Senior Design Project in Electrical & Computer Engineering

NVIS Antenna Development and Testing for WPB-110 and CPB-87 Class Cutters

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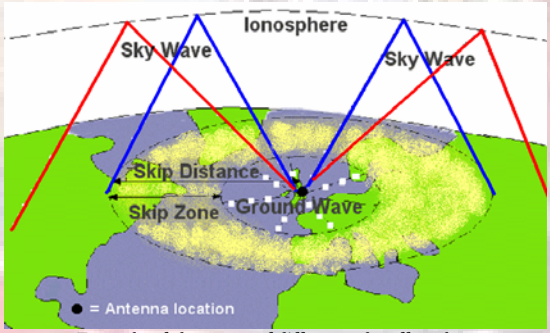
Sponsor: TISCOM

Project Background

Near Vertical Incident Sky wave (NVIS) antennas are a recent addition to the Coast Guard that help solve the problem of poor mid-range radio communication. In the Coast Guard fleet 110' cutters primary missions are search and rescue (SAR) and law enforcement (LE) operations. These missions require reliable communication between cutters and shore stations. Mid-range communications, are necessary for 110' class cutters because SAR and LE patrols take cutters offshore, beyond the capabilities of very high frequency (VHF) communications.

The current high frequency (HF) antenna configuration on a 110' cutter has proven unreliable for Mid-range communications. 110' cutters use a whip antenna, which creates a low take-off angle producing a large skip zone. This skip zone is the distance from where the ground wave ends and where the sky wave returns to earth after bouncing off the ionosphere. As a result, the cutters communication within a range of 50 to 500 miles is very poor.

In the below picture, a sky wave with a high take-off angle relative to the earth's surface is shown in blue. The size of the skip zone is reduced compared to a sky wave with a small take-off angle, shown in red. A NVIS antenna is guided by this theory. It sends out waves with high take-off angles to provide Mid-range communication coverage.



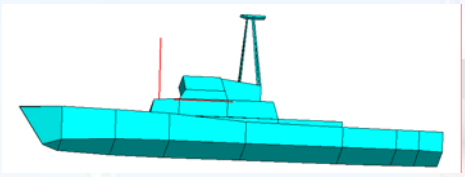
Example of sky waves of different take off angles reflecting off the ionosphere.

Project Plan

The project will test a towel bar NVIS antenna on a Coast Guard 110' cutter to determine if the high take off angle of the waves transmitted by the NVIS antenna provide sufficient communication coverage in the 50-500 mile skip zone. After testing the antenna on a 110' cutter an antenna model will be created for the 87' patrol boats.

Project Work

We will install a NVIS antenna on a 110' cutter and conduct tests to determine efficiency, radiation characteristics, and the driving point impedance of the antenna. We will then compare this data to theoretical data obtained from computer modeling done in a modeling program called WIPL-D. Once this data is analyzed, we will create an antenna model for an 87' patrol boat using WIPL-D.

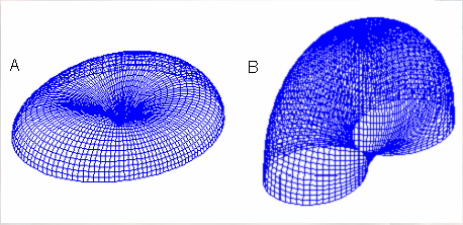


WPB-110' Cutter Model in WIPL-D

Project Deliverables

The project deliverables include:

- Install a NVIS antenna on a 110' cutter.
- Compare theoretical results obtained from the computer modeling programs GNEC and WIPL-D to actual data obtained from testing the antenna on a 110' cutter.
- Create a NVIS antenna model using WIPL-D for 87' coastal patrol boats.



Pattern A is the radiation pattern produced by a whip antenna where Pattern B is the radiation pattern made by a towel bar antenna. As can be seen the Vertical radiation of the towel bar antenna is much greater then that of the whip antenna, thus producing a higher take off angle. WIPL-D