Letters to the Editor

MULTI-LINE FIXES

Sir,—In a letter on this subject to this *Journal* (Vol. VI, p. 111) Mr. Proctor asks whether more multi-line fixing should be attempted in the air. By making a number of simplifying assumptions the answer to this question can be given in terms of the two quantities:

    (*a*) the chance of a blunder in the position line, *p*,

    (*b*) the ratio 'effort required to check a suspected blunder and, if necessary, to repeat the observation' to 'effort required to resolve the position line, *R*'.

If $p = 0$ all position lines are free from blunder and multi-line fixing is less economical in time than fixing from two position lines; the only gain is a small and wholly disproportionate increase in accuracy. If both *p* and *R* are sizeable, however, multi-line fixing may be of advantage.

In practice a number of alternative techniques are open to the observer when he plans his fix. He may for example:

    (1) choose two position lines, and use his D.R. position as a control against which suspicious information can be checked;

    (2) choose three position lines, using his D.R. position as in (1);

    (3) choose three position lines and ignore the influence of the D.R. position;

    (4) choose four position lines and ignore the influence of the D.R. position.

For each of these cases the average effort required to determine a fix can be calculated in terms of *p* and *R*, provided that a number of simplifying assumptions are made. One important assumption is that resolving three position lines is three times as onerous as resolving one; this assumption is likely to penalize multi-line fixes, particularly in the case of astro-navigation.

Both *p* and *R* vary with the observer, his fatigue, and the type of aid employed. In particular, *R*, which depends on the effort required to resolve a suspected blunder, would need to be measured not only in terms of time involved but also of inconvenience caused to the observer (e.g. the interruption of his normal drill). A value of $R = 5$ is chosen; this is deliberately large, an attempt being made to redress the balance in favour of multi-line fixing, which was somewhat penalized by the assumption detailed above.

With these assumptions, calculations show that it is more economic to use procedure (1) than procedure (2) unless the blunder ratio *p* exceeds 10 per cent, and more economic to use (3) rather than (4) unless *p* exceeds 7 per cent. Procedure (1) is always preferable to (3) provided that the effort required to construct the D.R. position is no greater than that required to resolve a single position line.

In view of the imponderable natures of *p* and *R*, particularly the latter, any such analysis can serve only as a rough and ready guide. Further, the small bonus arising from the slightly improved accuracy of a multi-line fix has been ignored. By adopting assumptions which are, as far as is possible, fair to both sides, it appears that two-line fixing, with the D.R. position used as a control, is the most economical of the four techniques considered, provided that the blunder ratio *p* is less than about 10 per cent.

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