7.17 Electromagnetic Fields and Electromagnetic Interference Assessment

7.17 ELECTROMAGNETIC FIELDS AND ELECTROMAGNETIC INTERFERENCE ASSESSMENT

7.17.1 Introduction

This chapter identifies potential effects from electromagnetic fields (EMF) and electromagnetic interference (EMI) at sample locations where receptors sensitive to EMF/EMI are located within the Affected Environment of this Tier 1 Final Environmental Impact Statement (Tier 1 Final EIS) Preferred Alternative.

The Federal Railroad Administration (FRA) defines EMFs and EMI below:

- **EMFs** occur throughout the electromagnetic spectrum, are found in nature, and are generated both naturally and by human activity. Electric fields describe forces that electric charges exert on other electric charges. Magnetic fields describe forces that a magnetic object or moving electric charge exerts on other magnetic materials and electric charges.
- **EMI** occurs when the EMFs produced by a source adversely affect operation of an electric, magnetic, or electromagnetic device such as a magnetic resonance imaging machine. EMI is a concern at medical and university research facilities that house sensitive imaging equipment that could be adversely affected by EMF from train operations along rail corridors.

Railroad infrastructure (e.g., substations, and communication and signal systems) and operations (e.g., electric locomotives, overhead catenary system [OCS]) emit EMF/EMI; therefore, EMF/EMI exist where railroad infrastructure is located and where trains operate. Identifying the "presence" of EMF/EMI in the Affected Environment or Representative Route, similar to how natural resources like freshwater wetlands are evaluated, did not provide an adequate assessment of the potential effects related to EMF/EMI emissions in the Study Area (e.g., EMF/EMI is not measured in acres). It was more accurate to identify locations that might be sensitive to the emissions of EMF/EMI resulting from railroad infrastructure or train operations, and to identify potential mitigation strategies for these potentially sensitive locations. Accordingly, the FRA identified representative locations and potential sensitive receptors to EMF/EMI based on representative land cover and land uses, and proposed at-grade construction of the No Action Alternative and Preferred Alternative.[1] Volume 2, Appendix E.17, contains additional information, including the results of the full analysis and assumptions on electric traction, OCSs, and rolling stock.

7.17.2 Resource Overview

The FRA identified two potential sources of EMF/EMI:

- **Electric traction systems:** EMF/EMI produced by electric traction systems would result from the power required to operate the railroad, using the same frequency (60 Hz) as other systems on the power grid. EMF/EMI caused by electric traction systems affects limited areas because their frequencies are low and decrease rapidly over the distance from the source point.

[1] Potential effects on sensitive receptors adjacent to other construction types (e.g., tunnel, aerial structure) are less likely because they shield EMF/EMI signals.

- **Communications and signaling systems:** Modern railway signaling systems, such as Positive Train Control, rely on wireless communication to transmit data to operation control centers, trains, operators, maintenance crews, and even passengers. Communications and signaling systems are usually confined to an area along the track through directional antennas and limited power emissions.

Section 7.17.3 identifies sensitive locations that are representative of the types of sensitive locations located along the Representative Routes (sample locations).

The following are key findings of this analysis:

- **Benefits:** There are very few potential sensitive locations within the entire Study Area. Mitigation could be either at the source or at the location.

- **Adverse Effects:** The Hartford/Springfield Line is electrified in the Preferred Alternative, and as a result, introduces a new source of EMF/EMI.

7.17.3 Affected Environment

Using the process described in the EMF/EMI effects-assessment methodology (Volume 2, Chapter 7.17, Appendix E.17), to identify locations of sample sensitive receptors, the FRA identified 20 counties and Washington, D.C., where land cover is predominantly developed (medium or high density) and the construction type of the Existing NEC + Hartford/Springfield Line or the Preferred Alternative is at-grade. Potential effects on sensitive receptors adjacent to other construction types (e.g., tunnel, aerial structure) are less likely because those construction types shield EMF/EMI signals. Table 7.17-1 provides the locations of sample sensitive receptors meeting these criteria, identified by state and county.

7.17.4 Environmental Consequences

The FRA further reviewed the 20 locations presented in Table 7.17-1, using aerial mapping to identify sample sensitive receptors along the Representative Routes. Using a screening distance of 500 feet, the FRA identified specific land uses within the Preferred Alternative that might be sensitive and most vulnerable to EMF/EMI (e.g., hospitals, universities, research facilities, high-tech manufacturing) under normal rail operations. Within these land uses, the FRA then identified sample sensitive receptors that may use equipment sensitive to EMF/EMI. The FRA considered these sample receptors to be representative of the types of sensitive receptors occurring end-to-end along the Representative Route. Table 7.17-2 identifies the state, county, and the approximate distance to the Representative Route where these sample sensitive receptors were identified. Land uses with potentially sensitive receptors are also common on the Hartford/Springfield Line, which operates only diesel services, but would be electrified in the Preferred Alternative.

Table 7.17-1: Locations of Sample Sensitive Receptors to Electromagnetic Fields/Electromagnetic Interference (Existing NEC + Hartford/Springfield Line and Preferred Alternative)

Geography	County	Developed Land Cover	Existing NEC + Hartford/Springfield Line	Preferred Alternative
D.C.		High Density	X	X
MD	Anne Arundel	Medium Density	X	X
	Baltimore City	High Density	X	X
	Cecil	High and Medium Density	X	X
DE	New Castle	High and Medium Density	X	X
PA	Delaware	High Density	X	X
	Philadelphia		X	X
NJ	Union	High Density	X	X
	Essex		X	X
	Hudson		X	X
NY	New York	High Density	X	X
	Brooklyn		X	X
	Bronx		X	X
CT	New Haven	Medium Density	X	X
	Hartford	High Density	X	X
	New London	Medium Density	X	X
RI	Kent	Medium Density	X	X
	Providence	High Density	X	X
MA	Hampden	High and Medium Density	X	X
	Suffolk	High Density	X	X

Source: NEC FUTURE team, 2016
Note: Representative locations are at-grade construction types only.
X = Representative location within the Affected Environment of specified alternative; specific names and locations have not been identified for this analysis. Specific locations and effects determination will be subject to Tier 2 project studies.

Effects from EMF/EMI resulting from train operations could disrupt equipment sensitive to EMF/EMI or cause it to malfunction. A majority of the sensitive receptors identified in Table 7.17-2 are proximate to new segments associated with the Preferred Alternative, where land uses were originally developed without concern for the effects of railroad infrastructure and related railroad operations (since none existed) on their uses. The following discussion focuses on those sample sensitive receptors that could be affected by EMF/EMI.

Locations where potential sensitive receptors might exist are in every state in which the Preferred Alternative would operate. However, as noted in Table 7.17-2, specific land uses with sample sensitive receptors—and thus more of a concern at the Tier 2 project level—are located near new segments of the Preferred Alternative in Delaware County, PA; and adjacent to the Hartford/Springfield Line in Connecticut.

Table 7.17-2: Environmental Consequences: Land Uses with Sample Sensitive Receptors to Electromagnetic Fields/Electromagnetic Interference (Existing NEC + Hartford/Springfield Line and Preferred Alternative)

ID	State	County	Existing NEC + Hartford/ Springfield Line	Preferred Alternative	Land Cover	Land Use	Observed Distance to Representative Route (feet)
1	MD	Cecil	X		Barren Land	Industrial, Transportation	<500
2	DE	New Castle		X	Developed, High Density	Industrial, University	<500
3				X	Developed, Medium Density	Medical	
4	PA	Delaware		X	Developed, High Density	Aviation, Manufacturing	<500
5				X			
6	CT	New Haven	X	X	Developed, Medium Density	Industrial	<500
7			X	X			
8		Hartford	X	X	Developed, Medium Density	Manufacturing-aerospace	<500

Source: NEC FUTURE team, 2016
X = Presence of resource and potential effects within the Representative Route; effects will be subject to Tier 2 project analysis.
Blank cell = No presence and no effects identified for listed resource.
* The Preferred Alternative assumes improvements to the Existing NEC + Hartford/Springfield Line; therefore, the data presented include the Environmental Consequences inclusive of improvements to the Existing NEC + Hartford/Springfield Line and any new off-corridor route associated with the Preferred Alternative.

7.17.4.1 Elements South of New York City

- **Maryland/Delaware – Bayview to Newport (new segment) –** Trains operating over this portion of the Preferred Alternative may affect a university facility that focuses on science, technology, and advanced research. The site is located just across the Maryland/Delaware border in western New Castle County, DE.
- **Delaware – Wilmington Segment (bypasses Wilmington Station) –**There is one potentially sensitive location—a medical facility—adjacent to this portion of the Preferred Alternative.
- **Pennsylvania – Philadelphia Segments (new segments) –**Two potentially sensitive locations near new infrastructure between Baldwin and Philadelphia 30th Street Station might be affected by operation of the Preferred Alternative. Both are aviation and manufacturing locations in Delaware County, PA, west of the Philadelphia International Airport.
- **New Jersey – New Brunswick to Secaucus (new segment) –** There are no potentially sensitive locations identified as part of this analysis adjacent to this new segment.
- **New Jersey – Secaucus/Bergen loop (new segment) –** There are no potentially sensitive locations identified as part of this analysis adjacent to the new segment.

7.17.4.2 Elements North of New York City

- **New York/Connecticut – New Rochelle to Greens Farms (new segment) –** There are no potentially sensitive locations identified as part of this analysis adjacent to the new segment.
- **Connecticut/Rhode Island – Old Saybrook-Kenyon (new segment) –** There are no potentially sensitive locations identified as part of this analysis adjacent to the new segment.
- **Connecticut/Massachusetts – Hartford/Springfield Line (upgraded track/electrification) –** There are three potentially sensitive receptors adjacent to the Hartford/Springfield Line. Two are industrial uses in New Haven County, in the town of North Haven. A third location is in Hartford County—an aerospace manufacturing facility, in Windsor, CT. The introduction of electric operations that are associated with the Preferred Alternative may have an effect on these locations.

7.17.5 Stations

The Preferred Alternative contains no potentially sensitive locations identified as part of this analysis near stations.

7.17.6 Human Exposure Limits

7.17.6.1 Passenger and Employees Onboard Existing and Proposed Trainsets

To date, research has not identified any potential health effects associated with EMF/EMI to passengers and employees onboard existing and proposed electric trainsets. The FRA examined potential onboard EMF/EMI effects due to the electrification infrastructure and operations of Amtrak Acela trains on the NEC from New Haven, CT, to Boston, MA.[2] The FRA determined that no EMF/EMI exposure to the public was exceeded by occupational limits of the Federal Communications Commission. It is likely that onboard EMF/EMI exposure in the equipment used by the Preferred Alternative would not exceed occupation limits of the Federal Communications Commission.

7.17.6.2 Residents and Workers Adjacent to the Railroad

Exposure limits are different for humans and systems. Limits on EMFs are usually more restrictive for systems than human exposure in order to limit induced step and contact voltages. Table 7.17-3 lists values of Maximum Permissible Exposure as presented in the Institute of Electrical and Electronics Engineers' *Standard for Safety Levels with respect to Human Exposure to Electromagnetic Fields*.

[2] *EMF Monitoring on Amtrak's Northeast Corridor: Post-Electrification Measurements and Analysis*, U.S. Department of Transportation, Office of Research and Development, DOT/FRA/RDV-06/01, Final Report, October 2006. Accessed at *https://www.fra.dot.gov/Elib/Document/2941*

Table 7.17-3: Maximum Permissible Values for Magnetic and Electric Fields (60 Hz) Attending to Usual Standards and Guides

Organization	Magnetic Field (mT)		Electric Field (kV/m)	
	Occupational	General	Occupational	General
IEEE C95.1	2.71	0.904	20.0	5.0
ICNIRP	1	0.2	8.33	4.17

Source: Institute of Electrical and Electronics Engineers and International Commission on Non-Ionizing Radiation Protection
mT = millitesla (1mT = 1,000 microtesla (μT))
kV/m = kilovolt per meter

Table 7.17-4 shows the typical maximum electric and magnetic field values at fundamental frequency of 25 kV electric traction systems of the type used on the NEC. The values are calculated at 10 meters (approximately 33 feet) from the centerline of the nearest track at 1 meter (approximately 3 feet) above top of rail. As shown in the table, the maximum EMF values for systems are several orders of magnitude lower than the Maximum Permissible Exposure limits for human exposure.

Table 7.17-4: Typical Maximum Electric and Magnetic Field Values at Fundamental Frequency from EN 50121-2

System	Frequency (Hz)	E-field (V/m)	H-field (μT)	Reference conditions	Reference documentation
25 kV	50	1000	16	Ic 1500 A, RMS U= 27.5 kV with feeder wire autotransformer	ITU(T) Directives CIGRE WG 3601

Source: European Standards EN 50121-2. *Railway applications - Electromagnetic compatibility -- Part 2: Emission of the whole railway system to the outside world (Appendix C)*
1μT = 0.001millitesla
kV/m = kilovolt per meter

7.17.7 Context Area

Within the Context Area, the areas of greatest concern are those with the greatest concentration of sensitive receptors. Should the Representative Route shift during future stages of the development process, more site-specific analysis and mitigation strategies will be conducted, with specific focus on areas where universities, medical facilities, and advanced industrial uses (such as aerospace manufacturing) occur.

7.17.8 Comparison to the Action Alternatives

The number of representative locations potentially-sensitive to EMF/EMI identified for the Preferred Alternative (seven total, see Section 7.17.4) is greater than those expected to be encountered by any of the Action Alternatives. However, the number of sensitive locations expected to exist south of New York City (two each in Delaware and Pennsylvania) is consistent with the number of sensitive locations expected to be encountered by Alternative 2, which also affects the most potentially sensitive locations out of all the Action Alternatives. As noted earlier, the key differentiator north of New York City between the Preferred Alternative and the Action Alternatives is the inclusion of the Hartford/Springfield Line, where more potentially sensitive sites are located in Connecticut.

7.17.9 Potential Mitigation Strategies

Electromagnetic compatibility ensures that systems function properly when in conflict with EMF/EMI. The FRA identified potentially sensitive receptors for each Action Alternative but did not identify specific effects on resources. The type of mitigation used to offset potentially adverse effects to sensitive receptors should be reviewed case by case, depending on the resource affected. However, typical mitigation strategies for EMF/EMI when dealing with rail infrastructure include the following:

- Modification of the electrical feeding system
- Consideration of voltage levels
- Positioning of OCS wires and traction power substations
- Changes to operations
- Incorporating electromagnetic interference transmission media through shields or filters

7.17.10 Subsequent Tier 2 Analysis

Subsequent Tier 2 project studies will be reviewed for site-specific sensitive receptors to EMF/EMI. If sensitive receptors are identified, analysis to determine the extent of effects on these receptors will be undertaken. Tier 2 project studies could include the development of a frequency management plan, which would more accurately analyze the strength and intensity of EMF/EMI emissions based on the service plan, equipment selection, and final design of the selected alternative.