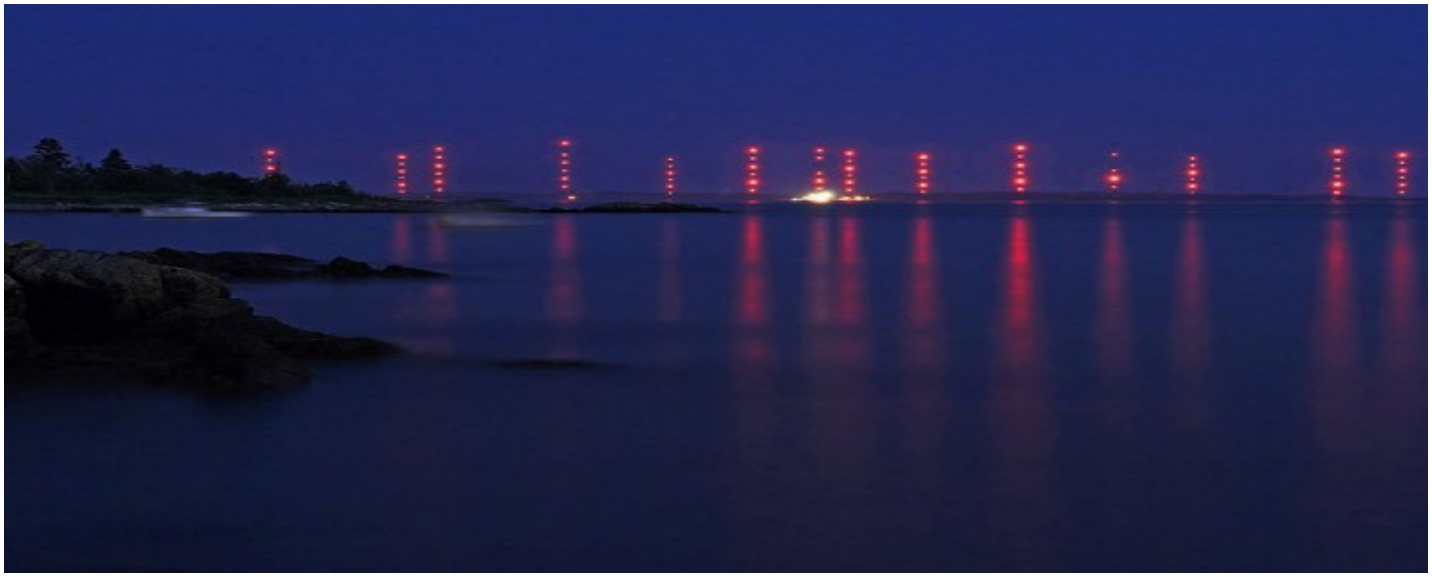
THE BIGGEST LITTLE ANTENNA IN THE WORLD



The Navy's VLF antenna at Cutler Maine

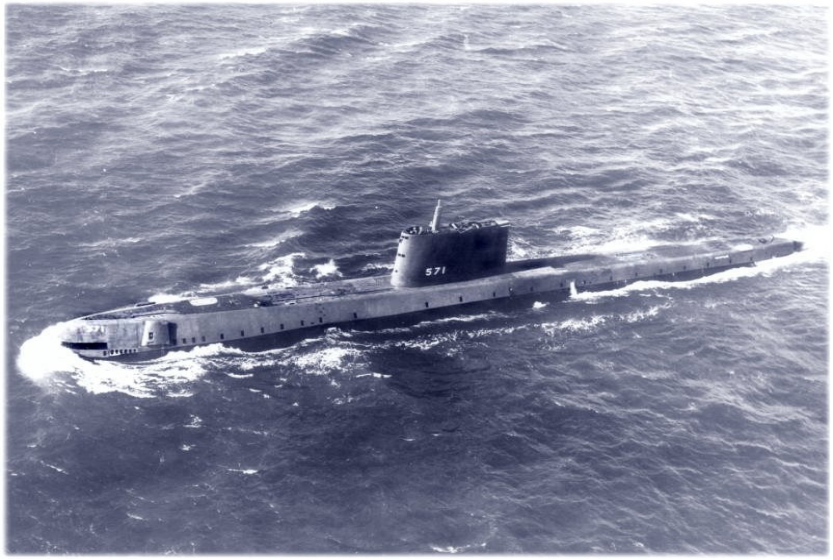
CUTLER VLF ANTENNA

- Why A VLF Antenna
- VLF Design Issues
- Antenna Structure
  - Types Of Antennas
  - Trideco Design At Cutler, Me.
  - Towers and Top Load
- Tuning Network
- Ground System
- Deicing
- Transmitter

WHY A VLF SYSTEM?

- With the creation of ballistic missile submarines it became essential to maintain communications
- To avoid detection, nuclear submarines must remain submerged
- VLF provided penetration of seawater 30 to 100 feet because of the very long wavelength
- Very low loss propagation (2 dB/1000 Km)

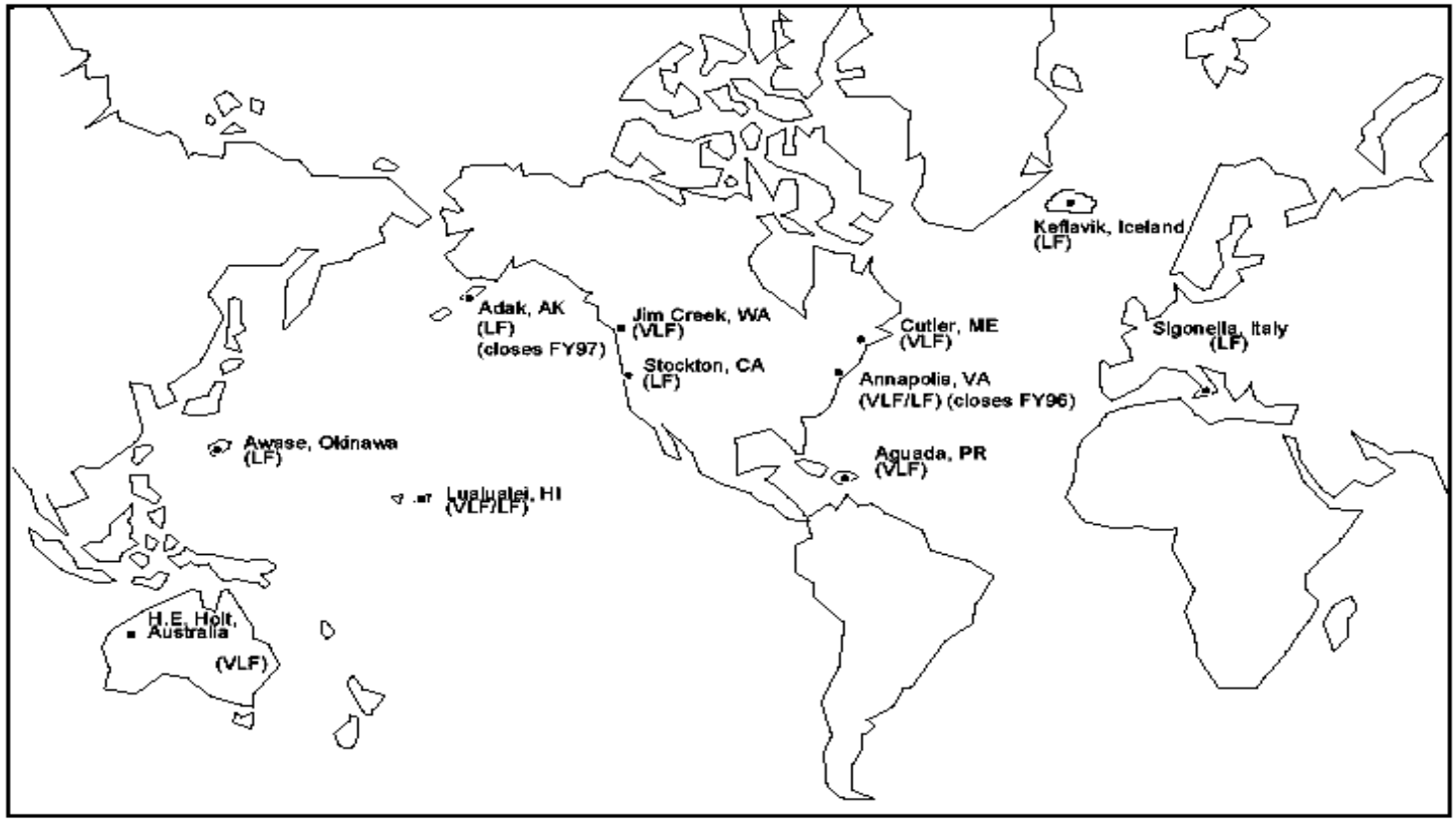
BALLISTIC MISSILE SUBMARINES



- USS NAUTILUS
- FIRST NUCLEAR-POWERED SUB
- COMMISSIONED 1954
- OPEPRATE SUBMERGED FOR MONTHS

- USS GEORGE WASHINGTON
- FIRST BALLISTIC MISSILE SUB
- 16 POLARIS MISSILES
- COMMISSIONED DEC 1959

US NAVY VLF COMMUNICATION SYSTEM



Very Low Frequency/Low Frequency Site Locations

VLF ANTENNA SYSTEM REQUIREMENTS

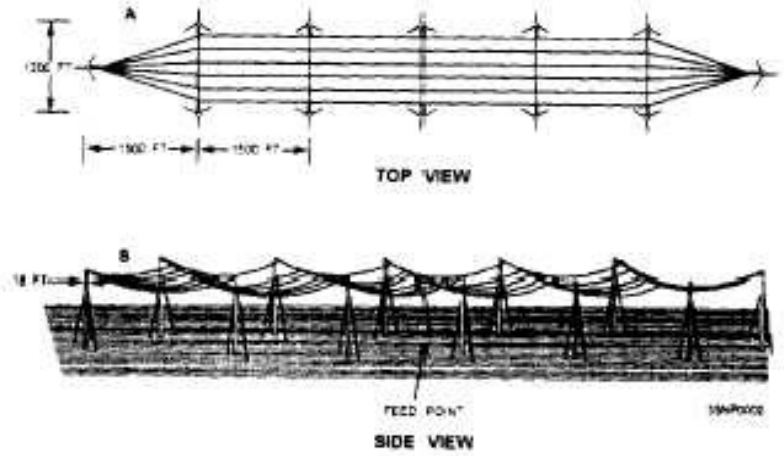
- Tunable 14-28 KHz
- Radiated Power 1 MW Guaranteed
- Efficiency >50% ($500K Penalty)
- Operational Conditions Include 3 In Ice and 175 MPH Winds
- Redundant For Reliability And Maintenance

VERTICAL ANTENNA COMPARISON

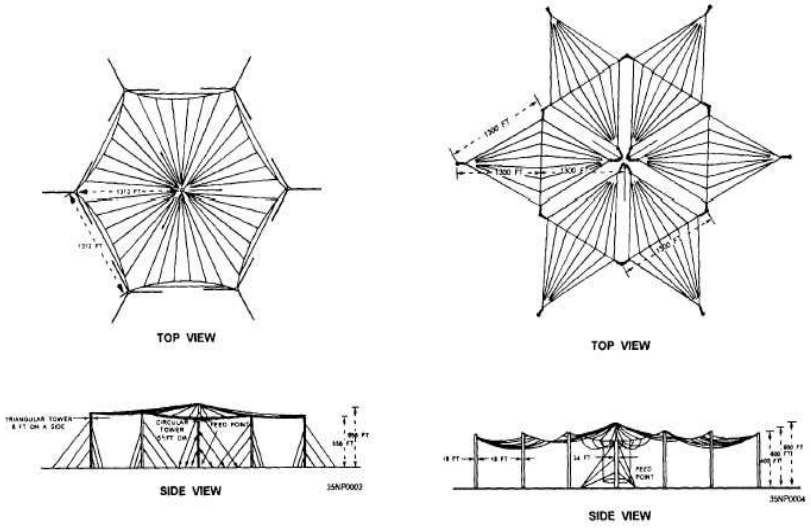
- 1.8 MHz (160m) ¼ Wave 131 ft
- .18 MHz (1600m) ¼ Wave 1310 ft
- 18 KHz (16000m) ¼ Wave 13,100 ft

- Impractical for land-based antenna
- Some airborne command posts used trailing wire

ANTENNA CONFIGURATIONS



TRIATIC TOP LOADING



TRIDECO TOP LOADING

EXAMPLE OF TRIATIC

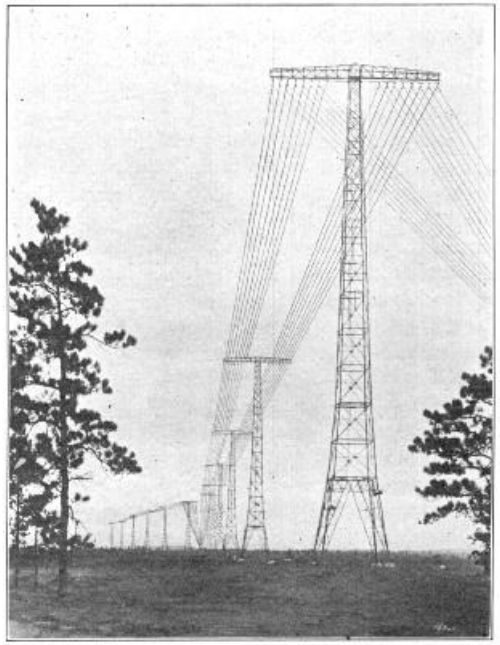
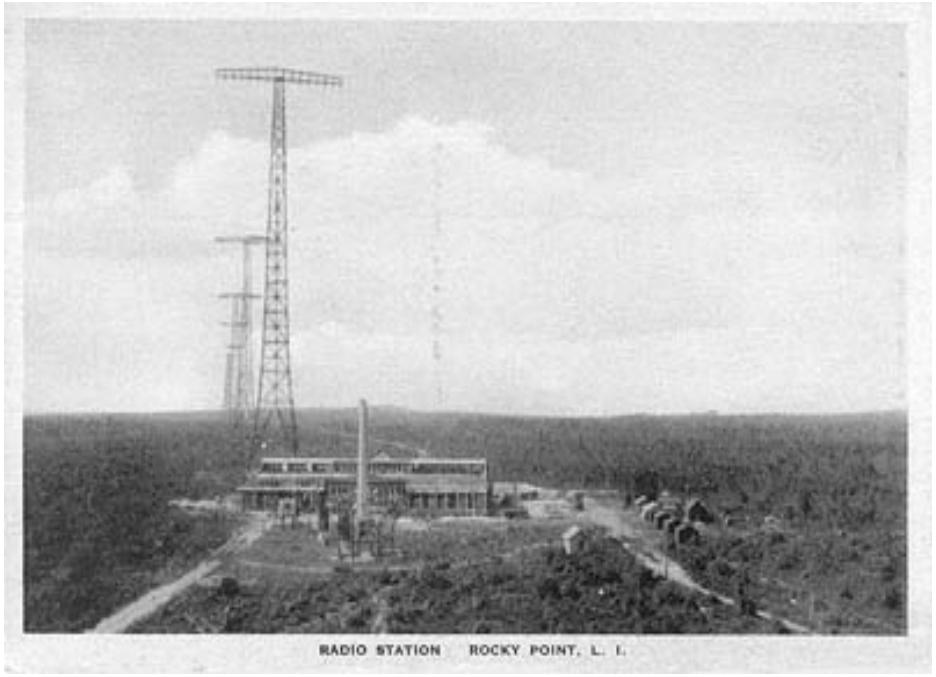


FIG. 172.—Two of the immense antennæ at Radio Central.



RADIO CENTRAL USED A SET OF TRIATIC ANTENNAS

TRIDECO ANTENNA SIZE

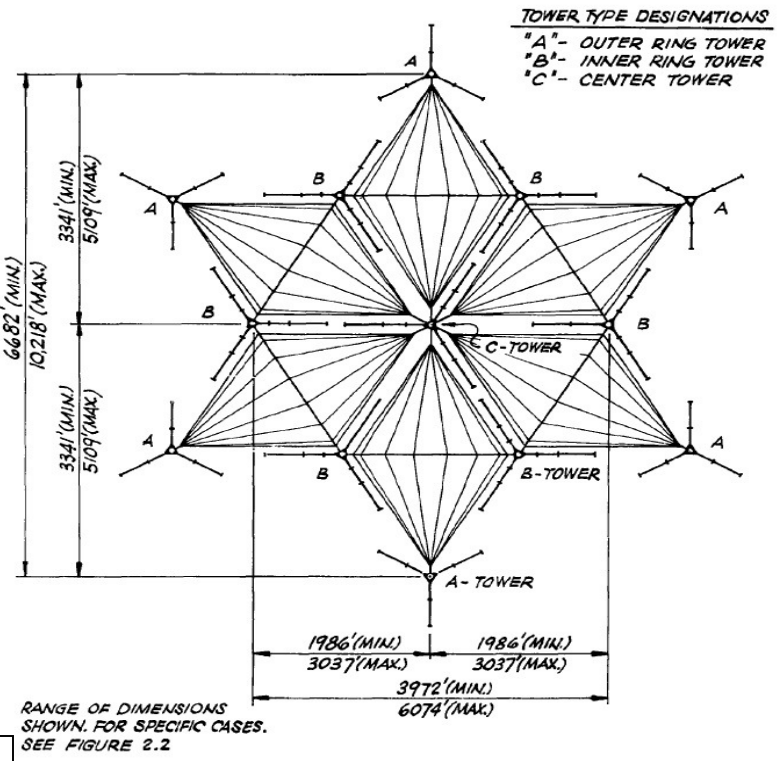


FIG. 2-1 LAYOUT OF ANTENNA ARRAY

Approx. 1000 Acres

TWO MONOPOLES OCCUPY 2000 ACRES ON A PENNINSULA

- DUAL TRANSMITTER
- HELIX HOUSE CONTAINS TUNER
- TRIDECO TOP LOAD USES 6 PANELS FOR EACH MONOPOLE

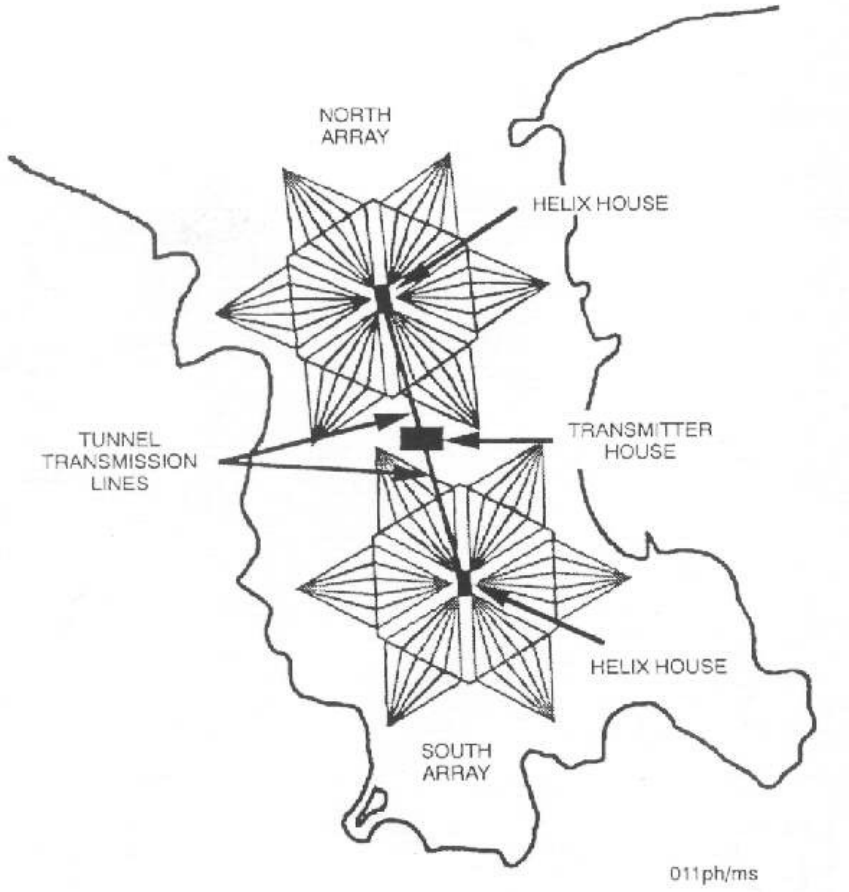


Figure 1. VLF Cutler.

OVERVIEW OF ANTENNA CONFIGURATION

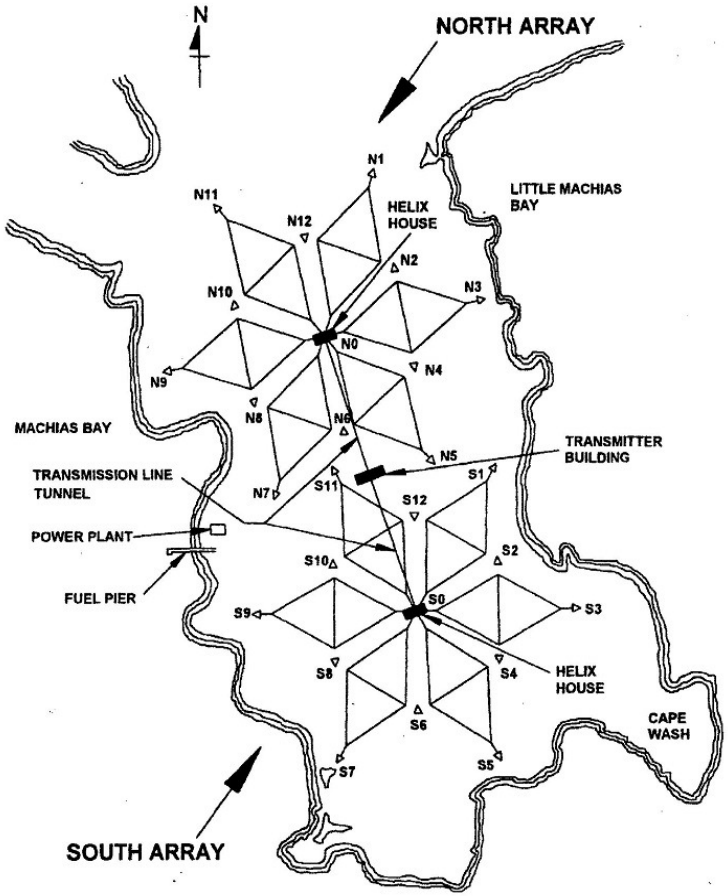
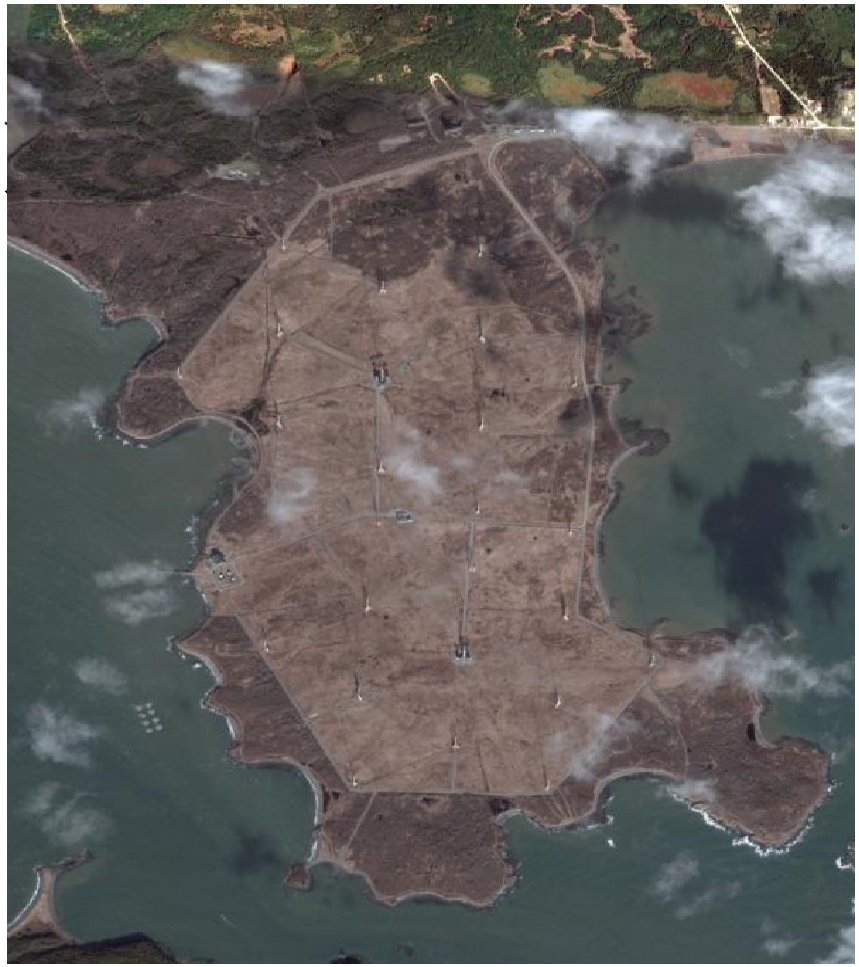


Figure 1. General layout, Cutler Peninsula.



SATELLITE IMAGES

Power Plant 18 MW

Main Tower And Helix House

ANTENNA DESIGN PARAMETERS

Table ES-1. South array antenna measurement results.

	Six-Panel Mode	Four-Panel Mode
Antenna effective height (m)	140.1 ± 2.8	130.4 ± 2.6
Antenna self resonance (kHz)	40.2	40.0
Antenna static capacitance (nF)	123.9	90.1
Gross resistance (ohms) measured at full power	0.2649	0.2675
Radiation resistance (ohms)	0.1984 ± 0.0077	0.1719 ± 0.0068
Antenna base reactance (ohms)	-j 35.4	-j 50.2
Antenna bandwidth (Hz) measured at low power	137.5	100
Antenna radiation efficiency (%)	74.9 %	64.3 %
Base voltage (kV)	65.5	99.7
Base current (A)	1850	1987
Radiated power (kW)	679	679

EACH ANTENNA CONSISTS OF 13 TOWERS

Towers are 900 to 1000 feet high

TOPLOAD PANEL CONSTRUCTION

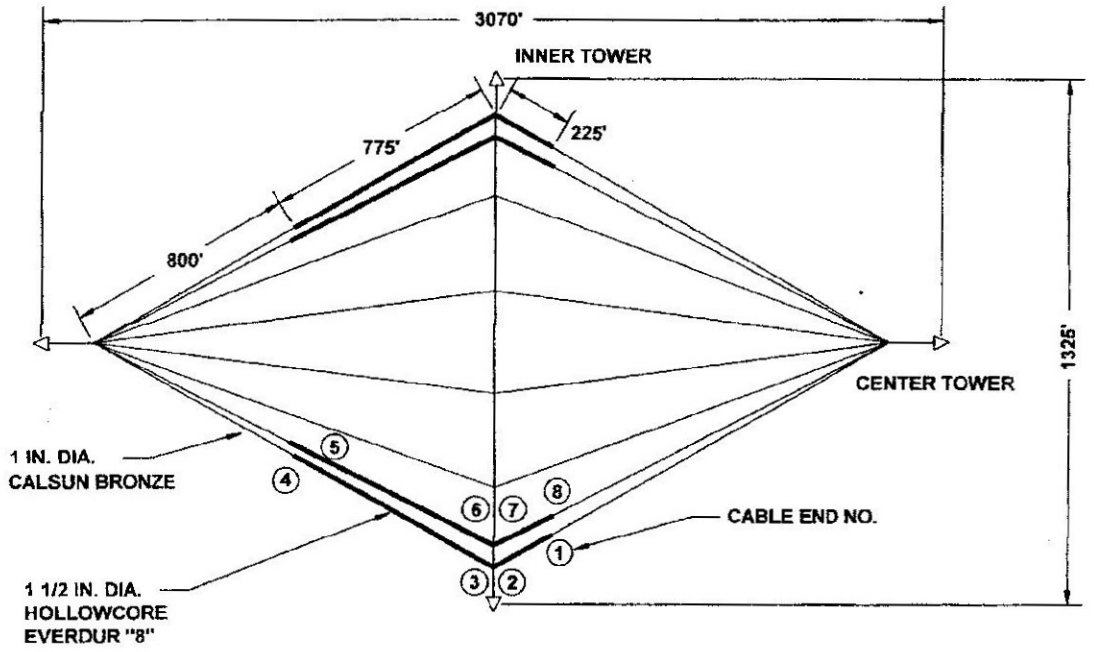


Figure 2. Plan view of a typical panel in VLF antenna array.

78000 FEET OF CABLE – 1000000 POUNDS, NOT INCLUDING ICE

TOPLOAD COUNTERWEIGHT SYSTEM

TOPLOAD COUNTERWEIGHT SYSTEM

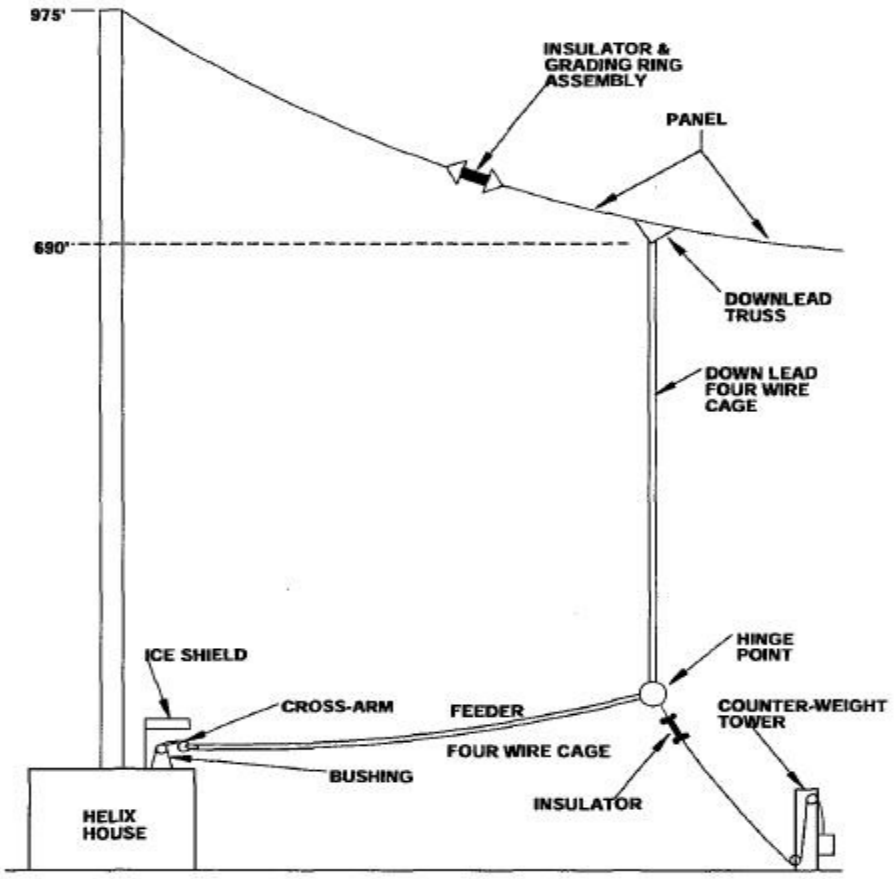
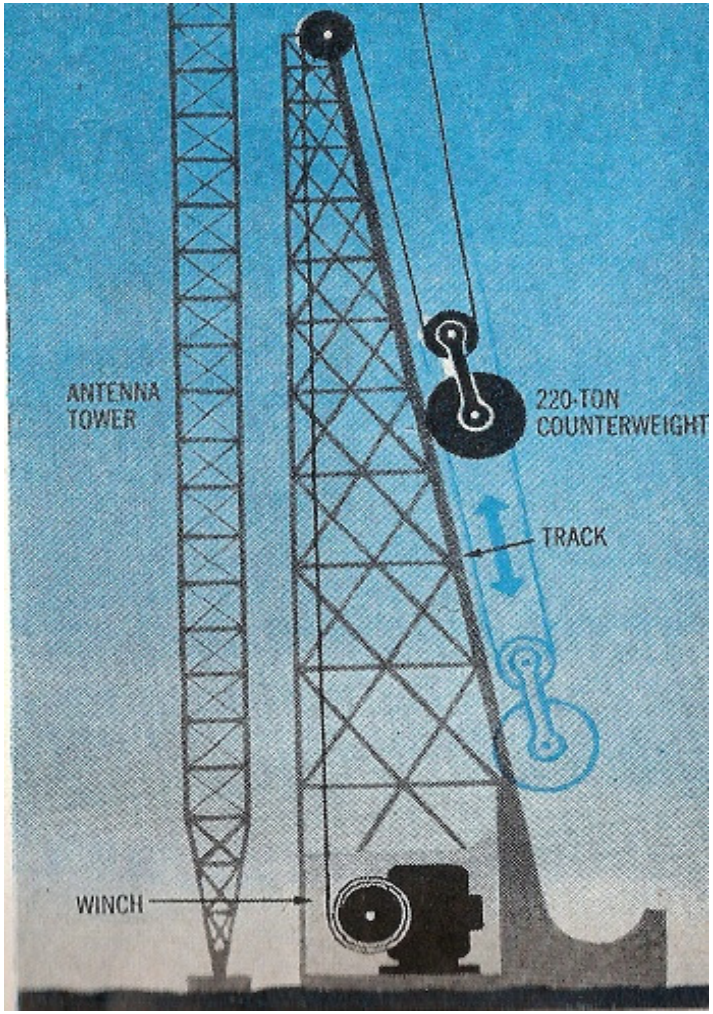


Figure 3. VLF Cutler feed-cage and counterweight configuration.

TOPLOAD COUNTERWEIGHT SYSTEM

- Counterweights
  Weight 220 Tons
- Panels Can Move With
  Wind And Ice Load
- Panels Can Be Lowered
  For Maintenance

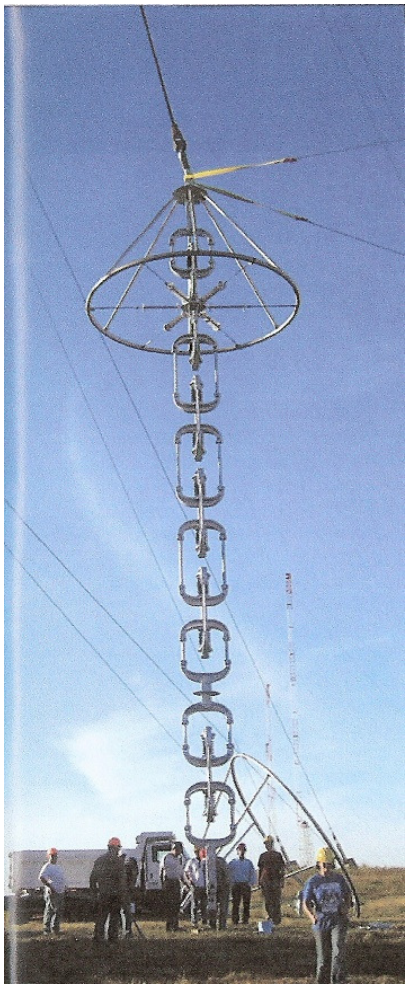


TOPLOAD COUNTERWEIGHT SYSTEM

Concrete Filled Wheel

TUNING NETWORK- HELIX HOUSE

EACH INSULATOR IS 30 FT LONG TO WITHSTAND 250 KV



TOPLOAD DEICING

DEICING POWER

- Deice One Antenna At A Time
- 1.6 W/Sq In =7.5 Megawatts To Deice
- Diesel Generators Provide 18 Mw

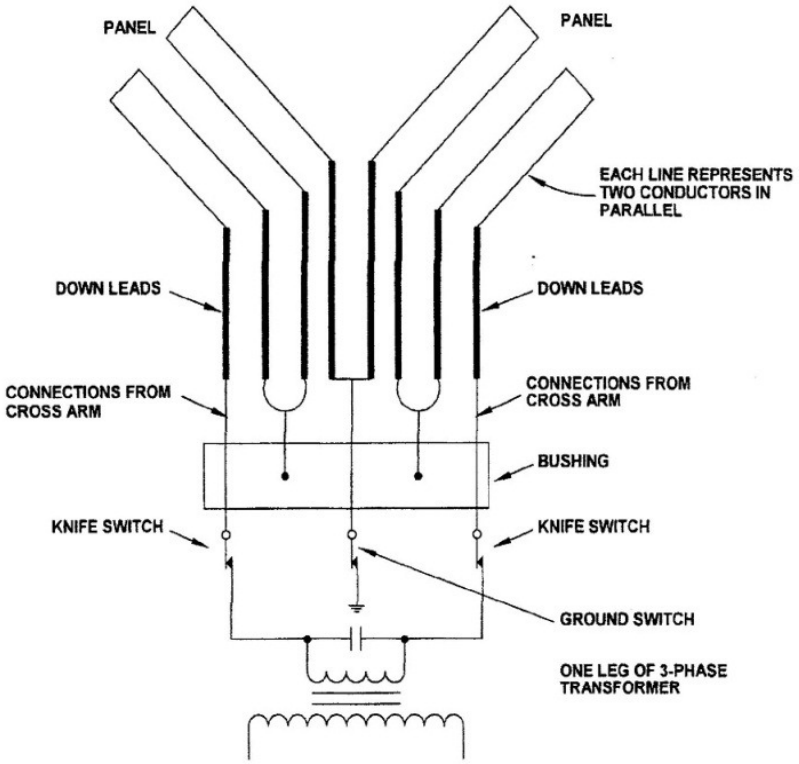


Figure 7. Simplified schematic diagram of one division in deicing mode.

TUNING NETWORK

-HANDLE 250 KV AND 1200 AMPS

-VERY LOW LOSS <0.1 OHM

-TUNE ANTENNA OVER 14-28 KHZ

-

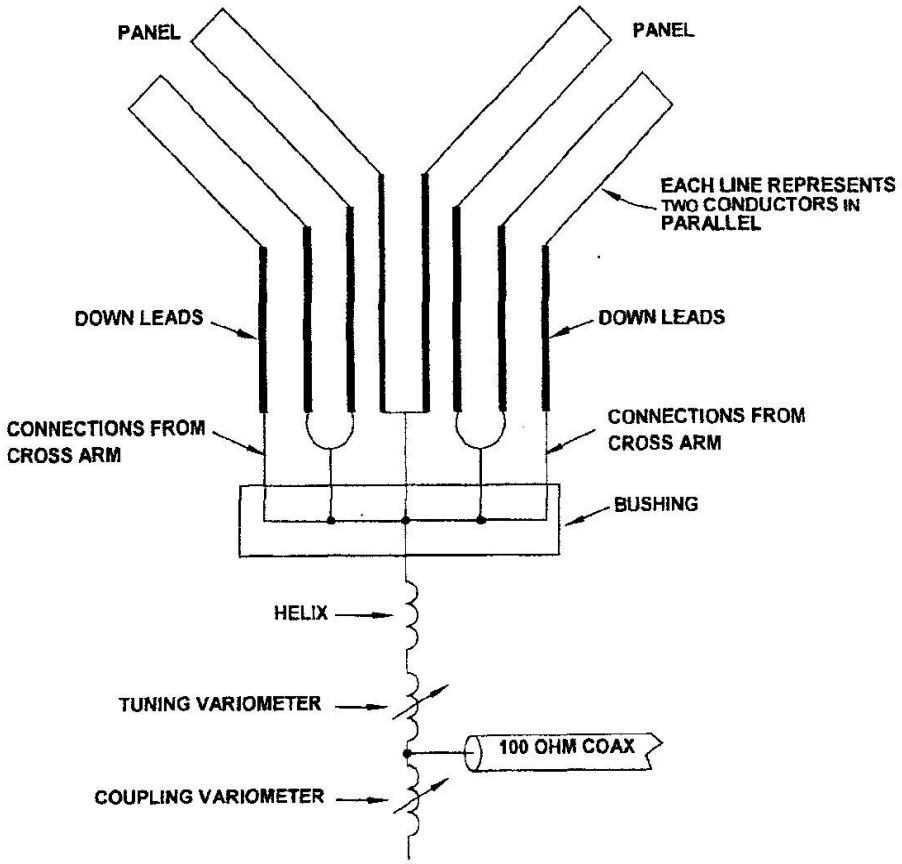
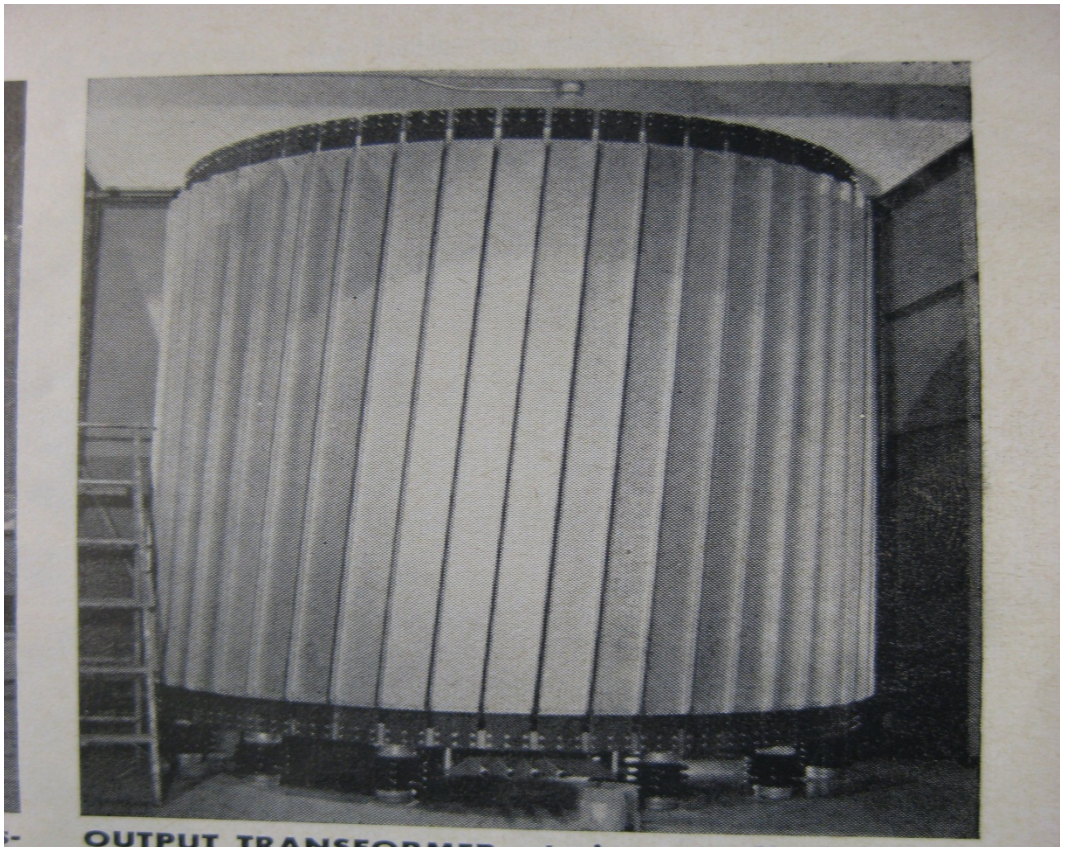


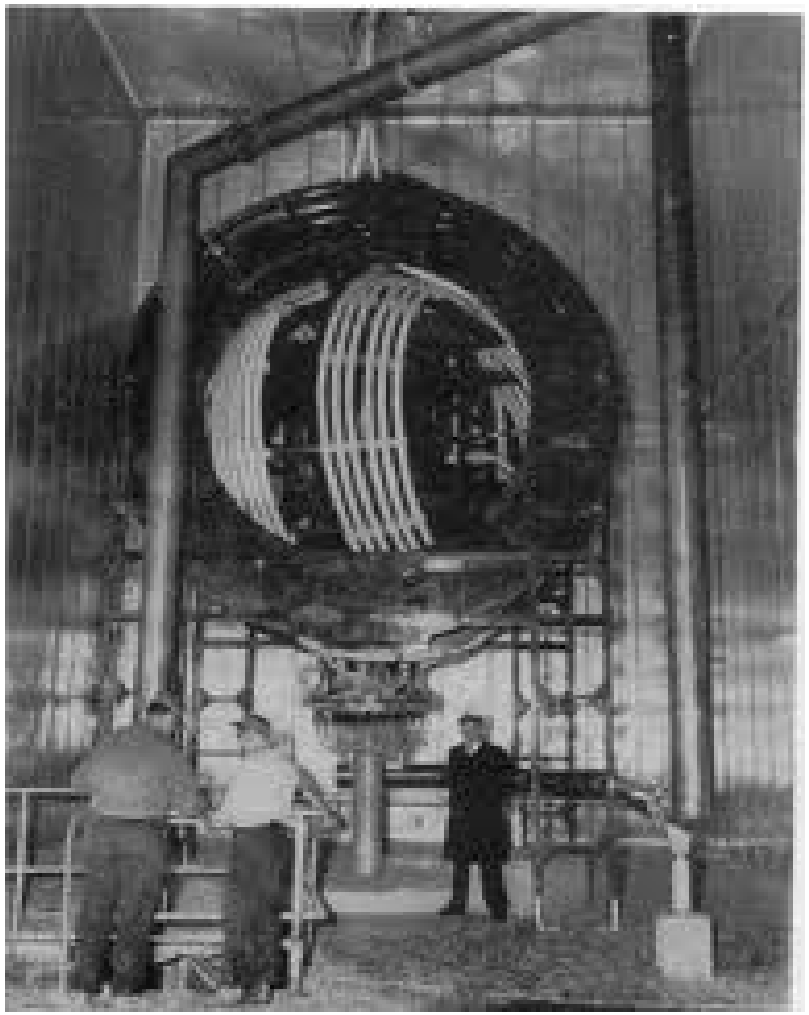
Figure 8. Simplified schematic diagram of one division in transmit mode.

TUNING NETWORK- COMPONENTS



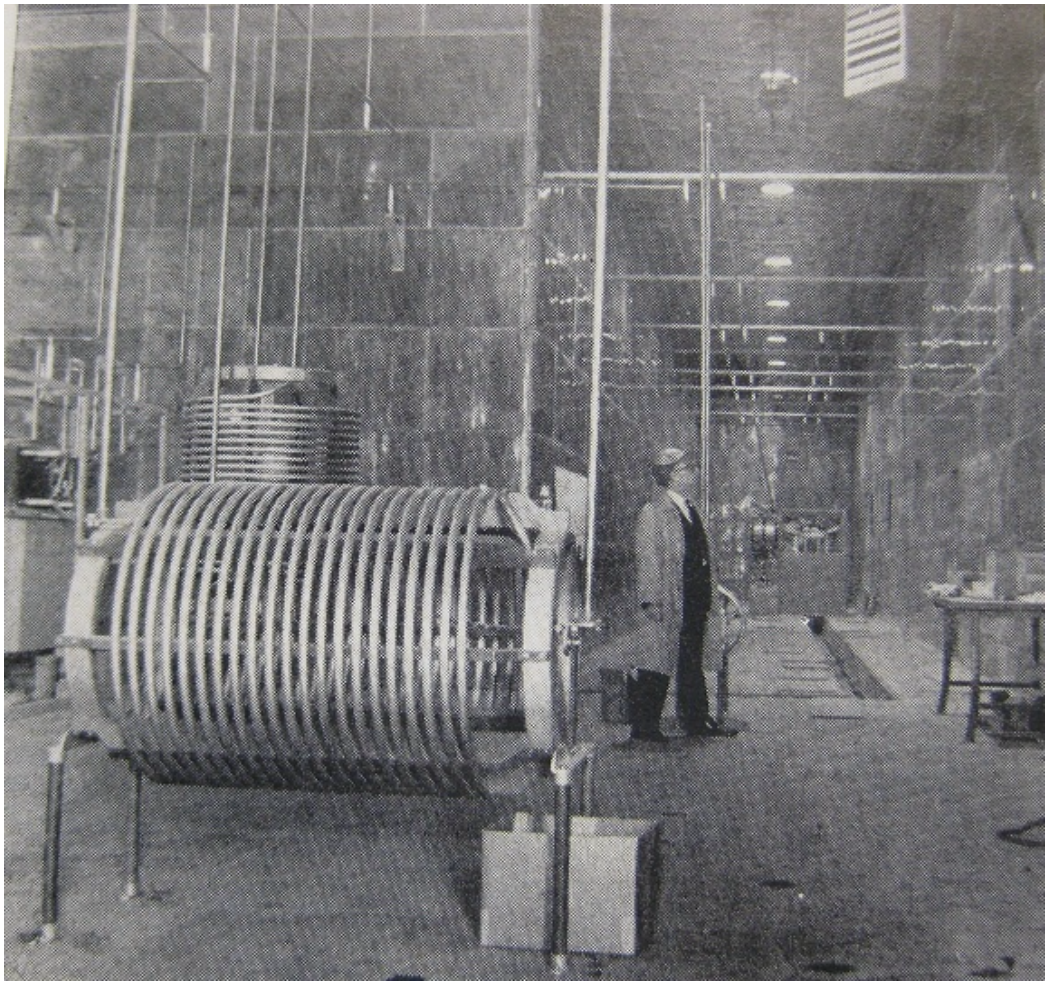
OUTPUT TRANSFORMER—twice as tall as a man —typifies over-size equipment. It is new "toroid" type with slanting copper strips corresponding to the coils of an ordinary transformer.

TUNING NETWORK-VARIOMETER



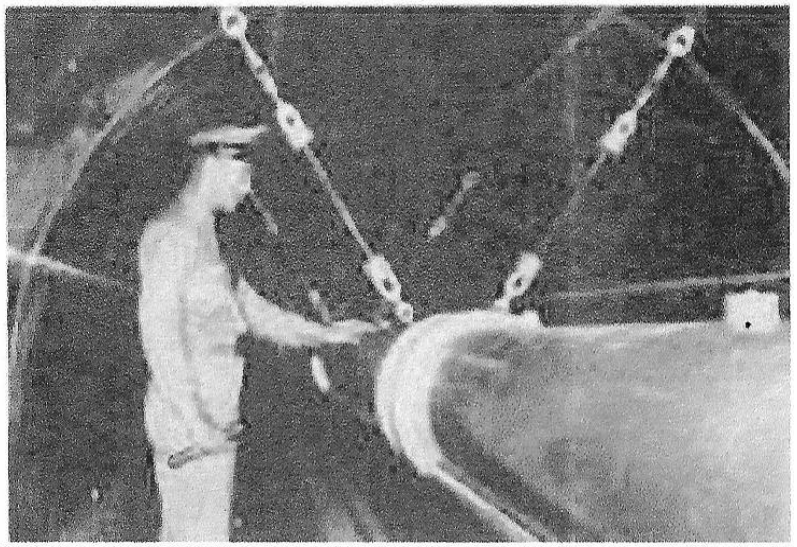
TUNING NETWORK-LITZ WIRE

TUNING NETWORK –COMPONENTS



COAXIAL FEED LINE-
TRANSMITTER TO HELIX HOUSE

- 100 Ohm Feedline From Transmitter To Helix House
- 1mw Power Capacity
- 100 KV Volts
- 2000 Amps



"Ever see a man standing inside a coax matching section? Chief Electronic Technician Swan, who is in charge of all maintenance at NAA, stands inside the copper-lined concrete tunnel mentioned in the text."

RADIO CENTRAL TUNING NETWORK

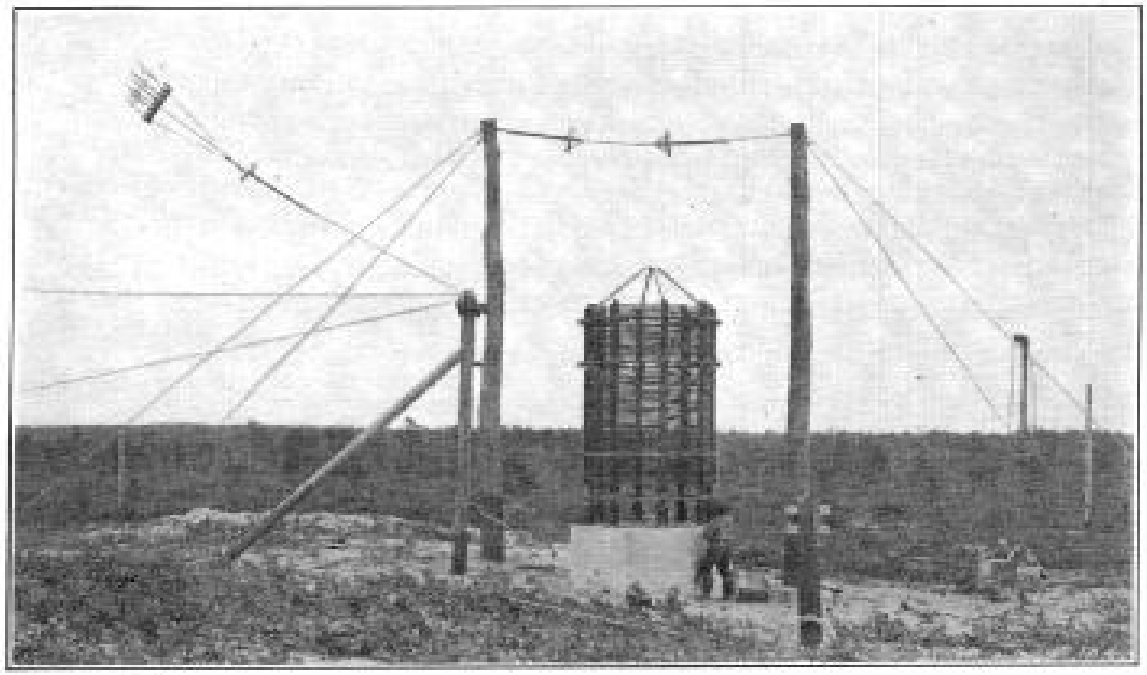
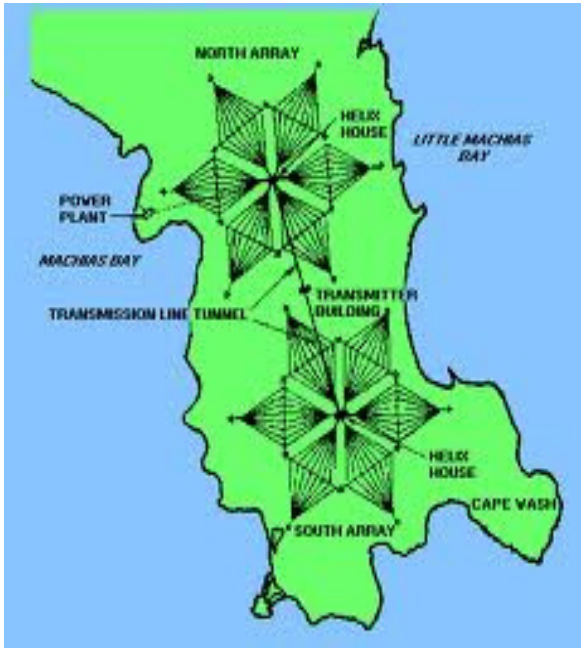


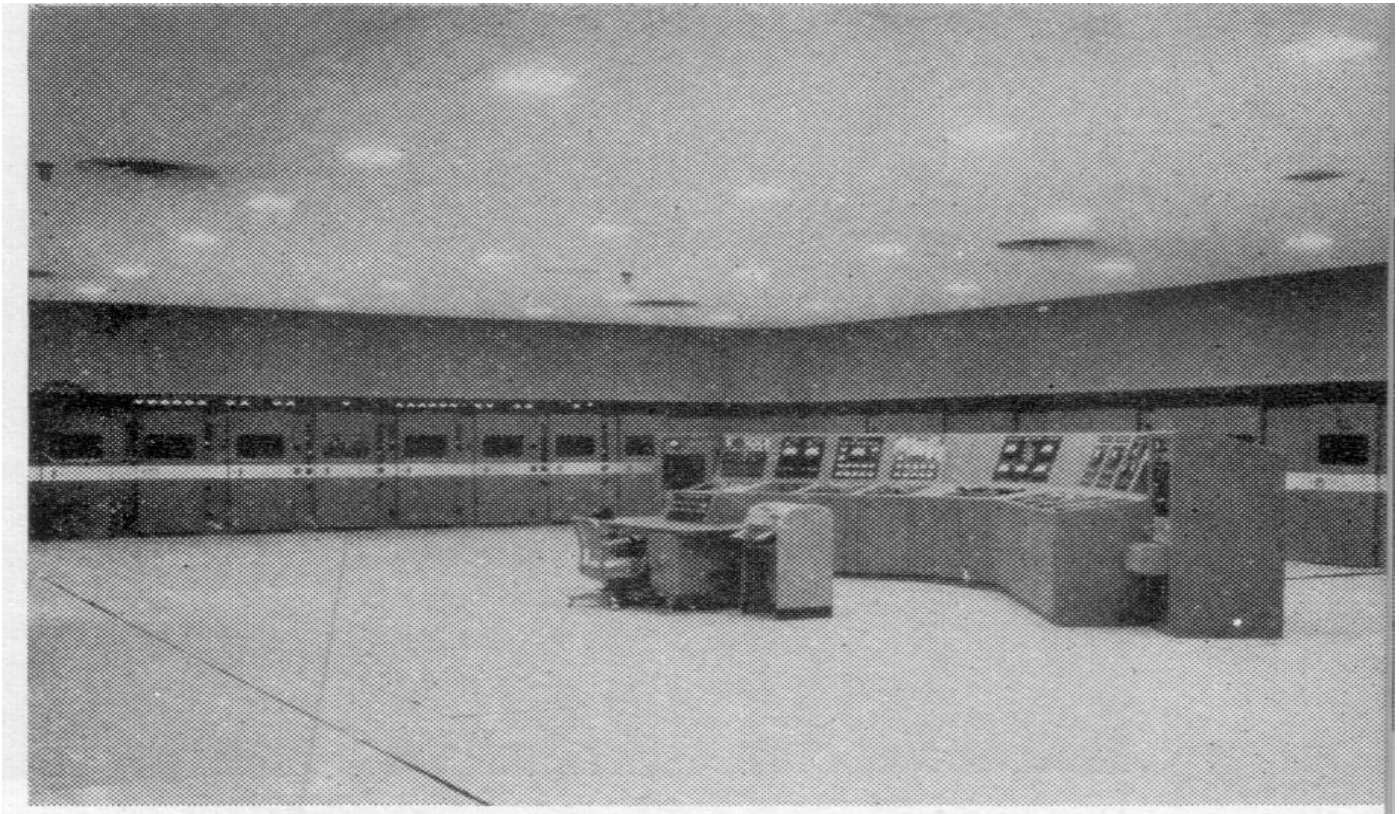
FIG. 174.—An immense transmitting tuning coil at Radio Central. Note the size, compared with the man standing at its base.

GROUND SYSTEM



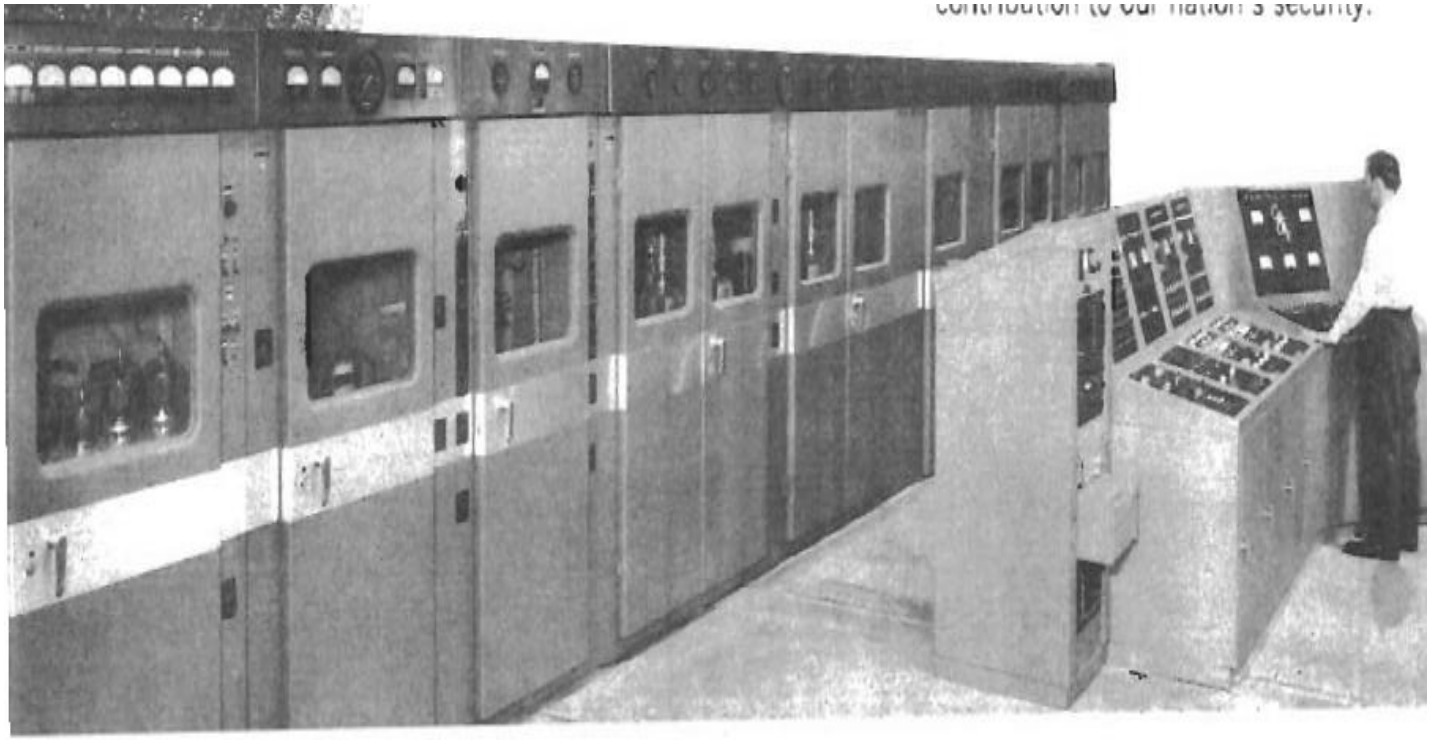
2000 Miles of #6 Copper Wire Cover the Peninsula and Run Into the Sea

DUAL TRANSMITTERS 1MW EACH



This is the control console for a two-megawatt transmitter. Driver stages and final amplifiers along the rear walls, with the "guts" of the units well-protected against accidental access.

TRANSMITTERS



RADIO CENTRAL TRANSMITTER

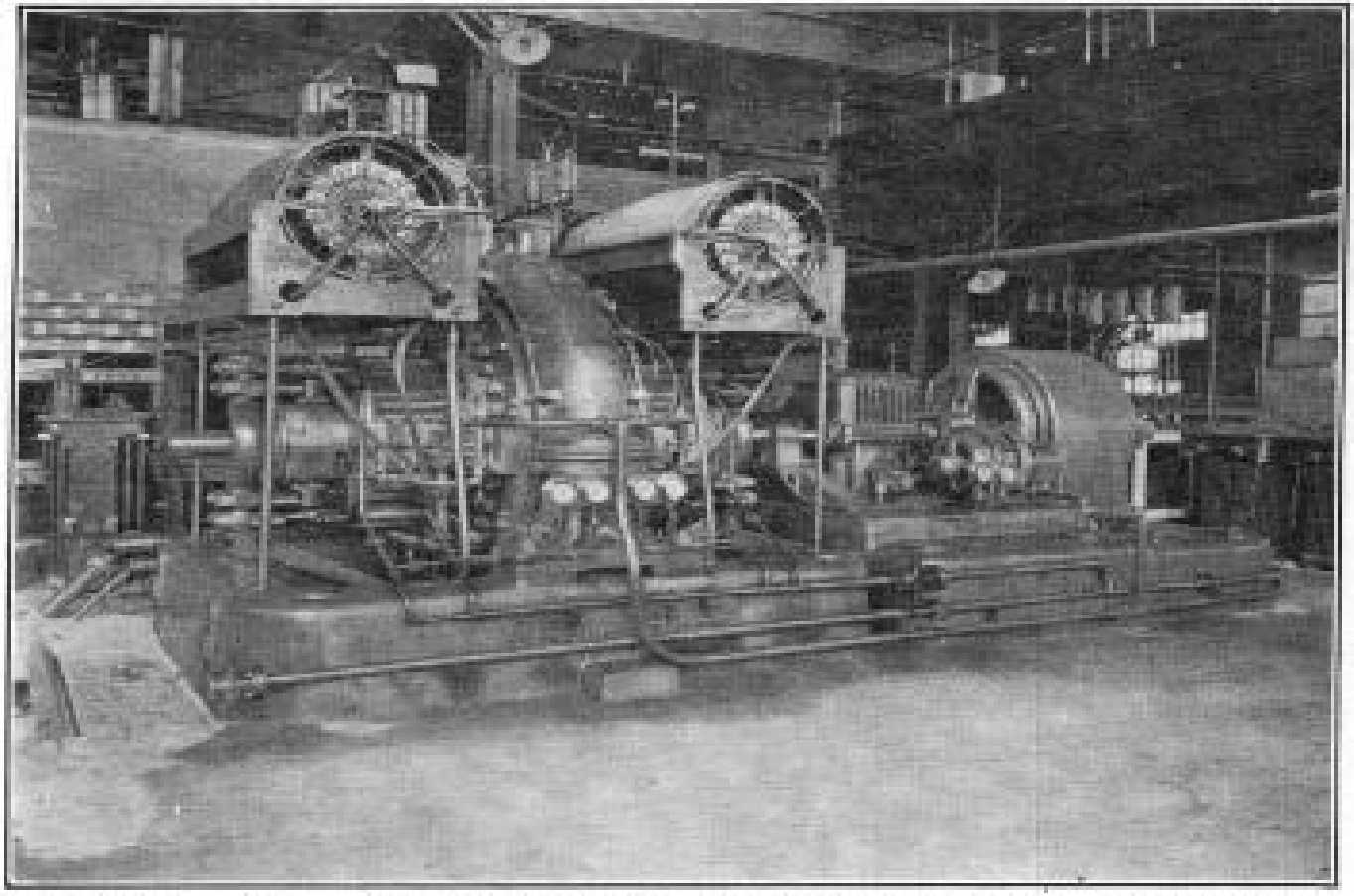


FIG. 173.—An Alexanderson high-frequency Alternator, capable of putting 700 amperes of high-frequency current into the antenna.