PRELIMINARY TRANSMISSION EMF MANAGEMENT PLAN
JEFFERSON-MARTIN 230 KV TRANSMISSION PROJECT

I. GENERAL DESCRIPTION OF PROPOSED PROJECT

Project Name: Jefferson-Martin 230 kV Transmission Project

Project Lead: Alain Billot (Project Manager)

Scope of Work:

The Jefferson-Martin 230 kV Transmission Project is needed to meet the projected electric demand in the Cities of Burlingame, Millbrae, San Bruno, South San Francisco, Brisbane, Colma, Daly City, and San Francisco (the north of San Mateo County area). The Project starts from PG&E's Jefferson Substation in San Mateo County and terminates at PG&E's Martin Substation in the City of Brisbane.

The Proposed Project includes:

- Installation of a new approximately 27-mile-long 230 kV transmission line with overhead and underground segments, with the first approximately 14.7 miles of this line to be installed on a rebuilt version of PG&E's existing Jefferson-Martin 60 kV double-circuit transmission line, and the remaining approximately 12.4 miles to be installed in a new underground duct bank, as further described in this PEA.
- Rebuilding the existing Jefferson-Martin 60 kV double-circuit tower line to enable the east side to operate at 60 kV and the west side at 230 kV.
- Construction of a new transition station near the intersection of San Bruno Avenue and Glenview Drive just east of Skyline Boulevard/Highway 35 to transition from the approximately 14.7-mile overhead 230 kV transmission line to the approximately 12.4-mile underground 230 kV transmission line.
- Modification of the existing Jefferson and Martin substations to accommodate the new 230 kV transmission line.
- Modifications to equipment at the existing San Mateo, Ralston, Millbrae and Monta Vista substations. (PEA § 2.3.5).
- Modification of Hillsdale Junction switching station for new 60 kV arrangement. (PEA § 2.3.5).

Base Cost of Transmission Line Proposed Project:

Based on the estimated cost of the transmission line components of the Proposed Project (Overhead, Underground, Transition Station, Transition Site, and Line Protection), the estimated base cost of the transmission line Proposed Project is approximately $138,668,397. Four percent of this estimated base cost is $5,546,736.

the low levels normally encountered near electric utility facilities, the field strength is expressed in a much smaller unit, the milliGauss (mG), which is one thousandth of a Gauss.

Power frequency EMF are present wherever electricity is used. This includes not only utility transmission lines, distribution lines, and substations, but also the building wiring in homes, offices, and schools, and in the appliances and machinery used in these locations. Magnetic field intensities from these sources can range from below 1 mG to above 1,000 mG (1 Gauss).

Magnetic field strengths diminish with distance. Fields from compact sources (i.e., those containing coils such as small appliances and transformers) drop off with distance "r" from the source by a factor of $1/r^3$. For three-phase power lines with balanced currents, the magnetic field strength drops off at a rate of $1/r^2$. Fields from unbalanced currents, which flow in paths such as neutral or ground conductors, fall off inversely proportional to the distance from the source, 1/r. Conductor spacing and configuration also affect the rate at which the magnetic field strength decreases, as well as the presence of other sources of electricity. The magnetic field levels of PG&E's power lines will vary with customer demand.

Magnetic field strengths for typical transmission power line loads at the edge of rights-of-way are approximately 10 to 90 mG.

ARRANGE PHASE CONDUCTORS:

Jefferson-Hillsdale Jct. 60 kV:

The phases of the Jefferson-Hillsdale Jct. 60 kV line will be arranged for minimum magnetic field level at the edge of the right of way. The phases will be arranged BCA (Top, Middle, Bottom).

Jefferson-Martin 230 kV Overhead:

The phases of the Jefferson-Martin 230 kV lines will be arranged for minimum magnetic field level at the edge of the right of way. The circuit will be arranged **ACB** (Top, Middle, Bottom).

Base Case Field Level at the Peak: 91.1 mG
Base Case Field Level at the Edge of the Right of Way: 51.3 mG
Field Level at the Edge of the Right of Way with Reduction Measure(s): 30.6 mG
Reduction: 40.4%, using base case load flows.
(See Table 1 and Graph 1)

Jefferson-Martin 230 kV Underground:

There are no feasible no cost field reduction measures that can be implemented on the underground part of this project.

Base Case Field Level at the Peak: 69.9 mG
Base Case Field Level at the Edge of the Right of Way: 15.0 mG
(See Table 2 and Graph 2)

	Before (mG)	After (mG)	Reduction in Magnetic Field @ edge of ROW	Estimated Cost
Overhead line route near schools	30.6	17.3	43.5 %	$198,000
Underground line route near schools	15.0	11.0	26.7 %	$1,500,000

Raising the transmission structures by 20 feet would result in a 43.5% reduction in the magnetic field at the edge of the right of way (See Table 1 and Graph 1). The cost to install 20-foot higher structures on the overhead transmission line near schools is estimated at $198,000.

Lowering the trench by 5 feet would result in a 26.7% reduction in the magnetic field at the edge of the right of way (See Table 2 and Graph 2). The cost to install a 5-foot lower trench on the underground transmission line near schools is estimated at $1,500,000.[1]

Mitigate Residential Areas:

Achieve lower magnetic fields at the edge of the right-of-way by moving the conductor further from the edge of the right of way in the Commercial/Industrial areas:

1. Raise the height of the conductors by installing 20 feet taller structures for the overhead transmission lines near residential areas.

2. Lower the depth of the conductors by installing 5-foot deep trench for the underground transmission lines near residential areas.

	Before (mG)	After (mG)	Reduction in Magnetic Field @ edge of ROW	Estimated Cost
Overhead line near residential areas	30.6	17.3	43.5 %	$1,000,000
Underground line near residential areas	15.0	11.0	26.7 %	$5,250,000

Raising the transmission structures by 20 feet would result in a 43.5% reduction in the magnetic field at the edge of the right of way (See Table 1 and Graph 1). The cost to install 20-foot higher structures on the overhead transmission line near residential areas is estimated at $1,000,000.

[1] The estimated cost for deepening the underground cable trench by 5 feet is necessarily preliminary and ultimately will vary depending upon groundwater depth, geology, underground obstructions, and other factors. The EMF Management Plan will be amended as appropriate as further information is available following the CPUC's selection of route and further engineering studies.

VII. CONCLUSION: FIELD REDUCTION MEASURES SELECTED

Mitigate Near Schools:

The phases of the Jefferson-Hillsdale Jct. 60 kV line will be arranged **BCA** (Top, Middle, Bottom) and the phases of the Jefferson-Martin 230 kV lines **ACB** (Top, Middle, Bottom). Optimal phasing would result in a 40.4% reduction in the magnetic field at the edge of the right of way (See Table 1 and Graph 1).

Raising the overhead transmission structures by 20 feet would result in a 43.5% reduction in the magnetic field at the edge of the right of way (See Table 1 and Graph 1). The cost to install 20-foot higher structures on the overhead transmission line near schools is estimated at $198,000. Lowering the underground trench by 5 feet would result in a 26.7% reduction in the magnetic field at the edge of the right of way (See Table 2 and Graph 2). The cost to install a 5-foot lower trench on the underground transmission line near schools is estimated at $1,500,000. The total cost to reduce magnetic field levels near schools along the route is estimated at $1,698,000. This is 1.22% of the estimated transmission line Proposed Project cost, and leaves $3,848,736 of the $5,546,736 that is the 4% of the total estimated transmission line Proposed Project costs.

Mitigate Residential Areas:

The phases of the Jefferson-Hillsdale Jct. 60 kV line will be arranged **BCA** (Top, Middle, Bottom) and the phases of the Jefferson-Martin 230 kV lines **ACB** (Top, Middle, Bottom). Optimal phasing would result in a 40.4% reduction in the magnetic field at the edge of the right of way (See Table 1 and Graph 1).

Raising the overhead transmission structures by 20 feet would result in a 43.5% reduction in the magnetic field at the edge of the right of way (See Table 1 and Graph 1). The cost to install 20-foot higher structures on the overhead transmission line near residential areas is estimated at $1,000,000. Lowering the underground trench by 5 feet would result in a 26.7% reduction in the magnetic field at the edge of the right of way (See Table 2 and Graph 2). The cost to install a 5-foot lower trench on the underground transmission line near residential areas is estimated at $5,250,000.

The total cost to install higher structures on the overhead transmission lines and lower trench on the underground lines for the residential areas along the route is estimated at $6,250,000. This amount exceeds the remaining $3,848,736 of the 4% estimated cost guideline for low cost work to reduce magnetic field levels. Therefore, based on the currently available information, no low cost mitigation would be available for the residential areas in this project.

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230 kV Overhead Transmission Lines

TABLE 1

Distance from Center line (feet)	Magnetic Field Level Three Feet Above Ground (milliGauss)		
	Base Case	Optimal Phasing	Raise Conductors 20 Feet
-200	5.0	1.9	1.7
-195	5.2	2.0	1.8
-190	5.5	2.1	1.9
-185	5.8	2.2	2.1
-180	6.1	2.4	2.2
-175	6.4	2.5	2.3
-170	6.8	2.7	2.5
-165	7.2	2.9	2.6
-160	7.7	3.1	2.8
-155	8.1	3.3	3.0
-150	8.7	3.5	3.2
-145	9.2	3.8	3.4
-140	9.9	4.1	3.6
-135	10.6	4.5	3.9
-130	11.3	4.9	4.2
-125	12.2	5.3	4.5
-120	13.1	5.8	4.9
-115	14.2	6.4	5.3
-110	15.4	7.0	5.8
-105	16.7	7.7	6.3
-100	18.2	8.6	6.8
-95	19.9	9.5	7.4
-90	21.8	10.6	8.1
-85	24.0	11.9	8.9
-80	26.5	13.5	9.8
-75	29.3	15.3	10.8
-70	32.6	17.4	11.8
-65	36.4	19.9	13.0
-60	40.7	22.8	14.3
-55	45.6	26.4	15.7
ROW 50	51.3	30.6	17.3
-45	57.7	35.6	18.9
-40	64.7	41.5	20.5
-35	72.1	48.2	22.1
-30	79.4	55.5	23.6
-25	85.7	62.9	25.0
-20	89.9	69.6	26.0
-15	91.1	74.5	26.6
-10	89.2	76.8	26.8
-5	85.4	76.3	26.5
0	81.4	73.5	25.7

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230 kV Underground Transmission Lines

TABLE 2

	Magnetic Field Level Three Feet Above Ground (milliGauss)		
Distance from Center line (feet)	Base Case	Lower Conductors 2 Feet	Lower Conductors 5 Feet
-200	0.1	0.1	0.1
-195	0.1	0.1	0.1
-190	0.1	0.1	0.1
-185	0.1	0.1	0.1
-180	0.1	0.1	0.1
-175	0.1	0.1	0.1
-170	0.1	0.1	0.1
-165	0.2	0.2	0.2
-160	0.2	0.2	0.2
-155	0.2	0.2	0.2
-150	0.2	0.2	0.2
-145	0.2	0.2	0.2
-140	0.2	0.2	0.2
-135	0.2	0.2	0.2
-130	0.3	0.3	0.3
-125	0.3	0.3	0.3
-120	0.3	0.3	0.3
-115	0.3	0.3	0.3
-110	0.4	0.4	0.3
-105	0.4	0.4	0.4
-100	0.4	0.4	0.4
-95	0.5	0.5	0.5
-90	0.5	0.5	0.5
-85	0.6	0.6	0.6
-80	0.7	0.7	0.7
-75	0.8	0.7	0.7
-70	0.9	0.9	0.8
-65	1.0	1.0	1.0
-60	1.2	1.2	1.1
-55	1.4	1.4	1.3
-50	1.7	1.6	1.6
-45	2.0	2.0	2.0
-40	2.6	2.5	2.4
-35	3.3	3.2	3.1
-30	4.4	4.3	4.0
-25	6.2	5.9	5.4
-20	9.3	8.6	7.6
ROW -15	12.7	11.9	10.9
-10	26.5	21.7	16.1
-5	49.4	35.1	22.5
0	69.9	44.3	26.0

Graph 2

JEFFERSON-MARTIN 230 KV TRANSMISSION PROJECT
230 kV Underground Transmission Lines