Comparing Active Radar Target Enhancers

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This article addresses performance of active radar target enhancers (RTE) as a companion piece to "Comparing Passive Radar Reflectors" in this series. As in the previous article, the multi-color analytic RCS (radar cross section) diagram is used to describe and compare performance. The tradeoff between active RTE and passive reflectors and unique features of active RTEs are discussed.

Performance

Analytic RCS diagrams for two active RTE are shown. Essentially green is very good and red means that the unit probably won't be detected. The two darker shades of green indicate larger RCS than found in most passive reflectors. A third active unit, Tideland Signal TE-70X designed for the Aids to Navigation market was omitted because of cost (over $4500).

Active vs. passive

Passive reflectors are made of flat metal plates or lenses assembled in such a way as to provide strong reflections of incoming radar pulses over as large a range of azimuth and elevation angles as possible. The size of the device as a radar target, the radar cross section (RCS) may be calculated analytically from the reflector's physical configuration. Active units are made of a receiving antenna, electronic amplifier, and transmitting antenna. These units capture an incoming radar pulse, amplify it, and transmit it back toward the radar. RCS is also used to describe the size of an active device as a radar target and RCS may be calculated analytically from the gain of the antenna and the gain of the amplifier.

The main differences between active and passive devices are listed in the table. In simple terms, the tradeoff is essentially improved magnitude and smoothness of RCS of active RTE vs. higher cost and the problems associated with electronic systems in the marine environment.

PRO	CON
Large RCS over appreciable range of aspect angles, up to 80 square meters	Higher cost, including purchase price and cost of installing wiring
Smooth variation in RCS with no isolated gaps	Possible failure, and power consumption (30 to 60 mA standby) of the electronics
Small size and light weight	Amplifier overload may decrease RCS at short range

Amplifier saturation decreases RCS

Unique to active RTE, limitations in the electronics produce an effect at short range that must be considered. As an active unit gets nearer to a radar antenna, the incoming pulse gets more powerful and the retransmitted pulse increases proportionally, keeping the effective RCS constant, but only as long as the amplifier can provide the required power. At some point as the range decreases the power required to keep the RCS constant exceeds the capability of the amplifier and the amplifier is said to saturate. That is, the incoming pulse keeps increasing but the outgoing pulse stays fixed at whatever the amplifier's limit is. With the amplifier saturated, the effective RCS decreases as the active RTE gets closer to the radar. The nominal RCS will only be achieved if the range is great enough that the amplifier does not saturate. At shorter range, the effective RCS is reduced. Since high-power radars will cause amplifier overload at greater range, the effect is more noticeable with more powerful radars. Given the power limits of the active units discussed here, one might expect a high-power commercial radar to overload them at about 6 miles and a low-power recreational radar to overload them at about 1 mile.

Amplifier overload might lead to some unexpected observations. For example, if two radars are scanning the same active unit at short ranges so that both radars cause saturation, the target will seem to be smaller to the high power radar than to the low power radar. Alternatively, if one radar is scanning an active unit and a small passive unit at the same range (but far enough apart that they are not illuminated simultaneously), it is quite possible that the small passive device looks larger than the active unit even though the active unit is distinctly better at longer range.

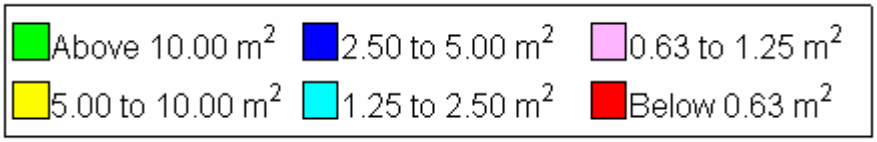
Of greater importance to the recreational sailor, amplifier saturation will probably not affect detection in good weather. If the unit is detected at long range, then, even though the RCS decreases as range decreases, the returned pulse will remain above the detection threshold and the target will be detected.

Detection in bad weather is another matter. In clear weather, the target must stand out against the background electronic noise. In bad weather, the target must also stand out against the background clutter from rain or waves. In this situation, it is possible that the effective RCS of the active unit decreases to the point that it no longer stands out against the background clutter and the target will cease to be detected at some short range.

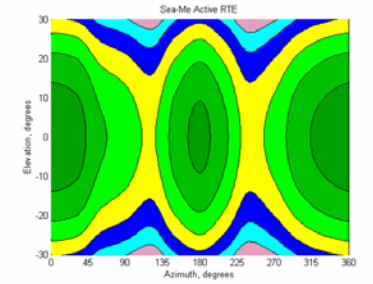
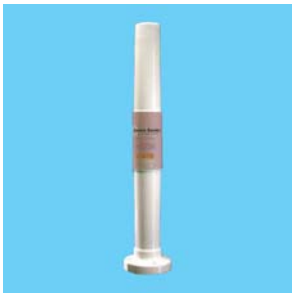
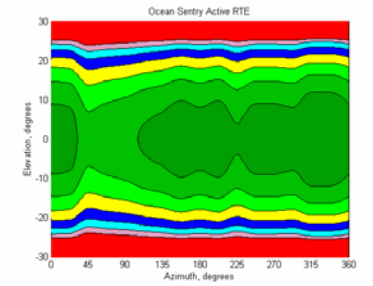
Availability of active RTE increases the number of options for improving a vessel's radar signature and makes the selection process more complicated. Each design, whether it is a passive radar reflector or active radar target enhancer provides a different balance of performance, complexity, and cost. Enough designs are available that you should be able to find something that suits your specific needs.

COMMON ACTIVE RADAR REFLECTORS
ANALYTIC RCS DIAGRAMS

RADAR CROSS SECTION LEGEND



Darker shades of green are greater than 20 m^2 and greater than 40 m^2 respectively

Unit	Analytic Diagram	Comments
		**Sea-Me** Quite a bit of very strong RCS but two azimuth regions of lower response.
		**Ocean Sentry** Very strong response to 15° tilt; good response to 25°

Beware RTE based on SART

The active units discussed above consist of a receiver, amplifier, and transmitter. They "reflect" a pulse identical to the incoming radar pulse instantaneously. Hence, the radar displays a single blip on the radar scope at the exact location of the RTE. There are units on the market that are essentially stripped down Search and Rescue Transponders (SART), and these should be avoided.. When triggered by a single radar pulse, a SART produces a series of 12 blips on the radar screen in a straight line pointing from the radar to the SART, making it very useful in search and rescue. The timing of the pulses is such that the 12 blips appear 0.64 nautical miles apart and the entire line covers about 8 miles. Now, some devices sold as RTE are simply SART units modified to produce a single blip rather than 12. The problem is that the position of the blip on the radar screen may be offset from the true position by as much as 0.64 miles. A second, much weaker pulse, is transmitted, and this may be detected at very close range, but even this pulse, if it is detected at all, may be offset as much as 150 meters. Because the vessel's position reported by these SART-based RTE devices are incorrect, they should not be used for collision avoidance applications.

References

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3. P. G. Gallman, *Can you see me now?* (effect of radar reflector mounting height), Cruising Tips, Sail Magazine, February 2007, pp 40-42.
4. P. G. Gallman, *How effective are active radar reflectors?*, Talking Back, Ocean Navigator, January/February 2007, pp 56-57
5. P. G. Gallman, *Why you should have radar*, Ocean Navigator, November/December 2007, pp 42-50.
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