RADAR HORIZON / LINE OF SIGHT

There are limits to the reach of radar signals. At the frequencies normally used for radar, radio waves usually travel in a straight line. The waves may be obstructed by weather or shadowing, and interference may come from other aircraft or from reflections from ground objects (Figure 1).

As also shown in Figure 1, an aircraft may not be detected because it is below the radar line which is tangent to the earth's surface.

Some rules of thumb are:

Range (to horizon):
\[ R_{NM} = 1.23 \sqrt{h_{radar}} \quad \text{with } h \text{ in ft} \]

Range (beyond horizon / over earth curvature):
\[ R_{NM} = 1.23 \left( \sqrt{h_{radar}} + \sqrt{h_{target}} \right) \quad \text{with } h \text{ in ft} \]

In obtaining the radar horizon equations, it is common practice to assume a value for the Earth's radius that is 4/3 times the actual radius. This is done to account for the effect of the atmosphere on radar propagation. For a true line of sight, such as used for optical search and rescue, the constant in the equations changes from 1.23 to 1.06.

A nomograph for determining maximum target range is depicted in Figure 2. Although an aircraft is shown to the left, it could just as well be a ship, with radars on a mast of height "h". Any target of height (or altitude) "H" is depicted on the right side.

See also Section 5-1 on ducting and refraction, which may increase range beyond these distances.

Figure 1. Radar Horizon and Shadowing

Figure 2. Earth Curvature Nomograph
This data was expanded in Figure 3 to consider the maximum range one aircraft can detect another aircraft using:

\[ R_{NM} = 1.23 \left( \sqrt{h_{r \text{adar}}} + \sqrt{h_{t \text{arget}}} \right) \]

(with \( h \) in feet)

It can be used for surface targets if \( H_{t \text{arget}} = 0 \). It should be noted that most aircraft radars are limited in power output, and would not detect small or surface objects at the listed ranges.

**Figure 3. Aircraft Radar vs Aircraft Target Maximum Range**

Other general rules of thumb for surface "targets/radars" are:

For Visual SAR:

\[ R_{V \text{isual}}(NM) = 1.05 \sqrt{\text{Alt in ft}} \]

For ESM:

\[ R_{E \text{SM}}(NM) = 1.5 \sqrt{\text{Alt in ft}} \]

**Figure 4. Ships Radar Horizon with Target on the Surface**

In this case "H" = 0, and the general equation becomes:

\[ R_{\text{max}}(NM) = 1.23 \sqrt{h_r} \]

Where \( h_r \) is the height of the radar in feet.