STATE OF CONNECTICUT
CONNECTICUT SITING COUNCIL

Northeast Utilities Service Company Application **to the Connecticut Siting Council for a Certificate of Environmental Compatibility and Public Need ("Certificate") For The Construction of a New 345-Kv Electric Transmission Line Facility and Associated Facilities Between Scovill Rock Switching Station in Middletown and Norwalk Substation In Norwalk, Including the Reconstruction of Portions of Existing 115-kV and 345-kV Electric Transmission Lines, the Construction of Beseck Switching Station in Wallingford, East Devon Substation in Milford, and Singer Substation in Bridgeport, Modifications at Scovill Rock Switching Station and Norwalk Substation, and the Reconfiguration of Certain Interconnections**

Docket No. 272

November 24, 2004

KEMA RESPONSES TO OFFICE OF CONSUMER COUNSEL'S FOURTH SET OF INTERROGATORIES (PARTIAL RESPONSE)

INTERROGATORIES:

OCC-32 Please refer to the KEMA Report, p. 9, stating that KEMA developed "a new 368-bus model" for its studies. Does KEMA believe that its model is fully equivalent to and consistent with the model used by the Applicant's consultant for its studies reported in this docket? Please explain any answer in specific detail.

A: The 368-bus system model was supplied to KEMA by the Applicant in ASPEN format. This model was also originally supplied to the Applicant's Consultant to build their EMTP model. KEMA built from this original ASPEN model the PowerFactory model used in its studies. KEMA has not had the opportunity to review the model used by the Applicant's consultant. Therefore, we cannot comment on the relative equivalence or consistency of the two models.

OCC-33. Harmonic performance. Refer to the KEMA Report, pp. 29-30.

(a) Did those aspects of the KEMA analysis implicating the Phase One transmission project assume or test any configurations for that project that differ from what actually is planned for its construction? Please explain any answer in specific detail.

A: No. Phase I was used only for comparison purposes. One HPFF cable for Phase I with Phase II in operation, is also one of the operational cases studied by the Applicant and their consultants.

(b) How does KEMA rank the relative importance of harmonic, transient, thermal and voltage, stability and short circuit performance when evaluating the reliability of various configurations for the Phase Two transmission project? Please explain any answer in specific detail.

A: All of these design criteria should be considered for a system to be reliable. Harmonic impedance calculations were used by KEMA, similar to the Applicant, as a screening tool for the different network configurations. KEMA has not established any ranking for these various performance criteria.

OCC-34. Refer to the KEMA Report, p. 69, Recommendation 3, stating that transient analyses should be performed.

(a) Does KEMA intend to do such transient analyses? If yes, when does KEMA expect the results of such studies to be available? If no, why not, and whom does KEMA propose could or should do such studies?

A: KEMA has not done any transient calculations on the specific configuration. We believe that the Applicant's consultant has performed some of these transient calculations since the summer, but no results have been made available. KEMA, as an independent consultant, will gladly contribute to these transient calculations in close cooperation with the Applicant, if and when required.

(b) Does KEMA believe that transient studies are required before a valid answer can be given to the question of how many miles of underground construction for the Phase Two project are compatible with electric system reliability?

A: Yes, if the transient analyses yield results that are not satisfactory, acceptable mitigation should also be evaluated before a final decision is made on the maximum length of undergrounding that is feasible.

OCC-35. <u>Transient performance</u>. Refer to the ROC Group Report, filed in this docket on August 16, 2004, and the studies conducted in connection with that report.

(a) Does KEMA believe that the transient performance of the SW CT electrical system must be acceptable for that system to be considered reliable?

A: Yes, but acceptable mitigation options should also be evaluated if the transient analyses do not yield satisfactory results.

(b) If no, why not? If yes, what does KEMA believe is the minimum acceptable level of transient performance for the SW CT electrical system, and what does KEMA believe is the preferable level of transient performance for the SW CT electrical system? Please explain any answers in specific detail.

A: KEMA has not established either "minimum acceptable" or "preferable" levels of transient performance.

OCC-36. Thermal and voltage performance. Refer to the Application, 10/9/03, Vol. 1, p. F-28 and the ROC Group Report, filed in this docket on August 16, 2004, and the studies conducted in connection with that report.

(a) Does KEMA believe that the thermal and voltage performance of the SW CT electrical system must be acceptable for that system to be considered reliable?

A: Yes.

(b) If no, why not? If yes, what does KEMA believe is the minimum acceptable level of thermal and voltage performance for the SW CT electrical system, and what does KEMA believe is the preferable level of thermal and voltage performance for the SW CT electrical system? Please explain any answers in specific detail.

A: The minimum acceptable levels of thermal and voltage performance for the SW CT electrical system are those that exactly meet the reliability standards established by the Applicant and NEPOOL. KEMA has not defined a "preferable" level of thermal and voltage performance for the SW CT electrical system.

OCC-37. Stability performance. Refer to the ROC Group Report, filed in this docket on August 16, 2004, and the studies conducted in connection with that report.

(a) Does KEMA believe that the stability performance of the SW CT electrical system must be acceptable for that system to be considered reliable?

A: Yes.

(b) If no, why not? If yes, what does KEMA believe is the minimum acceptable level of stability performance for the SW CT electrical system, and what does KEMA believe is the preferable level of stability performance for the SW CT electrical system? Please explain any answers in specific detail.

A: The minimum acceptable level of stability performance for the SW CT electrical system is that which exactly meets the stability standards established by the Applicant and NEPOOL. KEMA has not defined a "preferable" level of stability performance for the SW CT electrical system.

OCC-38. Short circuit performance. Refer to the Application, 10/9/03, Vol. 1, pp. F-29-30 and the ROC Group Report, filed in this docket on August 16, 2004, and the studies conducted in connection with that report.

(a) Does KEMA believe that the short circuit performance of the SW CT electrical system must be acceptable for that system to be considered reliable?

A: Yes.

(b) If no, why not? If yes, what does KEMA believe is the minimum acceptable level of short circuit performance for the SW CT electrical system, and what does KEMA believe is the preferable level of short circuit performance for the SW CT electrical system? Please explain any answers in specific detail.

A: The minimum acceptable level of short circuit performance for the SW CT electrical system is that which exactly meets the standards established by the Applicant and NEPOOL. KEMA has not defined a "preferable" level of short circuit performance for the SW CT electrical system.

OCC-39. Refer to the Application, 10/9/03, Vol. 1, pp. F-24-31, where the SW CT electrical system is described as inadequate to meet national and regional reliability performance standards.

(a) Does KEMA agree with this assessment of the present SW CT electrical system?

A: KEMA has made no independent evaluation of the Applicant's system assessment, as summarized in Volume 1 of the Application.

(b) How is such electrical system weakness measured and evaluated? How should it be measured and evaluated? Please explain any answer in specific detail.

A: To our knowledge there is no universally accepted definition of "electrical system weakness." In some instances "system weakness" is used to describe a system that is less "strong" than another system. In this context, system "strength" is a measure of the ability of a system to deliver power at a given location.

(c) Would construction of the transmission system configuration that KEMA recommends for further study (i.e., 10-20 miles of additional undergrounding) strengthen the SW CT electrical system?

A: From the KEMA report it is clear that with extended undergrounding both the system strength and system damping are increased over that for the SW CT system with Phase I improvements only.

(d) Would the construction of such a project (i.e., with 34-44 miles of undergrounding) fully resolve the present electrical system weaknesses found in SW CT?
A: A detailed analysis of all system weaknesses was not part of KEMA's harmonic analysis. With this amount of network extension a more reliable and interconnected system will result.

(e) If this transmission project were built with 34-44 miles of undergrounding, as KEMA has stated may be possible, would the SW CT electrical system still be relatively weak? Would it be measurably strengthened? Would it be decisively strengthened?

A: A detailed analysis of system weaknesses was not part of KEMA's harmonic analysis. However, it is clear from the harmonic impedance results that the proposed system will be significantly strengthened over the system with only the Phase I improvements.

OCC-40. Refer to the ROC Group Report filed in this docket on October 8, 2004, and specifically its analysis of "Case 7." Does KEMA agree with the ROC Group conclusion concerning STATCOM units, namely that no further consideration should be given to utilization of multiple STATCOM units as a mitigation measure? Please explain any answer in specific detail.

A: KEMA agrees that the use of multiple STATCOMS alone does not appear to be a feasible mitigation alternative due to its limited ability to keep the system's 1st harmonic resonance point above 3.0. However, the use of an additional 1 or 2 STATCOMS in conjunction with other mitigation, such as C-type filters, is worthy of further study.

OCC-43. Refer to the KEMA Report, p. 64, reporting the results of KEMA's analysis of underground construction for all of Segments 1 and 2 of the proposed project. Has KEMA concluded that it is definitely not possible to construct all 69 miles of this proposed project underground, based on system reliability considerations? Please explain any answer in specific detail.

A: Based on harmonic performance alone, KEMA has concluded this is not technically feasible. For undergrounding beyond 44 miles, first harmonic resonance points are approaching 3.0 even <u>with</u> mitigation from C-Type filters. ISO-NE has identified a first harmonic resonance point above 3.0 as a prerequisite for acceptability because of the potential for distortion and overvoltage due to harmonic amplification near the 2nd harmonic point.

OCC-44. Refer to the KEMA Report, p. 69, Conclusion 5, mentioning the difficulty of system operations when certain equipment is installed.

(a) Does KEMA believe that the difficulty of system operations is a factor that should be taken into account when evaluating whether an electrical system is reliable? Please explain any answer in specific detail.

A: Yes, system design and operability are inseparable factors in determining whether a given system alternative is reliable.

(b) Does KEMA believe that the SW CT electrical system will be more difficult to operate if the proposed project is constructed with 34-44 miles of undergrounding, with the additional filtering recommended, and with further mitigation measures included as appropriate?

A: KEMA has not made any studies to assess operational difficulties. KEMA does not believe these will be significantly greater than with 24 miles of underground cable.

OCC-56. Refer to the KEMA Report, p. 9. Where are the 368 busses located? Are all in SW CT, within the NU transmission system, or do they extend to all of the ISO-NE control area? How are ties to other areas modeled?

A: In the 368-bus system supplied by the Applicant, the buses are mainly located in SW CT with buses extended to most parts of Northern CT and to parts of Eastern CT. Systems beyond the modeled area were modeled using equivalents.

OCC-57. Other than the Phase I assets, how many miles of underground transmission lines are included in the 368-bus model? What type of cable is each of these, how long is each line, how are they modeled, and where are they located?

A: Data supplied to KEMA for lines of the 368-bus system other than Phase I contained information on positive and zero sequence impedance values only. The OCC could check with the Applicant for additional information about these lines.

OCC-58. Refer to the KEMA Report, p. 10. Please describe the PowerFactory computer program, its inputs and outputs, and how it functions.

*A: The **DIgSILENT PowerFactory** software is an integrated power system analysis tool that combines reliable and flexible system modeling capabilities, with state-of-the-art solution algorithms and a unique database management concept. The company's web site, http://www.digsilent.de/, provides a wealth of information about the capabilities of the software. Please visit company's web site and/or contact the company directly for detailed information.*

OCC-59. Refer to the KEMA Report, p. 13. Please identify all known power converters within the 368-bus model, provide their location, and describe how they were modeled.

A: Data received by KEMA did not indicate there were any converters with the modeled system. None were modeled.

OCC-60. Refer to the KEMA Report, pp. 23-24.

(a) How were the light and minimum generator dispatch conditions contained in Table 2 determined?

A: In Table 2, the light dispatch conditions are identical to the light dispatch conditions assumed by the Applicants consultant, GE, in its harmonic impedance studies. The "minimum dispatch" conditions in Table 2 are identical to the "light post project dispatch" used by GE.

(b) Were any other dispatch scenarios considered or utilized? How sensitive are the results to changes in this dispatch?

A: No other dispatch scenarios were utilized. A peak generator dispatch was considered but was not used because it would not stress the system as much as either the light or minimum generator dispatches.

(c) Would placing generation at Norwalk in-service affect the results?

A: We do not know because KEMA did not study this possibility. KEMA expects that such generation would be beneficial to harmonic performance.

OCC-61. Refer to the KEMA Report, p. 24. Would capacitors to perform voltage support be required more during heavy load periods or during light / medium periods?

A: Such capacitors would be required more during heavy load periods.

OCC-62. Refer to the KEMA Report, p. 25.

(a) Please describe the physical and electrical characteristics of XLPE and HPFF cables, as modeled in Powerfactory.

A: Detailed information about XLPE and HPFF cables could be found in many references. One of them is the EPRI's "Underground Transmission Systems Reference Book". In short, differences in the insulation material, the construction and the installation of cables would result in differences in their electrical parameters such as positive and zero sequence impedance including the charging capacitance, etc. In PowerFactory, a line is modeled using the positive and zero sequence line impedance values, regardless whether it is a cable or an overhead line.

(b) Explain why charging capacitance for XLPE is 60% of HPFF.

A: A XLPE cable generally has less charging capacitance than that of a HPFF cable, because it uses the insulation material and construction that is very different from that of a HPFF cable. The actual charging capacitance difference between cables depends upon the exact cables used for comparison. The data supplied by the Applicant indicate that a 3000 kcmil XLPE cable has approximately 60% of the charging capacitance of that of a 3000 kcmil HPFF cable.

(c) Explain how any differences in the physical and electrical characteristics (e.g., charging capacitance) of XLPE and HPFF cables affects the harmonic performance of the KEMA undergrounding proposal.

A: Assuming other conditions are the same (system short circuit level, line length, etc.), the higher the per-mile charging capacitance of a cable is, the lower the first resonance frequency of the system will be.

(d) How did KEMA treat such differences in its study?

A: KEMA used XLPE cable in its simulation cases, because it has lower per-mile charging capacitance which would allow for longer undergrounding than using a HPFF cable.

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