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Licensing of 765,000 Volt A/C Power Transmission Lines in New York State.
Part A - Present Status
Part B - Physical Effects*

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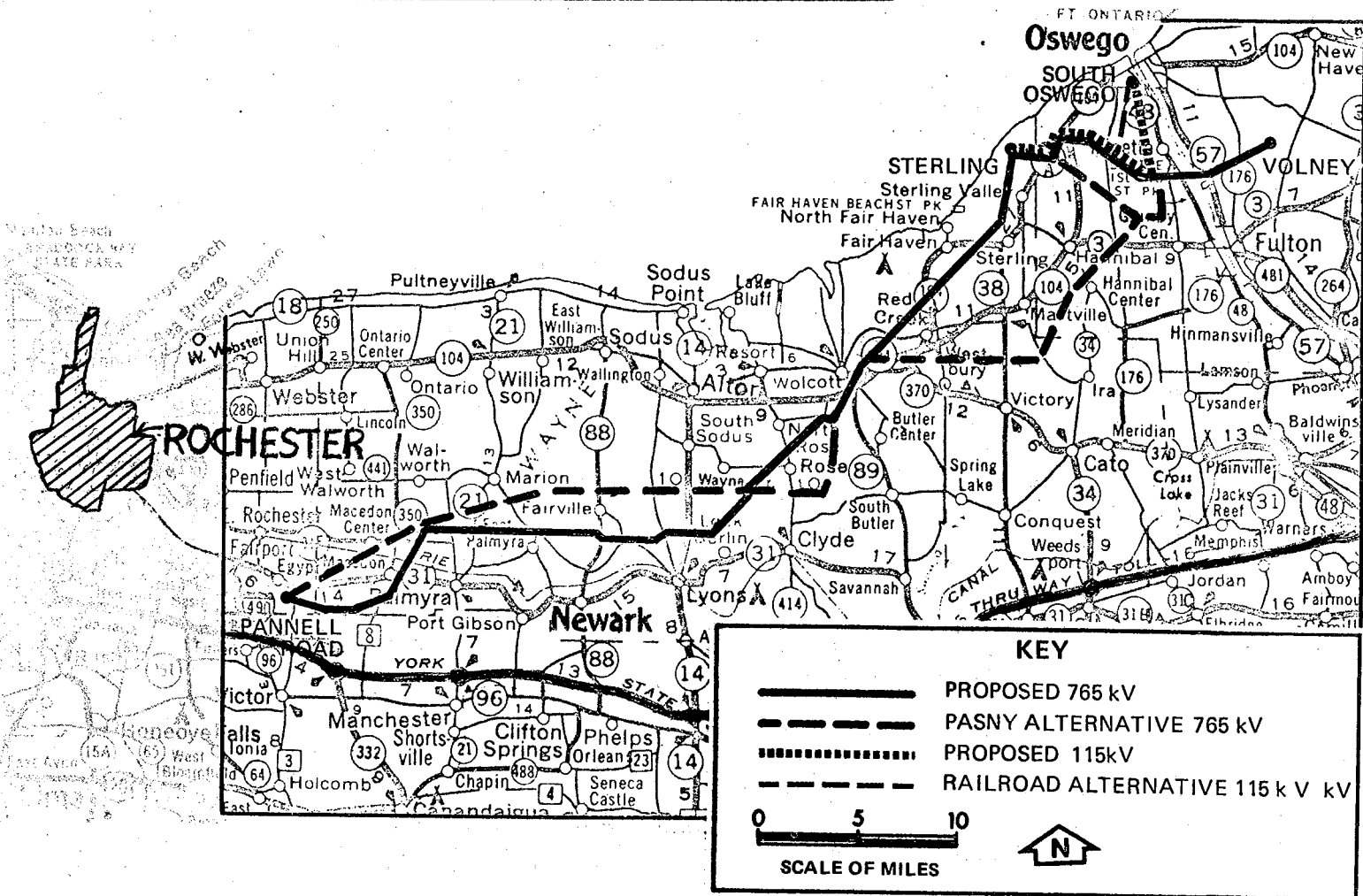
Licensing of 765,000 Volt A C Power
Transmission Lines in New York State:
Part A - Present Status

by
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Summary

There is some disagreement between experts testifying for RG & E and those testifying for Niagara-Mohawk in their respective applications for 765,000 volt AC transmission lines. There is further disagreement between their interpretations of the available research and the interpretation of the DEC. These disagreements will be explored during testimony and cross-examination in a generic hearing concerning high voltage lines and should clarify the expected effects of these transmission lines in terms of potential shocks, noise levels, ozone production and other issues affecting public health and safety. The legal procedure and status of the application are discussed in Part A of this two-part bulletin. The physical effects of these voltage and current levels are discussed in Part B.

Figure 1. The Proposed Route and Some Alternative Routes



Introduction

In January, 1974, Rochester Gas & Electric Corporation (RG & E) and Niagara Mohawk Power Corporation (Niagara-Mohawk) filed a joint application with the New York State Public Service Commission for the construction of a single circuit, 765,000 volt (765 kilovolts or 765kv) alternating current overhead transmission line (1). The line, if approved, will run from Pannell Road in the Town of Perinton, Monroe County, to the Town of Volney, in Oswego County, a distance of some 66.5 miles. The application was made under Article VII of the New York State Public Service Law, which became effective on July 1, 1970. One of the legislative purposes for the enactment of Article VII was to permit individuals and groups interested in conservation to participate in the decision to locate specific major power transmission facilities (2). The law governs power transmission facility applications with a design capacity of 125kv or more, which extend a distance of one or more miles and also facilities with a design capacity between 100 and 125kv which extend a distance of 10 or more miles. Excluded from this coverage are lines located wholly underground beneath cities with a population exceeding 125,000 (3). Before the preparation of a site for the construction of such a facility after July 1, 1970, the power company must apply to, and obtain from, the Public Service Commission a "Certificate of Environmental Compatibility and Public Need" (here, a "Certificate").

Each application must set forth the following:

- (a) the location of the site or proposed right-of-way;
- (b) a description of the transmission facility;
- (c) a summary of studies which have been made on the environmental impact of the project;
- (d) the need for the facility;
- (e) any reasonable alternate location together with a description of their comparative merits and why the primary proposed location was selected;
- (f) other relevant information which the Commissioner may require by regulation(5).

Once the application is filed with the Public Service Commission, public hearings are scheduled with participation by the State departments, including the Department of Environmental Conservation (DEC) (6). Also entitled to participate in the hearing is any resident of a municipality through which the proposed line may run (either primary or alternate routes), and any New York, non-profit corporation or association formed to promote conservation, or protect the environment (7). A party must file a notification with the Commission that it intends to participate (8).

This bulletin focuses on the recent application by RG & E and Niagara-Mohawk, which has been designated case 26559 by the Public Service Commission (PSC). Case 26559 has become a test case in which the possible effects of 765kv lines upon people and the environment will be examined more fully than ever before in a public proceeding. It is important because the findings of the Commission in this case will serve as precedent for similar applications in the future.

Background on 765kv AC Lines in New York State

Approximately 100 miles of 765kv AC capacity line presently exist in New York State. This is Niagara-Mohawk's "Edic-New Scotland" line, which now carries only up to 345kv (9). Construction of the Edic-New Scotland line was approved prior to the effective date of Article VII and, therefore, an examination into the potential effects of 765kv lines on people and the environment was not required for approval.

In addition to the 100 miles of existing 765kv capacity line, 65 miles have already been approved for construction under Article VII (10). This line is Niagara-Mohawk's "Edic-Volney" line, which has been designated case 26251. Although examination into the environmental impact of that line was required, no serious examination of safety and environmental impact was made. According to the DEC, these issues were treated summarily and inadequately in case 26251 (11). The Edic-Volney line is presently under construction, but initially it is to be energized only at 345kv AC (12).

Aside from case 26559 now under discussion, there is another 765kv line application pending before the Public Service Commission, from the Power Authority of the State of New York (PASNY). Approval is asked for a transmission facility running 155 miles from Utica, New York, to the Canadian border. That case has been designated #26529.

Section 149-b of the Public Service Law requires annual reports by all electric corporations in New York specifying, among other things, proposed new transmission facilities. In 1974 such a report was prepared by the New York Power Pool (NYPP), which is an association of all domestic electrical generating companies in New York State, and the Power Authority of the State of New York. In addition to the above mentioned existing and proposed lines, the report lists a total of 15 separate 765kv lines either proposed to be built before 1989 or under study (13). Regardless of the number of lines that are actually built, it is clear that many 765kv applications can be expected under Article VII.

RG & E - Niagara Mohawk Application: Case 26559

The application to the PSC in case 26559 was filed on January 28, 1974, and a notice of the hearings was published in local newspapers on March 1, 1974 (14). Ultimately, six groups and individuals became parties to the proceeding along with the DEC. Two citizens' groups are included. A proposed alternate route crosses the land of the Gananda Community Association and the primary route runs through communities where members of the Power Line Committee live. Once the notice was published, and the identities of the participants became known, open public hearings were scheduled before an examiner appointed by the PSC. At the hearings, the applicants' direct testimony was presented to support their case for a Certificate. In addition, the parties have been provided with an opportunity to cross-examine the applicants' experts regarding their direct testimony. Once cross-examination is completed, the other parties to the proceeding then normally would put in their direct case in opposition to the entire application or any part of it. The cross-examination of RG & E in case 26559 has been completed. Due to combined, generic hearings (described later), the presentation of the intervenor party's direct case has been delayed. Many days of hearings now have been held at various locations including Albany, Oswego, Lyons, and Rochester. The written transcript of testimony now consists of over 3,800 pages. A full, current copy of the transcript and the application is available and is in the main branch (Rundell) of the Rochester Public Library.

The issues raised in case 26559 include: 1) the best site for the power line; 2) whether the line should make use of existing power line rights-of-way or obtain new ones; 3) whether there is actually a need for the increased transmission capacity based upon current and projected population and consumption trends; 4) whether the line should be placed underground or overhead; and 5) the health and safety factors of the operation of the proposed line. Each of these important issues deserves attention beyond the scope of this bulletin. The most troublesome issue probably is whether a decision on the safety and environmental effects of the line should be made at all, because the existing state of knowledge on their effects is limited. The questions of public safety and environmental effects are crucial because this is the very first public proceeding to take a serious look at the topic.

In her book, Power Over People (1973)(15), Louise B. Young, Science Editor of the American Foundation for Continuing Education, has drawn considerable attention to claimed ill-effects of 765kv AC lines upon people and the environment. Some evidence used came from her first-hand observations of an existing 765kv AC line near her home in Ohio. Also, in both case 26559 and case 26529, the contrary expert testimony claiming that 765kv AC lines have no known ill-effects upon people and the environment, has raised many more questions than have been answered (16). This case will undoubtedly set a precedent for the many future 765kv AC line applications yet to come before the PSC; therefore it is important that these safety issues be explored in depth now.

Ambiguities and Possible Inconsistencies of Statements Presented in the Two Pending 765kv Proceedings

The DEC has pointed out* what it feels are apparent contradictions between expert testimony in cases 26529 and 26559. In case 26529 the applicants' expert witnesses testified that the audible noise produced by such a line during fair weather would exceed 49 dB(A) only 5% of the time (17). The DEC motion states that, in case 26559, an expert testified that the line (virtually identical to that of case 26529) would produce 0 dB(A) under similar conditions. Examination of the testimony in context shows the RG & E expert testified that the noise would remain at its existing level, whether that level is 26 dB(A) or 46 dB(A), and that the increase in noise due to the line (during fair weather) would be 0 dB(A).

In case 26529, PASNY's expert, Mr. Fullerton, testified that the maximum ozone produced by the line under the worst conditions would be 5.3 parts per billion (19). Yet Dr. Shah, RG & E's expert in case 26559 on the same topic calculated that this figure would be 26 parts per billion (20). RG & E representatives have explained to RCSI (50) that their expert predicts only 4.6 parts per billion for their transmission line under the worst conditions postulated by PASNY's expert and that their expert has calculated 26 parts per billion on an even less likely worst case situation (where a steady 1 mile per hour wind blows parallel to a 100,000 foot length of transmission line for an 8-hour period).

On the subject of the effect of such lines on nearby metal objects, an expert in case 26529 stated that metal objects near the line should be grounded if they "might give you trouble" (21). It was suggested that "trouble" meant a shock current of 5 milliAmperes (mA) or more (22). A value of 5 mA is often used as the "let-go current level": the person receiving the shock may not be able to let go if the level is higher (23). On the same subject, RG & E's expert stated that while 5 mA would not produce "detrimental effects", (24) he recommends a grounding policy based on the premise that people should not normally be subject to shocks above 1 mA (25). Another difference in expert recommendations resulted from PASNY's choice of 42 feet minimum ground clearance while RG & E chose 50 feet. (The lower the clearance, the more likely it is that people will be subjected to shock currents when touching metal objects under the line.) Finally, PASNY's expert said that it was not possible for electrical currents to flow under the line (26), while RG & E's expert said such currents would in fact flow under the line (27).

* The following information is taken from a motion by the DEC for Generic Hearings on the two pending proceedings. RCSI has not obtained all the sources cited in the motion and does not vouch for their contents, their reliability or their interpretation by the DEC. They are presented to illustrate the range of issues involved and the contradictory nature of the present interpretations of the facts.

The Motions for Generic and Combined Hearings

These possible inconsistencies and ambiguities in the two pending 765kv AC proceedings and the general lack of demonstrable knowledge on the environmental and safety aspects of operating these transmission lines, prompted the DEC, in September, 1974, to ask the PSC for rule-making or generic hearings on these aspects of 765kv AC lines. The DEC requested:

"A stay of all Article VII hearings involving 765 kv lines be granted until the generic hearings are completed and a final decision rendered. In the alternative, pending Article VII cases involving 765 kv lines might be completed without (consideration and determination of these aspects) although any decision or certification would await and be subject to the final determination of the generic hearings. (Also) the Public Service Commission should order that presently existing 765 kv lines not be operated above 345 kv levels until further order of the Public Service Commission." (28)

Joining in the motion were the State Departments of Health, Agriculture and Markets and the State Attorney General's Office. The Powerline Committee made a similar motion.

In response to the DEC's motion for generic hearings, the PSC Staff on September 30, 1974 made a countermotion requesting the Commission to order a common hearing in cases 26529 and 26559 for any additional testimony on the issues of audible noise, ozone, induced electric current shocks, and electromagnetic and electrostatic field effects from the 765 kv AC transmission lines proposed in those proceedings. It was proposed by the Commission's staff that such common hearings would be open to any interested party. Although the Commission's staff felt that these issues deserved further consideration beyond that already given in those proceedings, it apparently believed that a hearing on the effects of 765 kv AC lines in general, without reference to a specific line, would needlessly consume time and work a serious hardship to the applicants in the present proceedings. However, both the DEC and the Commission staff urged that further consideration be made on the issues of safety and environmental aspects in the operation of 765 kv AC lines.

On November 25, 1974, a joint ruling was made by the hearing examiners in each proceeding on the countermotion by the commission staff for a common hearing in both cases. In their ruling, the examiners stated:

"The undersigned both recognize that the issues should be developed as fully and completely as possible with respect to both cases. It is further recognized that the Commission may be in a position where it could not certify the construction and operation of a 765 kv transmission line in either case unless the matters of health and safety are gone into in greater detail than what has already been developed with respect to each case. It is therefore concluded that further expert testimony on the issues of audible noise, ozone, induced electric current shocks, and electromagnetic and electrostatic field effects should be presented in both proceedings. Since these issues are common to both 765 kv facilities, common hearings would provide the most complete record with respect to each application, and, therefore, would avoid the possibility of either proceeding concluding without the necessary evidentiary support for a final determination by the Commission.

....
...The Commission should not and cannot act until such questions have been developed fully and completely." (29)

Accordingly, it was ordered that hearings be convened at a future date in the City of Albany limited to the receipt of testimony from qualified experts with respect to health and safety issues. It was further ordered that upon completion of all testimony and cross-examination in the health and safety areas, each proceeding would follow in its normal course until completion.

Assuming that either the examiners' decision is affirmed on appeal, or not appealed at all*, the ruling will have the effect of subjecting the health and safety aspects of 765kv AC operations to the full, thorough evaluation resulting from adversary discussion of the issues. It should be noted that on November 6, 1974, RCSI sent a letter to the Chairman of the PSC, expressing RCSI's support for further hearings on the subject of safety and environmental aspects of such lines. Before the combined hearings convene it seems instructive to examine the existing state of scientific knowledge with respect to these lines and review some of the scientific research that has been done to date. This review is the subject of Part B of this Bulletin.

* There has as yet been no appeal and RG & E has stated that they plan no appeal (50).

THE ROCHESTER COMMITTEE FOR SCIENTIFIC INFORMATION
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Licensing of 765,000 Volt A C Power
Transmission Lines in New York State:
Part B - Physical Effects

by

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Background

If large quantities of power are to be generated at large plants, which are more efficient and economical than small plants, it must be transmitted to the users. For both alternating current (AC) and direct current (DC) transmission, doubling the voltage during transmission halves the necessary current for a given power. Halving the current quarters the losses of power during transmission. The high voltage line (765,000 volts) therefore acts in place of four similar lower voltage lines (345,000 volts - the level which has previously been the maximum in this region). Four lower voltage lines would either require four separate transmission corridors with their rows of towers and wires, or else four times larger wires in the single corridor. The latter would use four times the material, weigh four times as much, and need correspondingly more massive towers more closely spaced, thus increasing the visible impact as well as costing more. The high voltage alternative is less expensive and preferred by the utilities. DC high voltage transmission is presently many times more expensive than high voltage AC transmission and has been rejected by the utilities although it is still advocated by some groups in the areas through which the transmission must be routed. RG & E and Niagara-Mohawk have applied for permission to build a 66 mile length of overhead high voltage AC transmission line across Wayne County. Since there is some dispute about the effects of such high voltage AC transmission this has been opposed by groups from that area. This paper attempts to discuss some of the effects of the high voltage AC transmission lines.

Existing Research Into the Effects of 765kv AC Lines

Research has indicated that there are, under certain circumstances, electric shocks when touching ungrounded conductors, such as cars, fences, gutters, etc. The possible effects of 765 kv AC transmission lines may include: injury to vegetation; effects on wild and domestic animals and on humans due to ozone production and to noise pollution; and nervous and cardiovascular system disorders caused by the alternating electric and magnetic fields. These effects are discussed below. The research results and references are excerpted, essentially verbatim, from a lengthy memorandum** which Dr. Daniel Driscoll of the New York Department of Environmental Conservation sent to Mr. Werner Kuhn, Associate Counsel for Energy Matters for the DEC. For brevity not all of the 47 references cited by Driscoll are utilized in this brief summary.

** Driscoll, Daniel. Memorandum of Sept. 10, 1974 to Mr. Werner Kuhn, Associate Counsel for Energy Matters for the DEC and incorporated as Exhibit A in the PSC hearings on a motion to hold generic hearings on the health and safety of 765,000 v AC transmission lines.

Induced Currents

The electric and magnetic fields associated with 765kv AC transmission lines under certain circumstances can have the direct effect of causing electrical shocks. A DEC memorandum mentions letters from individuals living near transmission lines which recount incidents such as a "severe shock" while fixing a corn picker (30a); and metal roofs and fences which "really jolt you" (30a). A report prepared by the Ohio Attorney General's Office indicates that because of the special precautions necessary to avoid shocks, those living near the 765kv line do not have complete freedom to use their land. For instance, a survey of 18 Ohio farmers (58), judged to possibly be substantially affected by the power line, showed 4 of the 18 felt a need to use a chain grounding device on their farm machinery.

In the absence of Federal or State standards specifying the maximum permissible shock current, some parts of the power industry appear to be adopting a limit of 5 milliamperes (ma) (31). Although 5ma is probably not a lethal shock, that current constitutes a very painful shock for most adults (32, 33). Driscoll, of the DEC, states that some children may have cannot-let-go thresholds below 5ma (30a, 30b).

In addition, the involuntary muscular reaction which such a shock would produce may constitute a hazard to individuals (farmers) working with machinery under 765kv transmission lines. Research indicates that cardiac pacemakers may also be affected by the induced currents (34) although the degree of danger this effect causes is unclear. RG & E representatives have explained that constantly running pacemakers are unaffected while asynchronous pacemakers, which give an occasional pulse when the heart has failed to beat naturally within a prescribed time, may be caused to begin continuous pulsing at the normal heart rate rather than waiting for an excessive delay, as intended (50).

Ozone Production

Ozone probably causes more injury to vegetation than any other air pollutant in the United States (35). Although 50 to 120 parts per billion (ppb) are usually required to injure the most sensitive vegetation (e.g. eastern white pine, concord grape and sweet corn), concentrations as low as 20 to 30 ppb have been known to produce injury (30).

Adverse health effects, as shown by impairment of performance of student athletes, occurred over a range of hourly average oxidant concentrations from 30 to 300 ppb (36). An increased frequency of asthma attacks in a small proportion of subjects with this disease was shown on days when oxidant concentrations exceeded peak values of 130 ppb, a level which would occur at times when the hourly average concentration ranges from 50 to 60 ppb (36). The Federal and State primary ambient air quality standards for photochemical oxidants (primarily ozone) are set at 80 ppb one-hour average concentration.

A large number of papers on transmission line ozone production have been published recently (37). The DEC (30a) interprets one of the recent papers (38) to the effect that "one of the conclusions of the most recent paper is that 'present experimental data is insufficient to establish reliable analytical predictors of the rates of corona produced effluents for transmission line conductors' " and that "the instrumentation used in the experimental transmission line ozone studies may have produced unreliably low results." RG & E feels this paper is being misinterpreted and that the unreliability of the data is due to it being such a very small amount (50). Their expert's testimony cited the same paper (38) as showing "that there is no appreciable ozone emission generated by power lines" (57).

In the RG & E Pannell-Volney 765kv transmission line application, it was estimated that under stable wind conditions the ozone concentration due to the transmission line alone may be 26 ppb. The DEC feels that "considering the uncertainty of such an estimate and the evidence that 26 ppb may initiate injury to some vegetation, it is appropriate that the levels of ozone produced by 765kv transmission lines be given more careful consideration" (30). RG & E explains (50) that this high value is for an extremely unlikely situation where a steady one mile per hour wind blows along the transmission line for a length of 100,000 feet for a full eight hours. They say that for the worst case situation, as defined by the Niagara-Mohawk testimony in case 26251, the value for their proposed line would be only 4.6 ppb, less than the 5.3 ppb the Niagara-Mohawk line discussed in case 26251. Thus RG & E claims to be using a more stringent evaluation of "worst" which would be to their credit but it does indicate variability among the utilities' estimates of what is worst. The proposed generic hearings may serve to define some of these nebulous terms.

Noise Pollution

The DEC memorandum (30b) says the testimony in the PASNY application indicated that the noise level during fair weather would be 49 dB(A). RG & E feels this is probably a value for fog and rain rather than for fair weather (50) since fair weather values are usually around 25 dB(A). The application by RG & E indicates that during fair weather there will be no noticeable increase in noise, that is, the noise with the line will be the same as it was before the line was installed. The RG & E application does indicate that the worst noise level, during moist fog conditions, will be 49 dB(A) under the lines. This would reduce to 47.5 dB(A) at the edge of the right of way during moist fog, the worst condition (39). The State DEC recently held hearings concerning procedures to control and regulate noise from construction and stationary non-residential sites. The proposed rules set 45 dB(A) as the maximum allowable noise level at a residence at night (40). The rationale for this proposed noise level is that higher levels may interfere with the sleep of a significant percent of the human population. The proposed regulation was not put into effect. The hearing officer's report indicated that thousands of electric utility substations exceeded the maximum level and would be

in violation of the proposed standards (41). The official reason given for not issuing the proposed standards is that the DEC is not sufficiently staffed to enforce the standards (59). The application indicates that the noise (during rain and fog) would exceed the proposed standard for a distance of approximately 100 feet beyond the outer limits of the proposed right of way (39).

Nervous and Cardiovascular System Effects

The research into health effects is sparse and inconclusive. Not much has been done with 60 Hertz, the frequency of the proposed transmission line. Consequently some effects must be extrapolated from different frequencies or guessed from observations on linemen rather than from controlled experiments.

The power industry supported construction of an experimental 765kv AC line at Waltz Mills, Penna. before building commercial lines using this voltage. It was used to test various configurations of insulators, to try various physical effects such as noise levels, amount of corona and radio or TV interference. No controlled experiments on animals to determine the health effects are recorded.

After the first commercial 765kv AC lines were erected, by American Electric Power Co. in Ohio, Indiana and West Virginia (42), studies were undertaken on the linemen who work on the lines. These were undertaken because of rumors that the electric field was causing ill effects on the workmen (43). These linemen often work on the lines barehand although their bodies are insulated by virtue of being suspended in a large insulated bucket on a crane arm. This insulation was sufficient to hold the actual body current to low levels (70 to 375 microamperes*)(44) even when directly touching the bare high voltage wires. This is less than one tenth of the 5000 microamperes being proposed as an upper limit for civilians by some utilities (31) and about a third of the 1000 microamperes being adopted by RG & E (45). The low level established for such linemen compared to the general public should not be construed as a disregard for the public. The linemen work under adverse weather conditions on lines far off the ground for long periods of time. Under these circumstances it is felt that the distraction of feeling a tingle or a shock from their tools might cause a dangerous mistake or even a fall from great height. The level is therefore set to avoid effects which could cause distraction and accident rather than by direct health considerations (50). Although this explains why the linemen levels are less than the levels proposed for the occasional shock to the public it does not make the results of the analysis of health effects on these linemen directly applicable to the public health.

The level of 1000 microamperes, or 1 milliamperere, of current through the body is just low enough so that it would not be perceived by most persons. RG & E officials explain (50) that larger values could be generated only under very unusual circumstances. If a very large tractor trailer truck were parked at the edge of the right of way, at a point where the transmission lines have maximum sag, during a hot spell when the wires sag maximally, and the truck were insulated from the earth by being driven over rubber sheets (since normal tires are somewhat conductive) then a barefoot person touching it would get a 5 ma shock current. If the truck were not on rubber sheets its tires would conduct to the earth (even dry ground is compacted by the weight of the truck enough to conduct somewhat) and the shock would

* microampere = 1/1000 milliamperere

be reduced to only 3 ma. If the person were wearing normal shoes he would receive only about 1 ma from this uninsulated but not deliberately grounded truck. This maximal shock develops only when and where the lines sag to their lowest level, fifty feet above the ground for RG & E's proposed line. RG & E indicates that the design is such that this lowest sag point will never occur over any "maintained road" (any road which is plowed by a government agency during the winter). The minimum distance above such a road is to be 70 feet (50). Since electrical effects decrease with the square of the distance this would give the worst shock values at a maintained road of 2.5 ma for the insulated truck, 3/4 ma for the barefoot contact with the uninsulated truck, and 0.5 ma for contact with the uninsulated truck while wearing normal shoes.

Additionally, the number of linemen studied was small, (ten), so the conclusions are not very confident statistically. Furthermore, no record was kept of how much these men were actually exposed to these fields. It is claimed by the authors that they were still exposed even though eight of the ten were promoted to supervisory work rather than normal lineman duties (43). RG & E representatives explain that due to the need for careful supervision in this work the supervisor of such live line work is normally close to the work, not on the ground, although he may tend to be closer to the supporting tower structure than are the men he is supervising (50). Their exposure would appear to be for less than 8 hours/day and of limited intensity so the research does not apply directly to the health effects on close residents living nearly continuously in an electric field for a very long time.

Some controlled experiments done on animals have used the 60 Hertz frequency. These studies have found a reduction in growth rate apparently due to the electric or magnetic fields. One found a consistently lower growth rate in male progeny of mice exposed to very strong electric fields of 160,000 volts/meter, and a 33% greater death rate in the offspring of these exposed males (only males were exposed) (46). Another found egg production in chickens was decreased by about 50% in response to a magnetic field of 1 or 2 Gauss but only a transient response due to the moderate electric field of 1,600 v/meter (47). Another study found the magnetic field of 1.2 Gauss significantly reduced the growth rate of young chickens although the electric field of 3,400 v/meter did not significantly reduce it (48). For comparison the maximum electric field caused by the proposed transmission line would be 9,000 v/meter at the point inside the right of way, and would be about 2,700 v/meter at the edge of the right of way (49). This is a maximum, occurring at places where the line sags closest to the ground. The value would be lower where the line is higher, and would average 2,500 v/meter at the edge of the right of way (49). The magnetic field would be a maximum of 0.51 Gauss under the wires and would be 0.115 Gauss at the maximum value along the edge of the right of way (50).

Since results which are directly applicable are scarce, one is forced to make extrapolations from other frequencies and different levels. Much research has been done at very low frequencies (5 to 7 Hertz) because that frequency was to be used for the Navy's Project Sanguine, an attempt to communicate with underwater submarines. One study cited by Driscoll showed a significant effect on response time of humans (as well as effects on peach-leaf lice, lactic-acid bacteria, beer yeast and wheat germs) (51). Another showed a significant difference in inter-response times for trained monkeys (52) while another found subtle effects on human reaction times (53). The extrapolation of these low frequency effects to 60 Hertz is not very clear since these low frequencies are close to the alpha wave frequency of the human brain (54).

Many studies find no effect on the specific phenomenon investigated; in Rhesus monkey behavior, metabolic activity of soil microorganisms, cell function of bean seeds, and so forth; and a large number of studies are still underway or are still being evaluated (30).

The Soviet Union has been more active than the United States in assessing health effects of such high voltages. A study of two groups, one given little exposure and one much exposure to 500 and 500,000 volt switchyard conditions (at 50 Hertz, the European power frequency rather than the American 60 Hertz) found the high exposure group had greater variability of pulse and arterial blood pressure (55) as well as other changes.

The Russians consequently set limits on field strength exposure for humans and lengths of time for those exposures. They allow only 90 minutes' daily exposure to 10,000 to 15,000 volt/meter field intensities or 180 minutes' daily exposure to 5,000 to 10,000 v/m fields. Casual untimed exposure is limited to fields whose strength is less than 5,000 v/m (56). The field at the edge of the proposed right of way would be 2700 v/m.

Conclusion

It seems apparent that there is some variability in the situations which are defined as "worst possible" and some disagreement about the interpretation of the available evidence concerning the effects of 765 kv AC transmission lines. The DEC finds some of the available research inconclusive and conflicting. The testimony indicates that in the two applications made for such lines the applicants established different levels of maximum permissible shocks and predicted different maximums for ozone. It is not suggested that the applicants in the two pending 765kv AC applications sought to withhold any information within their knowledge from the public regarding the safety of these lines. It is important to note, however, that without the procedure providing for public participation in these licensing decisions, quite possibly these issues would never have received the attention and the scrutiny required to prompt a call for a closer examination. Whatever decision results from the combined hearings to be held later this year on the subject of 765kv AC transmission lines, it is gratifying to know that the Article VII procedure providing for public participation in licensing decisions is working effectively.

References

- (1) Rochester Gas & Electric Corporation and Niagara Mohawk Power Corporation, Application to the State of New York Public Service Commission for Certificate of Environmental Compatibility and Public Need (1974) (hereinafter cited as Application)
- (2) Laws 1970, Chapter 272, sections 1 & 6
- (3) New York Public Service Law, (1974) section 120
- (4) Id. section 121
- (5) Id. section 122
- (6) Id. sections 123-124
- (7) Id.
- (8) Official Compilation of Codes, Rules and Regulations of the State of New York, Title 16, Parts 86-88 (1970)
- (9) Vol. 2, Report of Member Electric Corporations of the New York Power Pool and the Empire State Electric Energy Research Corporation Pursuant to Article VIII. Section 149-B of the Public Service Law p. 299, ex. 19 (1974). (Hereinafter cited as NYPP Report)

- (10) Id., see also DEC, Motion to Public Service Commission for Rule-Making (Generic) Hearings Regarding Proposed 765 kV Transmission Lines (9/11/74)
- (11) Id.
- (12) NYPP Report, Ex. 19
- (13) Id., Ex. 20
- (14) Rochester, New York, Times-Union, 3/1/74
- (15) Oxford University Press
- (16) DEC Motion, loc. cit.
- (17) Id., Ex. B
- (18) CASE 26559, transcript p. 2395
- (19) Case 26529, transcript p. 300
- (20) Case 26559, Application p. 472
- (21) Case 26529, transcript p. 2980
- (22) Id. p. 2981
- (23) Case 26559, transcript p. 2756
- (24) Shah, K.R., Principal Engineer, Commonwealth Associates, "EHV and the Environment. An Engineering Guide", in *Transmission/Distribution*
- (25) Case 26559, transcript p. 2756
- (26) Case 26529, transcript p. 635
- (27) Case 26559, transcript p. 2784
- (28) DEC Motion, loc. cit.
- (29) Joint Ruling p. 5
- (30_a) Driscoll, Daniel. Memorandum of Sept. 10, 1974 to Mr. Werner Kuhn, Assoc. Counsel for the DEC, and incorporated as Exhibit A in the PSC hearings on a motion to hold generic hearings on the health and safety of 765,000 volt AC transmission lines.
- (30_b) Driscoll, Daniel. Memorandum of August 26, 1974 to Mr. Phil Gitlen, Assistant Counsel of the DEC concerning "Hearing Record Ambiguities" and incorporated as Exhibit B in the hearing
- (31) "Electromagnetic Effects of Overhead Transmission Lines - Practical Problems, Safeguards and Methods of Calculations", IEEE Transactions on Power Apparatus and Systems, PAS-93, No. 3. May/June 1974; as cited in Driscoll
- (32) Dalziel, C.F.; "Electric Shock Hazard", *IEEE Spectrum*, February, 1972; as cited in Driscoll
- (33) Dalziel, C.F. and Lee, W.R.; "Lethal Electric Currents", *IEEE Spectrum*, Feb. 1969, as cited in Driscoll

- (34) Furman, S., Parker, B., Krauthamer, M. and Escher, D.J.W., "The Influence of Electromagnetic Environment on the Performance of Artificial Cardiac Pacemakers", *Annals of Thoracic Surgery*, Vol. 6, No. 1; July, 1968
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- (36) *Air Quality Criteria for Photochemical Oxidants*, U.S. Dept. of Health, Education and Welfare, National Air Pollution Control Administration Publication AP-63, pp 6:4, 8:33 and 10:7; cited in Driscoll
- (37) See Driscoll letter for list of six papers
- (38) Roach, Chartier and Dietrich, "Experimental Oxidant Production Rates for EHV Transmission Lines and Theoretical Estimates of Ozone Concentrations Near Operating Lines", *IEEE*, PAS-93 No. 2; March/April 1974, cited in Driscoll
- (39) *Application to the State of New York Public Service Commission for Certificate of Environmental Compatibility and Public Need*, Vol. 1, Exhibit 4, pp. 4.62-4.64
- (40) Lee, R.E., "Noise Legislation: Federal, State, and Local", RCSI Bulletin #163; August 1973
- (41) New York State DEC Hearing Officer's Report, May 31, 1973
- (42) Friedlander, G., "The 'Other' Electric Company", *IEEE Spectrum*, June, 1974; pp 48-54
- (43) Slingewald, et al., "Medical Follow-up - Study of High Voltage Linemen Working in AC Electric Fields", *IEEE Transactions*, PAS-86 No. 4; November 1972
- (44) Kouwenhoven, W.B. et al., "Body Currents in Live Line Working", *IEEE Transactions*, PAS-85 No. 4
- (45) *Application to the State of New York...*loc cit. Vol. 1, Exhibit 4 p 4.64
- (46) Knickerbocker, et al., "Exposure of Mice to a Strong AC Electric Field - An Experimental Study", *IEEE Transactions*, PAS-96 No. 4; April 1967
- (47) Krueger, Giarola, et al., "*The Effect of Electromagnetic Fields on Fecundity in the Chicken*"; Submitted to New York Academy of Sciences, 1974. As cited in Driscoll
- (48) Krueger, et al., "Influence of Low-Level Electric and Magnetic Fields on the Growth of Young Chickens", *Biomedical Science Instrumentation*, Vol. 9, 1972 as cited in Driscoll
- (49) *Application to the State of New York...*loc cit Vol. 1, Exhibit 4, pp 4.65-4.66
- (50) Personal communication from Mr. Harry Saddock, Superintendent of the Electric System Planning and Operations Division, RG & E and David Laniak, Supt. of Electric Meters and Labs.
- (51) Konig, "*Ultra-Low-Frequency Atmosphericics*", Electro-Physics Institute, College of Technology, Munich; 1960 as cited in Driscoll

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- (57) Dr. K. R. Shah, in Case 26559 in Direct Testimony, pp KRS-21, 22
- (58) Busby, Kennerth; Driscoll, Daniel and Washbon, Wallace, " *A Field Survey of Farmer Experience with 765kv Transmission Lines*", Nov. 18-20, 1974
- (59) Personal communication from Dr. Fred Haag, Director Noise Bureau,

