

APPENDIX G EMF STUDY

ELECTROMAGNETIC FIELDS STUDY

1. INTRODUCTION

TUAL bn, LLC (Applicant), a subsidiary of BrightNight, LLC, plans to construct, own, and operate the Nottingham Battery Energy Storage System (BESS), a lithium-ion battery energy storage facility capable of storing and delivering power to the Portland General Electric (PGE) regional transmission grid (Nottingham BESS). The Nottingham BESS is located in Washington County, Oregon, on Tax Lots 2S120D001200 and 2S120D001100, occupying a 12.5-acre site. The Nottingham BESS received its Special Use and Development Review approval from Washington County in May 2025 (Casefile L2400314-SU/D).

The Nottingham BESS will interconnect to PGE's regional transmission grid at the PGE Sherwood Substation, located within the City of Sherwood. An approximately 0.5-mile 230 kilovolt (kV) generation-tie line (gen-tie) will connect the Nottingham BESS to the Sherwood Substation; approximately 1,200 feet of the gen-tie is within the City of Sherwood and will be co-located with PGE's existing 115kV line on new utility infrastructure. Applicant is upgrading existing PGE poles to accommodate approximately 1,200 feet of 230 kV gen-tie along with PGE's existing 115 kV line on up to five utility poles (proposed route). The proposed route for the gen-tie is shown in Figure 1.

This electromagnetic fields (EMF) study evaluates the portion of the gen-tie that is within Sherwood City limits using the Bonneville Power Administration (BPA) Corona and Field Effects Program, Version 3.1 (CAFE31). The report presents results for scenarios G1 through G5 along the 230-kV gen-tie corridor. The study evaluates electric field (EF), magnetic field (MF), radio interference (RI), television interference (TVI), audible noise (AN), corona loss, and ozone. This report includes technical study methods, input assumptions, and modeled results.

2. STUDY APPROACH AND INPUT DATA INVENTORY

The 60% design (referred to as BOD) (Revamp 2026a, 2026b) shows a 230-kV transmission line extending from the Sherwood Substation toward the BESS substation (Figure 2). From TUAL1 through TUAL5, the proposed 230-kV circuit is supported on structures shared with PGE's existing 115-kV circuit and associated all-dielectric self-supporting (ADSS) fiber. At TUAL5, the existing 115-kV circuit taps off toward its existing PGE route, while the proposed 230-kV circuit continues toward the BESS. The transmission-line alignment also crosses SW Langer Farms Parkway between TUAL3 and TUAL4. The 60% design drawings identify the transferred existing 115-kV conductor as 795-kcmil ACSR Drake and state that no shield wire is required for the proposed 230-kV circuit.

The study evaluates representative maximum-sag cross sections used in CAFE31. G1 through G5 represent consecutive transmission-line spans from TUAL1 through TUAL6. For G1 through G4, both the proposed 230-kV circuit and the existing 115-kV circuit are included because both circuits occupy the shared structures. G5 contains only the proposed 230-kV circuit after the 115-

kV circuit departs at TUAL5. The modeled scenarios included in this study are summarized in Table 1, which shows all the details related to tower dimensions. It is graphically illustrated in Figure 4.

The horizontal coordinates used in CAFE31 represent the transverse position of each conductor relative to a common model reference axis and should not be interpreted as span lengths or crossarm dimensions. The 60% LCA/POL geometry for the TUAL3/TUAL4 tangent configuration provides a useful example. In the original POL/design coordinate system, the 230-kV conductor plane is located at approximately -8.6 ft and the 115-kV conductor plane at approximately -5.1 ft, corresponding to a lateral separation of approximately 3.5 ft. The CAFE31 model was recentered so that the 230-kV phase plane is approximately aligned with $x = 0$, while preserving the same physical separation between the conductor planes.

POL/design coordinate system:

230-kV phase plane ≈ -8.6 ft

115-kV phase plane ≈ -5.1 ft

lateral separation ≈ 3.5 ft

CAFE31 recentered coordinate system:

230-kV phase plane ≈ 0 ft

115-kV phase plane $\approx +3.5$ ft

The recentering changes only the coordinate origin and does not change the physical spacing between the conductors. Because the shared structures use predominantly vertical conductor configurations, the individual phases within each circuit are nearly vertically aligned. As a result, the phase-to-phase x-offsets within the 230-kV circuit can be only fractions of a foot, while the larger 115-kV x-offset represents the lateral displacement of the entire 115-kV phase plane relative to the 230-kV phase plane. The actual x- and y-coordinates used in CAFE31 are shown in Figure 4.

The proposed 230-kV circuit is modeled using a 1272-kcmil ACSR Pheasant conductor. The co-located 115-kV circuit is modeled using the existing 795-kcmil ACSR Drake conductor identified in the design documents for transfer to the new steel structures. Although the structures provide accommodation for a future 1272-kcmil ACSS Pheasant 115-kV conductor, the present CAFE evaluation represents the existing Drake conductor and therefore does not model the future conductor configuration. The design drawing package also identifies dedicated 230-kV and 115-kV dead-end, jumper-post, and braced-post assemblies consistent with these conductor types.

ADSS fiber is excluded from the energized conductor set because it does not carry the phase voltage or load current evaluated in the CAFE model. Similarly, no 230-kV shield wire is included because the 60% design basis states that no shield wire is required under the applicable PGE standards.

TABLE 1 MODELED SCENARIOS

Scenario	Span / Segment	Circuits	Design span length (ft)	230-kV x-offsets, top/mid/bot (ft)	230-kV max-sag heights, top/mid/bot (ft)	115-kV x-offsets, top/mid/bot (ft)	115-kV max-sag heights, top/mid/bot (ft)
G1	TUAL1–TUAL2	230+115	359.64	–0.233 / 0.017 / 0.217	109.8 / 95.2 / 80.8	0.567 / 0.717 / 0.867	55.7 / 47.6 / 39.7
G2	TUAL2–TUAL3	230+115	315.89	–0.033 / 0.017 / 0.017	113.2 / 99.7 / 86.4	2.017 / 2.017 / 2.067	61.3 / 53.2 / 45.2
G3	TUAL3–TUAL4	230+115	273.76	0.100 / 0.000 / –0.100	113.6 / 101.6 / 89.6	3.600 / 3.500 / 3.500	65.4 / 57.2 / 49.3
G4	TUAL4–TUAL5	230+115	273.35	0.050 / 0.000 / –0.050	120.7 / 107.2 / 93.7	1.800 / 1.750 / 1.750	68.6 / 60.5 / 52.7

Note: Horizontal x-offsets are measured relative to the CAFE model reference axis. Positive and negative values indicate opposite sides of the reference axis. For G1 through G4, the reference axis is established relative to the 230-kV conductor phase plane. Values are listed in top/middle/bottom phase order.

The G1 through G4 maximum-sag elevations were established from the 60% PNP-1001 plan/profile and corresponding local ground elevations. The PNP-1001 drawing depicts the maximum-operating-temperature ACSR condition as 212°F, no wind, no ice, maximum sag. The resulting span-midpoint heights used by CAFE were independently checked against the available PLS-CADD/PLS-POLE LCA/POL information and the applicable STR, FRM, and LD drawings. The design package identifies PNP-1001, STR-1001 through STR-1006, FRM-1001 through FRM-1006, and LD-1001 through LD-1006 as part of the 60% transmission design set.

The same maximum-sag conductor geometry was retained for all three electrical load cases; therefore, the L1 and L2 evaluations do not take credit for potentially greater conductor clearances associated with lower conductor temperatures.

G1 through G4 each contain six energized phase conductors in CAFE: three phases of the proposed 230-kV circuit and three phases of the existing 115-kV circuit.. Each phase is represented as a single conductor; no bundled subconductors are used. The physical design span lengths shown in Table 1 are important because they influence conductor sag and therefore the maximum-sag conductor elevations. CAFE does not use physical span length as an independent field-calculation input; instead, it uses the resulting two-dimensional conductor coordinates at the representative cross section.

Horizontal conductor locations were established relative to the CAFE reference axis using the reviewed structure/LCA-POL geometry (Revamp 2026c). The three phases of each circuit were assigned phase angles of 0°, –120°, and +120° for the top, middle, and bottom phase positions, respectively. The same positional phase sequence was applied to the 230-kV and 115-kV circuits.

Because the reviewed design information does not establish the actual electrical phase relationship between the two circuits, the relative 230/115-kV phasing should be regarded as a modeling assumption for the shared-circuit scenarios G1 through G4. The current CAFE input documents both the transverse coordinates and this phase-order assumption.

Electrical conductor characteristics and 230-kV loading conditions were obtained from the Revamp Engineering 60% Basis of Design (Revamp 2026a). The modeled 230-kV circuit uses 1272-kcmil ACSR Pheasant conductor with a 1.382-in conductor diameter, and the existing 115-kV circuit uses 795-kcmil ACSR Drake with a 1.108-in conductor diameter. Line-to-ground voltages of 132.791 kV and 66.395 kV were used for the individual 230-kV and 115-kV phase records, respectively, corresponding to nominal line-to-line voltages of 230 kV and 115 kV.

The 60% Basis of Design identifies a 1,057-A steady-state current associated with the anticipated loading, a 1,173.6-A maximum-normal operating current, and a 1,294.7-A emergency/conductor-rated current for the 230-kV circuit. These conditions are designated L1, L2, and L3, respectively, in the CAFE analysis. The Basis of Design also reports an ampacity of 990.65 A for the existing 795-kcmil ACSR Drake conductor. Because a separate operating-current profile for PGE's existing 115-kV circuit was not provided in the reviewed design information, the 990.65-A ampacity of the Drake conductor was used as a conservative ampacity-based screening current for the 115-kV circuit in G1 through G4. The electrical load cases are summarized in Table 2.

TABLE 2 ELECTRICAL LOAD CASES

Load case	Description	230-kV current (kA) (G1-G4)	115-kV ampacity-based screening current (kA) G1-G4
L1	Steady-state loading	1.057	0.99065
L2	Maximum normal operating condition	1.1736	0.99065
L3	Emergency/conductor rated condition	1.2947	0.99065

The 115-kV value in Table 2 is an ampacity-based screening current rather than a documented operating load. Consequently, the 115-kV contribution is intentionally unchanged among L1, L2, and L3.

The L1, L2, and L3 cases differ only in the modeled 230-kV current. Accordingly, electric field and the corona-related quantities—including RI, TVI, AN, conductor gradient, corona loss, and ozone—are unchanged among the three current cases for a given geometry because voltage, conductor geometry, and the environmental inputs used by CAFE remain unchanged. To avoid presenting duplicate results, the L2 Maximum Normal case is used in the main text for these quantities. Magnetic field is presented for L1, L2, and L3 because it varies with current. The detailed CAFE model assumptions, computational settings, and additional model-specific inputs are described in the following section.

2.1 EMF MODEL INPUTS

CAFE31 model was used to calculate power-frequency electric field (EF) and magnetic field (MF), as well as corona-related radio interference (RI), television interference (TVI), audible noise (AN), conductor surface gradient, corona loss, and ozone concentration. Conductor surface gradients were computed internally by CAFE rather than entered by the user. The common model settings used for the G1 through G4 analyses are summarized in Table 3.

CAFE31 represents the overhead transmission line as a transverse, two-dimensional cross-section of parallel conductors above a ground plane. Each energized phase is represented by a conductor record that specifies the horizontal position, conductor or bundle-center height, number and diameter of subconductors, bundle spacing, line-to-ground voltage, phase angle, and current. With the conductor-gradient option set to computed, CAFE calculates conductor surface gradient from the specified electrical and geometric configuration rather than requiring a user-entered gradient.

For a balanced three-phase AC circuit, the phase-to-ground RMS voltage used in the individual conductor records is the nominal line-to-line voltage divided by the square root of three. Accordingly, the modeled phase-to-ground voltages are 132.791 kV for the 230-kV circuit and 66.395 kV for the 115-kV circuit. The top, middle, and bottom phase positions are assigned phase angles of 0° , -120° , and $+120^\circ$, respectively. For the shared 230/115-kV configurations G1 through G4, the same positional phase sequence is applied to both circuits. Because the reviewed design information does not establish the relative electrical phase relationship between the two circuits, this relative phasing is treated as a modeling assumption.

TABLE 3 KEY CAFE31 MODELING INPUTS AND ASSUMPTIONS

Parameter	Value / Treatment	Basis / Comment
Model	BPA CAFE Version 3.1 (CAFE31)	Study model
Units	English	CAFE input setting
Conductor gradient	Computed by CAFE	Surface gradient not user-entered
230-kV line-to-ground voltage	132.791 kV	$230/\sqrt{3}$
115-kV line-to-ground voltage	66.395 kV	$115/\sqrt{3}$
Phase angles	Top / middle / bottom = 0° / -120° / $+120^\circ$	Modeling phase-sequence assumption
Project elevation input	250 ft	Project design elevation from 60% Basis of Design

Parameter	Value / Treatment	Basis / Comment
Ground conductivity input	6.7 mmhos/m	Study input used for RI/TVI propagation; based on prior Oregon study information
Rain-rate input	2 in/hr	Study-selected CAFE input; not specified by the 60% BOD
Wind input	2 mi/hr	CAFE ozone input; approximately equivalent numerically to the 2.93 ft/s value used in the BOD thermal-rating calculation
AN microphone height	4.921 ft	CAFE observation-height input
RI antenna height	6.562 ft	CAFE observation-height input
TVI antenna height	9.842 ft	CAFE observation-height input
EF sensor height	3.280 ft (1.0 m)	Study evaluation height
MF sensor height	3.280 ft (1.0 m)	Study evaluation height
Ozone sensor height	0 ft	CAFE input
RI summary frequency	1 MHz	CAFE RI reporting input
TVI summary frequency	75 MHz	CAFE TVI reporting input
Lateral calculation profile	–200 ft to +200 ft	Common analysis extent for all reported quantities
Calculation points	100	Includes both –200- and +200-ft endpoints
Calculation-point spacing	4.040404 ft	400 ft / 99 intervals
230-kV conductor	1272-kcmil ACSR Pheasant; 1.382-in diameter; one conductor per phase	60% design basis
115-kV conductor	795-kcmil ACSR Drake; 1.108-in diameter; one conductor per phase	Existing conductor identified for transfer in 60% design basis
230-kV load cases	L1 = 1.0570 kA; L2 = 1.1736 kA; L3 = 1.2947 kA	See Table 2
115-kV ampacity-based screening current	0.99065 kA for G1–G4	Drake ampacity used because a separate operating-current profile was not provided

The BOD supports the 250-ft project elevation and identifies a wind speed of 2.93 ft/s in the conductor thermal-rating calculation, which is approximately 2 mi/hr. The present CAFE setup uses 250 ft and 2 mi/hr, while the ground-conductivity and rain-rate values are separate study/modeling inputs rather than electrical-design parameters from the BOD. The current study also distinguishes the BOD's 2 W/m-K radial thermal conductivity, which is an IEEE 738 conductor thermal property, from the 6.7 mmhos/m electrical ground conductivity used by CAFE.

The sensor-height and frequency inputs in Table 3 follow the CAFE input definitions. EF and MF are evaluated at 3.28 ft (1 m) above ground. AN, RI, and TVI use separate microphone or antenna heights because their empirical corona-effect calculations are referenced to their respective observation heights. RI is summarized at 1 MHz and TVI at 75 MHz. Ground conductivity is used in the interference calculations, while the wind and rain-rate inputs are used in the applicable CAFE corona/ozone routines. The current CAFE output setup confirms the AN, RI, TVI, EF/MF, ozone, frequency, wind, ground-conductivity, and rain-rate fields used in the calculations.

The lateral calculation profile extends from –200 ft to +200 ft (Figure 3) relative to the CAFE reference axis. The current analyses use 100 calculation points at approximately 4 ft spacing, which provides values at both exact endpoints. The same full ± 200 -ft profile is used for EF, MF, AN, RI, TVI, ozone, and corona-related result summaries. These distances are model coordinates and should not be interpreted as property-line or right-of-way distances unless separately related to surveyed corridor geometry.

Because CAFE is a cross-section model, it does not explicitly reproduce the longitudinal conductor sag curve, steel-pole shape, termination hardware, local buildings or vegetation, or three-dimensional conductor transitions at structures. The maximum-sag midspan cross-section is therefore used as the principal screening location for ground-level field characterization, while the design drawings and line-design files are used to establish and cross-check the conductor coordinates.

3. RESULTS AND DISCUSSION

This section presents the CAFE31 modeling results for the portion of the gen-tie that is within the City of Sherwood. The modeled results include electric field (EF), magnetic field (MF), radio interference (RI), television interference (TVI), audible noise (AN), conductor surface electric-field gradient, corona loss, and ozone generation. Results are evaluated across the modeled lateral profile extending from –200 to +200 ft relative to the CAFE reference axis.

Three electrical loading conditions were evaluated: L1 Steady, L2 Maximum Normal, and L3 Emergency. The only electrical input that changes among these cases is the modeled 230-kV current. Consequently, the electric field and the corona-related outputs are unchanged among L1, L2, and L3 for a given geometry because the operating voltage, conductor geometry, and environmental inputs remain constant. The magnetic field is current-dependent and therefore varies among the loading cases for configurations containing the 230-kV circuit. Accordingly, magnetic-field results are presented for all three load cases, while the L2 Maximum Normal case is used to represent EF and the corona-related outputs in the main discussion.

Results are compared, where applicable, with regulatory criteria, exposure reference levels, and screening or contextual comparison values identified for this study.

3.1 ELECTRIC FIELD

OAR 345-024-0090 establishes an alternating-current electric-field criterion of 9 kV/m at 1 m above ground in areas accessible to the public. Accordingly, the CAFE31 electric- and magnetic-field calculations for this study were evaluated at approximately 3.28 ft (1 m) above ground. Oregon does not establish a corresponding numerical magnetic-field exposure limit for transmission lines. For comparison, the general-public magnetic-field exposure reference levels are 9,040 mG under IEEE C95.1-2019 (IEEE 2019) and 2,000 mG under the ICNIRP (2010) guidelines.

Electric-field magnitude is governed primarily by operating voltage, conductor geometry, and conductor height above ground. Because these parameters are unchanged among L1, L2, and L3, the electric-field results are identical among the three loading cases for each modeled configuration. Table 4 summarizes the modeled electric field at –200 ft and +200 ft from the CAFE reference axis and the maximum value occurring within the modeled ±200-ft profile.

The highest modeled electric field is 0.774 kV/m for G1 (TUAL1–TUAL2). The modeled maximum decreases progressively through G2, G3, G4, with respective maximum values of 0.632, 0.545, and 0.498kV/m. This pattern reflects differences in conductor configuration and maximum-sag clearance among the modeled spans, including the presence of both the 230-kV and 115-kV circuits on the shared structures in G1 through G4.

All modeled maximum electric-field values are substantially below the Oregon 9-kV/m criterion. Electric-field values also decrease markedly with lateral distance from the conductors, with modeled values at ±200 ft ranging from approximately 0.048 to 0.058 kV/m among the evaluated configurations. The ±200-ft values represent the endpoints of the modeled lateral profile and are not intended to represent right-of-way or property-line values unless separately related to site-specific surveyed boundaries.

TABLE 4 ELECTRIC FIELD SUMMARY WITHIN ±200 FT

Scenario	Configuration	Electric Field at –200 ft (kV/m)	Maximum Electric Field (kV/m)	Electric Field at +200 ft (kV/m)
G1	TUAL1–TUAL2	0.058	0.774	0.056
G2	TUAL2–TUAL3	0.052	0.632	0.053
G3	TUAL3–TUAL4	0.047	0.545	0.051
G4	TUAL4–TUAL5	0.048	0.498	0.050

Note: Electric field evaluated at 3.28 ft (1 m) above ground. Values shown represent the L2 Maximum Normal case; identical EF results are obtained for L1 and L3 because voltage and conductor geometry are unchanged among the three load cases. Oregon electric-field criterion = 9 kV/m at 1 m above ground in areas accessible to the public (OAR 345-024-0090).

The modeled electric-field profiles for G1 through G4 are shown in Figure 5, Figure 7, Figure 9, and Figure 11, respectively.

3.2 MAGNETIC FIELD

Magnetic-field magnitude depends primarily on conductor current and conductor geometry. For G1 through G4, the modeled 230-kV current increases from L1 Steady through L3 Emergency; therefore, the predicted magnetic fields increase correspondingly. Table 5 summarizes the magnetic field at –200 ft and +200 ft and the maximum magnetic field within the modeled ± 200 -ft profile for each configuration and loading condition.

The highest modeled magnetic field is 73.29 mG for G1 under the L3 Emergency condition. G1 also produces the highest magnetic-field value for the L1 and L2 cases, with maximum values of 68.53 and 70.87 mG, respectively. The comparatively higher fields for G1 reflect the combined contribution of the 230-kV and 115-kV circuits and the conductor geometry and clearances associated with that span.

Maximum magnetic fields generally decrease from G1 through G4 as the maximum-sag conductor clearances increase and the cross-sectional geometry changes. These results demonstrate the influence of both current and conductor configuration on the predicted ground-level magnetic field.

The maximum predicted magnetic field of 73.29 mG is substantially below both the 2,000-mG ICNIRP general-public reference level and the 9,040-mG IEEE C95.1-2019 general-public reference level. Magnetic-field strength also decreases substantially with lateral distance from the transmission line, with all modeled values at ± 200 ft well below the maximum values occurring closer to the conductors.

TABLE 5 MAGNETIC FIELD SUMMARY WITHIN ± 200 FT

Scenario	Load Case	Magnetic Field at –200 ft (mG)	Maximum Magnetic Field (mG)	Magnetic Field at +200 ft (mG)
G1	L1 Steady	5.59	68.53	5.63
G1	L2 Maximum Normal	5.98	70.87	6.02
G1	L3 Emergency	6.39	73.29	6.42
G2	L1 Steady	5.24	55.06	5.32
G2	L2 Maximum Normal	5.59	57.01	5.68
G2	L3 Emergency	5.96	59.03	6.05
G3	L1 Steady	4.85	46.88	4.99
G3	L2 Maximum Normal	5.16	48.55	5.31
G3	L3 Emergency	5.49	50.29	5.64

Scenario	Load Case	Magnetic Field at –200 ft (mG)	Maximum Magnetic Field (mG)	Magnetic Field at +200 ft (mG)
G4	L1 Steady	5.12	43.10	5.19
G4	L2 Maximum Normal	5.47	44.79	5.54
G4	L3 Emergency	5.83	46.54	5.90

Note: Magnetic field evaluated at 3.28 ft (1 m) above ground. General-public reference levels shown for comparison are 2,000 mG (ICNIRP 2010) and 9,040 mG (IEEE 2019).

The modeled magnetic field profiles for G1 through G4 are shown in Figure 6, Figure 8, Figure 10, and Figure 12, respectively.

3.3 RADIO INTERFERENCE

Modeling results for radio interference (RI), expressed as L50 levels, are summarized in Table 6. RI is reported at 1 MHz, consistent with the CAFE31 model setup and within the AM broadcast frequency range commonly considered in transmission-line RI evaluations. IEEE Std 430-2017 (IEEE 2017) provides standardized procedures for measuring corona-related radio noise from overhead power lines and substations; however, it does not establish a single universal acceptable RI field-strength limit applicable to the modeled results. Accordingly, the RI results are presented to characterize the relative magnitude of potential corona-related interference and its attenuation with lateral distance from the transmission line.

During rainy conditions, the maximum modeled RI ranges from 32.7 to 57.1 dB μ V/m for the evaluated transmission-line configurations. G3 produces the highest maximum rainy-weather RI level of 57.1 dB μ V/m, followed by G2 at 56.1 dB μ V/m. At $\pm$ 200 ft from the CAFE reference axis, rainy-weather RI ranges from 16.0 to 45.8 dB μ V/m, demonstrating substantial attenuation with increasing lateral distance from the conductors.

Under fair-weather conditions, maximum RI ranges from 38.5 to 40.1 dB μ V/m, with values at $\pm$ 200 ft ranging from 26.4 to 28.8 dB μ V/m. Fair-weather RI is substantially lower than rainy-weather RI for all modeled configurations, consistent with the increased corona activity expected when conductor surfaces are wet.

The potential for actual interference at a particular radio receiver depends not only on the transmission-line radio-noise field strength but also on the strength of the desired broadcast signal, the resulting signal-to-noise ratio, receiver characteristics, and local reception conditions. Therefore, the CAFE31 RI results are used in this study to characterize the relative potential for transmission-line-generated radio noise rather than to demonstrate compliance with a numerical RI criterion.

TABLE 6 RADIO-INTERFERENCE SUMMARY AND COMPARISON LEVEL

Scenario	RI Rain max within ± 200 (dB μ V/m)	RI Rain at ± 200 (dB μ V/m)	RI Fair max within ± 200 (dB μ V/m)	RI Fair at ± 200 (dB μ V/m)
G1	55.6	43.4	38.6	26.4
G2	56.1	44.5	39.1	27.5
G3	57.1	45.8	40.1	28.8
G4	55.5	44.9	38.5	27.9

Note: RI reported as L50 at 1 MHz. "At ± 200 ft" represents the greater of the values at the -200 -ft and $+200$ -ft endpoints. The 56-dB μ V/m value is used as a screening comparison and is not an Oregon regulatory limit.

3.4 TELEVISION INTERFERENCE

Modeling results for television interference (TVI) are summarized in Table 7. TVI is reported at 75 MHz, consistent with the CAFE31 model setup. IEEE Std 430-2017 includes television-broadcast frequency bands within the scope of standardized power-line radio-noise measurements, but no single numeric TVI acceptance criterion directly applicable to the CAFE31 75-MHz results was identified for this study. Accordingly, the modeled values are presented to characterize the relative potential for interference and its attenuation with lateral distance from the transmission line.

The maximum modeled TVI levels range from 12 to 13.8 dB μ V/m among the evaluated configurations, with G3 producing the highest value. At ± 200 ft, TVI ranges from 4.3 to 6.2 dB μ V/m. In all configurations, modeled TVI decreases substantially with increasing lateral distance from the transmission line.

Negative values in dB μ V/m do not represent a negative physical electric-field strength. Because dB μ V/m is expressed logarithmically relative to 1 μ V/m, values below 0 dB μ V/m indicate modeled interference field strengths of less than 1 μ V/m.

TABLE 7 TELEVISION-INTERFERENCE SUMMARY

Scenario	TVI max within ± 200 (dB μ V/m)	TVI at ± 200 (dB μ V/m)
G1	12.4	4.3
G2	12.8	5
G3	13.8	6.2
G4	12	4.9

Note: TVI is reported at 75 MHz. The value reported "at ± 200 ft" represents the greater of the modeled values at the -200 -ft and $+200$ -ft endpoints. No directly applicable numeric TVI acceptance criterion was identified for this study.

3.5 AUDIBLE NOISE

CAFE31 predicts corona-generated audible noise (AN) as L50 values for rainy- and fair-weather conditions. The “A” in dBA refers to A-weighting, a standardized frequency weighting that accounts for the frequency-dependent sensitivity of human hearing. Table 8 summarizes the maximum modeled AN within the ± 200 -ft analysis profile and the AN level at ± 200 ft for each transmission-line configuration.

For context, OAR 340-035-0035 establishes statistical noise limits applicable to certain industrial and commercial noise sources, including L50 values of 55 dBA during daytime hours and 50 dBA during nighttime hours at applicable noise-sensitive measurement locations (OAR 340-035-0035). The CAFE31 results presented in Table 8 characterize only corona-generated transmission-line noise as a function of lateral distance and do not constitute a receptor-specific noise compliance analysis. Accordingly, the Oregon values are presented as contextual comparison levels rather than project-specific compliance criteria.

During rainy conditions, the maximum modeled AN ranges from 39.1 to 40.5 dBA for the evaluated configurations, with G3 producing the highest value. At ± 200 ft, rainy-weather AN ranges from 34.5 to 36.2 dBA. Under fair-weather conditions, maximum AN ranges from 14.1 to 15.5 dBA, with values at ± 200 ft ranging from 9.5 to 11.2 dBA. The higher predicted levels under rainy conditions reflect increased corona activity associated with wet conductor surfaces.

All modeled rainy- and fair-weather AN levels shown in Table 8 are below the 50-dBA nighttime and 55-dBA daytime L50 values used for contextual comparison.

TABLE 8 AUDIBLE-NOISE SUMMARY

Scenario	AN rain max within ± 200 (dBA)	AN rain at ± 200 (dBA)	AN fair max within ± 200 (dBA)	AN fair at ± 200 (dBA)
G1	39.1	34.5	14.1	9.5
G2	39.6	35.2	14.6	10.2
G3	40.5	36.2	15.5	11.2
G4	39.1	35.1	14.1	10.1

Note: AN values are CAFE31 corona-noise L50 predictions. The value reported “at ± 200 ft” represents the greater of the modeled values at the -200 -ft and $+200$ -ft endpoints.

3.6 CORONA LOSS AND OZONE

CAFE31 was used to evaluate conductor surface electric-field gradient, corona loss, and ozone generation for each modeled transmission-line configuration. Corona occurs when the electric-field intensity at the conductor surface becomes sufficiently high to ionize the surrounding air. Corona activity can result in radio interference, television interference, audible noise, electrical energy loss, and the generation of small quantities of ozone. Table 9 summarizes the maximum conductor surface gradient, total corona loss, and maximum modeled ozone concentration for each evaluated configuration.

Conductor surface gradient and corona loss are presented as characteristics of the modeled line configurations rather than compared with a single regulatory threshold. Modeled ozone concentrations are compared for context with the U.S. Environmental Protection Agency (EPA) ozone National Ambient Air Quality Standard (NAAQS) level of 70 ppb and the World Health Organization (WHO) 2021 air-quality guideline of 100 µg/m³ for the daily maximum 8-hour mean, which is approximately 50 ppb under standard reference conditions (EPA 2020; WHO 2021). These ambient-air values have averaging periods and regulatory forms that differ from the localized incremental ozone concentrations calculated by CAFE31; therefore, the comparison is provided to indicate relative magnitude and does not represent an ambient-air-quality compliance determination.

As summarized in Table 9, the maximum modeled conductor surface gradient ranges from 14.06 to 14.59 kV/cm, while total corona loss ranges from 14.050 to 17.309 kW/mi. G3 produces both the highest modeled surface gradient, at 14.59 kV/cm, and the highest corona loss, at 17.309 kW/mi.

Maximum modeled ozone concentrations range from approximately 0.458 ppb for G1 to 0.632 ppb for G3. The locations of the maximum ozone concentrations shown in Table 9 indicate that the CAFE31 spatial maxima occur near the transmission line and above ground for the evaluated configurations. Even the highest modeled incremental ozone concentration of 0.632 ppb is very small relative to the USEPA and WHO ambient-air contextual values. The results therefore indicate that ozone generated by transmission-line corona represents a very small incremental contribution under the modeled conditions.

TABLE 9 CORONA-LOSS AND OZONE SUMMARY

Scenario	Max gradient (kV/cm)	Total corona loss (kW/mi)	Max ozone (ppb)	Lateral location of maximum ozone (ft)	Height of maximum ozone (ft)
G1	14.06	14.050	0.458	15	90
G2	14.28	15.293	0.485	15	105
G3	14.59	17.309	0.632	15	105
G4	14.26	15.161	0.531	15	105

Note: CAFE31 ozone values represent modeled incremental ozone generated by transmission-line corona.

4. CONCLUSION

The CAFE31 evaluation presented in this report covers scenarios G1 through G4 for the portion of the Nottingham BESS gen-tie line within the City of Sherwood. G1 through G4 represent the shared-structure portions of the corridor where the proposed 230-kV gen-tie is modeled together with PGE's existing 115-kV circuit.

The modeled electric- and magnetic-field profiles show the expected highest values near the conductor configurations and substantial attenuation with increasing lateral distance. The electric field remains unchanged among the L1 Steady, L2 Maximum Normal, and L3 Emergency cases

because operating voltage and conductor geometry are unchanged. The highest modeled electric field is 0.774 kV/m for G1, substantially below the Oregon criterion of 9 kV/m at 1 m above ground in areas accessible to the public.

Magnetic field varies with conductor current for G1 through G4 and generally increases from L1 through L3. The highest modeled magnetic field is 73.29 mG for G1 under the L3 Emergency condition, substantially below the general-public reference levels of 2,000 mG identified by ICNIRP and 9,040 mG identified by IEEE C95.1-2019. Across the evaluated G1 through G4 configurations, maximum modeled magnetic fields range from 46.54 mG to 73.29 mG.

The radio-interference evaluation indicates that rainy-weather RI is higher than fair-weather RI for all evaluated configurations, reflecting the increased corona activity associated with wet conductor surfaces. The highest modeled rainy-weather RI is 57.1 dB μ V/m for G3, while the highest fair-weather RI is 40.1 dB μ V/m, also for G3. RI levels decrease substantially with lateral distance, with rainy-weather values at ± 200 ft ranging from 43.4 to 45.8 dB μ V/m. Because no single numeric RI acceptance criterion directly applicable to the CAFE31 results was identified, the modeled values are presented to characterize the relative potential for transmission-line-generated radio noise and its attenuation with distance.

CAFE31-predicted corona-generated audible noise is also low for the evaluated configurations. Rainy-weather levels are higher than fair-weather levels, reflecting the increased corona activity associated with wet conductor surfaces. The highest modeled AN value is 40.5 dBA for G3 under rainy conditions. All modeled values are below the Oregon L50 values of 55 dBA during daytime and 50 dBA during nighttime used in this report for contextual comparison. Because the CAFE31 calculations represent corona-generated transmission-line noise as a function of lateral distance rather than a receptor-specific community-noise assessment, these comparisons are provided for context and are not presented as a site-specific noise compliance determination.

The modeled conductor surface gradients and corona losses are likewise modest for the evaluated G1 through G4 configurations. G3 produces the highest surface gradient and corona loss, at 14.59 kV/cm and 17.31 kW/mi, respectively, while G1 produces the lowest values, at 14.06 kV/cm and 14.05 kW/mi. Maximum modeled incremental ozone concentrations range from approximately 0.458 ppb for G1 to 0.632 ppb for G3. These values are very small relative to the USEPA ozone NAAQS level of 70 ppb and the WHO 2021 short-term air-quality guideline of 100 μ g/m³ for the daily maximum 8-hour mean (approximately 50 ppb). Because the ambient-air reference values use averaging periods and regulatory forms that differ from the localized incremental concentrations calculated by CAFE31, the comparison is provided to demonstrate relative magnitude rather than as an ambient-air-quality compliance determination.

Overall, the CAFE31 results indicate that the modeled electric fields are well below the applicable Oregon electric-field criterion and that modeled magnetic fields are well below the IEEE and ICNIRP general-public reference levels. Corona-related RI, TVI, AN, corona loss, and ozone effects are generally greatest for the shared 230-kV/115-kV configurations, particularly G3 for several corona-related outputs, and decrease with lateral distance from the transmission line.

5. REFERENCES

CAFE31. *Corona and Field Effects Program, Version 3.1 (CAFE31)*, Bonneville Power Administration. U.S. Department of Energy, Bonneville Power Administration, 905 NE 11th Avenue, Portland, Oregon 97232. Accessed August 2026.

EPA 2020. *Final Decision: Ozone National Ambient Air Quality Standards*. U.S. Environmental Protection Agency, Washington, DC. 2020. The 2020 decision retained the 70-ppb ozone standards.

ICNIRP 2010. *Guidelines for Limiting Exposure to Time-Varying Electric and Magnetic Fields (1 Hz to 100 kHz)*. International Commission on Non-Ionizing Radiation Protection. Health Physics 99(6): 818–836. 2010.

IEEE 2017. *IEEE Standard Procedures for the Measurement of Radio Noise from Overhead Power Lines and Substations*. Institute of Electrical and Electronics Engineers, IEEE 430-2017, doi:10.1109/IEEESTD.2017.7882595. 2017.

IEEE 2019. *IEEE Standard for Safety Levels with Respect to Human Exposure to Electric, Magnetic, and Electromagnetic Fields, 0 Hz to 300 GHz*. IEEE Std C95.1-2019, New York, New York. 2019.

OAR 340-035-0035. *Oregon Administrative Rule OAR 340-035-0035. Noise Control Regulations for Industry and Commerce*. Department of Environmental Quality. Oregon.

OAR 345-024-0090. *Oregon Administrative Rule 345-024-0090, Siting Standards for Transmission Lines*. Oregon Department of Energy / Energy Facility Siting Council. Oregon.

WHO 2021. *WHO global air quality guidelines: Particulate matter (PM_{2.5} and PM₁₀), ozone, nitrogen dioxide, sulfur dioxide, and carbon monoxide*. Geneva: World Health Organization. 2021.

Revamp 2026a. Tualatin BESS 230 kV Transmission Line – Basis of Design. 60% IFR, Revision 2, Revamp Engineering, Inc. 2026. July 2026.

Revamp 2026b. Tualatin BESS 230 kV Transmission Line – 60% Transmission Design Drawings. Revamp Engineering, Inc. 2026. July 2026.

Revamp 2026c. Revamp Engineering/project PLS-CADD and PLS-POLE LCA/POL line-design files, 60% design, July 2026.

FIGURES

FIGURE 1 NOTTINGHAM BESS TRANSMISSION LINE ROUTE AND STRUCTURE IDENTIFIERS

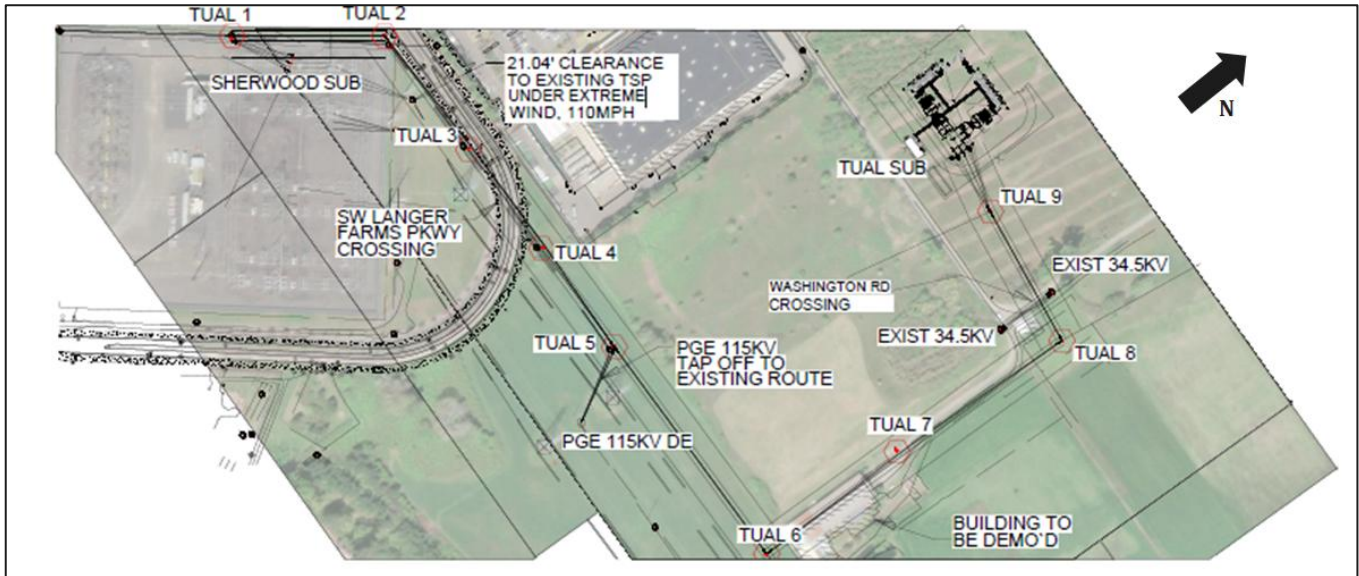


FIGURE 2 CONCEPTUAL ROUTE INCLUDED IN THE STUDY SCOPE (G1 THROUGH G4)

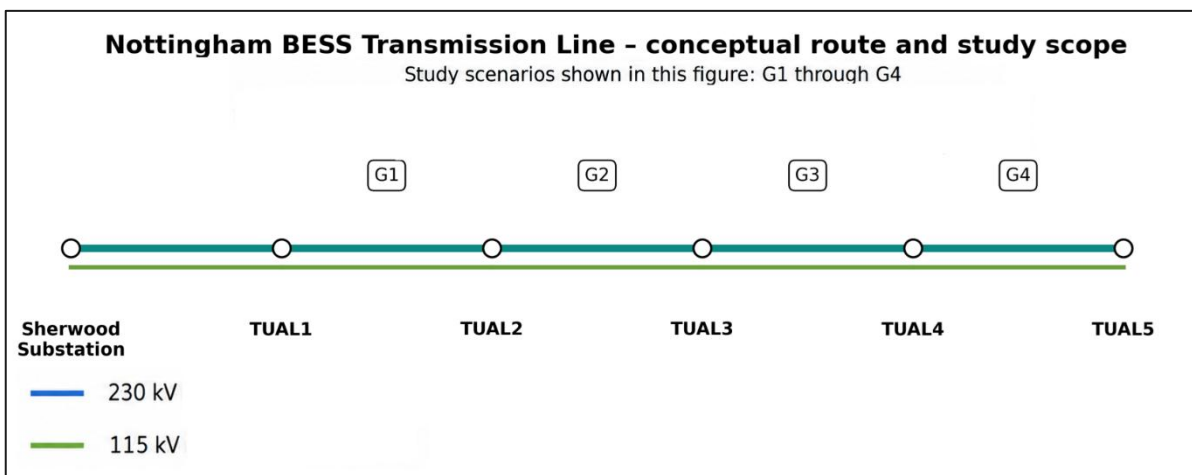


FIGURE 3 CAFE31 LATERAL MODELING AND REPORTING EXTENTS

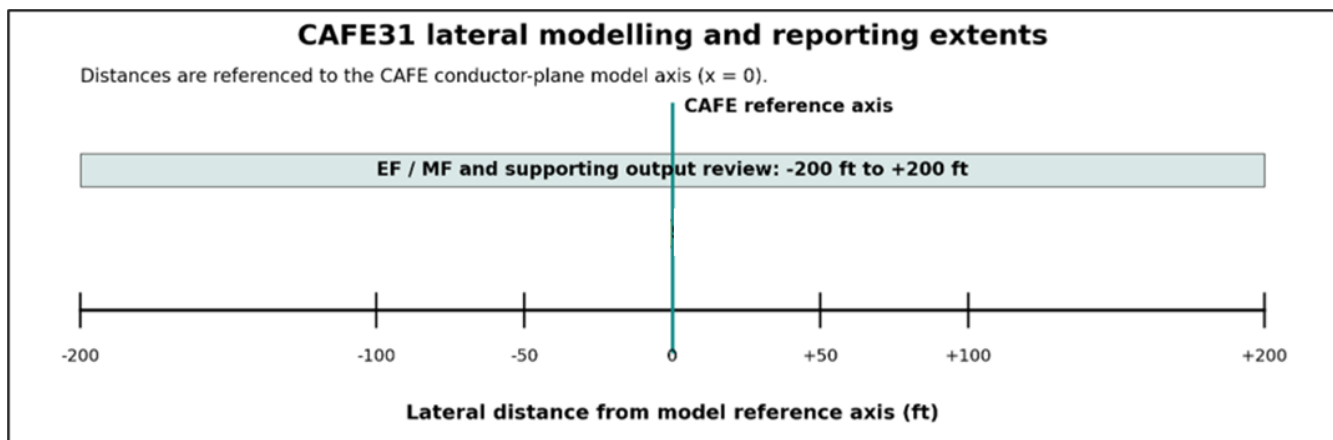


FIGURE 4 CAFE31 CONDUCTOR CROSS-SECTION GEOMETRY FOR G1 TO G4

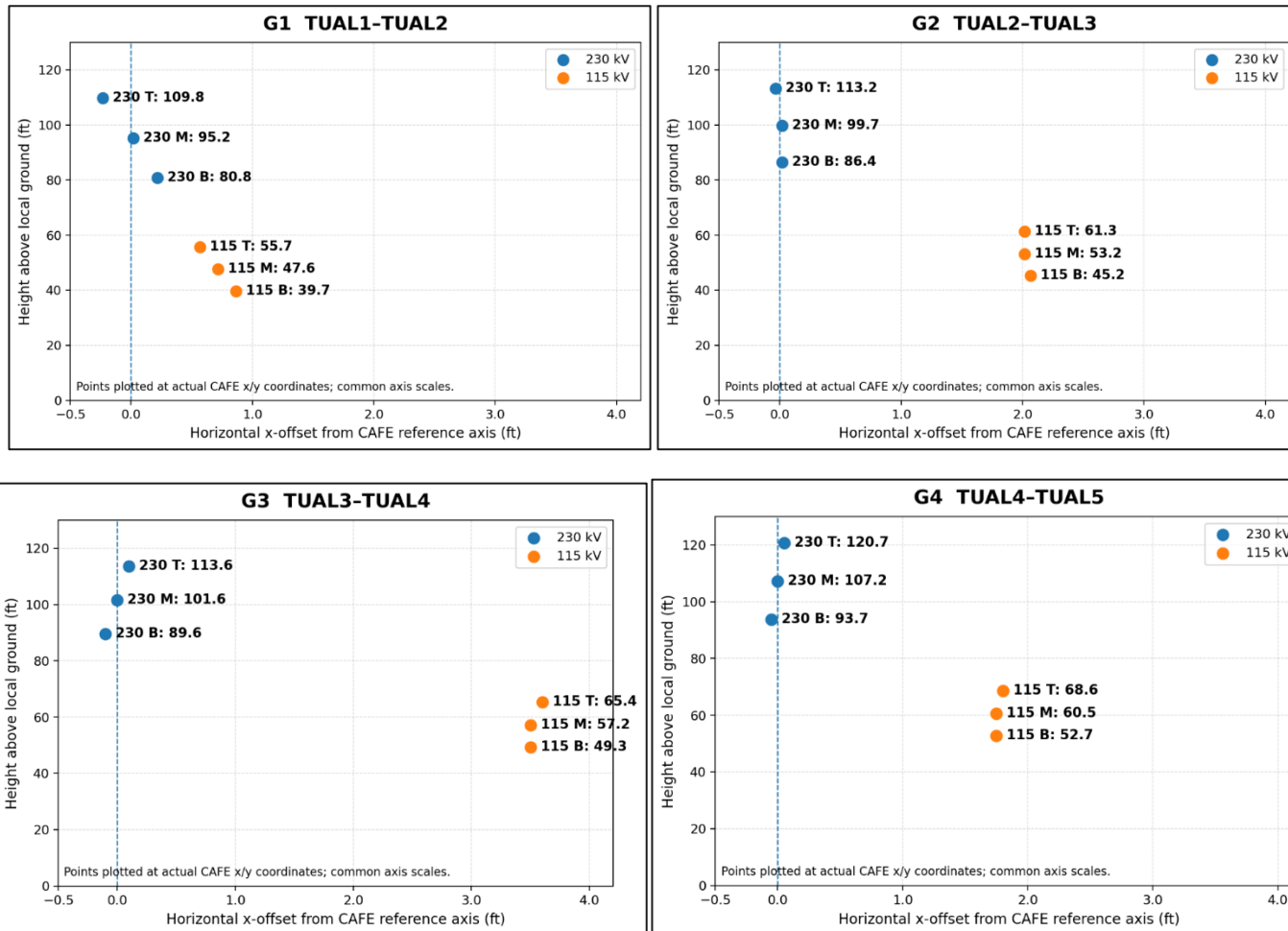


FIGURE 5 G1 ELECTRIC-FIELD PROFILE

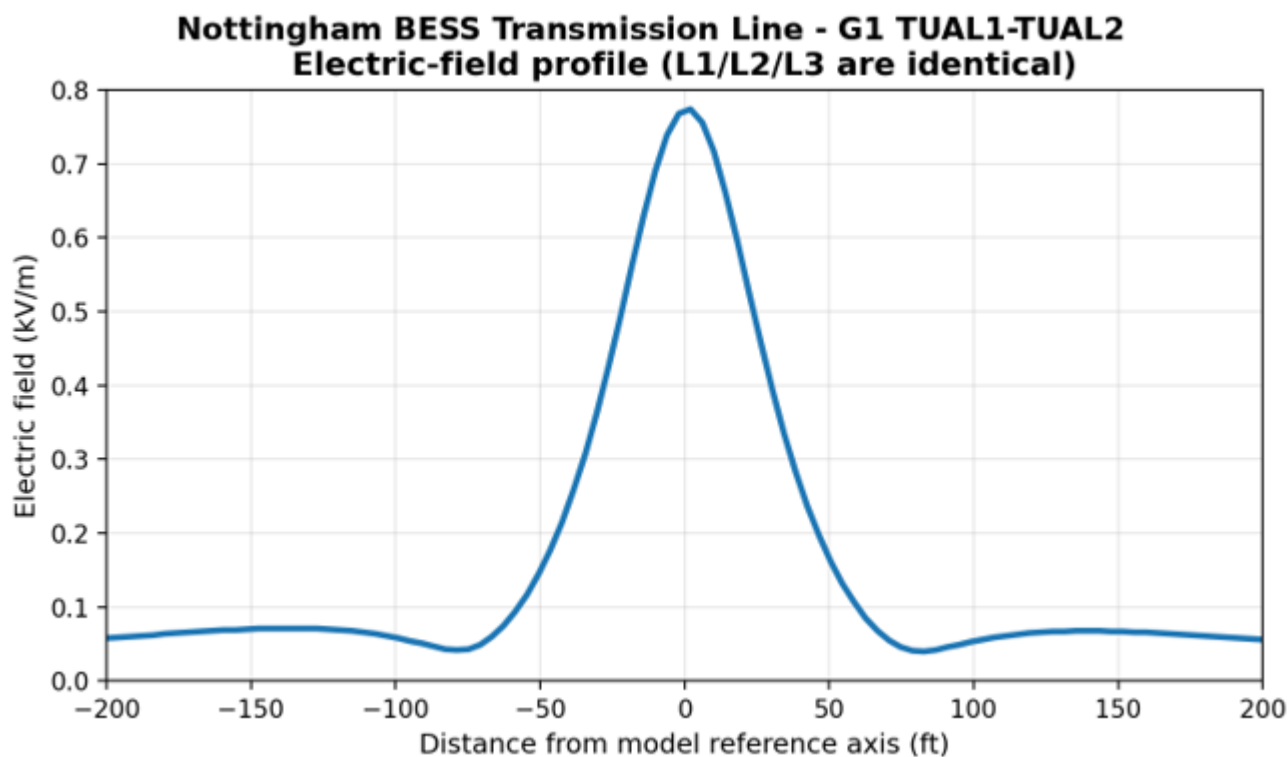


FIGURE 6 G1 MAGNETIC-FIELD PROFILE

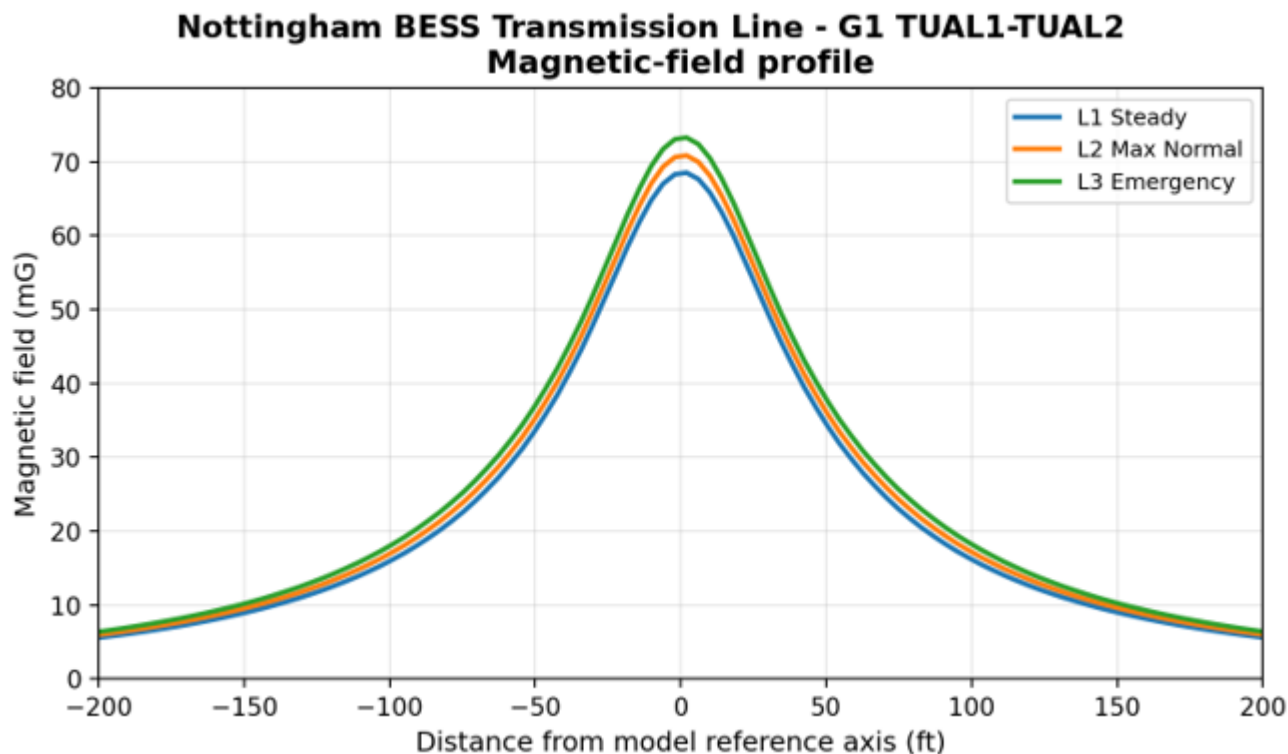


FIGURE 7 G2 ELECTRIC-FIELD PROFILE

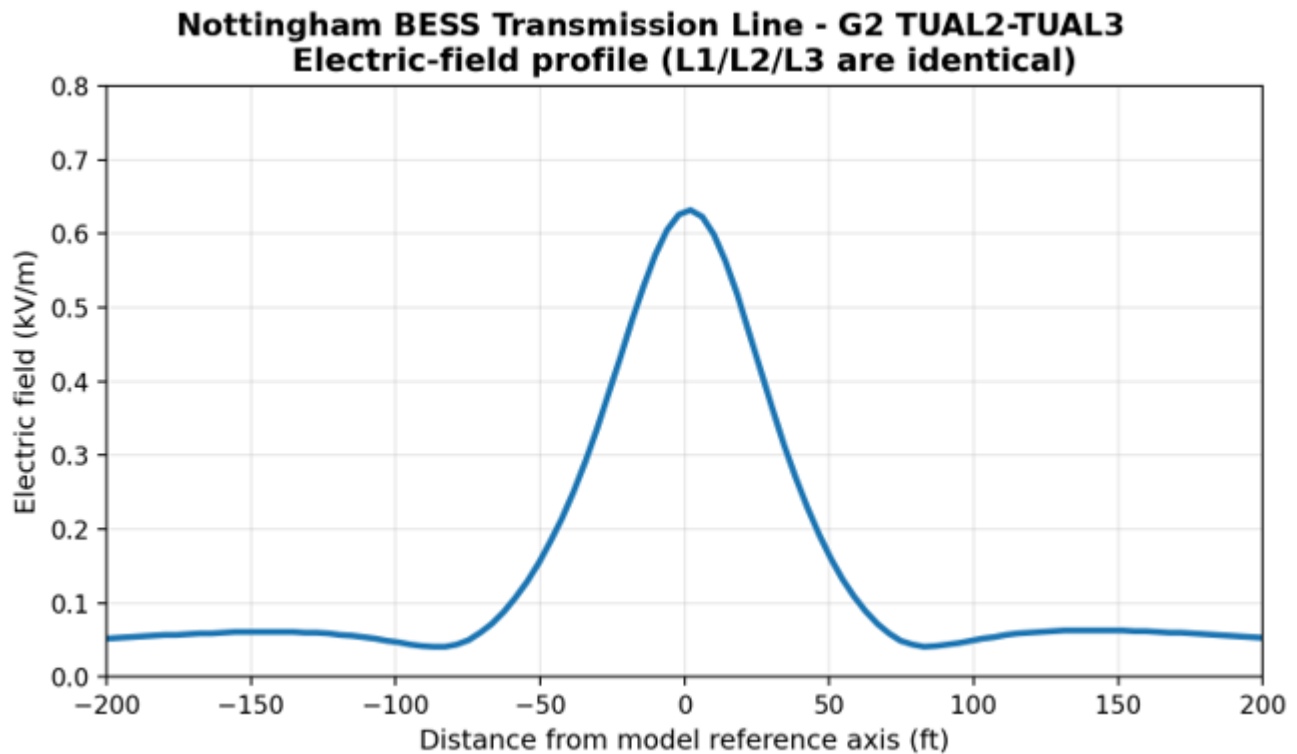


FIGURE 8 G2 MAGNETIC-FIELD PROFILE

Nottingham BESS Transmission Line - G2 TUAL2-TUAL3 Magnetic-field profile

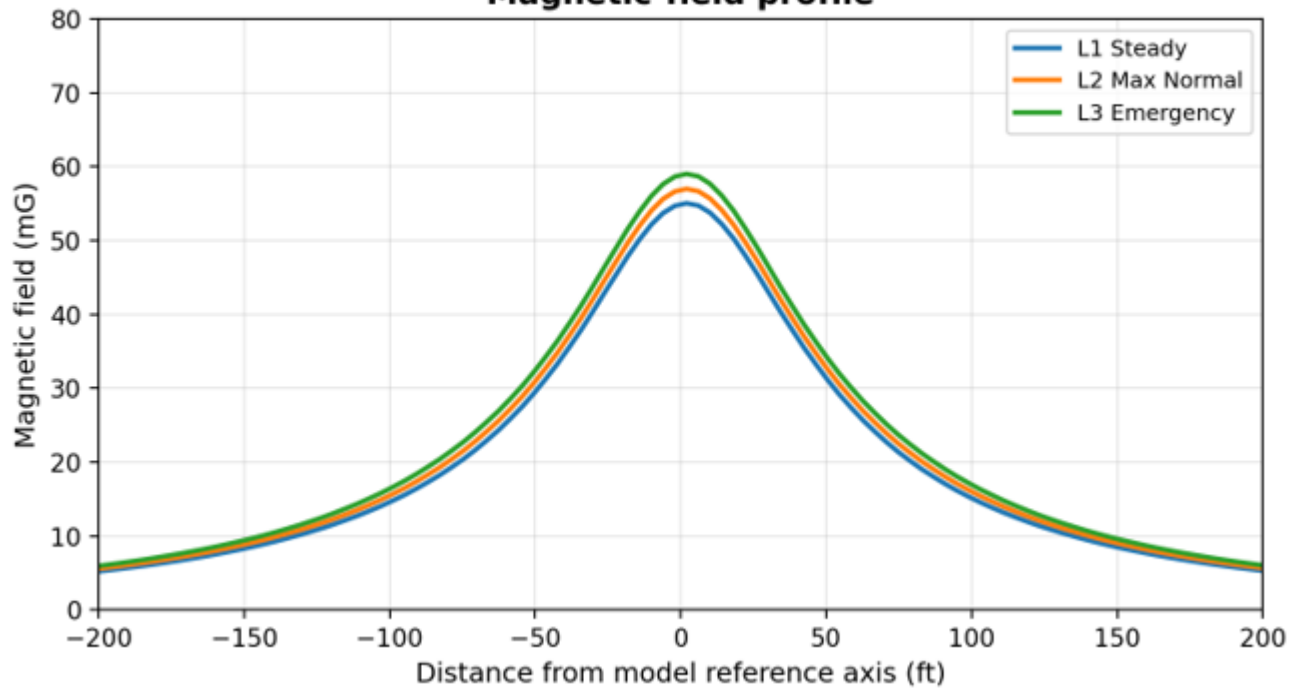


FIGURE 9 G3 ELECTRICAL PROFILE

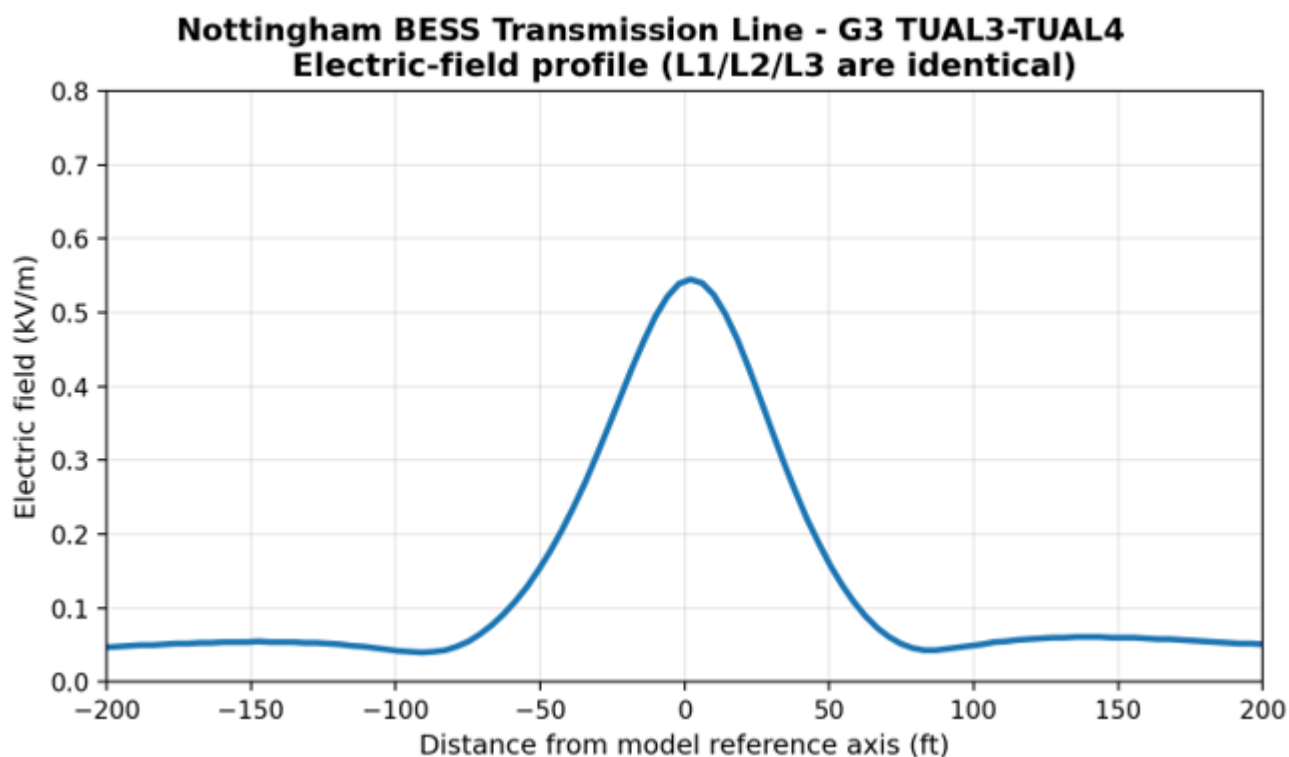


FIGURE 10 G3 MAGNETIC FIELD PROFILE

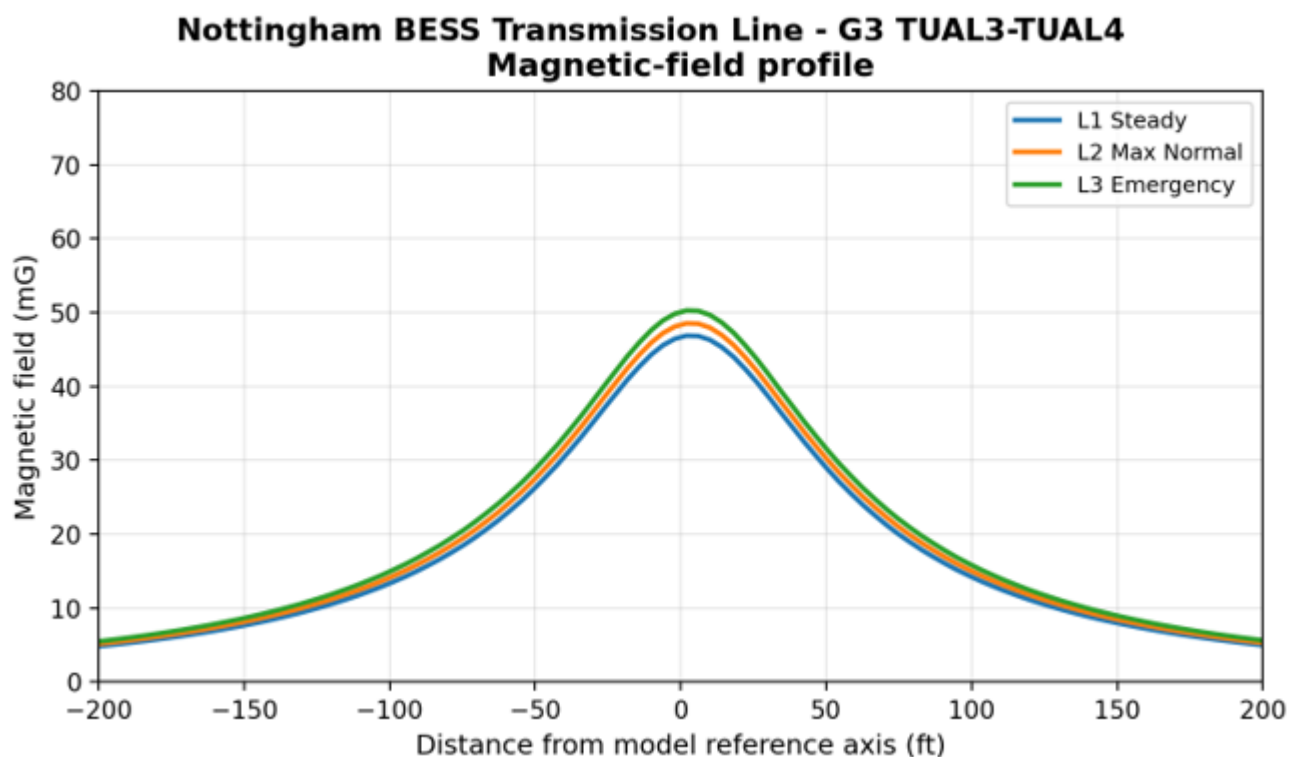


FIGURE 11 G4 ELECTRIC FIELD PROFILE

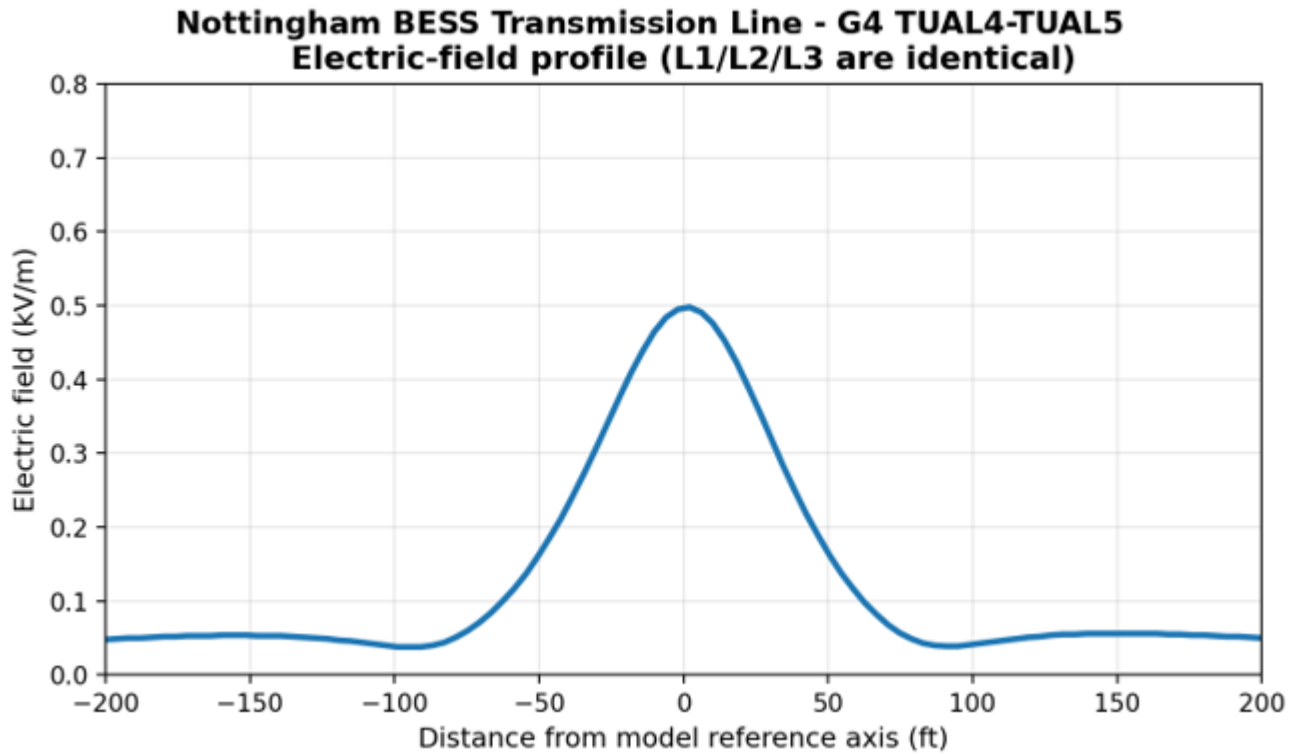
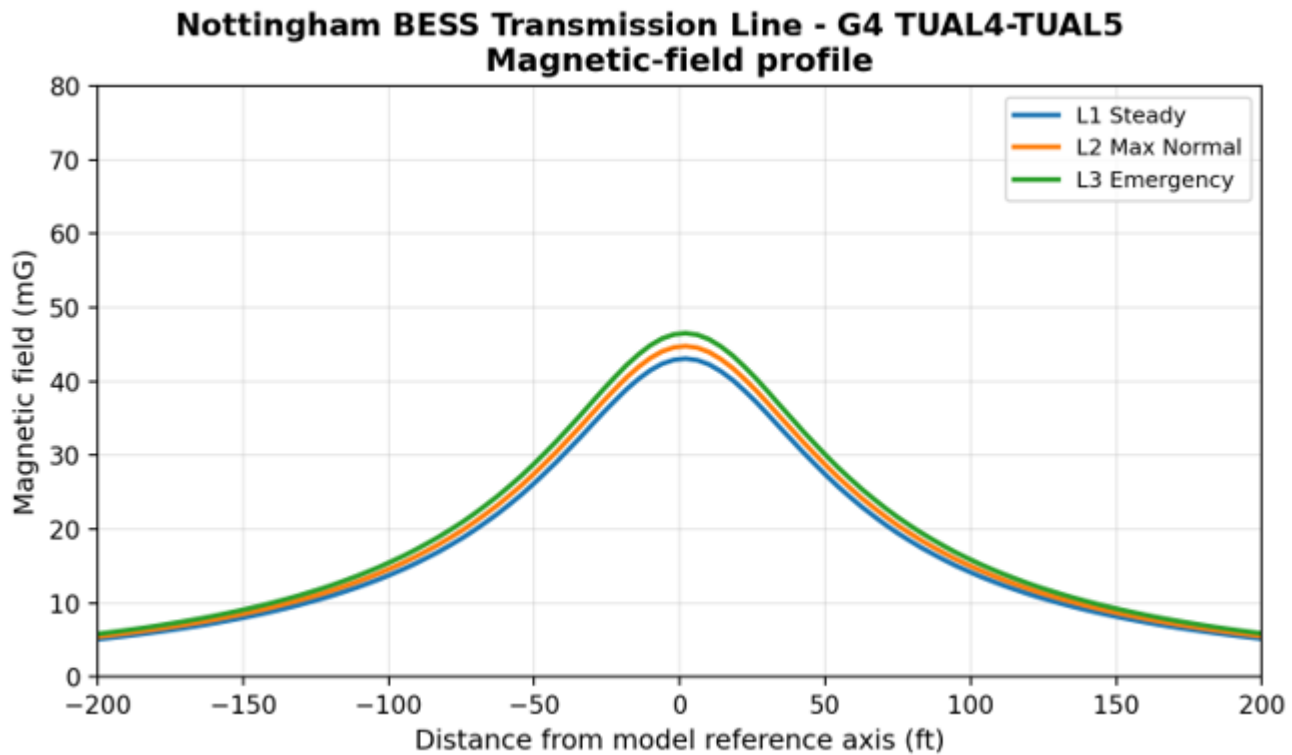


FIGURE 12 G4 MAGNETIC FIELD PROFILE



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ERM's Portland Office

1050 SW 6th Ave Ste 1650
Portland, OR 97204
(612) 337-3350
www.erm.com