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Background on Magnetic Fields from Direct Current Cables

New Jersey Offshore Wind Prebuild Infrastructure

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Exponent is an independent 3rd party firm employing leaders in technical fields across disciplines, with the majority of technical staff holding a Ph.D. in their respective field of expertise.

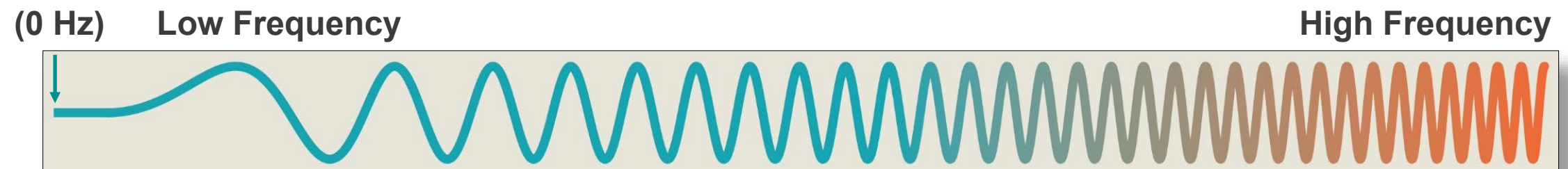
In the field of electric and magnetic fields Exponent has more than 25 years of experience and has assisted the federal government, utilities, infrastructure developers, municipalities, state regulatory agencies, medical device manufacturers, the U.S. Army, and many others understand science and engineering aspects of electric and magnetic fields.

Notice

The New Jersey Board of Public Utilities (NJBPU) requested that Exponent provide general information about static magnetic fields in the context of buried DC cables. Exponent's experience includes the preparation or review of environmental assessments for underground and submarine cables in the U.S., Canada, and Europe. The content of this presentation has been assembled from scientific and technical references cited and is not specific to a particular design feature of the NJBPU Prebuild Infrastructure (PBI) or to a specific project.

Electric and Magnetic Fields*

- Key Characteristic is FREQUENCY
- Frequency refers to the number of times per second that the field changes strength and direction
- Frequency determines how an electric or magnetic field interacts with the environment (and humans)

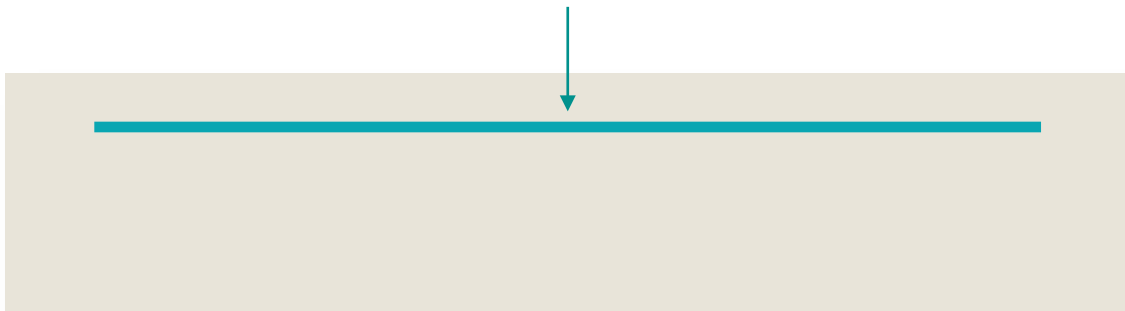


* The burial and cable construction of prebuild infrastructure will effectively block electric fields above ground and are not discussed further.

Frequency of Fields Associated with Electricity

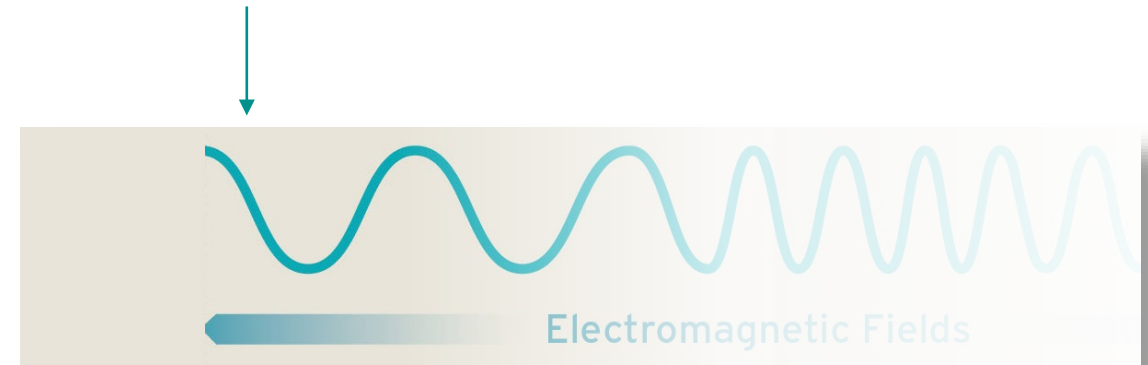
Direct Current (DC) Fields (aka Static Fields)
0 Hertz (Hz)

Static Fields of Prebuild Infrastructure
(0 Hz)



Alternating Current (AC) Fields (aka EMF)
1-3,000 Hz (60 Hz is dominant in North America)

Power Grid Frequency (60 Hz)

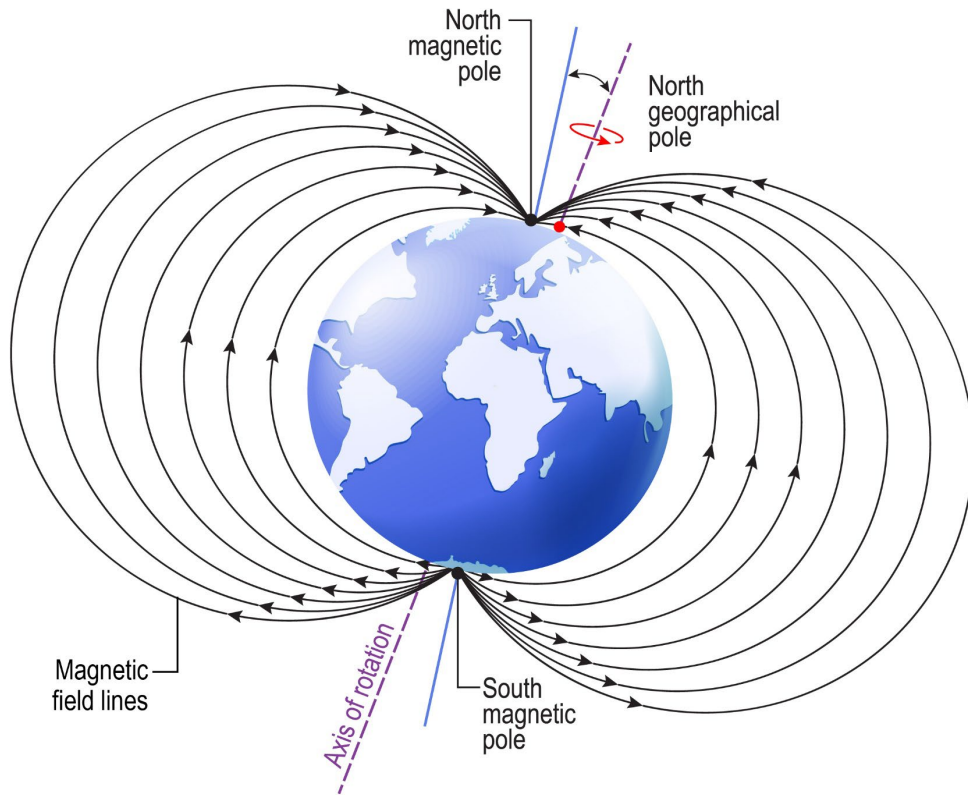


Extremely-Low Frequency Fields (<3,000 Hz)

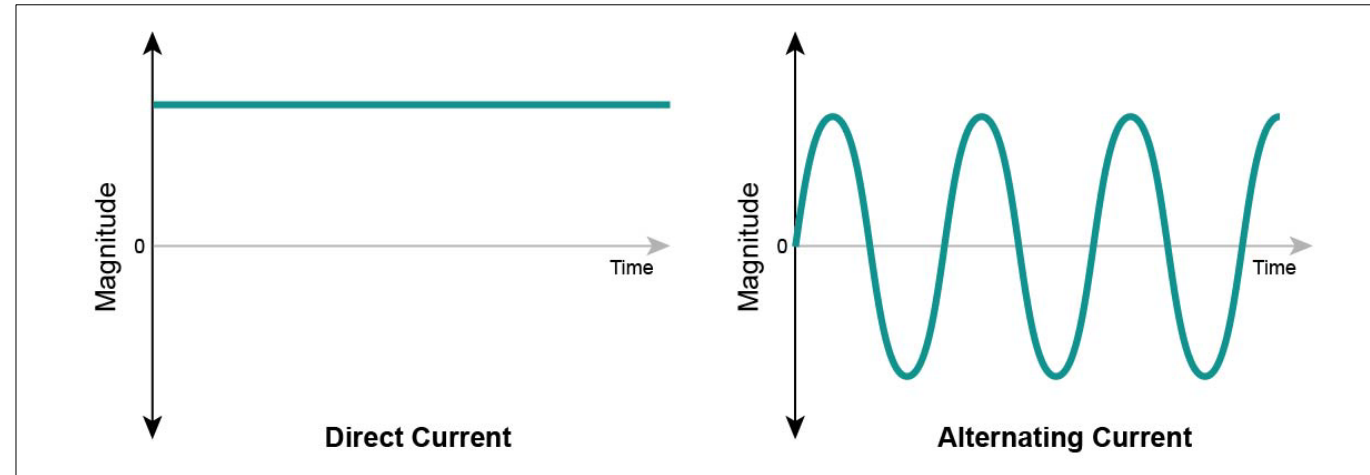
The static field of DC lines has the same frequency (0-Hz) as the static field of the Earth.

The energy in DC and AC fields is too weak to ionize or change atoms.

Static (DC) Geomagnetic Field of the Earth



Earth's Static Geomagnetic Field
~ 300–700 milligauss (mG)



* International Geomagnetic Reference Field (IGRF-13) Model
https://ccmc.gsfc.nasa.gov/modelweb/models/igrf_vitmo.php Accessed 9/15/2024

Common Sources of Magnetic Fields

Static or Direct Current (DC) Magnetic Fields (0 Hz)

- Earth (static magnetic field from the earth)
- Magnets, headphones
- Electric trains
- MRI
- DC power lines

~~Alternating Current (AC) EMF 60 (Hz)~~

- ~~– AC power lines~~
- ~~– Home appliances~~
- ~~– Building wiring~~
- ~~– Grounding systems (e.g., water pipes)~~
- ~~– Commonly referred to as EMF~~

Warning (1)

Unless the information you review from any source, website, or publication states that it describes or pertains to **static or DC magnetic fields**, it is likely to be referring to other frequencies, e.g., 60-Hz power frequency (i.e., AC EMF) or radiofrequency signals (e.g., cell phones, WiFi, radio, etc.) with frequencies between 3 kilohertz and 300 gigahertz.

Warning (2)

The Prebuild Infrastructure will not generate any appreciable AC magnetic fields at 60-Hz, or any higher frequency **so any information about frequencies other than static or DC magnetic fields are irrelevant** to your understanding of the proposed Prebuild Infrastructure and subsequent installations by applicants.

Prebuilt Infrastructure:

4 Direct Current (DC) Circuits

- DC circuits bring DC power to shore at Sea Girt National Guard Training Center by buried DC cables installed in conduits by horizontal directional drilling
- Cables connect to Transition Vaults west of shore landing
- Cables continue under roadway in DC duct banks:
 - 2 duct banks each protecting a ± 320 kV circuit
 - 2 duct banks each protecting a ± 525 kV circuit
- Cable vaults at $\sim 2,000$ -foot intervals where lengths of cable are spliced together under roadway
- Duct banks terminate at a Collector Station

Typical Static Magnetic-Field Levels from Common Natural and Man-made Sources

Source	Magnetic Field Level (mG)
Natural Sources	
Earth's geomagnetic field in New Jersey*	511 mG
Man-made Sources (WHO, 2006)	
Refrigerator magnets	~100,000 [†]
Battery operated appliances	3,000 – 10,000
Electrified railways	< 10,000
MRI machines	15 million – 40 million

* IGRF-13 Model for 2024 https://ccmc.gsfc.nasa.gov/modelweb/models/igrf_vitmo.php Accessed 9/15/2024

[†] US National High Magnetic Laboratory, <https://nationalmaglab.org/about-the-maglab/around-the-lab/maglab-dictionary/tesla> Accessed,9/15/2024

Standards for Exposure to DC Magnetic fields (1)

- There are no health effects of exposure to DC magnetic field of the earth, ≤ 700 mG.
- No federal or state limits on magnetic fields. Thomas Edison first operated DC lines to light cities in 1886.
- The U.S. Food and Drug Administration specifies that MRI devices pose no "significant risk" for static magnetic field exposures up to **40,000,000 mG** for newborns and **80,000,000 mG** for all older persons (FDA, 2014).
- **Some implanted medical devices** may be affected by DC magnetic fields. So standards specify that implanted medical device "shall not be affected by static magnetic fields of flux density of up to [**10,000 mG**]" (ANSI/AAMI/ISO Standard 14117:2019)

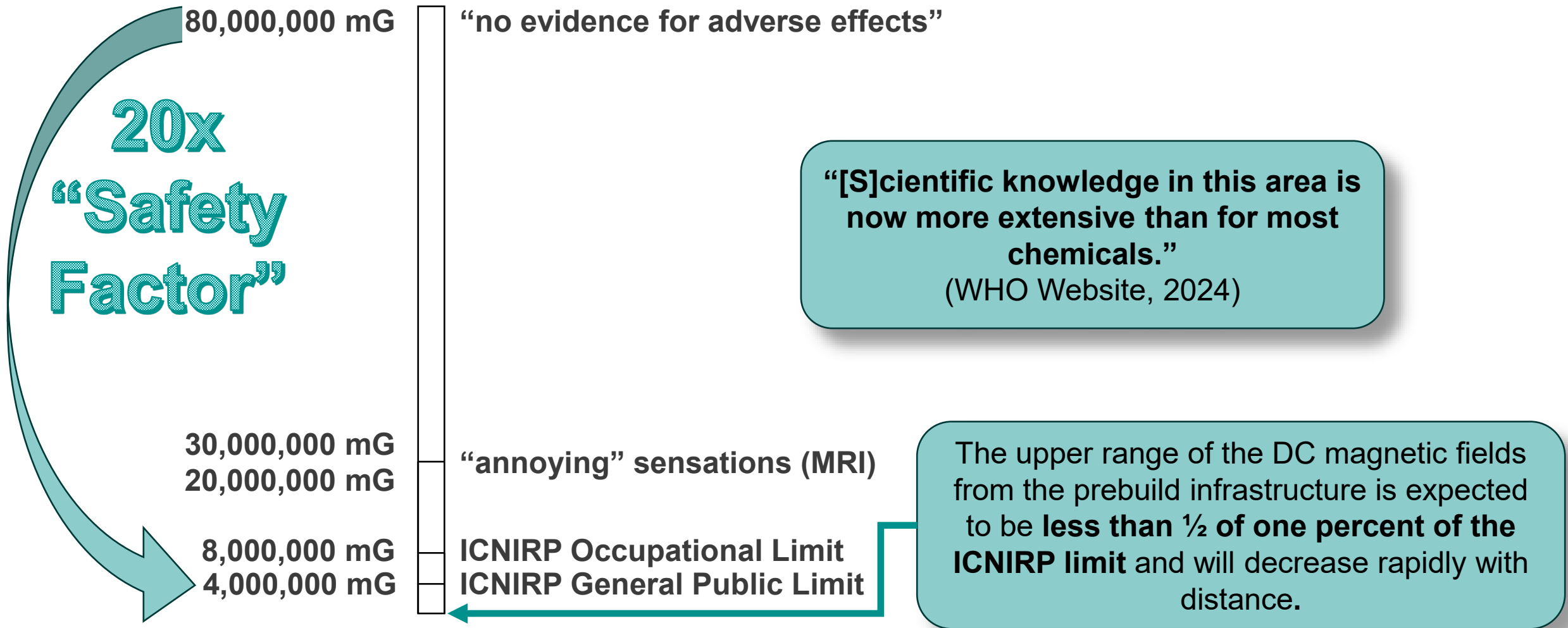


Standards for Human Exposure to DC Magnetic fields (2)

Exposure limits for DC magnetic fields are **4,000,000 mG** for the general public and **8,000,000 mG** for workers (ICNIRP, 2009) and include large **safety factors** compared to the lowest known effect (ICNIRP, 2009).

- ✓ The limit for workers “allow[s] potential occurrence, in some exposed workers, of temporary sensory effects **with no known long term or serious consequences**” (ICNIRP, 2009).
- ✓ “Magnetic fields of **[20,000,000 to 30,000,000 mG]** or higher (such as those generated by equipment in some industrial and medical settings or in some specialist research facilities - i.e. MRI) can evoke transient sensations such as vertigo and nausea...**These effects are not adverse health effects in themselves, but they can be annoying and they may impair normal functioning.**” (ICNIRP Website, 2024)
- ✓ “**There is no evidence for adverse effects of exposure to fields up to [80,000,000 mG],** except for limited information on minor effects such as on hand-eye coordination and visual contrast.” (ICNIRP Website, 2024)
- ✓ **There is no foreseeable circumstance whereby the operation of developer-installed cables in the Prebuild Infrastructure could produce DC magnetic field levels even close to the ICNIRP limit.**

DC Magnetic Fields from Prebuild Infrastructure Project Far Lower than Public Health Limits



References

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