



M E M O R A N D U M

TO: Pamela Monroe, Administrator, NH SEC
FROM: Benjamin Cotts, Ph.D., P.E.
CC: Paul Kasper, Assistant Director, Safety and Security, NH PUC
Dena Champy, PMP, Eversource Energy,
Christopher Soderman, P.E., Eversource Energy,
DATE: April 18, 2019
PROJECT: 1501863.001 Seacoast Reliability Project (NH SEC Docket 2015-04)
SUBJECT: Protocol for Measurements of Electric and Magnetic Fields

To comply with the Order and Certificate of Site and Facility with Conditions issued by the New Hampshire Site Evaluation Committee (NHSEC) for the Seacoast Reliability Project on January 31, 2019, Eversource requested Exponent to provide a draft protocol for performing measurements of electric and magnetic fields (EMF) both before and after the Project is placed into service in consultation with the Safety Division of the New Hampshire Public Utilities Commission (PUC).

Order and Certificate of Site and Facility Condition

The Order and Certificate of Site and Facility with Conditions issued by the New Hampshire Site Evaluation Committee (NHSEC) for the SRP dated January 31, 2019 states that it is:

“Further Ordered that the Applicant, in consultation with the PUC Safety Division, shall measure actual electromagnetic fields associated with operation of the Project both before and after construction of the Project during projected peak-load, and shall file with the Administrator the results of the measurements; and it is,

Further Ordered that if the results of the electro-magnetic field measurements exceed the guidelines of the International Committee on Electromagnetic Safety (ICES) or the International Commission on Non-Ionizing Radiation Protection (ICNIRP), the Applicant shall file with the Administrator a mitigation plan designed to reduce the levels so that they are lower than the ICES or ICNIRP guidelines; and it is,

Further Ordered that the Applicant shall measure the level of the electro-magnetic field at Mr. Fitch’s property before and after construction of the Project;”

Proposed Measurement Protocol

The proposed measurement protocol is divided into several sections including Measurement Preparation, Measurement Procedure, and Reporting.

Measurement Preparation and Location Identification

Exponent and Eversource have reviewed in detail the configuration and the residential density along the route of the proposed F107 transmission line and have identified 11 segments of the proposed project route where measurements are proposed to be taken before and after construction of the Project. These 11 route segments cover all the proposed configuration types and are expected to conservatively evaluate electric and magnetic field (EMF) levels for the entire route.^{1,2} The criterion for initial site selection was to evaluate all F107 structure types (e.g., delta, delta with underbuild, underground etc.) and to combine segments where similar configurations are proposed. Next, specific locations were selected where the F107 line would pass by a higher density of residences than other segments of the route with similar configurations. These 11 route segments for which measurements are proposed are described in Table 1 by the Line Section in the Application, structure type, and beginning and ending structure numbers.

Table 1. EMF measurement section proposal

Measure #	Line Section (Application Section)	F107 Structure Type	Begin Segment Structure #	End Segment Structure #
1	Madbury S/S to Route 4 Xing	Delta	Madbury S/S	9
2	Underground through UNH Parking Lot	Underground	23	24
3	UNH to Durham S/S	Delta w/ underbuild	25	32
4	Packers Falls S/S to Newmarket Rd.	Delta w/ underbuild & adjacent line	49	59
5	Timber Brook Ln. to Sandy Brook Dr.	Delta w/ underbuild	64	70
6	Sandy Brook Dr. to Durham Point Rd.	Delta & adjacent line	71	93
7*	Durham Point Rd. to Little Bay Launch	Delta	96	100
8	Little Bay Xing	Direct bury	Shoreline on west side of Bay	
9†	Underground through Frink Farm	Underground	109	113
10	Fox Point Rd. to Spaulding Turnpike Xing	Delta & adjacent line	115	137
11	Crossing at Fox Run to Portsmouth S/S	Vertical & adjacent lines	138	Portsmouth S/S

* The Fitch property (291 Durham Point Road) is located along this portion of the route.

† Amended line section

Within each of these 11 cross sections of the route Exponent and Eversource will select one measurement location (preferably with at least one alternate location), which is anticipated to be appropriate for measurements both before and after the Project is placed into service. These

¹ Spot measurements of magnetic field levels were previously performed on August 8, 2018 beneath the existing transmission line and at various points on the property and inside the Fitch residence at 291 Durham Point Rd.

² No measurements are proposed for the small portion of the route between structures 102 and 109 where the proposed configuration changes rapidly (from underground to vertical, to delta to H-frame and back to underground) over a relatively small area. Each of these configurations is measured elsewhere on the route except for the two spans where the F107 line is proposed in an H-frame configuration. No measurements are proposed for this configuration because it represents a very small (2 spans) portion of the route and because the nearest residence to this configuration is more than 400 feet away.

locations ideally will have the following characteristics that increase the likelihood of obtaining good quality measurements:

- 1) Free from other sources of EMF which may affect measured levels (e.g., overhead/underground distribution lines) or other facilities which can alter measured EMF levels (e.g., water or sewer pipes, gas or oil pipelines).
- 2) Flat, level surface beneath the transmission lines (or above underground transmission lines) that is away from transmission line structures (ideally near midspan of lines).
- 3) Free of underbrush, trees or other conductive objects which is necessary in order to match the conditions for which the modeled the electric field was calculated.

Additionally, foul weather, particularly precipitation, will interfere with the function of instruments and the valid measurement of electric field levels. Exponent will therefore coordinate with utility personnel and the Safety Division to identify a time-frame with anticipated favorable weather conditions. This timeframe (or timeframes) will be discussed with Eversource to confirm that there are no expected line outages, construction or system repairs, or other unusual line conditions scheduled for that period. Additionally, utility personnel will work with appropriate departments to ensure that necessary data (e.g., loading information of all transmission lines at the measurement locations) can be logged and available during the proposed measurement period. Post-construction measurements will be made during summer peak loading season.

Measurement Procedure

At each identified measurement location, Eversource will clear underbrush and other conductive objects, if necessary, to facilitate access and minimize interference with the measurement of electric fields. Exponent engineers will then photo-document the condition of the ROW and transmission lines. Engineers will then lay a long measuring tape on the ground beneath the lines which will be used to identify the horizontal location of conductors. The vertical height of each conductor over the tape will be measured and recorded using an acoustic and/or optical line height sensor. The time and date of the field measurements will be noted so that the loading on each of the lines at the time of field measurements can be matched.

Engineers will then proceed to perform EMF measurements using measurement equipment and methodology outlined in Institute of Electrical and Electronics Engineers IEEE Standard 644-1994 (R2008) and IEEE Std. C95.3.1-2010. Measurements will be performed at a height of 1 meter above ground and will be performed for a transect perpendicular to the transmission line. If a transect other than perpendicular is necessary, the angle of the transect to the transmission lines will be noted and measurement distances will be adjusted accordingly.

Both electric fields and magnetic fields will be measured as the total field computed as the resultant of field vectors measured along vertical, transverse, and longitudinal axes.³ The magnetic-field will be measured in units of milligauss (mG) by orthogonally-mounted sensing coils whose output is recorded by a digital meter (EMDEX II) manufactured by Enertech Consultants. The electric-field will be measured in units of kilovolts per meter (kV/m) with a single-axis sensor accessory manufactured by Enertech Consultants for the EMDEX II meter. The single-axis sensor will be aligned sequentially along vertical, transverse, and longitudinal axes to capture the full vector electric field. These instruments meet the IEEE instrumentation standard for obtaining accurate field measurements at power line frequencies (IEEE Std.1308-1994). All meters and measurement accessories will be calibrated by the manufacturer using methods like those described in IEEE Std. 644-1994.

The Emdex II is calibrated annually by the manufacturer and receives a certificate of calibration. The most recent calibration certificates for the two Emdex II units to be used for these measurements are included in Appendix A. In addition, the EMDEX II will be checked each morning prior to measurements with a portable calibration coil to ensure that it maintains calibration throughout the measurement trip. If measurements before the Project is placed into service are taken at line loadings lower than peak levels, field levels will be adjusted for peak loading conditions on existing lines and the new SRP line for comparisons to values in Appendix 41 and 41a (as applicable) in the Petition.

Exponent and Eversource will provide 7 days' notice to the NHSEC and PUC prior to planned measurements. If inclement weather or other factors require rescheduling, Exponent and Eversource will provide the NHSEC and PUC as much notice as possible and provide regular updates on the status of planned measurements.

Report

Exponent will prepare two measurement reports: the first summarizing measurements taken before Project commences construction; and the second summarizing measurements taken after the Project is placed into service. These reports will detail the measurement methods and include aerial maps of each measurement location with annotations reflecting the specific locations of electric and magnetic field measurements as well as a graphical summary of both electric and magnetic field measurement results. The two measurement reports will each be submitted within 60 days of completion of the respective measurements. Consistent with the NHSEC Certificate of Site and Facility, measurement values performed outside of near-peak or peak loading conditions will be summarized in raw form and as adjusted to the peak loading condition specified in the application.

³ Measurements along the vertical, transverse, and longitudinal axes will be recorded as root-mean-square magnitude, which refers to the common mathematical method of defining the effective voltage, current, or field of an alternating current system.

Appendix A

EMDEX II Calibration Certificates

Certificate of Calibration

The calibration of this instrument was controlled by documented procedures as outlined on the attached Certificate of Testing Operations and Accuracy Report using equipment traceable to N.I.S.T., ISO 17025, and ANIZ540-1 COMPLIANT.

Instrument Model: EMDEX II

Frequency: 60 Hertz

Serial Number: 1134

Date of Calibration: 10/24/2018

Re-Calibration suggested at one year from above date.

EMDEX
LLC EMDEX-LLC
1356 Beaver Creek Drive
Patterson, California 95363
(408) 866-7266

H. Christopher Hooper
Calibration Inspector

Certificate of Calibration

The calibration of this instrument was controlled by documented procedures as outlined on the attached Certificate of Testing Operations and Accuracy Report using equipment traceable to N.I.S.T., ISO 17025, and ANIZ540-1 COMPLIANT.

Instrument Model: EMDEX II

Frequency: 60 Hertz

Serial Number: 3074

Date of Calibration: 7/5/2018

Re-Calibration suggested at one year from above date.

EMDEX
LLC EMDEX-LLC
1356 Beaver Creek Drive
Patterson, California 95363
(408) 866-7266

H. Christopher Hooper
Calibration Inspector