Electric trains disturb military installation

How a military facility picked up extremely low-frequency transmissions from power lines acting as unintentional antennas.

The Danish military built an ELF listening station for research purposes, which has since been dismantled. It operated around the 1970s where it monitored magnetic fields in the 1 to 25 Hertz ELF range. The sensors were placed on the sea bottom, about a mile off the Danish coast near the town of Hellebaek.

The sensors were put together using telephone relay coils (14 in series for each X, Y and Z dimension, enhanced with mumetal cores). They had a total induction of about 7000-8000 H for each axis. The assemblies were mounted in airtight, sand filled boxes of glass fiber and installed on the sea bottom.

The sensors worked very well, but sometimes the technicians saw strong interference: A mysterious extremely low-frequency signal of about 17 Hertz.

The interference turned out to come from electric trains in Sweden, about 15 km (10 miles) to the east. The electrical grid in Sweden uses 50 Hertz AC, like the rest of Europe, but the electric trains use 17 Hertz AC (16.67 to be more exact).

Sweden was an early adopter of electric trains, due to the abundance of cheap hydropower. The technology for such large electric motors in those days dictated that the 17 Hertz frequency was used instead of 50 Hertz.

The Danes looked into the matter and found that when a train started from the station in Helsingborg, Sweden, it would immediately show up on the ELF sensors over in Denmark. They could then follow the train as it moved up through the hills. They would first lose the signal when the train entered another section of the track that received electricity from somewhere else.

The Swedish trains use an overhead wire over the tracks, which carry 15,000 volts. The electricity is passed through the electric train and returned through the tracks which are grounded to the earth (grounded neutral).

Together, the system acted as an unintentional antenna.

The overhead wire was one part of the antenna (dipole), while the tracks and surrounding soil were the ground plane (other dipole). This unintended antenna then operated when the electric train passed through, pulling a current on the overhead wire and closing the connection with the tracks (and the earth).

The Swedish train system is divided into sections that are each about 5 km (3 miles) long. Each section is fed by a separate booster transformer. When a train traverses a section, the overhead wire carries the current for the train. When the train leaves the track section, the current and the magnetic field stops.

The Swedish trains provided the strongest signal picked up by the ELF station, except for a Soviet warship which had its jammers on. The station used filters to ignore the 50 Hertz signals from the electrical grid, including submerged power cables linking the two countries.

This story was told to the author by a member of the Danish military engineering staff.

The Swedish trains have also been reported as a disturbance at the ionospheric research station in Kilpisjärvi, northern Finland. It is located about sixty miles (90 Km) east of the Kiruna-Narvik ore railway in Sweden.

That power lines in general can be picked up at some distance has been known for a long time. During World War II, Allied scientists considered using the power lines in Germany as navigation beacons for the bombers. Instead, the Loran system was designed. The story can be read in *The Invention that Changed the World* by Robert Buderi, Touchstone, 1977 (pg. 174).

This phenomenon is also an issue for radio astronomy, according to Felix Lokmen of the U.S. National Radio Astronomy Observatory in an interview with the Russian TV station 1TV (October 20, 2011).