

## Chapter 2: Antipodes\*

*In a state hearing on the safety of powerlines, three power-company experts are cross-examined and their opinions that electromagnetic energy from powerlines will be completely safe is rejected. 1974–1978.*

Although changes in powerline design for purposes of avoiding health risks would mean added costs, especially if the powerlines were built underground, I had initially expected that the companies would be willing to err on the side of safety because they were controlled monopolies and, according to Simpson, the state would let them increase the price of electricity to recover their costs. Consequently, honoring their fiduciary responsibility to be starkly truthful about the possibility of health risks would ultimately not have reduced their profits. But that wasn't the course the companies chose. They hired stridently negative experts, effectively ignoring their duty toward the exposed subjects, precisely the opposite of what Cardozo had described as lawful conduct, so the cross-examination phase of the hearing began.

### Becker Cross-Examination

The day Becker first took the witness stand I saw a glint of determination in his eye. The power-company lawyers were especially concerned about his direct testimony regarding involuntary human experimentation. They complained bitterly that it should be stricken from the record because it violated their clients' constitutional rights, but the hearing examiner refused. During the rest of the day and for three subsequent days the lawyers repeatedly returned to the issue of human experimentation, trying to induce Becker to change his testimony. They asked essentially the same question at different times in an effort to catch him at least arguably contradicting himself. I urged him to answer with a statement like "that's the same question I was asked earlier and my answer is the same," but he was slow to recognize that he was not lecturing medical students but rather involved in an adversarial process.

Q. Isn't it true that you previously defined human experimentation as doing something to look for a result, which you cannot, with absolute certainty, predict will occur, while using humans as the subjects?

A. I think your quote was accurate.

Q. Would you consider the construction of a powerline as doing something to look for a result?

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\* This is a preprint of a manuscript that will undergo copyediting and review before publication in final form.

A. If I understand your question correctly, I don't think you could characterize it as that.

Q. Well, then, the building of a powerline would not be human experimentation, would it, inasmuch as it is not being built in order to look for a result that you cannot with absolute certainty predict?

A. Well, I think the construction of the powerline certainly is not an experiment. That is obvious in itself. The operation of the powerline and the exposure of individuals to energy levels in excess of those we have used before, in my opinion, would constitute an experiment.

Q. Doctor, could you tell me then what specifically it is about the proposal to construct the powerlines that falls within your definition of human experimentation?

A. Well, I would look at that in the following light. The only analogy I can draw is if instead of working with animals, we were to work with humans in our experiments. If I set up a human experimental study involving the exposure of humans to powerline energy levels, that research would be subjected to human experimentation committee review, and we would have to then abide by all the pertinent regulations. If the establishment of the energy levels were not being done for the purposes of human experimentation, then I imagine it evolves into a legal question of whether or not you are experimenting on humans. The answer would depend on whether or not you knew that there was a question in regards to possible side-effects, and whether or not you had any kind of a program to look for side-effects.

Q. Yesterday you said that stress involves the brain and can lead to disease. Can you identify the source of your theory?

A. I think you have to understand that the concept of stress is one that has developed slowly over the years. Dr. Hans Selye in Montreal did a lot of work on stress and the physiological responses from stress. The majority of people who work in the field agree that a major portion of the response, whatever it may be, is the result of central nervous system action, so this is not solely my opinion.

Q. Doctor, Professor Michaelson testified that the biological response to stress can be "good for you." Is there some doubt that stress can cause a pathological state?

A. I don't believe there's any doubt that stress can cause a pathological state, nor do I think there's any doubt that certain amounts of stress are probably good for you. The question is the extent and the chronicity of the stress. Stresses are additive in a sense. Now, understand I use the term stress in a very wide sense. Let me take this opportunity to go a little further into this because I think you want to develop stress situations somewhat more.

Q. Surely.

A. There are certain physiological responses that are associated with a response to a stressful situation. These can now be identified in a wide variety of circumstances. The present concepts are that not only a few diseases but also the whole concept of disease in general is markedly influenced by mental mechanisms, by functions that take place within the brain. Now, the response to a situation is determined in part by what the animal or human perceives the situation to be and how they can react thereto. So it is quite conceivable that if you have circumstances that alter the functional state of the central nervous system, you could have then the same physiological responses that you see in a stressful situation. In other words, we may not be able to apply what the layman would say, "Well, this is stress and this is not stress." The organism may still respond in the same fashion and produce the same physiological responses solely because of some action at the level of the central nervous system.

Q. And it's not your testimony that stresses emanate only from the electromagnetic energy that we are discussing; isn't that correct?

A. All that we can say is that the response of the animal to the energy is in keeping with a stressful response. This does not necessarily imply that the energy, per se, was stressful. The effect could have been a functional effect upon the central nervous system with subsequent alterations, the same as a stressful situation.

Q. If powerlines can cause health problems, wouldn't they have been manifested in persons exposed to existing powerlines?

A. What you're getting at is, I think, that there are energy levels at various points around existing powerlines that are stronger than those from these new powerlines. Am I paraphrasing you correctly?

Q. That's correct.

A. And what you're saying now is since these energy levels did exist, should we not have seen some effect?

Q. Precisely.

A. Well, the answer to that is that all of these effects are common effects in our population. It's not at all uncommon to have patients with hypertension, arteriosclerotic heart disease, and gastric duodenal ulcers. These are very common in our society at the present time. To say that they are or are not due to the existing levels of electromagnetic energy that these people are exposed to would require an epidemiological type of study. In that type of study, you would have to take matched population groups within those fields of exposure and without these fields of exposure. There are a number of factors to be considered in the situation. The diseases that we see in medical practice today constitute a different class of disease than were the commonest diseases 40 or 50 years ago. Hypertension is a very common disease and I would suspect that increased irritability on the part of the general population is a very common condition, as evidenced by the consumption of

tranquilizers in the United States at the present time. We have had the occurrence of medical conditions that you didn't see in the literature 50 years ago. Hyperactivity on the part of children, for example. A very discernible percentile of children in school in the United States are under treatment for what is called a hyperactivity syndrome. Now, all this came out of the air, all of a sudden. In the area of growth disturbance, there's an increase in the attack rate of malignancies in our population. So, to say that these fields have existed since 1940 or 1950 and that apparently nothing has happened, I don't think that is correct. It is true that no one has their hair turned green and their eyeballs fall out when they stand underneath the transmission line, but whether or not the disease complex that we see in medicine today is or is not related thereto, I am not about to say at this time.

Q. Is what you're saying that these manifestations exist in the environment or among the population today, but that you can't relate these discernible effects to the fields generated by powerlines? Is that what you're telling us?

A. What I'm telling you is that the evidence that we have accumulated indicates that animals under controlled circumstances, if exposed to these parameters, will develop the physiological changes that we enumerated. That if you transfer this to the human population, then the same sort of thing would occur. I see no difference between rats and people in this regard. The question that then comes up is: if this is so, why haven't we seen it? I think this is what you are alluding to, and in that case all I can say is that no one has done the appropriate epidemiological study to establish this as the primary causative factor. This doesn't negate the possibility or the probability that this would occur.

Q. Doctor, are you in favor of shutting down all powerlines because of the harm that might be caused by the electromagnetic energy they emit?

A. In response to the question whether I would recommend construction of the powerlines as they are now designed, I said "no" for the reasons that they are possibly productive of biological effects. And I go on to say that the most prudent course to follow would be to determine the complete spectrum of biological effects produced by exposure to the electromagnetic energy. This obviously includes existing high-voltage powerlines. As a scientist, I can only say that we think that we have positive evidence that effects of electromagnetic energy do occur in the biological organism. It seems to me quite within the realm of possibility that not only the existing powerlines but also the existing ambient electromagnetic energy from other sources, particularly in urban areas, is productive of biological effects at the present time. I would, however, not be in favor of turning off the electricity because of the other social factors that would appertain as a result of such an event. These would obviously be in the medical sphere as well as in the economic and social spheres. The possible medical value gained by turning off all of the electrical power at the present time would be counterbalanced by the medical harm that would be done as a result of disruptions in our entire society. So, I could not in good conscience at the present time say that I recommend the discontinuance of operation of all powerlines. But I do stand

on my recommendations that a problem, in my opinion, does exist, that the problem will not go away, and that it should be studied.

## Marino Cross-Examination

My cross-examination was tense throughout. The company lawyers were antagonistic, quite different from their attitude toward Becker, and concentrated on attacking my credibility rather than the substance of my testimony, which was how they had attacked him. Before my cross began, the lawyers demanded copies of all of my raw data regarding all my gold-standard studies, an onerous demand for which there was no legal precedent in New York, especially for a *pro bono* expert witness. Nevertheless, following Simpson's advice, I provided thousands of pages of data, but in its stark simplicity, with no explanations whatsoever regarding the meaning of the numbers on the pages, which Simpson agreed I was not required to provide because raw data is not intended for publication. The lawyers, however, made their own meaning from my data and used their product as a basis for questioning me, leading to many days of aimless cross-examination. One day, a company lawyer named Robert Harvey presented me with a page of my data that contained no details regarding provenance, but on its face indicated a column of numbers representing the daily water consumption of a rat totaled "919 milliliters." Harvey asked me to concede that the correct sum was 920 milliliters. I told him I would not do calculations on the witness stand because the possibility of error was too high due to the stress of cross-examination. But then I agreed to make an exception and began adding the numbers slowly, repeating the process several times for the sake of accuracy while everyone in the hearing room waited. After about fifteen minutes, I told Harvey he was correct, and he asked, "Isn't this evidence that you were a sloppy recorder of data and therefore that your testimony about your experiments was unreliable?" "No," I replied, and he moved on to other similar lines of questioning.

I explicitly rejected Schwan's "biophysical principles," calling them "ridiculous," and testified that, regardless of whether he said they were "principles" or a "method," they were irrelevant and had no meaningful relation to the subject of biological effects due to powerline energy. But the company lawyers never challenged my testimony, even though I had criticized Schwan in the strongest language possible.

Schwan had also said that his calculations proved that the powerlines were completely safe. Several times during my testimony I offered to provide one million calculations, each equally as valid under the laws of physics as the calculations he had done, but that each yielded a range of results which varied by more than a million percent, thereby showing that his calculations were arbitrary and proved nothing. But again, the lawyer did not attack the substance of what I said.

Still another area where my testimony was unchallenged involved the gold-standard studies. When I went into the hearing room each day, I used a hand truck to bring in copies of every gold-standard study on the list I cited in my direct testimony, and additional

supporting studies. Wherever possible I supported an answer to one of the questions I was asked by explicitly referencing one or more of the studies, and I was prepared to discuss the cited study to any degree of specificity needed to support my testimony. But again the company lawyers gave me a free ride and almost never challenged me.

The peak of the theater of the absurd came on the thirteenth and last day of my cross-examination, as ordered by the commission. About mid-morning Harvey, knowing that I had been interviewed by *60 Minutes* regarding my testimony, asked me if I gave Richard Clark, the show's producer, any unpublished documents I had written. I answered affirmatively and when Harvey asked for a copy, I refused. Without asking why I refused, he demanded that the commission order me to produce a copy, arguing that it was necessary to protect his client's constitutional right to impeach me based on prior inconsistent statements, which he hoped to find in the document. All the company lawyers rose one by one to support Harvey, and Simpson opposed each of them, arguing that they had no right to make such a demand. The hearing examiner, perplexed by the brouhaha and unsure about what to do, struggled to maintain decorum. I just sat silently on the stand, watching the clock move inexorably toward quitting time. During the argument Simpson asked, "Dr. Marino, do you have a copy?" "No, I never made a copy," I replied. I saw blue veins on Harvey's forehead stand out as he told the hearing examiner that I was a lawyer and should have known that I had a duty to save a copy, but the hearing examiner just shrugged and Harvey asked for a recess.

When we went back on the record, Harvey asked the hearing examiner to order Clark to provide a copy of the document, and there ensued a long argument regarding whether the hearing examiner had that authority. He ultimately decided he didn't, but he authorized Simpson to immediately contact Clark and request a copy. Simpson, at the direction of the hearing examiner, called Clark in New York city and was told that Clark was fishing in Alaska. He was eventually reached in Alaska and when asked for a copy of the document "in the interests of justice," his response was, "Tell (Harvey) to go fuck himself." That was the way my last day on the stand ended. As I was packing my studies into boxes and loading them on the hand truck, one of the company lawyers told Harvey sardonically, "You had Marino eating out of the palm of your hand."

In the next phase of the hearing, the power-company expert witnesses were cross-examined. The law permitted expert witnesses to state opinions, like whether a given gold-standard study was done properly or whether powerlines electromagnetic energy was a health risk, as if they were facts. Essentially anyone with post-graduate degree was permitted to state opinion facts, so allowing a theoretician, veterinarian, and a botanist to opine in opposition to Becker and me was not surprising. But they were not knowledgeable and cited no publications to support their conclusionary facts, which they stated using clichés like "reasonable scientific certainty" that gave the misleading impression of scientific rigor. Consequently, even though the law required their opinions be considered as evidence in the hearing, the witnesses were vulnerable to an attack on their credibility by means of

cross-examination—the more successful the attack the less weight would be afforded their opinions. I designed their cross-examinations with the intent of impeaching their credibility, thereby demonstrating that all three witnesses were unreliable.

## Schwan Cross-Examination

### *Plan*

I regarded Schwan as the most severe dissembler and the gravest danger to public health, and made him my primary target in the cross-examination of the power-company experts. He had never performed an animal or human experiment, or any gold-standard study, and his method of confirming the safety of powerlines by analogizing human beings to balls of dead muscle was unreasonable on its face. Nevertheless, he was an experienced opinionator and a powerful political force in the U.S. regarding health risks of man-made electromagnetic energy. He had an authoritative, almost imperial manner of speaking, and a habit of using more than the necessary number of words to reply to a question or make an argument, which obscured the basis of his reasoning; his conclusion was invariably clear but how he got there was typically shrouded by fog even for those who understood the lingo. Schwan's mannerisms became exacerbated when the question put to him was one he didn't like or didn't want to answer, which would be the case with regard to almost every question I posed. So I decided to construct the entire cross-examination using leading questions in which the point I wanted to make was in my question, not his answer, which I assumed would be evasive. I had no power to require him to answer "yes" or "no" but I could construct the questions so that, ultimately, they were the only two possible answers that he could provide to Simpson, who was the only person that would actually execute the cross-examination, with me sitting beside him, whispering into his ear when necessary or replying to him when he had a question for me.

I envisioned four lines of attack. First, I wanted to show that he was not an expert in the area of health risks from electromagnetic energy, and therefore not actually qualified to state opinions as if they were facts, irrespective of his PhD and his politically-based stature as an expert in microwaves. Second, I wanted to show that his methodology, his so-called "biophysical principles," weren't principles at all but rather idiosyncratic verbal constructs—mathematical calculations and/or assumptions concerning biological function—invented to rationalize the interests of his clients. Third, I intended to confront Schwan with as many of the gold-standard studies as necessary to show the commission that he never accepted as valid *any* published study, regardless of its scientific merit, if the results were contrary to the interests of his clients. Confronting him with published studies that described biological effects due to electromagnetic energy that he claimed were impossible would be tedious because he was sure to resist, but the overall effect as captured in the written record would give Simpson a strong basis to urge the commission to reject Schwan's testimony because he was biased. Fourth, even assuming that Schwan's

calculations of the level of electromagnetic energy induced by powerlines inside a sphere of muscle were reliable, and further assuming that the calculated result applied to a normally-shaped living person, and still further assuming that the resulting temperature increase was small by whatever standard Schwan chose, his claim that the calculated level inside the living person would be completely safe was arbitrary and unjustified; I intended to plainly demonstrate that fact through his cross-examination.

### *Voir Dire*

I began a plan for the cross-examination with a direct attack on his qualifications as an expert in the area of health risks from man-made electromagnetic energy. I realized that the company lawyers would object because Schwan was regarded as an expert by the military and by engineering societies. But the law valued training and experience relevant to the area of his testimony; he had neither and I wanted to inform the record of that fact.

1. “You were awarded a PhD in biophysics in 1940, right?”

He had to say “yes” but could embellish his response with gratuitous information such as by telling me he also had other academic achievements. I couldn’t limit his initial response but I could always return to my question: “With that qualification, is the answer ‘yes’?” The answer couldn’t be “no” and I was prepared to exhaust all the gratuitous paths, so I knew I would wind up with a “yes.” My purpose was to begin my training of Schwan so that he realized I was in charge, not him—something new for him.

2. “Your research project leading to your 1940 PhD in biophysics involved microwaves, right?”

His research might have involved other things that he wanted to talk about, but I wanted to show that it involved microwaves. So I planned to wait for as long as he wanted to talk, and when he finished to ask, “With that qualification, is the answer ‘yes’?” I knew from his past testimonies that there were several directions in which he could prevaricate, and I was prepared to block each one because the lesson I was trying to teach him was crucial to the success of my cross-examination. If he objected to the term “microwave” I planned to use the generic term “electromagnetic energy” or “radiofrequency fields” or any other similar term. If he out-and-out lied I was prepared to warn him that he was under oath and that lying under oath was the crime of perjury. Nothing would prevent me from getting a “yes,” and the more he dissembled the more his credibility would be impaired, especially so considering it was a simple direct question.

3. “Your research project for the PhD also involved blood and animal tissues, isn’t that correct?”

He would have to agree sooner or later because it was a documentable fact, and I would continue to press him until I made my point.

4. “All the muscle and blood samples you studied in your research project for the PhD were dead, right?”



I expected a strong push-back because he likely would be concerned that his work would look trivial if he conceded what I knew to be an incontrovertible fact. I had seen examples where Schwan talked for a long time in an effort to diffuse what he perceived to be a cheapening of the value of his measurements. Consequently, regardless of his answer, I planned to press the question, with Simpson asking whatever follow-up questions were appropriate to box in Schwan, a few of which I scripted.

5. “Dr. Schwan, let me ask the question in another way. In 1946 did you prepare a report called FIAT No. 1097 under orders from American military authorities in which you described the research you had done in Germany prior to and during the war?”

Simpson would be sitting at the counsel’s table conspicuously holding a copy in case Schwan’s memory failed.

6. “All of the research described in FIAT No. 1097 was done on dead tissues, right?”

To the extent he showed any resistance, I was prepared to confront him with the report and each of his war-time publications and, when necessary, to remind him what perjury was. I wanted to clearly establish the fact that Schwan had never worked on living tissue. That would be a key fact for Simpson when he wrote his brief at the conclusion of the trial. He would argue that Schwan’s experience dealt solely with dead tissue and therefore that he was unqualified to testify regarding the effect of electromagnetic energy on living tissue, living animals, and especially on living humans. After we got the answer we wanted from Schwan, I moved to generalize the answer to his entire career:

7. “Between 1947 and the time you became an expert witness in this proceeding, which is about 30 years, you published 173 reports, abstracts, and papers of various kinds related to your research, isn’t that correct?”

In case his memory failed, Simpson will have a copy of the list of his publications that Schwan had previously furnished.

8. “Not even one of those 173 documents involved experimental research on actual live tissues, live animals, or human beings, right?”

In Schwan’s mind, calculations involving the reaction of spheres made of dead muscle to irradiation by electromagnetic energy was a kind of biological research. So Simpson would be ready to distinguish “theoretical” and “experimental” research, and to reiterate “actual live tissues” until he decided that his point had been adequately made—that Schwan never did energy research on live tissue, which was the specific topic on which he was offering opinions. The plan was to continue asking related questions until Simpson decided he had a sufficiently strong record to help support the point in his brief that Schwan was unqualified.

Having established that Schwan was a biophysicist whose life’s work in the laboratory consisted solely of measurements from dead tissue, the next objective of the *voir dire* was to show that he had no formal training or experience in any subject or area of endeavor that was even remotely related to what was safe for humans. I prepared an inter-related

series of questions designed to create a record that supported this point and could rebut the implication of the expected argument from the power-company lawyers that Schwan was a nationally-known expert in the area of health risks from man-made electromagnetic energy. Simpson would argue later that Schwan *was* a nationally-known expert in the health-risks area, but not deservingly so because he earned that reputation in the political arena, not based on actual training, experience, or research. It was no valid legal argument in favor of Schwan's putative scientific expertise that powerful stakeholders in the area accepted him as an expert.

Within Schwan's cognitive structure, the source of what he regarded as knowledge were the basic laws of physics; he had an almost religious belief that he could derive biological meaning from the laws, but he hadn't provided any basis for his belief or given any example of its validated application, and many of Simpson's questions would come from this perspective. During my cross-examination by the power-company lawyers, I had offered to do one million variations of Schwan's calculations, each equally as valid as were his, that yielded results significantly different than his. There was no clearer way to make the point that his calculations were not probative, which is a legal condition required for acceptance of an expert's opinion. Schwan's lawyers never took me up on my offer and avoided the subject during my cross-examination, which convinced Simpson that Schwan's calculations were not meaningful evidence, and we designed a series of questions to make this point.

The questions that concerned Schwan's actual training and experience were simple and straightforward. If he chose to dissemble, the follow-up questions would be obvious, and Simpson would ask them only if he felt that Schwan had undeservedly scored some points. If that happened, all subsequent questions in this line of examination would be modified on the fly by Simpson to avoid a repetition of any outcome that was favorable to Schwan. The Schwan-is-no-expert questions I planned were inter-related, but not sequential or ordered in any discernable way to maximize the possibility that Schwan would forget what he had said and might contradict himself. Simpson would construct the overarching narrative in the brief.

1. "You are not an expert in (medical specialty), right?"

The list of medical specialties we planned to ask about included: allergy; anesthesiology; dermatology; emergency medicine; family medicine; internal medicine; nuclear medicine; obstetrics and gynecology; ophthalmology; otolaryngology; pathology; pediatrics; physical medicine; preventive medicine; psychiatry; neurology; radiology; surgery; and urology.

2. "During your training at the University of Frankfurt you never took a course in any of those subjects, right?"

3. "You are not an expert in (biological specialty), right?"

The list of biological specialties we planned to ask about included: bioethics; cell biology; epidemiology; histology; immunology; molecular biology; physiology; oncology;

biochemistry; microbiology; neuroscience; pharmacology; molecular biology; ecology; ichthyology; botany; zoology; and genetics.

4. “During your training at the University of Frankfurt you never took a course in any of those subjects, right?”

5. “You are not an expert in anything except biophysics, right?”

6. “You believe your version of biophysics is generally accepted, right?”

7. “I will rephrase the question. Except for persons who work for power companies as employees or consultants, you can’t name even one biophysicist who you can tell this commission accepted your version of biophysics as it applied to powerline electromagnetic energy, right?”

If Schwan fought back, Simpson was prepared to ask him to name names. If he tried he would only be digging a deeper hole because there were none. I knew he could name a few experts who were bonded in one way or another to the industry, but there was nobody else who reasoned as he did.

Undoubtedly this line of questioning would irritate Schwan’s lawyers and probably the hearing examiner, who started from the assumption that since Schwan had a PhD, was a professor, had 181 publications, was strongly supported by industry and the military, and held opinions concerning health hazards of man-made electromagnetic energy that were accepted by those stakeholders, he therefore was an expert on the subject of his testimony. But the hearing examiners weren’t judges in usual sense of that term. The duty of an examiner was to create a record, insure civility, and make a preliminary decision. In every big case the actual decision was made by the commissioners of the Public Service Commission based on a *de novo* review of the record, and the powerlines hearing was in the big-case category. So, the preconceptions of the hearing examiners didn’t matter too much.

All the *voir dire* questions were intended to undercut Schwan’s undeserved head-start regarding credibility by demonstrating on the record that he could not explain how he got the knowledge on which he based his opinion of safety, or even name any other biophysicist who accepted his so-called “biophysical principles.” The line of questions would support Simpson’s argument that, in effect, Schwan lacked the knowledge he claimed—he was an Emperor but wore no clothes.

### ***Biophysical Principles***

For scientific evidence to be admissible, the law required that the methodology used to generate the evidence be generally accepted. Phrenology, the method of diagnosing disease by feeling the bumps on the scalp wasn’t admissible. The method of racial profiling invented by the Nazis wasn’t admissible. Identifying whether someone was telling the truth by using a lie-detector wasn’t admissible. My objective was to show that Schwan’s method for identifying whether a given level of man-made electromagnetic energy was safe by using “biophysical principles” shouldn’t be admissible for exactly the same reason the other methods weren’t admissible—they hadn’t been validated. Schwan’s method was not

generally accepted by any identifiable group except commercial and military MEE stakeholders and individual experts who were economically bonded to them.

1. “By ‘biophysical principles’ you mean physical principles applied to biological tissue, right?”

2. “Your biophysical principles came from the laws of physics, that’s what you said, right?”

3. “The basic laws of physics can’t explain life, right?”

The question was certain to encounter strong objections from the company lawyers, but its simple truth would underlie many questions we asked Schwan, and would be the basis of the attack on Schwan’s credibility by Simpson in his brief, so we planned to persist until Schwan agreed with the statement of fact in the question or he refused to respond.

4. “Doctor, it is a fact that if you listed every law of physics of a sheet of paper it would be impossible to deduce that there was such a thing as life, right?”

5. “If the laws can’t explain life, then logically, any principles you find in those laws can’t explain whether electromagnetic energy from the powerlines will or will not affect life, isn’t that obvious?”

6. “Taking all those qualifications into account, aren’t you trying to do the impossible when you say based on biophysical principles that powerline electromagnetic energy will be completely safe?”

7. “Your biophysical principles don’t distinguish between living and dead tissue, right?”

8. “Let me put the question another way. The physical effect of powerline energy is the same whether a person is alive or dead; the presence of life doesn’t make any difference, true?”

9. “I will rephrase my question. Whatever the energy is going to do to a person, it will do it regardless of whether or not the person’s heart is beating, isn’t that right?”

10. “Regarding your conclusion that the electromagnetic energy from powerlines would be completely safe, the only biophysical principles you identified were your calculations and the principle of heat production, isn’t that true?”

Those two principles were the basis of everything he had ever said in his testimonies, speeches, or publications concerning the health hazards of man-made electromagnetic energy. Simpson’s strategy was to ask follow-up questions until he got the answer he wanted or he decided Schwan’s expected evasions were reasonably clear in the record.

11. “There could be biophysical principles that you don’t know about which could explain how powerline energy causes biological effects, isn’t that true?”

12. “Doctor, you testified that no biophysical principles had been suggested by Dr. Marino in support of the validity of a large series published observations that he described. Assuming your statement is true, that doesn’t mean that the observations are invalid, right?”

13. “Doctor, what you are saying is that the commission should assume that powerline energy is completely safe until such time that you accept a biophysical principle other than heating, right?”

14. “Doctor, I’ll rephrase my question. If we know from experimentation on rats that there is an effect on rats, regardless of what the mechanism might be, exposing humans without their knowledge and informed consent would amount to involuntary human experimentation, right?”

15. “Taking that qualification into account, would you agree that exposing humans to powerline energy without their knowledge and informed consent would amount to involuntary human experimentation?”

16. “You concede the possibility that Dr. Becker is correct when he points to the publications of bioeffects and says the powerlines won’t be completely safe and that you are incorrect when you say the powerlines will be completely safe, right?”

17. “I’ll ask the question in a different way. If the scientific information is uncertain, your opinion is that the commission should err in favor the power companies, not in favor of public health, correct?”

18. “You are saying that your principles inform you that the powerlines are completely safe and that you won’t change your opinion until you are shown evidence proving to your satisfaction that your principles are erroneous, correct?”

### ***Gold-standard Studies***

The next line of questioning was a direct attack on what I saw as the central error in his testimony. One of the fundamental rules of science is that when theory is in conflict with observation, theory is wrong. Based on his “biophysical principles,” the muscle-sphere calculations and the values of the dielectric constant and conductivity of dead tissues, Schwan had testified deductively that powerline energy could not cause any biological effects. But many examples in gold-standard studies proved otherwise. As it turned out, such observations were readily possible—no great skill in experimental biology was required. I found them in the first three such studies I did, and about fifty other groups of investigators also found them. Studies showing biological effects were being published with such rapidity that I could hardly keep up with them. When I had prepared my direct testimony I arbitrarily stopped when the list reached forty studies, and I intended to confront Schwan with each study. If desirable at the time the cross-examination was actually carried out, we were prepared to present forty additional published gold-standard studies that were directly relevant in the hearing because each was another nail in Schwan’s coffin. Of course, Schwan knew that when theory conflicted with observation the theory was wrong, so to defend the validity of his cognitive construct he had to deny the validity of *every* gold-standard study—conceding the validity of even one study would contradict his testimony. To crystallize his dilemma for the benefit of the commission, I designed an

open-ended series of questions that had a simple basic structure and would continue until Schwan quit and walked off the stand:

1. “You are aware of the study by Dr. A and his colleagues titled ‘B,’ published in journal ‘C’ in (year), right?”

2. “You have read that study, right?”

He had to claim some familiarity with the study. Otherwise Simpson would have asked a series of follow-up questions designed to show that Schwan’s preparation for his testimony was incomplete, and that perhaps if he had read the study he missed, his opinion would have been different.

3. “The authors reported that (identify the electromagnetic energy that was employed) caused (state the biological effect) in (state the animal species), correct?”

4. “The report was scientifically valid, right?”

I expected him to deny the validity of each report—he really had no alternative. But I couldn’t anticipate all the different stories he could invent to deprecate a study, so I prepared a generic list of follow-up questions that was relatively independent of the details of stories Schwan might tell, but provided additional facts for Simpson to construct the narrative regarding our view of Schwan’s honesty.

5. “Did you ever perform a similar study?”

6. “Did you ever measure (list what was measured in the deprecated study)?”

7. “Did you ever perform a study on (list animal species used in the study)?”

8. “Did you ever perform a similar statistical analysis in a published study?”

9. “Did you ever inform the authors of the defects in their study that you perceived?”

10. “Did you ever discuss the defect you perceived in the study with anyone except Drs. Michaelson or Miller?”

11. “Did you ever find a similar defect in another study?”

12. “Were you aware of the study before it was cited by Dr. Marino in this case?”

13. “Did you identify the defect publicly prior to your testimony in this case?”

14. “Prior to this hearing, did you ever object to the use of 95% statistical certainty in a biological study?”

Beyond these questions, Simpson and I decided when Schwan interjected gofer dust into his answers, we would not use scripted follow-up questions but rather frame them at the moment the need arose. My objective was to create a record in which Schwan denied the validity of every published study that reported a biological effect of the type he claimed couldn’t happen according to his principles, indicating that they were inapplicable to the point of parody, and setting the stage for Simpson to make a “fifty-million-Frenchmen-can’t-all-be-wrong” argument in his brief.

### ***Complete Safety***

For purposes of a direct attack on Schwan's methodology, I conceded that his muscle-ball calculations were accurate, that Rajewsky's dielectric-constant and conductivity measurements of dead tissue were meaningful, and that the level of man-made energy Schwan opined would penetrate into the ball was what he had calculated (I called it "X"). The point of the cross-examination was to demonstrate that Schwan had no scientific basis to claim that X was safe.

1. "Dr. Schwan, your testimony is that X is completely safe, isn't that correct?"

With that qualification, the answer to my question is "yes," right?"

2. "Can you explain the details of the mechanism that the body uses to regulate and control bone growth?"

Simpson would repeat, reiterate, or rephrase the question as necessary, but never stop until he got "no" for an answer, which he would inevitably get because that was the only possible answer, if Schwan answered the question at all.

3. "Then Doctor, if you don't understand the details of the mechanism that the body uses to regulate and control bone growth, how can you say that adding X amount of powerline energy won't adversely affect the process?"

The list of processes that occur in the human body is huge. I chose a representative list of processes and rehearsed with Simpson the type of follow-up questions we would use to keep Schwan's feet in the fire and insure he conceded he didn't know adding X would be safe. Neither Simpson nor I believed we would need to present many of the processes to create a record Simpson could use in his brief. I chose: memory; cancer causation; sleep; depression; back pain; osteoarthritis; post-traumatic stress syndrome; and attention deficit hyperactivity disorder. What we prepared wasn't a list of questions but rather of topics that could be expanded in many directions depending on how Schwan responded.

### ***Cross-examination; Day One***

I was sitting beside Simpson when Schwan took the stand for his cross-examination; our eyes met but we did not acknowledge each other. Simpson began with questions regarding Schwan's competency as an expert in health effects of powerline electromagnetic energy. As expected, the company lawyers were surprised that their main expert was challenged on that basis and Schwan was testy, but Simpson got a good record, especially considering the huge head start Schwan had by virtue of his political connections with the military and industry. When we switched to an attack on the substance of his testimony, we were in charge, as we planned:

### ***Biophysical Principles***

Q. By "biophysical principles" do you mean all physical principles as they are applied to biological tissue?"

A. Yes. Let me put it this way. Physical principles frequently get extended to other areas. When they are applied to chemistry they are called biochemical principles. When they are extended to biology they are called biophysical principles.

Q. Regarding your conclusion that the electromagnetic energy from powerlines would be completely safe, the only biophysical principle you identified is the principle of heat production, isn't that true?

A. No, that's not correct. I have identified the principle of chain formation by cells. That's where the cells line up in a column, like a chain.

Q. That phenomenon has nothing to do with health risks from powerlines because it occurs only at very high energy levels and because it has been shown only in dead cells, right?

A. Mr. Simpson, you clearly know nothing about physics, or you would not ask such a question. Biophysical principles do not depend for their validity on the possibility that the subject material is alive.

Q. Are there biophysical principles that are yet to be discovered?

A. I cannot comment on anything that I do not know.

Q. Then there could be biophysical principles that you don't know about which could explain how powerline energy causes biological effects, isn't that true?

A. Who can say? I require that biophysical principles be known and understood before I accept biological observations as true. First of all, I cannot see how a biophysical principle can exist without being known. An unknown biophysical principle is not a biophysical principle, so the statement in itself is contradictory in itself. Secondly, a biophysical principle is, almost by definition, understood. Otherwise it would not be a principle. Thirdly, you ask me to accept observations. Are these observations which relate to the biophysical principles or any type of principle not related to it? I do not understand the question, Mr. Simpson.

Q. Doctor, you testified that no biophysical principles had been suggested by Dr. Marino in support of the validity of a large series of published observations that he described. Assuming that your statement is true, that doesn't mean the observations are invalid, isn't that true?

A. Not necessarily. It simply means that as far as principles are concerned, I am not aware how such claims can be reconciled with principles known to me. Now, let me point out in order to explain my attitude a little bit which pertains to scientific procedure. In the total advancement of science as it pertains to man's progress, we have learned to look for principles, and those principles have been used to exert judgment. Frequently it turns out that those principles were not sufficient to explain observations, and it becomes necessary to extend the principles and to discover new principles. But at a given moment



of time, it has proved to be beneficial to the advancement of mankind to make do with the best principles which are available.

Q. Doctor, what you are saying is that the commission should assume powerline energy is completely safe until you accept a biophysical principle other than heating, right?

A. It is highly desirable.

Q. That would be equivalent to permitting involuntary human experimentation as described by Dr. Becker, right?

A. No. If I accept Dr. Becker's research with regard to the effect of a given level of energy demonstrating certain pathological effects on rats, then I would indeed conclude that it might be dangerous to expose man to the same level, but I certainly would not conclude that level was a biological stressor. So, I would say that you should qualify your question better than you have done before I really in a responsive manner can respond to it.

Q. Doctor, I'll rephrase my question. If we know from experimentation on rats that there is an effect on rats, regardless of what the mechanism might be, exposing humans without their knowledge and informed consent would amount to involuntary human experimentation, right?

A. Not necessarily. People drive automobiles, and this is certainly a dangerous thing. People are exposed to ozone, people are exposed to noise. It is very easy to find a reference and specific evidence that demonstrates to you that noise can be harmful to man and yet we are all exposed to it so, in a way, we are all guinea pigs. If we would all be asked to give consent, my God, where would we be? Let me give you another example which is very illustrative with regard to physical phenomena which are potentially dangerous, and what conclusions to draw from it with regard to consent. You may have heard about the Chinese water torture where when the drop hits you all the time it's supposed to be very dangerous. Now, take that observation and you may hastily come to the conclusion that it should be forbidden that man is exposed to rain.

Q. Doctor, taking that qualification into account, would you agree that exposing humans to powerline energy without their knowledge and informed consent would amount to involuntary human experimentation?

A. Not necessarily.

### ***Gold-standard Studies***

When we began confronting Schwan with the gold-standard studies, the first study we used was one that Dr. Becker and I had published.

Q. Doctor I would now like to turn to biological literature that describes the effect of simulated powerline electromagnetic energy on various biological systems. Have you

read “The Effect of Continuous Exposure to Low Frequency Electric Fields on Three Generations of Mice” by Drs. Becker and Marino?

A. Yes.

Q. Do you accept the results?

A. No, because they could be artifacts and have nothing to do with the electromagnetic energy. There is also another possibility. There could be problems with their statistics.

Q. Are the artifacts you just referred to similar to the sensation that Dr. Miller described after touching a 9-volt battery to his tongue?

A. Yes, I think so.

Q. You do not have any experimental evidence on which to base that opinion, do you?

A. I have examined the exposure conditions used by Drs. Marino and Becker based on physical laws, and that was my conclusion.

Q. Subject to that qualification, you do not have any experimental evidence on which to base that opinion, right?

A. Yes.

Miller told people that he had asked power-company engineers to build a replica of the rat exposure apparatus he saw in my laboratory, and that he had used it to prove the rats were shocked. When Simpson heard a story that Miller had made movies of the reactions, he demanded that the power companies provide copies of the movies. After they complied, we saw that what Miller said was untrue—the rats exhibited no unusual reactions.

Q. Doctor, are you aware that Dr. Miller constructed a version of the apparatus Drs. Marino and Becker used, and that Dr. Miller failed to find evidence of the existence of the artifact whose existence you predicted theoretically?

A. No.

Q. You said that there could be problems with the statistics. Have you found any such problems?

A. I cannot answer that question without taking a rather close look at the data. I cannot commit myself presently. There is a pattern in the data, to be completely honest and fair to Dr. Marino, which is suggestive, but it is not convincing to me because I am not aware of any biophysical principles that could explain the data. I could conceive that there might be a principle of which I am unaware, but I do not consider it likely.

Q. So you agree that there might be a principle that you don't know about, is that correct?

A. That is always possible. I cannot exclude the possibility that a gigantic meteor will fall in the Atlantic Ocean tomorrow and we should prepare for it.

Q. Are you saying the possibility a biophysical principle exists that you don't know about is as likely as a meteor falling in the ocean?

A. It's unlikely but I cannot specify the level of unlikeliness.

Q. Is there a biophysical principle that precludes the observations made by Drs. Becker and Marino?

A. That is a nonsensical question because the only possible answer is no.

Q. Doctor, you said you did not accept the results of the study because of problems with statistics, but the authors described that all their results were 95% or more certain. Isn't 95% standard in biological science?

A. No. I would say that 95% is rather mediocre. I prefer 99% personally.

Q. Doctor, are you aware that most of the results in the study were between 99.0% and 99.9% certain?

A. I can't answer that question now.

Q. Doctor you haven't published any 99% biological studies involving animal or human subjects, right?

A. Right.

Q. You haven't published any 95% biological studies involving animal or human subjects, right?

A. Right.

Q. You haven't published any biological studies involving animal or human subjects, right?

A. Right.

Q. Doctor, have you read the paper entitled "Effect of Continuous Exposure to Power Frequency Electric Fields on Rats" by Drs. Becker and Marino and their colleagues?

A. Yes.

Q. Do you accept the results of this study, the effects on stress hormones?

A. No. The results could be artifacts. The authors were remiss in not checking this out. It is a major deficiency.

Q. Doctor, the artifact was the same one we discussed earlier in connection with Dr. Miller's tongue, right?

A. Yes.

Q. Is it your testimony that Drs. Marino and Becker did not consider the possibility of artifacts?

A. If they did, I don't remember.

Q. Is there any biophysical principle that precludes the observations described in their paper?

A. Your question is a nonsensical one in the sense identified before, since it enables only one answer, and that answer is no.

Q. Doctor, you never did any experiments with either mice or rats that were similar to the experiments done by Drs. Becker and Marino, isn't that true?

A. Yes.

Q. You never did any experiments on any kind with either mice or rats, right?

A. None that I published.

Q. Prior to the hearing you never contacted Drs. Becker and Marino to ask them about the defects you perceived in their studies, true?

A. Yes. I did not. That was not my responsibility.

Q. Doctor, when two scientists disagree don't they talk to each other to try to work out the problem, like plumbers trying to solve a plumbing problem?

A. They did not try to talk to me.

Q. Dr. Marino once wrote to you, and you responded but did not point out any artifacts. If you don't remember the response I can show you your letter.

A. I did not think it was my responsibility to offer a detailed critique back then. It is my responsibility to do so now, and that was what I did.

Q. How did you acquire knowledge that allows you to find the experimental shortcomings you listed even though the peer-reviewers who recommended acceptance of the work for publication apparently did not do so?

A. I read the paper carefully and applied general biophysical principles.

Q. Doctor, have you read the study entitled "The Effects of Electric Fields on Circadian Rhythms in Men" by Wever?

A. Yes.

Q. Do you accept the results he reported?

A. There is doubt in my mind regarding their validity. Firstly, he did not take naps into consideration. I think they should have been considered. Second, when I was in Germany I investigated his work and learned that he had done more than 100 experiments, only a fraction of which have been published. Why not all? Perhaps he selected only the results that supported his theories.

Q. What do naps have to do with the results?

A. I don't know. That's just the point. Wever didn't know that naps didn't have any effects. It's possible they did.

Q. Are you accusing Wever of fraudulently withholding data?

A. No. But that could be. It's possible.

Q. Doctor, have you read the study "Perception and Effects on Locomotor Activity in American Eels and Atlantic Salmon of Extremely Low Frequency Electric and Magnetic Fields," by McCleave and colleagues?

A. Yes.

Q. Do you accept the results of this study?

A. Not necessarily. Electrodes were used in this study. I have done a lot of work applying electrodes to muscle tissue, and I know that electrodes can sometimes cause artifacts, and that may have happened in this study, especially because the fish were swimming.

Q. Is it your testimony that the fish were swimming when McCleave made his measurements?

A. I have to look that up. At this time, I don't know.

Q. Doctor, are you aware that it is an established biological fact that some species of fish can detect and respond to energy levels that are far below the levels produced by the proposed powerlines, I am thinking of the work of Lissman, and Bullock?

A. Yes, but fish have special cells for detecting low energy levels.

Q. Human beings could have such cells, right?

A. No. Such cells have not been found.

Q. But they might exist, right?

A. Yes.

Q. In view of that concession, do you want to change your testimony to say the energy from the powerlines is not certainly completely safe because human beings might have special cells like other animals?

A. No. They are certainly completely safe until someone proves otherwise.

Q. Doctor, don't the studies by Lissman, and Bullock, and by many others that shows fish can detect extremely low levels of electromagnetic energy violate your biophysical principles which indicate to you that such detection is impossible?

A. Not necessarily. Fish live in water. Human beings live in air. Electromagnetic energy passes differently in water compared to air.

Q. Doctor, have you read "An Evaluation of Possible Effects of Electric Fields on Neurophysiology and Behavior of Monkeys by Gavales and colleagues?"

A. Yes.

Q. Do you accept the experimental results?

A. Not necessarily, because electrodes were used. That's a problem.

Q. With that qualification, would you agree that the study is some evidence that the energy from powerlines will cause biological effects?

A. Not at all.

Q. Doctor, is there any scientific principle that would preclude the kinds of observations that Galavas made.

A. No.

Q. Doctor, have you read the study entitled "Orientation of Gull Chicks Exposed to Project Sanguine's Electromagnetic Field" by Southern and colleagues?

A. Yes.

Q. Doctor, was this a valid study?

A. No. It is lacking in statistics, and there were inconsistencies in the data.

Q. Isn't it true that you never had any formal courses in statistics and never used inferential statistics in any of your publications?

A. I certainly have used statistics in some of my publications, but only where needed.

Q. Are you confident enough in your knowledge of statistics to find actual errors in a study that was published in *Science*, the most prestigious scientific journal in the world?

A. I am quite confident. Even *Science* makes mistakes.

Q. Doctor, have you read "The Effects of Extremely Low Frequency Electromagnetic Fields on Slime Mold" by Goodman and colleagues?

A. Yes.

Q. Do you think the study was done properly?

A. Almost, but not quite. The authors had certain inconsistencies in their data, so in my opinion the study is dubious. Also, according to my calculations, the level of energy used in the study doesn't apply to powerlines, so the results are not evidence that electromagnetic energy causes biological effects.

Q. Turning to the Russian study by Dr. Solovev that Dr. Marino described, "Experimental Studies of the Biological Action of Low Frequency Electric Fields," do you accept the results of this study?

A. Yes and no. I think the parts where he didn't find effects of the fields were correct, but there were shortcomings where he said he found effects. Also, the authors

studied field levels that were somewhat higher than what I assumed will come from the powerlines.

Q. Doctor, do you want to change your testimony to say that levels higher than you assumed would occur might be unsafe?

A. No.

Q. Doctor, you conceded there were effects at higher levels. Applying the idea of a safety factor, that would mean lower levels might be unsafe, right?

A. Not at all. A safety factor is not a biophysical principle. It has nothing to do with biophysics.

Q. Referring to the article by Watson that deals with the effect of electromagnetic energy on growth rates of bones in chickens, do you accept the results he reported?

A. I have no qualms with the general conclusions which the author stated from the results because the fields were higher than I considered.

Q. Doctor, would your answer be the same if I asked you about any biological study where the field levels were higher than those that you assumed?

A. Yes.

Q. Doctor, referring to “Augmentation of Bone Repair by Inductively Coupled Electromagnetic fields” by Bassett and colleagues, do you accept the validity of the results?

A. I cannot detect any faults at this time as far as I remember. I would need more time to study the article.

### *Cross-Examination; Morning of Day Two*

After Schwan’s first day of the witness stand ended, Simpson and I thought the fifty-million-Frenchmen-can’t-all-be-wrong line of cross-examination had developed as we hoped and expected. We had the option of continuing the approach the next day because we had not yet confronted Schwan with the majority of the reports that contradicted his testimony, but Simpson felt he had more than enough evidence in the record to argue in his brief that Schwan was unqualified to make unsubstantiated criticisms of the biological methodology used by so many different experts in their own areas, and that what Schwan had said was purely result-oriented—the studies weren’t methodologically faulty, Schwan just didn’t like the results because they contradicted him. Simpson’s fatigue was another factor—he was the only state lawyer, but the companies had a large team and they raised issues and objections that Simpson had to confront at the same time he was dealing with a crafty witness. So, we agreed to not continue the ‘Frenchman’ line of questions but settled on a series of questions that would allow us to make the point that Schwan was obdurate to the point of absurdity. The line of questioning was based on reports that had been cited by Michaelson and Miller in their testimony.

When the Navy first decided to build the Sanguine antenna, it hired a commercial research company named Hazelton Laboratories to do animal testing of the Sanguine electromagnetic energy. Hazelton produced a series of reports that found no effects from simulated Sanguine energy, which at least superficially seemed to support the Navy regarding the safety of the antenna. But the negative Hazelton studies were embarrassingly poor, and Hazelton had come under a cloud regarding rigged research for other clients, so the Navy undertook serious research involving university investigators and Navy research laboratories. Simpson and I supposed that if Schwan were confronted with the Hazelton studies he would accept them as valid, as obviously bad as they were, because they were negative, which Schwan believed was the correct conclusion based on his principles. Looking back now, more than forty years after Simpson and I cross-examined Schwan, I'm amazed that we thought we could successfully expose his hypocrisy, that he blindly accepted the validity of negative results simply because they fit his theory and saved the interests of his clients. But it happened, we succeeded:

Q. You read the research report by Coate of the Hazelton Laboratories that was done in connection with Project Sanguine, right?

A. Yes.

Q. Regarding the first study, the rat fertility study, do you think the results were valid?

A. As far as I can determine, yes. It states "No effects."

Q. With respect to the Hazelton canine physiology study, were those study results valid?

A. No, they were not. Several effects were described, but I calculated that the currents inside the dogs were high. Also, I noticed, and I quote, "During the second week of the experiment three dogs received current from a lightning which burned out a transformer and disintegrated electrodes attached to the dogs and charred the skin," which was a rather wild attack on the dog.

Q. Doctor, was the Hazelton insect mutagenesis study valid?

A. This is an area in which I am absolutely incompetent to opine. I am not a geneticist. I can only quote what I read, that there were no effects.

Q. Is the Hazelton plant cytogenetic study valid?

A. I am not a botanist, and I cannot judge very well.

Q. Did the Hazelton electric-field perception and preference studies yield valid experimental results?"

A. The conclusions are entirely reasonable because the levels of applied energy were high.



Q. Doctor, I didn't ask you if you thought they were reasonable but rather whether they were scientifically valid.

A. I think they were. Mr. Simpson, if I may make a rather general comment which pertains to the implications of your questions, it is the following one: I remember now as I peruse the Hazelton material that I felt whenever actually the claim was that no effect was observed, that I was not further interested in digging into the material. Clearly there are two logical possibilities, either there is no effect, or that with substantial refinement and many further studies there could have been observed an effect. Quite obviously, on such logical grounds, I didn't see any motivation to dig into it if there was no effect reported. I think that adequately summarizes my approach to the Hazelton studies.

Validity and meaning of scientific results are always debatable. Validity is determined by the rules of science, whereas meaning depends on human desire because human beings make it. Becker and Schwan had profoundly different value systems regarding what interest they favored protecting in the context of scientific uncertainty—that of the public or of the companies. In contrast, the validity of the results is far more objective and is evaluated on technical grounds, such as whether the experimental design matched the objectives of the study, a proper measurement technique was employed and used properly, the research animals were treated properly, and whether a correct statistical analysis was performed. Schwan presumably had employed these considerations when he criticized the validity of the positive bioeffects studies, but clearly did not when he evaluated the negative studies. It is axiomatic in science that the validity of results does not depend on the experimenter's desires. On the spot, Simpson exploited Schwan's dramatic and error:

Q. Doctor, as a scientist, why would you read more carefully those studies that showed no effects, compared with studies that showed effects?

A. I am confronted with the situation where phenomena are reported which may, if confirmed, carry rather sensational implications. You will find as you peruse the history of science, whenever scientists are confronted with such a situation, that they examine very carefully the evidence which is available which seems to indicate that entirely new principles may be implied. For example, Max Planck was forced to create quantum mechanics. He spent ten agonizing years going over and over again the classical concepts of physics, trying within the framework of physics to understand phenomena that seemed not to be explainable. After very intensive searches, he formulated quantum mechanics. I think it is entirely in this spirit that I looked with great care at those studies which seemed to imply your principles.

Q. Then your standards for validity regarding studies showing effects are different or are greater and stricter than your standards for studies showing no effect, correct?

A. That is a generalization of what I tried to say. What I said is: Whenever there are positive effects which indicate to me the emergence of entirely new principles which

go way beyond the principles so far known, then of course I look at the evidence with particular care.

Q. Doctor, that's the same as saying you only accept the studies you like and can explain to your satisfaction by your personal biophysical principles, isn't that true?

A. They are not my personal principles, they belong to the world.

Q. Principles you elucidated and gave to the world?

A. Precisely.

Q. A few moments ago you said, "I am confronted with the situation where phenomena are reported which may, if confirmed, carry rather sensational implications." The phenomena you referred to were reports of positive effects due to electromagnetic energy, right?

A. Yes.

Q. The "sensational implications" were the health risks, right?

A. Not necessarily.

Q. Well what were they, Doctor?

A. I can't possibly answer until I see the results of the studies.

Q. It's true that every positive study cited in this hearing you can't explain as a result of shock or heating, you have rejected it, and almost every negative study that you felt competent to evaluate you simply accepted it on its face because you believe a negative result is always correct, right?

A. There was no motivation for me to analyze the negative studies further since no reliable effects were reported.

Q. Doctor, are you aware that Dr. Morton Miller testified that the Hazelton negative studies were affirmative evidence indicating powerline energy is completely safe?

A. Yes, and it is a position with which I am in agreement.

Q. If the energy level didn't cause heating or neural stimulation, then the level would be completely safe, right?

A. Within the framework of my knowledge, I have to say yes.

Q. And it would be completely safe if it cannot cause heating or neural stimulation as in electrical shock, right?

A. Yes.

Q. Did you ever make that argument before you became an expert witness in this case?

A. I made it many times in relation to microwaves used in radar, and I would like you to know, Mr. Simpson, that the comment was very well received.

Q. Doctor, heating caused by electromagnetic energy is a physical phenomenon, right?

A. Yes.

Q. Heating caused by electromagnetic energy could take place in a ball of copper, right?

A. Yes. It could and would take place in any material.

Q. Heating caused by electromagnetic energy could take place in a glass of water?

A. I repeat my previous answer, it could take place in any material.

Q. It could take place in a piece of meat from a supermarket?

A. These questions are becoming tiresome, Mr. Simpson. I have already answered it.

Q. Subject to that qualification, your answer is yes, correct?

A. Yes.

Q. It could take place in a human muscle even if the person were dead, right?

A. Yes.

Q. In the case of the meat from a supermarket and the case of muscle of a dead person, there would be no other effect due to the energy because neural stimulation would be impossible, right?

A. Of course. You can't cause neural stimulation in a dead person because the nerves don't work.

Q. What is the lowest level of electromagnetic energy for which heating would take place?

A. Zero. Every material has a dielectric constant and conductivity, so every material will be heated to one extent or another by the energy.

Q. Doctor, I'm not sure I understood your answer, I'll rephrase my question. It is impossible according to the laws of physics to avoid heating of things exposed to electromagnetic energy, regardless of whether they are alive or dead, but the amount of heating depends on the energy level, the dielectric constant, and the conductivity?

A. Yes, particularly the conductivity.

Q. Now suppose that the person was alive, and the energy was below the level that causes neural stimulation. Heating would still occur, right?

A. I already answered that question.

Q. Subject to that qualification, is your answer yes?

A. Yes.

Q. In addition to causing heating, when a living person is irradiated with electromagnetic energy, every biochemical reaction occurring in the person's muscle would be speeded up because the rates of all biochemical reactions in living persons are increased when the temperature is increased, correct?

A. Yes.

Q. Then when energy strikes an inanimate object or a dead muscle, it produces heat but no other effects, and when energy strikes a living person it produces heat and also produces physiological changes in the sense that the heat has a secondary effect of affecting biochemical reactions that occur only in living persons, correct?

A. Yes.

Q. Physicians who practice physical medicine use this technique, which they call diathermy, to relieve pain in certain patients, right?

A. Yes.

Q. Your original research in Germany was intended to be used for diathermy, true?

A. Yes.

Q. Almost all of your published articles were devoted to one aspect or another of diathermy, isn't that correct?

A. Mr. Simpson, I have published many articles that deal with many different scientific questions including the temperature dependence of the dielectric constant and conductivity of blood, both at low frequencies and high frequencies. The mechanism of absorption of ultrasonic energy in blood and muscle. You can see for yourself in my bibliography. There are articles on hazards from radar, acoustic properties of hemoglobin, pearl-chain formation of cells, electrical properties of cardiac electrodes, electrical properties of lipid vesicles, electrical properties of the squid axon.

Q. Subject to that explanation, the answer to my question is yes, right?

A. Yes.

The next line of cross-examination was intended to make thoroughly clear to the commission that Schwan didn't know enough about biology to warrant his theoretical prediction that powerline energy was completely safe. My argument was that if he knew the laws that regulated a particular biological process, prediction of whether the energy would affect it might be possible. On the other hand, if he did not know the law for a process, the effect of the energy could not be deduced, so he could not predict that the process would be unaffected, which is what "complete safety" meant, at least for public-health purposes. When I designed the line of cross-examination, Schwan had already claimed, in his direct

testimony, knowledge of mathematical laws that governed two biological processes, shock and cooking, and had deduced the safety of powerlines from those laws. I was confident that they were the only thing he knew about biology.

My initial questions were framed to require him to reaffirm his testimonial claims regarding the two laws. Then I planned to ask, serially, about biological processes for which he indubitably did not know the regulatory laws. In each instance, he would necessarily concede he did not know the governing law and, therefore, following his reasoning, he could not validly deduce that the process would be unaffected by the energy. So, he could not reliably predict that the powerlines were safe with regard to that biological process.

When we began the actual cross, Schwan had been on the stand for almost two full days and was highly agitated, repeatedly calling Simpson a “poor physicist” while glaring directly at me. The danger was that he would simply walk off the witness stand, a development we desperately wanted to avoid because our case was proceeding well. So, we began the aggressive part of the cross as gently as possible and Simpson did his best to pose his questions so that we could keep Schwan on the stand as long as possible.

Q. Doctor, your ability to predict that the powerline energy will be completely safe with regard to electric shock or cooking tissue stems from the fact that you know the governing laws for those things and the energy levels that powerlines cause inside people, right?

A. Well, I could go along with that even though it is not necessary for this hearing. It would be sufficient to include all effects which one might reasonably expect to be harmful. For example, if there are effects that concern biorhythms, those effects have not proven to be harmful, so they do not need to be included in my opinion that the powerlines fields will be completely safe.

Q. Doctor, does your opinion of complete safety include effects that one might not reasonably suspect to be harmful?

A. Of course.

Q. So your opinion of complete safety applies to biorhythms, right?

A. Yes.

Q. The reason you know that the powerline energy will be completely safe with regard to shocks is that you can calculate the energy levels in people, and you know the laws that tell you how much energy is needed to trigger nerves, and the calculated levels are much lower than the levels needed to cause shocks, right?

A. Exactly. I think you finally understand.

Q. Doctor, in the questions I will now ask you, I want you to assume that I accept the correctness and accuracy of your calculations of the energy levels. All right?

A. Yes.

Q. Doctor, will knowledge of the energy level in bone permit you to predict whether or not bone tumors will occur?

A. It certainly will not permit me to do so.

Q. Will such knowledge permit you to determine whether the remodeling rate of bone will be affected?

A. No.

Q. Will knowledge of the energy level in bone permit you to predict whether the rate of fracture healing in bone will be affected?

A. No, it won't. Mr. Simpson, you are striking out in no man's land. You motivate me to state that that my total knowledge is based on what I know. I cannot comment about something which is outside my knowledge, and clearly that is something that is outside.

Q. Doctor, do you know the mechanism underlying bone remodeling, fracture healing, or the production of tumors?

A. No, no one does.

Q. Doctor, if you don't know those mechanisms or the laws that govern them, how can you conclude that the levels of energy in bone produced by the powerline field will not affect those functions?

A. I don't understand your question. There is an implication in your question, Mr. Simpson, that I said there will be no effects, and I said no such thing.

Q. Doctor, if you have no knowledge of these mechanisms, how do you know that the energy level you calculated will be safe with regard to those functions?

A. Pardon me, you misconstrue me, Mr. Simpson. I have already answered that question. I get a little bit bored by having to respond to it.

Q. I will rephrase the question. Doctor, would it be correct to say that since you do not know the mechanisms that control growth of bones, formation of bone tumors, or bone remodeling, that therefore you do not know whether the calculated energy level in bone produced by the powerlines will be safe with respect to those processes?

A. The question is nonsensical and the reason is that the energy levels have nothing to do with those processes. They are entirely unrelated phenomena Mr. Simpson, it is entirely nonsensical what you just asked. How do you know they are related? Can you explain that? If you do I will respond. Bone growth has nothing to do with energy levels.

Q. Doctor, how do you know that the energy levels have nothing to do with bone growth?

A. Because there is no conclusive evidence that they do.

Q. Is it your testimony that there is no conclusive evidence of effects on bone growth, so the proper scientific view is to conclude that energy levels have nothing to do with bone growth?

A. Precisely. How can one say that there are effects on bone growth if there is no scientific evidence?

Q. Wouldn't the opposite conclusion be equally justified, that until the evidence shows conclusively that electromagnetic energy doesn't affect bone growth, the proper scientific view would be to say that it could do so?

A. That's what I just said.

Q. Then wouldn't it be scientifically invalid to postulate principles and deduce complete safety, considering the uncertainty you just conceded exists?

A. Mr. Simpson, you obviously know nothing about how science works.

He addressed his answer to Simpson but stared at me as he spoke. His lawyers requested a short recess and huddled with Schwan. When the hearing resumed, Simpson continued the line of questioning.

Q. Doctor, if you do not know the mechanisms, how do you know that your calculated energy levels will be completely safe?

A. I still don't understand your question. For example, you might ask: If you do not know when the sun will rise, how can you know the energy level is safe? Can you explain to me what bone growth has to do with energy levels?

Q. Doctor, even assuming that your calculated energy levels are correct, you have no scientific basis for claiming that they will be completely safe because the requisite experiments have not been done, isn't that true?

A. May I rephrase your question?

Q. No. You may answer my question, Doctor.

A. I can only repeat that the question does not make any sense. I simply have to pass.

Q. I will rephrase my question. Assume that the energy level produced in bone by powerlines is as you have calculated. Will that level be harmful with respect to the bone process I listed?

A. I don't know because those experiments have not been done.

Q. Then until those experiments are done, you will argue that the powerlines should be assumed to be completely safe?

A. Yes.

Q. Thank you Doctor. Now I will move on to a related series of questions. Would knowledge of the energy level in lung tissue permit you to predict whether or not lung tumors will occur?

A. No. The implication of your question is that since I don't know I can't say whether the energy level I calculated is safe. I disagree completely. I maintain that I know it's safe until somebody proves it is unsafe, and nobody has done so.

Q. Thank you. Would your answer and your reasoning be the same if I asked you whether knowledge of the level of electromagnetic energy in lung tissue would permit you to predict whether exchanges of gases in the lung would be affected?

A. Yes. If you desire you can continue this sort of questioning, quoting about a million different functions of the body all through the next week to me, and through the week after that, motivating me to answer in the same way. I consider that utterly unproductive.

Q. With that qualification, the answer to my question was yes, right?

A. Yes.

Q. Then you agree that if the research hasn't been done you cannot conclude that the calculated level will be safe, right?

A. I disagree. I assume it to be safe until someone proves it by very convincing evidence that it is not safe.

Q. Doctor, please define "safe."

A. I cannot do so any more precisely than I have already done.

Q. Doctor, are malignant bone tumors safe?

A. Not necessarily, but I am not a medical expert.

Q. Tumors could be harmful, right?

A. To the extent that I cannot answer your question, yes. They could be harmful or not harmful.

Q. Doctor, is the function of the kidney outside your area of expertise?

A. It is.

Q. Then you would not know whether the energy level you calculated from the powerlines could affect kidney function.

A. There is no known relationship between energy levels and kidney function.

Q. But there could be such a relationship, right?

A. Of course.

Q. But we don't know if there is because there have been no studies, right?



A. Yes.

Q. If there were negative studies, would you assume that they were correct?

A. It depends on the details of the study.

Q. But you previously testified that if the study was negative you were not interested in digging into it because a negative study result was you expected, right?

A. As I explained earlier, the biophysical principles available to me require me to take that position.

Q. Doctor, if you do not understand the function of a kidney, how do you know that the energy level you calculated will be safe?

A. The underlying rationale is simplistic. Quite obviously, Mr. Simpson, you have not understood my testimony at all. Otherwise you would not ask the question that forces me to ask whether we need to go through my testimony and all the underlying arguments step by step again. Do we need to argue what scientific procedure is? Is all that forgotten? If all that is forgotten, then I am just lost with you. I do not know how I can respond to your question. It does not make sense to me.

Q. Doctor, I will rephrase my question. Your testimony is that you do not have to be an expert in kidney function to predict that the level of energy will not affect the kidney, right?

A. Precisely.

Q. And the assertion that the energy won't affect the kidney is a deductive conclusion from the laws of physics, right?

A. That is essentially correct.

Q. Doctor, is it your testimony that electrical energy can affect kidney function only by means of heating or neural excitation?

A. I didn't make that statement. No. The answer is no.

Q. What other mechanisms involving electromagnetic energy could affect kidney function?

A. I can't comment on that. It is outside my area of expertise.

Q. Doctor, if it is beyond your expertise how do you know that the powerline is completely safe, because there are possible mechanisms that are beyond what you know?

A. If you could cite to me papers that show powerline energy can affect the kidney, then you would have me in a bind. But to the best of my knowledge such studies haven't been conducted. There is a burden of proof that is on you to justify asking me about the effects of energy on kidneys, and you haven't done that. That is in essence what I have

been saying in different words, so how can you force me, then, to respond to your question? I cannot.

Q. Doctor, perhaps I can get a response if I put the question the other way around. Is it your testimony that there have been no experiments proving to a scientific certainty that the energy will affect kidney function, and therefore you assume that the energy will be completely safe regarding kidneys?

A. Exactly. When we consider safety today, it must be based on our knowledge that is available to us. The word “safe” always pertains to the existing body of knowledge. It may be quite possible that Dr. Marino or someone else is able tomorrow or a hundred years from now to prove that the energy affects some aspect of kidney function. If so, that would indicate that I should revise my opinion.

Q. Doctor, your testimony is that “safety” means the absence of clear and convincing evidence of harm, right?”

A. Yes.

Q. But even in the absence of clear and convincing evidence of harm, there is the possibility of harm, depending on what the experimental results might be, now or a hundred years from now, right?

A. That’s what I have been saying all day.

Q. This “convincing evidence” would be results of animal studies, correct?

A. Yes.

Q. If that happened you would conclude that the known laws of physics could explain it because you don’t believe that the situation would mean that a new law of physics had been discovered, isn’t that correct?

A. Obviously. If Dr. Marino proved that the energy could affect kidneys, I would not think that result would necessitate formulation of a new law of physics.

Q. So until Dr. Marino does definitive experiments, there is no evidence but there is uncertainty because, as you have agreed, he might find the evidence, isn’t that true?

A. Yes.

Q. So as a scientist, it is your opinion that the Public Service Commission of New York, confronted with this uncertainty, should err on the side of presuming safety, right?

A. That would be the correct decision.

Q. If there were a hundred peer-reviewed published animal studies performed by independent investigators that demonstrated to a statistical certainty that a hundred different biological functions not directly related to kidney function were affected by the energy,

your testimony would still be that the energy was completely safe with regard to kidney function, right?

A. Certainly. How can anyone say that kidney function will be affected if there is no direct evidence? If you take that evidence as a basis of casting a shadow of doubt on my testimony, you would be saying, in essence, that we can say absolutely nothing whatsoever, that we can make no predictions, we can make no decisions.

Q. Doctor, is it your general opinion that phenomena in experimental biology should be regarded with skepticism until they are demonstrated to be deductive consequences of physical laws?

A. Of course. No other answer is possible.

Q. What are these laws of physics, Dr. Schwan?

A. Basic biophysical principles applied to molecules, tissues, morphology, biology, et cetera permit me to make the statements which I have made. They come from the application of biophysical principles that fit beautifully with experience. They predict that there will be heating and shock at high levels and no effects at low levels, and that is precisely what is observed. The body of this practical experience and of the biophysical principles is the basis of my testimony. As I stated before, it's the apple and orange story. Like when you say if you don't know when the sun will rise how can you say that the energy level will be safe. It is not related, and I spelled out why. The reason very simply is that the biophysical principles I spelled out permit me to state what I have stated irrespective of tumors or kidney function or whatever you may have in mind following that.

Q. And when reports were published, as a scientist you would dig into the matter and look for an explanation for any reported results based on the laws of physics, correct?

A. Yes.

Q. What conclusion would you reach if you could not find an explanation?

A. Clearly more work must be done because if there are effects they must be explainable by the laws of physics.

Q. Doctor, isn't it true that the laws of physics haven't explained even one biological phenomenon, whether or not related to health risk?

A. I don't agree with that.

Q. You already testified that the laws of physics couldn't explain life, so how can they explain what happens to living things?

A. Mr. Simpson, you are talking apples and oranges.

Q. Doctor, can you give me an example of a biological phenomenon that is generally accepted as having been deductively explained by the laws of physics?

A. Not off-hand. I did not come here today prepared to answer such a question.

Q. Doctor, suppose that a hundred studies were published in the literature that each showed powerline energy affected a particular kidney function, you would accept the reliability of that conclusion, right?

A. Not necessarily, I would read the studies to determine whether there were any technical objections.

Q. Suppose, further, after reading the studies, that you had specific objections which prevented you from accepting the conclusion, that the NIH funded a study to address each of your objections, and that the results showed none of your objections had merit. You would accept the conclusion then, right?

A. Probably, but I would like to point out that nothing like that has happened, and until it does, I stand on the testimony I have given.

Q. Suppose, finally, that it happened. You would agree that the occurrence of an effect on the kidney function was a biological fact, right?

A. That is a long string of hypothetical statements, none of which is known to be true.

Q. Doctor, subject to that qualification, your answer is “yes,” right?

A. Correct.

Q. In that case, knowing with absolute certainty that the effect actually happened, would you then be able to deductively explain it from the laws of physics?

Schwan became agitated and refused to answer. At the suggestion of his lawyers, the hearing examiner adjourned the trial for lunch.

### *Afternoon*

Q. Doctor, I'd like you to consider a person in whom the safe energy level you calculated occurs in the pituitary gland, thyroid gland, parathyroid gland, adrenal glands, or pineal gland due to the powerlines. Assuming that the calculation were valid, would you be able to predict whether the secretions of the glands would be affected?

A. I have stated before that I cannot be specific with regard to any specific function of any particular organ.

Q. Are you saying that they are not affected?

A. No. I'm saying that in accordance with my principles I would not anticipate any effect to the best of my knowledge.

Q. Do those principles govern the secretion of those glands?

A. They cover all possible biological functions.

Q. Are the principles adequate to describe the function of the glands?

A. Not the function of the glands, but they certainly are adequate to describe if the energy will affect the glands.

Q. Doctor, if the energy won't affect the glands, doesn't that mean that it won't affect the function of the glands?

A. No. They are two different things.

Q. How do you know that?

A. It's obvious.

Q. Are the mechanisms that control the function of these glands clearly understood?

A. I can't comment on that because it is out of the range of my expertise. But referring to the implications of your question, even without knowing the details of a secretion it is nevertheless possible to draw conclusions as far as the effect of the energy is concerned. That is a general statement that applies to all biological processes.

Q. You have already agreed that your conclusion is an assumption based on your perception that neither Dr. Marino nor anybody else has presented evidence that the secretions will be affected, right?

A. Not necessarily.

Q. Doctor, isn't it a fact that Dr. Marino and more than five other groups of investigators have published peer-reviewed studies showing that the secretions were affected by powerline energy, and that you rejected each study as incompetent when I questioned you about them?

A. I don't remember the details from yesterday.

Q. Doctor Schwan, you are testifying that there will not be any effects in the glands we have been discussing due to the powerline energy, right?

A. Yes.

Q. And that you are not an expert regarding the glands?

A. That is precisely correct, yes.

Q. Doctor, in principle, there could be effects in these glands by the energy, right?

A. Oh yes, everything is possible.

Q. But so far, you haven't seen any that you accept, right?

A. Right.

Q. Just because you haven't come across any peer-reviewed studied you accept, that doesn't mean that there won't be any in the future, right?

A. Of course.

Q. It is possible that the next 100 studies might be acceptable to you, right?

A. Right.

Q. Then how do you know that the likelihood is small?

A. That is my experience, like if you ask me the likelihood a meteor will fall in the Atlantic Ocean. I just don't see that happening often. I look but I don't see it.

Q. But you don't do any biological studies. Couldn't that be the reason you don't see any effects?

A. I don't agree.

Q. Would you agree that even if your biophysical approach enabled you to predict the energy level in tissue, you couldn't predict the likely biological effect?

A. Not at the present time. No, pardon me; I would like to qualify that. I can predict the occurrence of heating and tissue excitation.

Q. But nothing else, right?

A. Yes. (Addressing the hearing examiner.) I have to make a very serious comment. I'm getting a little bit tired of this sort of questioning. We are stating these questions in one way or the other so far today, and now the same thing again and again. I must admit that if Mr. Simpson has his way, that another hour of this sort of discussion, he will get me so confused that I will contradict myself. I want to state that I do not feel necessarily responsible for what happens later on with that approach. It is absolutely confusing. I have said everything a dozen times. I have attempted to make it very clear. I don't know if I will be able to do it again and again and again and respond to that sort of thing for another hour or two.

Hearing examiner: Well, try to do the best you can, Doctor.

Q. Doctor, I am confused because you just said that you can judge the effect of energy on function, but in a previous answer you said you could not do so. Which answer was correct?

A. You get me tired and you get me to contradict myself.

Q. Doctor, can you explain how information is transferred in the nervous system?

A. Well that is a very complex business. Brain function is complex. I honestly can't give you a satisfactory answer.

Q. Doctor, if I asked you the same question about the biophysical principles underlying how memory worked, would your answer be the same?

A. I would give a similar answer.

Q. And would you give the same answer if I asked you how learning occurs?

A. Yes.

Q. Doctor, aren't learning, memory, and information transfer associated with excitable tissues, namely nerves?

A. Definitely.

Q. It's impossible to state that these basic processes will not be affected by the powerlines, right?

A. I do not agree with that, no. Present theoretical knowledge allows me to conclude that those processes will be unaffected.

Q. Then you believe that every peer-reviewed published report of the occurrence of such effects is in error, right?

A. Yes.

Q. Using learning as an example, would you apply your biophysical principles and show for the record that it will not be affected by the powerline energy?

A. I decline to answer. This is the same question that has been stated before. I simply must refuse to answer. That's definite, Mr. Simpson, that's it.

At this point, Schwan walked off the witness stand and the hearing ended for the day.

## Michaelson Cross-Examination

### *Plan*

Michaelson was a prominent spokesman for military and industrial stakeholders regarding electromagnetic energy. In a back-and-forth discussion, at a personal level, he was soft-spoken and gentlemanly. But when defending the interests of his clients at meetings or in legal proceedings, he was altogether different—a meretricious specialist in misdirection, personal attacks, and flat out lies. In the eyes of the law, he was an expert qualified to state opinions as facts, but his facts were entirely subjective, not the product of the scientific method.

His testimony concerning the powerlines was no different from what he had said for the last ten years when defending military and corporate interests related to microwave safety. He claimed that powerline electromagnetic energy was completely safe but without citing any personal research, supporting publications, or other objective basis for his opinion. Because there was no substance to attack in cross-examination, when I designed his cross I necessarily focused on his rhetoric, *ad hominem* attacks, and his barbarous research which I thought opened a window on his character. My aim was to systematically impeach his credibility by attacking his character so that the commissioners would see him as I did and afford his opinions no weight.

When I was interviewed in my laboratory by Mike Wallace for *60 Minutes*, he told me he wanted to talk with someone who held opinions opposite to mine, so I suggested

Michaelson. Wallace called him from my desk phone, and for ninety minutes tried to persuade Michaelson to grant an interview. Wallace appealed to Michaelson's sense of scientific responsibility ("Marino is going to tell forty million viewers that powerlines can be a health risk. Don't you think you should go on the same shown and tell the public the truth?"), his national stature ("You're a very famous man, and your opinion will carry a lot of weight"), his connections in the area of health risks ("You're on a lot of committees, you know a lot about what's going on"), and his scientific prowess ("You have done a lot of important research"). But Michaelson continually refused to be interviewed. Finally, Wallace said sarcastically, "Look, I'll pay you; how much do you get an hour?" and Michaelson hung up. Wallace turned to me and said, "I hate to say it about someone of my kind, but that guy is a sleaze." My aim was for the commission to see Michaelson as a "sleaze."

During my research on Michaelson's background I found many instances that resonated with Wallace's description. In a tort case, an ophthalmologist testified on the basis of his laboratory and clinical studies that low levels of microwaves could cause cataracts. Michaelson testified that the research was incompetent. After the trial, however, Michaelson sent his mother to the same ophthalmologist to have her cataracts removed. In a state hearing, a physicist testified about the details of a paper that reported bioeffects caused by electromagnetic energy. Michaelson, testifying against him, went into remarkable detail while telling the court why the work was thoroughly wrong-headed. After court adjourned Michaelson asked the physicist where the paper had been published—Michaelson had never heard of the work before Liboff had described it in court. In a senate hearing, Michaelson testified that Schwan's 10-milliwatt level was "exceedingly safe," and that it was "inconceivable" that lower levels could be hazardous. When a senator reminded Michaelson he had previously testified that the 10-milliwatt standard had to be re-examined because Soviet reports had showed there were nonthermal effects, Michaelson responded that he was now "affiliated with many organizations" and consequently felt more confident about his testimony. In an antenna-siting case, Michaelson testified that the antenna would be completely safe because its electromagnetic energy would be below Schwan's 10-milliwatt level. When Michaelson was asked about a book by a Soviet scientist who described adverse effects at far lower levels, Michaelson attacked Gordon's research as faulty because the author had used metal cages for the animals. Under oath, Michaelson replied to a series of questions:

Q. What is polystyrene?

A. That's a plastic.

Q. (Quoting from the book) "... the cages were made of polystyrene...." Now, Doctor, do you still state that this woman used steel cages?

A. Yes....



Q. In other words, even though she told everybody she uses polystyrene, she uses metal cages, is that right?

A. Yes.

Judge: Is it possible that she had the wrong picture in the book?

A. No.

There had never been anyone like Michaelson. He was a controlled agent aimed at mindlessly assassinating anyone opposed to the interests of his clients, like a Manchurian candidate.

In my conversations with Michaelson, I had seen that he often argued for two related points using contradictory reasons. I planned to disperse the questions from the various lines of cross-examination, and use what Simpson and I anticipated would be Michaelson's contradictory reasoning to impeach his credibility. To observers of the cross, the thread of our argument would be difficult to follow, but there was no truer of fact in the hearing room. That function would ultimately be performed by the commission, based on briefs prepared from the record by the lawyers. So, an intervening time interval between two answers would present no difficulties to Simpson when he wrote his brief.

### ***Dog Studies***

Michaelson's research involved extreme cruelty to dogs. By temperament and training he was insensitive to human health risks of energy levels that didn't produce dramatic and immediate effects, consequently his subjective opinions were not credible. I planned to establish Michaelson's insensitivity by putting into evidence his unimaginably brutal treatment of dogs, using language from his publications in the question that Simpson would pose. The facts would be in the record and Michaelson's answer wouldn't matter, except if he tried to deny the stated fact. In that case, Simpson would present him with a copy of his article and ask him to read the relevant portion. We would not move on to the next question until we were satisfied the record was sufficiently clear that the statement in the question was accurate.

1. "You published the results of 35 experiments that dealt with the clinical symptoms manifest by dogs subjected to very large doses of X-rays, right?"

2. "Your X-ray studies were funded by the Atomic Energy Commission to study radiation poisoning in dogs, right?"

3. "In these experiments, the dogs were irradiated for several minutes, observed daily until they died, and then autopsied to determine the cause of death, isn't that correct?"

4. "In your study entitled "The use of vitamin-fortified antibiotics in the therapy of acute radiation syndrome," only 20 of 100 dogs survived for 1 month following X-ray exposure, right?"

5. "In the study entitled "Lethality of upper body exposure to X-irradiation in beagles" you found that that 250 roentgens of X-rays killed 50 percent of the dogs when the

X-rays were directed against the entire body of the dogs, whereas 1775 roentgens were required to kill the same percentage when only the head was irradiated, right?"

6. "In a study entitled "The response of the dog to head irradiation," you observed that 5,000 to 50,000 roentgens applied to the head resulted in increased respiratory rate with continuous salivation, disturbance in equilibrium and vomiting, and that the dogs survived for 16 days, right?"

7. "In a study entitled "Exercise performance of upper-body X-irradiated dogs," the irradiated dogs were not able to perform exercises as efficiently as dogs that were not irradiated, right?"

8. "Subsequent to your X-ray experiments, you published the results of 13 experiments involving the effects on dogs of microwaves at levels used in normal household microwave ovens, right?"

9. "Your microwave experiments were funded by the U.S. Navy to ascertain how microwave heating caused heat stroke in dogs, right?"

10. "In a study entitled "Physiologic effects of microwaves on mammals," you observed that the dogs began to pant as soon as the irradiation was begun, true?"

11. "In a study entitled "Comparative studies on pulsed microwaves," you observed that the microwaves caused extreme agitation, excessive salivation, labored panting, frequent rasping, impairment of locomotion, acute distress, and exhaustion, correct?"

12. "In a study entitled "Microwaves in biomedical investigations," you observed that dogs exposed to microwaves exhibited deep burns as well as thermal stress, right?"

13. "In a study entitled "Biological effects of microwave exposure," you found that rabbits survived for 10 minutes, rats survived for 20 minutes, and dogs survived 85 minutes, is that correct?"

14. "In your list of publications, there are 38 publications in which you opined that microwaves were safe as long as the exposure levels were lower than those used in your studies, right?"

15. "The safety level that you advocated in your publications was the theoretical safety level discovered by Doctor Schwan based on his biophysical principles, right?"

16. "You adopted the biophysical principles described by Doctor Schwan, right?"

17. "You didn't develop any biophysical principles independently of Doctor Schwan, right?"

18. "His biophysical principles are beyond the scope of your expertise, right?"

19. "You never did any experiments to study the biological effects of electromagnetic energy that did not produce heat stroke, right?"

20. "You never did any experiments involving energy levels that you opined were completely safe, right?"

## ***Bias***

Michaelson was a veterinarian. That was how I first knew him—he had a contract to inspect the animal research facilities at the VA hospitals in the northeast part of the country, which included the hospital where I worked. Yet he offered opinions about human experimentation, the legal burden of proof regarding scientific evidence, biophysical principles, and how research in diverse specialties having nothing whatever to do with veterinary medicine should be done. He witlessly bad-mouthed investigators who were far superior to him, both American and Soviet scientists. I constructed questions that required him to defend his attacks, thereby exposing his bias and lack of expertise on the record. His most focused personal attack was against Deitrich Beischer, and that was a focal point of our cross-examination.

1. “Your testimony is that an effect should be presumed to be harmless until it is shown clearly and convincingly to be hazardous, right?”

2. “You have no scientific reason for reversing the evidentiary burden from presumed hazardous to presumed harmless, correct?”

3. “Implementation of your opinion constitutes involuntary human experimentation, true?”

4. “Your testimony is that the Public Service Commission should declare exposure to powerline energy as completely safe until there is incontrovertible scientific evidence to the contrary, right?”

5. “When you evaluate the results of animal or human studies that report effects due to man-made electromagnetic energy, you reject the studies that are not 100% certain, right?”

6. “You have not accepted as valid even one animal or human study that reported an effect due to man-made electromagnetic energy, true?”

7. “You were paid to testify on behalf of the Association of Home Appliance Manufacturers, right?”

8. “You were paid to testify on behalf of the Rockland Utilities Company, right?”

9. “You were paid to testify on behalf of the Raytheon Company, right?”

10. “You were paid to testify on behalf of the San Diego Electric and Gas Company, right?”

11. “You were paid to testify on behalf of the U.S. Navy, right?”

12. “You were paid to testify on behalf of the Electric Power Research Institute, right?”

13. “You testified that powerlines were “exceedingly safe,” that it was “inconceivable” that they could be hazardous,” right?”

Beischer came to the U.S. from Germany at the same time and by means of the same vetting process as Schwan, and was hired by the Navy for the same reason it hired Schwan. The two men had diametrically opposite opinions regarding the biological

consequences of electromagnetic energy, but the Navy kept an open mind and supported them both for many years. Beischer became the director of an advanced Naval laboratory dedicated to the study of electromagnetic energy. He performed many studies for the Navy related to its diverse interests, Sanguine being only one example. Several studies from his laboratory suggested that the energy had significant biological consequences, and Beischer retired soon thereafter, and became unavailable. Even so, the published reports of the studies were what they were, and on their face they did not support the Navy's position regarding Sanguine. Michaelson entered the picture and directed withering criticism at Beischer, who was prohibited from responding. Michaelson did the same thing in the hearing, and I designed cross-examination questions aimed at showing that his testimony concerning Beischer had no merit.

1. "Deitrich Beischer was the director of the Naval Aerospace Medical Research Laboratory, right?"

2. "The research facilities at that Laboratory are among the finest in the world, right?"

3. "You were hired by the Navy to be an advisor regarding the design of Beischer's studies, right?"

4. "Beischer conducted an experiment involving human volunteers who were exposed to electromagnetic energy comparable in strength to that of the proposed powerlines, right?"

5. "You never conducted similar experiments, right?"

6. "Beischer is one of the world's preeminent authorities in that field of research, right?"

7. "Do you consider yourself to be one of the world's preeminent authorities in that field of research?"

8. "Beischer observed that the electromagnetic energy caused elevated serum triglycerides in human volunteers, right?"

9. "You never did a human study involving man-made electromagnetic energy, right?"

10. "Actually you never conducted any experiments in which human beings were subjects, right?"

11. "You have no training or experience in conducting human experiments, right?"

12. "I will rephrase the question. What is the basis of your knowledge that allows you to criticize Dr. Beischer's research?"

13. "Beischer's research was performed completely within the administrative control and supervision of the U.S. Navy, right?"

14. "Beischer results were published by the Navy, right?"

15. "I will rephrase the question. The Navy would not have published Beischer's studies if it believed that they were done improperly, right?"

16. “Beischer’s results were independently confirmed by an independent group of Navy scientists, right?”

17. “Beischer’s work was reviewed by a committee of seven experts, appointed by the U.S. Navy, and was unanimously found to be competent and to warrant publication by the Navy, true?”

18. “You do not have any facts or contradictory data to support your criticism of Beischer’s research, right?”

19. “Isn’t your criticism of Beischer’s research motivated by the fact that his results don’t match your opinion in this case?”

### ***Soviet Studies***

1. “The U.S. and the Soviet Union have vastly different safety levels for man-made electromagnetic energy in the environment, right?”

2. “You have no evidence of why the levels differ, only theories, right?”

3. “I will rephrase the question. There are no publications that support your opinion about what accounts for the difference, right?”

4. “I will rephrase the question again. Neither the Navy nor the U.S. government have officially supported your theory for the difference in safety levels, right?”

5. “Doctor, you have spoken with the Russian scientist Dr. Ryazanov, right?”

6. “What are the names of the Soviet scientists with whom you spoke?”

7. “Did Dr. Ryazanov tell you, ‘Exposure that produces a measurable change in any biologic function, even if fully reversible, does not represent the optimum condition for human existence and should not be permitted by the government or tolerated by the people?’”

8. “You disagree with his opinion, right?”

9. “I will rephrase the question. You believe that measurable changes in any biologic function that are fully reversible should be permitted by the government and tolerated by the people, right?”

10. “You have no objective information that supports your assertion that the Soviets don’t follow their rules, right?”

11. “You have no factual basis for contradicting the study of the Soviet author X which showed that man-made electromagnetic energy can cause physiological effects in people, right?” X= Chebotareva; Portnov; Novikov; Khvoles; Rakhmanov.

### ***Cross-examination***

In the beginning of his cross-examination, Michaelson was evasive and oily, with a low-key demeanor, as we expected, and he seemed surprised by the bluntness of the questions. Simpson was persistent. He never stopped a line of questioning until he got what he wanted or until it was clear on the record that Michaelson would not respond.

### *Dog Studies*

Q. You published 35 papers dealing with the clinical symptoms manifest by dogs that were subjected to very large doses of X-rays, right?

A. ....(long winding answer)

Q. Subject to all that additional information, the answer to my question is Yes, right?

A. Yes.

Q. In these experiments, the dogs were irradiated for several minutes and after they died they were autopsied to determine the precise cause thereof, isn't that correct?

A. ....

Q. Subject to those qualifications, the answer to my question is yes, right?

A. Yes, more or less.

Q. In your study "The use of vitamin-fortified antibiotics in the therapy of acute radiation syndrome," only 20 of 100 dogs survived for 1 month following the exposure, right?

A. No. Some of the dogs survived longer than that.

Q. How long did they survive?

A. I don't remember. That study was done twenty years ago,

Q. In your experiment "Lethality of upper body exposure to X-irradiation in beagles" you found that a much higher dose of X-rays was needed to kill half the dogs when only their heads were irradiated, isn't that true?

A. I don't remember the details, but they sound about right because whole-body exposure produces effects more efficiently.

Q. The effects include increased respiratory rate, continuous salivation, disturbance in equilibrium, and vomiting?

A. These effects can occur, but they don't occur in every animal. In some animals, there are no effects.

Q. But the dogs all died within a few weeks, didn't they?

A. Yes. They died a peaceful death, without suffering.

Q. You also published the results of microwave experiments on dogs involving levels of electromagnetic energy comparable to those used in normal household microwave ovens, right?

A. Not necessarily. Sometimes the levels were lower than those in ovens.

Q. With regard to those lower levels, you could feel some warmth if you put your hand in the microwave beam?

A. I don't remember.

Q. Typically in your studies, the dogs would begin to pant as soon as you turned on the microwaves, right?

A. Usually only after a few minutes.

Q. You also observed that the microwaves caused agitation and excessive salivation, right?

A. Yes, but not all the time.

Q. Would there be more of a response if the microwave levels were higher?

A. Yes.

Q. You also observed labored panting and frequent rasping, true?

A. Yes.

Q. And impairment of locomotion, acute distress, and exhaustion, correct?

A. Yes.

Q. As well as thermal stress, you sometimes observed deep burns, isn't that right?

A. Sometimes.

Q. Why did rats survive in in the microwave ovens longer than rabbits?

A. Because rabbits have more hair. That insulates the rabbits and keeps the heat inside.

Q. But that doesn't explain why dogs lasted longer than rats does it?

A. No. I don't know why. I was still studying that important question when the research contract ended.

Q. I counted 38 review papers where you opined that microwaves were safe as long as the exposure levels were lower than those used in your studies, is that about right?

A. Yes.

Q. You have not done any experiments involving exposure levels that you opined were completely safe, right?

A. That's a ridiculous question. Why would I do experiments where there were no effects?

### ***Biophysics***

Q. In your testimony you stated that your conclusion regarding complete safety was based on an analysis of biophysical principles, right?

A. Yes.

Q. Doctor, can you tell me the biophysical principles you referred to in your testimony?

A. I am thinking of the total body of knowledge as far as the interaction of electromagnetic energy and biological tissues is concerned.

Q. What biophysical principles did you employ in reaching your conclusion?

A. I relied heavily on Dr. Schwan.

Q. His biophysical principles are beyond the scope of your expertise, isn't that true?

A. No. I would not admit to that. I am just saying that Dr. Schwan knows more than I do, and you should address these questions to him.

Q. Doctor, can you tell me specifically the biophysical principle that forms the basis for the conclusion you stated?

A. Yes. Very high levels of electromagnetic energy are needed to upset physiologic regulation.

Q. How do you know that?

A. There are many papers and plus my own experience in the area. I have taught this material for twenty-two years.

Q. Doctor, your testimony is that high levels of electromagnetic energy can upset physiological regulation, right?

A. Yes.

Q. Doctor, low levels of electromagnetic energy can also upset physiological regulation, right?

A. No, that does not occur.

Q. How do you know?

A. Because there are no scientifically valid cases where it has happened.

Q. Not even one case?

A. No case where the upset of the physiological regulation was proven hazardous.

Q. During those twenty-two years you did research for the Atomic Energy Commission to study radiation poisoning in dogs, right?

A. Yes.

Q. During those twenty-two years you also performed experiments for the Navy to study heat stroke in dogs, right?



A. Yes.

Q. But during those twenty-two years you never did any experiments to study more typical and less dramatic biological phenomena did you?

A. No.

### ***Human experimentation***

Q. If a biological effect is likely to be induced in the bodies of persons exposed to the powerline energy, based upon an evaluation of animal studies, that effect should be presumed to be hazardous until shown clearly and convincingly to be harmless, right?

A. Absolutely not. There is no scientific rationale for doing that. Something can't be unsafe by default. There must be evidence before such a claim can be made rationally.

Q. Doctor, you have no scientific reason for reversing the evidentiary burden, correct?

A. That's the way science works.

Q. Wouldn't implementation of your opinion constitute involuntary human experimentation?

A. Not in my opinion because there is no experiment. No one is collecting data to test a hypothesis.

Q. Would you advise the commission to consider powerline energy hazardous only if the scientific evidence was conclusive?

A. Yes. That's reasonable.

Q. There has been a complete failure on your part to show that any effects induced in the bodies of persons exposed to powerline energy would be harmless, isn't that true?

A. It's true but spending time and money to try would be waste of resources. The body is a very dynamic machine. It is able to adjust to many environments. There is an ability to adjust to all stimuli; otherwise we could not survive. In other words, we get sick, we recover; we get injured, we recover. The body has a tremendous capacity, resiliency for maintaining a certain level of equilibrium within a certain range. For example, there is a neutral temperature for the body. You can increase this temperature by up to 4°C with no trouble at all. The body can handle it beautifully. If you were raise someone's body temperature more than that, say by putting them in a very hot room or by irradiating with microwaves there could be trouble.

Q. Doctor, I'll rephrase the question. You never made any attempt to test your theory that any possible effects would be harmless. That's just something you believe, right?

A. I cannot give you specifics. It is unfair to ask me to respond to that because you are asking me to address a null situation, and it cannot be done.

Q. What do you mean by a null situation?

A. You cannot find anything if it is not there. If it is not there, you cannot find it.

Q. Have American power companies done any human studies on their employees?

A. Yes, and they were almost always negative.

Q. Were they gold-standard studies designed to find cause-and-effect relationships?

....

Q. Subject to those qualifications, the answer to my question is no, true?

A. Yes.

Q. Doctor, you believe that further research regarding the biological effects of electromagnetic energy from powerlines is not needed, right?

A. Further research is always desirable. However, as far as the levels we are taking about are concerned, I feel that they are perfectly safe.

Q. That opinion is based on Dr. Schwan's testimony, right?

A. Yes, and on biological studies showing that there are no effects.

Q. The body reacts to powerline energy the same way it reacts to temperature, right?

A. No. It does not react at all to powerline energy.

Q. Did Doctor Schwan tell you that?

A. Yes.

Q. Just to be completely clear, did Doctor Schwan tell you that powerline energy has no effect on the body and produces no change in temperature?

A. That is precisely true.

Q. Doctor, would it surprise you to learn that Schwan said the opposite, that powerline energy produces a change in temperature in every material structure, whether animate or inanimate, because every material structure has some electrical conductivity?

A. I am not a biophysicist. You should address such questions to Doctor Schwan.

***Beischer***

Q. Deitrich Beischer was the director of the Naval Aerospace Medical Research Laboratory, right?

A. I don't know what his title was.

Q. But you do know that he worked there, had a research laboratory there, did human studies there, right?

A. Yes.

Q. Were you were hired by the Navy to be an advisor regarding the design of Beischer's studies?

A. No. I was appointed to a committee to help advise on the medical aspects of the study. I received no money except for expenses.

Q. Did you receive money from the Navy for doing research?

A. I had a research contract with the Navy.

Q. Beischer conducted an experiment involving human volunteers who were exposed to electromagnetic energy comparable in strength to that of the proposed powerlines, right?"

.....

Q. Subject to those qualifications, the answer to my question is yes, right?

A. Yes.

Q. Did you ever do comparable human studies?

A. No.

Q. Beischer observed that the electromagnetic energy caused elevated serum triglycerides, right?

A. Yes.

Q. Did you ever measure serum triglycerides in your dogs?

A. No.

Q. Beischer's research was performed completely within the administrative control and supervision of the U.S. Navy, which published his results, right?

A. As far as I know.

Q. Beischer's results were independently confirmed by a second group of Navy investigators, right?

A. No. The other measurements, which were actually done first, were only uncontrolled observations in Navy personal who were occupationally exposed to Sanguine energy at a facility where a test version of the antenna was being evaluated.

Q. Beischer's work was reviewed by a committee of seven experts, appointed by the U.S. Navy, and was unanimously found to be competent and to warrant further immediate study, true?

A. I don't know.

Q. Doctor, when you were evaluating Dr. Beischer's study, didn't you come across information that the Navy had judged his research as reliable?

A. Not that I recall.

Q. Now that you know that his work was judged by the Navy to be reliable, does that change your opinion of the reliability of his work?

A. No.

Q. You do not have any facts or contradictory data to support your criticism on his research, right?

A. As I described in my testimony, even Dr. Beischer conceded that his work had shortcomings and limitations.

Q. Is your criticism of Beischer's research motivated by the fact that if his work were accepted, then your opinion that no further research was required would be contradicted?"

A. Certainly not.

### *Soviet Studies*

Q. You testified that the U.S. and the Soviet Union have different philosophies regarding safety levels for man-made electromagnetic energy in the environment, right?

A. Yes.

Q. You believe that this difference in philosophy accounts for the huge difference in safety levels between the U.S. and the Soviet Union, right?

A. Yes

Q. Can you explain this difference?

A. Their concept is that any departure from the physiologic norm, even if it is within the redundancy of the body to handle the insult that caused the departure should be considered in determining what is safe. They believe any departure should be considered. In the Western world we look at the ability of the body to handle these insults because there are always rhythms going on and the body is able to handle many of these insults. Otherwise we can't survive in the Western world. Our industrial and military philosophy accepts departures as long as they are within limits. Otherwise the harm that would be done to industry and the military would outweigh any proposed public-health benefit.

Q. There is no citation in the literature that supports your statement, correct?

A. I don't know offhand. I may have some but I'm not sure. You will have to take my word for it.

Q. How do you know about this difference in philosophy and how it impacts safety standards?

A. I have spoken with Russians and I read their literature.

Q. Doctor, you don't speak Russian or Ukrainian, do you?

A. No.

Q. Then how were you able to read the Soviet literature?

A. I read translations.

Q. Who did the translations?

A. The CIA.

Q. What Russians have you spoken with?

A. I speak with many people. I just know this.

Q. What are the names of some of these people?

A. I can't recall off-hand.

Q. You don't recall the names of any Russian scientists who told you about their philosophy as related to electromagnetic energy hazards, right?

A. Yes.

Q. Doctor, did the Russian scientist named Dr. Ryazanov once tell you, "Exposure that produces a measurable change in any biologic function, even if fully reversible, does not represent the optimum condition for human existence and should not be permitted by the government or tolerated by the people"?

A. Yes, but that's all just talk. Such rules aren't enforced. They don't follow the standards in practice. In the U.S. our standards are operational and are enforced.

Q. Doctor, do you recall our previous discussion regarding your contention that the Soviet Union is not enforcing its rules with regard to protection against electromagnetic energy from powerlines?

A. Yes, generally.

Q. I asked you through your counsel to supply appropriate references to support that contention, and in response you provided articles by Glass, Magnusson, Rjazavov, Dinman, Goldman, and Sandnutski. Do you recall doing so?

A. Not really. I would have to check my records.

Q. Doctor, isn't it true that none of those articles have anything to do with your contention that the Soviet Union is not enforcing its rules regarding protection against powerline energy?

A. As I said, I would have to check my records. That's all I can say now.

Q. Do you recall the names of some of the U.S. government scientists who told you about the U.S. philosophy as related to electromagnetic energy hazards?

A. I am not at liberty to say.

Q. Is there any information you have that leads you to conclude that the Soviets don't follow their rules?

A. I read the Soviet literature. I am on an international committee. I have worked with many groups. As I told you, I just know these things.

Q. You have no factual basis, no factual information on the basis of which you can contradict the authors of the Soviet studies, right?

A.

Q. Did you ever testify that Soviet studies by Chebotareva, Portnov, Novikov, Khvoles, and Rakhmanov showed that man-made electromagnetic energy can cause a wide range of physiologic effects, including changes in blood indices, heartbeat, respiration, and widespread morphologic changes?

A. I don't recall.

Q. You have no published evidence to support your claim that the Soviet Union is not enforcing its environmental standards with respect to health hazards from man-made electromagnetic energy, right?

A. Not specifically.

## Miller Cross-Examination

### *Plan*

There were gaping holes in Miller's testimony. He relied almost entirely on the Sanguine studies by Hazelton Laboratories that found effects. But negative studies are almost always meaningless because anybody can find nothing. Moreover, the Hazelton studies Miller cited had been repudiated by the Navy because they were so poorly done. And further, the credibility of Hazelton as a research-for-hire organization was low because it had been caught rigging research for drug companies. Besides all that, on its face, Miller's reasoning made no sense because most Sanguine studies done by university investigators and Navy research labs had actually found biological effects, but he completely ignored those studies in his testimony, as if that would prevent me from confronting him with them during cross-examination. But all those issues were less than half of Miller's problems. His opinion that a determination of powerline safety could be based on visual inspection of plants was ridiculous, and his attempt at reasoning made no sense—no Sanguine study could support the safety of high-voltage powerlines because Sanguine energy was many thousands of times weaker than powerline energy.

Miller's ultimate conclusion, that powerline electromagnetic energy "does not pose

an unreasonable risk to health,” was meaningless verbiage, and Miller obviously was not an expert in the area of his testimony. He was a botanist who had no relevant training or experience except for his bean-plant research, so there was no basis to believe that his testimony was reliable. Because his direct testimony was foolish on its face, only a few scripted questions were needed:

1. “Hazelton Laboratories was sanctioned by the FDA for performing rigged research for drug companies, right?”
2. “The Navy stopped funding Sanguine research at Hazelton in 1970, right?”
3. “The Navy has concluded that some of the Hazelton studies you relied on employed erroneous experimental procedures, right?”
4. “You testified that you relied on the Hazelton studies, but in experimental biology negative studies have no value, right?”
5. “I’ll rephrase the question. A negative study shows only that, under the conditions of the study, no effect was found, right?”
6. “A negative study gives no information at all regarding what would happen if the conditions were changed even slightly, isn’t that true?”
7. “With that qualification, isn’t a negative study like a dry hole which indicates only where there isn’t oil?”
8. “Taking those considerations into account, couldn’t a negative study mean that the investigator looked in the wrong place?”
9. “Doctor, a negative study isn’t scientific evidence that there was no effect, right?”

### *Cross-examination*

Simpson wanted Miller to explicitly concede the obvious shortcomings in his testimony, especially that the studies he relied upon were poorly done by an ethically challenged commercial research company, were rejected by the Navy, were entirely negative and hence not probative, and that in any case, studies using Sanguine-strength electromagnetic energy had no safety implications for powerlines because they had vastly higher energy levels. Miller was just stupid, but that didn’t mean he would be easy to deal with on the witness stand, and he wasn’t. But from the beginning he was combative and mealy-mouthed even when the answer was foreordained by his direct testimony. Simpson asked, “Doctor, your conclusions were mostly dependent on the Hazelton studies, right?” The subsequent colloquy in which Miller resisted answering and Simpson persisted lasted for more than an hour and finally ended when Miller conceded, “Well, the majority of the words in my testimony are pertinent to the Hazelton studies.” When Simpson asked, “The Sanguine studies can’t be evidence of powerline safety because their energy levels are so much greater than the energy levels used in the Sanguine studies, correct?” After evading an answer for 30 minutes Miller finally replied, “The Sanguine studies would have somewhat reduced relevancy.”

Simpson slugged through enough questions to develop his argument that Miller lacked credibility, but each time we decided we had more than enough evidence in the record to impeach Miller's credibility, he said something that was uniquely moronic, so we kept going forward with his cross-examination. In one of his answers, Miller referred to a Sanguine study by Goodman, and Simpson asked:

Q. Doctor, are you familiar with the Sanguine study Dr. Goodman and colleagues?

A. Yes. I think this is an outstanding study. It is a beautiful example of a well-controlled, well-analyzed experiment.

Q. Considering that it was a positive study and found an effect, doesn't that contradict your testimony that there will be no health risks from the powerlines?

A. No, not at all, because according to Dr. Schwan the level of electromagnetic energy used by Dr. Goodman was far higher than those due to either Sanguine or powerlines.

But Miller had repeatedly conceded that he lacked expertise in biophysics, so I wondered how confident he was that he had understood Schwan correctly. Simpson immediately began a line of cross purposed to persuade Miller that he had misunderstood Schwan, and that indeed Goodman's energy levels were comparable to those of the powerlines. Simpson succeeded, and Miller began to perceive Goodman's work as antagonistic to his position. Thereafter, Miller's attitude towards Goodman's research was quite different. He referred to it as having "a lack of appropriate controls," said that Goodman's results "may have been an artifact," and finally stated, "I am criticizing the experiment saying it was not a properly controlled type of experiment."

In another answer, Miller referred to a Sanguine study by McCleave, and Simpson asked:

Q. You are aware of the Sanguine study by McCleave which reported that fish are affected by very weak levels of electromagnetic energy, right?

A. Yes.

Q. Doesn't the report raise the possibility you are wrong because there is a reasonable basis for suspecting that there is a risk to humans?

A. Absolutely not because fish have special organs for detecting electromagnetic energy.

Q. Is that something you know of your own personal knowledge or did someone tell you that was the case?

A. It is a fact I learned from Dr. Schwan.

Q. Do the fish that McCleave studied have such an organ?

A. I presume so because that was the study we discussed.



Q. Doctor, would it surprise you to learn that the kind of fish McCleave studied do not have such an organ?

A. Yes.

At another point during his cross-examination Miller said that he had just gotten a contract for almost a quarter of a million dollars from the Department of Energy to study the biological effects of powerline EMFs. The hearing examiner asked him, “Why do you want to study that if you think there are no effects?” Miller answered, “I follow the golden rule.” “What’s that?” the hearing examiner asked, and Miller replied, “He who has the gold makes the rules.”

## Briefs

The hearing process ended and the 30,000 pages of testimony that had been produced were presented to the commission for evaluation and resolution. Simpson wrote legal briefs on behalf of the staff of the commission in which he advocated particular positions, and the lawyers who represented the power companies or other parties submitted their briefs in support of their clients. The most important question in the case, the reason that it lasted four years rather than a few months like all other cases in New York involving proposals to build new powerlines, stemmed from the concern Becker raised, the risk to health from chronic exposure of the public to the electromagnetic energy that would be carried by powerlines.

In the popular mind, at least to the extent that people thought at all about the process, electromagnetic energy transported by high-voltage powerlines was produced at a power station and carried inside the wires to wherever it was consumed by customers, who paid for each kilowatt-hour. In reality, however, the physics of the energy flow through overhead wires required it to move outside the wires, like water in a pipe except that energy flowed outside its wire-pipe. Along the way, the energy passed through the same space in which people lived and worked. Had the power companies agreed to bury the powerlines, the metaphor of water flowing through pipes would have been a physically accurate description of how the energy flowed—completely encased by a metal pipe. But the companies steadfastly refused to build the powerlines underground, with the inevitable consequence that energy and people frequently occupied the same place at the same time, which was the fact that formed the biological basis of Becker’s concern. So, a legal question that had never previously been considered anywhere was about to be decided by the commission, a small group of political appointees. On one side were Becker and me, and on the other were the blowhard Schwan, the Manchurian-candidate Michaelson, and the battery-sucking lickspittle Miller.

The governing law in New York was that the powerlines had to be “safe.” The credible testimony portended that the commission take some action to protect public health. During its deliberations regarding what actions would be reasonable, an awareness

developed and became palpable that whatever remedies the commission adopted would have implications for the safety of powerlines that had already been built and placed in operation, possibly resulting in unforeseeable costs and potential legal liabilities. The briefing phase took place under the shadow of this problem.

Becker and I had no clients, at least in the normal sense of that term, and we were not parties, so our roles in the hearing ended when the testimonial phase of the hearing ended. But I believed I understood the health-risk issue better than the power-company experts and lawyers, so I asked the commission for *amicus curiae* status, received it, and submitted *amicus* briefs in which I directly presented my analyses to the commission, analyses that sometimes went further in the direction of protecting public health than Simpson was able to do, given the institutional pressures he faced.

In the first round of briefs, I argued that the overwhelming weight of the credible scientific evidence showed that the electromagnetic energy produced by the powerlines would cause biological effects in the human beings exposed to the energy, and that the testimony of Schwan, Michaelson, and Miller purporting to show that there would be no harmful biological effects had no merit. I argued further that the power companies themselves and the commercial research companies on whose work their experts based their testimony were unreliable determiners of the truth because of their obvious conflicts-of-interests, and therefore that the commission should create an administrative research council to oversee the funding of basic and applied research dealing with the safety of powerlines. I asked the commission to employ a safety factor and designate a reasonable maximum permitted chronic human exposure level based on the levels used in published reports on animal studies, and to direct power companies throughout the state to give notice to the people of the existence of valid scientific dispute concerning the health hazards of exposure to powerline electromagnetic energy.

In their first-round briefs, the lawyers for the power companies made lipstick-on-a-pig arguments praising the testimony of Schwan, Michaelson, and Miller, and characterized me as a Svengali-like character who seduced Becker into believing that the gold-standard studies I defended were scientifically valid. The companies made no serious argument that the studies were invalid for the simple reason that most of them had never been addressed by their experts, so there was no basis in the record for such an argument. Instead, company lawyers argued that gold-standard animal studies were not the proper basis for assessing human health risks, and that such an assessment should be done on the basis of “biophysical principles” because that process was simpler and more economical. The company lawyers also argued that the health issues raised in the hearing were not new, and that the attention the issue had received was unwarranted, based on the testimony of their experts. But also, arguing in the alternative, assuming the question was regarded as one of first impression, they asserted that the Public Service Law required the commission to base its decision regarding the health hazards of powerline electromagnetic energy on evidence of “probable hazardous effects” occurring in humans exposed to the energy, an extremely

high evidentiary burden that would be almost impossible to meet. The overall conclusion of the company lawyers was that there was no credible testimony against their position in the case.

In my second-round brief, I addressed the arguments of the companies in support of the credibility of their experts. I thought their arguments had no chance to prevail, but I felt I couldn't let their absurdity go uncontested.

I also addressed the contention that the health issues raised in the hearing was not new. I argued that health issues had indeed been discussed in previous powerline hearings, but that the health issue framed by Becker was truly unprecedented. Thomas Edison had recognized the need for health-related rules regarding powerline electromagnetic energy and promulgated the rule that touching a live wire was unsafe. Over the next century the power industry adhered to the rule but never considered the biological impact of the electromagnetic environment created by powerlines of ever-increasing voltage. About 1970, scientists began performing laboratory experiments in which animals were chronically exposed to an electromagnetic environment similar to that created by high-voltage powerlines, and by 1975, approximately 50 reports had appeared. The inevitable clash between the economic interests of the industry and the emergent biological knowledge occurred in the present proceedings.

The commission was called upon to decide whether the general state of the scientific evidence regarding the biological consequences of the electromagnetic environment of the proposed powerlines proved by clear and convincing evidence that the powerlines would be completely safe. Or alternatively, whether the evidence suggested that health risks were possible and that some affirmative steps were needed to protect public health until such time that a more definitive answer to the question could be obtained. The issue had never previously been litigated, raised, or even considered in any fair or meaningful way before any administrative or judicial forum in the United States. The federal government had no regulatory authority regarding possible biological effects caused by high-voltage powerlines. Thus the issues before the commission were novel, and no other state or federal regulatory body had the jurisdiction to evaluate them. Consequently, the argument of the power-company lawyers that the hearing was just another powerline hearing was erroneous and misleading.

I also argued against the construction of the Public Service Law as requiring the commission to base its decision regarding the health hazards of powerline electromagnetic energy on evidence of "probable hazardous effects" occurring in humans exposed to the energy. That law required no such thing, and no such draconian interpretation was warranted. What that law actually said was that the commission could do anything that it "may deem appropriate." Contrary to the argument of the companies, the law gave the commission complete discretion regarding what they could do and provided no explicit evidentiary standards regarding how those decisions must be formed. If the commissioners deemed it "appropriate," they had the legal authority to order widening of the right-of-way, lowering

of the operating voltage, and/or building the powerlines underground, in which case the problem regarding health risks from powerlines would disappear altogether.

I made the point that that the commission could and should base its decision regarding the health hazards of powerline electromagnetic energy on evidence of “likely risks of biological effects,” based on a preponderance of the scientific evidence, not on the far higher evidentiary standard of “probable hazardous effects”—a standard that could be met only by involuntary human experimentation like the Nazis had done during the war and the U.S. Public Health Service had done in Alabama after the war. While the hearing was in progress, the Alabama experiment came to national attention and was accurately described by a national news anchor as an experiment that “used human beings as laboratory animals in a long and inefficient study of how long it takes syphilis to kill someone.” The subjects in the study had no idea of the looming danger because they had been misled into believing that the investigators were trying to help them. The subjects suffered and died painful deaths because that outcome was necessary to prove cause-effect relationships between the disease and death to a scientific certainty. The process in Alabama was, in effect, what the companies were asking the commission to adopt in New York. It wasn’t that the power companies argued explicitly in favor of involuntary human experimentation; on the contrary they were fully aware that the public would never allow it. But because the standard for the weight of the burden of proof that would be needed to establish that powerline electromagnetic energy was a health risk would be so high, if the commission adopted the interpretation of the law urged by the power companies, they could be certain that the standard would never be satisfied. I argued that Becker had established the nexus between “probable hazardous effects” and involuntary human experimentation during four days of cross-examination and that the argument of the company lawyers should be rejected.

## Decision

In its final decision, the commission adopted Becker’s testimony, rejected that of Schwan, Michaelson, and Miller, and denied a permit to construct one of the two proposed powerlines. It approved a second line, but only because of massive political pressure by the Governor who made the points that the owner of the new line, itself a state agency, had purchased all the necessary materials for the powerlines even before the hearing had begun. The commission ordered design changes that had the effect of limiting the level of electromagnetic energy at the edge of the right-of-way to the same level that existed in connection with pre-existing powerlines. The commission declined to order that people be given warnings about potential health hazards from powerlines, fearful of how such a step would affect property values, but it formally recognized that there was an issue of public health, that more research was needed to answer important questions, and that the state power company would be required to provide the money to the department of health which would carry out the studies.