

Direct Current (DC) Technology

What does direct current mean?

Electricity is transmitted as current. Current flows from generating stations over transmission lines to substations and finally through distribution lines before it reaches our homes and offices. Transmission lines can carry either alternating current or direct current —

- **Alternating current (AC)** changes direction 60 times per second, which is referred to as a frequency of 60 Hertz (Hz).

- **Direct current (DC)** flows constantly in only one direction (0 Hz).

Due to the ease of converting AC to the voltage levels used by household appliances and other equipment, AC is the primary method of electricity transmission and distribution. DC is sometimes used, however, to transmit electricity over long distances.

When is DC transmission an option?

DC transmission has less power loss than AC transmission. The major offset from the advantages of DC transmission, however, is the cost of converting between DC and AC. DC transmission is usually only justified when there is a sufficient amount of power being

transmitted and the savings from lower power loss are more than the cost of conversion. DC transmission is used extensively with underwater cables, because of the lower power loss compared to underwater AC transmission.

What electric and magnetic fields are associated with the operation of DC lines?

DC lines are sources of electric and magnetic fields (EMF). EMF are properties of the space that surrounds anything electrical, whether it uses AC or DC transmission, including power lines, appliances and wiring. Electric and magnetic fields are invisible and decrease rapidly with distance from their source. When constructed underground, the cable coverings and earth block the electric field, but not the magnetic field.

Electric and magnetic fields from DC transmission lines are commonly referred to as static fields.

- **Static electric fields** are created by electric charges. Electric fields are measured in volts per meter (V/m) or kilovolts per meter (kV/m), where $1 \text{ kV/m} = 1,000 \text{ V/m}$.
- **Static magnetic fields** are created by the flow of electric current in one direction. They are measured in units called milligauss (mG). The earth itself produces an identical static magnetic field.

What are other sources of static electric fields?

Static electric fields occur naturally in the atmosphere. Higher static electric fields are found near or underneath storm clouds. Friction can also cause the build-up of static electric fields, such as shuffling across a carpet. Other common sources of static fields include some electrified railway

systems and cathode ray tubes in computer and television screens. Table 1 shows the level of static electric fields measured near these common sources, and a representative level of the electric field at the edge of the right of way (EROW) for a DC line of the planned capacity.

A representative level of the static electric field from an overhead DC transmission line is less than the static electric field generated by these common sources.

Table 1. Static Electric Field Levels

Source	Level (kV/m)
Friction from walking across carpet	Up to 500
Computer screens	10–20 at 30 centimeters
Representative level at EROW	<10

What are other sources of static magnetic fields?

There are both natural and man-made sources of static magnetic fields. The earth produces a static magnetic field as a result of currents flowing deep within its core — it is this field that is used for compass navigation. Other sources include permanent magnets, battery-powered appliances, magnetic

resonance imaging (MRI) machines, some electrified railway systems, and certain industrial processes. Table 2 shows the levels of static magnetic fields measured near these common sources, and a representative level of the magnetic field at the EROW for a DC line of the planned capacity.

A representative level of the static magnetic field from an overhead DC transmission line is less than the static magnetic field of the earth in Maryland.

Table 2. Static Magnetic Field Levels

Source	Level (mG)
MRI machines	15,000,000–40,000,000
Battery-operated appliances	3,000–10,000
Electrified railways	<10,000
Earth's field in Maryland	525
Representative level at EROW of overhead line	<100
Representative level at 30 feet from underground/underwater cables	<25

Has research been conducted on the potential health effects of exposure to static electric and magnetic fields?

Yes. The research includes epidemiology studies of workers exposed to static magnetic fields, surveys of residents living near DC lines,

animal studies, and studies in cells and tissue. This research has been reviewed by independent scientific panels.

What have scientific panels concluded about the research on static electric and magnetic fields?

National and international scientific agencies responsible for public health have convened multidisciplinary groups of scientists to evaluate the research. Such groups include the World Health Organization (WHO) in 2006, the National Radiological Protection Board of Great Britain (NRPB) in 2004, and the International Agency for Research on Cancer (IARC) in 2002.

With regard to the low levels of static fields associated with the proposed DC transmission line and other common sources, these organizations came to the following conclusion:

- There are no known health effects associated with the low levels of static fields found in the everyday environment, including the low levels from DC lines.

Are there any standards or guidelines to limit exposure to DC electric or magnetic fields?

Yes, but they only apply to exposures greater than those associated with the proposed DC line. Scientific organizations that have published guidelines for exposure to static magnetic fields include the International Commission on Non-Ionizing Radiation

Protection (ICNIRP), the International Committee on Electromagnetic Safety (ICES) and the American Conference of Industrial Hygienists (ACGIH). These exposure limits are based on avoiding short-term effects, such as nausea, that can occur at high field levels.

Table 3. Recommended Limits for Exposure to DC Electric and Magnetic Fields, Compared to Estimated Levels Associated with Proposed Line

	Magnetic Field		Electric Field
	General public	Workers	Workers
ICNIRP	400,000 mG	2,000,000 mG* 20,000,000 mG**	—
ICES	1,180,000 mG	3,530,000 mG**	—
ACGIH	—	600,000 mG*	25 kV/m
Representative magnetic field level at EROW edge	<100 mG		—
Representative median electric field level at EROW edge	—		<10 kV/m

*Average ** Maximum

Where can I find more information?

For further information on static electric and magnetic fields, see the Fact Sheet on the World Health Organization's website:

- <http://www.who.int/mediacentre/factsheets/fs299/en/index.html>

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