Exhibit AA

Electromagnetic Frequencies from Transmission Lines

Nolin Hills Wind Power Project
February 2020

Prepared for

Capital Power
RESPONSIBLE ENERGY FOR TOMORROW

d/b/a Nolin Hills Wind, LLC

Prepared by

TETRA TECH

Tetra Tech, Inc.

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Acronyms and Abbreviations

AC	alternating current
Applicant	Nolin Hills Wind, LLC
BPA	Bonneville Power Administration
EMF	electric and magnetic fields
G	gauss
ICNIRP	International Commission on Non-Ionizing Radiation Protection
IEEE	Institute of Electrical and Electronics Engineers
kA	kiloampere
kV	kilovolt
kV/m	thousands of volts per meter
mG	milligauss
MHz	megahertz
OAR	Oregon Administrative Rule
Project	Nolin Hills Wind Power Project
ROW	right-of-way
TV	television
UEC	Umatilla Electric Cooperative
V/m	volt per meter

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1.0 Introduction

This Exhibit AA was prepared to meet the submittal requirements in Oregon Administrative Rule (OAR) 345-021-0010(1)(aa).

2.0 Proposed Transmission Line – OAR 345-021-0010(1)(aa)(A)

OAR 345-021-0010(1)(aa) Exhibit AA. If the proposed energy facility is a transmission line or has, as a related or supporting facility, a transmission line of any size:

(A) Information about the expected electric and magnetic fields, including:

2.1 Assumptions and Methods Used in the Analysis – OAR 345-021-0010(1)(aa)(A)(vi)

(vi) The assumptions and methods used in the electric and magnetic field analysis, including the current in amperes on each proposed transmission line.

2.1.1 Electric and Magnetic Field Background Information

Electric and magnetic fields (EMF) occur throughout nature and are one of the basic forces of nature. Any object with an electric charge on it has a voltage (potential) at its surface and can create an electric field. The change in voltage over distance is known as the electric field. When electrical charges move together (known as "current"), they create forces. These forces are represented by magnetic fields. All electric currents create magnetic fields.

The strength of EMF is related to the voltage and current, respectively, and to the distance away from the source. The strength of the electric field depends on the voltage (higher voltages create higher electric fields) and distance (electric fields grow weaker as the distance from the source increases). The strength of the magnetic field depends on the current or load (higher currents or loads create higher magnetic fields) and distance (magnetic fields grow weaker as the distance from the source increases). For transmission line sources, the arrangement of the conductors (line geometry) and phasing also influence the strength of the EMF.

The electric power distribution system creates alternating current (AC) EMF. In the United States, the power system uses current that alternates 60 times each second (60 hertz). For each electrical circuit, AC power is carried by each of the three-phase conductors. The AC voltage and current in each phase conductor is out of sync with the other two phases by 120 degrees, or one-third of a 360-degree cycle.

Transmission lines also create power-frequency electric and magnetic fields. Since the voltage of a transmission line is held relatively constant (typically within +/-5 percent), the electric field from a transmission line remains steady and is not affected by daily and seasonal fluctuations in usage of electricity by customers. However, the current in a transmission line does fluctuate due to consumer power usage and varies by time of day and also seasonally. Therefore, the magnetic field from a transmission line will also fluctuate (since magnetic field is related to the current or load on the line).

Electric fields are reported in units of volts per meter (V/m) or thousands of volts per meter (kV/m). Magnetic fields are reported in units of gauss (G), or more typically in units of milligauss (mG), which are equal to one-thousandth of a gauss (i.e., 1 mG = 0.001 G).

2.1.1.1 Electric Fields

The State of Oregon has an AC electric field limit of 9 kV/m at one meter above the ground surface in areas accessible to the public, as stated in OAR 345-024-0090.

2.1.1.2 Magnetic Fields

Presently, there are no magnetic field standards for the State of Oregon or federal health standards. Although there are no federal health standards in the United States specifically for 60 hertz, some non-regulatory organizations have developed guidelines: the International Commission on Non-Ionizing Radiation Protection (ICNIRP) and the Institute of Electrical and Electronics Engineers (IEEE). For the general public, the ICNIRP guideline is 2,000 mG (ICNIRP 2010) while the IEEE guideline is 9,040 mG (IEEE 2002).

2.1.2 Electromagnetic Frequency Modeling

2.1.2.1 Modeling Methods

Nolin Hills Wind, LLC (the Applicant) analyzed EMF levels by considering the peak electrical currents expected on the lines. These analyses were conducted conservatively, using the peak electrical currents expected on the lines that produce the highest magnetic fields. Additionally, the double-circuit collector line was modeled so that similar phases were located at the same elevation on each side of the support structure, which results in a conservative analysis. Finally, the modeling was performed at the point midway between transmission structures where the conductors are closest to the ground and where the EMF will be the highest.

The software tool program used for the analyses, Corona and Field Effects Program (Version 3.1), was developed by the Bonneville Power Administration (BPA) and is based on the methods and equations of the *Transmission Line Reference Book* (Electric Power Research Institute 1985).

2.1.2.2 Modeling Assumptions

The following assumptions were made during the development of the models:

- Elevation – 1,000 feet;

- Rain rate – 1 inch per hour;
- Wind speed – 2 miles per hour;
- Detector Information:
    - Radio interference antenna height – 6.6 feet;
    - Television (TV) interference antenna height – 9.8 feet;
    - Frequency at which radio interference values are to be calculated – 1 megahertz (MHz);
    - Frequency at which TV interference values are to be calculated – 75 MHz;
    - Magnetic field sensor height – 3.3 feet;
    - Ground conductivity – 6.7 millimhos per meter; and
    - Electric field sensor height – 3.3 feet;
- 230-kilovolt (kV)/115-kV double-circuit transmission line (Figure AA-1):
    - Width of modeling – 200 feet on each side of the centerline. Sample points are taken every 4 feet uniformly in a perpendicular direction to the centerline. The right-of-way (ROW) is estimated at 50 feet on each side of the centerline;
    - Horizontal location of the three conductors – 10 feet (A circuit), 13 feet (B circuit), and 10 feet (C circuit) on each side of the double circuit centerline;
    - Height of conductors – 24.9 (C circuit), 40.9 (B circuit), and 56.9 (A circuit) feet, respectively;
    - Conductor diameters – 1.345 inches;
    - Power – 961 amps, or 0.961 kiloamperes (kA);
    - Horizontal location of the two ground wires – 6 feet and -6 feet from each side of the double-circuit centerline;
    - Height of ground wires – 63.9 feet; and
    - Ground wire diameter – 0.5 inch;
- 230-kV single-circuit transmission line (Figure AA-2):
    - Width of modeling – 200 feet on each side of the centerline. Sample points are taken every 4 feet uniformly in a perpendicular direction to the centerline. The ROW is estimated at 50 feet on each side of the centerline;
    - Horizontal location of the three conductors – 10 feet (A circuit), -10 feet (B circuit), and 10 feet (C circuit);
    - Height of conductors – 44.9 feet (A circuit), 34.9 feet (B circuit), and 24.9 feet (C circuit);

- Conductor diameters – 1.345 inches;
- Power – 961 amps, or 0.961 kA;
- Horizontal location of the single ground wire – 5 feet from on one side of the centerline;
- Height of the single ground wire – 54.2 feet; and
- Ground wire diameter – 0.5 inch.

2.2 Distance from Proposed Center Line – OAR 345-021-0010(1)(aa)(A)(i)

(i) The distance in feet from the proposed center line of each proposed transmission line to the edge of the right-of-way;

The Nolin Hills Wind Power Project (Project) will interconnect to the regional grid via either publicly owned and operated transmission lines to be constructed locally by the Umatilla Electric Cooperative (UEC), or a new 230-kV transmission line anticipated to be constructed, owned, and operated by the Applicant to the proposed BPA Stanfield Substation.

The Applicant anticipates that the Project will connect to the BPA transmission system via new and upgraded UEC transmission lines from the northern Project substation to the existing UEC Cottonwood Substation, or via a new overhead 230-kV transmission line to the proposed BPA Stanfield Substation north of the Umatilla River. From the Cottonwood Substation, an existing UEC 230-kV transmission line with capacity for the additional power generated by the Project would carry that power north to BPA's McNary Substation. The UEC Cottonwood route is currently considered the primary option, with the BPA Stanfield route as a backup option. The final decision regarding which route will be used will be made by the Applicant based on the final Project construction schedule, BPA and UEC system requirements, anticipated costs, and other factors such as transmission agreements.

The width of the ROW may vary, but will be at a minimum of 50 feet wide along the centerline of each transmission line. This range is within the transmission line corridor width defined in OAR-345-001-0010(13).

2.3 Occupied Structures within 200 Feet of Proposed Center Line – OAR 345-021-0010(1)(aa)(A)(ii) and (iii)

(ii) The type of each occupied structure, including but not limited to residences, commercial establishments, industrial facilities, schools, daycare centers and hospitals, within 200 feet on each side of the proposed center line of each proposed transmission line;

(iii) The approximate distance in feet from the proposed center line to each structure identified in (A);

Table AA-1 shows potential receptors within 200 feet of either transmission lines.

Table AA-1. Potential Receptors within 200 Feet of Proposed Center Line

Receptor Number	Type of Structure	Approximate Distance to Transmission Line (Feet)
3	Occupied residence (house)	189
10	Occupied residence (house)	177
47	Occupied residence (house)	93
54	Occupied residence (house)	146
59	Occupied residence (house)	178
71	Occupied residence (house)	107
79	Occupied residence (house)	161
85	Occupied residence (house)	91
107	Occupied commercial building	114

2.4 Representative Field Strength along the Proposed Transmission Line – OAR 345-021-0010(1)(aa)(A)(iv)

(iv) At representative locations along each proposed transmission line, a graph of the predicted electric and magnetic fields levels from the proposed center line to 200 feet on each side of the proposed center line;

Table AA-2 shows the results of the electric field calculations for the overhead 230-kV/115-kV double-circuit transmission lines and 230-kV single-circuit transmission lines. Figures AA-3 and AA-4 provide graphs of the predicted electric field calculations for these lines from the proposed center line to 200 feet on each side of the proposed center line.

Table AA-2. Overhead Electric Field Calculations

Support Structure	Figure	Voltage	Electric Field (kV/m)[1]		
			Left Side (200 Feet)	Maximum (Location)	Right Side (200 Feet)
230-kV/115-kV Double-Circuit Transmission Line	AA-1, AA-3	230 kV	0.052	4.26 (8 feet right of center line)	0.061
230-kV Single-Circuit Transmission Line	AA-2, AA-4	230 kV	0.042	3.22 (12 feet right of center line)	0.044
1. Oregon Electric Field Standard is 9 kV/m within the right of way.					

Table AA-3 shows the results of the magnetic field calculations for the overhead transmission lines. Figures AA-5 and AA-6 provide graphs of the predicted magnetic field calculations for these lines from the proposed center line to 200 feet on each side of the proposed center line.

Table AA-3. Overhead Magnetic Field Calculations

Support Structure	Figure	Voltage	Magnetic Field (mG)				
			Left Side (200 Feet)	Left Side ROW	Centerline	Right Side ROW	Right Side (200 Feet)
230-kV/115-kV Double-Circuit Transmission Line	AA-1, AA-5	230 kV	15.0	30.7	225.6	30.7	14.3
230-kV Single-Circuit Transmission Line	AA-2, AA-6	34.5 kV	3.1	12.0	159.5	12.1	3.1

Tables AA-2 and AA-3 show the modeling results at the edges of and the highest values within 200 feet on either side of the centerline of the overhead 230-kV/115-kV double-circuit transmission lines and 230-kV single-circuit transmission lines, respectively. Results from the modeling software can be found in Attachments AA-1 and AA-2 for both support structures. The electric fields on the corridor of the proposed 230-kV/115-kV double-circuit transmission lines do not exceed 9 kV/m (see Figure AA-5). The electric fields on the corridors of the proposed overhead 230-kV single-circuit transmission lines do not exceed 9 kV/m (see Figure AA-6). These figures demonstrate that, for the proposed overhead transmission lines, the maximum electric field modeled is about 4.26 kV/m, which is less than the 9-kV/m standard set forth in OAR 345-024-0090(1).

As identified in Section 2.3, eight occupied residences and one commercial building will be within 200 feet of the overhead transmission lines. However, the maximum electric field modeled based on the 230-kV double-circuit transmission line configuration analyzed is less than 48 percent of the 9-kV/m standard set forth in OAR 345-024-0090(1). Therefore, the potential for human exposure to EMF from either the transmission lines is minimized.

2.5 Mitigation and Monitoring – OAR 345-021-0010(1)(aa)(A)(v)

(v) Any measures the applicant proposes to reduce electric or magnetic field levels.

The highest electric fields within the ROW will be much less than the Oregon standard of 9 kV/m, and therefore no mitigation is required.

As the maximum electrical field modeled in Section 2.4 are lower than the 9-kV/m standard set forth in OAR 345-024-0090(1), no monitoring program is proposed by the Applicant.

2.6 Proposed Monitoring Program – OAR 345-021-0010(1)(aa)(A)(vii)

(vii) The applicant's proposed monitoring program, if any, for actual electric and magnetic field levels.

As the maximum electrical field modeled in Section 2.4 is lower than the 9-kV/m standard set forth in OAR 345-024-0090(1), no monitoring program is proposed by the Applicant.

3.0 Radio and TV Interference

Radio and TV interference is caused by corona discharge from the line. This discharge will be greatest during rainy weather conditions. Interference may be noticed as a humming or buzzing sound on weak AM radio signals or as bands of snow across the picture in TV signals received by an over the air broadcast signal. FM radio signals and digital satellite or cable TV signals will not be affected.

The modeling results show that low levels of AM radio or TV interference may be noted due the corona discharge from the 230-kV transmission line. People listening to weak AM radio signals in their home or vehicle may notice some interference when located close to the transmission line. FM radio signals will not be affected. Satellite TV reception will not be affected because transmission line corona discharge does not affect satellite TV's digital format. Over the air TV signals are now broadcast in a digital format as well, which will not be affected unless the signal strength is extremely weak.

4.0 Conclusion

OAR Chapter 345, Division 21 does not provide an approval standard specific to Exhibit AA. However, compliance with OAR 345-024-0090 is demonstrated by the analysis above, as described in Exhibit DD.

5.0 References

Electric Power Research Institute. 1985. *Transmission Line Reference Book*. Third Edition.

ICNIRP (International Commission on Non-Ionizing Radiation Protection). 2010. Guidelines for Limiting Exposure to Time-Varying Electric, Magnetic, and Electromagnetic Fields (Up To 300 GHz). *Health Physics* 99 6: 818-836, December.

IEEE (Institute of Electrical and Electronics Engineers), 2002. IEEE Standard for Safety Levels with Respect to Human Exposure to Electromagnetic Fields, 0 – 3 kHz. IEEE Std C95.6-2002.

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Figures

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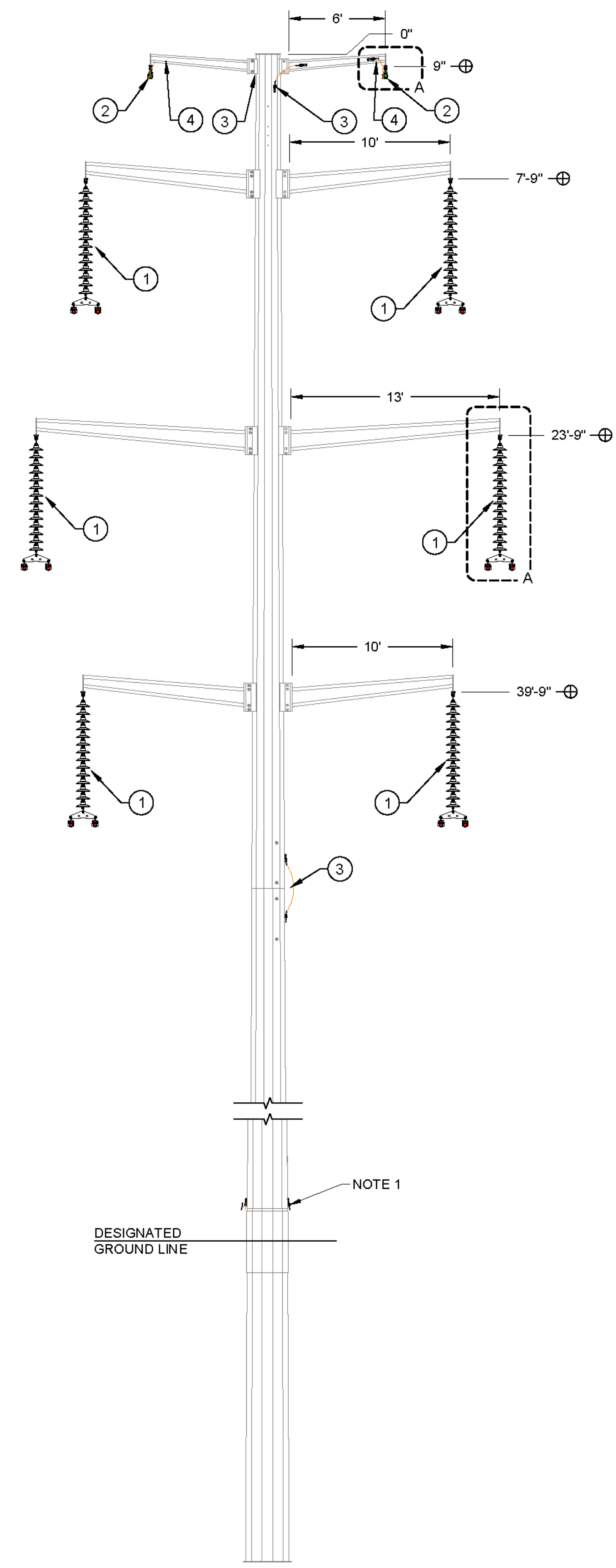
LIST OF MATERIALS				
#	QTY	DESCRIPTION	MANUFACTURER	PART NO.
1	6	INSULATOR ASSEMBLY, TANGENT		TM-1C
2	2	OPGW ASSEMBLY, TANGENT		TM-4A(OPGW)
3	A.R.	STEEL POLE GROUNDING, JOINT		TMS-9C(JT)
4	2	STEEL POLE GROUNDING, TOP		TMS-9C(TP)

NOTES:

1. THE FOLLOWING MATERIALS ARE TO BE SPECIFIED SEPARATELY ON PLAN AN PROFILE DRAWINGS: POLES, POLE GROUNDING ASSEMBLY, AND ANY ADDITIONAL GROUNDING UNITS.



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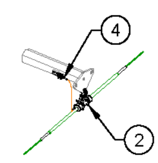

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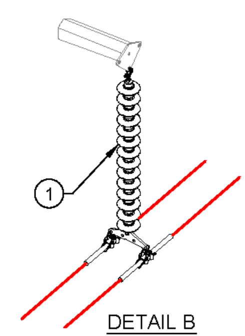


DETAIL B

DATE	REVISION	#
/ /	ISSUED FOR	0

WORKING

TOTH & ASSOCIATES
830 E PRIMROSE, SUITE 200
SPRINGFIELD, MO 65807
Ph: 417-888-0645 Fax: 417-888-0657
www.tothassociates.com
CERTIFICATE OF AUTHORITY: OR# not required
© 2019 Toth and Associates, Inc.

DRN. BY: SRC
CKD. BY: SEZ
APPD. BY: JLB
DATE: 02/07/19

PROJECT:
LOCATION:
CLIENT: UMATILLA ELECTRIC COOPERATIVE, HERMISTON, OREGON, OREGON-14-UMATILLA

TITLE: TRANSMISSION LINE STRUCTURES STEEL D.C. TANGENT WITH DAVIT ARMS

SHT NO: 1 of 1
TUS-230DC-1

Nolin Hills Wind Power Project

Figure AA-1

Typical Double-Circuit Transmission Line

UMATILLA COUNTY, OREGON

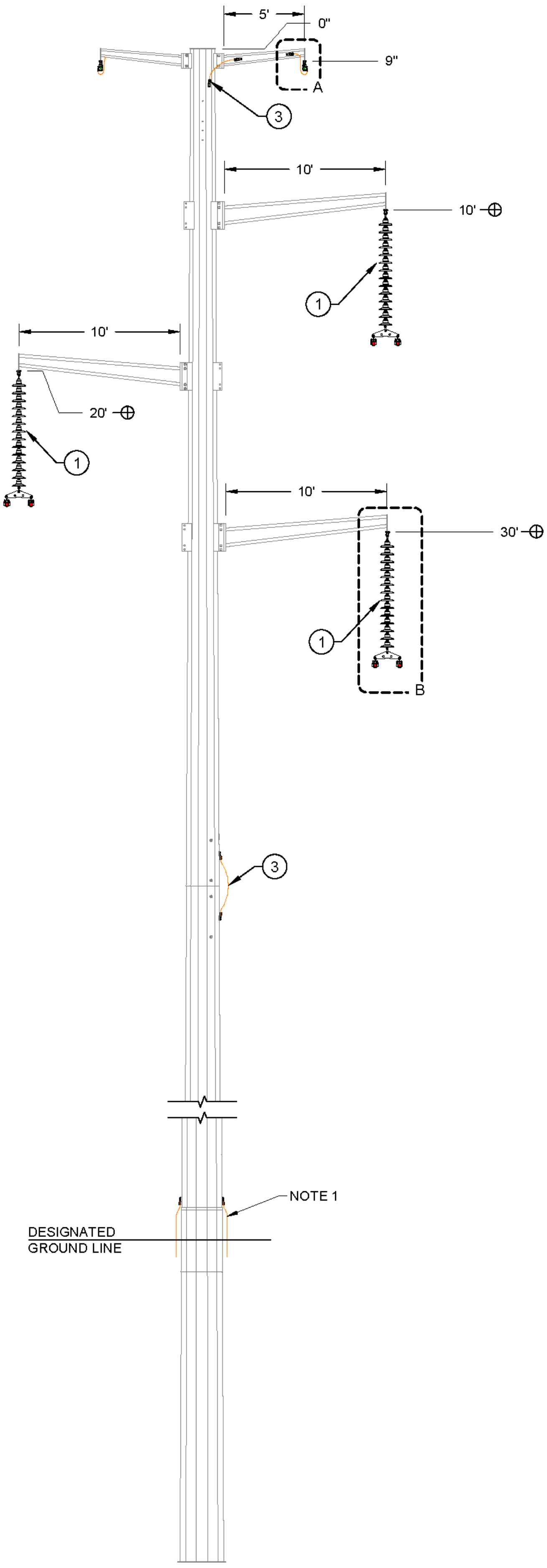
TETRA TECH

LIST OF MATERIALS

#	QTY	DESCRIPTION	MANUFACTURER	PART NO.
1	3	INSULATOR ASSEMBLY, TANGENT		TM-1C
2	2	OPGW ASSEMBLY, TANGENT		TM-4A(OPGW)
3	A.R.	STEEL POLE GROUNDING, JOINT		TMS-9C(JT)
4	1	STEEL POLE GROUNDING, TOP		TMS-9C(TP)

NOTES:

1. THE FOLLOWING MATERIALS ARE TO BE SPECIFIED SEPARATELY ON PLAN AN PROFILE DRAWINGS: POLES, POLE GROUNDING ASSEMBLY, AND ANY ADDITIONAL GROUNDING UNITS.



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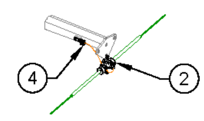

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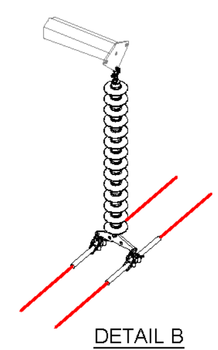


DETAIL B

DATE	REVISION	#
/ /	ISSUED FOR	0

WORKING

TOTH & ASSOCIATES
830 E PRIMROSE, SUITE 200
SPRINGFIELD, MO 65807
Ph: 417-888-0645 Fax: 417-888-0657
www.tothassociates.com
CERTIFICATE OF AUTHORITY:
OR# not required

DWN BY: SRC
CKD BY: SEZ
APPD BY: JLB
DATE: 02/07/19

PROJECT:
LOCATION:
CLIENT: UMATILLA ELECTRIC COOPERATIVE
HERMISTON, OREGON
OREGON-14-UMATILLA

TITLE: TRANSMISSION LINE STRUCTURES
STEEL TANGENT WITH DAVIT ARMS

SHT NO: 1 of 1
TUS-230-1

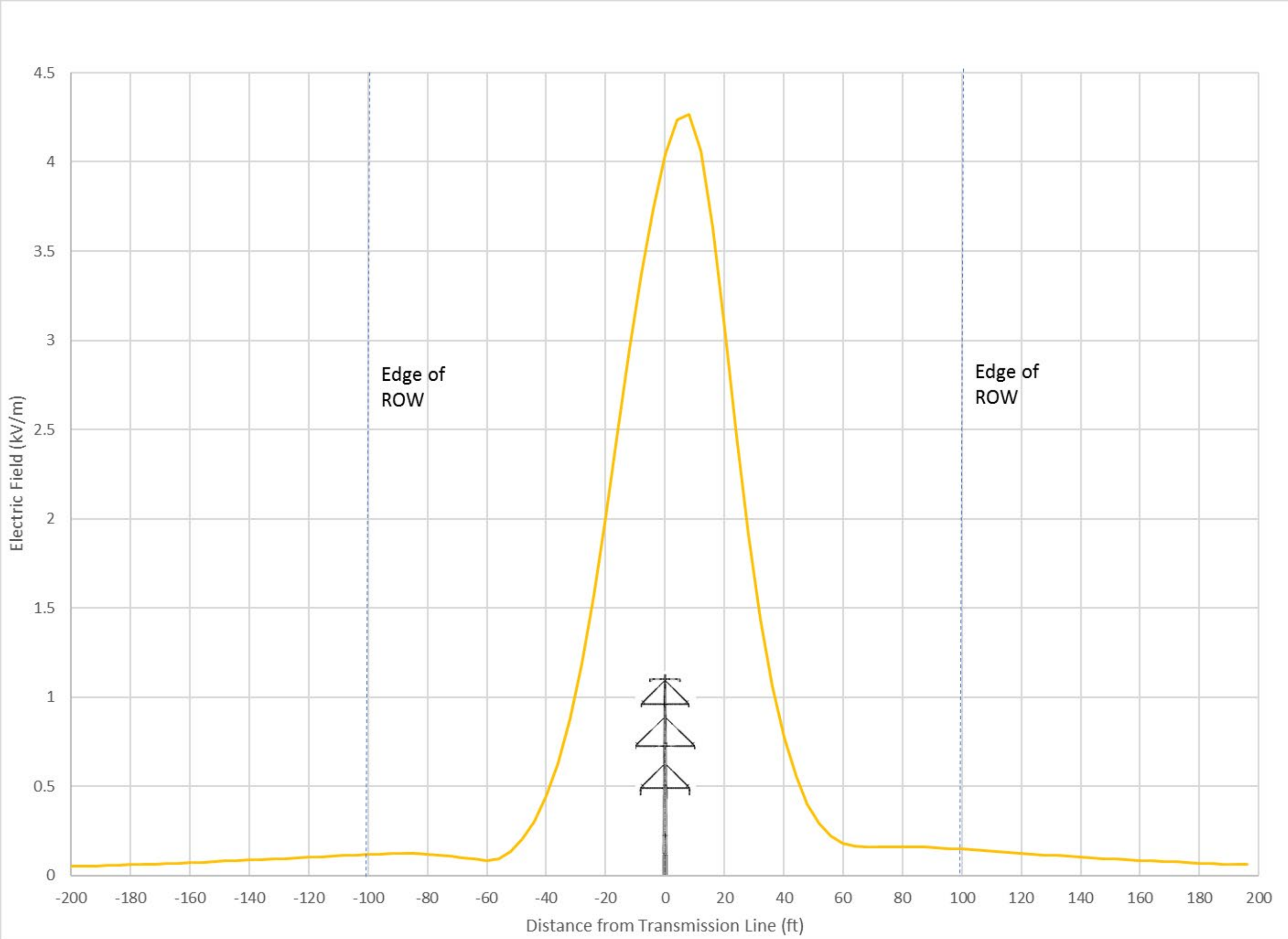
Nolin Hills Wind Power Project

Figure AA-2

Typical Single-Circuit Transmission Line

UMATILLA COUNTY, OREGON

TETRA TECH



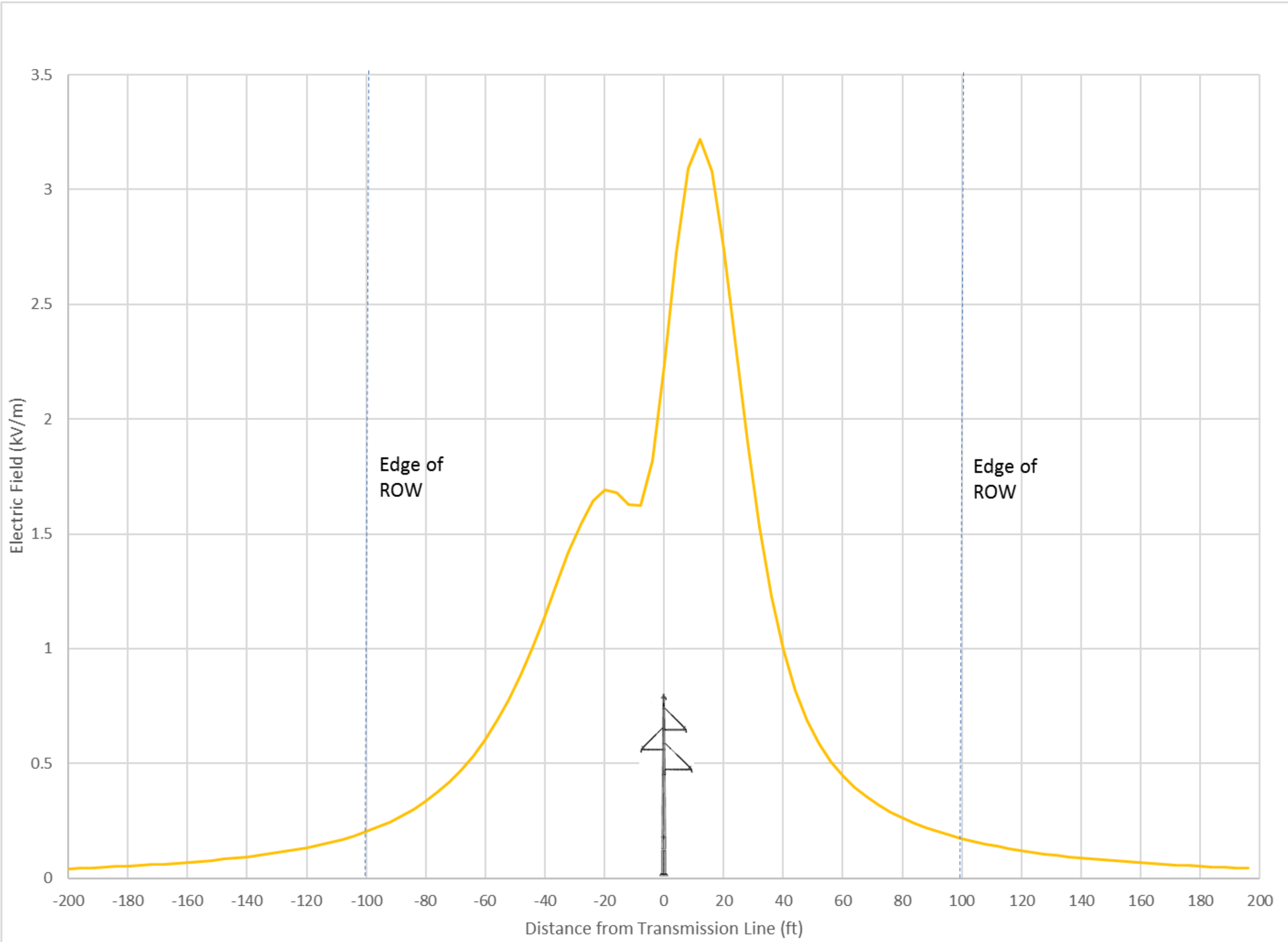
Nolin Hills Wind Power Project

Figure AA-3

Nolin Hills Double-Circuit 230-kV/115-kV Electric Field

UMATILLA COUNTY, OREGON

TETRA TECH



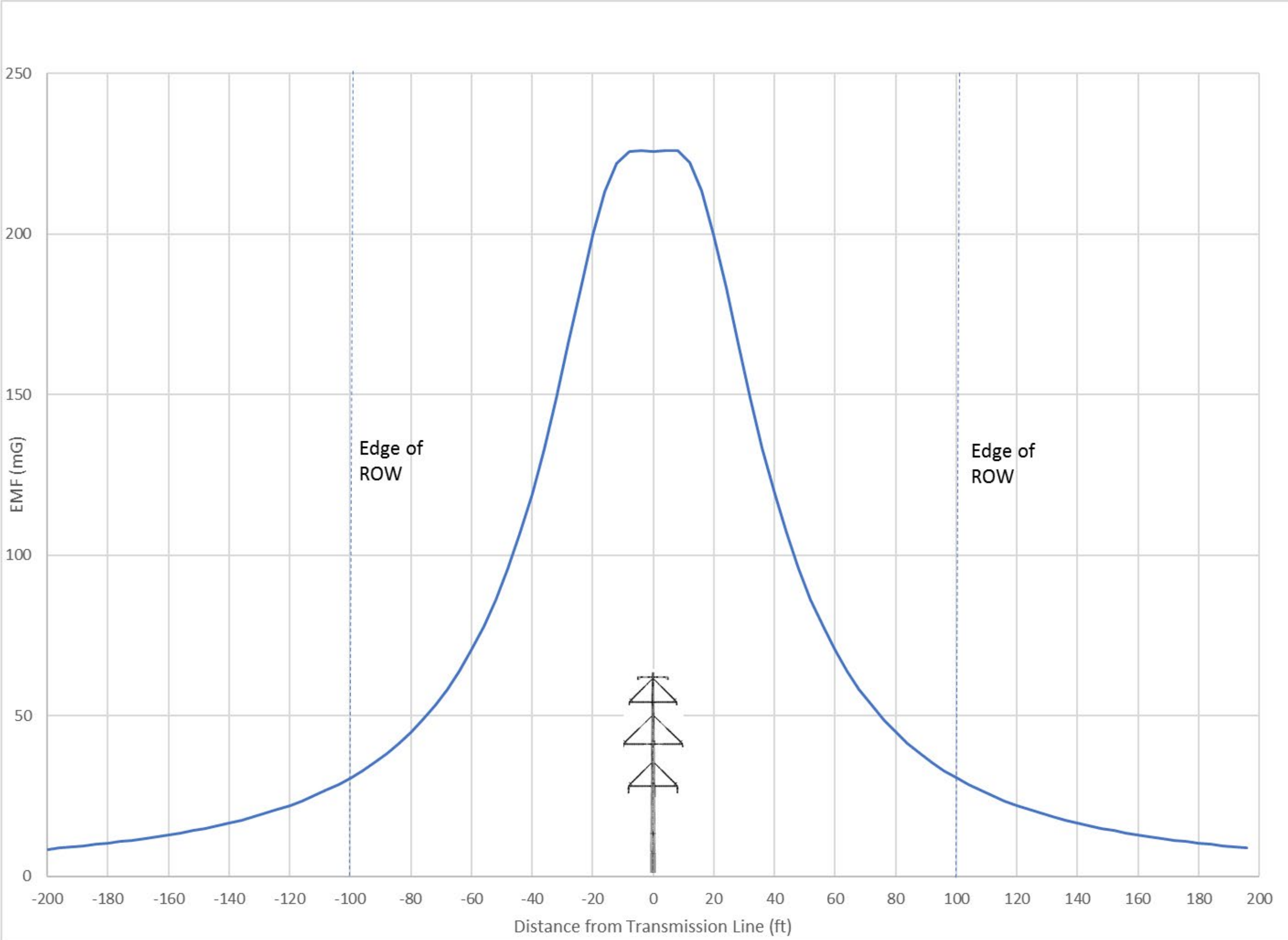
Nolin Hills Wind Power Project

Figure AA-4

Nolin Hills Single-Circuit 230-kV Electric Field

UMATILLA COUNTY, OREGON

TETRA TECH



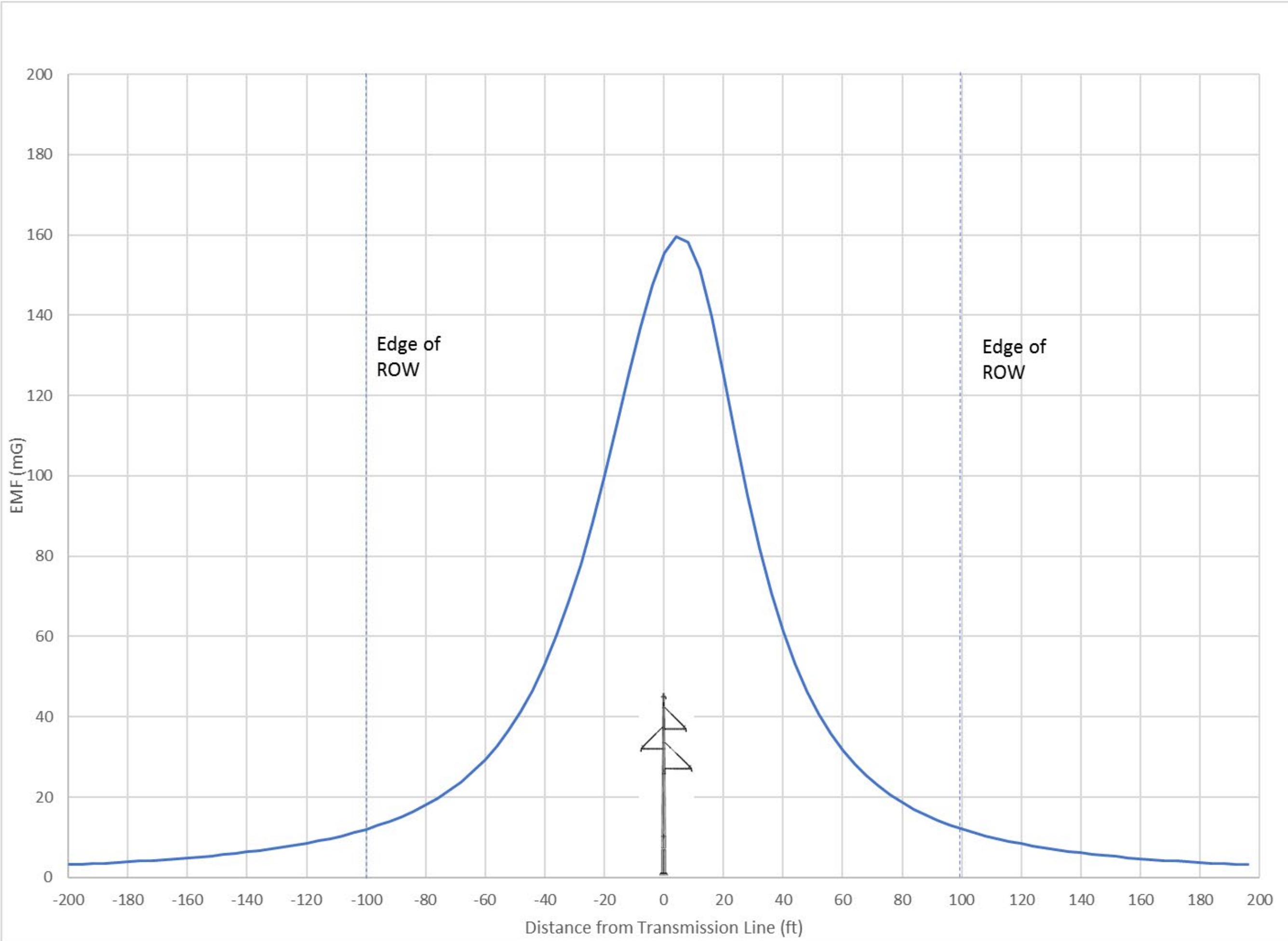
Nolin Hills Wind Power Project

Figure AA-5

Nolin Hills Double-Circuit 230-kV/115-kV Magnetic Field

UMATILLA COUNTY, OREGON

TETRA TECH



Nolin Hills Wind Power Project

Figure AA-6

Nolin Hills Single-Circuit 230-kV Magnetic Field

UMATILLA COUNTY, OREGON

TETRA TECH

Attachment AA-1. Results of the Bonneville Power Administration Corona and Field Effects Program for the 230-kV/115-kV Double-Circuit Transmission Line

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Û      C O R O N A   A N D   F I E L D      Û
Û E F F E C T S   P R O G R A M   V E R.  3   Û
Û   Source: Bonneville Power Administration   Û
ÛÜÜÜÜÜÜÜÜÜÜÜÜÜÜÜÜÜÜÜÜÜÜÜÜÜÜÜÜÜÜÜÜÜÜÜÜÜÜÜÜÜÜÜÜÜÜÛ
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 Buttercreek North
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(GRADIENTS ARE COMPUTED BY PROGRAM)

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1ELECTRIC FIELD CALCULATIONS

Nolin Hills UEC Double Circuit
Buttercreek North

	DIST. FROM REFERENCE FEET	HEIGHT FEET	MAXIMUM GRADIENT (KV/CM)	SUBCON. DIAM. (IN)	NO. OF SUBCON.	PHASE ANGLE (DEGREES)
230A	10.00	56.90	13.38	1.35	1	.0
230B	13.00	40.90	13.79	1.35	1	-120.0
230C	10.00	24.90	13.17	1.35	1	120.0
115A	-10.00	56.90	6.27	1.35	1	.0
115B	-13.00	40.90	6.78	1.35	1	-120.0
115C	-10.00	24.90	6.11	1.35	1	120.0
230G	6.00	63.90	7.19	.50	1	.0
115G	-6.00	63.90	5.26	.50	1	.0

SENSOR HT. = 3.3 FEET

DIST FROM

REFERENCE FEET	E-FIELD (KV/METER)	THETA (DEGREES)	EY-FIELD (KV/METER)	THETAY (DEGREES)	EX-FIELD (KV/METER)	THETAX (DEGREES)	SPACE POTENTIAL (VOLTS)
-200.0	.052	88.5	.051	150.6	.001	147.0	51.5
-196.0	.053	88.5	.053	150.5	.001	146.7	53.2
-192.0	.055	88.4	.055	150.3	.001	146.3	55.0
-188.0	.057	88.4	.057	150.2	.002	146.0	56.8
-184.0	.059	88.4	.059	150.1	.002	145.5	58.8
-180.0	.061	88.4	.061	149.9	.002	145.1	60.8
-176.0	.063	88.4	.063	149.7	.002	144.6	63.0
-172.0	.065	88.4	.065	149.5	.002	144.0	65.2
-168.0	.068	88.4	.067	149.3	.002	143.4	67.5
-164.0	.070	88.3	.070	149.1	.002	142.7	69.9
-160.0	.072	88.3	.072	148.9	.002	142.0	72.4
-156.0	.075	88.3	.075	148.6	.002	141.2	75.1
-152.0	.078	88.3	.078	148.4	.002	140.2	77.8
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-136.0	.090	88.3	.090	146.9	.003	135.0	89.8
-132.0	.093	88.3	.093	146.5	.003	133.1	93.0
-128.0	.096	88.4	.096	146.0	.003	130.9	96.3
-124.0	.100	88.4	.100	145.4	.003	128.2	99.7
-120.0	.103	88.5	.103	144.8	.003	125.0	103.0
-116.0	.106	88.5	.106	144.1	.003	121.0	106.4
-112.0	.110	88.6	.110	143.3	.003	116.0	109.7
-108.0	.113	88.7	.113	142.3	.003	109.6	112.8
-104.0	.116	88.9	.116	141.3	.003	101.2	115.8
-100.0	.119	89.1	.119	140.0	.003	90.3	118.3
-96.0	.121	89.3	.121	138.6	.003	76.4	120.4
-92.0	.122	89.6	.122	136.8	.003	60.3	121.8
-88.0	.123	90.0	.123	134.7	.004	43.6	122.3

-84.0	.122	90.6	.122	132.1	.005
28.7	121.6				
-80.0	.120	91.3	.120	128.8	.007
16.4	119.2				
-76.0	.116	92.2	.116	124.4	.010
6.6	114.9				
-72.0	.109	93.4	.109	118.3	.013
-1.3	108.3				
-68.0	.101	94.8	.101	109.4	.018
-7.8	99.4				
-64.0	.091	95.3	.091	95.6	.024
-13.5	89.6				
-60.0	.085	91.0	.085	73.8	.033
-18.5	83.8				
-56.0	.095	77.7	.093	44.6	.044
-23.2	93.6				
-52.0	.135	70.4	.128	18.1	.059
-27.6	130.3				
-48.0	.204	70.2	.193	-.1	.078
-31.9	197.2				
-44.0	.306	71.5	.290	-12.1	.104
-36.0	296.5				
-40.0	.445	72.8	.425	-20.5	.138
-39.9	434.0				
-36.0	.631	74.0	.607	-26.9	.180
-43.5	618.5				
-32.0	.876	75.1	.847	-32.1	.231
-46.8	860.1				
-28.0	1.188	76.3	1.154	-36.5	.288
-49.5	1168.1				
-24.0	1.570	77.6	1.533	-40.0	.343
-51.7	1545.4				
-20.0	2.012	79.2	1.976	-42.9	.383
-53.1	1982.8				
-16.0	2.487	81.0	2.456	-45.0	.394
-53.6	2454.0				
-12.0	2.954	82.8	2.930	-46.4	.372
-53.3	2920.2				
-8.0	3.376	84.4	3.361	-47.2	.329
-52.4	3346.4				
-4.0	3.741	85.8	3.731	-47.7	.276
-51.5	3714.4				
.0	4.041	87.1	4.035	-48.0	.206
-50.4	4010.2				
4.0	4.238	88.8	4.237	-48.0	.092
-43.7	4197.3				
8.0	4.264	91.0	4.263	-47.7	.084
108.6	4211.2				
12.0	4.059	93.8	4.050	-46.9	.276
118.8	4000.2				
16.0	3.632	96.6	3.608	-45.2	.429
121.2	3575.7				
20.0	3.065	99.1	3.026	-42.7	.500
123.2	3016.8				
24.0	2.464	101.1	2.417	-39.4	.492
125.5	2425.0				
28.0	1.908	102.7	1.862	-35.1	.434
128.3	1878.1				
32.0	1.439	103.8	1.398	-30.0	.358
131.6	1415.4				
36.0	1.064	104.6	1.030	-23.9	.284
135.4	1045.8				
40.0	.776	105.2	.749	-16.7	.219

139.7	761.6				
44.0	.560	105.5	.540	-7.9	.166
144.2	549.4				
48.0	.403	105.4	.389	3.0	.126
149.0	395.5				
52.0	.294	104.4	.285	16.8	.095
154.1	288.6				
56.0	.222	101.5	.218	33.6	.071
159.3	219.9				
60.0	.182	97.0	.181	52.2	.053
164.8	181.2				
64.0	.164	92.8	.164	69.9	.040
170.6	163.6				
68.0	.159	90.4	.159	84.8	.030
177.0	158.2				
72.0	.159	89.7	.159	96.3	.023
-176.0	157.9				
76.0	.160	89.7	.160	105.0	.018
-168.1	158.9				
80.0	.160	89.9	.160	111.6	.014
-159.2	159.5				
84.0	.160	90.3	.160	116.8	.011
-149.2	159.1				
88.0	.158	90.6	.158	120.9	.009
-138.2	157.6				
92.0	.155	90.9	.155	124.3	.007
-126.7	155.1				
96.0	.152	91.1	.152	127.0	.006
-115.3	151.9				
100.0	.148	91.3	.148	129.3	.006
-104.7	148.1				
104.0	.144	91.4	.144	131.3	.005
-95.3	143.8				
108.0	.139	91.5	.139	133.0	.005
-87.2	139.3				
112.0	.135	91.6	.135	134.5	.005
-80.3	134.7				
116.0	.130	91.7	.130	135.8	.004
-74.6	129.9				
120.0	.125	91.8	.125	136.9	.004
-69.8	125.2				
124.0	.121	91.8	.121	138.0	.004
-65.8	120.6				
128.0	.116	91.8	.116	138.9	.004
-62.4	116.0				
132.0	.112	91.8	.112	139.7	.004
-59.4	111.5				
136.0	.107	91.9	.107	140.4	.004
-56.9	107.2				
140.0	.103	91.9	.103	141.1	.003
-54.7	103.1				
144.0	.099	91.9	.099	141.7	.003
-52.8	99.1				
148.0	.095	91.9	.095	142.2	.003
-51.0	95.3				
152.0	.092	91.8	.092	142.8	.003
-49.5	91.6				
156.0	.088	91.8	.088	143.2	.003
-48.2	88.1				
160.0	.085	91.8	.085	143.7	.003
-47.0	84.7				
164.0	.082	91.8	.082	144.0	.003
-45.9	81.5				

168.0	.078	91.8	.078	144.4	.002
-44.9	78.5				
172.0	.076	91.8	.076	144.8	.002
-44.0	75.6				
176.0	.073	91.7	.073	145.1	.002
-43.2	72.8				
180.0	.070	91.7	.070	145.4	.002
-42.4	70.1				
184.0	.068	91.7	.068	145.7	.002
-41.7	67.6				
188.0	.065	91.7	.065	145.9	.002
-41.1	65.2				
192.0	.063	91.7	.063	146.2	.002
-40.5	62.9				
196.0	.061	91.6	.061	146.4	.002
-39.9	60.8				

1MAGNETIC FIELD CALCULATIONS

SENSOR HT. = 3.3 FEET

DIST FROM REFERENCE FEET	B-FIELD (GAUSS)	THETA	BY-FIELD (GAUSS)	THETAY	BX-FIELD (GAUSS)	THETAX
-200.0	.00843285	21.3	.00309390	-22.3	.00785940	-31.9
-196.0	.00876851	21.7	.00327779	-22.4	.00814865	-32.0
-192.0	.00912435	22.2	.00347633	-22.4	.00845334	-32.1
-188.0	.00950202	22.6	.00369100	-22.5	.00877450	-32.1
-184.0	.00990329	23.1	.00392343	-22.5	.00911327	-32.2
-180.0	.01033015	23.6	.00417548	-22.6	.00947083	-32.3
-176.0	.01078479	24.1	.00444920	-22.7	.00984849	-32.4
-172.0	.01126963	24.6	.00474696	-22.7	.01024762	-32.6
-168.0	.01178737	25.2	.00507138	-22.8	.01066973	-32.7
-164.0	.01234098	25.8	.00542544	-22.9	.01111641	-32.8
-160.0	.01293380	26.4	.00581256	-23.0	.01158937	-33.0
-156.0	.01356955	27.1	.00623657	-23.1	.01209041	-33.1
-152.0	.01425237	27.8	.00670186	-23.2	.01262149	-33.3
-148.0	.01498694	28.5	.00721347	-23.3	.01318464	-33.5
-144.0	.01577847	29.2	.00777711	-23.4	.01378200	-33.6
-140.0	.01663288	30.0	.00839939	-23.5	.01441583	-33.9
-136.0	.01755683	30.9	.00908787	-23.6	.01508842	-34.1
-132.0	.01855784	31.7	.00985130	-23.8	.01580212	-34.3
-128.0	.01964448	32.7	.01069978	-23.9	.01655928	-34.6
-124.0	.02082646	33.7	.01164500	-24.1	.01736213	-34.9
-120.0	.02211489	34.7	.01270056	-24.3	.01821275	-35.2
-116.0	.02352248	35.8	.01388229	-24.5	.01911288	-35.6
-112.0	.02506379	37.0	.01520866	-24.7	.02006374	-36.0
-108.0	.02675557	38.3	.01670124	-25.0	.02106576	-36.5
-104.0	.02861717	39.6	.01838537	-25.3	.02211819	-37.0
-100.0	.03067096	41.1	.02029071	-25.6	.02321862	-37.5
-96.0	.03294291	42.6	.02245219	-25.9	.02436225	-38.2
-92.0	.03546320	44.3	.02491084	-26.3	.02554090	-38.9
-88.0	.03826709	46.1	.02771495	-26.8	.02674176	-39.7
-84.0	.04139581	48.0	.03092127	-27.2	.02794555	-40.7
-80.0	.04489767	50.1	.03459635	-27.8	.02912406	-41.7
-76.0	.04882940	52.3	.03881796	-28.4	.03023687	-43.0
-72.0	.05325770	54.8	.04367632	-29.1	.03122680	-44.5
-68.0	.05826097	57.4	.04927500	-29.9	.03201389	-46.3
-64.0	.06393124	60.4	.05573080	-30.8	.03248759	-48.5
-60.0	.07037605	63.6	.06317162	-31.7	.03249708	-51.2
-56.0	.07771998	67.1	.07173046	-32.9	.03184110	-54.6

-52.0	.08610509	71.0	.08153219	-34.1	.03026345	-59.4
-48.0	.09568854	75.4	.09266687	-35.5	.02747894	-66.4
-44.0	.10663440	80.3	.10513950	-37.1	.02333698	-78.1
-40.0	.11909370	85.8	.11877900	-38.8	.01865475	258.6
-36.0	.13316320	92.0	.13308260	-40.5	.01836988	215.0
-32.0	.14880510	99.1	.14697230	-42.3	.02983184	176.9
-28.0	.16571240	107.1	.15847880	-44.1	.05197949	158.2
-24.0	.18311440	116.2	.16450070	-45.7	.08247465	148.5
-20.0	.19959810	126.3	.16107460	-47.0	.11900990	142.9
-16.0	.21318330	137.3	.14483580	-47.9	.15700590	139.4
-12.0	.22202020	148.7	.11564920	-48.3	.18977180	137.4
-8.0	.22568440	159.8	.07807843	-48.2	.21183180	136.4
-4.0	.22594370	170.2	.03855953	-47.9	.22264530	136.1
.0	.22560510	179.9	.00024727	-40.5	.22560490	136.1
4.0	.22603200	-170.3	.03810817	132.0	.22281310	136.1
8.0	.22584220	-159.9	.07773233	131.7	.21212830	136.4
12.0	.22221890	-148.8	.11544200	131.7	.19013290	137.4
16.0	.21339560	-137.4	.14476190	132.1	.15736740	139.4
20.0	.19980440	-126.4	.16110170	133.0	.11932820	142.9
24.0	.18330380	-116.3	.16458970	134.3	.08273257	148.5
28.0	.16588060	-107.2	.15859750	135.9	.05217795	158.2
32.0	.14895180	-99.1	.14709940	137.6	.02997665	176.8
36.0	.13328990	-92.0	.13320610	139.4	.01845108	214.7
40.0	.11920290	-85.8	.11889310	141.2	.01867382	258.3
44.0	.10672840	-80.3	.10524190	142.9	.02333766	-78.3
48.0	.09576970	-75.4	.09275721	144.4	.02747907	-66.5
52.0	.08617536	-71.1	.08161121	145.9	.03026667	-59.5
56.0	.07778102	-67.1	.07179925	147.1	.03184746	-54.7
60.0	.07042927	-63.6	.06323136	148.3	.03250587	-51.2
64.0	.06397783	-60.4	.05578266	149.3	.03249802	-48.5
68.0	.05830192	-57.5	.04932006	150.1	.03202532	-46.3
72.0	.05329382	-54.8	.04371552	150.9	.03123874	-44.5
76.0	.04886138	-52.3	.03885214	151.6	.03024895	-43.0
80.0	.04492610	-50.1	.03462622	152.2	.02913603	-41.8
84.0	.04142116	-48.0	.03094744	152.8	.02795722	-40.7
88.0	.03828978	-46.1	.02773795	153.3	.02675302	-39.7
92.0	.03548356	-44.3	.02493111	153.7	.02555167	-38.9
96.0	.03296124	-42.6	.02247011	154.1	.02437251	-38.2
100.0	.03068752	-41.1	.02030659	154.4	.02322835	-37.6
104.0	.02863217	-39.6	.01839948	154.7	.02212738	-37.0
108.0	.02676919	-38.3	.01671383	155.0	.02107441	-36.5
112.0	.02507618	-37.0	.01521991	155.3	.02007188	-36.0
116.0	.02353379	-35.8	.01389238	155.5	.01912053	-35.6
120.0	.02212524	-34.7	.01270963	155.7	.01821994	-35.3
124.0	.02083595	-33.7	.01165317	155.9	.01736888	-34.9
128.0	.01965319	-32.7	.01070717	156.1	.01656562	-34.6
132.0	.01856587	-31.8	.00985800	156.2	.01580808	-34.4
136.0	.01756424	-30.9	.00909395	156.4	.01509401	-34.1
140.0	.01663973	-30.0	.00840493	156.5	.01442108	-33.9
144.0	.01578481	-29.2	.00778216	156.7	.01378694	-33.7
148.0	.01499282	-28.5	.00721809	156.8	.01318928	-33.5
152.0	.01425783	-27.8	.00670609	156.9	.01262586	-33.3
156.0	.01357463	-27.1	.00624046	157.0	.01209452	-33.1
160.0	.01293854	-26.4	.00581613	157.1	.01159324	-33.0
164.0	.01234541	-25.8	.00542874	157.2	.01112006	-32.8
168.0	.01179151	-25.2	.00507442	157.2	.01067318	-32.7
172.0	.01127351	-24.6	.00474978	157.3	.01025088	-32.6
176.0	.01078842	-24.1	.00445182	157.4	.00985156	-32.5
180.0	.01033356	-23.6	.00417791	157.4	.00947374	-32.3
184.0	.00990649	-23.1	.00392569	157.5	.00911602	-32.2
188.0	.00950503	-22.6	.00369311	157.6	.00877711	-32.1
192.0	.00912719	-22.2	.00347830	157.6	.00845581	-32.1
196.0	.00877119	-21.7	.00327963	157.7	.00815099	-32.0

Attachment AA-2. Results of the Bonneville Power Administration Corona and Field Effects Program for the 230-kV Single-Circuit Transmission Line

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Û       C O R O N A   A N D   F I E L D       Û
Û E F F E C T S   P R O G R A M   V E R.  3   Û
Û   Source: Bonneville Power Administration   Û
ÛÜÜÜÜÜÜÜÜÜÜÜÜÜÜÜÜÜÜÜÜÜÜÜÜÜÜÜÜÜÜÜÜÜÜÜÜÜÜÜÜÜÜÜÜÜÛ


                              INPUT DATA LIST


               12/16/2019          13:55:54
 Nolin Hills UEC Single Circuit
 NH to Buttercreek
1,0, 3, 4,0.0,   2.00,   1.00,1000.00

(ENGLISH UNITS OPTION)

(GRADIENTS ARE COMPUTED BY PROGRAM)

PHYSICAL SYSTEM CONSISTS OF  4 CONDUCTORS, OF WHICH  3 ARE ENERGIZED PHASES

OPTIONS: ALL
  4.921,  6.562,  9.842,   .000,  1.000, 75.000,  3.280,  6.700,  3.280
'230A    ','A',   10.00,   44.90, 1,   1.345,    .000, 132.800,    .000,    .961,
.000
'230B    ','A',  -10.00,   34.90, 1,   1.345,    .000, 132.800,-120.000,    .961,
.000
'230C    ','A',   10.00,   24.90, 1,   1.345,    .000, 132.800, 120.000,    .961,
.000
'230G    ','A',    5.00,   54.15, 1,    .500,    .000,    .000,    .000,    .000,
.000
100 -200.0    4.0

1ELECTRIC FIELD CALCULATIONS


 Nolin Hills UEC Single Circuit
 NH to Buttercreek
             DIST. FROM              MAXIMUM   SUBCON.   NO. OF     PHASE
              REFERENCE    HEIGHT   GRADIENT   DIAM.    SUBCON.     ANGLE
                FEET        FEET    (KV/CM)    (IN)              (DEGREES)

230A            10.00       44.90    13.39      1.35         1         .0
230B           -10.00       34.90    12.98      1.35         1     -120.0
230C            10.00       24.90    13.50      1.35         1      120.0
230G             5.00       54.15     4.73       .50         1         .0

SENSOR HT. =  3.3 FEET

DIST FROM
REFERENCE      E-FIELD        THETA       EY-FIELD        THETAY        EX-FIELD
    THETAX   SPACE POTENTIAL
    FEET     (KV/METER)     (DEGREES)    (KV/METER)       (DEGREES)      (KV/METER)
   (DEGREES)      (VOLTS)

  -200.0          .042           87.9          .042          104.9           .002
      91.4          42.0
  -196.0          .044           87.9          .044          104.3           .002
      90.7          43.9
  -192.0          .046           87.8          .046          103.7           .002
      90.0          46.0
  -188.0          .048           87.8          .048          103.0           .002
      89.3          48.2
```

-184.0	.051	87.7	.051	102.3	.002	88.6	50.5
-180.0	.053	87.7	.053	101.7	.002	87.8	53.1
-176.0	.056	87.6	.056	101.0	.002	87.1	55.8
-172.0	.059	87.6	.059	100.2	.003	86.3	58.7
-168.0	.062	87.5	.062	99.5	.003	85.5	61.9
-164.0	.065	87.4	.065	98.7	.003	84.7	65.4
-160.0	.069	87.3	.069	97.9	.003	83.9	69.1
-156.0	.073	87.3	.073	97.1	.004	83.1	73.2
-152.0	.078	87.2	.078	96.3	.004	82.2	77.6
-148.0	.083	87.1	.082	95.4	.004	81.4	82.5
-144.0	.088	87.0	.088	94.5	.005	80.5	87.8
-140.0	.094	86.9	.094	93.6	.005	79.6	93.7
-136.0	.100	86.8	.100	92.7	.006	78.7	100.1
-132.0	.107	86.7	.107	91.7	.006	77.8	107.2
-128.0	.115	86.6	.115	90.7	.007	76.8	115.0
-124.0	.124	86.5	.124	89.7	.008	75.9	123.8
-120.0	.134	86.4	.133	88.6	.009	74.9	133.5
-116.0	.144	86.3	.144	87.5	.010	73.9	144.3
-112.0	.157	86.1	.156	86.4	.011	72.9	156.4
-108.0	.170	86.0	.170	85.3	.012	71.9	170.1
-104.0	.186	85.9	.185	84.1	.014	70.9	185.4
-100.0	.203	85.7	.202	82.9	.016	69.8	202.8
-96.0	.223	85.6	.222	81.7	.018	68.7	222.6
-92.0	.245	85.4	.244	80.4	.020	67.7	245.1
-88.0	.271	85.2	.270	79.2	.023	66.5	270.8
-84.0	.301	85.1	.299	77.9	.027	65.4	300.3
-80.0	.335	84.9	.333	76.5	.031	64.2	334.2
-76.0	.374	84.7	.372	75.2	.035	63.0	373.3
-72.0	.419	84.5	.417	73.8	.041	61.8	418.6
-68.0	.472	84.4	.469	72.4	.047	60.4	471.0
-64.0	.533	84.2	.530	70.9	.055	59.0	531.8
-60.0	.603	84.1	.600	69.4	.063		

57.5	602.2				
-56.0	.685	84.0	.681	67.9	.073
55.9	683.6				
-52.0	.779	84.0	.775	66.3	.084
53.9	777.2				
-48.0	.886	84.0	.881	64.7	.095
51.6	883.8				
-44.0	1.007	84.1	1.001	63.0	.106
48.7	1003.5				
-40.0	1.139	84.4	1.133	61.1	.116
44.8	1134.5				
-36.0	1.279	84.9	1.274	59.0	.122
39.1	1272.9				
-32.0	1.419	85.6	1.415	56.6	.122
29.9	1410.6				
-28.0	1.546	86.6	1.543	53.7	.119
13.9	1534.6				
-24.0	1.643	88.0	1.642	49.8	.123
-12.5	1627.4				
-20.0	1.690	89.7	1.690	44.4	.162
-42.2	1670.6				
-16.0	1.678	91.3	1.677	36.2	.247
-62.2	1656.1				
-12.0	1.626	91.5	1.626	23.6	.362
-72.7	1609.1				
-8.0	1.624	87.9	1.623	5.2	.482
-78.2	1616.9				
-4.0	1.820	81.8	1.803	-16.3	.570
-81.5	1802.3				
.0	2.239	79.9	2.206	-34.2	.588
-84.5	2191.8				
4.0	2.724	82.2	2.699	-46.1	.507
-90.0	2658.7				
8.0	3.093	86.0	3.085	-53.7	.342
-104.5	3023.2				
12.0	3.219	90.0	3.219	-58.9	.208
-149.7	3154.5				
16.0	3.079	93.7	3.072	-63.2	.268
158.7	3024.3				
20.0	2.742	96.6	2.724	-67.3	.356
140.3	2700.5				
24.0	2.319	98.6	2.292	-71.9	.381
132.5	2288.6				
28.0	1.897	99.8	1.869	-77.1	.353
127.7	1876.6				
32.0	1.528	100.2	1.504	-82.9	.301
123.7	1514.6				
36.0	1.228	100.1	1.209	-89.4	.244
119.8	1220.0				
40.0	.996	99.5	.982	-96.4	.192
115.6	990.7				
44.0	.819	98.7	.810	-103.5	.149
111.0	816.4				
48.0	.687	97.9	.680	-110.5	.116
105.9	684.7				
52.0	.586	97.1	.581	-117.2	.090
100.4	584.5				
56.0	.508	96.4	.505	-123.4	.071
94.7	507.0				
60.0	.446	95.8	.444	-129.0	.057
88.7	445.6				
64.0	.396	95.3	.395	-134.0	.046
82.7	395.9				

68.0	.355	95.0	.354	-138.4	.038	76.8	354.7
72.0	.320	94.7	.319	-142.4	.032	71.2	319.9
76.0	.290	94.5	.289	-145.9	.027	65.9	290.1
80.0	.264	94.3	.264	-149.1	.023	61.0	264.2
84.0	.242	94.1	.241	-151.9	.020	56.5	241.5
88.0	.222	94.0	.221	-154.5	.017	52.4	221.5
92.0	.204	93.9	.203	-156.8	.015	48.7	203.7
96.0	.188	93.7	.188	-158.9	.013	45.3	187.9
100.0	.174	93.6	.173	-160.8	.012	42.2	173.7
104.0	.161	93.5	.161	-162.6	.011	39.4	161.0
108.0	.150	93.4	.149	-164.3	.010	36.8	149.5
112.0	.139	93.3	.139	-165.8	.009	34.5	139.2
116.0	.130	93.2	.130	-167.3	.008	32.3	129.8
120.0	.121	93.2	.121	-168.6	.007	30.3	121.2
124.0	.114	93.1	.113	-169.9	.006	28.5	113.5
128.0	.106	93.0	.106	-171.1	.006	26.7	106.4
132.0	.100	92.9	.100	-172.2	.005	25.1	99.9
136.0	.094	92.8	.094	-173.3	.005	23.6	94.0
140.0	.089	92.8	.089	-174.3	.004	22.2	88.6
144.0	.084	92.7	.084	-175.3	.004	20.9	83.6
148.0	.079	92.6	.079	-176.2	.004	19.6	79.0
152.0	.075	92.6	.075	-177.1	.003	18.4	74.7
156.0	.071	92.5	.071	-177.9	.003	17.3	70.8
160.0	.067	92.4	.067	-178.8	.003	16.2	67.2
164.0	.064	92.4	.064	-179.5	.003	15.1	63.8
168.0	.061	92.3	.061	179.7	.003	14.1	60.7
172.0	.058	92.3	.058	179.0	.002	13.2	57.8
176.0	.055	92.2	.055	178.3	.002	12.3	55.1
180.0	.053	92.2	.053	177.7	.002	11.4	52.5
184.0	.050	92.1	.050	177.0	.002	10.6	50.2
188.0	.048	92.1	.048	176.4	.002	9.8	47.9
192.0	.046	92.1	.046	175.8	.002		

9.0	45.9				
196.0	.044	92.0	.044	175.2	.002
8.3	43.9				

1MAGNETIC FIELD CALCULATIONS

SENSOR HT. = 3.3 FEET

DIST FROM REFERENCE FEET	B-FIELD (GAUSS)	THETA	BY-FIELD (GAUSS)	THETAY	BX-FIELD (GAUSS)	THETAX
-200.0	.00314909	-70.3	.00307442	46.6	.00250990	-53.0
-196.0	.00327712	-69.9	.00319568	46.4	.00261080	-53.5
-192.0	.00341304	-69.4	.00332406	46.2	.00271803	-54.0
-188.0	.00355752	-69.0	.00346013	45.9	.00283212	-54.6
-184.0	.00371127	-68.5	.00360448	45.7	.00295368	-55.1
-180.0	.00387511	-68.0	.00375777	45.4	.00308341	-55.7
-176.0	.00404991	-67.5	.00392074	45.1	.00322206	-56.3
-172.0	.00423668	-67.0	.00409418	44.8	.00337048	-56.9
-168.0	.00443650	-66.4	.00427896	44.5	.00352963	-57.5
-164.0	.00465063	-65.9	.00447607	44.2	.00370059	-58.2
-160.0	.00488042	-65.3	.00468654	43.8	.00388459	-58.9
-156.0	.00512744	-64.6	.00491158	43.5	.00408301	-59.7
-152.0	.00539341	-63.9	.00515246	43.1	.00429742	-60.5
-148.0	.00568029	-63.2	.00541061	42.7	.00452964	-61.3
-144.0	.00599030	-62.5	.00568763	42.3	.00478172	-62.1
-140.0	.00632595	-61.7	.00598526	41.9	.00505604	-63.0
-136.0	.00669009	-60.9	.00630544	41.4	.00535533	-64.0
-132.0	.00708597	-60.0	.00665029	40.9	.00568276	-65.0
-128.0	.00751731	-59.0	.00702219	40.4	.00604202	-66.0
-124.0	.00798837	-58.0	.00742373	39.9	.00643742	-67.1
-120.0	.00850406	-57.0	.00785777	39.3	.00687401	-68.2
-116.0	.00907005	-55.9	.00832747	38.7	.00735773	-69.4
-112.0	.00969290	-54.7	.00883626	38.0	.00789561	-70.7
-108.0	.01038026	-53.4	.00938786	37.3	.00849599	-72.0
-104.0	.01114104	-52.0	.00998629	36.6	.00916883	-73.4
-100.0	.01198569	-50.6	.01063582	35.7	.00992603	-74.9
-96.0	.01292649	-49.0	.01134093	34.8	.01078189	-76.4
-92.0	.01397795	-47.3	.01210616	33.8	.01175367	-78.0
-88.0	.01515727	-45.4	.01293604	32.7	.01286220	-79.7
-84.0	.01648489	-43.4	.01383473	31.5	.01413272	-81.4
-80.0	.01798521	-41.3	.01480571	30.1	.01559583	-83.2
-76.0	.01968743	-38.9	.01585133	28.5	.01728859	-85.1
-72.0	.02162659	-36.3	.01697213	26.7	.01925572	-87.1
-68.0	.02384478	-33.5	.01816624	24.6	.02155084	-89.1
-64.0	.02639260	-30.3	.01942887	22.1	.02423745	268.8
-60.0	.02933070	-26.9	.02075277	19.1	.02738919	266.6
-56.0	.03273150	-23.0	.02213101	15.5	.03108843	264.4
-52.0	.03668060	-18.7	.02356561	10.9	.03542158	262.2
-48.0	.04127759	-13.9	.02508878	5.1	.04046823	259.9
-44.0	.04663524	-8.6	.02680904	-2.2	.04627957	257.6
-40.0	.05287560	-2.5	.02899706	-11.5	.05283955	255.3
-36.0	.06012062	4.3	.03220887	-22.9	.06000059	252.9
-32.0	.06847470	12.0	.03737049	-35.7	.06738890	250.3
-28.0	.07799604	20.6	.04565079	-48.7	.07428717	247.6
-24.0	.08865727	30.3	.05803761	-60.3	.07953899	244.3
-20.0	.10030120	41.1	.07480793	-69.7	.08158921	240.0
-16.0	.11260510	53.1	.09509324	-76.7	.07888903	233.5
-12.0	.12506610	66.2	.11658130	-81.8	.07111335	222.4
-8.0	.13700090	80.5	.13546990	-85.7	.06215644	201.6
-4.0	.14752380	95.8	.14689420	-89.0	.06388669	169.8

.0	.15548710	112.2	.14608780	267.1	.08467324	142.9
4.0	.15949500	129.4	.13067450	260.9	.11433190	128.0
8.0	.15824690	147.2	.10412420	249.3	.13830260	119.8
12.0	.15127460	164.8	.07832495	227.6	.14714190	114.3
16.0	.13950390	-178.3	.06799472	196.8	.13945660	109.5
20.0	.12492580	-162.7	.07163842	172.0	.12080710	104.1
24.0	.10963260	-148.8	.07625270	157.6	.09871171	97.5
28.0	.09510680	-136.5	.07640863	149.1	.07852692	89.5
32.0	.08210028	-125.8	.07255061	143.4	.06253964	80.1
36.0	.07083938	-116.5	.06643008	139.0	.05089280	70.0
40.0	.06126333	-108.4	.05949540	135.4	.04273105	60.0
44.0	.05318855	-101.3	.05263657	132.1	.03698835	50.7
48.0	.04639819	-95.1	.04630633	129.0	.03278099	42.6
52.0	.04068386	-89.6	.04068338	126.1	.02951113	35.8
56.0	.03586180	-84.8	.03579505	123.2	.02682170	30.1
60.0	.03177660	-80.5	.03159434	120.5	.02451413	25.4
64.0	.02829966	-76.6	.02800389	117.9	.02248084	21.5
68.0	.02532572	-73.2	.02493925	115.4	.02066248	18.2
72.0	.02276910	-70.2	.02232020	112.9	.01902397	15.3
76.0	.02056005	-67.5	.02007539	110.6	.01754225	12.9
80.0	.01864183	-65.1	.01814367	108.5	.01620010	10.7
84.0	.01696808	-62.9	.01647365	106.4	.01498342	8.9
88.0	.01550086	-61.0	.01502271	104.5	.01387985	7.2
92.0	.01420893	-59.3	.01375566	102.6	.01287832	5.7
96.0	.01306653	-57.8	.01264358	100.9	.01196873	4.3
100.0	.01205223	-56.5	.01166265	99.3	.01114189	3.1
104.0	.01114823	-55.4	.01079325	97.7	.01038946	1.9
108.0	.01033957	-54.4	.01001917	96.3	.00970391	.9
112.0	.00961370	-53.6	.00932695	94.9	.00907843	-.1
116.0	.00896000	-53.0	.00870539	93.7	.00850694	-1.0
120.0	.00836948	-52.5	.00814510	92.5	.00798398	-1.8
124.0	.00783445	-52.2	.00763820	91.3	.00750468	-2.6
128.0	.00734836	-52.1	.00717804	90.3	.00706468	-3.3
132.0	.00690557	-52.2	.00675896	89.3	.00666012	-4.0
136.0	.00650123	-52.5	.00637614	88.3	.00628754	-4.7
140.0	.00613115	-53.0	.00602546	87.4	.00594386	-5.3
144.0	.00579167	-53.7	.00570336	86.6	.00562633	-5.9
148.0	.00547965	-54.8	.00540677	85.8	.00533250	-6.5
152.0	.00519230	-56.1	.00513302	85.0	.00506020	-7.0
156.0	.00492723	-57.7	.00487980	84.3	.00480745	-7.5
160.0	.00468231	-59.7	.00464507	83.6	.00457252	-8.0
164.0	.00445565	-62.0	.00442705	83.0	.00435383	-8.4
168.0	.00424560	-64.6	.00422418	82.4	.00414997	-8.9
172.0	.00405064	-67.4	.00403505	81.8	.00395968	-9.3
176.0	.00386944	-70.4	.00385845	81.2	.00378182	-9.7
180.0	.00370074	-73.4	.00369328	80.7	.00361537	-10.1
184.0	.00354342	-76.4	.00353856	80.2	.00345940	-10.5
188.0	.00339641	-79.2	.00339342	79.7	.00331307	-10.8
192.0	.00325880	-81.8	.00325708	79.2	.00317562	-11.2
196.0	.00312972	-84.1	.00312884	78.8	.00304637	-11.5