GOMEL, BELARUS

KUDZIN V.P., ASTAHOV P.V.

ANTENNA ELEMENTS AND ARRAYS FOR OVER-THE-HORIZON RADARS
RADAR’S TYPES

• SKY WAVE OVER-THE-HORIZON RADARS (OTHR)
• SURFACE WAVE OVER-THE-HORIZON RADARS (OTHRSW)
SKY WAVE OVER-THE-HORIZON RADARS

Diagram showing the propagation of radar signals over the horizon, including terms such as $R_{l_{\text{max}}}$, $R_T$, $R_R$, $R_{\text{footprint}}$, $R_{\text{interception}}$, Ionosphere, OTHR antennas, Earth, Line-of-sight, and Target.
SKY WAVE OVER-THE-HORIZON RADARS. TECHNICAL REQUIREMENTS

- Operating frequency range: 3 – 30 МГц
- Polarization: horizontal (vertical)
- Sector survey in the azimuth plane: 60 – 90 deg
- Beamwidth in the azimuth plane:
  - Transmitting antenna: 20 – 90 deg
  - Receiving antenna: 2 – 20 deg
- Radiated power: 10 – 300 kW
SURFACE WAVE OVER-THE-HORIZON RADARS.

TECHNICAL REQUIREMENTS

- Operating frequency range 4 – 15 МГц
- Polarization vertical
- Sector survey in the azimuth plane 60 – 90 deg
- Beamwidth in the azimuth plane
  - transmitting antenna 20 –90 deg
  - receiving antenna 2 – 20 deg
- Radiated power 10 – 100 kW
BROADBAND DIPOLES

a) cylindrical dipole
b) biconical dipole
c) conical monopole
TRAVELING WAVE ANTENNAS

a) rhombic
b) triangular
c) folded dipole
d) helical
FREQUENCY INDEPENDENT ANTENNAS

Log-periodic dipole antenna

\[ \tau = \frac{x_{n+1}}{x_n} = \frac{x_{n+1}}{x_n} \]

\[ \alpha = \tan^{-1} \left( \frac{l_n}{x_n} \right) \]
FREQUENCY INDEPENDENT ANTENNAS

Log-periodic dipole antenna
FREQUENCY INDEPENDENT ANTENNAS

Log-periodic dipole antenna
(TCI company)
FREQUENCY INDEPENDENT ANTENNAS

Log-periodic dipole antenna (TCI company)
FREQUENCY INDEPENDENT ANTENNAS

Log-periodic zigzag antenna

\[ \tau = \frac{R_n}{R_{n+2}} \]
\[ \sqrt{\tau} = \frac{R_n}{R_{n+1}} \]
\[ R_{n+1} = \sqrt{R_n R_{n+2}} \]
Log-periodic zigzag antenna (TCI company)
FREQUENCY INDEPENDENT ANTENNAS

Conical log-spiral antenna
FREQUENCY INDEPENDENT ANTENNAS

Conical log-spiral antenna (TCI company)
CURRENT OTHER SYSTEMS IN USE

AUSTRALIA - Jindalee Operational Radar Network (JORN)

JORN can detect all sea and air Doppler moving targets in the area between 1,000 and 3,000 km north of the radar sites.
CURRENT OTHR SYSTEMS IN USE

AUSTRALIA - Jindalee Operational Radar Network (JORN)

Transmission Antenna Array
CURRENT OTHR SYSTEMS IN USE
AUSTRALIA - Jindalee Operational Radar Network (JORN)

Reception Antenna Array
CURRENT OTHR SYSTEMS IN USE

CANADA- High-Frequency Surface Wave Radar (HFSWR)

SWR-503:
frequency 3.5 - 5.5 MHz
distance 400 km

SWR-610:
frequency 6 - 10 MHz
distance 330 km

Reception Antenna Array
CURRENT OTHR SYSTEMS IN USE

FRANCE – Nostradamus (Onera)
CURRENT OTHR SYSTEMS IN USE

FRANCE – Nostradamus (Onera)
CURRENT OTHR SYSTEMS IN USE

FRANCE – Nostradamus (Onera)

100 km west of Paris

3 MHz < f < 30 MHz
288 elements
800 km < R < 3000 km
0° < \( \varphi \) < 360°
0° < \( \alpha \) < 90°

smart matching system
CURRENT OTHR SYSTEMS IN USE

FRANCE – Nostradamus (Onera)
CURRENT OTHR SYSTEMS IN USE

USSR – DUGA

1st: Belarus
2nd: Komosomolsk-na-Amure
3rd: Nikolayev
4th: Nakhoda
CURRENT OTHR SYSTEMS IN USE

USSR – DUGA

H = 150 m

H = 90 m
CURRENT OTHR SYSTEMS IN USE

USSR – DUGA
CURRENT OTHR SYSTEMS IN USE
RUSSIA – PODSOLNUKH-E
Thank you for your attention