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MATHEMATICAL REGULATIONS OF THE RADIOLOCATION DETECTION PROCESS OF AERIAL TARGETS

The optimal detection of electromagnetic signals is based on exceeding the level (magnitude or intensity) of the received useful signal I_{sig} above the obstacle level I_{in} that act on the input of the receiving device [1-4]. Therefore the following condition should be fulfilled:

$$I_{sig} \geq \delta \cdot I_{in} \qquad (1)$$

where δ - recognition coefficient, a dimensionless quantity determined as a result of signal processing in the receiving device of a radar station (RAL).

Electromagnetic wave intensity decreases during propagating in space due to the wave front expansion and volume attenuation. Its value is determined by the volume attenuation coefficient β. This coefficient value depends on the frequency of electromagnetic oscillations propagating in space and is determined empirically.

The reflected electromagnetic wave propagating in the reverse direction will be attenuated by wavefront broadening and bulk attenuation. The value of its intensity will decrease in proportion to the square of the current distance, expressed in meters $(4\pi D)^2$ and in km $10^{-0,1\cdot\beta D_{km}}$.

Taking into account the above the intensity of reflected electromagnetic wave from the target will take the following form:

$$\frac{P_i \cdot K_{str} \cdot 2\pi \cdot R_e^2}{(4\pi D)^4} \cdot 10^{-0,2\cdot\beta\cdot D_{km}} \geq \delta \cdot \frac{P_{rec}}{Kstr}. \qquad (2)$$

After transformations we finally get:

$$20 \cdot \lg D + \beta D_{km} + K \leq$$
$$\leq \frac{1}{2}\left(10 \cdot \lg \delta + 10 \cdot \lg P_{rec} - 20 \cdot \lg K_{str} - 10 \cdot \lg P_i - 20 \cdot \lg R_e\right), \qquad (3)$$

where, $K \approx 10,98$ dB.

Expression (3) is commonly called a non-strict inequality of the radar range. There are six terms in its right part expressing values of the main technical characteristics of the radar in decibel form: recognition coefficient δ, sensitivity of the receiving device P_{rec}, amplifying coefficient of the radar antenna - K_{str}, radiation power P_i and main parameter of the irradiated radar target - radius of the equivalent reflecting surface R_e.

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