April 18, 2016

Mr. Robert Stein
Connecticut Siting Council
10 Franklin Square
New Britain, CT 06051

Re: Petition No. Petition 1217 - Bloomfield to Windsor Reliability Project

Dear Mr. Stein:

This letter provides the response to requests for the information listed below.

Response to CSC-02 Interrogatories dated 04/13/2016
CSC-020, 021

Very truly yours,

Kathleen Shanley
Manager
Transmission,Siting
As Agent for CL&P
dba EversourceEnergy

cc: Service List

Witness: **Witness Panel**
Request from: **Connecticut Siting Council**

Question:
According to The Connecticut Light and Power Company d/b/a Eversource Energy's (Eversource)
response to question two of the first set of interrogatories, double-circuit structures expose two
circuits to an outage as a result of a single event such as a lightning strike or tower failure. However,
is Eversource's preference for single-circuit structures a result of an ISO New England report or
study or policy, or a NERC practice or requirement, or is it a result of an internal Eversource best
management practice? Please explain the origin of the policy where two circuits are preferred to be
on separate structures as opposed to utilizing double-circuit structures.

Response:
The proposed double circuit tower (DCT) separation is not due to a "preference" of Eversource, but rather to applicable reliability criteria, in particular ISO-NE Planning Procedure 3 (PP-3). The origin of this requirement and Eversource's practice with respect to building and separating DCTs is as follows:

A. **<u>The Requirement that the Loss of Both Circuits on a DCT Be Modeled as a Single Contingency</u>**

The reliability standards, criteria, and procedures with which electric transmission systems must comply are promulgated at both national and regional levels. At the national level, the North American Electric Reliability Corporation (NERC) adopts standards that apply throughout the United States and Canada. These standards, when approved by the Federal Energy Regulatory Commission, are mandatory in the United States. The Northeast Power Coordinating Council (NPCC) adopts additional criteria that apply throughout the Northeastern United States. Finally, criteria and procedures adopted by ISO-NE, the regional planning authority for New England, apply throughout the New England states. NERC, NPCC, and ISO-NE standards, criteria, and procedures specify the contingencies that must be considered in planning studies. The NPCC and ISO-NE criteria must be consistent with all NERC standards. Thus, NPCC criteria may be more stringent than, but must at a minimum conform to, the NERC standards. Likewise, ISO-NE criteria may be even more stringent, but also must conform to the NERC standards and NPCC criteria.

The contingencies that these standards and criteria specify include DCT contingencies, that is, the simultaneous failure of both circuits supported by a common set of support structures. Such a failure could be due to events such as a structure failure or a lightning strike. The relevant provisions include:

- **NERC** TPL-001-4 requires modeling of a "Multiple Contingency Common Structure" event, which is defined as "the loss of any two adjacent (vertically or horizontally) circuits on common structure".
- **NPCC** Regional Reliability Reference Directory # 1, titled Design and Operation of the Bulk Power System, requires that the electric system withstand the "simultaneous fault on two adjacent transmission circuits on a multiple circuit tower.
- **ISO-NE** Planning Procedure 3 (PP-3), titled Reliability Standards for the New England Area Bulk Power Supply System, requires that the system withstand "simultaneous permanent phase-to-ground faults on different phases of each of two adjacent transmission circuits on a multiple circuit transmission tower, with normal fault clearing".

NPCC Directory 1 and ISO-NE PP-3 require that the system not only withstand the loss of such adjacent circuits as a first contingency (N-1) but also that it withstand such a loss as a second contingency (N-1-1). To simulate such an N-1-1 contingency, the loss of certain other system elements, including a generator or another transmission circuit is modeled, followed, after a short period to allow adjustments of the system, by the loss of the two adjacent circuits.

Unlike some other regional criteria, the ISO-NE criteria do not automatically exempt short segments of DCTs from contingency analysis. Thus, the ISO-NE criteria relating to DCTs are somewhat more stringent than required by the NERC and NPCC standards, and somewhat more stringent than criteria of other regional reliability organizations. They are nevertheless binding on all New England transmission owners.

B. Eversource's Consideration of DCTs in Transmission Planning

The requirement that DCT contingencies be addressed in planning studies does not mean that no new DCTs may be built, or that all existing DCTs must be separated. In fact, Eversource's existing transmission system (Connecticut, Massachusetts, and New Hampshire) has over 1,000 circuit miles of double circuit tower transmission lines, and when one or more new circuits are required, consideration is given to configuring the new circuit(s) as a DCT. In developing transmission solutions, the Eversource transmission planners may consider:

- Keeping existing double circuit towers
- Separating existing double circuit towers
- Building new double circuit towers

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The power flow analyses that transmission planners use to design the transmission grid both model the existing system, and also take into account anticipated future system loads and known future changes to generation and transmission system elements. The applicable reliability standards require that the system under study be tested to define its performance and to determine if that performance is acceptable. If there is an existing DCT in the study area, the loss of both circuits on the DCT will be modeled as a contingency in determining the performance of the existing system and in modeling how the system will perform with the addition of any new system element under consideration. Modeling the simultaneous loss of both circuits on an existing or a potential future DCT in these simulations may or may not result in a violation of the thermal and voltage performance criteria with which the system is required to conform. If the simultaneous failure of both circuits on an existing DCT does not violate any thermal or voltage criteria, then the existing DCT will not be disturbed (although as existing and anticipated system conditions change, the reliability impact of the DCT will continue to be monitored).

Separating Existing DCTs

Separating DCTs is never done arbitrarily. However, separation (or some other system improvement) is required in situations in which DCT's cause reliability criteria violations. Load growth, changes in generation patterns, or changes in the transmission system may increase system stress to the point where a violation occurs when the loss of a DCT is modeled, even though none existed in the simulations when the DCT was created. In such a case, the DCT must be separated, if that is the most cost-effective means of eliminating the criteria violation. To date, there are very few DCT's that have needed to be separated. Of course, when such a separation is required in Connecticut, the Council learns about it through an application or petition. In other cases, it may not come to the Council's attention that the separation of DCTs has been avoided. For instance, as part of the Southwest Connecticut Reliability Study, consideration was given to splitting approximately four (4) miles of double circuit towers emanating from the Frost Bridge 115-kV Substation. Eversource selected the lower cost option of rebuilding the Bunker Hill 115-kV Substation and leaving the four miles of DCT intact. (However, a current reassessment of the need for that construction in light of the addition to the system of the Towantic Generation Station and associated transmission improvements is likely to indicate that it is not needed.) Similarly, in the recently completed Greater Hartford Central Connecticut studies, a modeled overload of the 1704 115-kV line between the South Meadow and Southwest Hartford Substations was caused by the loss of either of two DCTs as a second contingency, and could have been addressed by separating those DCTs. However, the 1704 line overload could also be addressed by adding a 3% series reactor to that line at the Southwest Hartford Substation. The series reactor was chosen as the preferred solution because it was less costly and had fewer environmental effects.

Creating New DCTs
When considering new construction, transmission planners will not put two transmission circuits on a common structure if that would result in a criteria violation under the conditions modeled in the current study. They will also likely avoid doing so even if there is no current criteria violation, if they are aware of a potential change in system conditions that could result in a criteria violation within a relatively short time. On the other hand, where no criteria violations occur or are foreseen, planners may place two transmission circuits on a common structure. This practice is more often employed with two circuits of different voltages than with two circuits of the same voltage.

The recently completed GSRP (NEEWS) Project in Massachusetts and Connecticut illustrates Eversource's consideration of creating DCTs when a new line is constructed. A new 345-kV transmission line was constructed as part of that project. In Massachusetts, the available ROW did not provide sufficient room for constructing the new line on an independent set of structures, and the ROW could not practically be expanded. Therefore, the new 345-kV line was placed on common structures with a rebuilt 115-kV line that pre-existed within the same ROW, for a distance of approximately 23 miles (46 circuit miles.) . This configuration was possible because reliability studies showed that contingency events involving this proposed DCT did not violate reliability standards and that this configuration would be acceptable for the ensuing long term period.

In Connecticut, the available ROW provided sufficient room for constructing the new 345-kV line on its own set of structures (and still left an open position for a possible future line.) Therefore, in Connecticut the new 345-kV line was constructed on separate structures for its entire length (approximately 11.9 miles). Except for a short section where the Council ordered that a split-phase configuration be employed, the new line was placed on H-Frame structures, typically 90 feet tall, alongside an existing 115-kV circuit that was supported by structures that were approximately 70 feet tall. As compared to the DCT construction in Massachusetts, the Connecticut configuration:

- Cost less: (As shown in Eversource's application in CSC Docket 370, Vol. 1, Appendix O-1, pp. 4 and 9, the estimated cost of the 90' H-frame construction was $3,739,000 per mile and the estimated cost of the "composite" DCT configuration was $8,972,000 per mile; this comparison did not include the cost of line outages).
- Was less visible: (The typical height of the H-frame structures used in Connecticut was 90', whereas the typical height of the DCT structures used in Massachusetts was 130').
- Required less construction time.
- Did not require line outages
- Was less susceptible to a common mode failure.

Thus, for new construction, placing a new line on its own structures will usually be preferred to creating a DCT with an existing line, where that choice is available.

Witness: **Witness Panel**
Request from: **Connecticut Siting Council**

Question:
Is Eversource aware that double-circuit structures are utilized outside of ISO-NE territory such as
Consolidated Edison territory (under NYISO) and the 500-kV Susquehanna-Roseland Reliability
Project (under PJM)? From Eversource's perspective, are line voltages a factor in detertnining
whether or not to utilize double-circuit or single-circuit structures because higher voltages may
involve larger right-of-ways and require more space?

A. **DCTs in OTHER CONTROL AREAS**
Yes. Eversource is aware that double-circuit structures are utilized outside of ISO-NE territory, as they are within ISO-NE territory. (See the response to Q-CSC-20.) However, DCTs are not utilized in these other territories when they violate applicable reliability criteria.

As stated in response to the previous question, all NPCC utilities (which include those in NYISO) and PJM must model the "simultaneous fault on two adjacent transmission circuits on a multiple circuit tower" in their reliability studies. However, it is true that ISO-NE is more stringent than other control areas in that it does not provide for automatic exemption of short segments of DCTs. For instance, the PJM Region Transmission Planning Process states: "Contingency definitions for double circuit tower line outages shall include any two adjacent (vertically or horizontally) circuits on a common structure, but shall exclude circuits that share a common structure for one mile or less." This PJM document also states, "In addition to single contingencies, PJM planning criteria requires that the PJM system withstand certain common mode outages. These outages include line faults coupled with a stuck breaker, double circuit tower line outages, faulted circuit breakers and bus faults."

B. **Relevance of Space Requirements for Different Voltage Lines**
Where a new circuit is to be placed on a ROW alongside an existing circuit, and the planner has a choice of constructing the new circuit on its own set of independent structures, or rebuilding the existing line as a DCT, the designer will take into account the comparative cost of the two approaches, as well as the value of retaining an open position on the ROW for future use. For instance, when considering the construction of an overhead high voltage line on an existing ROW that cannot practically be expanded, the line designer might consider creating a DCT with the new line and an existing lower voltage line; reconstructing the existing line and

placing the new line on adjacent, independent vertical structures; and taking the lower voltage line off the ROW and reconstructing it underground in order to free up a position for a new higher voltage line. In each case, the decision will be determined by a combination of cost, and environmental considerations. Where the planner considers specifying a configuration that will preserve a position for a future line, he is likely to consider the space required for an 345-kV line if it appears likely that one may be built in the future on that ROW.

Response: