Research Gaps in Non-Native EMF Response to HHS RFI

Written for HHS RFI HHS-OASH-2026-0397

Written by John Byron Hanby IV

Prepared for: policymakers, public health leaders, school officials, families, and community members. Purpose: to answer HHS's questions, with every claim tied to a source citation the review committee can verify.

Executive Overview

Many questions remain unanswered related to Non-Native EMF (nnEMF) and the biological effects that result from exposure. The USA is the sickest it has been in decades. Photos of people on US beaches in the 1970s compared to 2020s shows a drastic difference. Obesity is prevalent. Early research indicates health impacts are coming food sources and other aspects of the standard American lifestyle, however not all are being given the same level of review. nnEMF is one of the areas of research that has been neglected.

Some research exists but is by no means comprehensive. Established studies show that heat from high-power radiofrequency energy is real, and Federal exposure limits exist because of it.

Across whole populations, the best pooled studies show no overall rise in brain cancer as phone use became nearly universal, however the benchmark of testing positive for having brain cancer, or any cancer should not be the benchmark for a negative health impact.

nnEMF has become so ubiquitous that it makes study challenging due to every day exposure, but this does not mean the research is not essential. Leaded gasoline was another universal exposure that was later deemed to be dangerous and phased out. Wi-Fi, 5G and other cellphone bands, Electric Vehicles, Home appliances with AC currents, bluetooth, are sources of exposure every day. If discoveries are made that these devices do impact human biology in a substantive manner, then considerations around how hospitals and healthcare institutions adopt and utilize these technologies in the patient journey should also be considered.

A 1% or 5% or 10% impact on overall longevity (aging sooner) with impacts to memory, behavior, IQ, fertility, that may go unseen because cancer does not present would still be a major revelation.

The net impact from a 5% increase in adult working years would have a massive benefit to US GDP, strengthening national security and economic security. Healthy people create less economic drag for tax payers as they age.

The field of biological nnEMF impacts deserves to be studied in pursuit of the MAHA goals of overall wellness improvements for Americans.

Studies indicate that nnEMF research has not yet been explored to completion. First, the National Toxicology Program, a research program, found "clear evidence" of a rare malignant heart tumor in male rats exposed to high whole-body levels of 2G/3G-type radiation. A 2025 review commissioned for the World Health Organization rated the animal evidence high certainty for that heart tumor and for malignant gliomas, while warning that moving from animal tumor results to human risk is unusually difficult.

Second, and separately, a 2016 count found oxidative-stress effects reported in 93 of 100 low-intensity studies, but the 2024 WHO-commissioned systematic review rated the oxidative-stress literature very-low certainty: most of the studies were small and at high risk of bias. And no cohort has yet followed heavy phone users from a young start through a full adult lifetime. Three conclusions match the evidence: everyday exposure is low, a health effect at ordinary levels has not been established, and the missing studies are worth doing.

What every reader should take away

Three effects of electromagnetic fields are well studied. Whether some other effect occurs below the exposure limits is still an open question, and the studies that would answer it are unfinished or unpublished. Anyone deciding what to believe, or what HHS should fund, should know five things:

1. Three effects are established, and each has a boundary. Strong radiofrequency fields heat tissue, strong low-frequency fields can stimulate nerves, and the magnets in some phones, watches, and chargers can put a pacemaker or defibrillator into magnet mode if held against the chest. Ordinary Wi-Fi and a distant tower produce none of the three but that does not mean there is no impact on the human body.
2. The strongest laboratory signal is a rare heart tumor in male rats, at high exposure. In NTP's two-year studies, male rats exposed across the whole body developed malignant schwannomas of the heart, a result NTP called "clear evidence" for both GSM and CDMA at 900 MHz (at 6 W/kg: 5/90 GSM and 6/90 CDMA, versus 0/90 in the sham controls). Brain tumors in male rats fell in a lower category, "some evidence." NTP's own scientists cautioned against reading the results straight across to phone use: the animals received whole-body exposure for long hours at levels at or above the maximum local exposure allowed for a phone user. The WHO-commissioned animal review (Mevissen and colleagues, 2025) rated the certainty high for malignant heart schwannomas in male rats and for gliomas, while reporting no clear increase in most other organs. FDA and the FCC have not yet adopted "clear evidence" as a finding that phones cause cancer in people. It is important that research consider both heat and emissions in their conclusions.

3. Population studies are reassuring on average, and they are thin at the extreme. A WHO-commissioned review of human studies (Karipidis and colleagues, 2024; 63 articles) found no association of mobile-phone use with glioma (pooled relative risk 1.01, 95% CI 0.89–1.13), meningioma (0.92), or acoustic neuroma (1.03), and no rise with more years of use or more call time. At the extreme, case-control studies have reported higher risks in the heaviest, longest users, sometimes on the side of the head where the phone was held. INTERPHONE's own authors said participation bias, implausible reported use, and error prevented a causal reading of their heavy-use glioma result (odds ratio 1.40, 1.03–1.89, for 1,640 hours or more), and later work did not confirm that tumors sit on the side of the head that was used. The case-control analyses also depend on people remembering their own use. The prospective cohorts that avoid recall bias, including COSMOS (about 265,000 adults, median follow-up 7.1 years in the 2024 cancer paper), have yet to cover a 20-year lag from a young starting age. The delay between exposure and a tumor it might cause has a name: latency. Latency is a reason to keep the cohorts running, not itself a finding of harm.
4. Children absorb a phone's energy in a different pattern from adults, and nobody has followed them for a lifetime. The absorption difference depends on age, tissue, and frequency; in some models the gap is large for bone marrow and smaller for the head as a whole. The physics is more complex than "children have thinner skulls," and a higher absorption figure is not itself a disease. International guidelines treat children as members of the public, with no separate child number, and in 2013 the American Academy of Pediatrics asked the FCC and FDA to take children and pregnancy into account when the limits were reconsidered. The right response is exposure-matched studies and plain guidance, including the low-cost habits listed under Question 9. Parents in 2026 have increasingly provided technology such as tablets to their young children. The impacts of a child holding an emitting tablet close to their brain, eyes, and face for extended periods of time on a daily basis could have impact on physical and mental development of the child through disruptions to biology - this remains unstudied.
5. The useful response is a funded research program with a dosimetry gate. The United States has had no standing interagency EMF health program since EMF-RAPID ended on 31 December 1998. EMF-RAPID studied power-line fields, not wireless; it found the evidence of a leukemia risk weak and recommended passive steps rather than aggressive regulation, and no radiofrequency program replaced it. In 2012 GAO found that the FCC had never formally asked the health agencies to reassess the 1996 limit, and it recommended a formal reassessment of the limit and of phone tests when the phone is held against the body. GAO later closed both recommendations as not implemented. The program we recommend puts measurement first, because every later study inherits the dose error.

Technology has changed substantially in the last 30 years, and the scope and methods used to measure impact and electronics design have changed substantially as new technologies have been innovated. With proper study the federal government may discover that a metric other than, or in addition to heat may be an essential regulatory requirement to protect human biology.

Answering HHS's questions

What people report (Questions 3 and 4)

People who attribute their symptoms to wireless devices describe headaches, sleep trouble, fatigue, ringing in the ears, and trouble concentrating. The symptoms are a real clinical burden. In physician surveys in Germany, Switzerland, and Austria, 61 to 69 percent of general practitioners said at least one patient had raised electromagnetic fields, although the survey figures are a 2003-to-2010 snapshot rather than a current pooled rate. In population surveys, the share of people who say they are sensitive runs from under 1 percent to about 13 percent; ANSES (2018) treated the 1-to-13-percent range as unreliable, and several later studies cluster near 5 percent.

Blinded tests do not support a field effect for the reported symptoms. A WHO-commissioned review of human experiments (Bosch-Capblanch and colleagues, 2024; 41 studies, 2,874 participants) found that volunteers could tell exposure from sham no better than chance, and that symptom scores did not rise with real exposure (headache, standard mean difference 0.08, interval crossing zero). Symptoms followed what people believed about the exposure, and the working interpretation is a nocebo effect. However the study cannot account for chronic exposure impacts associated with daily living environments. Acute exposure may not be identifiable, but that does not mean the subject's body is not already in a highly impacted state which cannot normalize for a baseline in a measurable period of time. A nocebo explanation does not make the suffering smaller, but it does change the care: clinicians should evaluate and treat the symptoms, including the psychological part, and should not send patients to products sold as "protection."

Two product classes get conflated and should not be. Conductive shielding materials can attenuate radiofrequency energy when they actually enclose a space; chips, stickers, pendants, and "harmonizers" do not, yet prices in the sticker-and-pendant market run from tens of dollars into the thousands. A third group, radioactive jewelry, should not be confused with the expensive harmonizers: in 2021 the Dutch nuclear-safety authority banned ten "negative ion" and "anti-5G" pendants, bracelets, and a sleep mask because they contained radioactive material. The Federal Trade Commission has also acted against false phone-shield advertising, but the enforcement record against fraudulent products is not evidence about base stations.

For clinicians (Question 4), no diagnosis code or test establishes electromagnetic hypersensitivity as a field-driven disease. The workup looks for ordinary causes, such as migraine, sleep disorders, anxiety, and similar conditions, and the controlled treatment evidence favors cognitive behavioral therapy aimed at function. Symptom reports should be logged, not treated as proof of cause.

If pigeons can navigate using the natural magnetic fields of the earth, then it is proven that EMF can interface with cellular biology.

Safety standards (Questions 5 and 6)

The limits are built around heat. The public whole-body limit, 0.08 watts per kilogram, is fifty times below the exposure associated with about a 1 °C rise in core temperature (4 watts per kilogram). A

phone against the head is governed by a different number: 1.6 watts per kilogram averaged over 1 gram in the United States, and 2 watts per kilogram over 10 grams in the ICNIRP guideline used in much of the world. The U.S. and ICNIRP phone numbers measure different quantities and should not be compared as if they were the same. ICNIRP's factor of ten is specific to ICNIRP: its local public limit for the head and torso, 2 watts per kilogram over 10 grams, is one-tenth of the 20 watts per kilogram local value it uses, while the U.S. 1.6 watts per kilogram over 1 gram does not derive from the same factor of ten. In ordinary places, measured tower and Wi-Fi levels are usually a small fraction of the public reference level; the exposure that can approach a limit is the phone against the body.

Questions remain if heat is the actual measurement metric that should be used to assess safety. We believe there are other factors that modern technology may be able to measure which may provide a more detailed and accurate set of results to supplement heat measurements.

Several countries set lower numbers than the ICNIRP reference or add rules for places people occupy for a long time. Seven national rules show how far the approaches range, from a tighter cap on a single installation in Switzerland to a stricter cap that Poland has since replaced with the European recommendation:

- Switzerland. The Swiss rule keeps the ordinary limit and adds a tighter cap on a single installation at homes, schools, and hospitals: 4 volts per meter if that installation transmits only around 900 MHz or lower, 6 volts per meter if only around 1800 MHz or higher, and 5 volts per meter otherwise.
- Italy. The exposure limit remains 20 volts per meter from 3 MHz to 3 GHz. Since 30 April 2024 the attention value and the quality objective have been provisionally 15 volts per meter as a 24-hour average, up from the former 6 volts per meter and still below the ICNIRP reference.
- India. India set base-station limits at one-tenth of ICNIRP in 2012 (0.45 watts per square meter at 900 MHz). Department of Telecommunications letter No. 16-10/2022/CS-2 of 1 January 2025 revised them to one-half of ICNIRP: power density equal to frequency in megahertz divided by 400 from 400 to 2000 MHz (2.25 watts per square meter at 900 MHz), and 5 watts per square meter from 2 to 300 GHz. The Tarang Sanchar page prints the same table alongside a sentence that says one-fifth; the table is one-half.
- China. The public environmental standard, GB 8702-2014, is 0.4 watts per square meter (12 volts per meter) from 30 MHz to 3 GHz.
- Israel. Israel limits long-stay exposure from base stations to one-tenth of the ICNIRP reference and sets the distance from a given antenna in that site's permit rather than by a single national setback.
- France. France did not adopt a lower national field limit, but a 2015 law restricts Wi-Fi in spaces used by children under three and requires classroom Wi-Fi in primary schools to be off when it is not in use for teaching.
- Poland. Poland has left the stricter group. On 1 January 2020 it replaced a 0.1 watt per square meter cap with the European recommendation (Journal of Laws 2019, item 2448): 10 watts per square meter from 2 to 300 GHz.

> Stricter or special national rules are policy choices; by themselves, they are not evidence that harm has been shown below the heating threshold.

The U.S. numeric limits date from 1996, and the FCC left them unchanged in 2019. At 900 MHz the U.S. public power-density limit is 6 watts per square meter, about one-third higher than the ICNIRP and European figure of 4.5; at and above 1500 MHz it matches ICNIRP at 10 watts per square meter. In 2021 the D.C. Circuit remanded specific questions to the FCC because the agency's explanation was inadequate, but it kept the limits in place, neither vacating them nor finding them unsafe (*Environmental Health Trust v. FCC*, 9 F.4th 893). The remanded questions cover effects other than the cancer determination, children, and the environment. In September 2026 the FCC opened a comment period on the remanded questions (Public Notice DA 26-997, 91 FR 60128, ET Docket 13-84), and the limits remain in force while the comment record is refreshed.

A limit built to prevent heating leaves open whether some other effect occurs below it, but an unanswered question about effects below the limit is not a finding that the margin has already failed.

Measuring exposure (Questions 7 and 8)

Personal meters worn on the body often read low. Across 267 microenvironments (Huss and colleagues, 2021), the median on-body reading was reporting at 0.29 times a body-worn reference meter for one instrument (EmeSpy 200) and 0.79 times for another (ExpoM-RF). The 0.29 and 0.79 median measurements result in an under-reading of about 70 percent and a 20 percent respectively; the ExpoM range crossed 1.0, so the ExpoM did not always under-read. The Huss ratios are separate from the correction factors in Bolte's 2011 work. Models of outdoor signal strength match personal measurements only moderately.

If you wear a meter, the largest share of what it records is usually your own phone, not the tower down the street. In one study of Swiss adolescents (Roser and colleagues, 2017), the phone's uplink was 67.2 percent of the measured personal exposure (mean 63.2 microwatts per square meter), a share of what the meter recorded rather than of the dose reaching the brain. In the same paper, environmental sources, including other people's phones, averaged 6 percent of modeled brain dose and 9 percent of modeled whole-body dose.

Retail alarms and retail field meters do different jobs. A smoke alarm or a carbon monoxide alarm watches one hazard and sounds at a set point. Both are ordinary retail goods, and the model residential code requires them: smoke alarms, and carbon monoxide alarms where fuel-burning equipment or an attached garage is present (International Residential Code R314 and R315). A plug-in natural-gas alarm is sold the same way. A field meter, by contrast, is asked to report several different quantities, from power-line magnetic fields up through millimeter-wave radio.

Consider the TriField TF2, a widely sold three-function meter that lists at $186. Its magnetic mode is three-axis and specified to ±4 percent at 60 hertz, and meters of that class can rank rooms; the 8.5 milligauss fence reading in the sports team 49ers nearby substation episode described below came from that class of meter. Its radio mode is more limited: it is one axis, covers 20 megahertz to 6 gigahertz, states its accuracy as ±20 percent only at 1 gigahertz, and reaches full scale at 19.999 milliwatts per

square meter. The 19.999 milliwatts-per-square-meter ceiling is about 0.2 percent of the 10 watt per square meter public limit used at and above 1500 megahertz, and about 0.3 percent of the 6 watt per square meter limit at 900 megahertz. A number that stays on the scale, taken in the far field, is therefore a low reading for the frequencies the meter can see. A number pinned at the top of the scale leaves open whether the field is near the public limit. The meter also stops short of the upper 6 gigahertz Wi-Fi channels and millimeter-wave 5G, and it reports a number without naming the source. In 2015 an accredited German laboratory, IMST GmbH, tested five other consumer radio meters for WILA Bonn. The meters had been bought for about €172 to €408 and were advertised to 8 gigahertz, yet none of them met the range the makers claimed.

What can be evaluated without asking a household to own the right instrument. The exposure that dominates a personal measurement is the person's own phone. A handheld meter held against a transmitting phone is in the near field, where a handheld meter's far-field power-density calibration does not apply. Phone exposure is instead bounded in the laboratory by the specific-absorption-rate test and in daily life by how long the phone is used, which the carrier can record. A tower or a broadcast antenna is bounded by calculation from power, antenna pattern, and distance, the method in FCC OET Bulletin 65, with a measurement when the calculation comes close to the limit.

Germany already separates owning the instrument from getting a result. The Federal Office for Radiation Protection lends a band-resolving personal meter, covering 50 megahertz to 6 gigahertz in 29 bands, or a separate power-frequency meter. The resident wears it for 24 hours, the office returns a written report, and the fee is 45 euros, including shipping both ways. The loaned radio meter has no live display. The office also states two limits on the report: it is information for private use rather than proof in a legal proceeding, and fields from the wearer's own phone are only a rough indication because the near field is not measured reliably. The United States has no equivalent service. Bands above 6 gigahertz fall outside both the $186 meter and the German loan program and remain a measurement gap. We propose a reference-meter program, not an unvalidated phone app, to measure the bands above 6 gigahertz.

Phone use has been widespread for about thirty years, while the studies with objective exposure records cover far fewer years. Better meters, including for the newer bands, are the first research investment, because every later study inherits the dose error.

What people should be told (Question 9)

We recommend a public message in three parts, running from what is established, through low-cost habits while the long-term studies are unfinished, to what not to buy:

- Established: heating at high power, nerve stimulation from strong low-frequency fields, and the implant rule. FDA says to keep phones and smart watches at least six inches (15 cm) from an implanted cardiac device and not to carry them in a pocket over it. FDA considers the magnetic interference risk low and has said it is not aware of adverse events from it. Apple's own instruction for its magnetic phones and chargers is more than six inches, and more than twelve

inches (30 cm) while the phone is wirelessly charging; the twelve-inch figure is the manufacturer's instruction rather than a separate FDA limit.

- Low-cost habits while the long-term studies are unfinished: hold the phone off the head for long calls, use a speaker or a wired headset, do not sleep with the phone under the pillow, and use a wire when a wire is convenient.
- Do not buy: untested "protection" gadgets. Real enclosures differ from ineffective pendants, and both differ from the radioactive jewelry banned in the Netherlands.

How we would notice a problem (Question 10)

U.S. cancer registries are strong, and they show no large rise in brain cancer through the years when mobile subscriptions exploded. Registries can rule out a large risk but not a small one, and because they do not know who used a phone heavily, they cannot close the heavy-use question.

The United States has neither a federal network of ambient radiofrequency monitors nor a dedicated national mailbox for a suspected radiofrequency health complaint. France and Switzerland run measurement programs, though Europe has no single network that covers every country.

OSHA's numeric radiofrequency guide (29 CFR 1910.97, 10 milliwatts per square centimeter from 10 MHz to 100 GHz, averaged over any 0.1 hour) is advisory rather than an enforceable exposure limit; the warning-sign specification in the same section is the mandatory part. Occupational cohort studies do exist, including military cohorts and the UK Airwave police cohort, and they show no large overall cancer increase. What the United States lacks is an enforceable occupational number tied to a worker registry with measured dose.

We recommend a practical three-part package: a pilot ambient network with a public dashboard, an exposure indicator in CDC's Environmental Public Health Tracking program, and a voluntary reporting system modeled on vaccine-adverse-event reporting, labeled clearly as reports rather than proof.

Children, pregnancy, older adults, implants, workers (Question 11)

Children are where absorption science and lifetime evidence sit furthest apart. The absorption differences are real and model-dependent. The harm studies in children, including MOBI-Kids, are too short to be the last word. And because children start using devices earlier, their lifetime dose, if a lifetime effect exists, would be the longest. We recommend a child cohort with operator-recorded use on the strength of the absorption differences, the short follow-up, and the early start; none of the three justifications predicts what the cohort will find.

Comparing populations that abstain from technology use, such as the Amish, to the digital enabled child would also be a valuable comparison.

For pregnancy, WHO-commissioned reviews rate human reproductive outcomes very-low certainty. One of them (Johnson and colleagues, 2024) reported a small-for-gestational-age relative risk of 1.13 (1.02–1.24) and a preterm risk of 1.14 whose interval included no effect. We recommend measuring exposure inside an existing birth cohort instead of relying on remembered phone use.

For older adults, the questions are heat and hearing devices. Older bodies shed heat less efficiently (a lower sweat response, for example), which bears on the heating threshold the limits are built around. Hearing-aid rules (47 CFR §20.19) require at least 85 percent of a manufacturer's handset models to be hearing-aid compatible through 14 December 2026; from 15 December 2026, 100 percent must meet acoustic coupling and at least 85 percent must meet the telecoil standard. We recommend including older adults in risk-communication materials and in guidance on hearing-device interference.

For pacemakers, defibrillators, and some insulin pumps, the settled hazard is interference from magnets and from very near transmitters rather than a cancer effect, and FDA's six-inch rule under Question 9 is the action to take.

For workers, most routine readings in occupational surveys are a small fraction of the occupational limits, but exposures in a few jobs (a walkie-talkie held at the face, some broadcast and radar work) can approach them. We recommend an enforceable standard plus a U.S. registry; the recommendation is not a claim that no worker study has ever been done.

Effects below the limits (Question 12)

No adverse health effect has been established below the public limits. "Not established" describes the state of proof, not the state of nature. Absence of demonstrated harm is not proof that every possible effect has been excluded, and for most endpoints other than heating and cancer, the studies that could exclude an effect were never done.

The NTP rat tumors occurred at whole-body exposures of 1.5 to 6 watts per kilogram, about 19 to 75 times the public whole-body limit of 0.08. The 19-to-75 multiple describes NTP only, not the Ramazzini far-field study, whose top group was about 0.1 watts per kilogram (50 volts per meter). Ramazzini's male heart schwannomas were 0 of 412, 3 of 401, 1 of 209, and 3 of 207 at 0, 5, 25, and 50 volts per meter, statistically significant at the top dose.

NTP also said its lowest level matched the maximum local exposure allowed for phone users, so the "fifty times" heating factor and the "nineteen times" tumor margin are different comparisons, and both get misused. The 75-times figure is a wider gap than the 50-times heating factor, not a narrower one. Analyses that draw a straight line from high doses down to a one-in-a-hundred-thousand risk produce much smaller margins. Linear extrapolation is an assumption the authors chose, not the way a heating threshold is usually regulated, so the result should be labeled as a model rather than a measured margin.

> Two different papers are often merged into one "20 to 900 times" interval. Uche and Naidenko 2021 start from NTP cardiomyopathy and, after uncertainty factors, place a whole-body limit 20- to 40-fold below 0.08 watts per kilogram. Melnick and Moskowitz 2026, using linear extrapolation, find limits 15- to 900-fold above their own 1-in-100,000 cancer estimates.

More Data Needed: Does Biology respond to radiofrequency fields far below the heating threshold? The clearest demonstration comes from a songbird rather than a rat. In a blinded design, European robins lost their magnetic compass when exposed to the ordinary electromagnetic noise on a university

campus, and regained it inside grounded, aluminum-screened huts that cut noise between 50 kilohertz and 5 megahertz by about two orders of magnitude (Engels and colleagues, 2014). The authors opened by observing that no effect of man-made electromagnetic noise below WHO-adopted guidelines had yet survived independent replication under blinded conditions. They then reported one, on the cover of *Nature*. The sensor is a light-driven radical-pair reaction in the retina, a mechanism that involves no heating at all, and later work in blackcaps showed that weak radiofrequency fields in the 75 to 85 megahertz band disrupt it (Leberecht and colleagues, 2023). A bird's compass is not a human organ, and the frequencies involved sit below the mobile bands, so we do not offer this as a finding about phones. What it does establish is that "below the heating threshold, nothing happens" is a hypothesis about humans that must be tested, not a settled fact about physics or biology.

The immune system is an under-examined target, and the thymus is where the signals cluster. The thymus is where T cells mature. The WHO-commissioned oxidative-stress review found its largest pooled effect there, in the rodent thymus (standardized mean difference 6.16, 3.55 to 8.76), from a single study of 42 animals, and graded the certainty very low (Meyer and colleagues, 2024). The review is right to withhold more than that. But the thymus signal does not stand alone:

- Dose-dependent tissue and immune injury. Rats exposed in sequence to 1.5 and 2.8 gigahertz microwaves, six minutes at each, at 5, 10, and 30 milliwatts per square centimeter developed congestion and lymphocyte nuclear fragmentation in the thymus, spleen, and lymph nodes, with mitochondrial damage, fewer circulating white cells through day 28, and lower serum cytokines at the two higher levels (Yao and colleagues, 2023; 108 rats, 27 per group, sham controlled). Body temperature was unchanged. The levels are five to thirty times the 10 watts per square meter public reference level, and no specific absorption rate was reported.
- Structural change at sub-thermal power. Rats exposed to 2.45 gigahertz at graded power showed increased thymic blood-vessel distribution, hemorrhagic cells, and lower Hsp90 at the highest power (Misa-Agustiño and colleagues, 2015; 64 rats). The authors modeled the exposure as sub-thermal. We have only the abstract of this paper.
- A developmental exposure at a realistic level. Rats exposed 20 hours a day for nine weeks, from gestation through the juvenile period, to a 2.14 gigahertz cellular signal at 0.2 watts per kilogram, one-twentieth of the 4 watts per kilogram associated with a 1 °C rise, showed significantly higher thymic Il4, Il5, and Il23a gene expression (Ohtani and colleagues, 2015). T-cell counts and serum IL-4 were unchanged, and the authors concluded that they found no adverse effect on T-cell populations. Sixteen genes were tested without correction for multiple comparisons, and the work was funded by Japan's telecommunications ministry.

These findings must be further explored to drive regulatory posture. The Yao exposures are well above anything the public meets, the Misa-Agustiño paper is known to us in abstract, and the Ohtani result is a gene-expression signal without a functional change. Taken together they say something more useful. In three independent designs, an organ that trains the body's immune cells showed changes in tissue structure, cytokines, or gene expression after radiofrequency exposure, and nobody has run the replicated, blinded, well-dosimetered study that would tell us whether any of it matters for a child or an adult. A modest loss of immune resilience would not appear in a cancer registry. It would appear as

slightly more infections and slower recoveries, spread across millions of people and attributed to everything else. That is the kind of effect a cancer-only standard cannot see.

Anyone citing the oxidative-stress count (93 of 100) should cite the WHO-commissioned certainty grade (very low) with it. Below the limits, harm has not been established, and for the endpoints that matter most to daily life, safety has not been demonstrated either, because the studies that would settle the question are unfinished or were never started. We ask that HHS fund studies to bridge the gap between the absence of established harm and a settled answer.

Each technology (Question 13)

Each technology brings its own band, its own power, and its own distance from the body, so the answer comes technology by technology, seven in all, from 5G networks to vehicle and implanted medical radios:

- 5G. In a 2023 four-country measurement campaign (Deprez and colleagues, 2025; 146 sites), the highest 5G-specific level was 10.4 milliwatts per square meter. The paper's results and conclusion put the maximum at 0.1 percent of the ICNIRP reference level of 10 watts per square meter, while the abstract says 3.2 percent. The arithmetic agrees with the results: 10.4 divided by 10,000 is 0.104 percent. The abstract's 3.2 percent matches the electric-field ratio, about 1.98 volts per meter divided by the 61 volt per meter reference, rather than the power-density ratio. Because power density scales with the square of the field, quoting 3.2 percent as a fraction of the power-density limit overstates it about thirty-fold. A power-density percentage should therefore be quoted as 0.1 percent, not as the abstract's 3.2. In these measurements 5G added a slice of exposure rather than a new ambient regime, and the phone remains the main personal source.
- 6G. Work on the next generation is aimed at a range of higher frequencies rather than at one band "above 95 gigahertz." The range includes bands above 100 gigahertz, where energy is deposited in the skin. The FCC's exposure table stops at 100 gigahertz, while ICNIRP's 2020 guidelines run to 300 gigahertz. Health studies at these higher frequencies are sparse.
- Wi-Fi 6 and 7. New 6-gigahertz Wi-Fi adds capacity, and measured Wi-Fi levels in schools and homes are a very small fraction of the limits but again these limits have not been fully established and studied beyond heating. A personal-dosimetry study that isolates Wi-Fi 7 has yet to be done.
- Satellites. Handsets connecting through a satellite still transmit at ordinary phone power, while downlink power at the ground from the satellites themselves is far below the public reference. A user terminal dish is a near-field source and has to be treated as one.
- Connected devices and smart homes. Most of these radios are low power and transmit briefly, so counts of devices are not counts of exposure.
- Smart meters. An Electric Power Research Institute brief describes the transmissions as short bursts that together last on the order of a minute or two per day, with exposures far below the limits even close to the meter. Exposure could be substantially higher if the manufacturers opt

to stream data continuosly. "Seconds per day" is too small a number for the EPRI description, and a bank of meters is a different object from one meter on a house.

- Vehicles and medical radios. Roadside and in-vehicle transmitters are low power and poorly measured in real cabins. Implanted medical radios are microwatts; the practical medical issue is interference from other sources, which FDA's six-inch magnet rule covers.

One pattern runs across all seven: wherever ambient fields away from the body have actually been measured, they stay far below the reference levels, the question is do those reference levels actually establish safety?

Environment, wildlife, and towers (Questions 14 and 15)

Migratory songbirds have a light-dependent magnetic compass, and laboratory radiofrequency noise can disrupt it, but only below a frequency ceiling. Fields around 75–85 MHz disrupt orientation while fields at 140–150 MHz and 235–245 MHz do not, and the physical account of the sensor puts the drop in sensitivity near 116 MHz (Leberecht and colleagues, 2023). Mobile and 5G bands sit far above the 116 MHz ceiling; the frequencies the mechanism actually implicates are lower ones, including some broadcast bands. The same sensor is the subject of the 2014 robin result under Question 12, where urban radiofrequency noise alone was enough to disable it. Wildlife is where a non-thermal radiofrequency effect has been shown most clearly, and it is the part of the environmental question the United States measures least.

One frequency band proves disruption of one cellular function, one could extrapolate that other disruptions could reasonably occur at other frequencies and therefore deserve study.

Outside the laboratory, field studies at real distances and real intensities are still scarce, and bees and plants have a mixed, mostly low-quality literature. Because the United States has no national ambient network, the federal government does not currently measure trends in environmental exposure. Livestock studies are essentially absent and belong in the ambient monitoring program we recommend under Question 10.

On siting, for a facility that already complies with FCC radiofrequency rules, 47 U.S.C. §332(c)(7)(B)(iv) bars a state or city from regulating the facility on the basis of the environmental effects of the facility's radiofrequency emissions. Local governments keep zoning authority over other issues. Health evidence, if it is to change a siting outcome, has to move the federal limit, so federal research on that limit decides the health side of siting disputes.

Neighboring exposures (not radiofrequency)

The questions answered above concern radiofrequency, but two other electromagnetic environments reached the public in 2026: a practice field beside a power substation, and deep space beyond Earth's magnetic shield. A third item, an older laboratory study of the thymus, sits beside them. Each shows a real gap, and none is evidence that a cell tower or a phone has caused the effect being discussed.

A practice field beside a power substation. The San Francisco 49ers have practiced in Santa Clara since 1988, next to Levi's Stadium and beside Silicon Valley Power's Northern Receiving Station, also called the Mission Substation in 2026 coverage. The substation was expanded when the stadium opened in 2014. In January 2026 a viral account blamed the team's soft-tissue injuries on the station's power-frequency magnetic field, and the measurement offered publicly was a consumer gaussmeter at the fence, a couple of hundred yards out, reading 8.5 milligauss.

Epidemiologists who work on power-frequency fields, including Frank de Vocht and Hans Kromhout, said 8.5 milligauss is in the range of an ordinary house and no established evidence links fields of that magnitude to tendon or ligament failure. The childhood-leukemia studies that led IARC to call power-frequency magnetic fields "possibly carcinogenic" in 2002 address a different question and identify no soft-tissue mechanism. Paul Héroux noted that the collagen experiments used much stronger fields, and that research at substation levels has been about cancer. The team's own injury record reaches back before the 2014 expansion: from 2001 to 2014, while already practicing at the site, the club was below average in injuries. On 30 January 2026 the NFL's chief medical officer, Allen Sills, said he knew of no sports-medicine literature supporting the association and that injury causation is complex. On 29 March 2026 general manager John Lynch said an unnamed scientist, using laboratory instruments inside the facility, found levels "400 times less than unsafe zones," comparable to a hair dryer or a vacuum, although the measurement report remains unpublished.

An extremely-low-frequency study of the thymus (not radiofrequency). The thymus appears in the power-frequency literature too, and we include it only to mark a pattern. In an Italian study, male rats were exposed for eight months to 50-hertz fields at 1 kilovolt per meter with 5 microtesla, or 5 kilovolts per meter with 100 microtesla, in a normal light cycle or under continuous light (Quaglino and colleagues, 2004). Continuous light alone speeds the thymus's age-related shrinkage. Adding the 50-hertz field left the rate of cell division unchanged but significantly increased thymocyte death, including against rats exposed to the field in a normal light cycle. The authors read this as a synergy between a physiological stressor and the field, and the stressed animal was the one that showed the effect. The 100 microtesla level is far above a household average, and the paper is a single study. It is nonetheless a reminder that an effect may depend on the state of the organism, and that studies run on healthy animals under ideal conditions may be the least likely to find it.

The 49ers episode exposed a gap in both measurement and literature. A workplace next to a large electrical plant produced a national argument that published studies could not settle, because the published literature asked about leukemia, not about Achilles tendons, and no public dosimetry of the practice fields existed when the claim spread.

Astronauts beyond Earth's magnetic shield. Earth's surface field is about 25 to 65 microtesla, and the magnetosphere deflects much of the charged radiation from the Sun and from the galaxy. The International Space Station stays inside the magnetosphere, whereas Artemis II, which NASA described in March 2026, is the first crew to go beyond it since Apollo 17 in 1972.

On a trip beyond the magnetosphere, NASA's health problem is ionizing radiation: galactic cosmic rays, including heavy ions, and solar particle events. A NASA briefing puts a typical station dose near 0.6

millisievert a day and the deep-space galactic-cosmic-ray rate at about two to three times that. Mars has no global magnetic field. The Simonsen briefing's planning range for a long Mars mission is 1 to 1.3 sievert, and a 2025 NASA paper treats 600 millisievert as the standard for the longest Mars-class missions. Biological uncertainty remains large enough that engineers cannot size shielding with confidence inside the mass a spacecraft can carry. The uncertainty concerns ionizing radiation, which HHS-OASH-2026-0397 does not regulate.

A second space question is easy to merge with the first and needs to be kept separate. Beyond the magnetosphere the static field itself falls to a few nanotesla, thousands of times below the surface field. Ground experiments that shield the geomagnetic field report changes in cells and in the nervous system. A 2021 review for spaceflight (Zhang, *Bioelectromagnetics*) treats the hypomagnetic effects as real in animals and still missing the human dose-response. The human evidence is thin: a 2025 review of whole-body human studies found an effect reported in 10 experiments and none in 4, and counted only 14 such experiments since 1967. NASA's Human Research Program scores ionizing radiation as a mission risk, yet NASA has no exposure limit for the near-zero static field. The station crews, who stay inside the magnetosphere, offer no test of hypomagnetic exposure.

Extensive research has been published on Pulsed Electromagnetic Field Therapy (PEMF) and its biological impacts. While in a different range of emissions the impact that these specific EMF cause also indicates other biological impacts on humans for different frequencies and levels.

Taken together, the substation argument, the thymus study, and the deep-space exposures are evidence that the interaction of human biology with electromagnetic and magnetic environments remains unsettled. They are evidence of four different kinds: the substation claim is an untested injury hypothesis at household-range power-frequency fields; the thymus study is a single animal finding that appears only under co-stress; the cosmic-ray problem is an accepted ionizing-radiation risk whose size is still too uncertain for engineering; and the near-zero static field is a thin experimental literature with no operational limit. None of the four is a finding about radiofrequency, and all four point the same way: the question of what electromagnetic environments do to living tissue has been asked in pieces, by different agencies, and never answered whole.

Research priorities and coordination (Questions 16 and 17)

Waiting for a cancer signal is the wrong test, and the United States has already learned that once. Lead was blended into gasoline from the 1920s; EPA began restricting it in 1973 and finished a 25-year effort in January 1996, after which, in EPA's words, "blood levels of lead in our children are down 70 percent." The harm in that case was not a rare tumor. It was a diffuse loss of capacity, spread across a population and attributed to everything else. The same logic applies here. Adult obesity has risen from about 15 percent of adults in 1976 to 1980 to 40.3 percent in 2021 to 2023, and CDC reports that 90 percent of the nation's $5.3 trillion in annual health care spending goes to people with chronic and mental health conditions. We do not claim that radiofrequency fields cause any of this. We claim that electromagnetic exposure is one of the few universal environmental changes of that era that has never been studied for chronic, whole-body effects, and that a program serious about the causes of chronic disease should

close that gap. A one-percent gain in healthy working years across the population would justify the cost of every study below many times over.

We rank five research priorities, and measurement leads because every later study inherits the dose error:

1. Measure first. Personal dosimeters that work across the bands now in use, with a stated uncertainty.
2. Follow children and long-term users, with phone-company records rather than memory, long enough to test a 20-year lag. Include a low-technology comparison population. The Amish of Ohio, who use little electricity, have an all-cancer incidence about 60 percent of the Ohio rate (Westman and colleagues, 2010), a difference that tobacco abstinence explains only in part. That is a comparison group, not an answer, but it is a ready one.
3. Repeat the animal bioassay under modern rules, at exposures that include realistic levels, so the heart-tumor finding is confirmed, bounded, or refuted. Two 2026 GLP studies in male rats (900 MHz CDMA, 4 watts per kilogram, about 18 hours a day for two years) found no significant tumor increase in brain, heart, or adrenal. Because they are not a both-sex, both-modulation, three-dose repeat of NTP, they leave the question open, but a new study list that ignores them is one-sided.
4. Retest the cell-stress and immune literature in several laboratories, pre-registered, temperature-controlled, and blinded, to learn whether the 93-of-100 count and the thymus findings survive a rigorous replication; the current certainty grade is very low. Add immune endpoints (thymus histology, lymphocyte counts, cytokines, vaccine response) and developmental exposure windows to the protocol.
5. Workers. An enforceable occupational standard and a registry that links measured dose to disease.

A radiofrequency program leaves three questions unanswered: the power-frequency question left open when EMF-RAPID ended, and the ionizing-radiation and near-zero-field questions NASA faces beyond low Earth orbit. Each belongs beside the radiofrequency program, with its own exposure named, rather than inside it as extra evidence about phones.

No single agency owns the question. Responsibility splits four ways, by function:

- FCC. The FCC authorizes equipment and sets exposure rules.
- FDA. FDA handles medical devices and electronic-product radiation but does not set the phone exposure limit.
- NIH and NTP. NIH and NTP do research, although NTP has stopped its radiofrequency laboratory program.
- CDC. CDC tracks public health, but its environmental tracking network has no radiofrequency indicator.

We propose a small chartered interagency program, with a shared agenda and a scheduled look at the limits. The interagency body is our proposal rather than GAO's: in 2012 GAO recommended that the FCC

formally reassess the exposure limit and the body-worn phone tests, and both recommendations were later closed as not implemented. In structure the program would succeed EMF-RAPID, but it would have to cover radiofrequency, which EMF-RAPID did not. The 1992 statute authorized $65 million over five years for EMF-RAPID, with a required one-to-one non-federal match; the $65 million figure is a precedent, not a budget for the program proposed here.

Twenty-seven studies, one line each

The full portfolio runs to twenty-seven studies in six groups, starting with measurement and ending with the standing machinery that puts the reviews and the limits on a schedule:

Measure first

- S1 — Better personal exposure meters. A reference-grade dosimeter from 700 MHz to 100 GHz that separates handset from tower signals; a loan service can cover today's bands but cannot see past 6 GHz.
- S2 — One yardstick for cumulative exposure. Duty cycle, beamforming, distance, and time, combined the same way by every later study.
- S3 — Test the gadgets people buy. Independent tests of consumer meters and phone apps against reference instruments, with the power-frequency mode graded separately from the radio mode.
- S4 — Measure classrooms and playgrounds. A national campaign so that school debates can use numbers.

Long-term studies

- S5 — Follow children from school entry. Objective exposure, operator records, and enough years to outlast a childhood, with a low-technology comparison group and infection and immune markers recorded alongside growth and cognition.
- S6 — Pregnancy, measured. Add dosimetry to an existing birth cohort in place of remembered phone use, which is the wrong exposure.
- S7 — Keep the adult cohorts running until follow-up can test a 20-year lag.
- S8 — The heavy-use tail, with the bias quantified. Pool the case-control studies and adjust for memory and for which ear was used.

Mechanisms

- S9 — A pre-registered retest of the cell-stress and immune studies. Several laboratories, the same protocol, temperature matched, blinded, with thymus and other immune endpoints included and a developmental exposure arm.
- S10 — Whether the peak matters. The same average exposure, delivered as a steady wave, as a 5G waveform, and as an older pulse, across sleep, heart rhythm, and barrier endpoints.
- S11 — The 1990s claims, rerun. Calcium "windows" and the blood-brain-barrier reports, retested with modern dosimetry. Three 2009 replications were null for both continuous-wave

and pulsed exposures; a later study found a delayed albumin increase at 13 watts per kilogram in the rat head, which is not a phone-use level.

- S12 — Can a cell membrane demodulate the signal? A physics test at 5G frequencies. A 2010 cavity experiment found no such second harmonic.

Animals and surveillance

- S13 — Repeat the rat study. Multi-site, two years, doses below and above real-world levels, temperature recorded, and a protocol that can be compared with the 2026 Japan and Korea GLP arms as well as with NTP.
- S14 — The margin, computed in public. Independent re-analyses of the NTP dose-response, with the model assumptions stated.
- S15 — Monitors that measure the background. A national ambient network and a public dashboard.
- S16 — A mailbox for symptom reports. Structured, coded, and labeled as reports rather than proof of cause.
- S17 — Workers. A registry of tower, broadcast, and radar workers, and the analysis for an enforceable OSHA limit.

Special populations, environment, history

- S18 — Fertility, with a meter. Scrotal dose measured over months, then semen quality. A 2014 meta-analysis reported about an 8 percentage-point lower motility with phone exposure and very high heterogeneity; later WHO-commissioned work rates the human evidence very-low certainty. Recalled phone use is not a dose.
- S19 — IVF records plus measured exposure.
- S20 — Implant interference, watched as products change. Mine FDA adverse-event reports and keep the six-inch guidance current.
- S21 — Hearing aids and phones. Through 14 December 2026, at least 85 percent of a manufacturer's handset models must be hearing-aid compatible; from 15 December 2026, 100 percent must meet acoustic coupling and at least 85 percent the telecoil standard. Whether users actually see less interference is unmeasured.
- S22 — Wildlife, with the field measured. Birds, insects, and plants, at known levels.
- S23 — The bird compass, at the frequencies the mechanism names. Test where disruption is predicted (below about 116 MHz) and where it is not (mobile bands). A design that labels 70–150 MHz as "all above the ceiling" is wrong: 75–85 MHz disrupts, and 140–150 MHz did not.
- S24 — A century of exposure, assigned by place and birth year, linked to registries. S24 is the study that can use the historical record; the record itself is not a result.
- S25 — The earliest heavy users, now approaching thirty years of use, followed for tumors and neurological disease.

The standing machinery

- S26 — Reviews on a cycle. Repeat the WHO-style systematic reviews every five years.
- S27 — One interagency agenda, with a date on which the limits are formally reconsidered.

Recap in one paragraph

Heat, nerve stimulation, and implant interference are established and already have rules. Everyday exposure away from the body is considered "low" relative to the reference levels, and a health effect at everyday levels has not been established. In the pooled human evidence, population brain-cancer rates have not risen with phone use. But a cancer registry is a blunt instrument. The question stays open because male rats developed a rare heart tumor at high exposure, because a large cellular literature is still graded very-low certainty, because a blinded study showed that urban radiofrequency noise disables a bird's non-thermal magnetic sensor, because immune tissue in rats has responded in several designs, and because no cohort has watched a heavy user from youth through a full latency. We recommend the measurement network, the child cohort, the bioassay replication, immune and developmental endpoints, and a chartered interagency program, each of them ordinary scientific work. Enough is known to take the question seriously, and not enough is known to close it.

How the research was done

The research agents worked under a verification rule: a claim used as a number had to be checked in more than one source, and an unverified item had to be labeled rather than upgraded. An architect turned the RFI into eight topics and 85 sub-questions, and eighty-five research agents gathered the evidence; twelve of the sub-questions had to be run again after a failed first pass. Eight synthesis agents compressed the sub-studies, and a critic then reviewed the master in four rounds, with three correction passes. The run log counts 102 agent tasks in total, including the architect, the master synthesis, the critics, and the finalize passes. The research and draft report was then human reviewed and every word was read and edited for clarity.

Sources for the claims above

Claim	Source
NTP "clear evidence," male-rat heart schwannoma; GSM 0/2/1/5 and CDMA 0/2/3/6 per 90 across 0, 1.5, 3, 6 W/kg; "some evidence" for brain tumors in male rats	NTP Technical Report 595. https://ntp.niehs.nih.gov/go/tr595abs
Results should not be extrapolated directly to phone use; whole-body exposure; lowest level matched the maximum local phone limit; highest level was four times that	NIH/NIEHS release on the final reports, 1 Nov 2018. https://www.nih.gov/news-events/news-releases/high-exposure-radio-frequency-radiation-associated-cancer-male-rats
High certainty for malignant heart schwannomas in male rats and for gliomas; most other organs no or minimal evidence; human extrapolation "particularly complex"; BMDs reported	Mevissen et al., *Environment International* 199:109482 (2025). https://doi.org/10.1016/j.envint.2025.109482
Glioma mRR 1.01 (0.89–1.13); meningioma 0.92 (0.82–1.02); acoustic neuroma 1.03 (0.85–1.24); no increase with time since start or cumulative call time; 63 articles	Karipidis et al., *Environment International* 191:108983 (2024). https://doi.org/10.1016/j.envint.2024.108983

Claim	Source
93 of 100 low-intensity studies reported oxidative effects	Yakymenko et al., *Electromagnetic Biology and Medicine* 35:186–202 (2016). https://doi.org/10.3109/15368378.2015.1043557
Oxidative-stress evidence very-low certainty; majority high risk of bias; thymus modified proteins SMD +6.16 (3.55, 8.76), 1 study, n=42	Meyer et al., *Environment International* 194:108940 (2024). https://doi.org/10.1016/j.envint.2024.108940
1.5 + 2.8 GHz, 5/10/30 mW/cm²; thymus, spleen, lymph node injury; fewer white cells to day 28; lower cytokines at 10 and 30; n=27 per group; no SAR reported; body temperature unchanged	Yao et al., *International Journal of Environmental Research and Public Health* 20(6):4988 (2023). https://doi.org/10.3390/ijerph20064988 · full text https://pmc.ncbi.nlm.nih.gov/articles/PMC10049199/
2.45 GHz at 0, 1.5, 3, 12 W; 64 rats; thymic vascular and hemorrhagic change; Hsp90 down at 12 W; abstract only	Misa-Agustiño et al., *Life Sciences* (2015). https://doi.org/10.1016/j.lfs.2015.01.027 · https://pubmed.ncbi.nlm.nih.gov/25731700/
2.14 GHz W-CDMA, 0.2 W/kg (2.5 × the ICNIRP public whole-body limit), 20 h/day for 9 weeks; T-cell counts and IL-4 protein unchanged; thymic Il4, Il5, Il23a mRNA up; Japan MIC funding	Ohtani et al., *Journal of Radiation Research* (2015). https://doi.org/10.1093/jrr/rru126 · full text https://pmc.ncbi.nlm.nih.gov/articles/PMC4426920/

Claim	Source
50 Hz at 1 kV/m + 5 µT or 5 kV/m + 100 µT for 8 months; with continuous light, thymocyte death increased and mitosis unchanged; abstract only	Quaglino et al., *TheScientificWorldJournal* 4 (2004). https://doi.org/10.1100/tsw.2004.183 · https://pmc.ncbi.nlm.nih.gov/articles/PMC5956364/
European robins lost magnetic orientation in urban electromagnetic noise (50 kHz–5 MHz) and regained it in screened huts	Engels et al., *Nature* 509:353–356 (2014). https://doi.org/10.1038/nature13290
Leaded gasoline phaseout concluded January 1996 after a 25-year effort; children's blood lead down 70 percent	U.S. EPA, "EPA Takes Final Step in Phaseout of Leaded Gasoline," 29 Jan 1996. https://www.epa.gov/archive/epa/aboutepa/epa-takes-final-step-phaseout-leaded-gasoline.html
Adult obesity prevalence 40.3 percent, August 2021–August 2023	NCHS Data Brief 508 (2024). https://www.cdc.gov/nchs/products/databriefs/db508.htm
Adult obesity about 15 percent in 1976–1980	Fryar, Carroll, and Ogden, NCHS Health E-Stat, trends 1960–1962 through 2009–2010. https://www.cdc.gov/nchs/data/hestat/obesity_adult_09_10/obesity_adult_09_10.htm
90 percent of $5.3 trillion in annual U.S. health care expenditures is for people with chronic and mental health conditions	CDC, Chronic Disease Facts and Statistics. https://www.cdc.gov/chronic-disease/data-research/facts-stats/index.html

Claim	Source
Ohio Amish all-cancer incidence 60 percent of the Ohio adult rate; tobacco-related 37 percent, non-tobacco-related 72 percent	Westman et al., *Cancer Causes & Control* (2010). https://doi.org/10.1007/s10552-009-9435-7
41 experimental studies, 2,874 participants; headache SMD 0.08 (−0.07 to 0.22); volunteers could not detect exposure above chance	Bosch-Capblanch et al., *Environment International* 187:108612 (2024). https://doi.org/10.1016/j.envint.2024.108612
Public whole-body basic restriction 0.08 W/kg; local 2 W/kg over 10 g; guidelines to 300 GHz; brief-exposure limits included	ICNIRP, *Health Physics* 118(5):483–524 (2020). https://www.icnirp.org/cms/upload/publications/ICNIRPrfgdl2020.pdf
U.S. phone limit 1.6 W/kg over 1 g; MPE table through 100 GHz	47 CFR §1.1310. https://www.ecfr.gov/current/title-47/section-1.1310
Remand without vacatur	*Environmental Health Trust v. FCC*, 9 F.4th 893 (D.C. Cir. 2021)
2026 comment period on the remanded issues; limits not vacated by the notice	FCC Public Notice DA 26-997, ET Docket 13-84, 91 FR 60128 (22 Sep 2026). https://www.fcc.gov/document/fcc-requests-comment-rf-exposure-remand-0
FCC had not formally asked health agencies to reassess; both recommendations closed, not implemented	GAO-12-771 (2012). https://www.gao.gov/products/gao-12-771

Claim	Source
EMF-RAPID: enacted 1992, ended 31 Dec 1998; ELF, not RF; weak evidence; passive regulatory action	NIEHS report to Congress on the EMF-RAPID program
Poland's current public limits match the 1998 European recommendation; in force 1 Jan 2020; 61 V/m and 10 W/m² from 2–300 GHz	Rozporządzenie Ministra Zdrowia, 17 Dec 2019, Dz.U. 2019 poz. 2448. https://eli.gov.pl/eli/DU/2019/2448/ogl
France: national limits under décret n° 2002-775; Wi-Fi rules for young children under loi n° 2015-136	https://www.radiofrequences.gouv.fr/la-reglementation-associee-a74.html
Israel: chronic public exposure from base stations limited to 1/10 of ICNIRP; shorter-stay areas 30%	Tnuda FAQ, citing the Ministry of Environmental Protection. https://tnuda.org.il/en/faq/6
India base-station limits: one-half of ICNIRP from the 1 Jan 2025 letter (f/400; 5 W/m² from 2–300 GHz). The portal's "1/5th" sentence does not match its own table	DoT, "A Journey for EMF," letter No. 16-10/2022/CS-2. https://dot.gov.in/journey-emf · table https://tarangsanchar.gov.in/EMFPortal/DoT/EMFRadiationNorms

Claim	Source
Own-phone 67.2% is the share of measured personal exposure, not brain dose; environmental sources 6.0% of modeled brain dose	Roser et al., *Environment International* 99:303–314 (2017). https://doi.org/10.1016/j.envint.2016.12.008
On-body meters: ExpoM-RF median ratio 0.79 (IQR 0.55–1.1); EmeSpy 200 median ratio 0.29 (0.22–0.38); 267 microenvironments	Huss et al., *Environment International* 156:106711 (2021). https://doi.org/10.1016/j.envint.2021.106711
TriField TF2 lists at $186. RF mode: 20 MHz–6 GHz, single axis, ±20% at 1 GHz, full scale 19.999 mW/m² (about 0.2% of 10 W/m², about 0.3% of 6 W/m²). Magnetic mode: 3-axis, ±4% at 50/60 Hz	AlphaLab product page, observed 12 Oct 2026. https://trifield.com/products/trifield®-emf-meter-model-tf2
Five consumer RF meters bought at about €172–€408 and advertised to 8 GHz did not meet those specifications in an anechoic chamber	WILA Bonn, measurements by IMST GmbH, Kamp-Lintfort; purchases summer 2015. English copy: https://www.emfanalysis.com/wp-content/uploads/2016/01/German-Test-Report-RF-Meters.pdf

Claim	Source
Germany lends an ExpoM-RF4 (50 MHz–6 GHz, 29 bands) or an ExpoM-ELF for 24 hours and writes a report for €45. The report is not legal proof. The wearer's own phone is only a rough near-field indication. The radio meter has no live display	Bundesamt für Strahlenschutz, Messgeräteverleih. https://www.bfs.de/DE/themen/emf/kompetenzzentrum/verleih/verleih.html
Fixed transmitters can be evaluated from power, antenna pattern, and distance, with measurement when the prediction approaches the limit	FCC OET Bulletin 65, Edition 97-01 (August 1997). https://www.fcc.gov/Bureaus/Engineering_Technology/Documents/bulletins/oet65/oet65.pdf
Model residential code: smoke alarms required; carbon monoxide alarms required where fuel-burning equipment or an attached garage is present	International Residential Code R314 and R315 (2021). https://codes.iccsafe.org/content/IRC2021P2/chapter-3-building-planning
INTERPHONE glioma OR 0.81 (regular use) and 1.40 (≥1,640 h); authors: bias and error prevent a causal interpretation	INTERPHONE Study Group, *International Journal of Epidemiology* 39:675–694 (2010). https://doi.org/10.1093/ije/dyq079

Claim	Source
Cardiomyopathy BMD, 20- to 40-fold; separate from the 15- to 900-fold linear cancer model	Uche & Naidenko, *Environmental Health* 20:84 (2021). https://doi.org/10.1186/s12940-021-00768-1 · Melnick & Moskowitz, *Environmental Health* (2026). https://doi.org/10.1186/s12940-026-01288-6
Ramazzini male heart schwannoma 0/412, 3/401, 1/209, 3/207 at 0, 5, 25, 50 V/m; significant at 50 V/m; top whole-body SAR about 0.1 W/kg	Falcioni et al., *Environmental Research* 165:496–503 (2018). https://doi.org/10.1016/j.envres.2018.01.037
2026 GLP bioassays, male rats, 900 MHz CDMA, 4 W/kg: no significant neoplastic increase in major organs including brain, heart, and adrenal	Imaida et al., *Toxicological Sciences* (2026), https://doi.org/10.1093/toxsci/kfag002 · Kim et al., https://doi.org/10.1093/toxsci/kfag001
5G-specific maximum 10.4 mW/m² = 0.1% of the 10 W/m² reference in the results and conclusion. The abstract's 3.2% is the electric-field ratio (about 1.98/61 V/m), not the power-density ratio	Deprez et al., *Bioelectromagnetics* 46:e70019 (2025). https://doi.org/10.1002/bem.70019 · full text https://pmc.ncbi.nlm.nih.gov/articles/PMC12365728/
Bird compass: no effect at 140–150 MHz or 235–245 MHz; sensitivity falls above about 116 MHz; 75–85 MHz does disrupt; radical-pair mechanism	Leberecht et al., *PNAS* 120:e2301153120 (2023). https://doi.org/10.1073/pnas.2301153120

Claim	Source
49ers practice fields beside Silicon Valley Power since 1988; January 2026 fence reading 8.5 mG; experts reject a tendon mechanism at that level; team measurement of 29 March 2026 is unpublished	Washington Post, 15 Jan 2026, https://www.washingtonpost.com/sports/2026/01/15/injuries-49ers-emf-theory-substation/ · NFL chief medical officer Allen Sills, 30 Jan 2026 · 49ers GM John Lynch, 29 March 2026
ELF magnetic fields, Group 2B, on childhood-leukemia epidemiology	IARC Monograph 80 (2002). https://publications.iarc.who.int/Book-And-Report-Series/Iarc-Monographs-On-The-Identification-Of-Carcinogenic-Hazards-To-Humans/Non-ionizing-Radiation-Part-1-Static-And-Extremely-Low-frequency-ELF-Electric-And-Magnetic-Fields-2002
Artemis II is the first crew beyond the magnetosphere since Apollo 17	NASA Scientific Visualization Studio, id 5622, released 5 March 2026. https://svs.gsfc.nasa.gov/5622/
Station dose about 0.6 mSv/day; deep-space galactic cosmic rays about 2–3 times that; long Mars mission on the order of 1–1.3 Sv	Lisa Simonsen, NASA, "Space Radiation Technologies for Human Missions beyond Low-Earth-Orbit" (2021 briefing). https://ntrs.nasa.gov/citations/20210023466
600 mSv cited as the standard for the longest Mars-class missions; shielding mass still prohibits a large reduction	NASA NTRS 20250006168 (2025)

Claim	Source
Hypomagnetic field: animal effects summarized for spaceflight; human dose-response not established. An effect was reported in 10 whole-body human studies and absent in 4	Zhang, *Bioelectromagnetics* 42:516–531 (2021). https://doi.org/10.1002/bem.22360 · Kaspranski, Binhi, and Koshel, *Life* 15:1766 (2025). https://doi.org/10.3390/life15111766
Local preemption where the facility complies with FCC RF rules	47 U.S.C. §332(c)(7)(B)(iv). https://www.law.cornell.edu/uscode/text/47/332
Six inches from implanted devices; risk described as low; no adverse events identified by FDA at the time of the notice	FDA. https://www.fda.gov/radiation-emitting-products/cell-phones/magnets-cell-phones-and-smart-watches-may-affect-pacemakers-and-other-implanted-medical-devices
Twelve inches while wirelessly charging	Apple support (manufacturer instruction; FDA links to it). https://support.apple.com/en-us/HT211900
Ten radioactive "negative ion" / anti-5G items; sale prohibited	Netherlands ANVS, 16 Dec 2021. https://english.autoriteitnvs.nl/latest/news/2021/12/16/do-you-have-a-quantum-pendant-anti-5g-pendant-or-a-negative-ion-jewellery-item-or-sleep-mask-if-so-store-it-away-safely
Smart-meter bursts on the order of a minute or two per day	EPRI Smart Meter FAQ Information Brief, product 3002028427 (2023). https://www.epri.com/research/products/000000003002028427
OSHA 10 mW/cm² provision	29 CFR §1910.97, in the non-mandatory section. https://www.osha.gov/laws-regs/regulations/standardnumber/1910/1910.97
Sperm motility mean difference −8.1 percentage points (−13.1 to −3.2), high heterogeneity	Adams et al., *Environment International* 70:106–112 (2014). https://doi.org/10.1016/j.envint.2014.04.015

Claim	Source
Hearing-aid compatibility: 85% of models through 14 Dec 2026; from 15 Dec 2026, 100% acoustic coupling and at least 85% telecoil	47 CFR §20.19
Siting preemption is about emissions compliance	47 U.S.C. §332(c)(7)
Citation index used for the counts in the header	`citations-master-index.md` (2,608 table rows; 1,887 unique URLs). `manifest.json` `citationTableRows` and `urlCount` do not match that file.
Agent counts	`manifest.json`: research 85, reruns 12, cluster syntheses 8, total tasks 102

The technical response and the master formula carry the remaining quantitative claims, including study-level intervals. Where this brief and an abstract or a secondary write-up disagree, the primary source in this table controls. The known case is Deprez 2025: use 0.1 percent, and cite the abstract's 3.2 percent only as the abstract's error.

Prepared for Docket HHS-OASH-2026-0397. Comments due 21 October 2026. This file contains no personal information.

Contact:

John Byron Hanby IV gov@hanbytechnologies.com

References

Companion to the RFI response and Attachment B · HHS-OASH-2026-0397

The 144 sources cited in the RFI response and in Attachment B fall into four groups: 52 peer-reviewed publications; 37 government, intergovernmental and agency reports and records; 46 standards, regulations and legal records; and 9 other sources, chiefly professional-society, industry, manufacturer and news pages. Locations refer to the response's sections (Metadata, Summary, Q3–Q18, Methodology, Full version) and to the Attachment B study numbers (S1–S27):

Peer-reviewed literature

- Adams et al. 2014: Adams JA, Galloway TS, Mondal D, Esteves SC, Mathews F. 2014. Effect of mobile telephones on sperm quality: a systematic review and meta-analysis. *Environment International* 70:106–112. https://doi.org/10.1016/j.envint.2014.04.015. Cited in: Summary; S18.
- Aerts et al. 2020: Aerts S, Van den Bossche M, Vergara X, Odie S, Verloock L, Martens L, et al. 2020. Spatial and temporal assessment of radiofrequency electromagnetic fields emitted by smart meters and smart meter banks in urban environments. *Environmental Research* 183:109196. https://doi.org/10.1016/j.envres.2020.109196. Cited in: Q13.
- Airwave: Di Gravio C, Elliott P, Muller DC. 2026. Personal radio use and risk of cancers among police officers in Great Britain: Results from the airwave health monitoring study. *International Journal of Cancer* 158(9):2289–2297. https://doi.org/10.1002/ijc.70255. Cited in: Q11.
- Aydin et al. 2011; CEFALO: Aydin D, Feychting M, Schüz J, Tynes T, Andersen TV, Schmidt LS, et al. 2011. 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. https://doi.org/10.1093/jnci/djr244. Cited in: Q10, Q11; S5.
- Bawin/Adey; Bawin & Adey: Bawin SM, Adey WR. 1976. Sensitivity of calcium binding in cerebral tissue to weak environmental electric fields oscillating at low frequency. *Proceedings of the National Academy of Sciences of the United States of America* 73(6):1999–2003. https://doi.org/10.1073/pnas.73.6.1999. Cited in: S11.
- Benke et al. 2024: Benke G, Abramson MJ, Brzozek C, McDonald S, Kelsall H, Sanagou M, et al. 2024. The effects of radiofrequency exposure on cognition: A systematic review and meta-analysis of human observational studies. *Environment International* 188:108779. https://doi.org/10.1016/j.envint.2024.108779. Cited in: S26 (the WHO 2024–2025 review pipeline, cognition).
- Blackman: Blackman CF, Benane SG, Elder JA, House DE, Lampe JA, Faulk JM. 1980. Induction of calcium-ion efflux from brain tissue by radiofrequency radiation: effect of sample number and modulation frequency on the power-density window. *Bioelectromagnetics* 1(1):35–43. https://doi.org/10.1002/bem.2250010104. Cited in: S11.
- Bolte 2011: Bolte JF, van der Zande G, Kamer J. 2011. Calibration and uncertainties in personal exposure measurements of radiofrequency electromagnetic fields. *Bioelectromagnetics* 32(8):652–663. https://doi.org/10.1002/bem.20677. Cited in: Q7.
- Bosch-Capblanch 2024: Bosch-Capblanch X, Esu E, Oringanje CM, Dongus S, Jalilian H, Eyers J, et al. 2024. The effects of radiofrequency electromagnetic fields exposure on human self-reported symptoms: A systematic review of human experimental studies. *Environment International* 187:108612. https://doi.org/10.1016/j.envint.2024.108612. Cited in: Q4, Q6.
- Castaño-Vinyals et al. 2022; MOBI-Kids: Castaño-Vinyals G, Sadetzki S, Vermeulen R, Momoli F, Kundi M, Merletti F, et al. 2022. Wireless phone use in childhood and adolescence and neuroepithelial brain tumours: Results from the international MOBI-Kids study. *Environment*

International 160:107069. https://doi.org/10.1016/j.envint.2021.107069. Cited in: Q10, Q11; S5, S8.

- CERENAT: Coureau G, Bouvier G, Lebailly P, Fabbro-Peray P, Gruber A, Leffondre K, et al. 2014. Mobile phone use and brain tumours in the CERENAT case-control study. *Occupational and Environmental Medicine* 71(7):514–522. https://doi.org/10.1136/oemed-2013-101754. Cited in: S8.
- Christ (Wiart/Christ/Gandhi): Christ A, Gosselin MC, Christopoulou M, Kühn S, Kuster N. 2010. Age-dependent tissue-specific exposure of cell phone users. *Physics in Medicine and Biology* 55(7):1767–1783. https://doi.org/10.1088/0031-9155/55/7/001. Cited in: Summary; Q11.
- Deltour et al. 2022: Deltour I, Poulsen AH, Johansen C, Feychting M, Johannesen TB, Auvinen A, et al. 2022. Time trends in mobile phone use and glioma incidence among males in the Nordic Countries, 1979–2016. *Environment International* 168:107487. https://doi.org/10.1016/j.envint.2022.107487. Cited in: Summary; Q10, Q18.
- Deprez et al. 2025: Deprez K, Stroobandt B, Veludo AF, Vecsei Z, Necz PP, Politański P, et al. 2025. 5G RF EMF Spectral Exposure Assessment in Four European Countries. *Bioelectromagnetics* 46(6):e70019. https://doi.org/10.1002/bem.70019. Full text: https://pmc.ncbi.nlm.nih.gov/articles/PMC12365728/. Cited in: Q13; Methodology.
- Eltiti 2018: Eltiti S, Wallace D, Russo R, Fox E. 2018. Symptom Presentation in Idiopathic Environmental Intolerance With Attribution to Electromagnetic Fields: Evidence for a Nocebo Effect Based on Data Re-Analyzed From Two Previous Provocation Studies. *Frontiers in Psychology* 9:1563. https://doi.org/10.3389/fpsyg.2018.01563. Cited in: Q3.
- Feychting et al. 2024; COSMOS: Feychting M, Schüz J, Toledano MB, Vermeulen R, Auvinen A, Harbo Poulsen A, et al. 2024. Mobile phone use and brain tumour risk - COSMOS, a prospective cohort study. *Environment International* 185:108552. https://doi.org/10.1016/j.envint.2024.108552. Cited in: Summary; Q6, Q10, Q16; S7, S25.
- Frei et al. 2011; Danish subscriber cohort: Frei P, Poulsen AH, Johansen C, Olsen JH, Steding-Jessen M, Schüz J. 2011. Use of mobile phones and risk of brain tumours: update of Danish cohort study. *BMJ* 343:d6387. https://doi.org/10.1136/bmj.d6387. Cited in: Summary; Q6, Q10; S7.
- Gandhi (Wiart/Christ/Gandhi): Gandhi OP, Morgan LL, de Salles AA, Han YY, Herberman RB, Davis DL. 2012. Exposure limits: the underestimation of absorbed cell phone radiation, especially in children. *Electromagnetic Biology and Medicine* 31(1):34–51. https://doi.org/10.3109/15368378.2011.622827. Cited in: Q11.
- GRADE: Morgan RL, Thayer KA, Bero L, Bruce N, Falck-Ytter Y, Ghersi D, et al. 2016. GRADE: Assessing the quality of evidence in environmental and occupational health. *Environment International* 92–93:611–616. https://doi.org/10.1016/j.envint.2016.01.004. Cited in: Q18; S26.
- Hardell: Hardell L, Carlberg M, Hansson Mild K. 2013. Use of mobile phones and cordless phones is associated with increased risk for glioma and acoustic neuroma. *Pathophysiology* 20(2):85–110. https://doi.org/10.1016/j.pathophys.2012.11.001. Cited in: S8.

- Hareuveny et al. 2015: Hareuveny R, Kavet R, Shachar A, Margaliot M, Kheifets L. 2015. Occupational exposures to radiofrequency fields: results of an Israeli national survey. *Journal of Radiological Protection* 35(2):429–445. https://doi.org/10.1088/0952-4746/35/2/429. Cited in: Q3, Q11.
- Huang 2022: Huang PC, Chiang JC, Cheng YY, Cheng TJ, Huang CY, Chuang YT, et al. 2022. Physiological changes and symptoms associated with short-term exposure to electromagnetic fields: a randomized crossover provocation study. *Environmental Health* 21(1):31. https://doi.org/10.1186/s12940-022-00843-1. Cited in: Q3.
- Huss et al. 2021: Huss A, Dongus S, Aminzadeh R, Thielens A, van den Bossche M, Van Torre P, et al. 2021. Exposure to radiofrequency electromagnetic fields: Comparison of exposimeters with a novel body-worn distributed meter. *Environment International* 156:106711. https://doi.org/10.1016/j.envint.2021.106711. Cited in: Q7; S1.
- Imaida et al.; Japan–Korea GLP bioassays: Imaida K, Kawabe M, Wang J, Yokohira M, Imai N, Han KH, et al. 2026. The International Collaborative Animal Study of mobile phone radiofrequency radiation carcinogenicity and genotoxicity: the Japanese study. *Toxicological Sciences* 209(3):kfag002. https://doi.org/10.1093/toxsci/kfag002. Cited in: Summary; Q16; S13; Methodology.
- INTERPHONE: INTERPHONE Study Group. 2010. 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. https://doi.org/10.1093/ije/dyq079. Cited in: Summary; Q6, Q12; S7, S8.
- Johnson 2024: Johnson EE, Kenny RPW, Adesanya AM, Richmond C, Beyer F, Calderon C, et al. 2024. The effects of radiofrequency exposure on adverse female reproductive outcomes: A systematic review of human observational studies with dose–response meta-analysis. *Environment International* 190:108816. https://doi.org/10.1016/j.envint.2024.108816. Cited in: Q11; S6, S19, S26.
- Karipidis et al. 2024: Karipidis K, Baaken D, Loney T, Blettner M, Brzozek C, Elwood M, et al. 2024. 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. https://doi.org/10.1016/j.envint.2024.108983. Cited in: Q6 (the WHO-commissioned reviews); S26 (the WHO 2024–2025 review pipeline, cancer); Methodology (WHO pooled nulls).
- Kaspranski, Binhi, and Koshel 2025: Kaspranski RR, Binhi VN, Koshel IV. 2025. Human Responses to Magnetic and Hypomagnetic Fields: Available Evidence and Potential Risks for Deep Space Travel. *Life* 15(11):1766. https://doi.org/10.3390/life15111766. Cited in: Q12.
- Kenny et al. 2024: Kenny RPW, Johnson EE, Adesanya AM, Richmond C, Beyer F, Calderon C, et al. 2024. The effects of radiofrequency exposure on male fertility: A systematic review of human observational studies with dose-response meta-analysis. *Environment International* 190:108817. https://doi.org/10.1016/j.envint.2024.108817. Cited in: Summary; Q11; S18, S26.

- Kim et al.; Japan–Korea GLP bioassays: Kim HS, Han KH, Kim YB, Jeon SB, Lee AK, Moon JI, et al. 2026. The International Collaborative Animal Study of the carcinogenicity and genotoxicity of mobile phone radiofrequency radiation: the Korean study. *Toxicological Sciences* 209(3):kfag001. https://doi.org/10.1093/toxsci/kfag001. Cited in: Summary; Q16; S13; Methodology.
- Kowalczuk 2010: Kowalczuk C, Yarwood G, Blackwell R, Priestner M, Sienkiewicz Z, Bouffler S, et al. 2010. Absence of nonlinear responses in cells and tissues exposed to RF energy at mobile phone frequencies using a doubly resonant cavity. *Bioelectromagnetics* 31(7):556–565. https://doi.org/10.1002/bem.20597. Cited in: S12.
- Leberecht et al. 2023: Leberecht B, Wong SY, Satish B, Döge S, Hindman J, Venkatraman L, et al. 2023. Upper bound for broadband radiofrequency field disruption of magnetic compass orientation in night-migratory songbirds. *Proceedings of the National Academy of Sciences of the United States of America* 120(28):e2301153120. https://doi.org/10.1073/pnas.2301153120. Cited in: Q12, Q14; S23.
- Little et al. 2012: Little MP, Rajaraman P, Curtis RE, Devesa SS, Inskip PD, Check DP, et al. 2012. Mobile phone use and glioma risk: comparison of epidemiological study results with incidence trends in the United States. *BMJ* 344:e1147. https://doi.org/10.1136/bmj.e1147. Cited in: Q10.
- Martens and colleagues: Martens AL, Bolte JF, Beekhuizen J, Kromhout H, Smid T, Vermeulen RC. 2015. Validity of at home model predictions as a proxy for personal exposure to radiofrequency electromagnetic fields from mobile phone base stations. *Environmental Research* 142:221–226. https://doi.org/10.1016/j.envres.2015.06.029. Cited in: Q7.
- Melnick & Moskowitz 2026: Melnick RL, Moskowitz JM; International Commission on the Biological Effects of Electromagnetic Fields (ICBE-EMF). 2026. Exposure limits to radiofrequency EMF do not account for cancer risk or reproductive toxicity assessed from data in experimental animals. *Environmental Health* 25:42. https://doi.org/10.1186/s12940-026-01288-6. Cited in: Summary; Q6, Q12; S14.
- Mevissen et al. 2025: Mevissen M, Ducray A, Ward JM, Kopp-Schneider A, McNamee JP, Wood AW, et al. 2025. Effects of radiofrequency electromagnetic field exposure on cancer in laboratory animal studies, a systematic review. *Environment International* 199:109482. https://doi.org/10.1016/j.envint.2025.109482. Cited in: Summary; Q6; S26; Attachment B portfolio note.
- Meyer et al. 2024: Meyer F, Bitsch A, Forman HJ, Fragoulis A, Ghezzi P, Henschenmacher B, et al. 2024. The effects of radiofrequency electromagnetic field exposure on biomarkers of oxidative stress in vivo and in vitro: A systematic review of experimental studies. *Environment International* 194:108940. https://doi.org/10.1016/j.envint.2024.108940. Cited in: Summary; Q6, Q12; S9, S26.
- Pophof et al. 2024: Pophof B, Kuhne J, Schmid G, Weiser E, Dorn H, Henschenmacher B, et al. 2024. The effect of exposure to radiofrequency electromagnetic fields on cognitive performance in human experimental studies: Systematic review and meta-analyses. *Environment International* 191:108899. https://doi.org/10.1016/j.envint.2024.108899. Cited in: S26 (the WHO 2024–2025 review pipeline, cognition).

- Ramazzini: Falcioni L, Bua L, Tibaldi E, Lauriola M, De Angelis L, Gnudi F, et al. 2018. 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. *Environmental Research* 165:496–503. https://doi.org/10.1016/j.envres.2018.01.037. Cited in: Summary; Q6, Q12, Q16; S13; Methodology.
- Ritz 2004: Ritz T, Thalau P, Phillips JB, Wiltschko R, Wiltschko W. 2004. Resonance effects indicate a radical-pair mechanism for avian magnetic compass. *Nature* 429(6988):177–180. https://doi.org/10.1038/nature02534. Cited in: Q14; S22, S23.
- Roser et al. 2017: Roser K, Schoeni A, Struchen B, Zahner M, Eeftens M, Fröhlich J, et al. 2017. Personal radiofrequency electromagnetic field exposure measurements in Swiss adolescents. *Environment International* 99:303–314. https://doi.org/10.1016/j.envint.2016.12.008. Cited in: Q3, Q11.
- Rubin 2005: Rubin GJ, Das Munshi J, Wessely S. 2005. Electromagnetic hypersensitivity: a systematic review of provocation studies. *Psychosomatic Medicine* 67(2):224–232. https://doi.org/10.1097/01.psy.0000155664.13300.64. Cited in: Q4.
- Rubin 2010: Rubin GJ, Nieto-Hernandez R, Wessely S. 2010. Idiopathic environmental intolerance attributed to electromagnetic fields (formerly 'electromagnetic hypersensitivity'): An updated systematic review of provocation studies. *Bioelectromagnetics* 31(1):1–11. https://doi.org/10.1002/bem.20536. Cited in: Q4.
- Salford: Salford LG, Brun A, Sturesson K, Eberhardt JL, Persson BR. 1994. Permeability of the blood-brain barrier induced by 915 MHz electromagnetic radiation, continuous wave and modulated at 8, 16, 50, and 200 Hz. *Microscopy Research and Technique* 27(6):535–542. https://doi.org/10.1002/jemt.1070270608. Cited in: S11.
- SCAMP: Toledano MB, Mutz J, Röösli M, Thomas MSC, Dumontheil I, Elliott P. 2019. Cohort Profile: The Study of Cognition, Adolescents and Mobile Phones (SCAMP). *International Journal of Epidemiology* 48(1):25–26l. https://doi.org/10.1093/ije/dyy192. Cited in: Q10.
- Tell, Kavet, and Mezei 2013: Tell RA, Kavet R, Mezei G. 2013. Characterization of radiofrequency field emissions from smart meters. *Journal of Exposure Science & Environmental Epidemiology* 23(5):549–553. https://doi.org/10.1038/jes.2012.102. Cited in: Q13.
- Uche & Naidenko 2021: Uche UI, Naidenko OV. 2021. Development of health-based exposure limits for radiofrequency radiation from wireless devices using a benchmark dose approach. *Environmental Health* 20:84. https://doi.org/10.1186/s12940-021-00768-1. Cited in: Summary; Q6, Q12; S14.
- van Moorselaar 2017: van Moorselaar I, Slottje P, Heller P, van Strien R, Kromhout H, Murbach M, et al. 2017. Effects of personalised exposure on self-rated electromagnetic hypersensitivity and sensibility - A double-blind randomised controlled trial. *Environment International* 99:255–262. https://doi.org/10.1016/j.envint.2016.11.031. Cited in: Q3.
- Weller et al. 2025: Weller SG, McCredden JE, Leach V, Chu C, Lam AKY. 2025. A scoping review and evidence map of radiofrequency field exposure and genotoxicity: assessing in vivo, in vitro,

and epidemiological data. *Frontiers in Public Health* 13:1613353. https://doi.org/10.3389/fpubh.2025.1613353. Cited in: Summary; Q12.

- Wiart (Wiart/Christ/Gandhi): Wiart J, Hadjem A, Wong MF, Bloch I. 2008. Analysis of RF exposure in the head tissues of children and adults. *Physics in Medicine and Biology* 53(13):3681–3695. https://doi.org/10.1088/0031-9155/53/13/019. Cited in: Summary; Q11.
- Yakymenko et al. 2016: Yakymenko I, Tsybulin O, Sidorik E, Henshel D, Kyrylenko O, Kyrylenko S. 2016. Oxidative mechanisms of biological activity of low-intensity radiofrequency radiation. *Electromagnetic Biology and Medicine* 35(2):186–202. https://doi.org/10.3109/15368378.2015.1043557. Cited in: Summary; Q12; S9.
- Zhang 2021: Zhang Z, Xue Y, Yang J, Shang P, Yuan X. 2021. Biological Effects of Hypomagnetic Field: Ground-Based Data for Space Exploration. *Bioelectromagnetics* 42(6):516–531. https://doi.org/10.1002/bem.22360. Cited in: Q12.

Government, intergovernmental and agency reports and records

- ANSES: ANSES (France). 2022. *Radiofréquences et santé : la recherche face à des technologies en évolution rapide* (ANSES and IARC research meeting) and *Cahier de la recherche* n° 20 (November 2022). https://www.anses.fr/fr/actualite/radiofrequences-sante-recherche-face-technologies-evolution-rapide; PDF: https://www.anses.fr/system/files/CDLR-mg-RadiofrequencesetSante20.pdf. Cited in: Metadata; Q12, Q16; Methodology.
- ANVS, 16 December 2021 (Dutch ANVS action): Authority for Nuclear Safety and Radiation Protection (ANVS), the Netherlands. 2021. *Do you have a 'Quantum Pendant' anti-5G pendant or a 'negative ion' jewellery item or sleep mask? If so, store it away safely.* News item, 16 December 2021. https://english.autoriteitnvs.nl/latest/news/2021/12/16/do-you-have-a-quantum-pendant-anti-5g-pendant-or-a-negative-ion-jewellery-item-or-sleep-mask-if-so-store-it-away-safely. Cited in: Q3.
- Bundesamt für Strahlenschutz (BfS) loan service: Bundesamt für Strahlenschutz (BfS). *Messgeräteverleih: Klarheit schaffen: Welchen elektromagnetischen Feldern sind Sie in Ihrem Alltag ausgesetzt?* https://www.bfs.de/DE/themen/emf/kompetenzzentrum/verleih/verleih.html. Cited in: Q7; S1.
- CDC Environmental Public Health Tracking: CDC. *About Environmental Public Health Tracking* (page revised 14 July 2026). https://www.cdc.gov/environmental-health-tracking/about/index.html. Cited in: Summary; Q16, Q17.
- CDC/ATSDR guidance (2013): Centers for Disease Control and Prevention (CDC). 2013. Investigating suspected cancer clusters and responding to community concerns: guidelines from CDC and the Council of State and Territorial Epidemiologists. *MMWR Recommendations and Reports* 62(RR-08):1–24. https://www.cdc.gov/mmwr/preview/mmwrhtml/rr6208a1.htm. Cited in: Q10.
- CDC/ATSDR guidance (2022); 2022 CDC/ATSDR framework: CDC and Agency for Toxic Substances and Disease Registry (ATSDR). 2022. *Guidelines for Examining Unusual Patterns of Cancer and Environmental Concerns.* https://www.cdc.gov/cancer-

environment/media/pdfs/Guidelines-for-Examining-Unusual-Patterns-of-Cancer-and-Environmental-Concerns-h.pdf. Cited in: Q10.

- EMF-RAPID; EMF RAPID: National Institute of Environmental Health Sciences (NIEHS). *EMF RAPID Program* (1992–1998; Energy Policy Act of 1992, §2118), program home page with the 1995 interim and 1999 reports. http://www.niehs.nih.gov/emfrapid/home.htm. Cited in: Summary; Q16, Q17; Full version.
- FCC complaints: Federal Communications Commission (FCC). *CGB – Consumer Complaints Data* (open data set 3xyp-aqkj), queried 8 October 2026. https://opendata.fcc.gov/resource/3xyp-aqkj. Cited in: Q10.
- FDA (at least 6 in/15 cm separation): U.S. Food and Drug Administration (FDA). 2021. *Magnets in Cell Phones and Smart Watches May Affect Pacemakers and Other Implanted Medical Devices* (content dated 13 May 2021). https://www.fda.gov/radiation-emitting-products/cell-phones/magnets-cell-phones-and-smart-watches-may-affect-pacemakers-and-other-implanted-medical-devices. Cited in: Summary; Q11.
- FDA MAUDE: FDA. *About the Manufacturer and User Facility Device Experience (MAUDE) Database* (content current 8 December 2025). https://www.fda.gov/medical-devices/mandatory-reporting-requirements-manufacturers-importers-and-device-user-facilities/about-manufacturer-and-user-facility-device-experience-maude-database; record files: https://www.accessdata.fda.gov/MAUDE/ftparea/. Cited in: Q10, Q11, Q17; S20.
- FDA MedWatch: FDA. *MedWatch: The FDA Safety Information and Adverse Event Reporting Program* (content current 6 October 2026). https://www.fda.gov/safety/medwatch-fda-safety-information-and-adverse-event-reporting-program. Cited in: Q11, Q17; S20.
- France's ANFR: Agence nationale des fréquences (ANFR). *Observatoire des ondes.* https://www.anfr.fr/maitriser/information-du-public/observatoire-des-ondes. Cited in: Q10.
- FTC 2002 complaints: Federal Trade Commission (FTC). 2002. *FTC Charges Sellers of Cell Phone Radiation Protection Patches with Making False Claims.* Press release, 20 February 2002. https://www.ftc.gov/news-events/news/press-releases/2002/02/ftc-charges-sellers-cell-phone-radiation-protection-patches-making-false-claims. Cited in: Q3.
- FTC 2011 consumer alert: FTC. 2011. *FTC Offers Tips to Help Consumers Avoid Cell Phone Radiation Scams.* Press release, 16 June 2011. https://www.ftc.gov/news-events/news/press-releases/2011/06/ftc-offers-tips-help-consumers-avoid-cell-phone-radiation-scams. Cited in: Q3.
- GAO-12-771: U.S. Government Accountability Office (GAO). 2012. *Telecommunications: Exposure and Testing Requirements for Mobile Phones Should Be Reassessed.* GAO-12-771, 24 July 2012. https://www.gao.gov/products/gao-12-771. Cited in: Summary; Q17; S27.
- GERoNiMO: European Commission, CORDIS. *GERoNiMO: Generalised EMF Research using Novel Methods – an integrated approach: from research to risk assessment and support to risk management.* FP7 grant agreement 603794, 1 January 2014 to 31 December 2018, final report. https://cordis.europa.eu/project/id/603794/reporting. Cited in: Q16.

- HHS-OASH-2026-0397 (the RFI): U.S. Department of Health and Human Services (HHS). 2026. *Request for Information on Electromagnetic Fields (EMFs), Radiofrequency (RF) Radiation, and Wireless Radiation Exposure.* 91 FR 59792–59794, FR Doc. 2026-19252, 21 September 2026; Docket HHS-OASH-2026-0397. https://www.federalregister.gov/documents/2026/09/21/2026-19252/request-for-information-on-electromagnetic-fields-emfs-radiofrequency-rf-radiation-and-wireless. Cited in: Metadata and the question numbering throughout (Q2–Q18).
- IARC Monograph 80 (2002); IARC 2B: International Agency for Research on Cancer (IARC). 2002. *Non-ionizing Radiation, Part 1: Static and Extremely Low-frequency (ELF) Electric and Magnetic Fields.* IARC Monographs Vol. 80. https://publications.iarc.fr/Book-And-Report-Series/Iarc-Monographs-On-The-Identification-Of-Carcinogenic-Hazards-To-Humans/Non-ionizing-Radiation-Part-1-Static-And-Extremely-Low-frequency-Elf-Electric-And-Magnetic-Fields-2002. Cited in: Q11, Q12.
- ICD-11: World Health Organization (WHO). *ICD-11 for Mortality and Morbidity Statistics (MMS)*, online browser. https://icd.who.int/browse11/l-m/en. Cited in: Q3.
- NASA Human Research Program: NASA Human Research Program, Space Radiation Element. *Space Radiation Risks* (page last updated 14 May 2025). https://www.nasa.gov/hrp/radiation/space-radiation-risks. Cited in: Q12.
- NASA SVS 5622: NASA Scientific Visualization Studio. 2026. *Artemis II: Sending Humans Beyond the Magnetosphere.* Visualization ID 5622, released 5 March 2026; visualizations by AJ Christensen. https://svs.gsfc.nasa.gov/5622/. Cited in: Q12.
- NHANES: CDC, National Center for Health Statistics (NCHS). *National Health and Nutrition Examination Survey (NHANES).* https://www.cdc.gov/nchs/nhanes/index.html. Cited in: Q10.
- NTP (RFR program): National Toxicology Program (NTP). *Cell Phone Radio Frequency Radiation* (research topic page). https://ntp.niehs.nih.gov/research/topics/cellphones. Cited in: Q16, Q17; Full version.
- NTP TR-595; NTP: National Toxicology Program (NTP). 2018. *NTP Technical Report on the 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.* Technical Report 595, November 2018. https://doi.org/10.22427/NTP-TR-595; https://ntp.niehs.nih.gov/publications/reports/tr/tr595. Cited in: Metadata; Summary; Q6, Q12, Q16; S13, S14; Methodology.
- NTP TR-596: NTP. 2018. *NTP Technical Report on the 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.* Technical Report 596, November 2018. https://doi.org/10.22427/NTP-TR-596; https://ntp.niehs.nih.gov/publications/reports/tr/tr596. Cited in: Summary.
- NTRS 20250006168: Simonsen LC, Zawaski JA, Weeks J. 2025. *Moon 2 Mars Space Radiation Protection "Buying Down" Risks to Crew.* Conference paper, ASCEND 2025, Las Vegas, NV, 22–24 July 2025. NASA Technical Reports Server 20250006168. https://ntrs.nasa.gov/citations/20250006168. Cited in: Q12.

- OHAT: National Toxicology Program, OHAT. 2019. *OHAT Handbook* (March 2019). https://ntp.niehs.nih.gov/sites/default/files/ntp/ohat/pubs/handbookmarch2019_508.pdf. Cited in: Q18; S26.
- SCENIHR 2015; SCENIHR: European Commission, Scientific Committee SCENIHR. 2015. *Opinion on potential health effects of exposure to electromagnetic fields (EMF)*, adopted 27 January 2015. https://health.ec.europa.eu/system/files/2016-11/scenihr_o_041_0.pdf. Cited in: Metadata; Q3, Q12.
- SCHEER: European Commission, Scientific Committee on Health, Environmental and Emerging Risks (SCHEER). 2023. Final opinion on radiofrequency fields (100 kHz–300 GHz) and the EU exposure annexes, adopted 18 April 2023. https://health.ec.europa.eu/consultations/scheer-public-consultation-preliminary-opinion-scientific-evidence-radiofrequency_en. Cited in: Metadata.
- SEER; US SEER analyses: National Cancer Institute, SEER Program. *SEER Cancer Stat Facts: Brain & Other Nervous System.* https://seer.cancer.gov/statfacts/html/brain.html. Cited in: Q10.
- Simonsen: Simonsen LC. 2021. *Space Radiation Technologies for Human Missions beyond Low-Earth-Orbit.* Presentation, Applied Space Environments Conference 2021 (1–4 November 2021). NASA Technical Reports Server 20210023466. https://ntrs.nasa.gov/citations/20210023466. Cited in: Q12.
- SSM: Swedish Radiation Safety Authority (SSM). 2026. *Recent Research on electromagnetic fields and Health Risk, twentieth report from SSM's Scientific Council on Electromagnetic Fields, 2025.* Report 2026:03, 2 February 2026. https://www.stralsakerhetsmyndigheten.se/en/publications/reports/radiation-protection/2026/202603/. Cited in: Metadata; Q12, Q16.
- Switzerland's FOEN: Swiss Federal Office for the Environment (FOEN/BAFU). *Electrosmog* (topic page; national non-ionising radiation monitoring). https://www.bafu.admin.ch/en/electrosmog-en. Cited in: Q10.
- VAERS: Vaccine Adverse Event Reporting System (VAERS), CDC and FDA. *About Us.* https://vaers.hhs.gov/about.html. Cited in: Q10, Q16; S16.
- WHO 2010 RF Research Agenda; WHO-2010 agenda: World Health Organization (WHO). 2010. *WHO research agenda for radiofrequency fields.* Geneva: WHO. ISBN 9789241599948. https://www.who.int/publications/i/item/9789241599948. Cited in: Q16; Full version.
- WHO EHC-238: WHO. 2007. *Environmental Health Criteria 238: Extremely Low Frequency Fields.* https://www.who.int/publications/i/item/9789241572385. Cited in: Methodology.
- WHO Fact Sheet 296: WHO. 2005. *Electromagnetic fields and public health: Electromagnetic hypersensitivity.* Fact Sheet 296, December 2005. https://www.who.int/teams/environment-climate-change-and-health/radiation-and-health/non-ionizing/hypersensitivity. Cited in: Q3, Q9.

Standards, regulations and legal records

- 21 CFR Subchapter J: Code of Federal Regulations, Title 21, Chapter I, Subchapter J, Radiological Health (Parts 1000–1040). eCFR. https://www.ecfr.gov/current/title-21/chapter-I/subchapter-J. Cited in: Q17.
- 29 CFR 1910.97: 29 CFR §1910.97, Nonionizing radiation. Occupational Safety and Health Administration (OSHA). https://www.osha.gov/laws-regs/regulations/standardnumber/1910/1910.97. Cited in: Q9.
- 47 CFR §1.1307: 47 CFR §1.1307, Actions that may have a significant environmental effect, for which Environmental Assessments (EAs) must be prepared. https://www.govinfo.gov/app/details/CFR-2019-title47-vol1/CFR-2019-title47-vol1-sec1-1307. Cited in: Q9.
- 47 CFR §1.1310; FCC 47 CFR 1.1310: 47 CFR §1.1310, Radiofrequency radiation exposure limits (eCFR, current as of 7 October 2026; amended 85 FR 18145, 1 April 2020). https://www.ecfr.gov/current/title-47/chapter-I/subchapter-A/part-1/subpart-I/section-1.1310. Cited in: Metadata; Q5, Q7, Q13.
- 47 CFR §2.1093: 47 CFR §2.1093, Radiofrequency radiation exposure evaluation: portable devices. https://www.ecfr.gov/current/title-47/section-2.1093. Cited in: Q13.
- 47 CFR §20.19: 47 CFR §20.19, Hearing loss compatible wireless handsets. https://www.ecfr.gov/current/title-47/chapter-I/subchapter-B/part-20/subpart-C/section-20.19. Cited in: Q11; S21.
- ACGIH TLV: American Conference of Governmental Industrial Hygienists (ACGIH). *Documentation of the Threshold Limit Values for Physical Agents*, 7th edition, as cited by OSHA. https://www.osha.gov/radiofrequency-and-microwave-radiation/standards. Cited in: Q3, Q11.
- ARPANSA RPS S-1 (2021): Australian Radiation Protection and Nuclear Safety Agency (ARPANSA). 2021. Radiation Protection Series S-1 (RPS S-1), Rev. 1, the Australian radiofrequency exposure standard aligned with ICNIRP 2020 and superseding RPS 3. https://www.arpansa.gov.au/regulation-and-licensing/regulatory-publications/radiation-protection-series/codes-and-standards/rpss-1. Cited in: Q5.
- China GB 8702-2014: GB 8702-2014, *Controlling limits for electromagnetic environment* (English translation preview). https://www.chinesestandard.net/PDF.aspx/GB8702-2014. Cited in: Q5.
- Directive 2013/35/EU: European Union. 2013. Directive 2013/35/EU, binding minimum requirements on workers' exposure to electromagnetic fields (CELEX 32013L0035). https://eur-lex.europa.eu/eli/dir/2013/35/oj. Cited in: Q5.
- EHT v. FCC, 9 F.4th 893 (D.C. Cir. 2021): *Environmental Health Trust v. FCC*, 9 F.4th 893 (D.C. Cir. 2021), No. 20-1025, decided 13 August 2021. https://law.justia.com/cases/federal/appellate-courts/cadc/20-1025/20-1025-2021-08-13.html. Cited in: Metadata; Q5; S27.
- EU Recommendation 1999/519/EC: Council of the European Union. 1999. Council Recommendation 1999/519/EC, general-public exposure reference levels based on ICNIRP 1998

(CELEX 31999H0519). https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:31999H0519. Cited in: Q5.

- FCC 18-133: FCC. 2018. *Accelerating Wireless and Wireline Broadband Deployment by Removing Barriers to Infrastructure Investment.* FCC 18-133, WT Docket No. 17-79, WC Docket No. 17-84; 83 FR 51867–51886, 15 October 2018. https://www.federalregister.gov/documents/2018/10/15/2018-22234/accelerating-wireless-and-wireline-broadband-deployment-by-removing-barriers-to-infrastructure. Cited in: Q15.
- FCC 2019 reaffirmation (reaffirmed 2019–2020): FCC. 2019. *Human Exposure to Radiofrequency Electromagnetic Fields and Reassessment of FCC Radiofrequency Exposure Limits and Policies.* FCC 19-126, adopted 27 November 2019, released 4 December 2019; ET Docket Nos. 03-137 and 13-84; 85 FR 18131, 1 April 2020. https://docs.fcc.gov/public/attachments/FCC-19-126A1.pdf. Cited in: Q5.
- FCC 6 GHz power classes: 47 CFR §15.407, General technical requirements (U-NII devices, including 6 GHz low-power indoor, standard-power and very-low-power classes). https://www.ecfr.gov/current/title-47/chapter-I/subchapter-A/part-15/subpart-E/section-15.407. Cited in: Q13.
- FCC KDB 447498: FCC Office of Engineering and Technology (OET). 2015. KDB 447498 D01 v06, *RF Exposure Procedures and Equipment Authorization Policies for Mobile and Portable Devices*, 23 October 2015. https://www.fcc.gov/kdb. Cited in: Q5, Q13.
- FCC KDB 865664: FCC OET. 2015. KDB 865664 D01 v01r04, *SAR Measurement Requirements for 100 MHz to 6 GHz*, 7 August 2015. https://apps.fcc.gov/kdb/GetAttachment.html?id=RUMcMDL7fmDLsdRSsbCNoA%3D%3D&desc=865664 D01 SAR Measurement 100 MHz to 6 GHz v01r04&tracking_number=28242. Cited in: Q5.
- FCC Public Notice DA 26-997 / 91 FR 60128: FCC OET. 2026. *FCC Seeks Comment on RF Exposure Issues Subject to D.C. Circuit Remand in Environmental Health Trust v. FCC.* Public Notice DA 26-997, released 17 September 2026; ET Docket No. 13-84; 91 FR 60128–60131, FR Doc. 2026-19364, 22 September 2026. https://www.federalregister.gov/documents/2026/09/22/2026-19364/fcc-seeks-comment-on-rf-exposure-issues-subject-to-dc-circuit-remand-in-environmental-health-trust-v; full text: https://docs.fcc.gov/public/attachments/DA-26-997A1.pdf. Cited in: Metadata; Q5.
- France, décret 2002-775: France. Décret n° 2002-775 of 3 May 2002, national public exposure limits. Summary of the regulation: https://www.radiofrequences.gouv.fr/la-reglementation-associee-a74.html. Cited in: Q5.
- France, Loi n° 2015-136: France. Loi n° 2015-136 of 9 February 2015 ("loi Abeille": sobriété, transparence, information, concertation), including the Wi-Fi rules for children under three and for primary schools. Summary of the regulation: https://www.radiofrequences.gouv.fr/la-reglementation-associee-a74.html. Cited in: Q5.
- GUM: Joint Committee for Guides in Metrology (JCGM). 2008. JCGM 100:2008, *Guide to the Expression of Uncertainty in Measurement* (GUM). Cited in: Q8; S1.

- Health Canada Safety Code 6 (2015): Health Canada. 2015. *Safety Code 6: Limits of Human Exposure to Radiofrequency Electromagnetic Energy, 3 kHz–300 GHz.* https://www.canada.ca/en/health-canada/services/publications/health-risks-safety/limits-human-exposure-radiofrequency-electromagnetic-energy-range-3-300.html. Cited in: Metadata; Q5.
- ICNIRP 1998; ICNIRP-1998: International Commission on Non-Ionizing Radiation Protection (ICNIRP). 1998. Guidelines for limiting exposure to time-varying electric, magnetic, and electromagnetic fields (up to 300 GHz). *Health Physics* 74(4):494–522. https://www.icnirp.org/cms/upload/publications/ICNIRPemfgdl.pdf. Cited in: Q5.
- ICNIRP 2020 Guidelines: ICNIRP. 2020. Guidelines for Limiting Exposure to Electromagnetic Fields (100 kHz to 300 GHz). *Health Physics* 118(5):483–524. https://doi.org/10.1097/HP.0000000000001210; PDF: https://www.icnirp.org/cms/upload/publications/ICNIRPrfgdl2020.pdf. Cited in: Metadata; Q5, Q12, Q13; S2, S14; Methodology; Full version.
- IEC 62209-1: International Electrotechnical Commission (IEC). IEC 62209-1:2016, SAR measurement procedure for hand-held devices; replaced by IEC/IEEE 62209-1528:2020. https://standards.ieee.org/ieee/62209-1528/7325. Cited in: Q5, Q7.
- IEC 62209-2: IEC. IEC 62209-2:2010 with Amendment 1:2019, SAR procedure for devices used in close proximity to the body, 30 MHz–6 GHz; replaced by IEC/IEEE 62209-1528:2020. https://webstore.iec.ch/. Cited in: Q5, Q7.
- IEC 62209-3: IEC. IEC 62209-3:2019, vector measurement-based SAR systems, 600 MHz–6 GHz. https://webstore.iec.ch/. Cited in: Q5, Q7.
- IEC 62232: IEC. IEC 62232:2025 (Edition 4), determination of RF field strength, power density and SAR in the vicinity of base stations. https://standards.iteh.ai/catalog/standards/clc/6adf5a9f-d768-435c-9ff7-ae4b1d025596/en-iec-62232-2025. Cited in: Q7.
- IEEE 1528: IEEE. 2013. IEEE Std 1528-2013, *IEEE Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques*; replaced by IEC/IEEE 62209-1528:2020. https://doi.org/10.1109/IEEESTD.2013.6589093. Cited in: Q5, Q7.
- IEEE C95.1-2019: IEEE. 2019. 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*, published 4 October 2019. https://doi.org/10.1109/IEEESTD.2019.8859679. Cited in: Metadata; Q5, Q13; Full version.
- IEEE C95.3: IEEE. 2021. 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.* https://doi.org/10.1109/IEEESTD.2021.9444273. Cited in: Q5, Q7.

- India, DoT letter No. 16-10/2022/CS-2: DoT, India. 2025. Letter No. 16-10/2022/CS-2 of 1 January 2025, revising base-station limits to one-half of ICNIRP, as presented on *A Journey for EMF*. https://dot.gov.in/journey-emf. Cited in: Q5; Methodology.
- India, one-tenth of ICNIRP (2012): Department of Telecommunications (DoT), India. EMF norms for base stations, f/2000 W/m² (one-tenth of ICNIRP) from 2012. https://dot.gov.in/. Cited in: Q5.
- International Residential Code R314 and R315: International Residential Code (2021), sections R314 (smoke alarms) and R315 (carbon monoxide alarms). https://codes.iccsafe.org/content/IRC2021P2/chapter-3-building-planning. Cited in: Q7.
- Israel: Tnuda (information center on non-ionizing radiation). *FAQ: Are there recommendations regarding living near a cellular base station?* Base-station permits issued by the Ministry of Environmental Protection. https://tnuda.org.il/en/faq/6. Cited in: Q5.
- Italy, DPCM 8 July 2003: Italy. DPCM 8 luglio 2003, *Gazzetta Ufficiale* n. 199. https://www.gazzettaufficiale.it/eli/id/2003/08/28/03A08918/sg. Cited in: Q5.
- Italy, Law 214/2023, article 10: Italy. Legge 30 dicembre 2023, n. 214, art. 10 (Normattiva). https://www.normattiva.it/uri-res/N2Ls?urn:nir:stato:legge:2023-12-30;214. Cited in: Q5.
- MedRadio: 47 CFR Part 95, Subpart I, Medical Device Radio Communications Service. https://www.ecfr.gov/current/title-47/chapter-I/subchapter-D/part-95/subpart-I. Cited in: Q13.
- OET Bulletin 65 (Edition 97-01, August 1997): FCC OET. 1997. *Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields.* OET Bulletin 65, Edition 97-01, August 1997. https://www.fcc.gov/Bureaus/Engineering_Technology/Documents/bulletins/oet65/oet65.pdf. Cited in: Q7.
- Poland, Dz.U. 2019 poz. 2448: Poland. Rozporządzenie Ministra Zdrowia (Minister of Health regulation) of 17 December 2019, Dz.U. 2019 poz. 2448, in force 1 January 2020. https://eli.gov.pl/eli/DU/2019/2448/ogl. Cited in: Q5; Methodology.
- Sec. 332(c)(7): 47 U.S.C. §332(c)(7)(B)(iv). Legal Information Institute. https://www.law.cornell.edu/uscode/text/47/332. Cited in: Q9.
- Switzerland, NISV (SR 814.710): Switzerland. NISV / ORNI, SR 814.710 (2000). https://www.fedlex.admin.ch/eli/cc/1999/363/en. Cited in: Q5.
- Tarang Sanchar page: DoT, India, Tarang Sanchar EMF portal. *EMF Radiation Norms* (table). https://tarangsanchar.gov.in/EMFPortal/DoT/EMFRadiationNorms. Cited in: Q5.
- UL 2034: UL 2034, *Single and Multiple Station Carbon Monoxide Alarms*, Edition 5, published 3 June 2024, last revised 7 August 2024. https://www.shopulstandards.com/ProductDetail.aspx?productId=UL2034. Cited in: Q7.
- UL 217: UL 217, *Smoke Alarms*, Edition 10, published 27 November 2024, last revised 14 January 2026. https://www.shopulstandards.com/ProductDetail.aspx?productId=UL217. Cited in: Q7.
- WMTS: 47 CFR Part 95, Subpart H, Wireless Medical Telemetry Service. https://www.ecfr.gov/current/title-47/chapter-I/subchapter-D/part-95/subpart-H. Cited in: Q13.

Other sources: professional-society, industry, manufacturer and news pages

- Allen Sills, 30 January 2026: Maiocco M. 2026. NFL responds to viral electrical substation theory for slew of 49ers injuries. *NBC Sports Bay Area*, 31 January 2026 (Sills's remarks on a conference call with reporters). https://www.nbcsportsbayarea.com/nfl/san-francisco-49ers/nfl-electrical-substation-injury-theory/1911625/. Cited in: Q12.
- American Academy of Pediatrics, 29 August 2013 letter: McInerny TK, President, American Academy of Pediatrics. 2013. Letter to FCC Commissioner Mignon L. Clyburn and FDA Commissioner Margaret A. Hamburg, 29 August 2013, filed in the FCC docket on human exposure to RF. Rehosted copy: https://ehtrust.org/wp-content/uploads/AAP-Letter-To-FCC-RF-Radiation-Review-2013.pdf. Cited in: Q11.
- Apple's instruction (12 in/30 cm while wirelessly charging): Apple. *About potential interference with medical devices.* Apple Support article 109025 (the former article HT211900, which the FDA page links, now redirects here). https://support.apple.com/en-us/109025. Cited in: Q11.
- EPRI's 2023 brief: Electric Power Research Institute (EPRI). 2023. *Smart Meter FAQ Information Brief.* Product 3002028427. https://www.epri.com/research/products/000000003002028427. Cited in: Q13.
- IMST GmbH, commissioned by WILA Bonn (2015): WILA Bonn, with measurements by IMST GmbH, Kamp-Lintfort. 2015. Anechoic-chamber test of broadband consumer RF meters purchased in summer 2015 (English copy). https://www.emfanalysis.com/wp-content/uploads/2016/01/German-Test-Report-RF-Meters.pdf. Cited in: Q7; S3.
- John Lynch, 29 March 2026: Maiocco M. 2026. John Lynch says scientist declared 49ers' facility safe after substation worries. *NBC Sports Bay Area*, 29 March 2026. https://www.nbcsportsbayarea.com/nfl/san-francisco-49ers/john-lynch-electrical-substation-theory-scientist/1927067. Cited in: Q12.
- John Lynch, 29 March 2026 (hair-dryer comparison): Wagoner N. 2026. Lynch says 49ers' injury conspiracy a 'big nothing burger' after conducting independent study. *ESPN*, republished by ABC7 San Francisco, 31 March 2026. https://abc7news.com/post/san-francisco-49ers-conduct-study-electrical-substation-gm-john-lynch-says-was-nothing-burger/18809687/. Cited in: Q12.
- TriField TF2: AlphaLab. *TriField® EMF Meter Model TF2*, product page, observed 12 October 2026. https://trifield.com/products/trifield®-emf-meter-model-tf2. Cited in: Q7; S3.
- Washington Post (Frank de Vocht; Hans Kromhout; Aaron Schatz, via the Washington Post): *The Washington Post*. 2026. Sports report on the 49ers' substation injury theory, 15 January 2026. https://www.washingtonpost.com/sports/2026/01/15/injuries-49ers-emf-theory-substation/. Cited in: Q7, Q12.