why is the plural used in the opening words in Rules 16 and 17 and why does 'crossing' appear only in clause (c) of 17? Rule 13 by itself contains no instructions concerning the behaviour of give-way and stand-on vessels. That two such diametrically opposed opinions should exist about an important Rule is startling and it is to be hoped that someone will look into it.

A number of points in my original note are not mentioned by Professor Hugon, notably the ambiguities which may arise from a combination of 17(d) for the give-way ship and 8(d) for the stand-on ship acting on 17(a) (ii).

## REFERENCES

1 Wylie, F. J. (1973). Some comments on the Regulations for Preventing Collisions at Sea. This *Journal*, **26**, 365.

2 Wylie, F. J. *Choosing and Using Ship's Radar*, pp. 122, 137.

# The Extraction of Information from a Radar Display

R. J. Turner

THE comments of Captain Maybourn on collision-avoidance systems in his paper 'The Pay-off from Improved Navigational Aids' (**27**, 133) prompt me to make a number of observations. What information, *in principle*, are we able to extract from a radar display? This information will, of course, be degraded by the system errors, but that is another matter. Some of the following comments may appear trivial but it seems to me that they are of fundamental importance and escape sufficient emphasis.

First of all, what is it that the shipborne radar *measures*? It is, of course, the range and bearing of targets from the aerial, that is from own ship, and a succession of these observations measures the velocity of a target relative to own ship. It is important to remember that this is the only *measurement* made by the radar. Any other information is deduced by employing other measurements (or estimates) *not* made by the radar.

Secondly, I come to the problem of the description of a vehicle's dynamic state, that is its position, velocity and acceleration. Here we are primarily concerned with velocity and I will confine myself to that. If we wish to describe (or measure) a vehicle's velocity, we must do so relative to a stated frame of reference. It is important to remember that *all* motion is relative: not even Einstein was able to find an inertial frame of reference. The marine industry has an unfortunate tendency to acquire, and subsequently to refuse to relinquish, inappropriate jargon. I deprecate the terms 'relative display' and 'true motion display'. Firstly all displays are relative displays whether it be relative to own ship, relative to the water, or relative to the ground, and furthermore all displays are true in the sense that they represent a physical fact. The use of the term 'true

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motion display' unconsciously implies that all others are in some way false; the Department of Trade specification for a marine radar appropriately uses the terms sea-stabilization and ground-stabilization.

If we wish to convert an 'own ship stabilized display' to a sea-stabilized display, we must feed into the radar own ship's velocity relative to the water and in doing so we cannot ignore leeway: it cannot be assumed that poor visibility is always accompanied by low wind speed. Therefore the inputs need to be (i) not heading but 'wake course' and (ii) resultant water speed (engines + wind) and this can only be measured by a towed log or a two-component doppler log operating on sea returns. Single-component doppler logs, electro-magnetic logs, pressure logs and the like only measure the fore and aft component of water speed. If we do achieve a proper sea-stabilized display, the information to be obtained from it is then the velocity of a target relative to the water; with leeway this is not the direction in which it is heading and since it would be entirely fortuitous that both own ship and target are experiencing the same leeway, it is therefore apparent that heading and hence aspect *cannot* be determined. Lest it be thought that this is just academic theorizing let us consider one of the examples cited by Captain Maybourn (pp. 140, 141). Let there be a strong NW. wind blowing. Own ship A is deeply laden and experiencing no significant leeway. Target C is in ballast and making 10° leeway. For condition (a) own ship is properly sea stabilized and deduces that target C has a velocity relative to the water of 210°, 7 knots. Target C is then *heading* 220° and the aspect is R10°; had the same wind been blowing from the SE. the aspect would be G10°. But of course own ship A has no knowledge of C's leeway and cannot determine the aspect.

Captain Maybourn's condition (b) is, I think, somewhat extreme: a log reading 0·5 knot high at 5·0 knots has a 10 per cent error; this must be a system fault or operator blunder and if we begin to consider possibilities such as these the problem becomes unbounded.

If we want a ground stabilized display we feed into the radar own ship's velocity relative to the ground—as measured by a two-component doppler log on bottom returns. The information to be obtained from the display is then the target's velocity relative to the ground and *only if we assume that own ship and the target are experiencing the same leeway and tide* can we deduce target's heading and hence aspect.

Captain Maybourn's Table III illustrates the unfortunate ambiguities that generally exist over the terms 'course' and 'speed'. These ambiguities cause endless trouble to students and it is to be regretted that the new British Standard Glossary of Navigation Terms has not resolved them. In condition (a) course and speed (in the absence of wind) means 'heading' and 'water speed'. In condition (d) the same words mean 'course made good' and 'speed made good'. In conditions (b) and (c) they mean velocity relative to some frame of reference that is neither fixed in the water nor the ground and therefore of not much relevance. Furthermore, there is a column labelled 'Aspect' and since aspect is the angle between *heading* and line-of-sight, aspect is only obtained in condition (a) and then only if there is no leeway. In conditions (b), (c) and (d) 'aspect' is in fact the angle between line-of-sight and the direction of travel relative to whatever frame of reference is used. It is to be noted that all the above remarks about radar displays apply equally well to radar plots.

Captain Maybourn's conclusion that a radar should be sea stabilized for anti-collision work does not cover the situation where one is both navigating and

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avoiding collision at the same time as, for instance, when in a complex of fairways and buoyed channels.

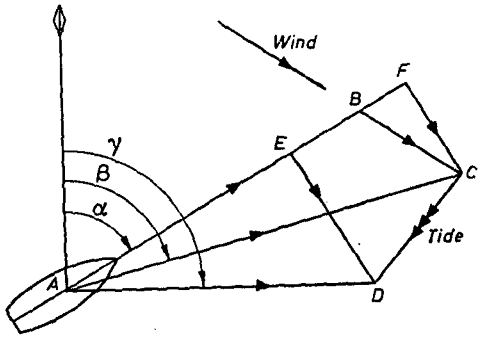


FIG. 1

Figure 1 illustrates the velocity of the ship relative to different frames of reference and also the quantities measured by the different types of log. It is apparent that technology has outstripped teaching, text-books and training. Radar plotting exercises (and for that matter chartwork exercises) and, more importantly, examination questions, usually refer to own ship's 'course' and 'speed' and require the student to deduce conclusions. In the light of today's technology this is just not good enough: the ship's velocity must be more precisely referred to a particular frame of reference and greater emphasis laid on just what can and cannot be obtained from any type of display.

# Behaviour Patterns in Encounters between Ships

## *from* Captain D. A. G. Dickens

In G. R. Spooner's interesting if not important article (27, 265), a situation was described wherein a risk of collision was created by basic non-adherence to the Rules. Firstly, the intention of the officer-of-the-watch to alter course to port was wrong, whilst that of the Master, substantially to alter course to starboard, was right. Secondly, the action of the non-burdened vessel was in error in as much as she should have stood on in anticipation of the burdened vessel making a decisive turn to starboard. The fact that at the precise moment of ordering this turn the other ship altered to port need not have necessarily prevented the burdened vessel from altering to starboard and 'taking a turn out'—a procedure adopted in many such instances as that under discussion.

Analysing the position still further, it can be said that delay was initially occasioned by the original wrong intention of the officer-of-the-watch, and subsequent correct countermand of the Master; in addition, it is possible that information gained from the radar, as to the approaching ship's distance of 3

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