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Cellular Telephones and the Potential Hazards of RF Radiation: Responses to the Fear and Controversy

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I. Introduction

1. In recent years the public has become concerned that the electromagnetic radio-frequency radiation [hereinafter RF radiation] emitted by cellular telephones may pose serious health risks, including the risk of cancer.[1] This concern prompted regulatory action and gave rise to intensive scientific research aimed at determining if there are health hazards associated with the use of cellular telephones.[2] To date, the scientific community has not provided evidence to prove, or disprove, allegations that the RF radiation emitted from cellular telephones is hazardous.[3] While some studies conclude that exposure to RF radiation emitted by cellular telephones could lead to adverse health effects,[4] others suggest that cellular telephones are safe.[5] For courts and regulatory agencies faced with pressure to respond to this emerging public-health concern, the uncertainty surrounding the safety of cellular telephones has created a policy-making quandary.[6] Policy-makers must make difficult choices and balance conflicting interests in deciding a course of action which adequately protects the public from potential harm, without running the risk of driving a useful product out of the market.
2. Clearly, a failure by regulatory agencies and courts to effectively act on this unresolved issue could lead to serious, if not catastrophic, consequences. There are approximately 50 million cellular telecommunications subscribers in the United States today.[7] Industry forecasters predict that the demand for cellular services will grow dramatically well into the future, to the point where nearly all Americans will have a cellular communications device.[8] In consideration of the number of people who are, or will be, using cellular telephones, and the possibility that scientific evidence may someday surface to prove the alleged dangers of RF radiation, there appears to be a compelling reason for courts and agencies to take appropriate steps to avoid the possibility of a public health crisis resulting in a flood of litigation.[9]
3. On the other hand, there is a real danger that in satisfying the public's need for protection from potential health risks, courts and agencies may unnecessarily and unreasonably cause harm to the cellular telecommunications industry, a multibillion-dollar industry which plays a role in advancing the general welfare of citizens and businesses through improved telephonic communications.[10] Cellular technology enhances the ability of police, fire and other rescue personnel to provide emergency services, increases business productivity and efficiency, and facilitates the exchange of information.[11] In consideration of these benefits, and society's increasing dependency on cellular services, an aggressive response by agencies or courts, in the absence of scientific certainty, may not be appropriate at this time.[12] The public might misinterpret federal action as confirmation that RF radiation is hazardous, which could stunt the development of the cellular phone industry, and drive a useful product out of the market.[13] Such action could produce a false sense of protection, which would ultimately harm the public interest in health and safety.[14]
4. This article examines various responses to this issue, and questions the validity of decisions made in the absence of scientific evidence proving that a hazard exists. Part II provides technical background information on electromagnetic RF radiation. Part III assesses the regulatory responses to the RF radiation exposure issue. Part IV examines the industry's response. Part V discusses the judicial treatment of RF radiation cases and analyzes some of the key legal issues which will play a role in future litigation. This article concludes by stressing the need for policy makers to maintain restraint while the scientific community struggles to determine with certainty

whether exposure to RF radiation from cellular telephones is hazardous to human health.

II. Background on RF Radiation

5. In order to completely understand the fear and the controversy surrounding the use of cellular telephones, it is necessary to briefly describe what constitutes electromagnetic RF radiation and how it may cause harmful effects.

A. What is Electromagnetic RF Radiation?

6. Electromagnetic radiation ranges from high frequency, ionizing forms of radiation, to lower frequency, non-ionizing forms of radiation.[15] Ionizing radiation, which exists as X-rays, gamma rays and other forms of nuclear radiation, is capable of dislodging electrons from matter, and is known to be hazardous.[16] The electromagnetic RF radiation emitted by cellular telephones is a form of non-ionizing radiation, which is, by contrast, electric energy that is too weak to dislodge electrons as it passes through matter.[17] All low-frequency, electromagnetic fields (EMFs)[18] generated by electric power,[19] or occurring naturally, [20] fall under the category of non-ionizing radiation.[21] Non-ionizing radiation was once believed to be harmless, and aroused very little concern or controversy.[22] The attention focused instead on the harmful effects of ionizing radiation.[23] Studies revealed, however, that non-ionizing radiation may also present a danger to human health.[24] This discovery caused the public and the scientific community to alter their view of non-ionizing radiation and to shift attention to questions concerning the hazards of EMFs and, most recently, to questions concerning the effects of exposure to electromagnetic RF radiation, specifically from cellular telephones.[25]

B. Effects of Electromagnetic RF Radiation

7. As already mentioned, no scientific study has yet provided conclusive evidence to prove that the use of cellular telephones is hazardous to human health.[26] Scientists have, however, reported on a variety of biological and behavioral effects caused by exposure to low-levels of radiation, albeit at frequencies not used by cellular telephones.[27] For instance, one study has suggested that exposure to low-level radiation could adversely affect the central nervous system,[28] while other studies show that exposure could diminish the effectiveness of the immune system,[29]or facilitate the development of cancer.[30] A more recent study found that mice exposed to radio transmissions, similar to those used by cellular telephones, developed lymphoma, a form of cancer, at twice the rate of other mice.[31]
8. The studies which suggest that exposure to RF radiation may cause adverse effects have raised important questions but have not provided conclusive evidence.[32] The failure of these studies to rise to the level of probative value is due in part to a number of methodological problems which, according to critics, have prevented scientists from reaching accurate test results.[33]

9. Studies which attempt to examine the effects of exposure to RF radiation will not likely produce consistent, replicable results until the scientific community has reached a consensus on which aspects of exposure are relevant or important.[34] The level of RF frequency, intensity, consistency, duration and direction of field, are all aspects of exposure which affect scientific research and can dramatically alter results.[35] For example, some studies are conducted on the premise that biological effects occur only at certain levels, or "windows" of frequency and intensity.[36] Other studies suggest that the "transient effect" of a very rapid change in magnetic field strength, caused simply by turning an electrical device off, can cause cancer.[37] How scientists treat and prioritize these aspects of exposure is therefore a vital and determinative feature of any study assessing the health risks posed by RF radiation.

III. Regulatory Responses to the RF Radiation Exposure Issue

A. The Rise of Preventative Policy Making

10. During the late 1960s, administrative agencies in the United States began to play an active role in regulating technologies that could potentially pose threats to public health, safety, and the environment.[38] This movement toward preventative policy making, driven by a perceived need to control the processes of scientific and technological change,[39] represented a dramatic shift in regulatory thinking.[40] Agencies were expected to go beyond regulating hazards which were known to be harmful, to guarding against risks.[41]
11. Risk-based regulation, however, is a complex discipline,[42] placing regulators in an uncomfortable position where they are subject to pressure from Congress and the public to enact safety standards, when there is insufficient scientific evidence to support such actions,[43] and vulnerable to charges that they have misinterpreted or misused scientific findings.[44] This struggle to deal with outside pressures and the problem of scientific uncertainty[45] is evident in the assessment and control of the potential hazards associated with the use of cellular telephones.

B. Federal Actions in the Absence of Scientific Certainty

12. Several federal agencies play a role in ensuring the safety of cellular devices. The main agencies involved are the Federal Communications Commission ("FCC"), the Food and Drug Administration ("FDA"), and the Environmental Protection Agency ("EPA").[46] Although there is insufficient evidence proving that exposure to RF radiation presents health hazards,[47] the FCC and the FDA have nonetheless responded to congressional and public pressure[48] by considering and undertaking limited actions aimed at minimizing exposure and reducing the potential risks.[49]

1. FCC Response

13. On August 1, 1996, under intense congressional pressure to act,[50] the FCC adopted and issued a new set of RF radiation exposure guidelines that were for the first time applicable to cellular telephones.[51] The FCC adopted this regulation to meet its responsibilities under the National Environmental Policy Act ("NEPA") of 1969, which "requires federal agencies to evaluate the effects of their actions on the quality of the human environment."[52]
14. The FCC does not consider itself a health agency with the expertise to determine what levels of radiation are safe, and it turns to health and radiation experts outside the agency for guidance on these issues.[53] For this reason, and because there were no existing federal guidelines on radiation exposure,[54] the FCC adopted exposure limits based on industry standards established by the American National Standards Institute ("ANSI"),[55] and the Institute of Electrical and Electronic Engineers ("IEEE").[56] These standards are similar to standards recommended by the National Council on Radiation Protection and Measurements ("NCRP").[57] The new limits for cellular telephones "are based on exposure criteria quantified in terms of specific absorption rate ("SAR"), a measure of the rate of RF energy absorption."[58] For example, hand-held cellular telephones must meet the SAR limit of 1.6 watts/kg as averaged over one gram of tissue.[59] This requirement became effective in August of 1996.[60]
15. Following the adoption of standards, the FCC received seventeen petitions for reconsideration and numerous comments in response to these petitions.[61] With a few exceptions,[62] most of the parties who filed comments with the FCC supported the guidelines applicable to cellular telephones.[63] Cellular telephone manufacturers, who were already involved in testing their products to ensure compliance with the exposure standards adopted by the FCC,[64] did not resist the rule, but subsequently recommended certain modifications.[65]

2. Evaluation of FCC Response

16. Scientists and commentators who disagree with the FCC's action have raised a number of issues to consider. They argue that the FCC's guidelines are an ineffective or inadequate measure to guard against any of the potential risks of RF radiation.
17. According to some scientists, the FCC's guidelines are flawed because they do not take into account the possibility that weaker levels of RF radiation are as harmful to human health as stronger levels.[66] As discussed previously, some studies indicate that biological effects occur at certain "windows" of exposure,[67]or through a "transient effect" of a very rapid change in power strength.[68] This suggests that the FCC's adoption of RF radiation exposure standards may be an ineffective way to reduce the potential health risks associated with cellular telephone use.
18. Others argue that the FCC's exposure standards are inadequate because they are limited to providing protection from thermal effects,[69]and fail to address the potential non-thermal effects[70]of exposure to RF radiation.[71] Thermal effects are well-established and therefore form a legitimate basis for establishing limits to RF radiation.[72] In contrast, non-thermal effects are not well-established and, currently, do not form a scientifically acceptable basis for restricting human exposure to RF radiation from cellular telephones.[73] Those who challenge the adequacy

of the FCC's hazard threshold argue that the public will not be protected from the potential risks of RF radiation until there is sufficient scientific evidence to prove that the standard is adequate to protect against both thermal, as well as non-thermal effects.[74]

19. The FCC's adoption of RF radiation exposure standards, an effort to protect the public interest in safety, may satisfy Congress and allay the public's concern, but it appears that this action can not be fully justified on the basis of available science.

3. FDA Response

20. The FDA is empowered by Congress to directly regulate electronic products that emit radiation with regard to public health and safety, and appears to have the primary responsibility to respond to the concern over cellular telephones.[75] Thus far, the FDA has refrained from exercising the full extent of its powers, choosing instead to take limited actions until the scientific community can confirm that there are hazards associated with exposure to RF radiation.[76]
21. The FDA first took action in 1993, when it made arrangements to meet with representatives of the cellular telephone industry to discuss the potential problems and their suggested solutions.[77] Since then, the FDA has worked with manufacturers, seeking ways to minimize human exposure to RF radiation.[78]
22. Although the FDA has not performed or sponsored research specifically addressing the levels of RF radiation emitted by cellular telephones, it has supported research which may be relevant to the question of cellular telephone safety.[79] In addition, the science and advisory group of the FDA has demonstrated its willingness to review research conducted by the federal government and private industry.[80]

4. Evaluation of FDA Response

23. Without conclusive scientific evidence to prove that cellular telephones are hazardous to public health and safety, and under minimal pressure from consumers,[81] the FDA has indicated that it is not prepared to devote its resources to protect the public from the unknown risks of RF radiation.[82]
24. The FDA can take additional steps to ensure that the public is informed of any potential risks, without straining its resources or imposing unreasonable costs on the cellular telephone industry. For example, the agency can exercise its authority to require that cellular telephone manufacturers provide unambiguous warnings advising users of the potential risks associated with the use of cellular telephones and to inform them of the status of research.[83] By developing uniform warnings and safety instructions, the FDA can help to remove the uncertainty and guess-work that is involved when manufacturers attempt to articulate the potential risks to cellular phone users.[84] While admittedly not a perfect solution to the RF radiation problem,[85] this measure will at least ensure that all individuals who purchase and use cellular telephones will obtain accurate and complete information from an impartial source on the status of research on RF radiation and the safety of cellular telephones.

IV. Industry Response

25. In response to the concern over RF radiation, the cellular telephone industry[86] pledged $25 million, in early 1993, to establish and support the Science Advisory Group (SAG), since renamed Wireless Technology Research, L.L.C. (WTR).[87] The goal of the WTR is to facilitate science-based decision-making relating to the health and safety of current and future wireless technology.[88] The WTR is charged with (1) managing a research program to develop a scientific database upon which public health decisions can be made, (2) informing the industry of any health risks associated with the use of cellular phones, and (3) providing advice on strategies for the mitigation of those risks.[89]

A. Evaluation of Industry Response

26. The cellular telephone industry's investment in research to clear the scientific uncertainty surrounding RF radiation appears to be an extraordinary response considering the harsh, common-law treatment of product safety research.[90] Although manufacturers have an obligation to conduct a reasonable amount of testing for safety,[91] the common-law liability rules act to penalize those who go beyond the minimum testing requirements and invest in comprehensive research programs which might reveal potential risks associated with a product.[92]
27. Generally, manufacturers believe that safety research for latent hazards increases, rather than reduces, exposure to litigation and catastrophic liability.[93] Therefore, to protect themselves from liability, many manufacturers choose to remain ignorant of the latent hazards of their products,[94] relying on the causation-rule in toxic torts to escape liability.[95] Cellular telephone manufacturers, who already conduct in-house safety tests to gain FCC approval, support the WTR's research program despite the risks they face in doing so.[96]
28. The WTR has not, however, escaped criticism. Some critics allege that the WTR is unlikely to produce valid results because the cellular telephone industry improperly controls and influences the program, while others are more generally concerned about the WTR’s slow pace of research. This later group is concerned why, after five years, the organization has still not achieved its stated objectives.[97]

V. Judicial Treatment of RF radiation cases

A. The Shift Toward a Pro-Defendant Position

29. Courts, like regulatory agencies, have struggled with the basic problem of scientific uncertainty. As previously discussed, regulators have refrained from acting aggressively to protect public health and safety in the absence of sufficient proof showing that RF radiation is hazardous. Similarly, courts in the past few years have responded to this lack of evidence with caution and restraint, refusing to allow recovery to plaintiffs who have brought claims for injuries allegedly

caused by exposure to RF radiation from cellular phones.[98]

30. The judicial treatment of RF radiation cases can also be viewed as a reflection of a recent trend in tort law and practice characterized by a shift away from earlier, very strong pro-plaintiff positions, to positions more favorable to business and other classes of defendants.[99] While there is no concrete explanation for this shift in favor of defendants, it seems plausible to argue that courts are trying to control and contain tort litigation, particularly in the area of toxic tort litigation,[100] where RF radiation cases would appropriately fall.[101] Toxic tort cases, such as those involving asbestos, have demonstrated a tendency to grow into "monstrous" dimensions.[102] Courts may fear that one plaintiff's victory in an RF radiation case would open the floodgate of litigation,[103]which the judicial system may not be prepared to adequately address in the absence of conclusive scientific evidence.[104]
31. Considering this shift toward a pro-defendant position, and taking into account the complexities and cost of litigation,[105]as well as the difficulty in proving causation,[106] it is no surprise that there are few cases involving RF radiation.[107] These cases, however, are instructive. They raise important questions and legal issues which will shape and control the direction of future litigation. Two of these issues, the problem of causation and the question of admissibility of expert testimony, deserve closer attention in this article.

B. The Issue of Causation

32. Causation, described as the "most metaphysical of all the elements of negligence,"[108] is an inherently difficult issue for judges and juries to address in assessing the validity of claims brought by individuals alleging injuries caused by exposure to RF radiation and other toxic substances.[109] In the absence of sufficient scientific evidence to support the claim that RF radiation is hazardous to human health, and under the current tort law system,[110] the causation element will continue to represent the most difficult legal hurdle for plaintiffs to overcome when bringing claims against cellular telephone manufacturers.[111]
33. To make a persuasive case for compensation, the plaintiff in a toxic tort lawsuit must show (1) that the substance to which they were exposed is capable of causing harm (general causation), and (2) that it is more likely than not that the exposure caused by the defendant's actions was the actual cause of injury (specific or individual causation).[112] Satisfying these legal requirements is difficult to achieve in cases where there are a number of factors working together to prevent the identification of a causal link.[113] These factors include long latency periods, a lack of understanding of causal mechanisms of disease, diverse patterns of exposure, multiple actors introducing the same substance into the environment, and the possibility of interaction with other causal agents.[114] Commentators have proposed major doctrinal changes to alleviate the problem,[115] but courts have continued to apply traditional notions of causation.[116]
34. In *Reynard v. NEC Corp*.,[117]one of the first cases attempting to link RF radiation from cellular telephones to cancer, the issue of causation was a salient and determinative factor influencing the outcome of the case.[118] In this case, the plaintiff claimed that exposure to RF radiation initiated, or aggravated and accelerated, the growth of a brain tumor which eventually killed his wife.[119]

The court, after reviewing two medical journal articles and a medical expert's affidavit, held that the plaintiff had failed to establish the requisite degree of causation, and granted the defendants' motion to dismiss the lawsuit.[120]

C. Admissibility of Expert Testimony

35. Closely tied to the issue of causation in RF radiation cases is the issue of admissibility of scientific evidence and expert testimony. In cases where there is a high level of scientific uncertainty, courts and commentators have acknowledged that the dangers of allowing unreliable or untested science in the courtroom can be significant.[121] Courts, therefore, have developed a strict standard for determining the admissibility of the types and quality of scientific evidence and expert testimony.[122]
36. In *Daubert v. Merrell Dow Pharmaceuticals*,[123] the Supreme Court established the criteria for admissibility of scientific evidence at trial.[124] In *Daubert*, the Court held that the trial judge must assume the task of ensuring that an expert's testimony rests on both a reliable foundation and is relevant to the task at hand.[125] The Court further stated that although it was not setting out a definitive checklist or test, the following questions were appropriate: (1) whether the theory or technique has been or can be tested; (2) whether the theory or technique has been subjected to peer review and publication; (3) whether there is a known or potential rate of error in the technique; and (4) whether the theory or technique is generally accepted in the scientific community.[126]
37. The Ninth Circuit of Appeals clarified the Supreme Court's *Daubert* decision[127] and emphasized that judges should carefully examine whether the experts are proposing to testify about matters growing naturally and directly out of research they have conducted independent of litigation, or whether they have developed their opinions expressly for the purposes of testifying.[128] In *General Electric Co. v. Joiner*[129], the Court further strengthened the trial judge's "gatekeeping" role, reminding courts that under the federal rules of evidence, the trial judge "must ensure that any and all scientific testimony and evidence admitted is not only relevant, but reliable."[130]
38. Before *Daubert*, courts took a deferential view of science, and did not see a need to consider how the expert arrived at his opinion.[131] The *Daubert* decision, therefore, changed the course of toxic tort litigation, and other areas of law, by mandating judicial scrutiny of scientific methodology and giving judges the task of guarding against the intrusion of flawed science.[132] Clearly, as the *Reynard* case suggests,[133] the strict judicial scrutiny of scientific evidence established by *Daubert* will have a substantial impact on RF radiation cases, potentially benefiting defendants while the issue remains clouded by scientific uncertainty.

VI. Conclusion

39. The federal government, the cellular telephone industry, and courts all face pressure to respond to the public's concern about RF radiation.[134] Thus far, they have taken limited measures to placate the public outcry but have refrained from taking any action which would seriously

interfere with the development of the cellular network or deprive the public of the many benefits provided by cellular telecommunication services. Without conclusive scientific evidence to justify further action, this approach of restraint is proper, if not necessary, to preserve the integrity of policy makers charged with the difficult task of protecting the public from the unknown risks of RF radiation.

Footnotes

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[1] Public concern about the safety of cellular telephones emerged as early as 1993 following extensive media coverage of a lawsuit filed by David Reynard who alleged that his wife died of a brain tumor caused by RF radiation emitted by cellular telephones. For a discussion of this case, which ended in dismissal, *see infra* pp. 24-25 and accompanying notes. Since 1993, the press has fueled the debate over whether cellular telephones are hazardous. *See, e.g.* David Kirkpatrick, *Do Cellular Phones Cause Cancer?* FORTUNE, Mar. 8, 1993, at 82; John J. Keller, *Are They Safe? Nobody Knows, But Studies are Underway to Determine the Health Effects of Cellular-Frequency Radio Waves*, WALL ST. J., Feb. 11, 1994 at R13; Mike Mills, *Still Waiting for the Call; Do Cellular Phones Cause Brain Tumors? Researchers' Inability To Provide an Answer So Far Is Only Raising More Questions*, WASH. POST, Apr. 6, 1997, at H1; Jeffrey Silva, *Are Policymakers Blind to WTR's Slide?* RCR RADIO COMM. REP., Mar. 31, 1997, at 1.

Some commentators argue that the media is largely responsible for creating the irrational public fear that cellular phones cause cancer. *See, e.g.*, Michael Fumento, *Shock Journalism*, REASON, Jan., 1995, at 22 (criticizing media's careless reporting of EMF exposure issue). Fumento blames fear of RF radiation on "junk reporting", or irresponsible journalism, which fails to take into account all available evidence, and which distorts and manipulates statistical data and other information in order to arouse public attention).Others attribute the fear to "technophobia", a basic societal fear of progress and technology, unsupported by science, which has been a historical force of resistance to change MICHAEL FUMENTO, SCIENCE UNDER SIEGE, 218-255 (1993).

[2] *See* U.S GENERAL ACCOUNTING OFFICE, 95-32, REPORT ON THE STATUS OF RESEARCH ON THE SAFETY OF CELLULAR TELEPHONES 3-5 (Nov. 1994) [hereinafter GAO REPORT], (reporting that available studies were inconclusive to determine whether handheld cellular telephones pose public health risks, and recommending that industry and federal agencies work together to develop research agenda).

[3] For a detailed discussion of the methodological problems which have prevented scientists from

reaching accurate test results, *see infra* notes 32-37 and accompanying text. The pace of research has been slow due in large part to the multitude of variables that scientists must consider when assessing cellular phone health effects. For example, scientists do not know whether ten one-minute phone calls equal one ten-minute phone call; whether jewelry or wire-rimmed glasses play a role in either deflecting or directing radio waves; or whether it makes a difference if the antenna is up or down. Scientists must also take into account the fact that the density and power level of each call depends on a pocket phone's proximity to a cellular tower. There are a myriad of services and frequencies over which cellular phones operate, such as analog, digital and the proposed satellite-based phone services, which further complicates research. Mills, *supra* note 1, at H12.

[4] A study by Australian scientists, recently published in the journal Radiation Research, suggests that radio signals similar to those given off by cellular telephones may cause cancer in mice. The results, however, do not necessarily apply to humans. Jonathon Marshall, *Cell Phones Linked to Cancer in Mice; Radiation Study Finds Twice the Normal Rate*, S.F. CHRON., May 9, 1997, at A1. For an extensive review of studies showing positive findings and health effects, *see* GAO REPORT, *supra* note 2, at 16 (discussing the following studies: H. LAI, ET AL., DEPARTMENT OF PHARMACOLOGY AND CENTER FOR BIOENGINEERING, UNIVERSITY OF WASHINGTON, NEURAL MECHANISMS INVOLVED IN MICROWAVE-INDUCED DEFICIT IN RADIAL-ARM MAZE PERFORMANCE, (presented at the Bioelectromagnetics Society meeting, Feb. 1993); D.B. Lyle, et al., *Suppression of T-Lymphomocyte Cytotoxicity Following Exposure to Sinusoidally Amplitude-Modulated Fields*, 4 BIOELECTROMAGNETICS 281 (1993); E.K. Balcer-Kubiczek and G.H. Harrison, *Neoplastic Transformation of C3H/10T-1/2 Cells Following Exposure to 120-Hz Modulated 2.45-GHz Microwaves and Phorbal Ester Tumor Promoter*, 126 RADIATION RES. 65 (1991); L.G. Salford, et al., *Experimental Studies of Brain Tumor Development During Exposure to Continuous and Pulsed 915 Mhz Radiofrequency Radiation*, 30 BIOCHEMISTRY & BIOENERGETICS 313 (1993)).

[5] A National Academy of Sciences panel stated there is no conclusive evidence to prove that ordinary exposure to electromagnetic fields in the home can produce cancer, adverse neurobehavioral effects, or reproductive and developmental effects. The study was based on an analysis of seventeen years' worth of research and more than 500 published studies, and follows the publication of a large-scale study from Finland, examining nearly 400,000 people over a span of twenty years, which found that residential EMFs "do not seem to be related to the risk of overrall cancer in adults." Curt Suplee, *Power Line Hazard Called Small, Electromagnetic Fields Not Linked to Health Problems*, WASH. POST, Nov. 1, 1996, at A1, A4. For a discussion of how EMFs and RF radiation relate, *see infra* pp. 6-7 and accompanying notes.

See also, *Scientists Find No Cancer Indications in DNA Study*, MOBILE PHONE NEWS, June 17, 1996, at 3 (reporting on studies led by Joseph Roti Roti of Washington University Medical Center); *CTIA's Research Reveals No Link Between Cancer, Cellular Phone Usage*, MOBILE PHONE NEWS, Aug. 2, 1993, at 8 (reporting on the multi-million dollar study conducted by the Cellular Telecommunications Industry Association (CTIA); *Study Finds Cellular Phones' RF Emissions Within Safe Levels*, FCC REP., Dec. 15, 1993, at 10 (reporting results of study conducted by Dr. Om Gandhi of University of Utah for the National Institutes of Health (NIH), entitled *Electromagnetic Absorption in the Human Head for Cellular Telephones*).

[6] *See* Barbara Ann Aurecchione, Note, *EMF Regulation: Is Congress Riding the Wave of Paranoia?* 18 SETON HALL LEGIS. J. 261, 294 (1993) (noting that "The EMF exposure issue is a thorn in the side of the federal government, utilities, the consumer public, and many others affected by its ambiguity.")

[7] Jube Shiver, *Safety First is Nice in Theory, but Cost is Real Bottom Line*, L.A. TIMES, July 7, 1997, at D4.

[8] GAO REPORT, *supra* note 2, at 8. The number of subscribers today is remarkable when one considers the industry's relative infancy. *See* John W. Berresford, *The Impact of Law and Regulation on Technology: The Case of History of Cellular Radio*, 44 BUS. LAW. 721, 723-31 (describing historical development of cellular telecommunications and noting that although cellular communication theory dates back to sometime before 1947, the first cellular telephones were not available to the general public until late 1982).

[9] *See* Roy W. Krieger, *On the Line*, 80 A.B.A. J. 40 (1994) (arguing that the EMF radiation issue resembles the asbestos crisis, which also involved element of scientific uncertainty); *See generally*, Edward Gerjuoy, *Electromagnetic Fields: Physics, Biology and the Law*, 35 JURIMETRICS J. 55 (1994) (arguing that EMF litigation could dwarf the asbestos litigation crisis, and calling attention to fact that the asbestos crisis resulted in the filing of hundreds of thousands of claims, driving asbestos industry into bankruptcy).

[10] *See* New Brunswick Cellular Telephone Co. v. Old Bridge Township Planning, 636 A.2d 588, 596 (N.J. 1993), (assessing the benefits of cellular technology and concluding that it is "inherently beneficial" to society).

[11] *Id.* at 596. Surveys show that safety and security are primary motivations behind purchasing a wireless phone. Shiver, *supra* note 7, at D4. Some 25% of "911" calls to emergency operators are made from wireless telephones. With the proliferation of digital cellular, personal communication service (PCS), and enhanced specialized mobile radio (ESMR), this percentage is expected to increase significantly. *Wireless Emergency "911" Service May Bring Revenue Applications*, STATE & LOC. COMM. REP., Feb. 7, 1997, at 3. Recognizing the important role that cellular services can play in serving public safety needs , the FCC recently issued a mandate requiring the cellular phone industry to install technology that would enable police, fire and public safety officials to pinpoint the location of a cellular caller. *Id*. The media has been actively reporting incidents which demonstrate the crucial role that cellular technology plays in emergency situations. *See, e.g., Cellular Phones Can Be Vital For the Solitary Outdoorsman*, WASH. TIMES, Jan. 8, 1997, at B5 (describing benefits of cellular phones in life-and-death situations); Roger Bray, *Get Prepared For Hurricane Caribbean*, FIN. TIMES, Aug. 24, 1996, at 12 (reporting that hotels and resorts in Caribbean have been advised to equip their staff with cellular phones so that they can stay in contact when land lines go down); Rikki Lee, *Carriers Increase Relief Programs: Operators Offer Phones, Airtime to Local Agencies*, WIRELESS WEEK, Apr. 1, 1996, at 22 (reporting that American Red Cross rescue personnel, equipped with cellular phones, helped evacuate residents in an emergency situation after a train derailed and cut off the traditional wired phone system); Hanh Kim

Quach, *California Forest-fire Reporting Shifting to Cell Phones, Satellites*, DALLAS MORN. NEWS, June 23, 1996 at 6A (reporting that communities are relying on cellular systems to fight fires).

[12] *See* STEPHEN BREYER, BREAKING THE VICIOUS CIRCLE: TOWARD EFFECTIVE RISK REGULATION, 50-51 (1993) (arguing that the public will inevitably lose confidence in agencies which enact standards and set agendas to prove that they have erred on side of safety, when there is no evidence to prove that health risks exist). *See also* M. Granger Morgan, *Prudent Avoidance*, PUB. UTIL. FORT. Mar. 15, 1992, at 26 (describing the costs of taking measures to address public concerns). On the other hand, limited action might have the effect of producing a false sense of protection, which would harm, rather than serve, the public interest in health and safety.

[13] *See Cellular Industry Claims Phones Are Safe; Evidence Is Inconclusive*, COMM. DAILY, Jan. 26, 1993, at 1 (reporting that in 1993, cellular stock prices fell dramatically following press coverage of the RF radiation exposure issue).

[14] OFFICE OF TECHNOLOGY ASSESSMENT, U.S CONGRESS, BIOLOGICAL EFFECTS OF POWER FREQUENCY ELECTRIC AND MAGNETIC FIELDS, OTA-BP-E-53, at 76 (May 1989) [hereinafter OTA-BACKGROUND PAPER] (arguing that limited regulatory measures to assure public safety may produce a false sense of protection).

[15] Sean T. Murray, Note, *Comparative Approaches to the Regulation of Electromagnetic Fields in the Workplace*, 5 TRANSNAT'L L. & CONTEMP. PROBS. 177, 180 (1995).

[16] Krieger, *supra* note 9, at 41.

[17] *Id.*

[18] Electricity in motion creates electric and magnetic fields. The interaction of electric and magnetic fields create an electromagnetic field. Thus, wherever there is electricity in motion, there are EMFs. *See* John Weiss, *The Power Line Controversy: Legal Responses to Potential Electromagnetic Field Health Hazards*, 15 COLUM. J. ENVTL. L. 359, 361-363 (1990) (providing scientific background for understanding the nature and dangers of EMF radiation).

[19] Common examples of EMF sources generated by electric power are power lines, distribution lines, hair dryers, baby monitors, pencil sharpeners, dishwashers, clocks, microwaves, vacuum cleaners, household wiring, computers, video display terminals, fans and lighting fixtures. Sources emit EMFs at varying frequency levels. Aurecchione, *supra* note 6, at 272-273.

[20] For example, EMFs exist during thunder or lightning storms, in front of cold fronts, and are present in human cell membranes. Weiss, *supra* note 18, at 361-363.

[21] *Id.*

[22] Rufus C. Young, Jr. et al., *Update: Electromagnetic Fields and Their Land Use Implications,* A.L.I-A.B.A. COURSE OF STUDY, Aug. 16, 1995, at 1051.

[23] Weiss, *supra* note 18, at 360.

[24] The Soviet Union issued the first report on the adverse health effects of exposure to non-ionizing radiation. Power line workers exposed to EMFs were afflicted with symptoms of sleeplessness, headaches and upper respiratory tract problems. *See* Leonard A. Sagan, *Epidemiological and Laboratory Studies of Power Frequency Electric and Magnetic Fields,* JAMA, Aug. 5, 1992, at 625 (citing V. Korobkova et al., *Influence of the Electric Field in 500 and 750kv Switchyards on Maintenance Staff and Means for its Protection* (Presented at the International Conference on Large High-Tension Electric Systems in Paris, France, Aug. 28-Sept. 6, 1972). The next major study to reveal hazards associated with exposure to EMFs was conducted in Denver and published in 1979. The results of this study demonstrated a link between exposure to EMF from power lines and increased incidence of childhood cancer. Nancy Wertheimer & Ed Leeper, *Electrical Wiring Configurations and Childhood Cancer,* 109 AM. J. EPIDEMIOLOGY 273 (1979).

[25] GAO REPORT, *supra* note 2, at 2.

[26] *See supra* note 3.

[27] *See* sources cited *supra* note 4.

[28] Lai, *supra* note 4, at 16. Researchers at the University of Washington found that rats had difficulty learning a maze after 45 minutes of exposure to low-level, pulsed radio-frequency radiation near the frequencies that personal communication devices will use. The researchers concluded that exposure to low-level RF radiation decreases certain chemical agents in the rodents' central nervous system which are essential for spatial learning. *Id.*

[29] Lyle, *supra* note 4, at 16. The 1983 study found that the effectiveness of certain immune system cells in fighting off tumor cells was temporarily diminished after only 4 hours of exposure to low-power, pulsed radio-frequency radio signals. The researchers found that the effectiveness of the immune system cells was diminished most when the RF radiation was pulse-modulated 60 times per second, slightly more than the 50 times per second that digital cellular telephones' signals "pulse". *Id.*

[30] Balcer-Kubiczek, *supra* note 4, at 16. The 1991 study found that low-power RF radiation may facilitate the development of cancer in the presence of other substances known to cause cancer. According to this study, when cells were exposed for 24 hours to low-level, pulsed radio-frequency alone, there was no effect on the cells' survival or transformation into tumor cells. However, when the cells

were treated with a tumor-promoting chemical, exposure to RF radiation significantly enhanced the transformation of the cells into tumor cells. *Id.*

[31] *See* Marshall, *supra* note 4, at A1 (reporting results of Australian study).

[32] A major problem is that studies which are based on the effects of radio waves outside the cellular frequency or on exposure levels different from those of cellular users may not be helpful in determining the potential hazards of cellular telephone use. *See* GAO REPORT, *supra* note 2, at 16-17 (discussing inadequacy of studies).

[33] *See* James H. Stilwell, *Straddling the Wire: Electromagnetic Fields and Personal Injury Suits*, 14 REV. LITIG. 545, 552 (1995) (discussing EMF studies).

[34] Murray, *supra* note 15, at 180.

[35] *Id.*

[36] *See* OTA BACKGROUND PAPER, *supra* note 14, at 37 (citing K. OSSENKOPP & D. CAIN, ELF LOW INTENSITY MAGNETIC FIELDS AND EPILEPSY, (1986) and discussing the technical report prepared for New York State Power Lines Project which found that exposure to low-frequency EMFs at one intensity reduced epileptic seizures in rats, but exposures at higher or lower intensities had no effect). *See also* M. Granger Morgan et al., *Controlling Exposure to Transmission Line Electromagnetic Fields: A Regulatory Approach That is Compatible with the Available Science*, PUB. UTIL. FORT., Mar. 17, 1988, at 50 (citing tests by Blackman, et al., 1985; Goodman and Henderson, 1986; McLeod et al., 1987; Smith et al., 1987, and noting that in some of these tests the location of the "windows" depends on the magnitude and orientation of the earth's natural magnetic field).

[37] Gerjuoy, *supra* note 9, at 55.

[38] SHEILA JASANOFF, SCIENCE AT THE BAR: LAW, SCIENCE AND TECHNOLOGY IN AMERICA 71 (1995).

[39] *Id*. at 4.

[40] *Id*. at 71.

[41] *Id*.

[42] *See* ACCEPTABLE EVIDENCE: SCIENCE AND VALUES IN RISK MANAGEMENT, 49 (Deborah G. Mayo & Rachelle D. Hollander, eds., 1991) (discussing the problems inherent in assessing risks and noting that these problems are particularly evident in assessment of chronic health effects caused by low-level

exposures to toxic chemicals and radiation). For an in-depth discussion of the problems which plague efforts to regulate small, but significant risks to public health, *see* BREYER, *supra* note 12, at 10-29 (discussing major problems in regulating risks).

[43] JASANOFF, *supra* note 38, at 72.

[44] *Id.* at 73 (citing the following works which discuss special vulnerability of U.S agencies to legal questioning: JOSEPH L. BADARACCO, JR., LOADING THE DICE (1985); RONALD BRICKMAN, SHEILA JASANOFF & THOMAS ILGEN, CONTROLLING CHEMICALS: THE POLITICS OF REGULATION IN EUROPE AND THE UNITED STATES (1985); DAVID VOGEL, STYLES OF REGULATION (1986)).

[45] Scientific uncertainty, marked by a lack of consensus among experts and scientists, is considered by some to be the most serious impediment to effective environmental and public health decisionmaking. *Id.* at 72.

[46] GAO REPORT, *supra* note 2, at 12. The EPA has refrained from taking action. *See* WILLIAM F. HAMMETT, RADIO FREQUENCY RADIATION: ISSUES & STANDARDS, 70-75 (1997) (noting that the EPA, due to budgetary constraints, lack of specific congressional directive, and concern for more urgent issues, has refrained from issuing an RF radiation policy).

[47] *See supra* notes 1-5 and accompanying text.

[48] The public and Congress exerted pressure on regulators to consider the health effects of cellular telephone use. *See* Silva, *supra* note 1, at 1 (describing how the media frenzy in early 1993, by exploring the link between cellular telephones and cancer, gave rise to public fear, which prompted Congress to hold a cellular telephone safety briefing and then direct the General Accounting Office ("GAO") to investigate the status of research on the issue, which led to a GAO report recommending regulatory action).

It is not uncommon for federal agencies to take action in response to an issue that has generated significant public and congressional interest. *Cf.* Breyer, *supra* note 12, at 50-51 (arguing that the tendency to react to outside pressure can be a serious problem, impeding effective public health decisionmaking).

[49] *See infra* Part IIB(1-2) and accompanying notes.

[50] HAMMET, *supra* note 46, at 81.

[51] Guidelines for Evaluating the Environmental Effects of Radiofrequency Radiation, 61 Fed. Reg. 41,006 (1996) (to be codified at 47 C.F.R. pts. 1, 2, 15, 24, 97) (proposed Mar. 1993) [hereinafter FCC Guidelines].

[52] FCC Guidelines, *id.* at 41,006.

[53] GAO REPORT, *supra* note 2, at 5.

[54] *See* HAMMET, *supra* note 46, at 75 (criticizing the EPA for failing to provide guidance on RF radiation matters, which forced the FCC to look outside the federal government for guidance).

[55] The ANSI guidelines that were in effect from 1982 to 1991 were called the ANSI-C95.1-1982 Radiofrequency Protection Guidelines. (ANSI-1982). In 1992, ANSI adopted the IEEE C95.1-1991 standard, *see infra*, note 59, to replace the ANSI-C95.1-1982 guidelines. SCIENTIFIC ADVISORY GROUP ON CELLULAR TELEPHONE RESEARCH, POTENTIAL PUBLIC HEALTH RISKS FROM WIRELESS TECHNOLOGY: RESEARCH AGENDA FOR THE DEVELOPMENT OF DATA FOR SCIENCE-BASED DECISIONMAKING, 76 (1994) [hereinafter SAG REPORT].

[56] The IEEE, an engineering trade association, revised the 1982 ANSI standard in 1991. GAO REPORT, *supra* note 2, at 24 n.12. The revised standard is described in IEEE STANDARDS COMMITTEE 28, THE INSTITUTE OF ELECTRICAL AND ELECTRONIC ENGINEERS, IEEE STANDARD FOR SAFETY LEVELS WITH RESPECT TO HUMAN EXPOSURE TO RADIO FREQUENCY ELECTROMAGNETIC FIELDS, 3 KHZ TO 300 GHZ, IEEE C95.1-1991 (REVISION OF ANSI C95.1-1982 (1992)).

[57] FCC Guidelines, *supra* note 51, at 41,006. The EPA was pressing the FCC to adopt the NCRP-86 exposure guidelines, found in the NCRP REPORT NO. 86, BIOLOGICAL EFFECTS AND EXPOSURE CRITERIA FOR RADIOFREQUENCY ELECTROMAGNETIC FIELDS (1986), while the industry was lobbying for the adoption of the ANSI-92 standard. The FCC settled this question by adopting portions of both NCRP-86 and ANSI-92, but neither one completely. HAMMET, *supra* note 46, at 81. For a discussion of the standards setting activities of ANSI, IEEE, NCRP and other authoritative agencies and groups, *see* SAG REPORT, *supra* note 55, at 67, 73-77 (discussing criteria used in formulating standards).

For criticism of the ANSI/IEEE and NCRP standards, *see* David Fichtenberg, Ad-hoc Ass'n of Parties Concerned about the FCC's RF Health & Safety Rules, Pet. for Recons. of Commission Rule & Order 96-326, and First Mem. of Op. & Order FCC 96-487, 6-31 (June 10, 1997) [hereinafter Ad-hoc Ass'n Pet] (discussing differences between standards and their shortcomings).

[58] FCC Guidelines, *supra* note 51, at 41,007. The term was first introduced in an NCRP report in 1981 as an alternative to the term "dose rate" which was already in use for ionizing radiation. HAMMET, *supra* note 46, at 54-55.

[59] Robert F. Cleveland, Office of Engineering & Technology, FCC, *New FCC Policies and Guidelines for Evaluating Human Exposure to Radiofrequency Electromagnetic Fields*, Remarks at the International Business Communications (IBC) conference *Cellular Phones - Is there a Health Risk?* (June 23-24, 1997) (transcript available from IBC).

[60] *Id.*

[61] *Id.*

[62] *See infra* text accompanying notes 65-73.

[63] Cleveland, *supra* note 59.

[64] *FCC Adopts Wireless Emission Guidelines, Cellular Telephones No Longer Exempt,* MOBILE PHONE NEWS, Aug. 12, 1996, at 8.

[65] Manufacturers recommended that the FCC assist in developing and adopting standardized testing procedures which they can rely upon to assure RF devices comply with the SAR levels. *See* Ericsson Corp., Reply Comments in ET Docket No. 93-62, 5 (Apr. 25, 1994) (advising FCC to designate an outside organization to develop such standards, which should then be incorporated into FCC's environmental rules).

[66] *See* OTA BACKGROUND PAPER, *supra* note 14, at 2-3 (suggesting that weaker electromagnetic fields may pose a health risk).

[67] *Id.* at 37.

[68] Gerjuoy, *supra* note 9, at 65.

[69] "Thermal effects" are biological effects which occur when tissues are exposed to RF or microwave fields strong enough to raise the temperature. Proposals for a Research Programme by a European Commission Expert Group on the Possible Effects Related to the Use of Cellular Telephones, 1.3.1 (September, 1996) [hereinafter Expert Group Proposals].

[70] "Non-thermal effects" describe biological responses to amplitude-modulated RF or microwave fields at SARs too low to involve any response to heating. *Id.* at 1.3.2.

[71] Ex Parte Comments Pertaining to ET-Docket 93-62 Regarding Petitions for Reconsideration of Commission Rule & Order FCC 96-326, and First Memorandum of Opinion and Order FCC 96-487, submitted by the Ad-hoc Association of Parties Concerned about the FCC's RF Health and Safety Rules, 11 (June 10, 1997) [hereinafter Ad Hoc Petition]. *See also* Silva, *supra* note 1, at 1) (discussing debate over whether FCC guidelines protect against any long-term non-thermal bio-effects from cellular phones).

[72] Expert Group Proposals, *supra* note 69, at 1.3.1-1.3.2.

[73] *Id.*

[74] Ad-Hoc Petition, *supra* note 71, at 11-13.

[75] The FDA Secretary shall "prescribe performance standards for electronic products to control the emission of electronic product radiation from such products if he determines that such standards are necessary for the protection of the public health and safety. Such standards may include provisions for the testing of such products and the measurement of their electronic product radiation emissions, may require the attachment of warning signs and labels, and may require the provision of instructions for the installation, operation, and use of such products." Electronic Product Radiation Control, 21 U.S.C.A § 360kk(a)(1) (West. Supp. 1997).

[76] *Update on Cellular Phones,* FDA TALK PAPER NO. T93-7, 3-4 (Feb. 4, 1993).

[77] GAO REPORT, *supra* note 2, at 21.

[78] The FDA and manufacturers have discussed, for example, the advantages and disadvantages of redesigning the placement of the antenna so that this source of radiation is further from the user's head. Telephone Interview with Joanne Barron, Representative of the FDA Science Advisory Board (Nov. 1, 1996) [hereinafter Interview].

[79] FDA-supported research at the Johns Hopkins Applied Physics Laboratory found that permanent damage occurred to the eyes of test animals when the animals were exposed to low-level microwave radiation. This effect was enhanced when the test animals were treated with drugs used in glaucoma treatment and exposed to RF radiation at frequency levels several times lower than those emitted by cellular telephones. GAO REPORT, *supra* note 2, at 17.

[80] *Id.* at 19.

[81] There have been very few documented reports of radiation injuries submitted to the FDA through its complaint system. Interview, *supra* note 78.

[82] Interview, *supra* note 80.

[83] *See* Electronic Product Radiation Control, *supra* note 75 (detailing possible measures for regulating electronic products which emit radiation).

[84] Manufacturers now have discretion to articulate the potential dangers of RF radiation in their own

terms, and to the extent they find it necessary to do so. Interview, *supra* note 78.

[85] Warnings and labels will have no impact on safety if the public never reads them. S*ee* Breyer, *supra* note 12, at 56-57 (arguing that the popular, less restrictive warning labels are not a real solution to the problems of risk regulation).

[86] The "cellular telephone industry" refers to manufacturers of cellular telephones, manufacturers of the telecommunications infrastructure, and cellular telephone carriers. SAG Report, *supra* note 55, at 1.

[87] The research group has spent $17 million since 1993. Mills, *supra* note 1, at H1.

[88] SAG Report, *supra* note 55, at 1.

[89] *Id.* The research program under the WTR operates under several guiding principles: (1) the research should focus on studies relevant to the public health impact of wireless communication devices; (2) all studies conducted must be performed in accordance with the highest scientific standards, including Good Laboratory Practices and Good Epidemiology Practices; (3) all studies must receive scientific peer review by both the WTR and the independent Peer Review Board coordinated by the Harvard Center for Risk Analysis; and (4) all researchers funded through the program must submit their work for publication in the open, peer-reviewed scientific literature. Memorandum in Support of the Motion of the Wireless Technology Research, L.L.C. to Dismiss or, in the Alternative, for Summary Judgment, Wright v. Motorola, No. 95 L 4929 (C.C.Ill. filed Sept. 25, 1995) at 10 [hereinafter WTR Memorandum].

[90] For a discussion of the common-law rules influencing safety research, *see* Wendy E. Wagner, *Choosing Ignorance in the Manufacture of Toxic Products*, 82 CORNELL L. REV. 773 (1997) (arguing that manufacturers under current system of liability have little incentive to invest in safety research).

[91] *Id.* at 803.

[92] *Id.* at 774.

[93] Safety research invites litigation to the extent that it produces information or vital evidence for plaintiffs' attorneys. *Id.* at 775.

[94] As one commentator stated: "If manufacturers face virtually no penalty for remaining ignorant about the latent health risks of potentially toxic products, but risk crushing liability if they learn of long-term hazards, it is only rational for manufacturers to choose ignorance." *Id.* at 775.

[95] *Id.* at 794. *See infra* Part IV(B) and accompanying notes.

[96] *See supra* notes 91-93 and accompanying text.

[97] *See* Mills, *supra* note 1, at H1 (questioning WTR's independence). There are numerous safeguards in place, however, to ensure that the WTR remains independent of industry influence. The WTR's funding mechanism, which requires the CTIA to remit contributions into an unrestricted, deposit-only escrow fund is one such safeguard. In addition, the WTR's research agenda is subjected to peer review coordinated independently by the Center for Risk Analysis of the Harvard University School of Public Health, and key federal agencies monitor the program. WTR Memorandum, *supra* note 89, at 5-12.

[98] *See Courts Review Thirteen Health Lawsuits Dating Back to 1992*, MOBILE PHONE NEWS, Apr. 28, 1997 (discussing judicial treatment of cases linking cellular phone use to health problems).

[99] Guido Calabresi & Jeffrey O. Cooper, *New Directions in Tort Law*, 30 VAL. U. L. REV. 859 (1996). *See* Theodore Eisenberg & James A. Henderson, Jr., *Inside the Quiet Revolution in Products Liability*, 39 UCLA L. REV. 731 (1992) (describing pro-defendant trends in product liability lawsuits); The press has also reported on the existence of a pro-defendant trend. *See*, *e.g.*, George Flynn, *Jury Awards Becoming "More Sensible" Locally; Trend Shows Plaintiffs Getting Less*, HOUSTON CHRON., July 9, 1995, at A29; Richard Perez-Pena, *Study Finds Sharp Drop Last Year in Awards for Medical Malpractice Cases,* N.Y TIMES, Jan. 27, 1995, at B7; Bill Rankin, *Tort Reform: The Price of Justice,* ATLANTA J. & CONST., May 21, 1995, at D1; Richard Waters, *Where Passions and Court Awards Run High - The Tide is Turning in Favor of Corporate Defendants in U.S. Product Liability Cases,* FIN.TIMES, May 24, 1995, at 27.

[100] The Association of Trial Lawyers of America identified "toxic torts" as a distinct area of litigation in 1977. JASANOFF, *supra* note 38, at 118.

[101] Torts occurring as a result of exposure to RF radiation can be classified as toxic torts. Although RF radiation is not a chemical, it can be considered a toxic substance. Nicholas Shannin, Note, *Converging Theories: An Analysis of the Future of Medical Monitoring as a Remedy for the Victims of Powerline Radiation Torts,* 7 U. FLA. J. L. & PUB. POL'Y 127 (1995).

[102] John A. Siliciano, *Mass Torts and the Rhetoric of Crisis*, 80 CORNELL L. REV. 990, 1010 (1995). The astronomical growth in claims involving asbestos created crisis conditions for the judicial system. Teresa Moran Schwartz, *The Role of Federal Safety Regulations in Products Liability Actions,* 41 VAND. L. REV. 1121 (1988).

[103] *See* Susan R. Poulter, *Science and toxic Torts: Is There a Rational Solution to the Problem of Causation?*, 7 HIGH TECH. L.J. 189, 193 (1992) (stating that an occasional plaintiff's verdict may encourage other suits and increase value of settlements).

[104] *See* Siliciano, *supra* note 102, at 1011 (stating that courts must follow rules of the tort system and insist upon scientific proof before awarding recovery to plaintiffs, in order to guard against 'the next

asbestos').

[105] Weiss, *supra* note 18, at 362.

[106] *See infra* Part III(B) and accompanying notes.

[107] *See Courts Review Thirteen Health Lawsuits Dating Back to 1992, supra* note 98 (discussing status of thirteen health-related cellular phone lawsuits).

[108] Marenghi v. Barton, No. 90-863-B, Slip Op. at 4 (Mass. Sup. Ct. Apr. 25, 1994) (quoting NOLAN 37 Mass. Prac. § 225, at 370 (1987) *cited in* Mark A. Lowe & R. Paul Roecker, *Claims for Bodily Injury Due to Electromagnetic Fields: Shocking Result,* 38 B. B. J., 6, 20 Nov/Dec, 1994.

[109] The problem of causation for the toxic tort plaintiff is well documented. Particularly good summaries are found in: Jeffrey D. Cutler, *Implications for Strict Scrutiny of Scientific Evidence: Does Daubert Deal a Death Blow to Toxic Tort Plaintiffs?* 10 J. ENVTL. L. & LITIG. 189, 197 (1996); Jack L. Landau & W. Hugh O'Riordan, *Of Mice and Men; The Admissibility of Animal Studies to Prove Causation in Toxic Tort Litigation,* 25 IDAHO L. REV. 521 (1988-89).

[110] *See* Steve Gold, Note, *Causation in Toxic Torts: Burdens of Proof, Standards of Persuasion, and Statistical Evidence,* 96 YALE L. J. 377, n5 (listing various proposals for changes in tort law).

[111] *See* Wagner, *supra* note 90, at 791-93 (arguing that plaintiffs in toxic tort cases will inevitably bear all losses resulting from limitations in scientific knowledge, and criticizing current common-law liability rules which discourage manufacturers from producing scientific information to prove causal link).

[112] *See* Cutler, *supra* note 109, at 197 (citing In re Paoli R.R. Yard PCP Litig., 35 F. 3d 717, 751 (3d Cir. 1994)).

[113] *Id.*

[114] *Id*. *See* Siliciano, *supra* note 102, at 992 (discussing causation problem in mass toxic tort litigation context, citing asbestos, Agent Orange, and DES as examples of cases where causation issue stretched boundaries of rules governing liability and damages).

[115] *See* Gold, *supra* note 110, at. 377, n5 (1986) (citing Delgado, *Beyond Sindell: Relaxation of Cause-in-Fact Rules for Indeterminate Plaintiffs,* 70 CALIF. L. REV. 881 (1982) (favoring shifting burden to defendants and making recovery proportional to probability of causation); Ronald B. Lansing, *The Motherless Calf, Aborted Cow Theory of Cause,* 15 ENVTL. L. 1 (1984) (advocating abandonment of causation requirement in favor of consistency rule); Note, *Tort Actions for Cancer: Deterrence, Compensation and Environmental Carcinogenesis,* 90 YALE L.J. 840 (1981) (advocating burden shifting);

Wendy E. Wagner, *Trans-Science in Torts*, 96 YALE L.J. 428 (1986) (arguing for a 'qualitative' causation standard, with burden shifting).

[116] One commentator identified the tendency of courts to "cling to conceptions of individual responsibility that coincide neatly with 18th century science's notions of causation" as the source of the problem. Cutler, *supra* note 109, at 197 (*citing* Troyen A. Brennan, *Causal Chains and Statistical Links: The Role of Scientific Uncertainty in Hazardous-Substance Litigation*, 73 CORNELL L. REV. 469, 491 (1988).

[117] 887 F. Supp. 1500 (Fla. 1995).

[118] *Id.* at 1504 .

[119] *Id.* at 1502.

[120] The court pointed to the flaws in the plaintiff's evidence. One article from a publication entitled "Microwave News" contained numerous statements expressing uncertainty as to whether microwaves could act as a cancer-causing agent. The other article, written by Dr. William L. Caldwell, discusses a theory relating to radiation which does not clearly apply to cellular telephone emissions. The expert's affidavit, according to the court, contained speculative scientific hypotheses and allegations unsupported by specific facts and data. *Id*. at 1504.

[121] Jay P. Kesan, *Note, An Autopsy of Scientific Evidence in a Post-Daubert World*, 84 GEO. L.J. 1985, 2012 (1996).

[122] *Cutler, supra* note 109, at 189.

[123] 113 S.Ct. 2786, 509 U.S. 579 (1993).

[124] *See infra* text accompanying notes 125 -126.

[125] *Daubert*, 113 S.Ct. at 2799.

[126] *Id*. at 2796-2797.

[127] *Daubert v. Merrell Dow Pharmaceuticals, Inc.*, 43 F. 3d 1311 (9th Cir. 1995) [hereinafter Daubert II].

[128] *Id.* at 1317.

[129] 118 S.Ct. 512 (1997).

[130] *Id.* at 513 (quoting *Daubert*, 509 U.S. 579, 589).

[131] *See, e.g.*, United States v. Baller, 519 F.2d 463, 466 (4th Cir. 1975), *cert. denied*, 423 U.S. 1019 (1975) (stating "..an opinion that claims a scientific basis is apt to carry undue weight with the trier of fact."); United States v. Addison, 498 F.2d 741, 744 (D.C. Cir. 1974) (stating "Scientific evidence may assume a posture of mystic infallibility in the eyes of a jury of laymen."); United States v. Amaral, 488 F.2d 1148, 1152 (9th Cir. 1973) (noting scientific testimony has an "aura of special reliability and trustworthiness."); D'Arc v. D'Arc, 385 A.2d 278 (N.J. Super. Ct. App. Div. 1980), *cert. denied*, 451 U.S. 971 (1978) (stating scientific evidence has an "aura of mystic infallibility.")

[132] *See* Cutler, *supra* note 109, at 211 (assessing whether "gate-keeping" role assigned to judges is proper).

[133] "Theoretical speculations, unsupported assumptions, and conclusory allegations advanced by an expert...are [not] entitled to any weight when raised in opposition to a motion for summary judgment... [W]hen causation is the issue, courts are particularly wary of expert opinion...The uncertainty of the evidence in [toxic tort] cases, dependent as it is upon speculative scientific hypotheses and epidemiological studies, creates a special need for robust screening of experts and gatekeeping . . ." *Reynard*, *supra* note 117, at 1506 (quoting Bell v. Swift Adhesives, Inc, 804 F. Supp. 1577, 1579 (S.D.Ga. 1992)).

[134] Many commentators assert that the public's perception of risk is irrational, having little, if anything to do with actual incidence of harms. *See, e.g.*, ACCEPTABLE EVIDENCE, *supra* note 42, at 219 (discussing views by Mary Douglas and Aaron Wildawsky who emphasize value judgments in hazard assessment, and claim that citizens who lack knowledge in science and mathematics lack ability to measure risks objectively). Psychologists have identified certain patterns of thinking that inhibit society from gaining a rational perspective of risks, such as the tendency to (i) oversimplify and engage in quick decision-making, (ii) react more strongly, and give greater importance, to events that stand out from the background, (iii) feel a stronger ethical obligation toward family, friends and community, rather than toward those who live in distant places, (iv) lack the ability to judge between experts when those experts disagree with each other, (v) resist modifying decisions once they have been made, and (vi) overestimate small probabilities. BREYER, *supra* note 12, at 33-39.