Lyman Moulton
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Electrical Engineer
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Salt Lake City, Utah 84095
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Re: UTAH PUBLIC SAFETY COMMISSION

FOR THE ROCKY MOUNTAIN POWER DRAPER TO SOUTH JORDAN UPGRADE,
SOUTH JORDAN CITY, SALT LAKE COUNTY, UTAH

LYMAN MOULTON, Property Owner affected by RMP Draper to So.Jordan Upgrade	**AFFIDAVIT** For submission to Utah Public Safety Commission, April 29, 2019

COMES NOW, LYMAN MOULTON, being first duly sworn, deposes and says under oath:

1. I, Lyman Moulton, have contacted 10 Engineering firms to get a NESC (National Electrical Safety Code) Right of Way (ROW) number for the proposed 138kV upgrade line in my backyard, in the absence of information prayed for and solicited from RMP and their PE Vernon Black:

2. All statements made herein are true and accurate to the best of my knowledge, information, engineering and legal due diligence.

3. I am competent to testify on the above-named matters due to my Bachelor of Science Electrical Engineering BSEE from the University of Utah and my Juris Doctor from the

Franklin Pearce School of Law New Hampshire and my active Utah bar license 11928 and my active Patent Attorney Registration 59449 and would so testify if called upon to do so in court.

4. On April 24, 2019, I contacted PE and Structural Engineer Greg Parent of Ultieg consulting, licensed in Utah. His reply, "Hello, Lyman, this is Greg Parent calling you back. As I mentioned to you earlier, I talked to a few of the 'higher ups' here and ***they may not really be interested in us pursuing kinda getting into litigation against a utility. But, I checked a couple things on my end, I definitely think that the horizontal required offests that you need from NESC that were shown on my testimony (May 18, 2018 New Mexico, Public Record), but plugging in numbers for a 138(kV), you would need 9.5 feet from the edge of the conductors to the edge Right of Way, since you have two circuits (both sides), 9.5 feet times two, plus the width of those circuits, you are probably looking at a bare minimum of 25 to 30 feet of ROW with no wind blowing against it (his testimony adds 14.6 feet for wind one side 345kV line), just at rest (from NESC Rule 234). So ten feet violates that but i***t depends on agreements you have for your property and their ROW if they can blowout onto your land. Regarding if you want to look at it further contact Exponent, we have used for a safe distance, that is what they do." See Exhibit A, (iphone voicemail recording available)

5. I also asked Greg Parent if he could give me an audible noise evaluation as required by the **Environmental Protection Agency (EPA) in 1974 set at 55dBA limit** in their published Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety for outdoor noise threshold that would prevent

activity or annoyance. See page 8 of Exhibit A. Greg included this analysis in his testimony but said he couldn't help me because his company had a possible conflict of interest in doing business with RMP. **RMP has never addressed this noise requirement from the EPA for the Draper to South Jordan Upgrade Transmission Lines in any of the public hearings on the same**.

6. **Per the NESC, the Draper to South Jordan Transmission line upgrade of this Affidavit falls in Extreme weather and Extreme Wind loading regions and the blowout (swing of the transmission lines under load) is extreme and needs to be added to any Right of Way determination.** See NESC Exhibit B, pages 148, 149 and 151.

7. Per the NESC tables as published in the TC 151 Transmission Control Standard, published April 18th, 2017 for RMP employees, quote, "This standard provides minimum clearances of wires, conductors, cables and equipment from buildings, as required by the **NESC Rule 234.** Table 1, 98kV to 140kV, Elevation 3301 to 6300, a 9.4 feet horizontal clearance required without wind times 2 circuits each side, Table 2 same parameters a 8.9 feet horizontal clearance required by wind times two circuits each side, plus the 12.6 feet conductor to conductor spacing measured on actual 138kV poles. Pg 1 same TC 151: "For transmission line construction it is strongly recommended that a construction tolerance of three (3) feet be added to the clearances listed in this standard to ensure that the NESC minimum clearances are met under the worst loading conditions, therefore **the NESC required ROW is at least 52.2 feet = 9.4*2 + 8.9*2 + 12.6 + 3.0 ft).** See attached Exhibit C.

8. RMP Siting Transmission Lines and Substations Dec. 3, Electrical Plan Task Force, (see attached Exhibit D) pg 12, "Minimum width of the right-of-way required for a transmission line is set by the National Electrical Safety Code, Takes into account conductor blowout, how far the wire can be expected to swing during a high wind on a hot day," pg 13, "**138kV Transmission Right of Way, Single Pole (Double Circuit) Typically 60 feet ROW,"** pg 31 South Jordan Substation included.

9. Also on April 24th, 2019 I contacted Exponent Engineering consulting and spoke with a Paul Bennet who said their hourly rates were over $500 an hour and referred me to a Mike Lowe of Knott Labs (303 514-8467). He said in an email that he and company could not help me at the present time but maybe in the future. I replied for a 2 to 3 week timeframe and he hasn't returned my email asking to contract with his firm for a ROW number per the NESC.

10. On April 3, 2019 I personally contacted a Kevin Hill of Hunt Electric (801 975-8844) who told me a ***ROW number for a 138kV line in South Jordan would be approximately 53.6 feet to 60ft from a NESC*** conductor to conductor spacing of 13.6 feet PLUS 20 feet blowout on each side. He said other factors such as span, wire weight and pole height would influence the NESC numbers. I asked if I could have a Professional Engineering number from him and he said he couldn't help me when I mentioned it was for a dispute with RMP.

11. Also, on April 3, 2019 I contacted a Gretchen Horn of GAI Consultants, Florida She informed me an analysis on PLS CADD simulation (Power Line System Computer Added

Design) would cost me several thousand dollars. She said she would call me back for a single span quote. She never returned my calls.

12. Also, on April 3, 2019 I contacted a ICPE consulting in Midvale UT (801 255-1111) for a ROW Width determination. My calls were not returned.

13. Also, on April 3, 2019 I contacted a Fernando Rodriguez of ECF consulting(561 471-4029) for a ROW clearance evaluation and remediation. My calls were never returned.

14. Also, on April 3, 2019, I contacted a Bryan Shore of Stanley Consultants SLC office (1-800-553-9694) and was told a blowout ROW calculation and simulation would cost $10,000 to $15,000 and a single span simulation would cost $3000 to $4000.

15. Also, on April 3, 2019 I contacted ECI to speak to Mr. Vernon Black who has contracted with RMP to design this Draper to South Jordan Upgrade. I left a voicemail for him asking for information regarding the Draper to South Jordan 138kV RMP upgrade which he never returned.

16. Also, on April 3, 2019 I contacted a Sean Jurica of McCord Consulting Texas (979 764-8356) for transmission line consulting . He said ROW was both a matter of politics and engineering and would call me back with an estimate of services but he never did call me back.

17. Also, on April 3, 2019 I contacted an Andrew Ackerman of NEI consulting (303 431-7895) but he never returned my call.

I declare under Utah Code Section § 78B-5-705 and criminal penalty of the State of Utah that the foregoing is true and correct.

DATED this 29th day of April, 2019.

Lyman Moulton

STATE OF UTAH
COUNTY OF: Salt Lake
ON THE 29th DAY OF April, 2019
PERSONALLY APPEARED BEFORE ME
Lyman Moulton SIGNER(S) OF THE ABOVE INSTRUMENT, WHO DULY ACKNOWLEDGED TO ME THAT HE/SHE/THEY EXECUTED THE SAME

NOTARY PUBLIC

NOTARY PUBLIC
TERESA HEIN
Commission No. 693999
Commission Expires
MARCH 15, 2021
STATE OF UTAH

Exhibit A Lynn Moulton

VIRTUE & NAJJAR, PC

LAWYERS

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May 18, 2018

FILED IN OFFICE OF
MAY 1 8 2018
NM PUBLIC REGULATION COMM
RECORDS MANAGEMENT BUREAU

HAND – DELIVERED

Melanie Sandoval
Record Bureau Chief
New Mexico Public Regulations Commission
1120 Paseo de Peralta
Santa Fe, NM 87501

The Corona Wind Companies Case No. 18-00065-UT.
Supplemental Testimony of Greg Parent.

Dear Ms. Sandoval:

Enclosed for filing, please find an original and five copies (plus a sixth copy for conforming for our records) of the ***Supplemental Testimony of Greg Parent*** pursuant to the Hearing Examiners' Order Granting Joint Applicants' Expedited Motion to Submit Supplemental Testimony of Greg Parent dated May 18, 2018.

Please contact me at your earliest convenience with any questions or comments.

Sincerely,

Carla R Najjar

Daniel A. Najjar
Carla R. Najjar
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Attorneys for the Corona Wind Companies

Exhibit A
Lyman Moreton
Ulteig 888 858 3441
Greg Parent 720 873 5789

Ulteig Engineering
Project Name: Corona Wind Farm Project
Required NESC Horizontal Clearances - Rule 234B1a & 234B1b
Engineer: Greg Parent
Date: 04-19-18

Ulteig
We listen. We solve.™

(VN) = Nominal Opperating Voltage Phase-Phase (kV) $V_N := \sout{345\ kV}$ 138 kV

(VM) = Max Transient Overvoltage Phase-Phase (kV) $V_M := 1.05 \cdot V_N = \sout{362.25\ kV}$ 144.90

(Elev) = Design Elevation (ft) $Elev := \sout{7100\ ft}$ 4226

(CHAR) = Required Horizontal Clearance At Rest (ft) NESC RULE 234B1a

(CH@6psf) = Required Horizontal Clearance under 6psf (ft) NESC RULE 234B1b

(CH@100mph) = Recomended Horizontal Clearance under 100mph

$$CH_{AR} := 7.5\ ft + \left((50\ kV - 22\ kV) \right) \cdot \left(\frac{0.4 \frac{in}{kV}}{12 \frac{in}{ft}} \right) + \left(\frac{V_M}{\sqrt{3}} - 50\ kV \right) \cdot \left(\frac{0.4 \frac{in}{kV}}{12 \frac{in}{ft}} \right) \cdot 1.03^{\frac{Elev - 3300\ ft}{1000\ ft}}$$

$$CH_{AR} = 14.369\ ft$$

$$CH_{@6psf} := 4.5\ ft + \left((50\ kV - 22\ kV) \right) \cdot \left(\frac{0.4 \frac{in}{kV}}{12 \frac{in}{ft}} \right) + \left(\frac{V_M}{\sqrt{3}} - 50\ kV \right) \cdot \left(\frac{0.4 \frac{in}{kV}}{12 \frac{in}{ft}} \right) \cdot 1.03^{\frac{Elev - 3300\ ft}{1000\ ft}}$$

$$CH_{@6psf} = 11.369\ ft$$

$$CH_{@100mph} := 345\ kV \cdot \frac{0.1 \frac{in}{kV}}{12 \frac{in}{ft}} \cdot 1.03^{\frac{Elev - 3300\ ft}{1000\ ft}}$$

Assuming 10kV per inch dielectric constant for air

$$CH_{@100mph} = 3.217\ ft$$

180' ROW

JOSHUA E. POTTS
NEW MEXICO
23051
LICENSED PROFESSIONAL ENGINEER

5-17-2018

A. Mr. Price states on page 6, lines 11-13 of his testimony an explanation for how ROW width is determined. He states that generally the ROW width required for an electric high voltage transmission line is determined by required access for the construction, operation, and maintenance of the line and for National Electric Safety Code ("NESC") compliance. I agree with this testimony but would also add compliance with the requirements of the Environmental Protection Agency ("EPA") as an additional factor in determining the width of a transmission facility. Additionally, on page 7, Mr. Price explains the need for the 180-foot ROW for the proposed Corona Gen-Tie Transmission System. I agree with his statements completely but add as an additional factor in warranting the 180-foot ROW width the need for compliance with the recommended audible noise restrictions. EPA requirements for audible noise levels at the edge of the ROW are in the interest of the landowners and intended to reduce the audible noise impact off the approved transmission ROW.

Q. CAN YOU ELABORATE ON THE BASIC DESIGN CONDITIONS YOU EVALUATED IN DETERMINING THAT A 180-FOOT ROW WAS REQUIRED FOR THESE PROJECTS?

A. Yes. Preliminary design considerations include geotechnical soil studies, topographical surveys and wind and weather conditions to determine a range of preliminary specifications for equipment and infrastructure for the proposed location for the proposed transmission and interconnection facilities. The loading conditions for the transmission lines follow the requirements stated in the National Electric Safety Code (NESC-2017). We analyzed the required ROW width for the following load cases:

1. NESC 234.C.1.a (At Rest)
   a. 0 psf wind pressure acting perpendicular to the conductor

b. 60 deg Fahrenheit ambient temperature.

2. NESC 234.C.1.b (6 psf Wind)

    a. 6 psf wind pressure acting perpendicular to the conductor

    b. 60 deg Fahrenheit ambient temperature

3. NESC 250B – Heavy Loading District Loading without load factors

    a. 4 psf wind pressure acting perpendicular to the conductor

    b. ½" of radial ice

    c. 0 deg Fahrenheit ambient temperature

4. NESC 250C – Extreme Wind. The wind load map in NESC 250C matches the basic wind speed map in the American Society of Civil Engineers – Minimum Design Loads for Building and Other Structures - ASCE 7-05. The Corona Wind Project extends over a large region. The extreme wind speed varies over this region. Part of the Corona Wind project is in the 90-mph wind speed region but also extends into a "Special Wind Region". These special wind regions experience higher wind speeds than 90mph. Pattern has determined that the extreme wind speed for these special wind regions should be set at 100mph. For consistency the extreme wind speed for the entire project has been set to 100mph whether it is inside or outside the special wind regions.

    a. 100 mph wind speed (25.6psf) acting perpendicular to the conductor

    b. 60 deg Fahrenheit ambient temperature

Under these conditions, and the aforementioned considerations, we evaluate the clearances, conductor movement, and structure deflection to calculate span lengths and structure types and configurations.

Q. DO YOU BELIEVE THAT THE CRITERIA YOU RELIED UPON IN DETERMINING THE NECESSITY FOR A 180-FOOT ROW REASONABLE?

A. Yes. These criteria are appropriate and consistent with the accepted practice within the industry. I have designed approximately a dozen 345kV transmission lines and the right of way widths for those projects ranged between 150ft – 200ft. The variations in right of way width for these projects depended on design spans, structure types and audible noise requirements that were used on each line.

Q. DO YOU HAVE EXHIBITS SUPPORTING YOUR CALCULATIONS THAT WARRANT THE 180-FOOT ROW WIDTH THAT THE JOINT APPLICANTS' REQUEST IN THIS PROCEEDING?

A. Yes. Please see the attached exhibit titled GP-1.

Q. PLEASE EXPLAIN THE INFORMATION CONTAINED IN EXHIBIT GP-1.

A. Page 1 of this exhibit provides the calculations for the NESC required horizontal clearances from the transmission line conductor to building structures for NESC Rules 234B1a, 234B1b. Also provided is the recommended horizontal clearance when the transmission line is subject to 100mph wind speed. The above clearances have been adjusted for an altitude of 7100ft. The following pages of this Exhibit GP-1 illustrate the results of the blowout analysis for three different structure types. The three structure types are as follows:

- Double Circuit Steel Monopole,
- Single Circuit Steel Monopole
- Single Circuit Wood H-Frame.

The actual structure types that will be used on this project have not yet been determined and will depend on material lead times, material costs and construction cost of the different structure types. It is critical that the ROW be wide enough to accommodate any of the above structure types.

To determine conductor blowouts and pole deflections each structure type was modeled using a bundled (2) 954kcmil ASCR "Cardinal" conductor per phase. A 1300 ft design span between structures was assumed. Actual design spans could vary depending on the topography. A design span of 1300ft would likely be a maximum design span. Pole heights were determined to provide adequate vertical clearance under the conductor during maximum operating temperature at mid-span assuming flat terrain.

Each structure type was analyzed under the following four different load cases:

1. NESC Rule 234B1a – [At Rest Condition, 0 psf wind, 60 degF]
2. NESC Rule 234B1b – [6psf Condition, 6 psf wind, 60 degF]
3. NESC Rule 250B – Heavy Region [4psf wind, ½" Radial Ice, 0 degF]
4. NESC Rule 250C – Extreme Wind [100 mph (25.6 psf), 60 degF]

To determine the conductor blowouts and pole deflections, each structure type and each load case was modeled in the transmission line design software PLS-CADD. The results of the required right of way width are illustrated in Exhibit GP-1. The controlling structure type and load case were the single circuit wood H-Frame under NESC Rule 250C – Extreme Wind [100 mph (25.6 psf), 60 degF]. This structure type and load case would require a minimum right of way width approximately 177'-5" wide, which is just shy of the requested 180'-0" Right of Way width. A detailed analysis of the H-Frame structure under the 250C – Extreme Wind case is provided in the last (4) pages of Exhibit GP-1. This structure and load case control the Right of Way width.

Another calculation that was performed was the audible noise volume that would be heard at the edge of the right of way. In 1974, the Environmental Protection Agency (EPA) published *Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety* in which the EPA set 55dBA as the outdoor noise threshold that would prevent activity interference or annoyance. Many utilities I have worked with have a 50dBA noise threshold limit at the edge of the right of way. Page 14 of Exhibit GP-1 shows the calculations of the audible noise for the Single Circuit Wood H-Frame structure. In this analysis the audible noise produced by the transmission line would be 49.61 dBA 90ft from the transmission line center line (90ft x 2 = 180ft ROW). With the transmission line centered in a right of way width of 180ft the audible noise produced is just under the recommended 50dBA limit. From the analysis performed to determine required ROW widths, it is my opinion that a right of way of 180ft is appropriate for this line.

Q. DOES THIS CONCLUDE YOUR TESTIMONY?

A. Yes.

CERTIFICATE

Exhibit B

By Authority Of

THE UNITED STATES OF AMERICA

Legally Binding Document

By the Authority Vested By Part 5 of the United States Code § 552(a) and Part 1 of the Code of Regulations § 51 the attached document has been duly INCORPORATED BY REFERENCE and shall be considered legally binding upon all citizens and residents of the United States of America. *HEED THIS NOTICE*: Criminal penalties may apply for noncompliance.

Document Name: IEEE C2: National Electrical Safety Code

CFR Section(s): 7 CFR 1755.503(d)(1)

Standards Body: Institute of Electrical and Electronics Engineers

APPROVED

Official Incorporator:

THE EXECUTIVE DIRECTOR
OFFICE OF THE FEDERAL REGISTER
WASHINGTON, D.C.

Section 25.
Loadings for Grades B and C

250. General Loading Requirements and Maps

A. General

1. It is necessary to assume the wind and ice loads that may occur on a line. Two weather loadings are specified in Rules 250B and 250C. Where both rules apply, the required loading shall be the one that has the greater effect.
2. Where construction or maintenance loads exceed those imposed by Rule 250A1, which may occur more frequently in light loading areas, the assumed loadings shall be increased accordingly.
3. It is recognized that loadings actually experienced in certain areas in each of the loading districts may be greater, or in some cases, may be less than those specified in these rules. In the absence of a detailed loading analysis, no reduction in the loadings specified therein shall be made without the approval of the administrative authority.

B. Combined Ice and Wind Loading

Three general degrees of loading due to weather conditions are recognized and are designated as heavy, medium, and light loading. Figure 250-1 shows the districts where these loadings apply.

NOTE: The localities are classified in the different loading districts according to the relative simultaneous prevalence of the wind velocity and thickness of ice that accumulates on wires. Light loading is for places where little, if any, ice accumulates on wires.

Table 250-1 shows the radial thickness of ice and the wind pressures to be used in calculating loads. Ice is assumed to weigh 913 kg/m^3 (57 lb/ft^3).

C. Extreme Wind Loading

If no portion of a structure or its supported facilities exceeds 18 m (60 ft) above ground or water level, the provisions of this rule are not required, except as specified by the addition in Rule 261A1. Where a structure or its supported facilities exceeds 18 m (60 ft) above ground or water level the applicable horizontal wind speed of Fig 250-2, determined by the linear interpolation, shall be used to calculate horizontal wind loads which shall be applied to the entire structure and supported facilities without ice loading with the applicable shape factors in Rules 251A2 and 252B2. The following formulas shall be used to calculate wind loads on projected areas:

$$\text{load in newtons} = 0.613\,(V_{m/s})^2 \times \text{shape factor} \times \text{projected area } (m^2)$$

$$\text{load in lb} = 0.00256\,(V_{mi/h})^2 \times \text{shape factor} \times \text{projected area } (ft^2)$$

Table 250-2 lists the conversions of velocities to pressures for typical wind speeds as calculated by the formulas listed above with a shape factor of 1.0.

Figure 250-2 is a wind map of the contiguous United States and Alaska reproduced from ASCE 74. For Hawaii and Puerto Rico, the basic wind speeds are 36 m/s (80 mi/h) and 42 m/s (95 mi/h), respectively.

NOTE: Wind velocity usually increases with height; therefore, experience may show that the wind pressures specified herein need to be increased.

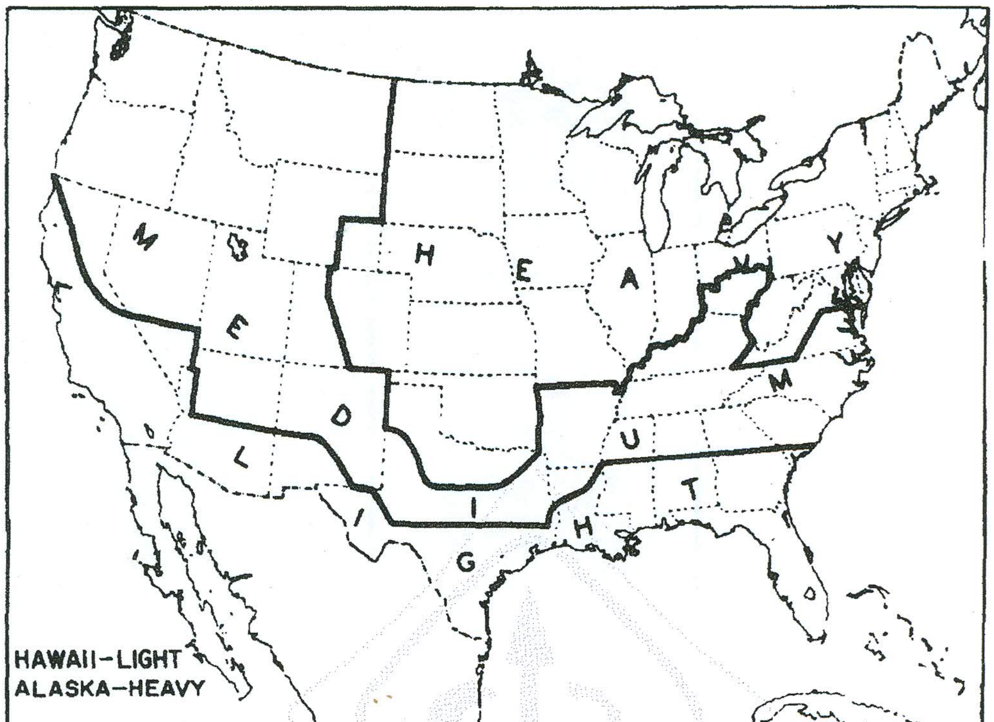
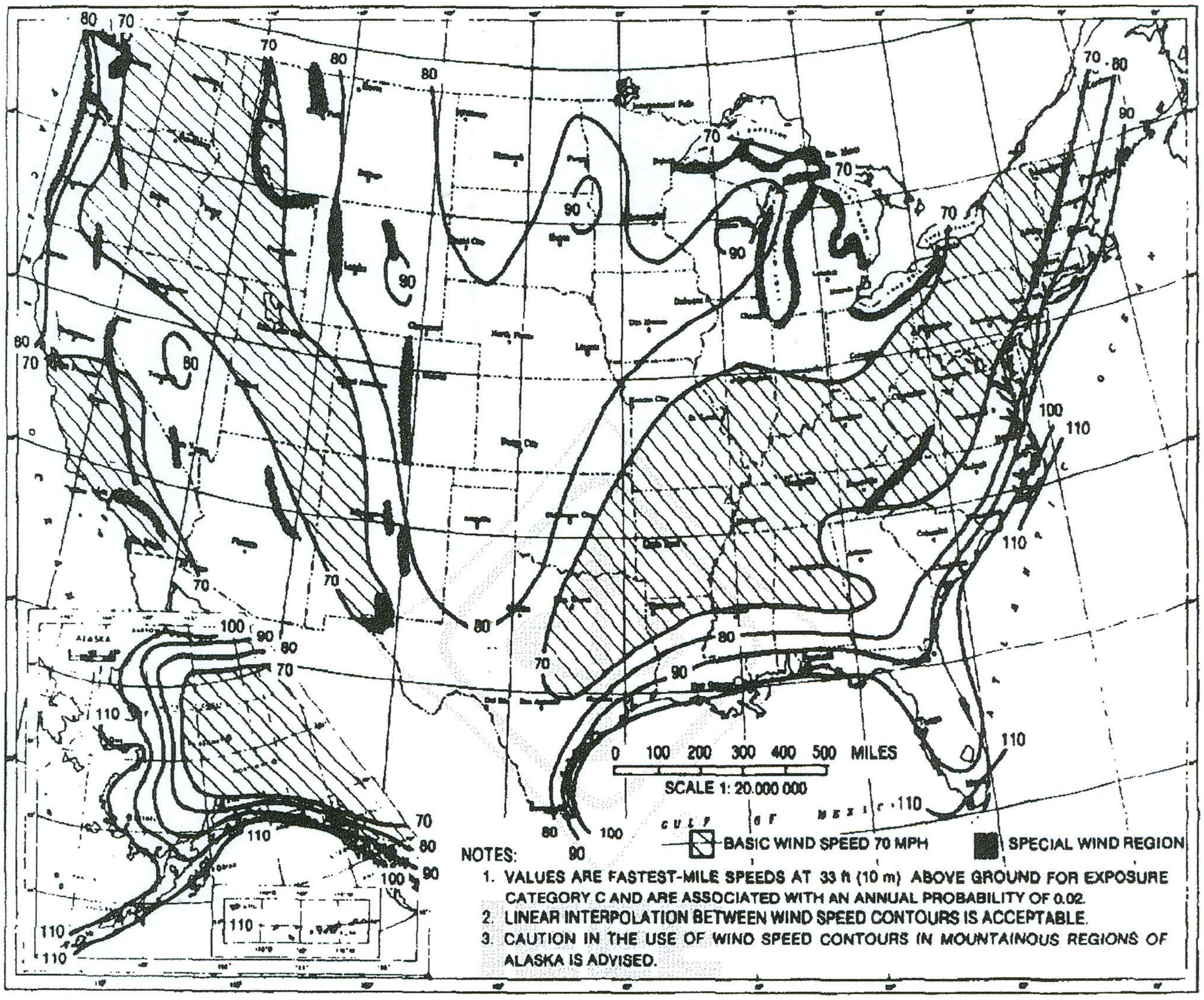


Fig 250-1
General Loading Map of United States
with Respect to Loading of Overhead Lines



This figure is reproduced from ASCE 74, Guidelines for Electrical Transmission Line Structural Loading, by permission of the American Society of Civil Engineers.

Figure 250-2
Basic Wind Speed (miles per hour)

Exhibit C, Lynn Moulton

TC 151 Clearances of Wires, Conductors, Cables, and Equipment from Buildings, Bridges, and Other Installations

Disclaimers

Disclaimer for Rocky Mountain Power and Pacific Power employees: this standard provides a reference to the National Electric Safety Code and has been expanded to cover common voltages used by Rocky Mountain Power and Pacific Power. As an estimator or designer you are responsible for verifying that this standard is current and that additional clearance requirements including but not limited to elevation adders, state and local rules or regulations are applied appropriately or in concert with this standard.

Disclaimer for Contractors: this standard is developed for internal company use **only** and is provided as a reference document. Contractors are responsible for understanding and adhering to all federal, state and local rules and regulations which may supersede this standard.

Purpose

This standard provides minimum clearances of wires, conductors, cables and equipment from buildings, bridges, swimming pools, and other installations as required by the National Electrical Safety Code (NESC) Rule 234. These minimum clearances must be maintained on all lines operated by Rocky Mountain Power and Pacific Power in the states of Utah, Wyoming, Idaho, Oregon, and Washington. These clearances do not apply in the state of California where General Order No. 95 is the governing regulation.

Scope

This standard contains extrapolated tables for company use from Rule 234 of the 2017 edition of the NESC. This standard also contains tables that were not provided by the code, but were derived from applicable sections of the NESC Rule 234 (2017). Since the NESC (2017) provides clearance values for voltages up to 22 kV or 50 kV line to ground, highlighted sections of the tables were developed to include clearance values for higher voltages used by the company. These values incorporate elevation adder and/or voltage adder for all applicable line voltages and were calculated based on the NESC Rule 234G1 and 234G2 (2017).

NOTE 1: text in this font, that follows "NESC Rule" headings in this document is taken directly from NESC C2-2017 (National Electrical Safety Code® (NESC®) (Accredited Standards Committee C2-2017). All rights reserved. Figure titles, table headings, and footnotes indicate figure or table content that has been taken directly from NESC C2-2017.

NOTE 2: it is the user's responsibility to ensure that the calculated clearances are compliant with the most current edition of the NESC.

Additional Clearances

1. **Construction Tolerance** – line construction has many aspects that have inherent variability, which include but are not limited to mapping inaccuracies, structure setting depth variations, and conductor sag variations. For transmission line construction it is strongly recommended that a construction tolerance of three (3) feet be added to the clearances listed in this standard to ensure that the NESC minimum clearances are met under the worst loading conditions.

ROCKY MOUNTAIN POWER   PACIFIC POWER

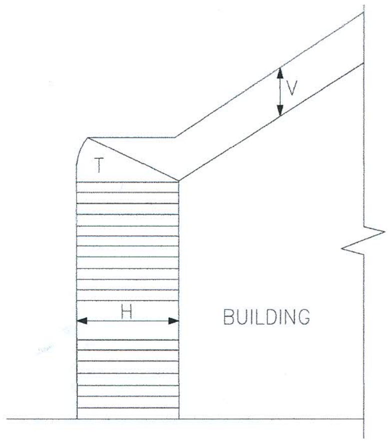


Figure 2—Transitional Clearance when H is Greater than V

NESC Rule 234B (2017) Clearances of Wires, Conductors, and Cables from Other Supporting Structures

Wires, conductors, or cables of one line passing near a lighting support, traffic signal support, a supporting structure of a second line, or intermediate poles in skip-span construction, without being attached thereto, shall have clearance from any part of such structure not less than the following:

Horizontal Clearances

Table 1—Horizontal Clearance of Conductors from Other Supporting Structures NO WIND‡

Note: Table cell revisions are in the company's green table revision style and also italicized to help them stand out.

Conductor or cable	Horizontal clearance required without wind (ft.)			
	Elevation: Sea level to 3300 ft.	Elevation: 3301 to 6300 ft.	Elevation: 6301 to 9300 ft.	Elevation: 9301 to 12300 ft.
Up to 22 kV phase-to-ground (ft.)†	5.0	5.0	5.0	5.0
22 kV to 70 kV phase-to-ground 115 kV phase-to-phase (ft.)	*6.6*	*6.8*	*6.9*	*7.1*
70 kV to 84 kV phase-to-ground 138 kV phase-to-phase (ft.)	*7.1*	*7.3*	*7.5*	*7.7*
84 kV to 98 kV phase-to-ground 161 kV phase-to-phase (ft.)	*7.6*	*7.9*	*8.1*	*8.4*
98 kV to 140 kV phase-to-ground 230 kV phase-to-phase (ft.)	*9.0*	*9.4*	*9.8*	*10.1*
140 kV to 210 kV phase-to-ground 345 kV phase-to-phase (ft.)	*11.3*	*11.9*	*12.5*	*13.1*
210 kV to 318 kV phase-to-ground 500 kV phase-to-phase (ft.)	*14.9*	*15.8*	*16.7*	*17.6*

† **EXCEPTION:** For effectively grounded guys and messengers, insulated communication conductors and cables, neutrals meeting Rule 230E1, and cables of 300 V or less to ground meeting the requirements of Rule 230C1, 230C2, or 230C3, the horizontal clearance may be reduced to 900 mm (3 ft.).

ROCKY MOUNTAIN POWER PACIFIC POWER

‡ The NESC (2017) does not provide a table for horizontal clearances (*without* wind) of wires, conductors, or cables from other supporting structures. The base value of 5.0 ft. was obtained from the NESC Rule 234B1a (2017), and the voltage and elevation adders were calculated from the NESC Rule 234G1 and 234G2 (2017). The calculated values were rounded up to the nearest tenth of a foot.

Table 2—Horizontal Clearance of Conductors from Other Supporting Structures WITH WIND§

Note: Table cell revisions are in the company's green table revision style and also italicized to help them stand out.

Conductor or cable	Horizontal clearance required when displaced by wind				
	(m.)	(ft.)	Elevation: 3301 to 6300 ft. (ft.)	Elevation: 6301 to 9300 ft. (ft.)	Elevation: 9301 to 12300 ft. (ft.)
Open supply conductors, 0 to 750 V①	1.1	3.5	3.5	3.5	3.5
230C2 cable, above 750 V	1.1	3.5	3.5	3.5	3.5
230C3 cable, above 750 V	1.1	3.5	3.5	3.5	3.5
Open supply conductors, over 750 V to 22 kV	1.4	4.5	4.5	4.5	4.5
22 kV to 27 kV phase-to-ground 46 kV phase-to-phase (ft.)	--	4.7	4.7	4.7	4.7
27 kV to 42 kV phase-to-ground 69 kV phase-to-phase (ft.)	--	5.2	5.2	5.2	5.2
42 kV to 70 kV phase-to-ground 115 kV phase-to-phase (ft.)	--	6.1	*6.3*	6.4	*6.6*
70 kV to 84 kV phase-to-ground 138 kV phase-to-phase	--	6.6	6.8	*7.0*	*7.2*
84 kV to 98 kV phase-to-ground 161 kV phase-to-phase (ft.)	--	*7.1*	*7.4*	*7.6*	*7.9*
98 kV to 140 kV phase-to-ground 230 kV phase-to-phase (ft.)	--	*8.5*	*8.9*	*9.3*	*9.6*
140 kV to 210 kV phase-to-ground 345 kV phase-to-phase (ft.)	--	10.8	*11.4*	*12.0*	*12.6*
210 kV to 318 kV phase-to-ground 500 kV phase-to-phase (ft.)	--	14.4	15.3	*16.2*	*17.1*

① Does not include neutral conductors meeting Rule 230E1.

§ The non-highlighted portion of the table was copied from the NESC Rule 234B1b (2017), courtesy of IEEE, (National Electrical Safety Code® (NESC®) (Accredited Standards Committee C2-2017). All rights reserved. The highlighted portion was added to account for voltage and/or elevation adders for applicable voltages. These adders were calculated based on the NESC Rule 234G1 and 234G2 (2017).

Exhibit D, Lyman Moulton

Siting Transmission Lines & Substations

Salt Lake County Electrical Plan Task Force

December 3rd

Mickey Beaver
Customer and Community Manager
Rocky Mountain Power

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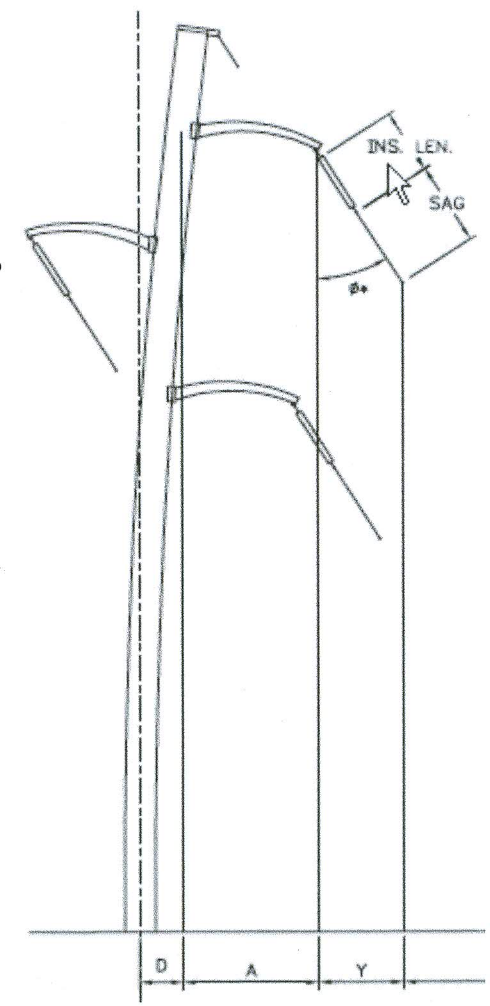
Transmission Design – Government Regulations

- Code Requirements
  - *Vertical clearance*
    - o Maximum conductor sag (line heating, line tension, ambient temperature, conductor weight)
    - o What does the conductor cross (roads, railroads, trails, water, structures, etc.)
    - o Construction error
  - *Horizontal clearance*
    - o Pole deflection
    - o Conductor and insulator string blowout
    - o Construction error



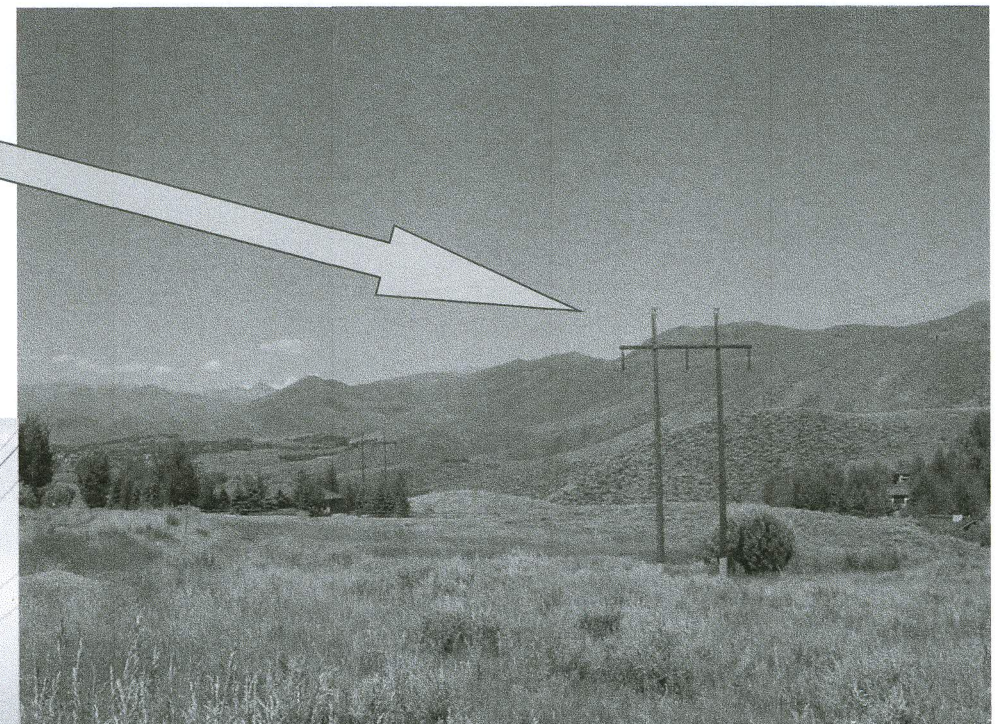
Transmission Right of Way

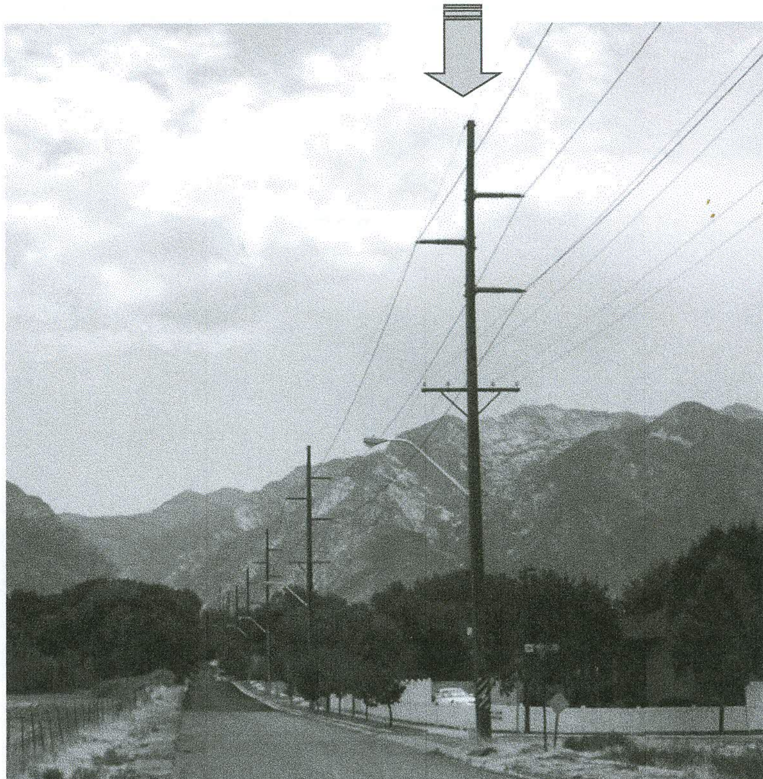
- Minimum width of right-of-way required for a transmission line is set by the National Electrical Safety Code
  - *Takes into account conductor blowout*
    - How far the wire can be expected to swing during a high wind on a hot day
    - Can't come close to structures or trees because of wind
  - *Pole structure, wire size and span length go into the equation*

- Single pole structures require less ROW width than lattice or multiple pole structures

Transmission Right of Way

– 138 kV
- *H-frame*
  - o Typically 100 feet ROW
  - o 600 ft average span
- *Single Pole*
  - o Typically 60 feet ROW
  - o 300 ft average span





If located near road right-of-way, the private width requirements can be reduced

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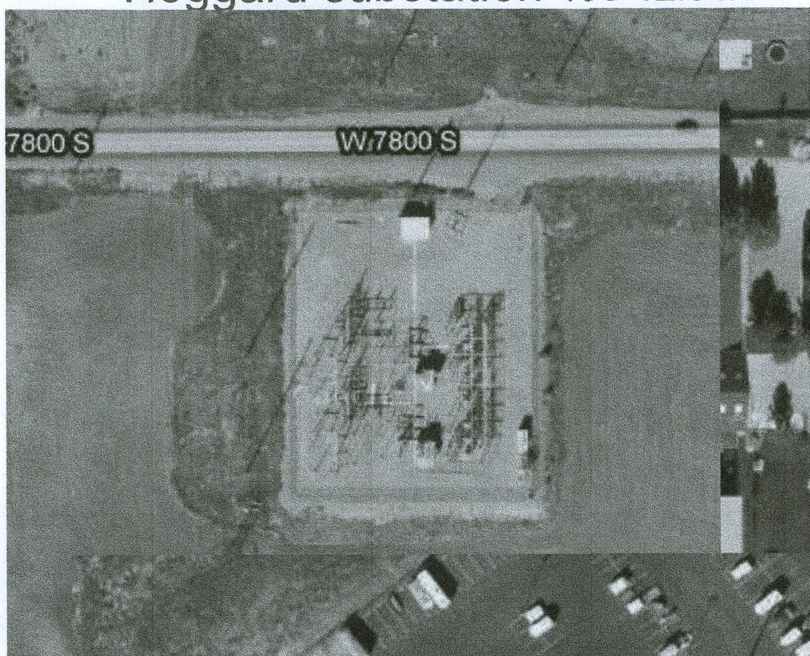
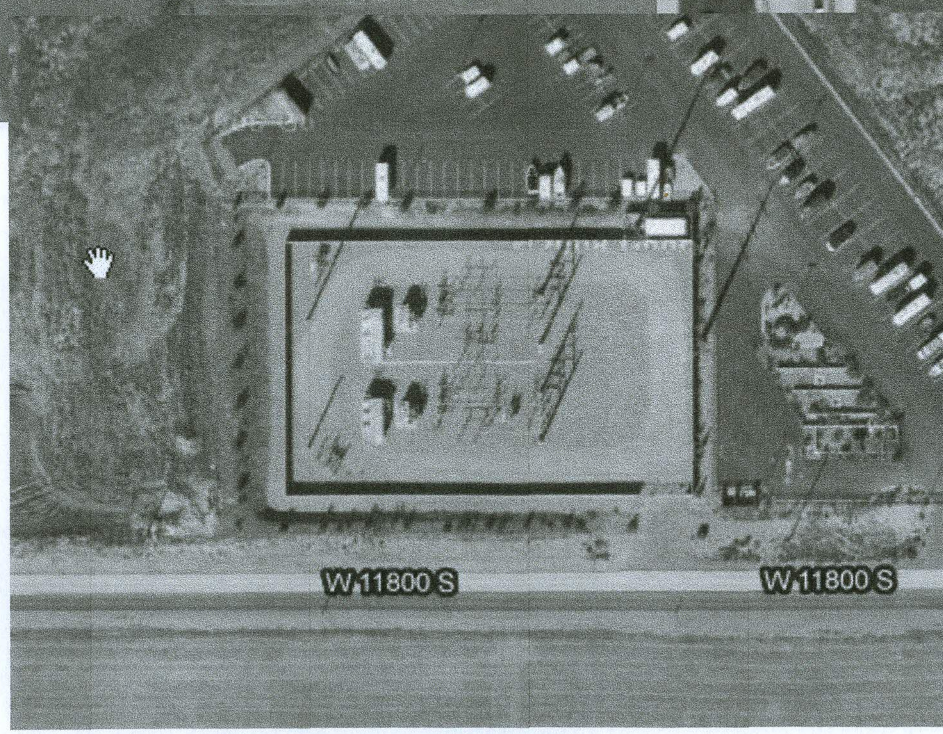
13

Hoggard substation 138-12.5 kV



South Jordan substation
138-12.5 kV



Sunrise substation
138-12.5 kV

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