**Develop new guideline on radar reflector (reflection) properties**

**General**

* **definition of radar reflector**

Radar reflector is a RTE (radar target enhancer) device specially arranged to have the property of reflecting incident electromagnetic energy parallel to the direction of incidence to enhance the radar response.

Please note that this is the term as it stands in the original IALA Dictionary edition (1970-1989)

BARTON 1 , “Measure of the reflective strength of a target”. The E. W. Handbook of U.S. Navy defines, “A measure of the radar reflection characteristics of a target. It is equal to the power reflected back to the radar divided by power density of the wave striking the target. For most targets, the radar cross section is the area of the cross section of the sphere that would reflect the same energy back to the radar if the sphere were substituted. RCS of sphere is independent of frequency if operating in the far field region”.

SKOLNIK 2 provides the following short and concise definition, “The radar cross section of a target is the (fictional) area intercepting that amount of power which, when scattered equally in all directions, produces an echo at the radar equal to that from the target”.

* **explanation of how they work**

RTEs work by reflecting radar energy directly back to the radarantenna so that AtoN appears to be a larger target.

* theoretical calculations of RF energy return based on size and geometry
* range
* **explanation of radar cross section** (this allows radars to be directly compared when the test geometry is the same, angle of heel)

Radar cross-section (RCS) is a measure of how detectable an object is by [radar](https://en.wikipedia.org/wiki/Radar). A larger RCS indicates that an object is more easily detected.

An object reflects a limited amount of radar energy back to the source. The factors that influence this include:

* the material of which the target is made;
* the absolute size of the target;
* the relative size of the target (in relation to the [wavelength](https://en.wikipedia.org/wiki/Wavelength) of the illuminating radar);
* the [incident angle](https://en.wikipedia.org/wiki/Angle_of_incidence_(optics)) (angle at which the radar beam hits a particular portion of the target, which depends upon the shape of the target and its orientation to the radar source);
* the reflected angle (angle at which the reflected beam leaves the part of the target hit; it depends upon incident angle);
* the polarization of the transmitted and the received radiation with respect to the orientation of the target.
* examples of different types
* **explanation of the factors that affect the reflection performance**
  + **size:** As a rule, the larger an object, the stronger its radar reflection and thus the greater its RCS. Also, radar of one band may not even detect certain size objects. For example, 10 cm (S-band radar) can detect rain drops but not clouds whose droplets are too small.
  + Geometry:
  + heel angle
  + height of radar reflector
  + effect of the radar antenna height
  + effect of the radar frequency / x-s-band
  + effect of the manufacturing quality, rectangularity
  + effect of the material: Materials such as metal are strongly radar reflective and tend to produce strong signals. Wood and cloth (such as portions of planes and balloons used to be commonly made) or plastic and fibreglass are less reflective or indeed transparent to radar making them suitable for radomes. Even a very thin layer of metal can make an object strongly radar reflective. Chaff is often made from metallised plastic or glass (in a similar manner to metallised foils on food stuffs) with microscopically thin layers of metal. Also, some devices are designed to be Radar active, such as radar antennas and this will increase RCS.
  + mounting inside of a plastic buoy

RCS is a function of:

* + Position of transmitter/receiver relative to target
  + Target geometry and material composition
  + Angular orientation of target relative to transmitter/receiver
  + Frequency or wavelength, · Antenna polarisation.

**Measurement**

* introduction to measurement

• explanation of measurement in an anechoic chamber in accordance withan aproved international standard to certify the reflective properties of a radar reflector.

**Practical use of radar reflectors**

* What size of Radar Reflector is required ?
* IALA VTS Guideline 1111 suggests that a Aids to Navigation with radar reflector will be from 4 (S-band) to 10m2 (x-band) RCS (Discuss) – (table 8 on page 32)
* IMO requires small vessels to have a radar reflector compliant with ISO 8729-1 (Discuss)
* The selection of the radar reflector is affected by the ability of the buoy to support a particular type and size of reflector. (Discuss limitations / restrictions).
* Select the largest reflector that will fit on the buoy with the greatest consistency of RCS return across angless of heel deemed appropriate (+/- 10 degrees ?? ; +/- 20 degrees ??)

Collect information about the technical background

• Classify different radar reflector types, their properties and performance

• Define measurement methodsDevelop guidance on quantifying buoy characteristics to meet nautical and operational requirements and ways to verify them

A radar reflector is a passive device designed to return the incident radar pulses of electromagnetic energy back towards the source and thereby enhance the response on the radar display.

“IALA Guideline 1111 – Preparation of Operational and Technical Performance Requirements for VTS Systems” provides general information about the anticipated radar reflection of vessels with radar reflectors but does not include information about the different reflector types and their performance.

ISO 8729-1:2010 concerns passive reflectors and gives specifications for the construction, performance, testing, inspection and installation of radar reflectors. In the moment IALA has no appropriate guideline concerning this.

Develop a guideline with an overview of radar reflector types, properties, performance and measurement.