ROCKY MOUNTAIN POWER
A DIVISION OF PACIFICORP

1407 West North Temple
Salt Lake City, Utah 84116

Structure Loading Wind and Seismic

Background

One of the primary objectives of Rocky Mountain Power (RMP) standards is to "ensure uniform, safe and economical construction practices." The standards also clearly state the most restrictive code shall be followed in all cases. Therefore, the safest, not the most economical**,** standard shall apply.

Wind Loading:

Transmission structures in the United States are regulated by National Electric Safety Code (NESC) loading requirements. NESC has developed the loading requirements based on extensive research using past weather data. It is mandatory that all transmission utility companies adhere to the loading requirements specified by this code. As per the code, the three general loading requirements are as follows (1) Combined ice and wind (Rule 250B), (2) Extreme wind (Rule 250C) and (3) Extreme ice with concurrent wind (Rule 250D).

RMP has regulatory obligations to design and construct the proposed transmission line according to the NESC load cases. NESC requires that the transmission structures be designed to withstand the forces produced by a 90 mph wind. This is the same as the International Building Code (IBC) and ASCE 7 basic wind speed for all structures designed within the Tooele Valley. To increase the reliability and safety of the proposed line, RMP will be designing the 345 kV transmission poles using a wind speed of 110 mph. The 500 kV lattice towers will be designed for a minimum wind speed of 100 mph. The National Climatic Data Center (NCDC) maintains records of storm events in the United States. For the time period 1950 thru October of 2009, high wind events were infrequently reported with average wind speeds about 65 mph with a few reaching as high as 95 mph. These wind speeds are below RMP's design wind speeds.

Apart from the regulatory load cases, other load cases have been considered to ensure safe and reliable operation of the transmission line throughout its service life. These load cases are not regulatory requirements, but are developed from RMP's past experience of building, operating and maintaining thousands of miles of transmission lines throughout its service territory. These cases are –

- Failure Containment (load case related to broken conductor(s) or shield-wire(s))
- Anti-Cascading loading for select dead-end structures (to minimize cascade failure of multiple structures along a stretch of the line)
- Construction and Maintenance load cases (to avoid any unforeseen failure during construction of line as well as during routine maintenance)
- Uneven loading due to ice accumulation on one span and no ice on adjacent span resulting in unbalanced longitudinal forces.

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Seismic Loading:

Transmission lines have historically performed well in earthquake events. They are composed of relatively light weight structures at discrete locations, connected by flexible conductors. It should be noted that design of transmission lines and their structures are specifically excluded from coverage under the International Building Code (IBC). There are other codes to which the designs of transmission lines must adhere. These include the NESC, as previously mentioned, as well as several guidance documents published by the IEEE and ASCE. With regard to seismic considerations, ASCE 74, Guidelines for Electrical Transmission Line Structural Loading states, "Transmission structures are not typically designed for vibration caused by earthquakes because these loads are less than that of wind/ice combinations." By virtue of being designed to handle the wind and ice load combinations, transmission structures are inherently capable of withstanding earthquake induced forces.

Exceptions to these statements are; damage due to liquefaction induced settlement and failure due to surface fault rupture or fracture propagation through the soils in which the foundation is installed. The risks identified are associated with specific geologic hazards. RMP has conducted extensive research of available mapping of the geologic hazards in the Tooele Valley. An assessment of these hazards, as they relate to the transmission line, was prepared by Mr. Bill Black, PG as part of the desktop geotechnical effort. Mr. Black is one of the primary authors of the UGS publication discussing the geologic hazards of Tooele Valley. RMP mitigates these risks by avoiding the hazard whenever possible.

In some instances it has not been possible to completely avoid the risk associated with these hazards. Specifically, the transmission line is planned in areas where liquefiable soils are known to exist. Studies will be performed, using well accepted engineering principles, to ascertain the amount of potential liquefaction induced settlement. The settlement will be accounted for in the design.

Foundations cannot be designed to handle the forces that they would experience if a fault were to propagate through the soils in which they are installed. Preliminary structure locations have been compared to the mapped fault rupture data. Where appropriate, structures have been relocated incorporating setbacks to avoid the mapped surface trace of ruptures. Due to the limitations of the mapped data, as part of the design process, structure locations, in areas identified to be close to the mapped traces, will be staked. A site assessment will be performed by a licensed engineering geologist to ascertain the actual relationship of the structure location to the surface trace. Some fault crossings will be unavoidable. In these instances, the transmission line will be designed to include features that permit the ground to move without causing the structure to fail. In short, the crossing will be configured such that slack is introduced in the conductors if the ground ruptures.

Transmission lines are designed and constructed with safety as a primary concern. From the above discussion, it can be concluded that RMP does not settle for the regulatory minimum values for design and construction of its transmission lines.