Standards, Guidelines, and Regulatory Frameworks

Federal health agencies should consider the following frameworks, each of which rests on a documented review of the peer-reviewed scientific literature:

IEEE Std C95.1-2019. “IEEE Standard for Safety Levels with Respect to Human Exposure to Electric, Magnetic, and Electromagnetic Fields, 0 Hz to 300 GHz,” developed by IEEE ICES Technical Committee 95 and approved by the IEEE SA Standards Board on 8 February 2019. As described in response to Question 4, the standard identifies 1,550 references in its bibliography and sets out its scientific rationale across Annexes B and C.

IEEE Std C95.1-2005, as amended by IEEE Std C95.1a-2010. The predecessor standard, which identifies 1,143 papers in its Annex F Literature Database. The 2010 amendment specified ceiling values for induced and contact current and clarified the distinction between localized exposure and spatial peak power density; it did not alter the SAR limits.²⁴

Auvinen A, Schüz J, “Time trends in mobile phone use and glioma incidence among males in the Nordic countries, 1979–2016,” *Environment International* 168:107487 (2022), doi:10.1016/j.envint.2022.107487; Karipidis K, Elwood M, Benke G, Sanagou M, Tjong L, Croft RJ, “Mobile phone use and incidence of brain tumour histological types, grading or anatomical location: a population-based ecological study,” *BMJ Open* 8(12):e024489 (2018), doi:10.1136/bmjopen-2018-024489. These are incidence-trend (ecological) analyses, which cannot by themselves establish or exclude causation. The MWF reports the bounds of the inference as the authors state them: the observed trends are incompatible with the larger risk estimates reported in certain case-control studies, while smaller effects, or effects with induction periods longer than those observable to date, are not excluded. See Deltour et al. (2022) (observed trends consistent with no measurable effect of mobile phone use on glioma risk for the technologies and exposure levels studied, with risks below approximately 8 percent and latencies beyond 20 years not excluded).

²³ National Cancer Institute, *Cell Phones and Cancer Risk Fact Sheet*, available at www.cancer.gov/about-cancer/causes-prevention/risk/radiation/cell-phones-fact-sheet.

²⁴ IEEE Std C95.1a-2010, Amendment 1 to IEEE Std C95.1-2005, Abstract.

ICNIRP 2020 Guidelines. ICNIRP, “Guidelines for Limiting Exposure to Electromagnetic Fields (100 kHz to 300 GHz),” superseding the 1998 guidelines for this frequency range.²⁵

FCC RF Exposure Regulations. The FCC's RF exposure limits are codified at 47 C.F.R. § 1.1310 and applied to portable and mobile devices through 47 C.F.R. §§ 2.1091 and 2.1093. As the regulation itself states, these limits are based upon ANSI/IEEE Std C95.1-1992 and NCRP Report No. 86, “Biological Effects and Exposure Criteria for Radiofrequency Electromagnetic Fields” (1986).²⁶

International Adoption and the Case for Harmonization

The majority of countries around the world have adopted the ICNIRP guidelines, either directly or as the basis for national regulation, and the ICNIRP guidelines are formally endorsed by the WHO. Within the European Union, Council Recommendation 1999/519/EC adopts the ICNIRP basic restrictions and reference levels for all Member States.²⁷

For localized exposure of the head and torso, the ICNIRP guidelines set a general public limit of 2.0 W/kg averaged over 10 grams of tissue.²⁸ The current IEEE standard sets an identical limit: IEEE Std C95.1-2019, Table 5, specifies a dosimetric reference limit for local exposure of the head and torso of 2 W/kg, averaged over any 10 g of tissue in the shape of a cube, for persons in unrestricted environments.²⁹

The FCC, however, continues to apply the older and numerically more restrictive value carried forward from ANSI/IEEE Std C95.1-1992: a peak spatial-average SAR of 1.6 W/kg averaged over any 1 gram of tissue for general population/uncontrolled exposure.³⁰ That value has not been the IEEE's position for more than twenty years. IEEE Std C95.1-2005 expressly changed the peak spatial-average SAR values “from 1.6 W/kg and 8 W/kg for exposure of the public and exposures in controlled environments to 2 W/kg and 10 W/kg, respectively,” and changed the tissue-averaging mass “from 1 g to 10 g.”³¹ The standard explains that this change was “based on the scientific considerations explained in C.2.2.2 and was also influenced by the desire to harmonize the basic restrictions with ICNIRP where scientifically justified,” and that the 10 g averaging mass rests on “the

²⁵ ICNIRP (2020), *Health Physics* 118(5):483–524.

²⁶ 47 C.F.R. § 1.1310.

²⁷ Council Recommendation 1999/519/EC of 12 July 1999 on the limitation of exposure of the general public to electromagnetic fields (0 Hz to 300 GHz), 1999 O.J. (L 199) 59.

²⁸ ICNIRP (2020), *Health Physics* 118(5):483, Table 4.

²⁹ IEEE Std C95.1-2019, Table 5.

³⁰ 47 C.F.R. § 1.1310(c).

³¹ IEEE Std C95.1-2005, cl. C.1.

biologically based rationale of ICNIRP related to exposure of the eyes and extensive theoretical biophysical research quantifying RF energy penetration in biological tissue.”³² IEEE Std C95.1-2019 retained that limit and explained that the change is supported by research showing that RF energy compliant with the standard “is incapable of causing significant local temperature increases in small tissue volumes within the body.”³³

The result is that the United States regulates localized RF exposure from wireless devices by reference to a 1992 consensus standard that its own issuing body superseded in 2005 and again in 2019, and that diverges from the limit applied by most of the rest of the world. Adoption of the current, science-driven limit — 2.0 W/kg averaged over 10 grams of tissue, as set by both IEEE Std C95.1-2019 and ICNIRP (2020) — would materially improve the assessment, disclosure, and regulation of RF exposure from wireless devices. It would align U.S. requirements with the prevailing international framework, reduce unnecessary divergence in compliance testing, and ensure that the federal limit reflects the current understanding of the relationship between SAR, tissue temperature, and adverse effect thresholds rather than the dosimetric assumptions of three decades ago.

Question 5(n): Scientific, Technical, or Regulatory Changes to Improve Assessment, Disclosure, and Regulation

The existing clear institutional division of responsibilities continues to best serve the public interest. The role of health agencies (such as the FDA and NIH) should be to continue to conduct comprehensive human health risk assessments based on the totality of peer-reviewed evidence. The role of the FCC – as well as of standards and guidelines development organizations (such as the IEEE and ICNIRP) – should be to continue to be informed by such assessments and then translate them into objective, repeatable, and quantifiable engineering standards and certification procedures. Finally, manufacturers and accredited laboratories must verify and demonstrate product compliance against those codified engineering metrics.

With regard to the current standard for RF exposure, the MWF does not believe that the protective adequacy of the current federal framework is in doubt. The FCC's limits incorporate substantial safety margins and have not been shown to permit any established adverse health effect, for the reasons and on the authorities set out in the MWF's responses to Questions 6 and 12 below. The MWF recommends the following changes, each directed at aligning federal requirements with current science rather than at increasing stringency:

³² *Id.*

³³ *IEEE Std C95.1-2019*, cl. B.1.1.

(1) Adopt the current science-based localized SAR limit. While the FCC's current localized limit of 1.6 W/kg over 1 g is highly conservative and fully protective of public health, HHS should support future interagency efforts to harmonize federal rules with current global standards. The FCC should eventually adopt the limit of 2.0 W/kg averaged over 10 g of tissue established by IEEE Std C95.1-2019 and ICNIRP (2020). This would align U.S. requirements with the prevailing international framework and reduce unnecessary divergence in compliance testing without compromising safety.

(2) Maintain currency with international measurement standards. Compliance testing methodologies should remain aligned with the current internationally harmonized measurement standards, principally IEC/IEEE 62209-1528:2020 and IEC/IEEE 63195-1:2022 and 63195-2:2022 for absorbed power density above 6 GHz.³⁴ Updates to these standards should be reflected promptly in federal compliance requirements.

(3) Ensure accurate public health communication. Federal RF/EMF communications should be consistent with the conclusions of the WHO, ICNIRP, and IEEE ICES, and should not overstate scientific uncertainty in ways that create unwarranted public concern regarding technologies that deliver substantial public health, safety, and economic benefits.

Question 5(o): Additional Research on Minimizing Exposure and Evaluating Exposure Standards

Given the volume of research already conducted, additional work should be undertaken only where a well-defined scientific question remains open. The MWF does not identify any deficiency in the current exposure limits that would require a broad new research program to justify their adequacy. The IEEE and ICNIRP frameworks are each subject to periodic review — IEEE standards are reviewed at least every ten years — which is the appropriate mechanism for revision as evidence accumulates.³⁵

One targeted area where further work could resolve specific questions is the refinement of exposure assessment methods for epidemiological research, so that individual exposure can be characterized more accurately than by participant recall.

³⁴ IEC/IEEE 62209-1528:2020, “Measurement procedure for the assessment of specific absorption rate of human exposure to radio frequency fields from handheld and body-worn wireless communication devices”; IEC/IEEE 63195-1:2022 and IEC/IEEE 63195-2:2022.

³⁵ IEEE Std C95.1-2019, “Updating of IEEE Standards documents.”

Question 5(p): Classification Systems and Exposure-Related Characteristics

The exposure-related characteristics listed in Question 5(p) are precisely the characteristics that the IEEE and ICNIRP frameworks already address in establishing their limits and reference levels.

SAR is the established dosimetric quantity for assessing localized energy absorption from devices used at or near the body, and it integrates the effects of operating frequency, radiated power, tissue dielectric properties, and proximity to the source. For frequencies between 100 kHz and 6 GHz, IEEE Std C95.1-2019 expresses its dosimetric reference limits in terms of whole-body average SAR and peak spatial-average SAR.³⁶ Above 6 GHz, where energy deposition is confined to superficial tissue, the standard shifts to epithelial power density, set at 20 W/m² for persons in unrestricted environments, averaged over any 4 cm² of body surface.³⁷ ICNIRP (2020) adopts the corresponding approach using absorbed power density above 6 GHz, which is an equivalent metric to epithelial power density. This frequency-dependent structure directly addresses operating frequency, power density, field strength, distance from source, and proximity to the body.

Modulation, pulse characteristics, and duty cycle. The scientific evidence does not support a conclusion that pulsed or modulated signals pose health risks different from continuous-wave signals of equivalent time-averaged power at levels below the applicable limits. Both IEEE and ICNIRP examined this question directly and incorporated specific provisions for brief and pulsed exposures rather than a separate limit structure. ICNIRP (2020) added restrictions applying to exposures of less than six minutes at frequencies of 400 MHz and above, specifically to address technologies that operate with short pulses. IEEE Std C95.1-2019 addresses the same considerations in its treatment of averaging time and special considerations.³⁸

Beamforming and simultaneous multi-frequency exposure. IEEE Std C95.1-2019 and ICNIRP address exposure to multiple simultaneous sources, requiring that compliance be determined by summing the percentages of the applicable exposure reference levels that each frequency contributes and ensuring the total does not exceed 100 percent, consistent with IEC/TR 62630.³⁹ This is a rigorous and already-operative treatment of aggregate exposure across sources and frequencies.

Cumulative exposure over time. Time-averaging is built into the limits themselves: SAR is averaged over 30 minutes for whole-body exposure and six minutes for local

³⁶ *IEEE Std C95.1-2019*, Table 5.

³⁷ *Id.*, Table 6.

³⁸ *IEEE Std C95.1-2019*, Annex B, cl. B.6 (Averaging time) and cl. B.7 (Special considerations).

³⁹ *Id.*, cl. 4.3.2 and Annex D, cl. D.2 (Multifrequency exposures).

exposure.⁴⁰ Cumulative exposure over years has been examined epidemiologically — most directly by the COSMOS study, which analyzed cumulative call time over a median of more than seven years of prospective follow-up and found no association with brain tumor risk.⁴¹

The MWF accordingly recommends that any classification system be grounded in the established physical and biological science reflected in IEEE Std C95.1-2019 and ICNIRP (2020), and that speculative or unvalidated exposure metrics not be introduced absent evidence that they correspond to a mechanism of biological effect.

Question 6: Scientific Evidence Regarding Potential Adverse Health Effects at Current Exposure Limits

There is no credible, replicated scientific evidence that RF/EMF exposure at or below the current federal exposure limits causes adverse health effects in humans. That consistent conclusion has been reached by each of the bodies that has systematically reviewed the evidence:

WHO: “Based on a recent in-depth review of the scientific literature, the WHO concluded that current evidence does not confirm the existence of any health consequences from exposure to low level electromagnetic fields.”⁴²

ICNIRP: The 2020 Guidelines, following review of the published literature on biological and health effects across 100 kHz to 300 GHz, concluded that adherence to the guidelines protects against all substantiated adverse health effects from RF EMF exposure.⁴³

IEEE: IEEE Std C95.1-2019 states that its limits “protect against established adverse health effects in humans associated with exposure to electric, magnetic, and electromagnetic fields in the frequency range of 0 Hz to 300 GHz,” and that the standard “incorporates a large margin of safety.”⁴⁴

SCHEER: The European Commission's Scientific Committee on Health, Environmental and Emerging Risks found in its 2023 Opinion no established adverse health effects from RF exposure below the EU exposure limits, stating that it “could not identify moderate or strong level of evidence for adverse health effects resulting from chronic or acute RF EMF exposure from existing

⁴⁰ *Id.*, Table 5, n.a.

⁴¹ Feychting et al., *Environment International* 185:108552 (2024).

⁴² World Health Organization, *Radiation: Electromagnetic fields*, Questions and Answers, available at <https://www.who.int/news-room/questions-and-answers/item/radiation-electromagnetic-fields>.

⁴³ ICNIRP (2020), *Health Physics* 118(5):483.

⁴⁴ *IEEE Std C95.1-2019*, cl. 1.1 and cl. B.1.1.

technology at levels below the limits set in the annexes” of Council Recommendation 1999/519/EC and Directive 2013/35/EU.⁴⁵

National Cancer Institute: “[E]vidence to date suggests that cell phone use does not cause brain or other kinds of cancer in humans.”⁴⁶

FDA: The agency has concluded that “the current safety limits for cell phone radiofrequency energy exposure remain acceptable for protecting the public health.”⁴⁷

Swedish Radiation Safety Authority (SSM): SSM’s Scientific Council on Electromagnetic Fields publishes an annual review of the science. In its 20th Report it found: “No new established causal relationships between EMF exposure and health risk have been identified.”⁴⁸

Norwegian Institute of Public Health (FHI): FHI's umbrella review, *Weak radio-frequency electromagnetic fields and health effects – an umbrella review*, concluded: “The main finding of this report is that no clear effects of RF-EMF exposure below established limit values have been demonstrated with respect to tumor risk, reproduction and development, brain function, or other physiological functions, nor for self-reported symptoms such as pain, discomfort, or hypersensitivity. ... Furthermore, no new evidence has emerged regarding mechanisms for health-relevant biological effects of low-level RF-EMF exposure, apart from tissue heating. ... Consequently, there is no scientific basis for recommending a reduction of current exposure limits or for implementing specific new measures to reduce exposure to radiofrequency electromagnetic fields.”⁴⁹

French Agency for Food, Environmental and Occupational Health & Safety (ANSES): ANSES's updated expert appraisal on radiofrequencies and cancer,

⁴⁵ Scientific Committee on Health, Environmental and Emerging Risks (SCHEER), *Final Opinion on the need of a revision of the annexes in Council Recommendation 1999/519/EC and Directive 2013/35/EU, in view of the latest scientific evidence available with regard to RF (100 kHz – 300 GHz)*, at 2, 7 (adopted by written procedure Apr. 18, 2023), available at health.ec.europa.eu/system/files/2023-06/scheer_o_044.pdf.

⁴⁶ NCI, *Cell Phones and Cancer Risk Fact Sheet*.

⁴⁷ FDA, *Review of Published Literature between 2008 and 2018 of Relevance to Radiofrequency Radiation and Cancer* (Feb. 2020) (“FDA 2020 Review”).

⁴⁸ Swedish Radiation Safety Authority (SSM), *Recent Research on Electromagnetic Fields and Health Risk: Twentieth Report from SSM's Scientific Council on Electromagnetic Fields, 2025*, Report No. 2026:03 (Feb. 2, 2026), available at www.stralsakerhetsmyndigheten.se/en/publications/reports/radiation-protection/2026/202603/.

⁴⁹ Pham TA, Eide DM, *Svake radiofrekvente elektromagnetiske felt (100 kHz – 300 GHz) og helseeffekter – en paraplyoversikt* [Weak radio-frequency electromagnetic fields (100 kHz – 300 GHz) and health effects – an umbrella review] (Norwegian Institute of Public Health, Jan. 26, 2026), ISBN 978-82-8406-528-1, English Summary, available at www.fhi.no/contentassets/5d0b05aea9cd4d6cbdd4e90d13a4ae36/emf-rapport-2026.pdf.

which considered almost a thousand studies published since its 2013 and 2016 assessments, “concluded that no causal link could be established between exposure to radiofrequency waves and the development of cancer,” and found that “epidemiological studies have provided no convincing evidence of the development of cancer in humans.”⁵⁰

The National Toxicology Program (NTP)⁵¹ and Ramazzini Institute⁵² studies

The MWF is aware that the rodent studies conducted by the National Toxicology Program (NTP) and associated findings by the Ramazzini Institute are sometimes cited as evidence of health risk and addresses them directly. The NTP studies exposed rats and mice to whole-body RF at SAR levels of 1.5 to 6 W/kg for rats and 2.5 to 10 W/kg for mice, applied for approximately nine hours per day over two years — exposures far above, and of a duration and character unlike, human exposure from wireless devices. The findings were not representative of real-world exposure conditions, and the exposed animals in several groups exhibited longer survival than controls, a pattern inconsistent with a carcinogenic effect. Although the Ramazzini study utilized a different (far-field, lifetime) exposure methodology it yielded results subject to similar criticisms and statistical problems, as noted below.⁵³

Importantly, the FDA, which nominated the NTP studies, reviewed the results and concluded that they “should not be applied to human cell phone usage” and that the agency's review of the broader literature did not support a change to the existing exposure limits.⁵⁴ ICNIRP reached the same conclusion for all of these studies, finding that neither

⁵⁰ ANSES, *Radiofréquences et cancer: Connaître, évaluer, protéger*, Avis de l'Anses, Rapport d'expertise collective, Saisine No. 2016-SA-0176 (Oct. 2025), available at www.anses.fr/system/files/AP2016-SA-0176-RA.pdf; ANSES, *Exposure to waves: new studies provide more insights into the risk of cancer* (Nov. 26, 2025), available at www.anses.fr/en/content/exposure-waves-new-studies-provide-more-insights-risk-cancer.

⁵¹ *Toxicology and Carcinogenesis Studies in HSD: Sprague Dawley SD Rats Exposed to Whole-Body Radio Frequency Radiation at a Frequency (900 MHz) and Modulations (GSM and CDMA) Used by Cell Phones*, Nat'l Toxicology Program, U.S. Dep't of Health & Human Servs., NTP TR 595 (2018); *Toxicology and Carcinogenesis Studies in B6C3F1/N Mice Exposed to Whole-Body Radio Frequency Radiation at a Frequency (1,900 MHz) and Modulations (GSM and CDMA) Used by Cell Phones*, Nat'l Toxicology Program, U.S. Dep't of Health & Human Servs., NTP TR 596 (2018).

⁵² L. Falcioni et al., *Report of Final Results Regarding Brain and Heart Tumors in Sprague-Dawley Rats Exposed from Prenatal Life Until Natural Death to Mobile Phone Radiofrequency Field Representative of a 1.8 GHz GSM Base Station Environmental Emission*, 119 Env't Int'l 434 (2018).

⁵³ See note 55, *infra*.

⁵⁴ FDA, Statement from Jeffrey Shuren, M.D., J.D., Director of the FDA's Center for Devices and Radiological Health, on the National Toxicology Program's report on radiofrequency energy exposure (Nov. 1, 2018); FDA 2020 Review.

the NTP nor Ramazzini results provide a consistent, reliable basis for revising the exposure guidelines.⁵⁵

Most significantly, the NTP findings have now been tested directly, and they did not replicate. Under the International Collaborative Animal Study, research teams in the Republic of Korea and Japan conducted parallel two-year studies designed to verify the key NTP findings.⁵⁶ Neither study found a statistically significant change in tumor incidence, and neither found evidence of DNA damage or chromosomal aberrations in exposed animals. The Korean investigators concluded that “long-term exposure to CDMA-modulated 900 MHz RF was neither carcinogenic nor genotoxic at a SAR of 4 W/kg in male rats,” and the Japanese investigators that “long-term exposure to 900 MHz RF-EMFs did not produce reproducible carcinogenic or genotoxic effects in male rats.”⁵⁷ The Australian Radiation Protection and Nuclear Safety Agency (ARPANSA), reviewing the two studies, described their findings as “remarkably consistent and in contrast to the NTP study,” and stated that “[t]he results of this Japan–Korea collaborative research do not substantiate the results previously reported by the NTP study.”⁵⁸

In efforts to probe the NTP findings by the German Office for Radiation Protection (BfS) and by a recent study⁵⁹ the researchers have arrived at similar conclusions: the findings likely were caused by overheating of the animals due to the RF exposure method.⁶⁰ As expressed by BfS:

With the high whole-body exposures, it cannot be ruled out that thermal stress – with body temperature increases that occur above

⁵⁵ ICNIRP, “Note on Recent Animal Carcinogenesis Studies” (2019), available at www.icnirp.org.

⁵⁶ Kim HS, Han K-H, Kim Y-B, Jeon SB, Lee A-K, Moon J-I, Choi HD, Imaida K, Yokohira M, Kawabe M, Imai N, Wang J, Ahn YH, “The International Collaborative Animal Study of the carcinogenicity and genotoxicity of mobile phone radiofrequency radiation: the Korean study,” *Toxicological Sciences* 209(3):kfag001 (2026), doi:10.1093/toxsci/kfag001; Imaida K, Kawabe M, Wang J, Yokohira M, Imai N, Han K-H, Kim Y-B, Jeon SB, Kim HS, Ahn YH, “The International Collaborative Animal Study of mobile phone radiofrequency radiation carcinogenicity and genotoxicity: the Japanese study,” *Toxicological Sciences* 209(3):kfag002 (2026), doi:10.1093/toxsci/kfag002. Both studies are indexed in the EMF-Portal at www.emf-portal.org/en/article/61927 and www.emf-portal.org/en/article/61890.

⁵⁷ Kim et al., *Toxicological Sciences* 209(3):kfag001 (2026); Imaida et al., *Toxicological Sciences* 209(3):kfag002 (2026).

⁵⁸ ARPANSA, *Korean and Japanese studies agree that radiofrequency exposure does not cause cancer in rats* (Jan. 2026), available at www.arpansa.gov.au/korean-and-japanese-studies-agree-radiofrequency-exposure-does-not-cause-cancer-rats.

⁵⁹ See A. Faraone et al., “A Monte Carlo Computational Framework Yielding Optimal RF-Dose Bounding for Rodent Bioassays Conducted in Reverberation Chambers,” in *IEEE Access*, doi: 10.1109/ACCESS.2026.3741073.

⁶⁰ *Id.*; Bundesamt für Strahlenschutz [BfS] [Federal Office for Radiation Protection], *Annex 3: Thermoregulatory stress as a possible cause for findings in the NTP main study* (Dec. 18, 2025), <https://www.bfs.de/EN/bfs/science-research/emf/statements/ntp-study/thermal-causes.html>.

the limit values and are known to lead to health effects – led to the striking results, especially in male rats.

The whole-body exposures used in the animal experiments are about 20 times (and more) above the limit value for whole-body exposures of the general population. They therefore cannot be compared to the cell phone exposures that occur in people's everyday lives⁶¹.

Further, the most recent computational dosimetry conducted by experts supports the thermoregulatory stress hypothesis by BfS.⁶²

In sum, the principal animal evidence cited in support of a carcinogenic effect has been reviewed and found unpersuasive by the cognizant expert groups as well as been subjected to independent replication that failed to reproduce the findings of adverse health effects.

Question 7: Scientific Methods for Characterizing Individual and Population-Level RF Radiation Exposure

A mature and internationally standardized suite of methods is available:⁶³

SAR measurement. For devices used at or near the body, SAR is assessed under IEC/IEEE 62209-1528:2020, which consolidated the former IEC 62209-1/-2 and IEEE Std 1528 procedures into a single international standard. The procedure uses validated tissue-simulating liquids, standardized anthropomorphic phantoms, and calibrated vector electric-field probes. Compliance is verified by accredited laboratories before a device may be marketed. For frequencies above 6 GHz, absorbed power density is assessed under IEC/IEEE 63195-1:2022 (measurement) and IEC/IEEE 63195-2:2022 (computational).

Field strength and power density measurement. Ambient RF fields from infrastructure sources are characterized using broadband and frequency-selective instruments calibrated

⁶¹ Bundesamt für Strahlenschutz [BfS] [Federal Office for Radiation Protection], *Technical Statement of the Federal Office for Radiation Protection on the Results of the NTP Study* (Dec. 18, 2025), <https://www.bfs.de/EN/bfs/science-research/emf/statements/ntp-study/ntp-statement.html>.

⁶² See note 59, *supra*.

⁶³ In addition to the methods described in the text, two further methods support research use. *Personal exposure meters.* Wearable multi-band dosimeters measure an individual's time-averaged exposure across daily activity and have been validated and deployed in population exposure surveys in numerous countries, permitting characterization of the distribution of exposure within a population rather than at a single point. *Operator network records.* For epidemiological research, objective records of call time and transmitted power held by network operators provide exposure information free of recall bias. This approach was used in the COSMOS study. Feychting et al., *Environment International* 185:108552 (2024).

to national metrology standards, under procedures including IEEE Std C95.3-2021 and IEC 62232:2025⁶⁴ for determination of RF field strength in the vicinity of base stations.⁶⁵

Computational dosimetry. Finite-difference time-domain and finite-element methods applied to anatomically realistic voxel human models permit detailed simulation of energy deposition. IEEE Std C95.1-2019 notes that improvements in numerical and measurement dosimetry have materially increased knowledge of the SAR–temperature relationship, which it describes as essential to assessing potential biological and health effects.⁶⁶ For base-station assessment, IEC 62232:2025 provides comprehensive methods for determining RF field strength, power density, and SAR in the proximity of base stations.

Question 8: Improvements in Exposure Assessment Methodologies

The existing methodologies are mature and validated. The MWF identifies the following as areas where incremental improvement would benefit research:

- (1) Smaller, lighter dosimeters with comprehensive frequency coverage, including the bands used for 5G, would facilitate deployment in large prospective cohorts and improve recall-based exposure characterization.⁶⁷
- (2) Greater international harmonization of dosimeter calibration and exposure survey methodology would improve comparability across multinational studies.
- (3) Ongoing development of anatomical models, including models representing children and other body types, could improve the accuracy of compliance assessment across the user population.

The MWF has not found any fundamental deficiency in existing exposure assessment methodology that would undermine confidence in current compliance determinations or in the existing epidemiological record, given that they are already extremely conservative. For example, to demonstrate compliance with SAR limits, devices are tested under laboratory conditions according to IEC/IEEE 62209-1528:2020, which prescribes the testing positions and all operational characteristics of the device, including testing using the maximum possible transmit power. This built-in conservatism is further reinforced by the standardized physical test models mandated by international standards (IEC/IEEE 62209-1528) and FCC rules. The Specific Anthropomorphic Mannequin (SAM) phantom used in compliance certification is geometrically derived from

⁶⁴ Int'l Electrotechnical Comm'n, *IEC 62232:2025, Determination of RF field strength, power density and SAR in the vicinity of base stations for the purpose of evaluating human exposure* (4th ed. 2025).

⁶⁵ IEEE Std C95.3-2021, *IEEE Recommended Practice for Measurements and Computations of Electric, Magnetic, and Electromagnetic Fields with Respect to Human Exposure to Such Fields, 0 Hz to 300 GHz*; IEC 62232:2025.

⁶⁶ *IEEE Std C95.1-2019*, cl. B.1.1.

⁶⁷ The MWF has supported work in this area, including through its participation in the COSMOS study.

anthropometric surveys of U.S. military personnel to represent the upper 90th percentile of adult human head dimensions. By utilizing an envelope representing the largest 10% of adult heads, the SAM model provides an intrinsically conservative absorption boundary that accommodates the entire population, including children and smaller adults.⁶⁸ Extensive multi-laboratory validation studies demonstrate that standardized testing with the SAM phantom produces a higher peak spatial-average SAR than that absorbed by actual anatomical adult and child heads.⁶⁹

In addition, the tissue-equivalent liquids filled inside the SAM shell are deliberately formulated with homogeneous dielectric parameters (permittivity and conductivity) engineered to overestimate RF energy absorption relative to actual layered human head anatomy. While real human heads contain protective, low-water-content outer layers—such as subcutaneous fat and skull bone—that attenuate RF fields before they reach brain tissue, standardized phantom fluids mimic high water content tissue throughout, ensuring that compliance measurements reflect an overestimate of real-world absorption.⁷⁰

The use of such “worst case” parameters, especially the use of the maximum possible transmit power, results in SAR values significantly above real-world exposure levels. In reality, devices operate at significantly lower power levels, constantly adapting to use the minimum transmit time and power required to make and maintain a connection to maximize battery life and efficiency. Additionally, many current devices utilize proximity sensors that cap the maximum transmit power when the device is close to the user’s body. Several studies⁷¹ of mobile phones in everyday use around the world have shown that phones typically operate at a very small fraction of the phone’s maximum power output.

Base-station exposure assessments apply a similarly conservative approach. They assume operation at maximum transmit power and maximum traffic load, although such conditions are not generally required or sustained in practice. For antennas capable of dynamically directing signals toward users, further efficiency is possible by allocating

⁶⁸ Wolfgang Kainz et al., *Dosimetric Comparison of the Specific Anthropomorphic Mannequin (SAM) to 14 Anatomical Head Models Using a Novel Definition for the Mobile Phone Positioning*, 50 *Phys. Med. Biol.* 3423 (2005). <https://pmc.ncbi.nlm.nih.gov/articles/PMC5839323/>

⁶⁹ Brian B. Beard et al., *Comparisons of Computed Mobile Phone Induced SAR in the SAM Phantom to That in Anatomically Correct Models of the Human Head*, 48 *IEEE Trans. Electromagn. Compat.* 397 (2006). <https://pmc.ncbi.nlm.nih.gov/articles/PMC5837060/>

⁷⁰ Int’l Telecomm. Union, *Radiofrequency electromagnetic field (RF-EMF) exposure levels from mobile and portable devices during different conditions of use*, ITU-T Recommendation K.Suppl.13 (Dec. 2021). <https://www.itu.int/epublications/publication/itu-t-k-suppl-13-2021-12-radiofrequency-electromagnetic-field-rf-emf-exposure-levels-from-mobile-and-portable-devices-during-different-conditions-of-u>

⁷¹ Joshi P, Colombi D, Thors B, Larsson LE, Törnevik C, “Output Power Levels of 4G User Equipment and Implications on Realistic RF EMF Exposure Assessments,” *IEEE Access* 5:4545–4550 (2017), doi:10.1109/ACCESS.2017.2682422; Persson T, et al., “Output power distributions of terminals in a 3G mobile communication network,” *Bioelectromagnetics* 33:320–325 (2012); Jovanovic D, et al., “Mobile telephones: A comparison of radiated power between 3G VoIP calls and 3G VoCS calls,” *Journal of Exposure Science and Environmental Epidemiology* 25:80–83 (2015).

signals dynamically to users where and when needed rather than transmitted continuously across the entire coverage area.⁷²

Question 9: Technical and Exposure-Related Information for Disclosure

The FCC's regulations distinguish two exposure categories, with corresponding disclosure obligations: general population/uncontrolled exposure, which covers consumers, and occupational/controlled exposure, which covers workers.⁷³ Occupational exposure limits apply to situations in which persons are exposed as a consequence of their employment, provided those persons are fully aware of the potential for exposure and can exercise control over their exposure.⁷⁴ Under the regulatory framework, site operators must utilize proactive labels, physical barriers, and color-coded signage to ensure occupational safety, while visual advisories are required for occupational devices.⁷⁵ For wireless infrastructure, operators are required to demonstrate compliance with the applicable exposure limits before deployment.⁷⁶

For the general public – including consumers – the FCC requires that RF exposure be kept within the stricter limits set out in 47 CFR § 1.1310(c). Consumers can obtain SAR information for their devices from multiple sources, including: the FCC Equipment Authorization System database,⁷⁷ the MWF website,⁷⁸ the mobile phone itself,⁷⁹ and manufacturers' users guides.⁸⁰

The MWF supports accurate and transparent disclosure of information that is scientifically meaningful to its intended audience. The key to making SAR data

⁷² Because 5G base stations dynamically direct narrow traffic beams toward individual user equipment rather than broadcasting uniformly, the broad geographical measurement approach drastically overestimates real-world exposure. To resolve this, the Actual Maximum Approach (per IEC 62232) shifts the evaluation focus to realistic, time-averaged transmission levels during live operations.

⁷³ See 47 C.F.R. § 1.1310 (setting separate limits for general population/uncontrolled and occupational/controlled exposure, the latter applying to persons exposed as a consequence of their employment who are fully aware of the potential for exposure and can exercise control over it).

⁷⁴ *Id.*

⁷⁵ See 47 C.F.R. § 1.1307(b)(4)(vi); 47 C.F.R. § 2.1093(d)(5).

⁷⁶ 47 C.F.R. § 1.1307(b).

⁷⁷ <https://www.fcc.gov/engineering-technology/laboratory-division/general/equipment-authorization>.

⁷⁸ www.mwfai.org.

⁷⁹ On many handsets the device's SAR value can be displayed by entering *#07# on the keypad; on other devices the value is available through the manufacturer's regulatory information screen or documentation.

⁸⁰ See, e.g., <https://regulatoryinfo.apple.com/rfexposure>, <https://www.samsung.com/sar/sarMain/>, Motorola.com/sar.

meaningful is to provide context for the raw numbers – that is, to explain that the limits are set well below levels of any effect. Disclosure of data to non-technical audiences without the appropriate context can create misunderstanding and unnecessary distrust of the technology.

Question 10: Data Sources and Surveillance Systems

Robust surveillance infrastructure already exists and is directly capable of detecting any population-level effect of RF exposure on cancer incidence. In the United States, the National Cancer Institute's Surveillance, Epidemiology, and End Results (SEER) Program and the CDC's National Program of Cancer Registries (NPCR) together provide effectively complete national coverage of cancer incidence. These systems have recorded stable brain and central nervous system cancer incidence across the period of dramatic growth in wireless device use — a finding directly inconsistent with a causal association.⁸¹

(a) Disease registries. Existing cancer registries are the appropriate instrument for population-level surveillance and already capture the outcomes of interest. A new RF-specific registry would add administrative burden without adding analytic power, since it is cancer incidence, not RF exposure, that constitutes the outcome requiring surveillance.

(b) Occupational monitoring. Occupational RF exposure is addressed through the occupational tier of IEEE Std C95.1-2019 (persons permitted in restricted environments) and the FCC's occupational/controlled limits, supported by required RF safety programs.⁸² Occupational cohort studies, including the Motorola employee study discussed in response to Question 4, have not identified elevated cancer risk attributable to RF exposure.

(c) Environmental monitoring. Periodic ambient RF surveys provide transparent data demonstrating margin to the limits, and the MWF supports their continuation. The most recent large-scale campaign of this kind measured more than 800 microenvironments across ten European countries in 2023 and 2024 and found mean environmental exposure between 0.33 mW/m² and 1.72 mW/m² depending on country — below international guideline values in every case, and well under one percent of the applicable reference level.⁸³

⁸¹ NCI, *Cell Phones and Cancer Risk Fact Sheet*.

⁸² IEEE Std C95.1-2019, cl. 4.5; 47 C.F.R. § 1.1310(b).

⁸³ Veludo AF, Stroobandt B, Van Bladel H, et al., “Assessing radiofrequency electromagnetic field exposure in multiple microenvironments across ten European countries with a focus on 5G,” *Environment International* 200:109540 (2025).

(d) Longitudinal cohort studies. Prospective cohorts are the most powerful design available for this question, and COSMOS represents the current state of the art. Given the consistency of results across COSMOS, the Danish cohort, the Million Women Study, and the WHO-commissioned systematic review, the MWF does not consider an additional large-scale prospective cohort to be indicated at this time.

(e) Biomonitoring. RF exposure does not produce stable biological markers analogous to those available for chemical exposures, which limits the applicability of conventional biomonitoring. Dosimetric methods and operator network records are the appropriate exposure-characterization tools.

(f) Adverse event reporting. A general adverse event reporting system for RF would be likely to generate a large volume of reports of uncertain evidentiary value, given the documented tendency toward symptom attribution in the absence of any demonstrated physiological mechanism.⁸⁴ Reporting mechanisms for RF interference with implanted medical devices are a distinct matter and are appropriately handled through existing FDA medical device reporting channels.

Question 11: Exposure Assessment and Risk Evaluation for Sensitive Populations

The current limits are set well below the thresholds for established adverse effects. IEEE Std C95.1-2019 confirms a whole-body average SAR threshold of 4 W/kg for potentially adverse effects, against which the general public whole-body limit is set at 0.08 W/kg — a factor of 50.⁸⁵ The standard states that it “incorporates a large margin of safety.”⁸⁶ That margin is what protects population subgroups whose absorption characteristics differ somewhat from the reference case.

(a) Children. Children's head and body geometry produces different SAR distributions than that of adults. This has been addressed technically through the inclusion of child-representative phantom and voxel models in compliance assessment and computational dosimetry. Specifically, dosimetry studies conducted across 14 international research laboratories confirmed that the 90th percentile SAM phantom mandated by IEEE 1528 / IEC 62209-1528 produces a higher peak spatial-average SAR than anatomical child head models under standardized handset operating positions. Because larger heads couple more efficiently with handset antennas, and because homogeneous tissue-simulating

⁸⁴ See WHO, Fact Sheet No. 296 (2005); Rubin et al., *Bioelectromagnetics* 31(1):1–11 (2010).

⁸⁵ *IEEE Std C95.1-2019*, cl. B.1.2.3 and Table 5.

⁸⁶ *Id.*, cl. B.1.1.

liquids overestimate energy absorption compared to layered anatomical tissues, the standardized testing methodology provides an intrinsically conservative exposure envelope that fully protects children.⁸⁷ Epidemiologically, the CEFALO international case-control study of brain tumors in children and adolescents aged 7 to 19 found no association with mobile phone use, including for subjects with the longest duration of use.⁸⁸ ICNIRP examined age-related differences and concluded that the guidelines are protective for children.⁸⁹ The MWF does not identify a scientific basis for a separate, more restrictive limit for children.

(b) Pregnant women. ICNIRP (2020) treats the fetus as a member of the general public, with the effect that pregnant workers are subject to the more conservative general public restrictions rather than occupational restrictions — a change from the 1998 guidelines. This is a specific, science-based accommodation already embedded in the international framework. No replicated evidence demonstrates a risk to fetal development at exposures within the limits.

(c) Older adults. The literature does not identify older adults as a population at elevated risk from RF exposure within current limits, and the existing safety margins are adequate.

(d) Individuals with implanted medical devices. This concern is distinct from the general RF safety question, and the MWF treats it as such. It concerns electromagnetic compatibility and interference rather than biological effect. IEEE Std C95.1-2019 expressly notes that its exposure limits “might not prevent interference with medical and other devices that might exhibit susceptibility to electromagnetic interference.”⁹⁰ The issue is properly addressed through device-specific immunity standards — including ISO 14117 for active implantable cardiovascular devices — and through device labeling and clinical guidance. The MWF supports continued attention to this area through the existing medical device regulatory framework.

(e) Workers with elevated occupational exposure. Occupational settings are addressed through the upper tier of the IEEE standard and the FCC's occupational/controlled limits, which are premised on informed awareness and the

⁸⁷Brian B. Beard et al., *Comparisons of Computed Mobile Phone Induced SAR in the SAM Phantom to That in Anatomically Correct Models of the Human Head*, 48 IEEE Trans. Electromagn. Compat. 397 (2006). <https://pmc.ncbi.nlm.nih.gov/articles/PMC5837060/>

⁸⁸ Aydin D, Feychting M, Schüz J, et al., “Mobile phone use and brain tumors in children and adolescents: a multicenter case-control study,” *Journal of the National Cancer Institute* 103(16):1264–1276 (2011).

⁸⁹ ICNIRP (2020), *Health Physics* 118(5):483–524.

⁹⁰ IEEE Std C95.1-2019, cl. 1.1.

operation of an RF safety program.⁹¹ This two-tier structure is the established and appropriate approach.

(f) Individuals with preexisting medical conditions. Apart from those with RF-susceptible implanted devices, addressed above, the MWF is not aware of evidence establishing that individuals with preexisting medical conditions face elevated risk from exposure within the limits, and neither ICNIRP nor IEEE identified such a population in the literature reviews underlying their respective guidelines.⁹²

The MWF emphasizes that any population-specific modification of exposure limits should rest on a demonstrated biological or epidemiological basis. Precautionary adjustments unsupported by evidence do not increase protection — the existing margins already exceed what the established effect thresholds require — but they do risk signaling a hazard that the scientific record does not support.

Question 12: Scientific Evidence on Potential Adverse Health Effects Below Current Federal Exposure Limits

The accumulated evidence does not demonstrate adverse health effects from RF/EMF exposure below the current federal limits. The MWF relies on the following authorities:

- (1) ICNIRP's 2020 review of the biological and health effects literature, set out in Appendix B to the Guidelines, covering cancer, reproductive and developmental effects, cognitive and neurological effects, cardiovascular effects, and hypersensitivity, and finding no substantiated adverse health effect within the specified limits.⁹³
- (2) The scientific analysis underlying IEEE Std C95.1-2019, set out in Annexes B and C and supported by the 1,550 references in Annex E, reaching the same conclusion.⁹⁴
- (3) The WHO-commissioned systematic review, which screened more than 5,000 publications and analyzed 63 studies, finding no association between mobile phone use and cancers of the head.⁹⁵
- (4) The major prospective cohort and case-control studies described in response to Question 4 — Interphone (2010), the Danish cohort (2011), the Million Women

⁹¹ *IEEE Std C95.1-2019*, cl. 4.5; 47 C.F.R. § 1.1310(b).

⁹² ICNIRP (2020), *Health Physics* 118(5):483–524; *IEEE Std C95.1-2019*, Annexes B and C.

⁹³ ICNIRP (2020), *Health Physics* 118(5):483–524, Appendix B.

⁹⁴ *IEEE Std C95.1-2019*, Annexes B, C and E.

⁹⁵ Karipidis et al., *Environment International* 191:108983 (2024) and 196:109274 (2025).

Study (2013), and COSMOS (2024) — none of which demonstrated an elevation in cancer risk attributable to mobile phone RF exposure.

(5) Population-level cancer surveillance showing stable brain and central nervous system cancer incidence across the period of dramatic growth in wireless use.⁹⁶

(6) The FDA's determination that the current safety limits remain acceptable for protecting the public health.⁹⁷

The MWF notes that the distinction between a reported biological effect and an established adverse health effect is central to any sound assessment. A measurable physiological response is not by itself evidence of harm. The standards bodies have applied this distinction rigorously, and both IEEE and ICNIRP set limits by reference to demonstrated adverse effect thresholds with safety factors applied.⁹⁸ The MWF urges HHS to maintain that distinction in evaluating the evidence submitted in this proceeding.

The MWF also addresses a recurring misstatement: that ICNIRP considers only thermal effects and disregards all others. That is not correct. ICNIRP states expressly that, “[f]or the purpose of determining thresholds, evidence of adverse health effects arising from all radiofrequency EMF exposures is considered, including those referred to as ‘low-level’ and ‘non-thermal’, and including those where mechanisms have not been elucidated.”⁹⁹ ICNIRP evaluates that evidence against a stated standard: “reported adverse effects of radiofrequency EMFs on health need to be independently verified, be of sufficient scientific quality and consistent with current scientific understanding, in order to be taken as ‘evidence’ and used for setting exposure restrictions.”¹⁰⁰ ICNIRP has examined the studies reporting non-thermal effects under that standard and has not found them to be scientifically sound evidence of harm. The guidelines are framed around thermal effects not because other effects were ignored, but because heating is the effect the science has shown to be present in the frequency range in which wireless communications operate. As ICNIRP explains, “[t]he lowest exposure levels that can cause adverse health effects are due to thermal mechanisms, and so restrictions have been set based on the thermal effects, as these will protect against any other effects that could occur at higher exposure levels.”¹⁰¹ A guideline that references only the effect that has been established is not incomplete; it reflects the evidence.

⁹⁶ NCI, *Cell Phones and Cancer Risk Fact Sheet*.

⁹⁷ FDA 2020 Review.

⁹⁸ IEEE Std C95.1-2019, Annex A, cl. A.3 (Adverse health effects).

⁹⁹ ICNIRP (2020), *Health Physics* 118(5) at 487.

¹⁰⁰ *Id.* at 484.

¹⁰¹ ICNIRP, *Frequently Asked Questions: Radiofrequency*, “Does ICNIRP consider non-thermal effects of RF EMF on health?” available at www.icnirp.org/en/rf-faq/index.html. At the lower end of the 100 kHz –

Question 13: Technologies and Cumulative Exposure Patterns

New and evolving technologies should be evaluated against the applicable limits using the established measurement methods identified in response to Question 7. The MWF observes the following:

(a) 5G. 5G operates across existing sub-6 GHz bands and, in some deployments, millimeter-wave bands above 24 GHz. Sub-6 GHz 5G presents exposure characteristics broadly comparable to 4G LTE. At millimeter-wave frequencies, energy deposition is confined to superficial tissue, which is why both IEEE and ICNIRP shift to a surface power density metric above 6 GHz.¹⁰² Systematic measurement of deployed 5G networks supports the adequacy of that framework. The UK regulator Ofcom measured EMF levels at 38 sites near 5G base stations across England, Scotland, Wales and Northern Ireland between April and October 2021 and recorded a maximum of approximately 0.87% of the ICNIRP general public reference levels.¹⁰³ A larger multinational campaign measured RF-EMF across more than 800 microenvironments in ten European countries — Austria, Belgium, France, Hungary, Italy, the Netherlands, Poland, Spain, Switzerland and the United Kingdom — during 2023 and 2024, and found mean environmental exposure ranging from 0.33 mW/m² in Switzerland to 1.72 mW/m² in France, in every case below international guideline values and well under one percent of the applicable reference level.¹⁰⁴ ICNIRP has confirmed that its 2020 guidelines apply to and are protective for 5G.

(b) 6G. 6G remains in research and pre-standardization. That said, the frequencies being discussed and planned for 6G, including the centimeter bands between 7-24 GHz, are already covered by both the IEEE Std C95.1-2019 as well as the ICNIRP Guidelines that already extend up to 300 GHz. As we move forward, IEEE ICES and ICNIRP will continue to monitor and review the science as part of their assessments of appropriate limits, as they have done to date.

(c) Wi-Fi. Wi-Fi access points operate under the FCC's Part 15 power limits, at radiated power substantially below that of licensed mobile transmitters and are typically used at greater distance from the body than a handset.¹⁰⁵ Environmental RF measurement campaigns find that total ambient exposure across all sources,

300 GHz range, ICNIRP also identifies nerve stimulation and changes in the permeability of cell membranes as substantiated effects. ICNIRP (2020), *Health Physics* 118(5) at 487.

¹⁰² IEEE Std C95.1-2019, Table 6; ICNIRP (2020).

¹⁰³ Ofcom, *Electromagnetic Field (EMF) Measurements near 5G Mobile Phone Base Stations* (Nov. 26, 2021).

¹⁰⁴ Veludo et al., *Environment International* 200:109540 (2025).

¹⁰⁵ 47 C.F.R. § 15.247.

including Wi-Fi, remains well below one percent of the applicable reference levels.¹⁰⁶

(d) Satellite-based communications. Satellite earth stations and space stations authorized for service in the United States are subject to the FCC's RF exposure requirements in the same manner as terrestrial facilities.¹⁰⁷ By way of example, Australia's carrier Telstra undertook measurements of its satellite messaging service which uses SpaceX.¹⁰⁸ Using two standard mobile phones — a Samsung S25 Ultra and an iPhone 14 — to send and receive messages at a remote location where no terrestrial network operated, Telstra measured the uplink power from the devices and the receive level from the satellite. The uplink never exceeded its maximum power of 23 dBm to make the connection. Telstra reported the receive levels as “less than -110dBm. That's millions of times below the EME public safety limits — as you would expect — and thousands of times below TV and radio broadcast EME levels in our everyday lives.”¹⁰⁹

(e)–(k) IoT, wearables, smart homes, smart cities, autonomous vehicles, wireless medical devices, and smart meters. All such devices require FCC equipment authorization and demonstrated compliance with the RF exposure limits before marketing in the United States.¹¹⁰ These are predominantly low-power, low-duty-cycle transmitters. Aggregate exposure from their proliferation is expected to remain well within the limits, consistent with the ambient exposure measurements conducted to date, which found total environmental exposure across all sources in ten European countries to be below international guideline values in every microenvironment measured.¹¹¹

Cumulative and Time-Averaged Measurements of Base Stations

RF EMF Measurement programs have been undertaken by regulatory authorities and agencies in many countries. The programs can be characterized as falling into several different categories: one-off / ad hoc agency measurement campaigns, repeated systematic national campaigns and permanent continuous monitoring arising from the deployment of dedicated monitoring sensors. The results from many of these monitoring

¹⁰⁶ Veludo et al., *Environment International* 200:109540 (2025).

¹⁰⁷ 47 C.F.R. § 1.1307(b).

¹⁰⁸ See Telstra, *Testing EME from SpaceX Satellites*, available at www.telstra.com.au/connected/news/testing-eme-from-spacex-satellites.

¹⁰⁹ *Id.*

¹¹⁰ 47 C.F.R. §§ 2.1091, 2.1093.

¹¹¹ Veludo et al., “Assessing radiofrequency electromagnetic field exposure in multiple microenvironments across ten European countries with a focus on 5G,” *Environment International* 200:109540 (2025).

programs have already been published and are indicated below. The consistent findings from these programs are that base stations, irrespective of time, location or technology operate at levels well below international guidelines and standards. Examples of the programs are:

Australia: ARPANSA conducted several measurement surveys of emissions from mobile phone base stations at various locations across Australia,¹¹² as well as RF levels from Wi-Fi and other sources in Australian schools.¹¹³

Greece — NOEF & Pedion24

Two parallel networks: NOEF (National Observatory of Electromagnetic Fields), run by the Greek Atomic Energy Commission (EEAE), and Pedion24, run by four Greek university labs.¹¹⁴

Italy — national ARPA/APPA network

One of the earliest continuous monitoring programs, it was started in 2002 and is run by the Ministry of Communications with Fondazione Ugo Bordoni and the regional/provincial Environmental Protection Agencies (ARPA/APPA). It now incorporates more than 1,250 stations rotated across sites.¹¹⁵

Japan

The National Institute of Information and Communications Technology (NICT) has run a large-scale, long-term monitoring project since 2019. This is not a fixed continuous-sensor network but involves repeated physical and car-mounted surveys. There have been several publications of data from the project.¹¹⁶

¹¹² ARPANSA, *ARPANSA Base Station Survey 2007–2013*, available at www.arpansa.gov.au/research/surveys/mobile-phone-base-station-survey; ARPANSA, *Radiofrequency Electromagnetic Energy and the ARPANSA Safety Standard*, available at www.arpansa.gov.au/regulation-and-licensing/regulatory-publications/radiation-protection-series/codes-and-standards/rpss-1-qa; Henderson et al., “A Survey of the Radiofrequency Electromagnetic Energy Environment in Melbourne, Australia,” *Radiation Protection Dosimetry* 199(6):519–526 (2023).

¹¹³ Karipidis K, Henderson S, Wijayasinghe D, Tjong L, Tinker R, “Exposure to radiofrequency electromagnetic fields from Wi-Fi in Australian schools,” *Radiation Protection Dosimetry* 175(4):432–439 (2017), doi:10.1093/rpd/ncw370.

¹¹⁴ Iakovidis S, Manassas A, Apostolidis C, Samaras T, “5G EMF Exposure at 3.6 GHz in Greece Using Data From Frequency-Selective Monitoring Sensors,” *Bioelectromagnetics* 46(6):e70008 (2025), doi:10.1002/bem.70008.

¹¹⁵ Troisi F, Boumis M, Grazioso P, “The Italian national electromagnetic field monitoring network,” *Annals of Telecommunications* 63(1–2) (2008), doi:10.1007/s12243-007-0011-4.

¹¹⁶ See, e.g., Onishi T, Ikuyo M, Tobita K, Liu S, Taki M, Watanabe S, “Radiofrequency Exposure Levels from Mobile Phone Base Stations in Outdoor Environments and an Underground Shopping Mall in Japan,” *International Journal of Environmental Research and Public Health* 18(15):8068 (2021),

Romania — ANCOM (Monitor-EMF)

Operated by the National Authority for Management and Regulation in Communications since 2016, it now includes 200 fixed stations across Bucharest and 140 other cities. The data for each site is available online.¹¹⁷

South Korea

The Radio Research Agency (RRA, part of MSIT) runs a compliance measurement program for every base station in the country which is measured at its nearest publicly accessible point and with results published on the Agency's website rra.go.kr and on emf.or.kr.¹¹⁸

Spain (Catalonia) — SMRF

A continuous fixed-sensor network run by the Catalan authorities since 2005. Now involving more than 320 fixed monitoring stations across more than 180 municipalities in Catalonia and measuring continuously 365 days/year.¹¹⁹

United Kingdom: In addition to the Ofcom measurements already discussed, the UK Health Security Agency undertook a program of RF EMF spot measurements in line-of-sight to 56 active 5G macro base stations across 30 publicly accessible locations in the UK.¹²⁰

On cumulative exposure generally: the limits already incorporate time-averaging, and IEEE Std C95.1-2019 and ICNIRP provide explicit summation rules for simultaneous exposure to multiple sources and frequencies, requiring that the combined fraction of the applicable limits not exceed 100 percent.¹²¹ The MWF is not aware of evidence that

doi:10.3390/ijerph18158068; Onishi T, et al., "Large-Area Monitoring of Radiofrequency Electromagnetic Field Exposure Levels from Mobile Phone Base Stations and Broadcast Transmission Towers by Car-Mounted Measurements around Tokyo," *Electronics* 12(8):1835 (2023), doi:10.3390/electronics12081835; Liu S, Tobita K, Onishi T, Taki M, Watanabe S, "Electromagnetic field exposure monitoring of commercial 28-GHz band 5G base stations in Tokyo, Japan," *Bioelectromagnetics* 45(6):281–292 (2024), doi:10.1002/bem.22505.

¹¹⁷ www.monitor-emf.ro.

¹¹⁸ Results are published at rra.go.kr and emf.or.kr. *See also* Selmaoui B, Mazet P, Petit PB, Kim K, Choi D, de Seze R, "Exposure of the South Korean population to the 5th generation (5G) of mobile phone networks (3.4 to 3.8 GHz) and its respective contribution among other radio frequencies in the country," *2021 XXXIVth General Assembly and Scientific Symposium of the International Union of Radio Science (URSI GASS)*, Rome, Italy, at 1–4 (IEEE 2021) (reporting measurement results).

¹¹⁹ Lunca E, Salceanu A, "An Overview of RF-EMF Monitoring Systems and Associated Monitoring Data," *2016 International Conference and Exposition on Electrical and Power Engineering (EPE)* (2016), doi:10.1109/ICEPE.2016.7781374.

¹²⁰ Calderon C, Addison D, Peyman A, "In-Situ Measurements of Radiofrequency Electromagnetic Fields Measurements Around 5G Macro Base Stations in the UK," *Bioelectromagnetics* 46:e70012 (2025), doi:10.1002/bem.70012.

¹²¹ *IEEE Std C95.1-2019*, cl. 4.3.2 and Annex D, cl. D.2.

cumulative exposure below the limits, aggregated across sources, presents a risk not already addressed by that framework.

Question 14: Potential Adverse Environmental Effects of RF Radiation

The MWF reads this question as capable of two meanings and responds to each.

To the extent the question concerns the effect on humans of RF present in the environment, the MWF's responses to Questions 5 through 13 above provide the answer, and the MWF incorporates them by reference here.

To the extent the question concerns the impact of RF on animals or vegetation in the environment, the MWF responds as follows.

The Systematic Map of the Environmental Literature

The most comprehensive assessment of this literature is a systematic map conducted by ARPANSA with Swinburne University of Technology, which screened 26,537 publications and analyzed the 334 that met its eligibility criteria — 237 concerning fauna and 97 concerning flora.¹²²

The central finding is a clear inverse relationship between methodological quality and reported adverse effect. As the authors state: “For poor quality studies, radio waves were found to adversely affect plants and animals. For good quality studies, radio waves were not found to cause adverse effects.” The studies classified as good quality were those employing rigorous methods, including appropriate exposure assessment and suitable comparison or control groups; those classified as poor quality exhibited such flaws as the absence of experimental controls, inadequate assessment of radiation exposure, and failure to account for confounding environmental factors such as pollution. ARPANSA summarizes the result as follows: there is “no substantiated evidence that radio wave exposure below safety limits adversely affect plants and animals.”¹²³

The MWF draws HHS's attention to this finding not only for its conclusion but for its methodological lesson, which bears directly on how the evidence submitted in this proceeding should be weighed. The apparent disagreement in the environmental RF literature is not a genuine scientific controversy between equally credible bodies of work. It resolves along the axis of study quality, and it resolves in one direction.

¹²² Brzozek C, Mate R, Bhatt CR, Loughran S, Karipidis K, Wood AW, “Investigating the impact of anthropogenic radiofrequency electromagnetic fields on animals and plants in the environment: analysis from a systematic map,” *International Journal of Environmental Studies* 81:2343 (2024), doi:10.1080/00207233.2024.2375861.

¹²³ ARPANSA, *Good Quality Research Shows No Environmental Effects from Radio Waves* (Aug. 22, 2024), available at www.arpansa.gov.au/good-quality-research-shows-no-environmental-effects-radio-waves.

The MWF also reports the authors' own stated limitation rather than omitting it. The number of good-quality studies within the eligible set was limited, and the investigators concluded that further rigorous research is needed to reconcile the findings of the methodologically weak and robust studies. The systematic map was also restricted to English-language publications, and where primary studies failed to report dosimetric measures such as power density or SAR, those data were not separately obtained. This is consistent with the MWF's general position that additional research is warranted in specific, targeted instances; environmental effects are one such instance, and the MWF does not oppose well-designed research in this area.

(a) Animals. The systematic map found no adverse effects on animals in the good-quality studies.¹²⁴ That finding is reinforced by the structure of the exposure limits themselves. A wide range of animal species has been used in the research underlying those limits, and the limits can be extrapolated to those animals. The bibliography of IEEE Std C95.1-2019 and the supporting analysis in its Annexes B and C draw on studies in rats, mice, rabbits, dogs, hamsters, guinea pigs, quail, and nonhuman primates including rhesus and squirrel monkeys. The whole-body threshold on which the standard rests was itself derived from those animal data: IEEE Std C95.1-2019 states that “[t]he selected threshold of 4 W/kg is based primarily on behavioral disruption data in laboratory animals of several different species exposed to RF fields over durations of minutes to more than 1 h.”¹²⁵ Because the human limits sit far below that animal-derived threshold — the general public whole-body limit of 0.08 W/kg is a factor of 50 below it¹²⁶ — an animal present in a field compliant with the human limits is itself well below the effect threshold observed in animals. The standard further notes that the occupational whole-body limit “is 10 times less than that needed to increase core temperature by 1 °C in rats and monkeys.”¹²⁷

The MWF notes one dosimetric qualification, in the interest of precision. Energy absorption from a given incident field is not uniform across species: absorption “depends on the size and orientation of the object with respect to the wavelength and polarization vector of the incident field,” and whole-body absorption is maximal where the longest body dimension is approximately 0.4 times the free-space wavelength.¹²⁸ Consequently, a species differing substantially in body dimension from an adult human will reach its own resonance at a different

¹²⁴ Brzozek et al., *International Journal of Environmental Studies* 81:2343 (2024).

¹²⁵ *IEEE Std C95.1-2019*, cl. B.1.3.3.

¹²⁶ *Id.*, Table 5.

¹²⁷ *Id.*, cl. B.4.1.2.2.1.

¹²⁸ *Id.*, cl. 3.1 (definition of “resonance region”) and cl. B.5.2.2 (citing Durney et al.).

frequency, and the same incident field will produce a different whole-body SAR in that species than in a human. This does not disturb the conclusion above, because the margin between the human limits and the animal-derived threshold is large. It does mean that any species-specific assessment should be conducted in terms of SAR rather than incident field strength.

(b) Vegetation. The systematic map identified 97 eligible studies concerning flora and found no adverse effects on plants among the good-quality studies.¹²⁹ The MWF is not otherwise aware of evidence establishing adverse effects of RF exposure on vegetation at levels below the applicable exposure limits. As noted above, the authors of the systematic map observe that the good-quality evidence base remains limited in size, and the MWF would not oppose further rigorous research directed at that gap.

Question 15: Scientific Evidence for Evaluating RF Exposure from Wireless Infrastructure

The scientifically valid framework for evaluating infrastructure exposure is measurement of actual exposure against the applicable limits, using the procedures identified in response to Question 7 — principally IEC 62232:2025 and IEEE Std C95.3-2021. What determines whether any health concern arises is the intensity of the field to which a person is actually exposed, not the number, proximity, or visibility of the sources producing it.

(a) Proximity to homes, schools, childcare facilities, healthcare facilities, and workplaces. RF field intensity from a base station falls off rapidly with distance. At the separations typically found between antenna installations and nearby occupied buildings, measured exposure is a small fraction of the applicable limits. Ofcom's measurements at 38 sites near 5G base stations across the United Kingdom recorded a maximum of approximately 0.87% of the ICNIRP general public reference levels, at locations accessible to the public.¹³⁰ Proximity is therefore a poor proxy for exposure, and installation-specific measurement under IEC 62232:2025 should be preferred to distance-based rules, which regulate a variable that does not reliably track the quantity of concern.

(b) Cumulative neighborhood exposure. Aggregate ambient RF levels in dense urban environments may exceed those in less densely served areas — the ten-country campaign found environmental levels approximately 80% lower in

¹²⁹ Brzozek et al., *International Journal of Environmental Studies* 81:2343 (2024); ARPANSA, *Good Quality Research Shows No Environmental Effects from Radio Waves* (Aug. 22, 2024).

¹³⁰ Ofcom, *Electromagnetic Field (EMF) Measurements near 5G Mobile Phone Base Stations* (Nov. 26, 2021).

villages than in cities — but cumulative ambient levels remained below international guideline values in every microenvironment measured, with country mean values between 0.33 mW/m² and 1.72 mW/m².¹³¹ The urban-rural difference is therefore a difference between two levels that are both far below the limits, not a difference in margin of safety. Where aggregate exposure is at issue, the summation methodology in IEEE Std C95.1-2019 provides the appropriate analytic framework.¹³²

(c) Antenna density. Network densification generally permits both base stations and handsets to operate at lower transmitted power, because path loss is reduced. The effect of higher antenna density on individual exposure is therefore not straightforwardly additive and may be reductive, particularly for handset exposure, which is typically the dominant contributor to individual dose. Compliance must in all cases be demonstrated by measurement.

(d) Small-cell deployment. Small cells operate at substantially lower power than macro base stations, but their lower mounting height places the antenna closer to persons at street level, which alters exposure geometry. This is precisely why compliance assessment procedures such as IEC 62232:2025 require installation-specific evaluation rather than generic assessment. Actual environmental exposure is nonetheless substantially lower than theoretical worst-case estimates, because real-world networks utilize dynamic beamforming and variable duty cycles.

(e) Livestock. Livestock are addressed by the MWF's response to Question 14(a) above. A wide range of animal species was used in the research underlying the exposure limits, and because the human limits sit far below the animal-derived effect threshold, livestock present in fields compliant with those limits are themselves well below the threshold observed in animals.¹³³ The MWF is not aware of evidence establishing adverse effects in livestock at the exposure levels produced by compliant wireless infrastructure.

Question 16: Highest Priority Research Gaps

Because the existing research base is substantial and supports the protective adequacy of the current limits, the MWF identifies a limited and specific set of priorities rather than a broad program:

¹³¹ Veludo et al., *Environment International* 200:109540 (2025).

¹³² *IEEE Std C95.1-2019*, Annex D, cl. D.2.

¹³³ *IEEE Std C95.1-2019*, cl. B.1.3.3 and Table 5.

- (1) Improved personal dosimetry. Development and validation of personal exposure meters with comprehensive frequency coverage including the 5G bands, to support accurate individual exposure characterization in any future epidemiological work.
- (2) Symptoms attributed to RF exposure. Continued well-designed research into the etiology of symptoms reported by individuals who attribute them to RF exposure would benefit those individuals, whose symptoms are real and currently lack an established cause, and would inform clinical management.
- (3) The investigation of whether there are any environmental effects on animals and plants. The ARPANSA systematic map discussed in response to Question 14 found no adverse effects in the good-quality studies, but its authors observe that the good-quality evidence base is limited in size and that further rigorous research is needed to reconcile those findings with the weaker studies reporting effects.¹³⁴ Research directed at that specific gap, conducted with proper exposure assessment and adequate controls, would be well founded.
- (4) Continued cancer registry surveillance. Existing SEER and NPCR surveillance should continue, including for children and adolescents, as the most efficient means of detecting any population-level signal. This requires no new infrastructure.
- (5) NTP study dosimetry. As referenced in the discussion above, the dosimetry conducted for the NTP studies has given rise to several questions, including whether possible artifacts such as the thermoregulatory stress suggested by Germany's BfS require an improved dosimetric approach.¹³⁵ Those questions can only be addressed by further targeted research concerning the dosimetry.

The MWF cautions against launching large-scale research programs premised on an assumption that the current limits are inadequate. Such programs would misrepresent the state of the science, divert resources from better-supported public health priorities, and risk communicating a level of scientific uncertainty that the evidence does not reflect.

Question 17: Federal Agency Coordination of EMF and RF Radiation Research

(a) FDA. The FDA should retain the lead federal health agency role for RF/EMF and human health. It has the relevant institutional expertise, has conducted systematic literature reviews on this question, and has an established working relationship with the

¹³⁴ Brzozek et al., *International Journal of Environmental Studies* 81:2343 (2024).

¹³⁵ See notes 59, 60 *supra*, and accompanying text.

FCC on device authorization and exposure compliance under 21 C.F.R. Part 1010 and the FCC's Part 2 rules.¹³⁶ The FDA should also serve as the principal federal voice communicating the scientific consensus on RF safety to the public. The MWF further recommends that the FDA support the FCC in adopting the current IEEE and ICNIRP localized SAR limit, as described in response to Question 5.

(b) NIH. NIH's role should be to fund the targeted research identified in response to Question 16, in coordination with international programs to avoid duplication. NIH should require that funded RF research employ validated exposure systems with documented dosimetry and temperature control and be conducted at exposure levels relevant to real-world conditions. Experience with prior large animal studies illustrates the cost of not imposing those requirements at the outset.

(c) CDC. CDC should maintain and support the NPCR cancer registry infrastructure, which provides the surveillance capacity described in response to Question 10, and should ensure that its public-facing RF/EMF materials accurately reflect the conclusions of the WHO, ICNIRP, IEEE, and FDA.

Across agencies, the MWF recommends sustained U.S. participation in the international scientific bodies that review this evidence — the WHO International EMF Project, ICNIRP, and IEEE ICES — so that federal positions remain informed by and aligned with the international consensus. Coordination with the FCC is essential, because regulatory authority over RF emissions from wireless devices and infrastructure rests there. The MWF notes that the divergence between the FCC's 1992-derived localized SAR limit and the current IEEE and ICNIRP limit, discussed in response to Question 5, is a concrete example of where improved interagency coordination would produce a measurable improvement in the science basis of federal regulation.

Question 18: Additional Scientific Evidence, Technical Information, and Recommendations

Standards of Evidence

The MWF urges HHS to apply consistent and rigorous evidentiary standards in weighing the material submitted in this proceeding. This is not merely a policy preference. It is a statutory and regulatory obligation under the HHS Scientific Integrity Policy¹³⁷, the Information Quality Act (IQA)¹³⁸, OMB Information Quality Guidelines (67 FR 8452)¹³⁹, and President Trump's Executive Order 14303¹⁴⁰ ("Restoring Gold Standard Science").

¹³⁶ See FDA 2020 Review.

¹³⁷ Note 4, *supra*.

¹³⁸ Note 5, *supra*.

Under E.O. 14303, federal agencies are explicitly directed to ensure that any scientific assessment informing agency policy adheres to nine core tenets: reproducibility and replicability, data transparency, clear communication of error and uncertainty, interdisciplinary collaboration, skepticism of unverified assumptions, falsifiability of hypotheses, unbiased peer review, acceptance of negative results, and independence from conflicts of interest. Similarly, the Information Quality Act requires federal agencies to ensure the 'objectivity, utility, and integrity' of information relied upon for regulatory or health-risk determinations, mandating a formal 'weight-of-the-evidence' standard.

Greatest weight should attach to peer-reviewed published research with transparent and reproducible methodology and documented dosimetry; findings replicated by independent research groups; systematic reviews and meta-analyses conducted through transparent expert processes with pre-specified inclusion criteria; and assessments by established international scientific bodies operating under published procedures, including the WHO, ICNIRP, and IEEE ICES.

Correspondingly less weight should attach to studies with inadequate exposure characterization or dosimetry, absent temperature control in thermal-range exposures, small sample sizes without replication, or exposures far exceeding the levels humans actually encounter. The MWF makes this recommendation not to exclude any particular finding but because the reliability of a conclusion cannot exceed the reliability of the evidence supporting it, and this is a field in which conclusions drawn from methodologically weak studies have at times received attention disproportionate to their evidentiary weight. Regrettably, this has led to, and continues to, cause unfounded concerns for some members of the public.

That this distinction is consequential rather than merely formal is demonstrated empirically by the ARPANSA systematic map discussed in response to Question 14. Across 334 eligible studies of RF effects on animals and plants, the reported outcome tracked methodological quality: “For poor quality studies, radio waves were found to adversely affect plants and animals. For good quality studies, radio waves were not found to cause adverse effects.”¹⁴¹ Where an evidence base divides in this way, aggregating all studies without regard to quality does not produce a balanced view. It produces a false appearance of scientific disagreement, and it is precisely the error that rigorous evidentiary standards exist to prevent.

The MWF directs HHS to the following additional resources:

¹³⁹ Note 6, *supra*.

¹⁴⁰ Note 7, *supra*.

¹⁴¹ Brzozek et al., *International Journal of Environmental Studies* 81:2343 (2024).

- (1) The MWF website, describing the peer-reviewed studies and research programs the MWF has sponsored on RF health and safety and SAR measurement methodology.¹⁴²
- (2) The EMF Explained information series, developed jointly by the MWF, the GSMA, and AMTA, providing accessible and WHO-aligned information on the scientific evidence.¹⁴³
- (3) The IEEE ICES expert review series, providing peer-reviewed expert analyses of specific topics in RF bioeffects research.¹⁴⁴
- (4) The WHO International EMF Project, including the environmental health criteria documents, fact sheets, and the systematic reviews supporting the WHO's ongoing RF health risk assessment.¹⁴⁵
- (5) ICNIRP publications, including the 2020 RF Guidelines, the supporting appendices, and ICNIRP's published notes and statements on specific studies.¹⁴⁶
- (6) The GSMA's EMF and health resources, providing research summaries and links to the peer-reviewed literature.¹⁴⁷
- (7) The IEEE standards submitted in this docket — IEEE Std C95.1-2005, IEEE Std C95.1a-2010, and IEEE Std C95.1-2019¹⁴⁸ — whose annexes identify the studies evaluated and set out the scientific rationale for the exposure limits in full.

II. CONCLUSION

The Mobile & Wireless Forum appreciates the opportunity to comment. The weight of the scientific evidence — developed over more than six decades, evaluated systematically in standards documents identifying more than 1,100 studies in 2005 and more than 1,500 in 2019, and reviewed independently by the WHO, ICNIRP, SCHEER, the FDA, and the National Cancer Institute — supports the safety of RF/EMF exposure within the current

¹⁴² www.mwfai.org.

¹⁴³ www.emfexplained.info.

¹⁴⁴ sagroups.ieee.org/ices/expert-reviews/.

¹⁴⁵ www.who.int/teams/environment-climate-change-and-health/radiation-and-health.

¹⁴⁶ www.icnirp.org.

¹⁴⁷ www.gsma.com.

¹⁴⁸ See notes 11, 12 and 24, *supra*.

federal limits. No replicated scientific evidence demonstrates adverse health effects at those exposure levels.

The MWF respectfully submits that the most consequential improvement available to federal agencies in this area is not additional restriction but alignment with current science. The FCC's localized SAR limit for wireless devices derives from a 1992 consensus standard that the IEEE superseded in 2005 and again in 2019, and it diverges from the limit applied by ICNIRP and by most countries worldwide. Adoption of the current, science-based limit of 2.0 W/kg averaged over 10 grams of tissue would improve the assessment, disclosure, and regulation of RF exposure from wireless devices, and would place U.S. regulation on the same evidentiary footing as the international framework.

The MWF urges HHS to ground any recommendation, communication, or policy change in the totality of the scientific evidence, according appropriate weight to systematic reviews by international expert bodies, large-scale epidemiological studies, and established physical and biological principles. That approach is essential to ensuring that public health communications are accurate, that regulatory requirements reflect actual rather than assumed risk, and that public confidence in wireless technologies — which deliver substantial public health, safety, economic, and social benefits — rests on a sound foundation.

The MWF remains available to provide additional information or clarification as HHS conducts its review.

Respectfully submitted,

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