CASES 26529 & 26559—Common Record Hearings on the Health and Safety of 765 kV Transmission Lines.

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Amicus Curiae Brief on Exceptions

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## **History of the Proceeding**

Staff sponsored witnesses, Robert O. Becker, M.D. and Andrew A. Marino, Ph.D., work at the Veterans Administration Hospital, Syracuse, New York. Becker founded the Orthopedic Research Laboratory at the hospital in 1957, and Marino joined the laboratory in 1964 as a research biophysicist.

In September, 1973, after a presentation of their electric field research at a meeting of the New York academy of Sciences in New York City, Capt. Paul Tyler of the United States Navy introduced himself to Becker and Marino and explained the Navy's interest in their work. Several years earlier, the Navy proposed the construction of a large antenna, known as Sanguine, which would permit communications with submerged submarines. Around 1970, the Navy began funding a variety of scientific studies dealing with the biological effects of Sanguine-type fields.<sup>fn-1</sup> By the fall of 1973, a body of scientific data had been accumulated by the Navy, and Tyler was assembling a committee to evaluate the information. The night of the N.Y. Academy of Sciences Presentation, Tyler asked Becker to be a member of that committee, and Becker agreed.

The committee, which became known as the Ad Hoc Committee for the Review of Biomedical and Ecological Effects of ELF Radiation (Ad Hoc Committee), met in Washington D.C. in December, 1973. It received summaries of existing programs in a number of broad areas, including human studies, behavioral effects, physiology, genetics, growth and development, and ecology. In each area, at least some of the experimental data provided by the Navy indicated the existence of positive effects. On the basis of the evidence reviewed, the Ad Hoc Committee unanimously expressed its concern for the health of the humans who would be exposed to the Sanguine strength fields, and proposed a broad research orogram.

The first connection between Sanguine and high voltage transmission lines was made by the Ad Hoc Committee; it unanimously recommended that the federal government

"...be apprised of the positive findings evaluated by this committee and the possible significance, should they be validated by future studies, to the large population at risk in the United States who are exposed to 60 Hertz fields from power lines and other 60 Hertz sources."

Shortly after Becker returned from the Washington, D.C. meeting, he wrote a letter to Henry Diamond, Commissioner of the Department of Environmental Conservation, copies of which were sent to Joseph Swidler, Chairman of the Public Service Commission (PSC) and to the Niagara Mohawk Power Corporation. He said:

"I wish to call to your attention certain serious human health and general ecological problems that might be associated with the proposed 765 kV electrical power transmission line."

Becker described the Navy program in general terms and pointed out that the Navy had found a number of deleterious effects at Sanguine field strengths, and that

"these strengths are significantly *lower* than those that would be present along the 765 kV line."

In the summer of 1974, hearings were underway in Albany before the PSC on the application of the Rochester Gas & Electric Corporation (RG&E) and the Niagara Mohawk Power Corporation (NMP) to build a 765 kV transmission line. During the hearing, an attorney on the staff of the PSC called and asked to see Becker to discuss the letter to Chairman Swidler. Because of recently initiated ELF field experiments, Marino was also invited to attend the meeting. Becker and Marino subsequently agreed to the request of the PSC staff to appear in the RG&E case as staff-sponsored expert witnesses.

Marino and Becker declined to be paid, but requested that the hearing be held in Syracuse on the particular days on which they would testify, because their services to the PSC would be in addition to their other responsibilities which would have to be met simultaneously. The hearing examiners agreed to the condition requested by Becker and Marino.

Becker and Marino prepared written testimony which was served by staff in October, 1974. Marino described eight experiments published in the open scientific literature in which ELF fields had caused biological effects in man or animals. Becker discussed the ELF reports and gave his medical opinion concerning the biological effects; he testified that the data showed that ELF fields were biological stressors and that as a physician, he would have to assume that they were harmful. Both Becker and Marino

recommended against construction of the 765 kV transmission line as it had been proposed. Becker reasoned that

"...the strength of both the electrical field and magnetic field produced by the line will be in the range possibly productive of biological effects. I believe that chronic exposure to such fields should be viewed as human experimentation and subjected to the rules previously mentioned."

Very shortly after the testimony of Marino and Becker was distributed, and before it was adopted, the procedural setting of the hearing changed greatly. In November, 1974, the RG&E case was combined with the case involving PASNY. RG&E withdrew its biological effects testimony, and, in the light of the testimony already furnished by Becker and Marino, began preparing a new position. In June, 1975, the Commission invited other utility companies to joint the hearings. What had begun as a proceeding involving two relatively small upstate New York utility companies guickly took on a much wider focus. Becker and Marino viewed their testimony as a contribution towards the development of better, safe high voltage transmission lines. Soon after it was released however, reports began to circulate that RG&E would reject the testimony in its entirety. PASNY's public comments quickly revealed that it too would oppose as unnecessary any attempt to protect the public from exposure to the fields of its proposed line. The Commission's June invitation brought in still more opposition to any change. A siege mentality developed almost overnight, with the various New York utility companies united in opposition to the ideas that chronic exposure to the fields of high voltage transmission lines should be prevented because of the potential health hazard.

There was a yet more ominous development. One could easily perceive the developing community of interest between the utilities and the Navy, which still sought permission to build Sanguine. Given the commitment to Sanguine, it was predictable that the Navy would employ its resources to oppose a judgment by the Public Service Commission that exposure to transmission line fields was a health hazard.

Many things crystallized when the utilities chose their witnesses, including the nature of the hearing. RG&E brought in Morton Miller, a botanist, Sol Michaelson, a veterinarian, and Edwin Carstensen, a biophysicist, all of the University of Rochester; NMP added Herman Schwan, a biophysicist from the University of Pennsylvania. Michaelson's research almost exclusively involved the study of very gross and acute effects of strong doses of X-rays and microwaves. Both Carstensen and Schwan specialized in the study of electrical and acoustical properties of isolated tissue; neither had performed experimentation of any kind involving living animals. Every one of Miller's published experiments involved only plants. None of the utility company witnesses had performed any kind of animal research involving ELF, nor had they performed any other kind of animal research, with the exception of Michaelson's studies. More disturbing than the absence of expertise was the presence of bias. Michaelson and Schwan were well known as consultants to the Navy and recipients of Navy research funds. For many years they served the Navy and various corporate interests, in the controversy surrounding the health hazards of microwaves. Their public position in the microwave controversy was fundamentally inconsistent with even the possibility that ELF fields

could be hazardous.

In early 1975, the Navy published a compilation of some of its ELF research that had been revealed to the Ad Hoc Committee in December, 1973. The document described two kinds of research projects. The first type of ELF research was performed in-house at a Navy research facility by Navy personnel; the second type was performed at universities by faculty personnel. With two exceptions, the in-house Navy projects all concluded that ELF fields didn't cause any biological effects. Most of the studies performed by the university scientists, however, found positive effects due to ELF fields. By the end of 1975, the university scientists who had reported ELF bioeffects had lost their Navy research funding, and the head of the Naval Aerospace Medical Research Laboratory (NAMRL), whose research team was responsible for the two exceptions regarding in-house Navy research, had retired.<sup>fn-2</sup>

Some Navy in-house research projects just disappeared. A Navy bibliography dated July, 1974, described a report involving gerbils. When asked for a copy, the Navy replied, "NAMRL 1197 was originally entitled: 'Effects of Extremely Low Frequency (ELF) Fields on Cellular Organelles of Liver Parenchymal Cells of the Mongolian Gerbil' (By R.J. Brehl) (Nov. 1973). This was rewritten and published as 'Search for Effects of 45 Hertz Magnetic Fields on Liver Triglycerides in Mice.' Authors: Beischer and Brehl, March. 1975." The "rewritten" version of NAMRL 1197 had actually been written in 1973.

Perhaps the most serious instance of disappearance of in-house research occurred in connection with the ELF research project at the Naval Air Development Center at Warminster, Pennsylvania, Around 1971, an ELF bioeffects team was founded by the Navy at Warminster. A number of different kinds of experiments were performed; by 1975, it was clear that the most important were those involving 30-day exposure of rats. The scientists exposed the rats to a range of very weak ELF electric fields. Although the details of the experiments remained secret until 1976, the experimental procedure and the results observed were remarkably similar to the experiments performed by Becker and Marino in 1975, except that the Navy research team employed weak, Sanguinestrength electric fields. The Navy scientists consistently found that the exposed rats were stunted. The Navy Sanguine officials however, felt that the results must be flawed because they were not 'consistent;' the Navy scientists observed stunting at all field strengths studied while the Navy Sanguine officials believed that if the effect were real it would have to be proportional to dose, resulting in more stunting at higher strength fields. The Navy Sanguine officials made several trips to the Warminster facility in an attempt to find a defect in the experimental set-up. They found none however, and the scientists continued to report stunting of growth, whereupon the Navy terminated the project and dissolved the research team. The various periodic reports which the group had filed with the Navy Sanguine officials were not released.<sup>fn-3</sup>

In 1975 and thereafter, the only substantial ELF research conducted by the Navy was work aimed at undoing the in-house positive results reported in previous years. Thus Mathewson, of the Armed Forces Radiobiology Research Institute, began a repeat of the Warminster rat studies; Grissett, of NAMRL, began a repeat of the Beischer studies; Houk, also of NAMRL, undertook a repeat of earlier studies, reported by the Navy to the Ad Hoc Committee, in which positive findings were made on exposed workers at a Sanguine test facility in Wisconsin. Ultimately, Mathewson, Grissett and Houk all dutifully reported negative findings.

At the end of 1975 there was incontrovertible evidence that the Soviet Union regarded ELF electric fields as a health hazard; exposure limits had been set and a broad research program had begun.

During 1975 Becker and Marino performed rat experiments involving 30-day exposure to an ELF electric field. They found that the ELF field caused a series of changes indicative of biological stress. In another study, exposure to ELF electric fields produced stunted growth in three generations of mice.

Becker and Marino filed their expanded testimony in December of 1975. In addition to their own research, it included more than 30 ELF reports of independent scientific investigators, and Soviet reports. All of Becker and Marino's research, and the great majority of the other ELF reports, had been subjected to peer review by independent scientists prior to publication. The factual data regarding all research results was separately described in their testimony and kept distinct from value judgments about non-quantifiable factors such as risk to health.

On November 1, 1975, barely six weeks before the testimony was filed, R.A. Helliwell and his colleagues at the Stanford Radioscience Laboratory published a paper in the Journal of Geophysical Research. They presented evidence that showed that radiation from high voltage transmission lines traveled out from the earth about 90,000 miles to a region of the earth's atmosphere called the magnetosphere, causing changes therein. The existence, composition, and characteristics of the earth's magnetosphere are universally recognized as important influences on life on earth. Prior to Helliwell's work no one had known that power lines could produce such a global impact.

The utilities' witnesses testimony was received in late December, 1975. None of the witnesses mentioned the Helliwell phenomenon.

Miller analyzed the negative Sanguine studies, while Michaelson's testimony dealt primarily with the Soviet studies. It became clear that in his capacity as a Navy consultant, Michaelson had been provided with a large number of Soviet studies dealing with the biological effects of electric fields. Michaelson also discussed his concept of medical risk. Becker had said that as a physician he could not allow his patients to experience a biological effect, such as stress, from a high voltage transmission line because the effect would be not for the patient's well-being, but for the good of the utility company. He would regard the effect as a potential hazard. Michaelson however, said

"...the fact that a living organism responds to many stimuli is a part of the process of living; such responses are examples of biological effects. Since biological organisms have considerable tolerance to change, these 'effects' may be well within the capability of the organism to maintain a normal equilibrium. If,

on the other hand, an effect is of such an intense nature that it compromises the individual's ability to function properly or overcomes the recovery capability of the individual, then the 'effect' may be considered a 'hazard'."

Schwan said that he had done calculations in which a human being, depicted as a ball of metal, was placed under a high voltage transmission line. He said that he amount of electrical energy the ball would receive would be harmless.

The testimony of the utilities' team cited only the negative Sanguine literature, a few reports, still-secret Soviet literature, some capricious calculations, and concluded that the line would be safe. It was apparent that the utilities had no reasonable evidence tending to establish that the lines would be safe. For the rest of the hearings, the focus was on whether Becker and Marino had reasonable evidence tending to establish that the lines would be unsafe.

The Proceedings of the Ad Hoc Committee became public on December 8, 1975, when it was released by Senator Gaylord Nelson of Wisconsin. Nelson said that the report

"...contains strong evidence that the proposed Sanguine underground communications system would pose hazards to human health."

The Senator also accused the Navy of suppressing the report for two years:

"It appears that the Navy kept the wraps on the existence of this report because it contains the very first scientific evidence that Sanguine indeed would have an adverse environmental impact. Up to this moment, this was a matter of concern and conjecture. Now there is hard evidence that must be pursued."

The Navy immediately received a great deal of adverse publicity in the media. Shortly thereafter, the Navy announced that a committee under the aegis of the National Academy of Sciences (NAS) had been chosen to study the possible health hazards of Sanguine. On January 13, 1976, the chairman of the Navy-HAS committee, Woodland Hastings of Harvard, wrote to Marino requesting "contact and consultation" with regard to the area of ELF bioeffects. In early March of 1976, Becker and Marino learned of the composition of the NAS committee. On March 8th, Marino telephoned Hastings and asked if he was aware that three of the committee members, Morton Miller, Sol Michaelson, and Herman Schwan had already taken strong public positions regarding the merits of the issue which the committee was charged to investigate. Hastings said that he was unaware of their background. Marino told Hastings that Miller, Michaelson and Schwan had, in December of 1976, taken strong public stands that the ELF fields of high voltage transmission lines are about 1,000,000 times stronger than the Sanguine field, and since they had already stated their beliefs that the transmission line fields were harmless, it was inconceivable that Miller, Michaelson or Schwan could find that Sanguine fields were hazardous, regardless of the evidence turned in to the committee. Hastings said that if these facts were true, he would resign from the chairmanship of the committee. Marino asked Hastings how the committee was chosen; Hastings said that an NAS staff officer, Samuel Abramson, had been given a list of names by the Navy

Sanguine officials. Abramson had approved the Navy choices, and then asked for Hastings' acceptance of the chairmanship. Hastings agreed on the condition that his friend, T.T. Wu, a Harvard physicist, be added to the Navy's list of 15 names. Hastings said that after the Navy-NAS committee had been picked, the NAS rules required the individuals who were chosen to complete conflict of interest questionnaires. As chairman, Hastings had access to the questionnaires and he asked Marino to call the next day at which time Hastings would have had time to review the questionnaires submitted by Miller, Michaelson and Schwan. On March 9th, Hastings said that the questionnaires of neither Miller, Michaelson nor Schwan disclosed that they had taken public positions on the question of ELF bioeffects, or in fact that they had any link whatever with electric utility companies except for the fact that Morton Miller owned more than \$10,000 in NMP stock. Hastings said he would seek confirmation of Marino's information from Abramson. By March 11th Hastings had received the confirmation. He told Marino that there were only three alternatives that would prevent his resignation: either Miller, Michaelson and Schwan were removed from the Navy-NAS committee; or Becker and Marino were appointed to the committee; or both. Marino and Becker. however, had no desire to serve on the committee which was tainted from the beginning. On March 24, therefore, while Abramson was still contemplating their appointment, Becker and Marino addressed a public letter to the Navy-NAS committee disclosing the bias of Miller, Michaelson and Schwan. Hastings said "that letter disgualified them. If we try to appoint them, we'd have had resignations from half the committee."

Marino's direct testimony was cross-examined for ten days. Robert Harvey, RG&E's lawyer, demanded the right of unlimited cross-examination; otherwise, he said, RG&E's right to due process would be denied. The examiner said:

"I think the applicants lose sight of the fact that staff has very limited money, no money, really, to pay witnesses and cannot make demands on witnesses the way it could if it gave retainers."

Later, the utilities' cross-examination of Marino was characterized by the Commission as follows:

"...we do wish to make one observation about the cross-examination of that important witness. Generally speaking, it appears to have been relatively unproductive, especially considering the time and energy spent on its conduct. More tightly organized cross-examination, and a greater reliance on the other vehicles available to the parties for supporting their respective cases would, we believe, contribute to a clearer and more expeditious record in this proceeding."

Becker was cross-examined for four days. He said:

"...in response to the question, would I recommend construction of 765 kV lines, I said no, with the reasons (that they are) possibly productive of biological effects, and I go on to say, as I quoted before, that the most prudent course to follow would be to determine the complete spectrum of biological effects produced by

exposure to 60 Hertz fields. This obviously includes your lower voltage transmission lines. It also obviously includes any 60 Hertz in the vicinity to which humans are exposed. As a scientist, I can only say that we think that we have positive evidence that effects of 60 Hertz electric fields do occur in biological organisms. It seems to me quite within the realm of possibility that not only the existing transmission line, but the existing ambient electric field, particularly in urban areas, is productive of biological effects at the present time. I would however, not turn 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 electric power at the present time would be counter-balanced by the medical harm that would be done as a result of disruptions in our entire society. So, I would not in good conscience at the present time say that I recommend discontinuance of operation of transmission lines, 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. Now, it is quite possible that the result of study will indicate that we have produced electromagnetic pollution of the environment, that equals or perhaps exceeds the chemical pollution that we have produced. I don't know. In that case, then certain things would have to be done, to draw an analogy with the chemical pollution, time tables are set up with this continuance of pollution sources and the same sort of a principle I think, should be applied here."

Later, Becker was asked whether as a physician, he would consider chronic intermittent exposure to ELF electric fields to constitute human experimentation. He replied,

"I would put it this way. If I set out to make a determination of whether or not laying under an electric blanket for eight hours a night produced any biological effects in humans, I would have to set up an experiment in which I had two equal groups of human patients, one who was exposed to a definite measured field strength arising from the blanket and another group which slept under regular blankets, and had the same degree of warmth. In other words, there would be no sense to compare patients sleeping under electric blankets with one sleeping under a very thin cotton blanket in a cold room. The circumstances have to be controlled. Now, if I propose to go down to my ward and divide it in half, and put half the patients under electric blankets and the other half under wool blankets, that certainly constitutes being an experiment. I would have to abide by the rules of human experimentation."

Becker was asked why he had testified that a safety factor ought to be used in the setting of a permitted exposure level to the fields of the proposed transmission line, as the federal government had done when it undertook to regulate food additives. Becker replied:

"The similarities lie solely in that you are dealing with the human population which has innate variability in its responses to any factor, a population that has a wide variety of disease states within it, and a population over whom you have no control as to the extent of exposure, to either food stuffs released for the general public, or to its exposure to electromagnetic fields. You have to consider in both instances the possibility that some people may have had a very large amount of exposure."

Becker and Marino were the only two witnesses, out of thirty-one, who testified that the proposed 765 kV transmission line should not be built. Becker was the only physician; he was the only scientist who founded and headed a research laboratory and the only scientist who performed human experimentation. Becker had co-authored more publications in the scientific literature dealing with the biological effects of non-ionizing electromagnetic energy than perhaps anyone else, anywhere. He had, in fact, been one of the founders of the field of science which deals with the interaction of electromagnetic energy and biological systems. His first publications in this field occurred when Marino was in high school; the cornerstone presentation of his theories and results occurred when Marino was a sophomore in college. Nevertheless, Matias and Colbeth, in the first of three major aberrations contained in their opinion to the Commission, completely dismissed Becker's testimony in a footnote; they said

"Dr. Becker's position echoed that stated by Dr. Marino, but Dr. Becker acknowledged that his conclusion rested on the validity of the conclusions reached by his colleague."

The Applicants sought and received permission to submit a rebuttal case. The PSC staff witness in rebuttal was Marino.

In February, Marino was called by Dr. Joseph Noval, then of Temple Medical School. Noval identified himself as one of the investigators who conducted the Navy research project at Warminster, Pennsylvania. Later, he sent a manuscript which described the research. The experiments and the results were essentially identical to those found by Becker and Marino in their rat studies, except that the ELF electric field employed by Noval was about 1,000 times less intense.

During his cross-examination, Miller said that by virtue of his service on the Navy-NAS Committee, he had been given "three linear feet" of material dealing with ELF bioeffects. The Chairman of the Public Service Commission requested, on behalf of the staff, a copy of the material to which Miller had referred. The NAS information officer replied:

"I regret that we shall not be able to duplicate for your use file copies of material in our possession. We feel that this would be an unjustified use of the staff time while the study is in progress."<sup>fn-4</sup>

When he was cross-examined, Michaelson referred to a large number of Soviet ELF bioeffects publications. On September 29, 1976, the PSC staff requested copies of each of the specific Soviet studies Michaelson had cited. In his reply, Harvey said that the studies "are not available," and "these requests are untimely and unreasonably burdensome." In its reply, the staff said it

"...refused to accept this absurd excuse any longer: It is nothing more than a

rationalization for your decision not to cooperate."

Nevertheless, Harvey never supplied the information.

Discussion of the possible environmental consequences of the Helliwell phenomenon (alteration of the earth's magnetosphere by radiation from high voltage transmission lines) was conspicuously absent from the testimony of the utility witness team in the direct phase.

On November 1, 1975 Helliwell wrote:

"In a recent experiment, discrete VLF emission from the magnetosphere were triggered by a transmitter at Siple Station in Antarctica. Spectrograms of these signals as received at the conjugate point, Roberval, Quebec, showed changes in slope, entrainments, and cutoffs at frequencies close to the harmonic induction lines from the local power system. This observation led to the suggestion that harmonic radiation from the power system enters the magnetosphere and interacts with the triggered emissions. New evidence supporting this suggestion has been found in spectrograms of simultaneous recordings made at Roberval and Siple Station in Antarctica."

The December, 1975 issue of *Physics Today* said:

"Electromagnetic radiation from the Canadian power system is entering the earth's magnetosphere, according to a recent report in the Journal of Geophysical Research. The authors, a team from the Stanford Radioscience Laboratories, headed by Robert Helliwell, have also found evidence that these powerline emissions are amplified within the magnetosphere and cause the precipitation of electrons from it. Further studies of these phenomena, including satellite experiments, are underway."

"Together with the results of earlier experiments, the new findings indicate that this "rain" of electrons affects the ionosphere, which is at the bottom of the magnetosphere, in a number of ways, including the production of ion pairs and bremsstrahlung X-rays, and that it affects ionospheric radio communications. This, Helliwell suggests, opens the possibility of human control over the earth's radiation belts... What possible benefits and environmental impact do these results point to? Specific environmental impacts at this time due to electrons precipitated by power lines are minor, Williams (a colleague of Helliwell) told *Physics Today*, as the amount involved is only a tiny fraction of the number of particles impacting the atmosphere due to natural causes."

The January, 1976 issue of Industrial Research said,

"Evidence of man's unexpected impact on the natural world continues to grow, the latest being Stanford University's Radioscience Laboratory finding that the earth's radiation belt can be altered by harmonic very low frequency radiation from electric power lines. At least in this case, the environmental changes are believed to be benign, as Professor Robert A. Helliwell stressed to Industrial Research."

On January 16, 1976, Marino wrote to Helliwell:

"The New York State Public Commission is currently holding a hearing to determine the environmental compatibility of high voltage transmission lines (765 kV). My colleague, Dr. Robert O. Becker, and myself are serving as expert witnesses for the state in the area of the biological impact of the proposed lines. For those of us who are unfamiliar with your field, your report appears to describe an effect which ought to be studied further from the environmental impact viewpoint. For instance, if the total radiated power were given (at each harmonic) of the seventy mile transmission line being proposed, would it be possible to compute the magnitude of the electron and energy shower on the ionosphere that would result? Also, how does the magnitude of the stimulated emission compare to that normally present? If you could provide me with some rough answers to these questions, it would help greatly in our preliminary evaluation of the environmental significance of the effect which you have described."

On January 20, Helliwell responded:

"We would not expect that a new transmission line would produce a noticeable change in the electron precipitation from the magnetosphere. Although we indicate in our paper that power-line radiation exercises control of the radiation belt, I think that it is fair ot say that in the absence of power-line radiation the belt intensity would simply build up to the point where more spontaneous emission would occur and we would observe about the same amount of total precipitation."

The discovery of the Helliwell phenomenon raised two questions: (1) what changes in the magnetosphere are due specifically to radiation from high voltage transmission lines, and (2) what is their biological significance? Helliwell apparently felt, but was hardly convinced, that there were no significant biological consequences. Furthermore, Helliwell's work was supported in part by the Navy. There was therefore a question concerning possible constraints on his consideration of the issue.<sup>fn-5</sup> The possibility also remained that Helliwell was not qualified to assess the biological consequences of the physical phenomenon he had discovered.

The scope of the Helliwell phenomenon is vast and global; any possible biological consequences would therefore be on a comparable scale. The X-rays for instance, produced by the electron rain would not penetrate the earth's ionosphere, but the ultraviolet light which they produced could reach the earth's surface. Additionally, if by virtue of the Helliwell phenomenon the electron precipitation rate or frequency is altered, changes might be brought about in global weather patterns. There were, therefore, in late 1976, a number of speculative but specific and overwhelmingly significant consequences of the Helliwell phenomenon.

In the direct phase of the hearing, the great majority of the ELF bioeffects cited dealt

with the consequences of electric fields. There were many fewer reports dealing with the biological consequences of ELF magnetic fields. As testimony was prepared in the rebuttal phase, the existence of a significant number of magnetic field studies became apparent. The existence of both ELF electric and magnetic field induced biological effects necessitated consideration of the possibility of synergistic interactions.<sup>fn6</sup> High voltage transmission lines produce simultaneous electric and magnetic fields, and exposed individuals experience both fields simultaneously. Virtually all ELF research involved the study of the biological consequences of either an ELF electric field or an ELF magnetic field. That is, the real-life situation involving the simultaneous application of the electric and magnetic fields has not been the subject of laboratory experimentation.

Marino's rebuttal of the utilities' witness team was served on November 24, 1976. The testimony also included additional ELF bioeffects reports, a description of the Noval study, as well as a description of the difficulty encountered in obtaining information from the Navy-NAS committee, RG&E, and others. The testimony also described the possible significance of the Helliwell phenomenon, and the possible significance of synergism.

Miller's testimony was a series of accusations of incompetence against virtually every ELF investigator.<sup>fn7</sup> Schwan and Carstensen reiterated their feeling that mathematical calculations could show that the proposed lines were safe.

The utilities presented a new witness, Henry Hess. Hess identified himself in his testimony as the manager of a computer section for a company which prepares environmental impact statements for electric utility companies. He had no experience in laboratory research, and had made no contributions to the scientific literature. He said that he had been given the raw data of the Becker and Marino experiments, and that his testimony was an independent appraisal of the design and methods used in some of them. His analysis focused exclusively on the rat studies which showed that ELF electric fields were biological stressors. The studies yielded organ weights, food and water consumption levels, blood steroid concentrations, and various other kinds of data.<sup>fn8</sup> Hess massaged the data from the rat studies according to his methods and concluded that Marino<sup>fn9</sup> had committed errors in "experimental design, procedure, arithmetic, and judgment."

Throughout the hearing, Carstensen and Schwan did not criticize the design or procedure or arithmetic or judgment of Becker's research group, or of Marino. Miller and Michaelson however, each said that they agreed with Hess.

Since the rebuttal testimony of the utilities' witness team and the PSC staff had been served simultaneously, Marino didn't know that the rat experiments would be criticized (or that the mice experiments would not be seriously criticized), and also did not know the specific charges that the utilities would make against his work. When Hess's testimony was received, Marino asked, through staff, for permission to respond to the criticism of his and his colleagues' work. Matias and Colbeth responded in an unusual fashion. They said that they would allow Marino to write the reply to Hess and to submit

it to them for their perusal. They said that after they read it they would decide whether to allow it to be admitted. The rebuttal was drafted and submitted to Matias and Colbeth; on March 1, 1977, the rejected it. On March 16th, the Commission overruled Matias and Colbeth. It said:

"Here, where staff and applicants went forward with rebuttal testimony at the same time, and where criticisms of staff testimony were made directly for the first time in applicants rebuttal, we conclude that equity requires that staff be given a chance to respond to those criticisms."

In the second major aberration in their opinion to the Commission, Matias and Colbeth quoted and discussed Hess's criticisms for more than 10 pages, and concluded that Marino

"...had a clear and admitted lack of expertise in the use of statistical tools to design experiments and to analyze the results obtained therefrom."

They held that each of Hess's criticisms was true. Matias and Colbeth then went far beyond Hess's testimony. Hess dealt only with the rat studies, the data of which could be manipulated with a computer for any desired purpose. The mice experiments however, were quite clear-cut; Marino had submitted photographs showing the stunted growth, and no witness in the hearing had seriously questioned the results. In their final opinion, Matias and Colbeth juxtaposed their personal criticisms with quotes from Hess in a manner which seems intended to create the impression that no experiment participated in by Marino could be reliable.

At the same time that the PSC staff was attempting to obtain admission of Marino's reply to Hess, the utilities were attempting to exclude almost all of Marino's rebuttal testimony. Matias and Colbeth struck the testimony dealing with the Helliwell phenomenon. They said:

"Dr. Marino admits that the necessary research has not been performed. Later he urges that the effect of transmission line radiation should be studied prior to construction of the proposed 765 kV lines. Certainly many months and many dollars would be involved in such research... Dr. Marino's recommendation would lead to an indefinite postponement of the Commission's decision in this proceeding."

They also struck a portion of the testimony dealing with synergism, even though the utilities had withdrawn their motion with respect to it. Matias and Colbeth struck the portion of Marino's testimony dealing with the Soviet regulations which govern the exposure of the public to high voltage transmission lines. Matias and Colbeth also struck 12 other sections including the description of the manner in which the Electric Power Research Institute was arranging its research so as to produce only favorable results.

On March 3, 1977, the Commission reversed the ruling by Matias and Colbeth and ordered that Marino's entire rebuttal testimony be received into evidence. The

## Commission said:

"...we conclude that this testimony should be admitted as evidence, so that the other parties to this proceeding will have a full opportunity to contest it by cross examining him, by criticizing his testimony in their own briefs, or even by introducing surrebuttal testimony if that time consuming step proves necessary. Under no circumstances can we envision ignoring grave allegations concerning the health or safety of 765 kV lines on technical procedural grounds. When the record in this phase of the case is complete, Dr. Marino's allegations will either be accepted as proven or rejected because they are unsupportable on their face, or have been discredited on cross examination, or because they have been contradicted by more convincing testimony of other witnesses."

Much of the Commission's language referred to the Helliwell phenomenon. Clearly, the Commission wanted some development of the issue; it even authorized a surrebuttal phase if Marino was not "discredited on cross examination."

When he was cross-examined in March, 1977, Marino was asked some questions concerning the Helliwell phenomenon; his testimony, however, was not discredited. During that cross-examination, the utilities produced a letter from Helliwell in which he gave his evaluation of Marino's testimony. The letter was thoughtful and concise, and served only to underscore the need for a thorough, impartial consideration of the biological consequences of the Helliwell phenomenon. On the same day that Helliwell wrote that letter, he wrote another letter<sup>fn-10</sup> to Louise Young, Winnetka, Illinois, and said:

"Thank you for your letter of Feb. 6, 1977. Although power line radiation may cause X-rays, I believe it is not a significant factor on the average for a simple reason. If man-made input to the magnetosphere were diminished, the concentration of radiation belt particles would simply increase until natural wave activity produced the same average precipitation as before. However, a detailed understanding of this question must await further research."

In February, 1977, two papers which confirmed the existence of the Helliwell phenomenon were submitted to the Journal of Geophysical Research. In the abstract of the first, the authors said in part

"...interpretation of these results is based on radiated power-line harmonics that leak into the magnetosphere and stimulate the recorded emissions through cyclotron interaction with trapped energetic electrons. These results emphasize the need for a careful evaluation of the effects of man-made VLF noise on the ionosphere and magnetosphere."

In the abstract of the second, the author said in part:

"A detailed explanation of VLF spectra shows that the strongest waves emerging from the middle magnetosphere during the storm recovery period and during isolated sub-storm activity are often emissions stimulated by radiation from the electrical power distribution system. Several different types of power line radiation effects are illustrated using broad band spectral data from stations in Antarctica and North America. It appears that man made VLF noise has a strong influence on the energetic particle population in the magnetosphere."

Following Marino's cross-examination in March, 1977, RG&E told the PSC staff that it had hired Malcolm Savedoff, of the University of Rochester, to evaluate the biological consequences of the Helliwell phenomenon. In his testimony, Savedoff said that the Helliwell phenomenon due to the proposed transmission lines would cause little, if any, climatic change, and would have a negligible effect on the level of ultraviolet radiation.

Preparations were underway to cross-examine Savedoff when it was aborted by Matias and Colbeth by the expedient of scheduling it in Albany and limiting it to one day's duration. Several times during the hearing Matias asked Marino to agree to participate in Albany; in each instance Marino refused, and cited both Matias's initial promise, and his own personal commitments at the VA Hospital. The order to cross-examine Savedoff in Albany could clearly be predicted to have the effect of prohibiting Marino' participation in Savedoff's cross examination because Matias knew Marino was unable to go to Albany. Since the PSC staff was unable to cross examine Savedoff without Marino's assistance, Savedoff was not cross examined. In the third major aberration in their opinion to the Commission, Matias and Colbeth said:

"Following a careful review of the record, it must be concluded that Dr. Marino's testimony on transmission line radiation is based upon nothing but reckless speculation about the results published by scientists in a field far removed from his own. The Commission has been receptive in this case to the introduction of all genuine issues. It is unfortunate that Dr. Marino chose to cause delay and extra expense in the proceedings by raising an issue which lacks even the color of importance."

In January, 1977, PASNY's activities with regard to its 765 kV transmission line compelled Becker and Marino to write to Governor Carey.

PASNY signed contracts to purchase power from Canada and stockpiled materials to be utilized in construction of a 765 kV line, without approval and without establishing the need for the line. In the spring of 1976, a bill passed the State Assembly declaring it to be the legislature's finding that all health, safety and environmental regulations applicable to the line had been satisfied; it ordered the PSC to give its approval to the PASNY line.

The obvious intent of PASNY, as the proponent of the Assembly bill, was to coerce the PSC to immediately approve its line. If the bill became law, the PSC's jurisdiction would have been seriously undermined; consequently all rational consideration, based on an orderly produced record of the issues of siting and construction would have been jeopardized. Additionally, if the bill became law, logic then compelled the view that RG&E's line was also safe since as it was similar to the PASNY line; the hearing therefore would be a nullity. It was clear that if the PSC did not approve the PASNY line,

the bill would become law.

On June 30, 1976, the PSC partially certified the PASNY line. In a dissenting opinion, Commissioner Jerry said:

"The decision of the majority will damage seriously public confidence in the procedural fairness, environmental concern and judicial independence of the Public Service Commission.

"The decision is wrong procedurally and substantively. It destroys the legal rights of all parties in two different proceedings by violating prescribed rules for judicial and administrative conduct... Perhaps worst of all, in certain fundamental respects the decision is based on the fact the Power Authority has already purchased and obtained the building materials for the transmission line... It is hard to imagine a greater travesty of our quasi-judicial role than the Commission's handling of this particular issue. If a private utility were involved here, the adoption of such procedures is beyond my powers of imagination. But the Commission has somehow been terrorized by the Power Authority."

PASNY is an agency of the State of New York. Consequently it has an even higher standard of duty to the people of New York than does an ordinary investor-owned utility with regard to the protection of the health and safety of the people and the safeguarding of the environment. Virtually every public statement and action by PASNY officials however, evinced contempt for the public and the PSC.<sup>fn-11</sup>

In the hearing, PASNY presented no witnesses to support its contention that its lines would be safe. It merely adopted the utilities' witnesses, thereby forging an unseemly bond between private corporations and a political sub-division of the state, each of which owed different duties of care to different elements of the citizenry. PASNY's cross-examination was perfunctory, and concentrated almost exclusively in peripheral and non-substantive areas. Most of it consisted of questions concerning various letters sent to and received by Marino. On two days that Marino was cross-examined, no PASNY lawyer attended the hearing.<sup>fn-12</sup>

By January, 1977, Becker and Marino had given extensive testimony and detailed scientific reasons supportive of their conclusions that the proposed transmission lines were health hazards. PASNY was, nevertheless, constructing a 765 kV line according to a design which was not necessarily adaptable to the regulations that would be found necessary at the conclusion of the hearing. It was, for instance, possible that the health and safety issues would require that the line be built underground. In that event the existence of the line would have an obvious distorting effect on the regulations ultimately adopted. Marino and Becker therefore viewed the construction of the PASNY line as an imminent health hazard; they conveyed their views to Governor Carey by letter on January 19. They said:

"The most basic issue in the Public Service Commission hearing is whether exposure to the fields of high voltage transmission lines constitutes a human health hazard. Notwithstanding that the issue is presently *sub judice*, recent events compel us to inform you that the 765,000 volt transmission lines as presently designed endanger public health, and to request your urgent assistance in halting construction of the Power Authority's 765,000 volt transmission line until its health hazards are properly considered.

"The Power Authority has not participated in the Public Service Commission hearing in good faith... The Power Authority has presented no witnesses to counter our arguments that their proposed high voltage transmission line is a health hazard. Its team of lawyers conducted only the most perfunctory crossexamination of us, carefully avoiding all areas dealing with the merits of our position. In some cases the Power Authority lawyers did not even attend the hearing, even though in theory their client' rights could have been affected by our testimony... It seems clear to us as intimate participants in these proceedings for almost three years, that the action of the New York Legislature in the Spring of 1976, in preparing to pass a bill declaring the Power Authority's transmission line to be safe, was a significant factor in the Commission's decision to administratively approve the line.

"We respectfully urge that you take immediate steps to halt construction of the Power Authority line until the health issues have been resolved. The present policy of piecemeal certification will obviously result in a vested economic interest on the part of the Power Authority which will preclude any decision, executive, administrative, or judicial to deny the Power Authority the right to energize the transmission line, notwithstanding its hazards to human health."

In March, 1977, when Marino took the stand for cross-examination of his rebuttal testimony, Matias expressed his personal disapproval of the letter. He indicated that he did not like witnesses to send such letters to the Governor, or anyone else, because it was "beyond the forum." He said he scanned the letter and that it appeared to contain "several mis-statements of fact." Matias suggested that the letter indicated a "reckless attitude on the part of Dr. Marino." In their opinion to the Commission, Matias and Colbeth said that since Becker and Marino had sent the letter to Governor Carey, it showed that Marino was reckless and that his testimony regarding the health hazard of the proposed transmission line was less reliable.

If Matias was displeased by the letter to the governor, Francis Wallace, PASNY's lawyer, was considerably more agitated. As if to act out the criticisms contained in the letter, Wallace spent most of the time allotted to him for cross-examination of Marino on the letter to the governor.

On February 15 people from the CBS show "60 Minutes" came to Syracuse to interview Becker and Marino concerning the health hazards of high voltage transmission lines. After Syracuse, the CBS team planned to go to Rochester and interview Michaelson; shortly after they arrived in Syracuse however, a question developed concerning Michaelson's availability. Mike Wallace of CBS' *60 Minutes* called Michaelson at the University of Rochester several times during the morning of February 15, but was

unsuccessful in contacting him. Wallace then called Harvey seeking his cooperation in obtaining an interview with an RG&E expert. Harvey said that he could not speak for RG&E and that a vice-president would respond shortly. Soon thereafter, Harvey called Wallace and said that RG&E would not authorize its PSC witnesses to speak on its behalf, but that they were free as individuals to be interviewed. About 2:30 PM, Michaelson returned Wallace's earlier calls and Wallace asked Michaelson for an interview; Michaelson refused. He said that an interview would be an adversary process and that he did not engage in adversary processes. Wallace offered to pay Michaelson his usual fee, but Michaelson still refused. Michaelson said that Becker and Marino were poor scientists, and Wallace asked whether he felt obligated to make this information known to the 40,000,000 people who would see and hear Becker and Marino. In spite of this entreaty and several others, Michaelson remained adamant throughout the hour long conversation. Wallace then called Miller, who also refused to be interviewed; Miller said that he discussed his scientific views only in scientific journals.

When Miller testified at the hearing, about five members of the public were in attendance; when Michaelson testified there were even fewer. Including their colleagues, about 10 persons were present during the testimony of Becker and Marino. There was almost no coverage of the hearing in the media in either Syracuse or Rochester.

These facts prompted Marino to write a letter to the Editor of *The Rochester Democrat and Chronicle*. He said in part,

"...RG&E has proposed to build a 765 kV line to run near Rochester. As presently designed people within several miles of the proposed power line will be exposed to essentially the same electrical environment which has been shown in laboratory experimentation to produce a variety of biological effects in animals. These effects which include stunting of growth, alterations of the cardiovascular system and behavioral modification have been demonstrated in our laboratory and the laboratories of more than 50 other independent investigators around the world. In hearings before the Public Service Commission to determine the safety of RG&E's proposed line, I have testified to these experiments and their implications in great detail. In opposition RG&E has hired Morton Miller, a botanist, Sol Michaelson, a veterinarian, and Edwin Carstensen, a physicist, all of the University of Rochester to testify that RG&E's power line will be safe.

"The PSC hearing has been going on for about three years. During this time there has been little public awareness of the health and safety issues posed by the power line... We have given an interview to Mr. Mike Wallace of the 60 *Minutes* program explaining why the RG&E power line is a threat to the many thousands of people who live or work near the planned route of the power line. Unfortunately, neither Miller nor Michaelson would consent to be interviewed by Mr. Wallace... Thus the residents of the Rochester area face the unwholesome prospect of having the health hazard of RG&E power line determined largely on the testimony of Miller and Michaelson in the complete absence of an accounting to the general public."

The letter was never published in the *Rochester Democrat and Chronicle*. When Marino was cross examined however, on March 22nd, PASNY's lawyer Francis Wallace produced the letter. He said that the editor of the *Democrat & Chronicle* had not given it to him, and that he had not obtained it by theft; beyond that, he refused to explain how it came into his possession.

In their final opinion to the Commission, Matias and Colbeth said that Marino's letter to the Editor of the *Rochester Democrat and Chronicle* made his conclusions concerning high voltage transmission lines less believable. They said that as an attorney, Marino should have realized that "fear of the possibility of editing" motivated Miller and Michaelson's refusal to be interviewed by CBS. Matias and Colbeth suggested that the only proper forum for scientists who are hired by industry is a courtroom because only in that manner could the scientists' clients' rights be safe-guarded.

Marino's rebuttal testimony was cross-examined for three days. However, only a few questions dealt with his testimony. The utilities' lawyers concentrated intensively on the Becker and Marino letter to Governor Carey and Marino's letter to the *Rochester Democrat and Chronicle*. The tendency of the cross-examination was to focus on storms in teacups and the interest which Matias developed in Marino's correspondence as well illustrated by the letter to CBS' *60 Minutes*, which was the third most popular topic of cross-examination.

The CBS episode stretched over three days. Early on March 22nd, Marino said that he had given CBS' 60 Minutes a letter dealing with high voltage transmission lines. Francis Wallace, PASNY's lawyer, demanded a copy of the letter; Marino said that he did not have a copy. Wallace asked Marino to authorize CBS to release the letter, but Matias asked Wallace why he didn't request CBS for a copy. Wallace replied that CBS had been asked, but had refused. Wallace then asked Matias to obtain the letter by serving a subpoena on Becker and Marino. A discussion ensued concerning whether CBS or Becker and Marino were the proper parties on whom to serve a subpoena. Matias ordered Marino not to destroy or alter the letter in any way. Wallace asked Marino to search his files at night to look for the letter. Matias asked Marino to call Becker and determine whether he had a copy of the letter. On March 23rd, Marino reported to Matias that Becker had no copy, whereupon Matias asked whether Marino would write to CBS and direct them to furnish a copy of the letter to the utilities. Following a discussion, Matias decided that it might best be done through counsel, and he asked the PSC staff to write a letter to CBS on his behalf, as a representative of the Public Service Commission, requesting a copy of the letter. Following a discussion, the staff was ordered to speak to Marino to find out whether Marino would authorize a letter by staff to CBS.

On March 24th, the last day of cross-examination, a kind of frenzy set it. Matias was informed that Marino had no objection to the release of the letter by CBS. Marino was criticized for not having saved a copy of the letter. Matias and various counsel discussed the means by which CBS would be approached and informed that Marino

had no objection. Several lawyers argued that the utilities had no right to demand the letter because it was private and was not part of his testimony. Matias said however, that the letter was not designed to be confidential. Harvey said that the utilities would be happy to pay for a phone call to New York City. It was pointed out that since March 24th was the last day of cross-examination, even if CBS released the letter it could not be available in the courtroom. Harvey however, said that it could be done. He said that it could be teletyped from New York City to Syracuse and carried to the hearing room by messenger. The procedure agreed upon was that all the lawyers would collectively place the call to New York City, informing CBS that Marino had no objection to the release of the letter. The call was placed. However, Richard Clark, the CBS 60 Minutes Executive Editor, was on vacation for two weeks and could not be contacted immediately.

Near the end of the day the participants in the hearing received a phone call from Nome, Alaska. At Matias' direction, among a huddle of lawyers, the PSC staff counsel asked Clark for the letter; Clark's reply, paraphrased for delicacy, was "absolutely not." Nothing occurred thereafter in the hearing concerning the letter. In their opinion to the Commission, Matias and Colbeth suggested that Marino's testimony concerning high voltage transmission lines was less believable because Marino had written the letter.

The final Navy-NAS report was issued in August, 1977. The report contained an analysis of the ELF bioeffects experiments. In virtually every case, the report concluded that the ELF investigators were incompetent and consequently that their work was unreliable. The analysis of the ELF bioeffects experiments was written by Miller, Michaelson, and Schwan. They wrote draft copies of their opinions of each ELF experiment, and Abramson synthesized them into the form contained in the final Navy-NAS report. In almost every instance, the language and arguments in the Navy-NAS report which charged the ELF investigators with incompetence was identical to the language employed by Miller, Michaelson and Schwan in their testimony in New York. The only major exception involved the work of W. Ross Adey's group at UCLA. During the hearing, Miller, Michaelson and Schwan were stridently critical of the work of Adey's group, dismissing it as due to artefact. The Navy-NAS report, however, contained glowing comments regarding the scientific merit and fundamental scientific importance of the work of Adey's group.<sup>In-13</sup>

With the exception of Adey (who presently enjoys very significant Navy research support), none of the other Navy-NAS committee members contributed to the analysis of the ELF bioeffects literature, or to any other significant facet of the final report. They did however, contribute their names.<sup>fn-14</sup>

After the hearing ended, Harvey provided Matias and Colbeth with a copy of the Navy-NAS report. Over strong PSC staff objections, Matias and Colbeth admitted the report into evidence. In their opinion to the Commission, they said that the Navy-NAS Committee "consisted of distinguished, nationally known scientists." Matias and Colbeth said that these scientists disagreed with Marino and that therefore a "credibility issue" was raised.<sup>fn-15</sup> Matias and Colbeth also said that the Commission should depend on the Navy for research on the health hazards of high voltage transmission lines. In their final decision, Matias and Colbeth accepted several major points and principles that had been advanced by Becker and Marino. Becker and Marino said that all bioeffects chronically induced by the lines were potentially hazardous, and the utilities urged the contrary; Matias and Colbeth said:

"The weight of scientific evidence in this case dictates that observed effects not known to be benign must be considered potentially hazardous unless they are temporary or reversible."

Becker and Marino said that there were *bona fide* ELF induced biological effects even though such effects were not predicted by theory, and the utilities urged that no such effect existed; Matias and Colbeth said:

"The one solid conclusion that can be drawn from all of the scientific testimony in this case is that there are ELF field interactions with biologic organisms which cannot be adequately explained on the basis of current knowledge."

Becker and Marino said that the proposed transmission lines constituted involuntary human experimentation because exposure to them entailed a health risk, and the utilities urged that there was no human experimentation because there was no risk; Matias and Colbeth said:

"What is necessary is to remove the involuntary feature, i.e., to insure that persons living or working near the line are not involuntarily exposed to danger and that persons who enter the right-of-way do so voluntarily with knowledge that chronic, long-term exposure may entail some risk."

Becker and Marino said that an electric field exposure limit was necessary, and the utilities argued against it; Matias and Colbeth said:

"Thus we find that transmission lines should be built and operated so that no person works daily, or lives, in an electric field greater than 1 kV/m."

Matias and Colbeth provided no analysis to support either their choice of 1 kV/m or their other major conclusions. They seemed to say that their conclusions arose from their concern for the public health, which itself had been heightened by the record as a whole. Virtually the only witnesses in the hearing whose testimony provided evidence upon which their conclusions were possible were Becker and Marino. Matias and Colbeth however, dismissed Becker's testimony in a footnote and mounted a drumfire of gratuitous criticisms against Marino dealing with every aspect of his professional ability and personal character. Compounding their enigmatic view of the record was the strained, almost tortured language<sup>fn-16</sup> and logic<sup>fn-17</sup> that dotted their opinion.

Perhaps the most paradoxical position taken by Matias and Colbeth concerned the recommendation that people be warned that high voltage transmission lines posed some health risk. Various witnesses, and some parties such as the PSC staff, recommended that some means be devised by the Commission to inform those living or working near high voltage lines that they were undergoing some risk. In the transcript

and exhibits of the hearing, the PSC and the utilities possess a detailed analysis of the health risk. On the other hand, most ordinary citizens are completely unaware of the risk. There is a fundamental principle, deeply embedded in the American legal system, that there exists a strict duty of disclosure whenever a person is exposed to a risk by someone with much greater knowledge. In their opinion, Matias and Colbeth said that high voltage transmission lines were a health risk, and that the involuntary nature of the exposure to them must be ended. Inexplicably however, they opposed all specific suggestions aimed at informing the public of the risk, and they themselves made no specific suggestions. They opposed the sending of a letter of warning, and said "It appears that such a letter would only cause confusion and raise anxiety by revealing the present lack of scientific evidence." They also opposed the posting of signs along rights-of-way because "Disputes would then arise as to where, how many, and what they should say." Matias and Colbeth also said that posted signs would "alarm the public unduly."

Throughout the hearing, many exhibits were offered by the various parties. Matias and Colbeth said in their final opinion to the Commission:

"The distinguished scientists who testified called upon their knowledge of the applicable literature to form and confirm their conclusions. However, scientific research is so vast that it would have been impractical to enter as exhibits all of the hundreds of scientific papers discussed. Simply collecting them would have required months, if indeed they all could have been acquired. Dr. Marino alone cited over 200 references. Some of the scientists' reports were taken into the record and have been so identified.<sup>fn-18</sup> Appendix D contains a summary of some of the more prominent studies discussed in this case."

That however, was not accurate. Throughout the hearing a double standard prevailed by which Matias and Colbeth admitted into evidence virtually every exhibit submitted by the utilities but frequently denied admission to exhibits submitted by the staff. For example, the staff sought to have admitted into evidence all the individual ELF studies upon which Marino had relied to reach the conclusions in his testimony, but Matias and Colbeth refused.<sup>fn-19</sup> The staff sought to have admitted a published article by Michaelson in which he employed a scientific method which, when employed by Becker and Marino, was criticized by the utilities' witnesses as erroneous, but Matias and Colbeth refused. The staff sought to have admitted Micahelson's testimony before the Commerce Committee of the United States Senate where, previous to his employment by the utilities, Michaelson gave testimony quite contradictory to that in the hearing, but Matias and Colbeth refused. After the hearing had ended, however, Matias and Colbeth admitted numerous documents at Harvey's request.

Appendix D contained descriptions of seven specific reports, most of which was distorted and incorrect. The most extreme error was Matias' and Colbeth's description of Dumanskiy's research. They said that Dumanskiy reported no effects, whereas he reported a variety of biological effects which he concluded supported his government's position that ELF fields in the environment must be regulated.<sup>fn-20</sup>

Matias and Colbeth considered the possible role of synergism from the electric and magnetic fields of the proposed transmission lines. In their final opinion to the Commission they said that assuming a person to be a metal ball, and assuming that if magnetic fields cause any biological effects they will do so through the production of electric fields, and assuming that Faraday's law applies,

"...it seems entirely safe to assume that any synergism can be accounted for by a worst-case summation of two current densities within the body."

There was however, no evidence presented in the hearing for any of the assumptions made by Matias and Colbeth. They employed the same calculations of current density and concluded that bedridden persons and sleeping persons undergo a reduced risk from exposure to the fields of high voltage lines because they are prone. Their logic therefore leads to the conclusion that they perceive a difference between prone and non-prone metal balls.

In the hearing, Becker said that the results of his research and of that of many of his colleagues, indicated that ELF electric fields are biological stressors. He said that as a physician, he could not allow his patients to experience stress as the consequence of living near high voltage transmission lines, because such stress would not be in the best interests of the patient, but rather would be in the interests of the utility company. Michaelson disagreed; he said, "Even if an electric field were a stressor, it need not necessarily be harmful." Choosing between the advice of Becker and Michaelson on the subject of biological stress would be about as difficult for most people as choosing between the advice of Jonas Salk and Donald Duck on the subject of the cause of polio. Nevertheless, in their final opinion to the Commission, Matias and Colbeth said,

"It would seem impossible to resolve this dispute between Becker and Michaelson because the nature of field interactions with human organisms is not understood sufficiently to permit meaningful arguments."

In 1965, as a graduate student in physics at Syracuse University, Marino took a course entitled "Introduction to Experimental Physics" taught by Professor John Trischka. Trischka assigned a number of texts as required reading, including a text by Parratt. In 1976, under cross-examination, Marino was asked what courses in statistics he took and which texts he used; after replying, and upon further cross-examination, Marino said that he was not an expert in statistics. In their final opinion to the Commission, Matias and Colbeth revealed that they had obtained a copy of Parratt's text from their library, and read in the preface that Parratt intended the book for undergraduate students. Matias and Colbeth said that they therefore interpreted

"the testimony of Dr. Marino to demonstrate clearly that he is not an expert in the field of statistics area of the design of experiments."

The logic employed by Matias and Colbeth was similar to concluding that since Marino was not an expert in relativistic electrodynamic quantum field theory, he was therefore neither an expert on Ohm's law nor in the ancillary area of turning on a light.<sup>fn-21</sup> As the

hearing wore on longer than expected by the PSC staff and the examiners, Matias found it inconvenient to journey to Syracuse; he expressed his feeling during several attempts to obtain Marino's assent to an Albany hearing.

Expert witnesses in the field of ELF bioeffects have been in great demand. Fees for such services range from \$250 to \$1500 per day, including travel time, and time required for the preparation of reports. The fair market value of the services donated to the Public Service Commission by Becker and Marino during their four years as staff witnesses and advisors exceeded \$150,000. Additionally, Becker and Marino received more than 100 offers for their services as expert consultants in more than 30 states. Becker refused every offer and Marino refused all but three. Marino went to Montreal and to California after the utility witnesses had appeared there, and to Louisiana. Marino was paid in California (by the state) and in Louisiana. Harvey obtained a copy of a letter which listed Marino's fees in Louisiana (\$5,000) and Matias and Colbeth admitted it into evidence. In their final opinion to the Commission, Matias and Colbeth made it seem that Marino's participation in the hearing was motivated by money. They also implied that Marino's trips to Louisiana and California showed Marino to be inconsiderate in not traveling to Albany for the hearing. Matias and Colbeth suggested that a financial motive and his inability to travel to Albany for the hearing made Marino a less believable witness.

In 1975 in Minnesota, a controversy developed concerning a high voltage transmission line. An engineer for a state agency wrote a memo and said that Marino's testimony in New York had been "challenged on cross examination and discredited." In 1977 Marino was sent a copy of the memo and asked his opinion of its analysis of the New York hearing; he replied that the engineer's evaluation was "amateurish."

In 1976 Marino appeared before the National Energy Board (NEB) at the request of friends whose land was to be affected by the pending NEB order. Marino gave the NEB a copy of his direct testimony from New York, and was cross-examined for about 15 minutes. When the NEB issued its decision, it did not follow Marino's advice.

In 1975, an engineer at an Electric Power Research Institute (EPRI) project wrote to Marino and said that Marino's apparatus for generating the electric field was in error. However, the utilities never supported that claim nor relied on it, thereby, implicitly admitting there was no such error.

When they wrote their final opinion to the Commission, Matias and Colbeth cited the Minnesota engineer's memo, the NEB decision, the EPRI engineer's letter and the Navy-NAS report and suggested that "regulators and scientists" were agreed that Marino was wrong. Matias and Colbeth implied that therefore Marino's testimony in the hearing was not reliable. Matias and Colbeth didn't mention that the California Energy Resources Conservation and Development Commission was the only agency, except for New York, which thoroughly investigated high voltage transmission line induced biological effects. Both the utility witnesses and Marino testified during the California hearing.

In its decision the California agency said:

"The Committee recommends the Commission require the applicant and the Commission staff to assess and to compare the technical and economic feasibility of widening the rights of way, reducing the line voltage, altering the line configuration and any other method applicant may choose to apply, to comply with Marino's proposed electric field standard of 1 volt per centimeter at the edge of the right of way, and to submit detailed information on these options."

## Footnotes

<sup>fn-1</sup>The Sanguine frequency and magnetic field are both comparable to high voltage transmission lines; the Sanguine electric field however, is about 1,000,000 times less intense than that of a high voltage transmission line. Both Sanguine and high voltage transmission lines operate in the extremely low frequency (ELF) part of the spectrum.

<sup>fn-2</sup>The scientist, Dr. Dietrich Beischer, had an international reputation in the area of biological effects of magnetic fields. Following his retirement, he abruptly cancelled his planned attendance at a seminar on biological effects of magnetic fields at the Veterans Administration Hospital in Syracuse. Beischer has been in seclusion, and he has not spoken or written publicly since his retirement.

<sup>fn-3</sup>The results of the Warminster project surfaced in 1976 in what is now known as the Noval study.

<sup>fn-4</sup>The final report of the Navy-NAS Committee was first scheduled for release in December, 1976. With each successive delay in the 765 kV hearing there was a corresponding delay in the date for the issuance of the final Navy-NAS report. After the close of the 765 kV hearing, the final Navy-NAS Committee report was issued. The committee material was then impounded.

<sup>fn-5</sup>Transmission lines radiate not by design, but as a consequence of the laws of physics. Transmission lines are therefore to be distinguished from the Navy Sanguine antenna which is designed to radiate. On January 6, 1977, Marino wrote to Abramson and specifically advised him of the possibility that radiation from the Sanguine antenna might produce biological consequences as a result of the Helliwell phenomenon. When the Navy-NAS committee issued its final report it did not discuss the Helliwell phenomenon.

<sup>fn-6</sup>Synergism is a biological reaction which sometimes occurs when two substances, each of which produces an effect in an organism when administered individually, are administered to the organism simultaneously. When a synergistic reaction occurs, the effect produced in the biological organism is greater than the effect produced by either of the substances when administered alone, and is also greater than the sum of the effects produced by each substance individually. <sup>fn-7</sup>Miller said that McElhaney 'reported spurious results,' and that Giarola used 'faulty experimental cage design.' Miller concluded Durfee's research 'must be viewed with considerable skepticism.' Miller said that Yates' work contained 'internal inconsistencies,' and that Hamer's work 'provided no valid statistical treatment of the data.' Miller said that Konig's work was not 'statistically significant,' and Blanchi's work had 'faulty experimental design.' Miller said that there is an 'unlikelihood' that Altman observed the effects which he reported, and that Lang's work 'may well be simple eyeball' estimates. Referring to the work of Mamantov, and also the work of Gann, Miller said, 'these two studies provide very simple uncomplicated examples of poor experimental design.' Miller dismissed the work of Solovev because 'artefacts were likely in the experiment.' Describing Moos' experiments, Miller said 'the results of the various experiments were inconsistent.' Concerning Wever's work, Miller said it 'certainly suffered from internal inconsistency.' Miller said 'I do not consider the Warnke study to be a valid indicator of biological effects caused by an electric field.' Miller said that the results of Spittka, Hilmer, Gavalas-Medici, Watson, Beischer, Southern, Graue, and Lott, among others, were each due to artefacts. It should be noted that Miller himself has never performed animal research.

<sup>fn-8</sup>The Becker and Marino mouse study resulted in stunted growth for three successive generations. The data it generated were body weights, and photographs; the existence of the effect was therefore incontrovertible.

<sup>fn-9</sup>And presumably the other four authors who collectively have made about 200 contributions to the peer-reviewed scientific literature.

<sup>fn-10</sup>All letters from and to Helliwell cited herein are reproduced in Appendix A.

<sup>fn-11</sup>Francis Wallace, PASNY's lawyer, described the PSC hearing process as not 'issueoriented,' but rather a 'wide-open, free-wheeling, anything goes system.'

<sup>fn-12</sup>On September 1, 1976, Matias said: "Is the Power Authority here this morning?" Harvey replied: "Mr. Examiner, I have been requested by Mr. Davidson to make the appearance of the Power Authority and to indicate that unfortunate circumstances have prevented their counsel from appearing today and tomorrow…" (S.M. 10510)

<sup>fn-13</sup>Adey was a member of the Navy-NAS Committee.

<sup>fn-14</sup>In January, 1978, Hastings said that each member of the Navy-NAS Committee "endorsed" each criticism of each ELF investigator. The word "endorsed" as used by Hastings does not mean that the committee members originated the criticism, or agreed to the criticism after hearing both sides, or understood the criticism, or even that they knew of the criticism before seeing it in Abramson's draft analysis. The word "endorsed" as used by Hastings means that no committee member will disassociate himself publicly from any conclusion contained in the final report.

<sup>fn-15</sup>The Navy-NAS Committee and the efforts to institute a Science Court are described in Appendix B.

<sup>fn-16</sup>They said "If a person is not continuously exposed to an electric field of 1 kV/m or greater, there is no risk to his health." It is obviously true, however, that if a person is not exposed to an electric field of *any* strength, there is no risk to his health.

<sup>fn-17</sup>Electric fields of 1 kV/m arise from lines operating at many different voltages. Matias and Colbeth, however, said that only the 765 kV lines should be regulated.

<sup>fn-18</sup>Matias and Colbeth followed no governing principles in their decisions concerning which reports to admit; on one day Matias might admit an ELF report, and deny such a report admission on another day.

<sup>fn-19</sup>In support of Matias and Colbeth's refusal, Harvey argued that "the Commission was not competent to make scientific judgments concerning the individual ELF reports," and that the Commission "had to rely solely on the opinion of the experts who testified."

<sup>fn-20</sup>The actual reports written by Dumanskiy are reproduced in Appendix C.

<sup>fn-21</sup>It did not concern Matias and Colbeth that the statistics used by Marino were quite elementary and consisted of averages, standard deviations, and t-tests. The great majority of research scientists never, throughout their careers, have need for more sophisticated kinds of statistical procedures. Most science students are introduced to the elementary procedures very early (and usually for the only time) in their undergraduate career.