June 21, 2013

EMF Analyses of the 115kV A and C Lines

Introduction:

An electromagnetic field (EMF) analysis was performed by Central Hudson Gas and Electric Corporation (CHGE) on the A and C Lines to compare existing EMF levels to expected levels following the proposed rebuild of the two lines. The A and C Lines are two 115kV transmission lines that run north to south in Dutchess County from the Pleasant Valley Substation to the Todd Hill Substation (C line) and from the Todd Hill Substation to the Fishkill Plains Substation (A Line).

The New York State Public Service Commission (NYSPSC) has set forth a *Statement of Interim Policy on Magnetic Fields of Major Electric Transmission Facilities* (Issued and Effective: September 11, 1990). This Interim Policy states:

"Future Article VII transmission circuits shall be designed, constructed and operated such that magnetic fields at the edges of their rights of way (measured one meter above ground) will not exceed 200 milligauss (mG) when the circuit phase currents are equal to the winter-normal conductor rating."

The Statement of Interim Policy on Magnetic Fields of Major Electric Transmission Facilities clarifies its position stating "Such a standard thus would apply to future transmission line facilities subject to Article VII of the Public Service Law, and would not be intended to imply either "safe" or "unsafe" levels of exposure. Its function would be to restrict the design choices for future transmission facilities; designs which could produce higher magnetic fields than typical 345 kV lines are to be avoided."

For electric fields, the *Interim Policy* states and adopts the following:

"Opinion 78-L3 established an electric field strength interim standard of 1.6 kV/m for Article VII electric transmission facilities (at the edge of the right-of-way, one meter above ground level, with the line at rated voltage)."

As a new transmission facility subject to Article VII of the Public Service Law, the A and C Lines were analyzed to ensure that they meet the values discussed in these guidelines.

Areas of interest:

The following four areas of interest were selected as the representative structures and right-of-way (ROW) configurations along the project route:

1. A and C Lines running independently within a ROW (3.6 miles).
2. Shared ROW with the C Line running parallel to the CHGE M Line (115kV) coming out of the Pleasant Valley Substation heading south (0.8 miles).
3. Shared ROW with the A orC Lines running parallel to the CHGE G Line (69kV) north and south of the Todd Hill Substation (4.9 miles).
4. Shared ROW with the A Line running parallel to four 345kV Consolidated Edison (Con Ed) circuits north of the Fishkill Plains Substation (1.6 miles).

Model views showing the existing and proposed configuration of transmission lines in each of these areas of interest are included in the results section of this report.

Analysis Methodology and Assumptions

Analyses were performed using Electric Power Research Institute (EPRI) EMF Workstation 2012. EMF Workstation 2012 allows a user to create a computer model of Transmission Lines, Distribution Lines, Buswork, and Substation Equipment. The software then calculates Electric and Magnetic Fields produced from these sources in the modeled configurations. The model for the existing line was created using information derived from existing plan and profile and structure drawings. The model for the proposed design was based on the A and C Line design model dated May 5, 2013. For the purposes of the analyses, the following A and C Line data were entered for typical spans within each area of interest (see Tables 1 and 2): average span length, average mid-span sag at conductor winter normal temperature and winter normal conductor ratings (as outlined in the NYSPSC *Statement of Interim Policy on Magnetic Fields of Major Transmission Facilities*), average structure height, typical structure configuration, polarity diagram data, and, in the case of shared ROW, the location of the maximum mid-span sags of the other line(s) coincided at the same longitudinal location.

The phase angles used in the models for phases A, B, and C were 0°, -120°, and 120°, respectively (as shown in Table 2). In cases where CHGE facilities share a ROW with neighboring utilities, phase angle information has been confirmed to match with CHGE nomenclature. Unless otherwise noted, the general design factors used for existing and proposed A and C Lines are as follows (Note that these general design factors were applied to all four Areas of Interest. General information, phasing, and conductor spacing for the other lines sharing ROW with the A and C Lines are included in Tables 3, 4, 5, 6, 7, & 8 below):

Table 1. General Design Factors for the A and C Lines

A and C Line Design Factors	Existing	Proposed
Conductor	397.5 Ibis ACSR	1033 Ortolan ACSR
Winter Normal Rating (A)	873	1563
Average span length (ft)	500	450
Sag (ft)	15	15
Average Structure Height (ft)	65	75
Typical Structure Configuration	H-Frame (two-pole)	Davit Arm (single pole)

Existing and proposed conductor spacing and polarity on the A and C Lines are presented below in Tables 2A and 2B:

Table 2A. A and C Line Phasing (existing)

Phases	Horizontal Spacing (ft) from Centerline	Height (ft) of Attachment Point above Ground
Phase A (0°)	-14	34
Phase B (-120°)	14	34
Phase C (120°)	0	34

Table 2B. A and C Line Phasing (proposed)

Phases	Horizontal Spacing (ft) from Centerline	Height (ft) ofAattachment Point Above Ground
Phase A (0°)	-7	43
Phase B (-120°)	7	48
Phase C (120°)	-7	53

Table 3 below presents design factors and conductor spacing for the M Line within Area of Interest 2.

Table 3. General Design Factors for the M Line

M Line Design Factors	Existing
Conductor	795 ACSR Tern
Winter Normal Rating (A)	1330
Average span length (ft)	550
Sag (ft)	20
Average Structure Height (ft)	65
Typical Structure Configuration	H-Frame

Table 4. M Line Phasing/Conductor Spacing:

Phases	Horizontal Spacing (ft) from Centerline	Height (ft) of Attachment Point Above Ground
Phase A (0°)	-10.75	44
Phase B (-120°)	-9.5	55
Phase C (120°)	10.75	44

Table 5 below presents design factors and conductor spacing for the G Line within Area of Interest 3.

Table 5. General Design Factors for the G Line

G Line Design Factors	Existing
Conductor	1/0 7 Str Cu
Winter Normal Rating (A)	454

Average span length (ft)	290
Sag (ft)	6
Average Structure Height (ft)	50
Typical Structure Configuration	Single Pole

Table 6. G Line Phasing/Conductor Spacing:

Phases	Horizontal Spacing (ft) from Centerline	Height (ft) Of Attachment Point Above Ground
Phase A (0°)	-5	38
Phase B (-120°)	5	38
Phase C (120°)	-5	32

Table 7 below presents design factors and conductor spacing for the 345 kV Con Ed circuits within Area of Interest 4.

Table 7. General Design Factors and Assumptions for Con Ed 345kV Lines

Con Ed 345kV Design Factors and Assumptions	Existing
Conductor	Bundled 2156 ACSR Bluebird
Winter Normal Rating (A)	4230
Average span length (ft)	1000
Sag (ft)	36
Average Structure Height	150
Typical Structure Configuration	Double Circuit Lattice Tower

Table 8. Phasing Assumptions/Conductor Spacing for Con Ed 345kV Lines:

Spacing (in ft.)	Left Tower Circuits Spacing (in ft.)		Right Tower Circuits Spacing (in ft.)	
Phase	Horizontal	Vertical	Horizontal	Vertical
A (0°)	-22	75	22	123
B (-120°)	-22	123	22	75
C (120°)	-22	99	22	99

Results:

Using these data inputs, the EMF analysis was run for each of the areas of interest. Results of the analysis for each area are presented below.

Area of Interest 1 - Existing vs. Proposed A and C lines

Model View:

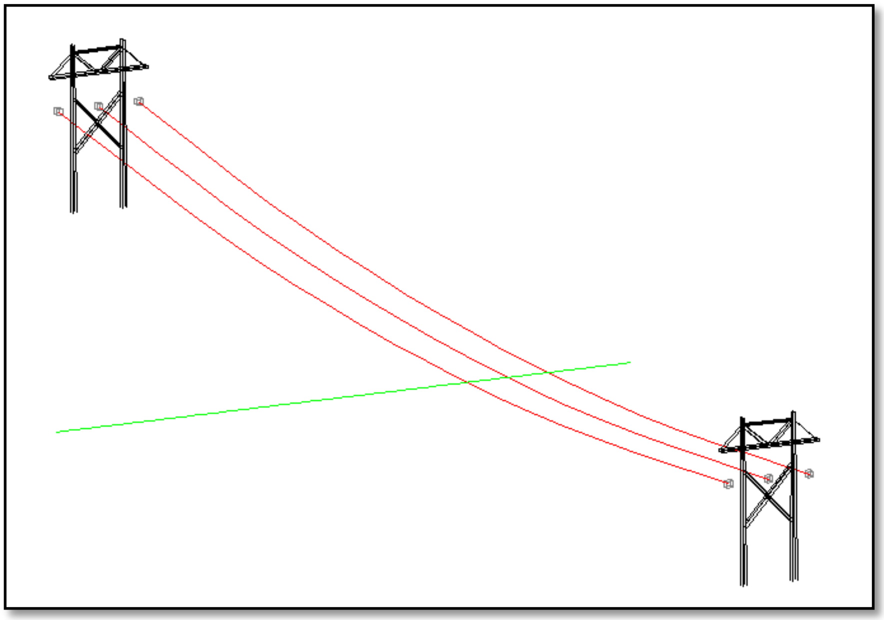

Figure 1. Existing A and C Lines

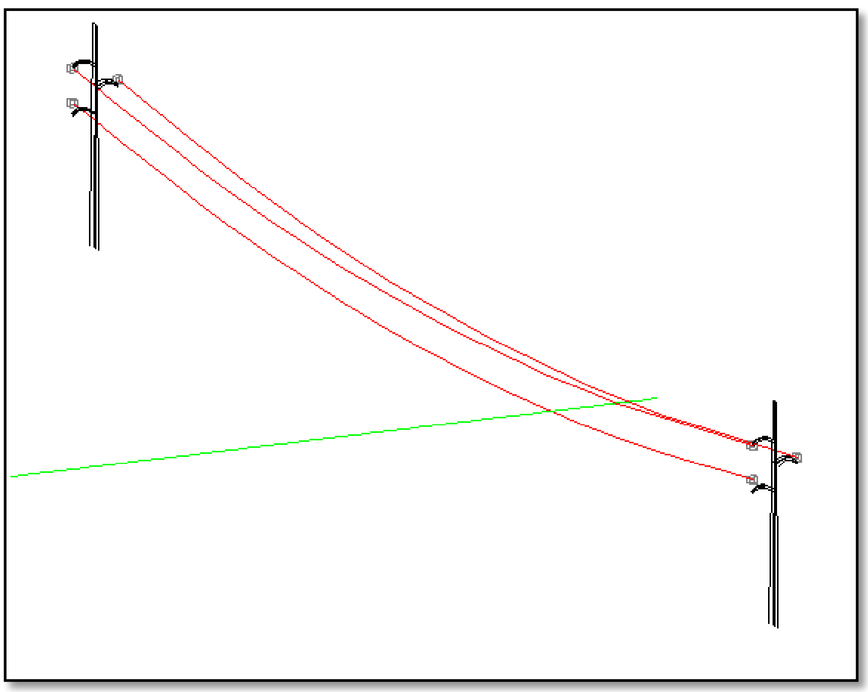

Figure 2. Proposed A and C Lines

Area of Interest 1 Results:

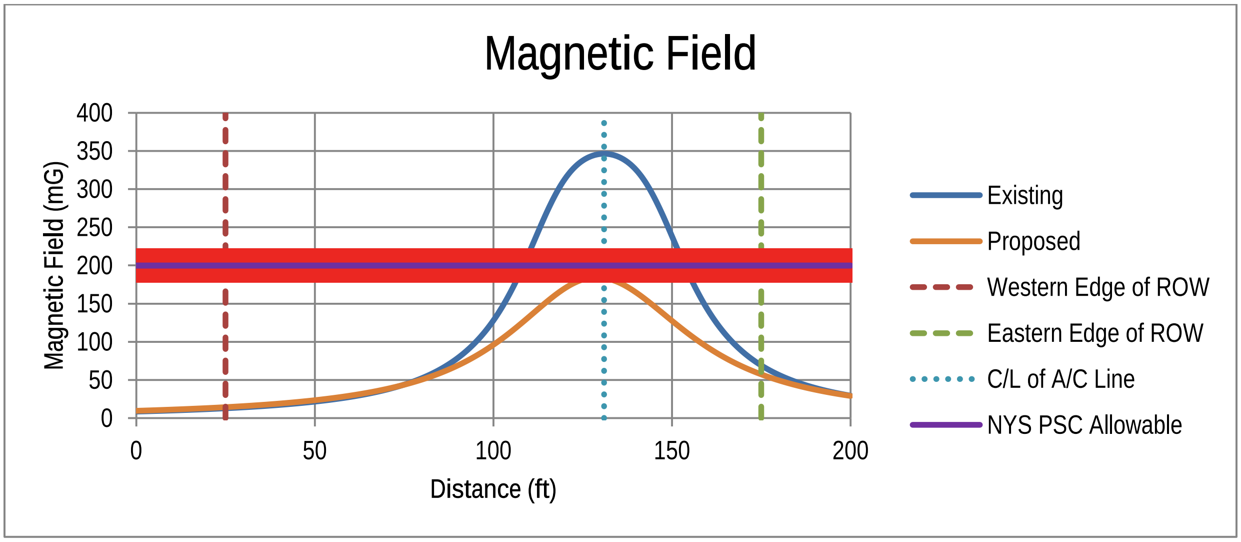

Figure 3. MF Levels on ROW with A and C Lines

As shown above, in Area of Interest 1 the proposed design would reduce the maximum magnetic field (MF) on the ROW by approximately 21%, from 346mG to 184mG. The expected MF for the western edge of the ROW would nominally increase by 1mG, from 13mG to 14mG. On the eastern edge, the MF values would decrease by 12mG from 69mG to 57mG. Both of these predicted values meet the NYSPSC guideline not to exceed 200mG at the edge of ROWs.

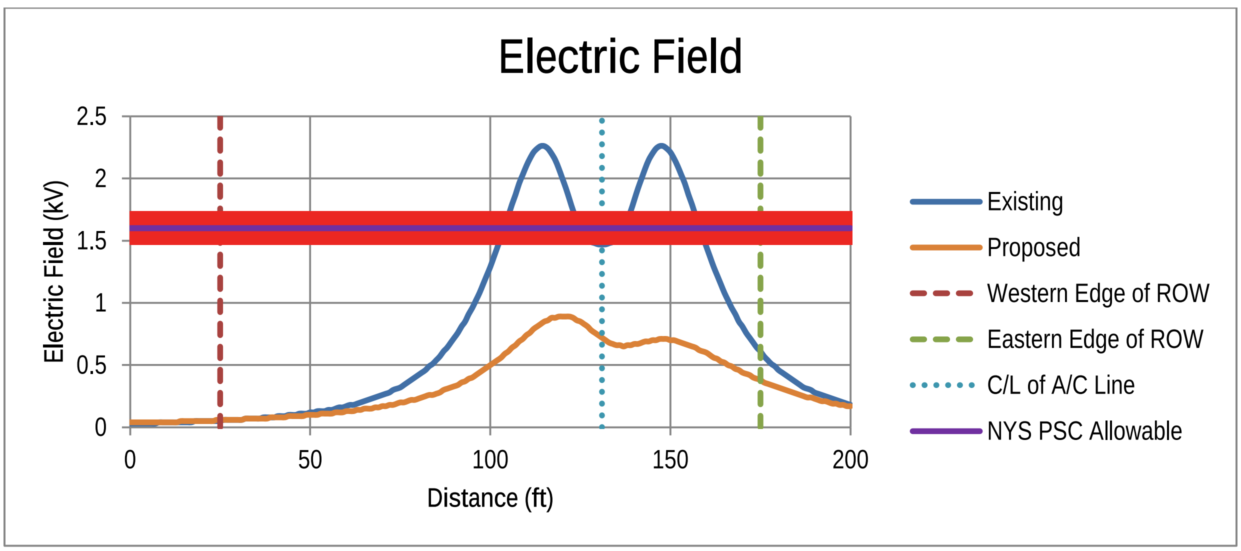

Figure 4. EF Levels on ROW with A and C Lines

Within Area of Interest 1, the proposed design significantly reduces the maximum electric field (EF) on the ROW from 2.26 kV/m to 0.89 kV/m. EF on the western edge of the ROW would marginally increase by .01kV/m, to 0.06kV/m. The reduction in EF at the eastern edge is predicted to be 0.23kV/m, moving from 0.61kV/m to 0.38kV/m. Predicted values at both edges of the ROW are within the NYSPSC allowable limit of 1.6 kV/m.

Area of Interest 2- Shared ROW with the C and M Line

Model View:

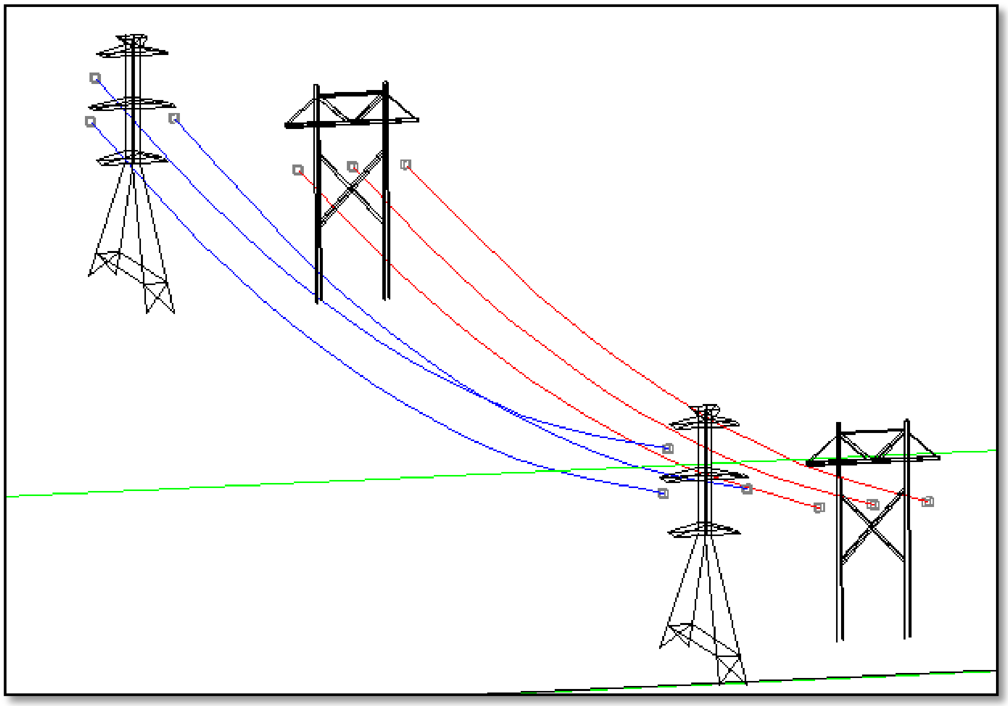

Figure 5. Existing M Line (left) with Existing C Line (right)

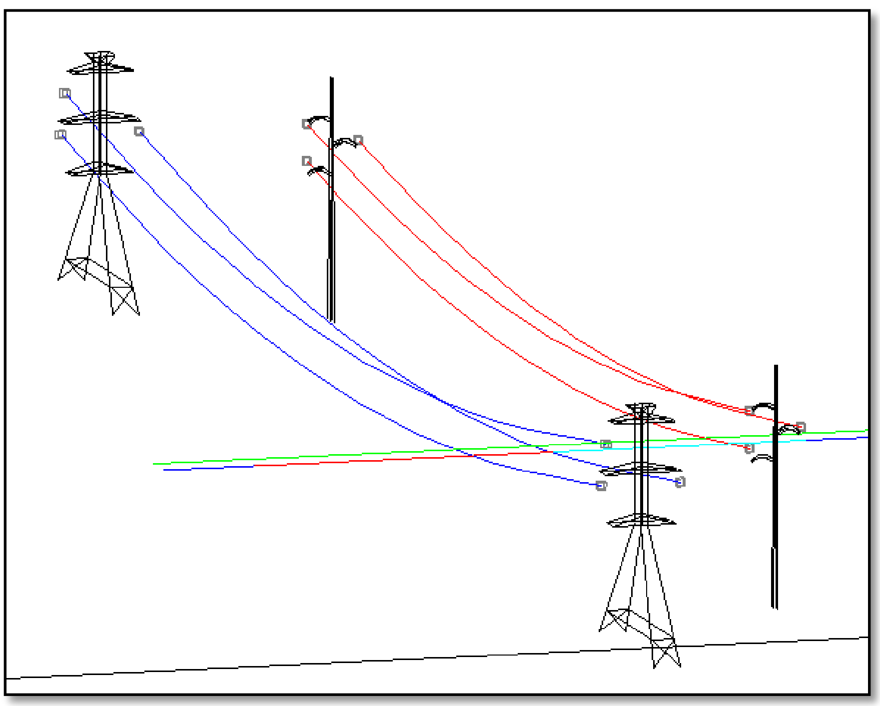

Figure 6. Existing M Line (left) with Proposed C Line (right)

Area of Interest 2 Results:

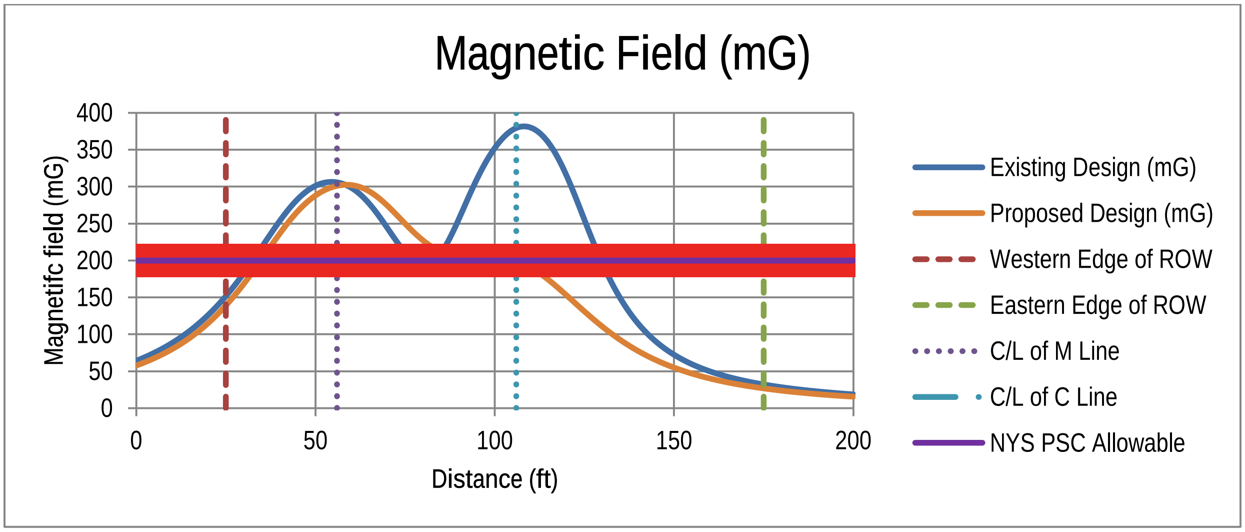

Figure 7. MF Levels on ROW with M and C Lines

As shown above, in Area of Interest 2 the proposed design would reduce the maximum MF on the ROW by approximately 21%, from 381mG to 302mG. The expected MF for the western edge of ROW would decrease by 13mG, from 152mG to 139mG. On the eastern edge, the MF values would decrease by 5mG, from 32mG to 27mG. Both of these predicted values meet the NYSPSC guideline not to exceed 200mG at the edge of ROWs.

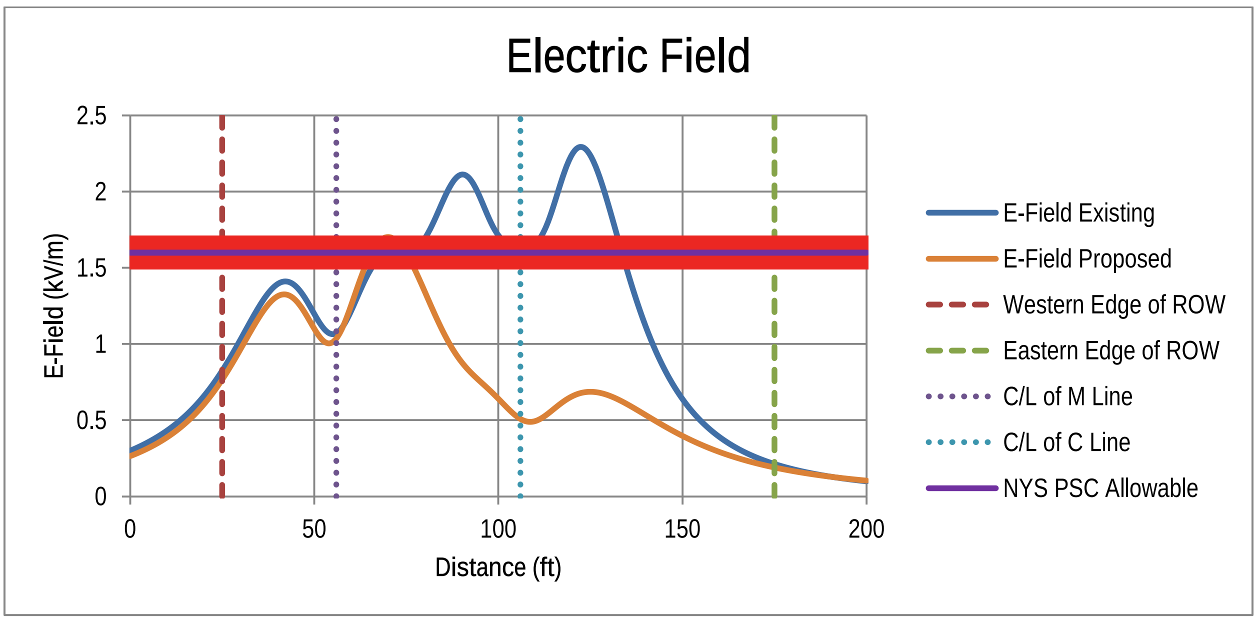

Figure 8. EF Levels on ROW with M and C Lines

Within Area of Interest 2 the proposed design significantly reduces the maximum EF on- the ROW from 2.29kV/m to 1.7kV/m. This is a reduction of 26%. EF at the western edge of the ROW would decrease by 0.06kV/m, from 0.83kV/m to .77kV/m. The reduction in EF at the eastern edge is .02 kV/m, moving from 0.21 kV/m to 0.19 kV/m. Predicted values at both edges of the ROW are within the NYS PSC allowable limit of 1.6 kV/m.

Area of Interest 3 - Shared ROW with the A or C Lines and G Line

Model View:

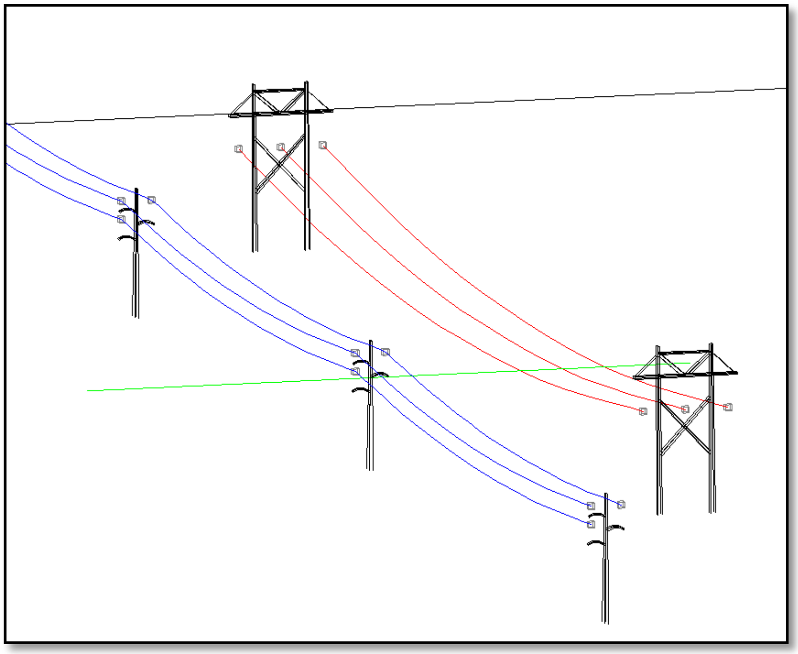

Figure 9. Existing G Line (left) and Existing A or C Line (right)

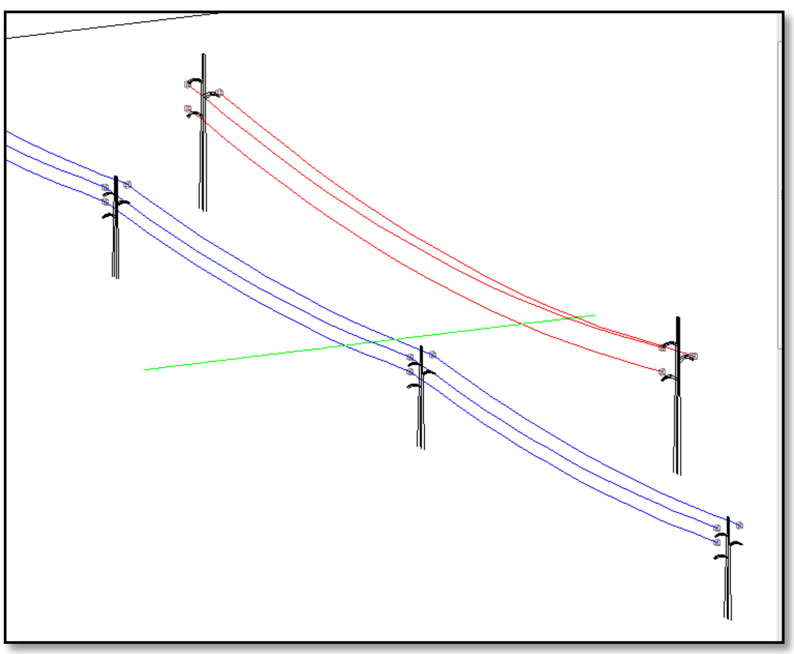

Figure 10. Existing G Line (left) and Proposed A or C Line (right)

Area of Interest 3 Results:

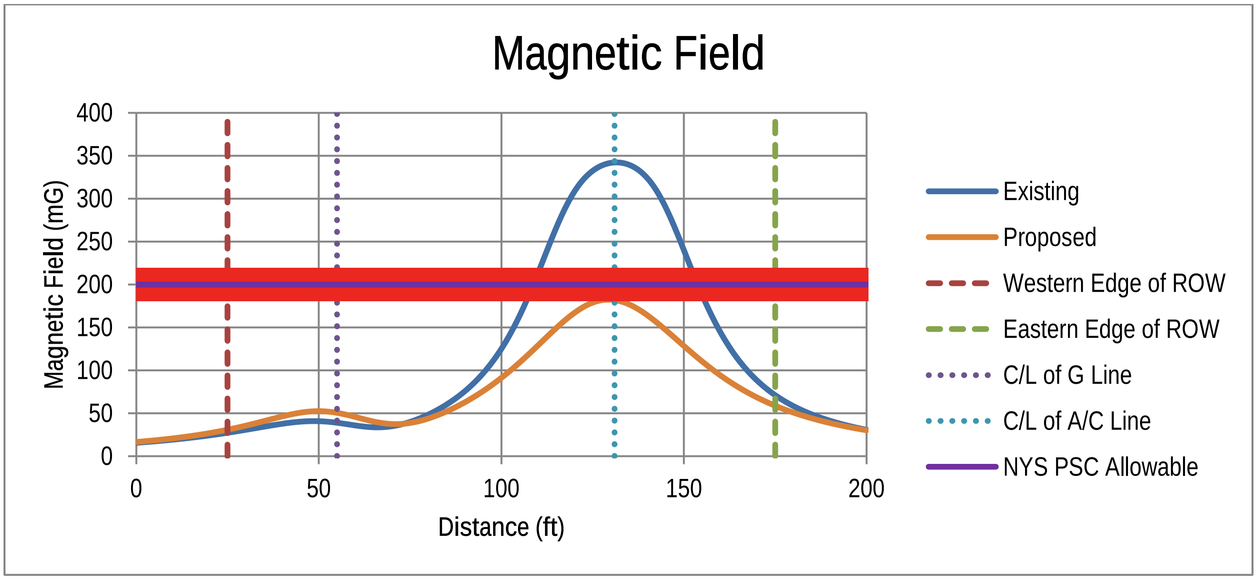

Figure 11. MF Levels on ROW with G and A and C Lines

As shown above, in Area of Interest 3 the proposed design would reduce the maximum MF on the ROW by approximately 47%, from 342mG to 181mG. The expected MF for the western edge of ROW would increase by 4mG, from 27mG to 31mG. On the eastern edge, the MF values would decrease by 13mG, from 71mG to 59mG. Both of these predicted values meet the NYSPSC guideline not to exceed 200mG at the edge of ROWs.

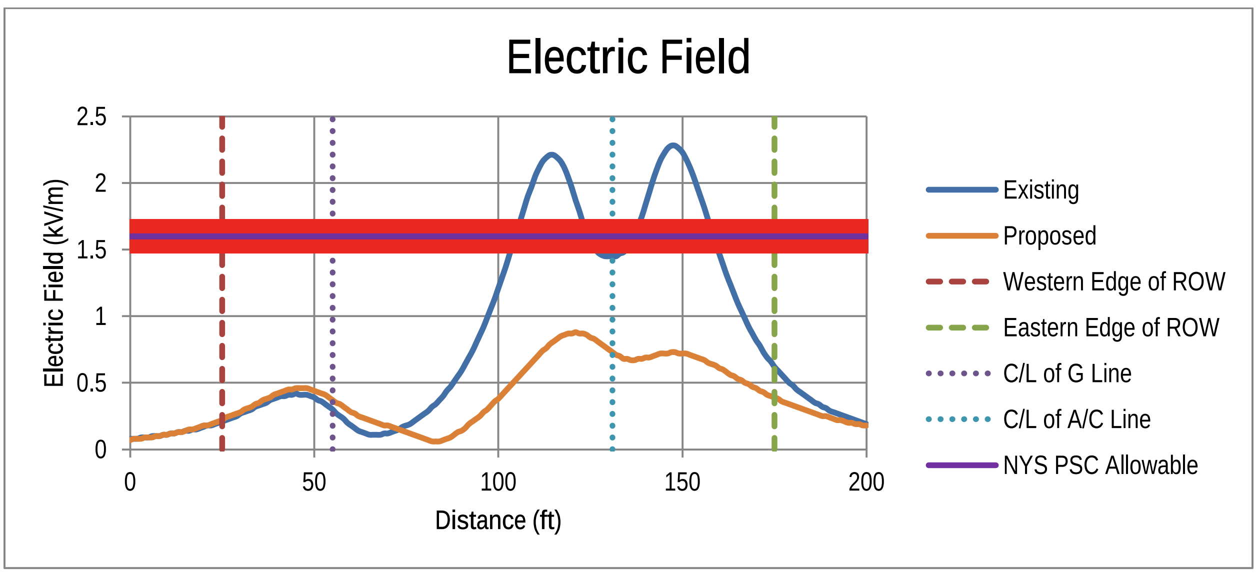

Figure 12. EF Levels on ROW with G and A and C lines

Within Area of Interest 3 the proposed design significantly reduces the maximum EF on the ROW from 2.28 kV/m to .88 kV/m. This is a reduction of 61%. EF at the western edge of the ROW would increase by .01kV/m from .21 kV/m to .22 kV/m. The reduction in EF at the eastern edge is .23 kV/m, moving from .62 kV/m to .39 kV/m. Predicted values at both edges are within the NYS PSC allowable limit of 1.6 kV/m.

Area of Interest 4 - Shared ROW with the A Line and four 345kV Con Ed circuits

Model View:

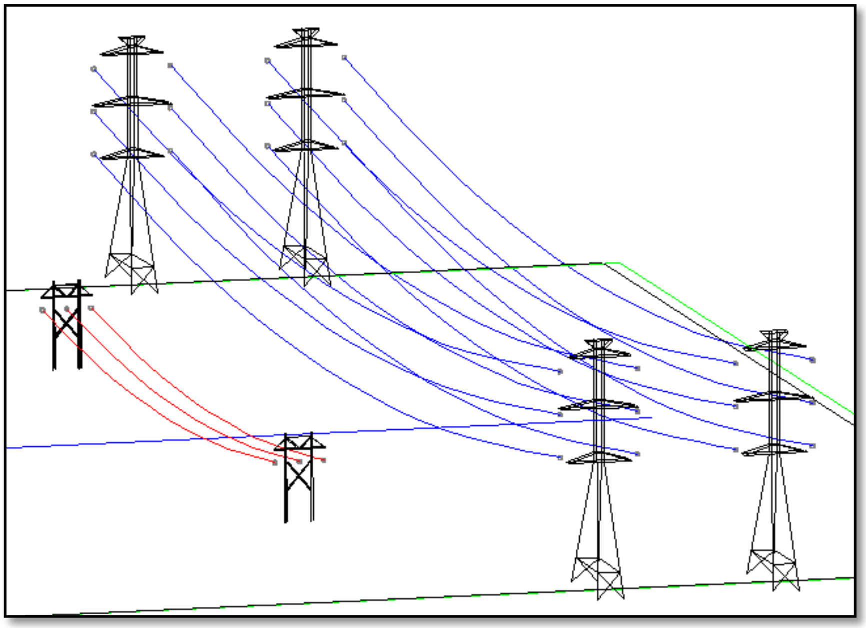

Figure 13. Existing A Line (left) and Con Ed Transmission lines (right)

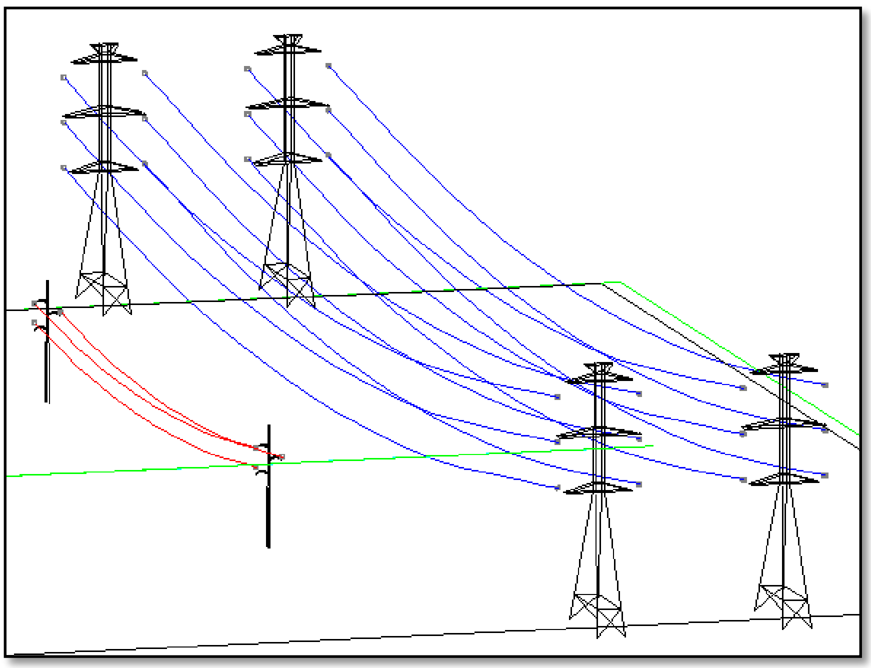

Figure 14. Proposed A Line (left) and Con Ed Transmission lines (right)

Area of Interest 4 Results:

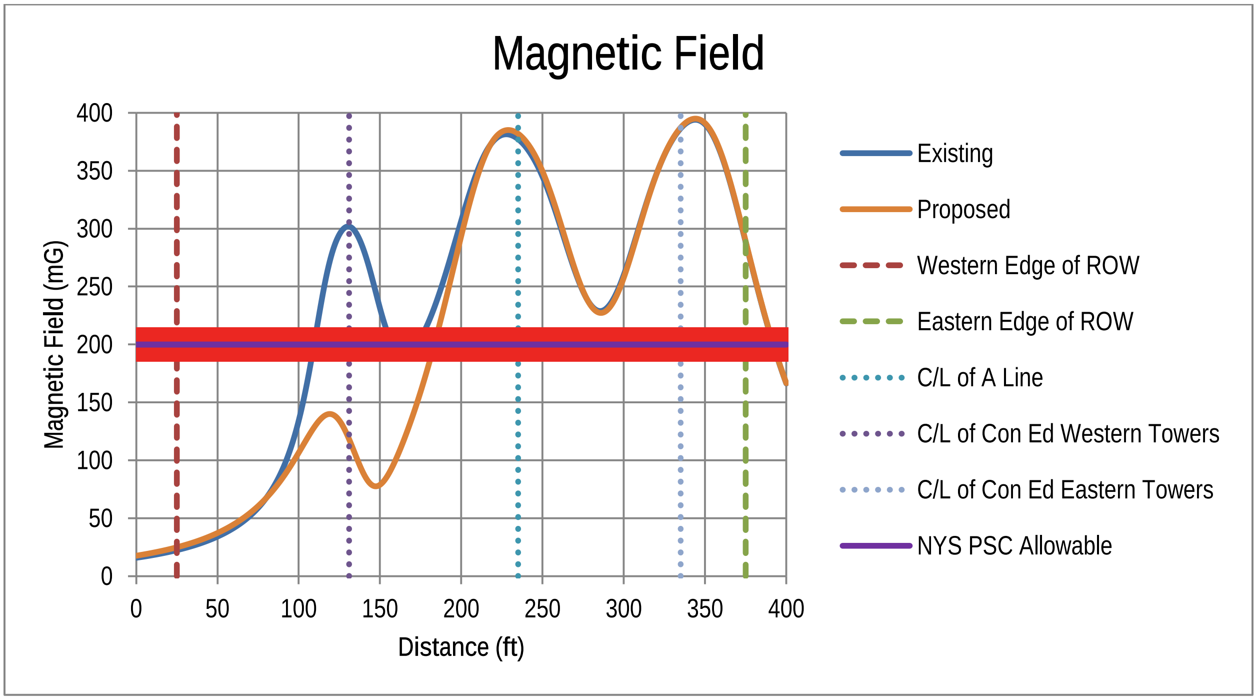

Figure 15. MF Levels on ROW with A Line and Con Edison lines

As shown above in Area of Interest 4, the proposed design would not alter the maximum MF on the ROW, as current levels are the result of the existing Con Ed 345kV lines. The Con Ed 345kV Lines were installed prior to the September 1990 issued *Statement of Interim Policy on Magnetic Fields of Major Transmission Facilities.* However, the maximum MF from the A Line by itself would decrease by 162mG, from 302mG to 140mG. On the western edge of the ROW (most influenced by the A Line project), the MF values would increase by 3mG, from 22 mG to 25 mG, still well below the NYSPSC guideline of 200 mG.

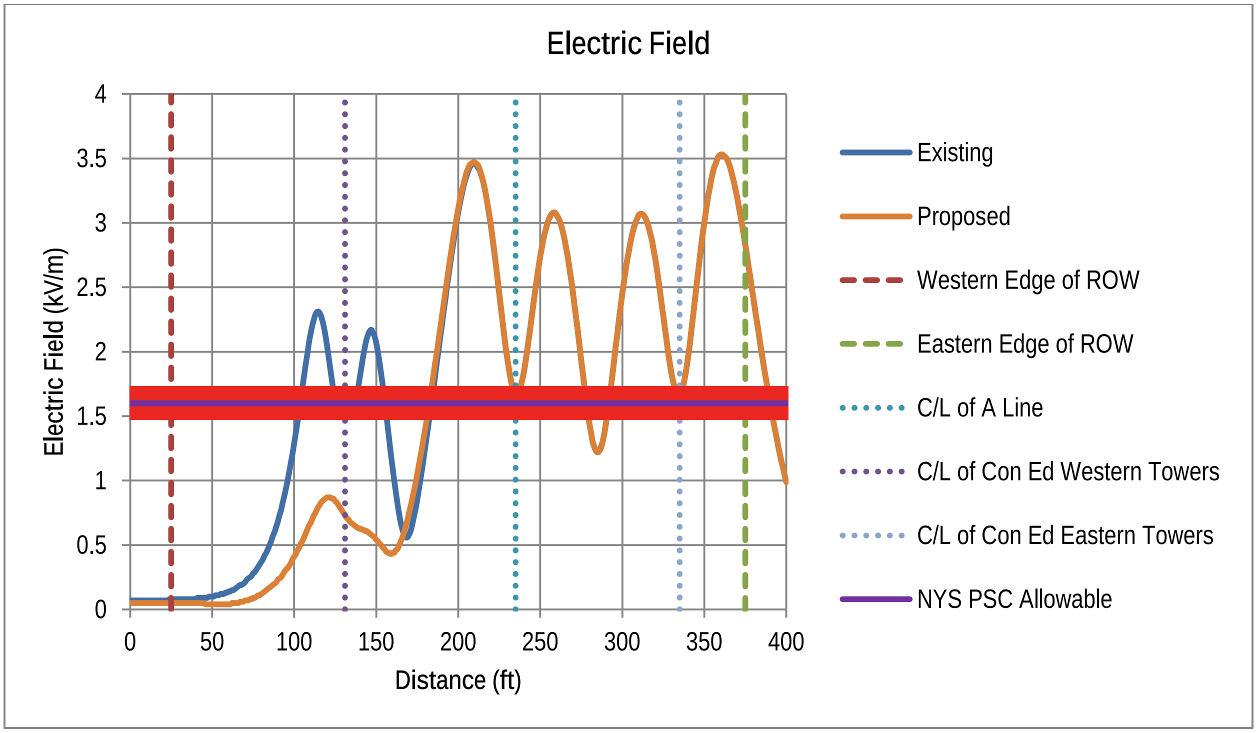

Figure 16. EF Levels on ROW with A and Con Edison lines

Within Area of Interest 4, the proposed design maintains the maximum EF on the ROW, while significantly reducing the EF generated by the A Line from 2.31 kV/m to .87 kV/m. This is a reduction of 62%. EF at the western edge of the ROW would decrease from .08 kV/m to .05 kV/m.

Conclusions:

As indicated by the results presented above, the proposed designs for the A and C Lines generally reduce both magnetic and electric field levels within the ROW. In cases where edge of ROW MF or EF values are projected to increase, these increases will be minimal, and still well within NYSPSC guidelines.