TECHNICAL GUIDELINES
FOR
ELITE TRAIL ORIENTEERING

Timed control at WTOC 2004, Västerås, Sweden

IOF Trail Orienteering Commission

July 2008

Summary

The key to high quality of competition in elite international trail-O is good terrain, good maps, good planning and good controlling. This document, issued by the IOF Trail Orienteering Commission, advises on each of these elements and specifies the IOF interpretations of the rules and established practice. These guidelines apply to all IOF events in trail orienteering and are recommended as a basis for any trail-O event.

CONTENTS

1. INTRODUCTION

Trail-orienteering is one of the four disciplines of international orienteering. Originally developed from the core discipline of foot-orienteering, it is a form of the sport in which contested physical performance has been eliminated to allow participation by competitors with impaired mobility, including those requiring the use of wheelchairs. Trail orienteering competition at all levels demands skills of map reading and terrain interpretation. At advanced level the competitors' speed of decision making is also tested.

The appeal of trail orienteering has extended to able-bodied orienteers over a wide range of experience, including world champion foot orienteers, all attracted to its technical challenge. The World Trail Orienteering Championships (WTOC) are open to all-comers, irrespective of age, gender or physical ability, in which those with mobility disabilities can compete with the able-bodied on equal terms. There is also a closed 'Paralympic' class restricted to those eligible and with medically-certified IOF approval.

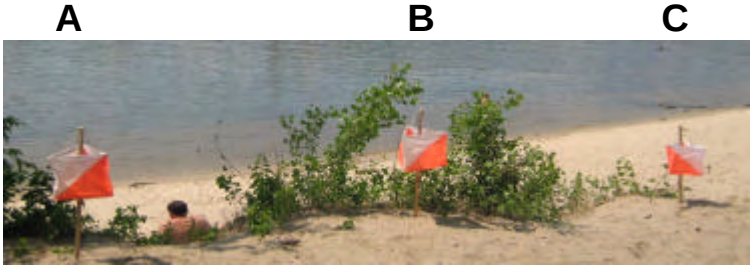
ESSENTIALS of ELITE TRAIL ORIENTEERING

In trail-O the control sites, with a number of marker flags at each site, are out of bounds to the competitors. The flags are viewed from permitted access routes, usually tracks and paths, sometimes with wheelchair-friendly deviation off-path, the limits of which are marked in the terrain.

The competitors are required at each control location to determine whether the feature at the centre of the circle on the map and defined in the control description is marked by a flag in the terrain. Between one and five flags may be used at each site. At elite level there is a sixth option, no flag at the centre of the circle, giving a zero answer.

In solving elite control problems the competitors have to demonstrate advanced understanding of the relationship between map and terrain. The only permitted technical aid is a standard orienteering compass.

In viewing the controls the competitors may move (except at timed controls) up and down the permitted tracks or marked areas off-track. The flags are identified from a decision point marked on the ground but not on the map. The coding used for recording the competitors' decisions is that the flags are referenced A to E, starting with the flag furthest to the left:



Currently the decision is recorded on a control card with six boxes for each control (A to E and zero) marked by a pin punch placed a short distance along the course from the decision point. Electronic forms of recording are being developed and IOF-licensed electronic punching systems are likely to become standard.

In addition to the main course, which has to be completed within a given overall time, there are a number of timed controls which test mental speed and accuracy. The times taken are used to distinguish between competitors who have the same number of correct controls on the main course.

ELITE TRAIL-O and ELITE FOOT-O COMPARED

The World and Regional Trail Orienteering Championships aim to be of the highest elite technical standard. This demands competitor skills of terrain recognition and map reading that are, in some respects, more advanced than those required of foot orienteers, even in world championships.

This difference exists because the elite foot orienteers spend only a few seconds matching map and ground (albeit with very great skill) before moving on, whereas the trail orienteers can spend several minutes examining each control site and, in doing so, may have to be far more precise with their interpretations than the foot orienteers.

This expansion of the time available to examine the terrain (but not at the timed controls, where speed of decision is tested) has enabled trail orienteering to evolve beyond its starting point in foot orienteering and to use additional position-fixing techniques to locate the feature at the centre of the circle. Such techniques include sighting lines and precise compass bearings.

Also, in modern cartography and map production, the control circles are drawn and printed within the map, and this results in the centres of the circles being very precisely located, so that it is no longer an essential requirement for the control to be uniquely described. This extends the range of different terrain recognition problems possible in elite trail orienteering and contributes to its being an extremely challenging and rewarding mental exercise.

The basis of successful trail orienteering competition is careful control setting. The planning of testing but fair controls at elite level is particularly difficult and often underestimated by those who have not taken part in international competition at this level. Therefore most of this document is about the practical issues of control selection and description.

Although prepared for providing technical guidance for elite trail orienteering, these guidelines can be useful at all levels as participants progress from the basic skills of introductory courses to the more precise and demanding techniques of national and international competition.

2. TERRAIN REQUIREMENTS for ELITE TRAIL-O

There are many similarities between the terrain requirements for elite events in foot orienteering and trail orienteering.

However, there are some important differences. Much more attention has to be given to the conditions of the surfaces over which the competitors are permitted to move. Also the terrain detail and visibility have more rigorous requirements.

Two questions have to be answered:

(i) Is the visible terrain suitable for Elite Trail Orienteering?

The best Trail-O terrain, visible from the tracks and permitted areas, has complex ground and contour detail, together with water and vegetation features, demanding skills of map interpretation.

Man-made features can play a part in elite Trail-O but are generally of secondary value, the best competition, as in Foot-O, being based upon natural detail.

Trying to guess from an existing Foot-O map, at 1:15000 or 1:10000 scale, whether the terrain is suitable for elite Trail-O is difficult because the Trail-O competition map, typically at 1:5000 scale, shows necessary detail which is often too fine to be on the Foot-O map.

The sprint map at 1:5000 or 1:4000 is much more useful but, even so, the terrain ***must*** be visited to make sure there are enough sites of elite standard to support the competition.

(ii) Can a wheelchair competitor get round the course?

The IOF Rules for international trail orienteering events state:

"The terrain must be chosen so that the least mobile competitors, the person confined to and propelling a low fixed wheelchair and the person who walks slowly and with difficulty, can negotiate the course within the maximum time limit, using official assistance where provided." Rule14.2

There is also useful guidance in Appendix 1 – Principles of Course Planning for Trail Orienteering – attached to the Rules.

The wheelchair competitors need firm surfaces and room to turn. This last point is important as competitors will often need to sight a problem from different positions before making a decision at the viewing point.

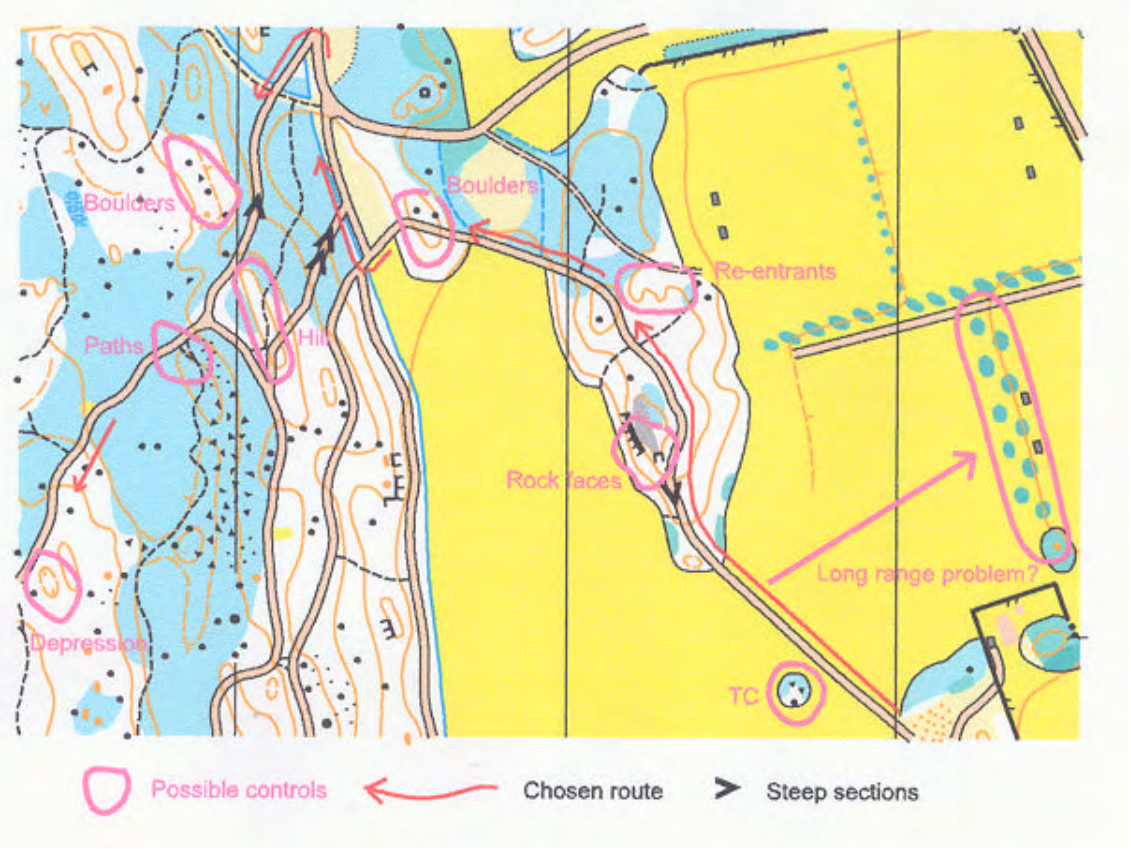
The firmness of the surface has to be carefully considered, particularly in softer ground that may become difficult in wet conditions. It may be necessary for sections of the tracks to be repaired for the competition or have temporary surfaces installed.

The gradients on the course may be critical. Appendix 1 of the IOF Trail-O Rules gives information about the limits to gradients for unassisted progress. Particular care should be taken concerning down slopes in wet conditions.

It is recommended that organisers seek on-site advice of those with practical knowledge of negotiating surfaces and slopes with wheelchairs.

Difficult sections will need physical assistance from helpers provided by the Organiser.

Here is an example of elite trail-O terrain with good wheelchair access:



The notes on the map are from the early planning, outlining possible control sites. Some of these were used, others were not. Those rejected were unable to provide problems of the required elite standard.

If the two questions about terrain quality and wheelchair access can be satisfactorily answered, then an elite event is possible.

3. MAPPING for ELITE TRAIL-O

Reference: International Specification for Orienteering Maps (ISOM), IOF 2000, Section 7, Map Specification for Trail Orienteering.

The preparation and correction of trail-O mapping is closely integrated with the planning process and is, therefore, included in detail in these technical guidelines.

Maps for international trail orienteering are based on foot orienteering mapping specifications and are usually modified versions of foot orienteering maps. But there can be important differences.

Since competitors in trail orienteering are forbidden to leave the tracks, paths and marked areas, there are a number of consequences for trail orienteering mapping. The competition area is that adjacent to the trails, generally within 50m, occasionally 100m or more when good visibility and contrast permits the placement of flags at longer distances.

Concentrating on this greatly reduced area, compared with foot orienteering competition, requires much more detailed terrain representation and consequently an enlarged map scale. The enlarged scale also permits increased symbol sizes over those for 1:15000 maps.

Map specifications recommended for international trail orienteering:

- ***1:5000 scale with symbol dimensions at 150%, or***
- ***1:4000 scale with symbol dimensions at 200%*** ***(TG 1)***

The increased symbol sizes improve map legibility. Note that the symbol sizes do not increase in the same proportion as the map scale change. This reduces the difficulties arising from generalisation in which the symbols are larger on the map than the features on the ground, and giving rise to lateral displacement on the map where such features are close together.

For example, the symbol diameter (0.4 mm) for a small boulder at 1:15000 scale is equivalent to 6m on the ground, much larger than the actual size of the boulder, making accurate representation of groups of such boulders difficult. At the increased size (0.6 mm) at 1:5000 scale, this reduces to 3m, allowing closer positioning of adjacent boulders on the map.

The contour interval should comply with the general principle that it “should correspond with the prevailing terrain gradient and compromise between understandable expression of terrain and drawing density”. As a guide, a contour interval of 2.5m with 1.25m form lines is recommended.

The map must fairly represent the terrain **as seen** from the trails and permitted access areas *and non-visible features may be omitted*, if their inclusion would otherwise distort the map.

The concept of runnability cannot apply in trail orienteering and is replaced by representations of appearance and visibility.

The precision with which a control flag is placed in trail orienteering may be to 1m or less. At a map scale of 1:5000 this is positioning the centre of the control circle to 0.2mm. This precision can be achieved with modern printing technology, provided the control circles are integral to the map. Therefore:

- **The control circles and courses should be integrated into the map prior to printing. Hand drawing of courses is not permitted. Overprinting of courses is not recommended.** ***(TG 2)***

MODIFYING EXISTING MAPS

It is possible to survey and draw a new map specially for a trail-O competition, but it is usual to modify an existing foot-O map. If an existing map is to be used for elite competition, it is essential that it is modified. All maps are generalised, in that the mapped detail is a simpler, or smoother, version of the actual terrain. Foot-O maps are more generalised than those in trail-O because the latter's enlarged scale requires finer detail to be represented.

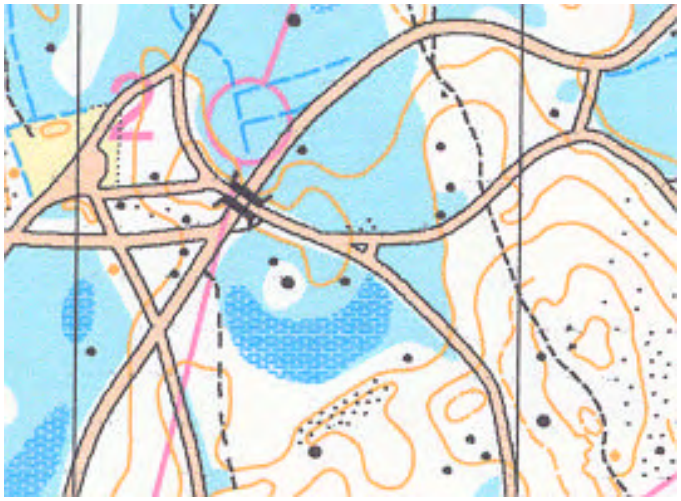
Many of the changes to the map will be made by the mapper without difficulty. These will be modifications to features already on the map, such as adjusting contours, removing tags from rock faces to improve clarity, and so on.

Some of the changes may be resisted by the mapper. This may occur when the changes conflict with the standard adopted across the map. For example, if the smallest boulder mapped is 1.5 m high because there are so many in the terrain, the mapper may be reluctant about specially mapping 1.0 m boulders at trail-O control sites. The solution is to persuade the mapper that this requirement is for is a one-off special version of the map for this competition only, and the map file can be deleted or archived after the competition.

SPRINT MAPS IN TRAIL-O

Reference: International Specification for Sprint Orienteering Maps (ISSOM), 2007.

The ISSOM Sprint map for international foot orienteering makes an ideal base for international trail orienteering. The main and obvious change from conventional orienteering maps is the representation of roads, tracks and large paths with the same style of symbol, parallel black lines of different width with brown infill. Small paths remain as before – broken black lines.

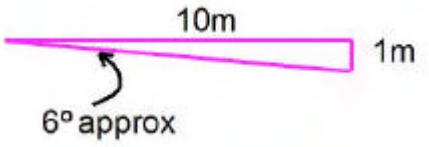


In trail-O competitions confined to the tracks and large paths, competitors can be instructed that, unless marked as no-go on the map and/or on the ground, all the brown roads, tracks and large paths may be used – **and no other path.**

MAGNETIC NORTH

Since precision compass bearings may be used at some control sites (see Position Fixing in the next section), it is essential that, at those sites, the features are mapped so that their bearings are consistent with the magnetic north lines on the map.

Remember that quite small lateral distances in the position of an object or the point from which a bearing is taken can change the bearing by several degrees:



It is also important that magnetic north is generally correct across the rest of the map used for the course. If competitors notice significant magnetic discrepancies, they may lose confidence in the map, even though the control sites which demand precision compass use may have been carefully surveyed for that purpose.

The potential for general misalignment in magnetic north has increased in recent years due to the use of maps revised from old bases and also the greatly increased rate of change of magnetic variation now occurring.

Precision compass problems, if used in course planning, should only occur sparingly. Competitors should be advised that precision compass solutions should not be attempted unless a more precise method is not apparent.

Maps in this document
The map segments in the following pages are for illustrative purposes and are modified extracts from competition maps and solution sheets. Most are at a scale of approximately 1:2500.

4. POSITION FIXING TECHNIQUES

There are several position fixing techniques in elite trail orienteering.

Position at or near a mapped feature

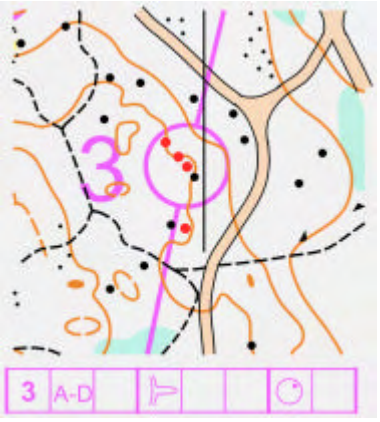
This is the basic form of precision fixing of a control position on or next to a mapped feature which can be identified in the terrain. At advanced level identification may be more difficult due to complexity and variability of the features, in that some are mapped and some are not.

Example. A straightforward map reading exercise but complicated in the terrain by small unmapped features and visibility restricted by vegetation.

The red dots represent control flags.

Position by contouring

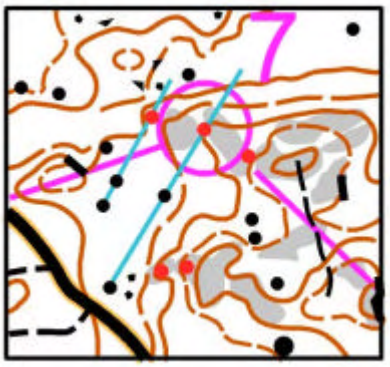
This is an advanced form of precision position-fixing which requires skill and practice. It is the tracing across the ground of a contour or form line from a selected reference point on the map. The reference point may be a feature at the same height as the contour or it may be between features at different heights. To position by contouring with accuracy needs a good sense of horizontal level in structured and sloping terrain.



Example. In this case the contour line passes through the nearby boulder which, once identified, is a good reference point for tracing the contour across the ground. Of the two flags nearest to the boulder both were possible selections but the contour traced through one flag, with the correct flag being slightly higher up the spur.

Position by sighting lines

This is an advanced form of precision fixing similar to that used by boatmen in coastal waters following sighting lines which pass through leading marks. The trail orienteering technique is to identify two reference points on the map which line up with the centre of the circle. Locating these points in the terrain and sighting along the line between them leads to the control point at the centre of the circle.



Example. Once the correct spur has been identified, the boulders acting as leading marks can be sighted across to identify the correct flag.

As a distractor an incorrect flag also had leading mark boulders.

Position by compass bearing

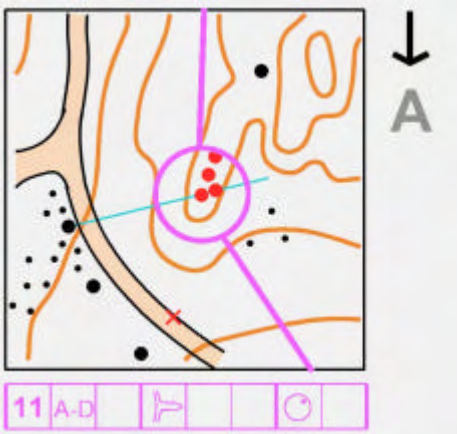
The standard compass may be used to transfer a direction from the map to the terrain. This is not as precise as the techniques listed above but can be a useful technique for correctly planned control problems. It is important not to demand too high a precision, otherwise competitors would seek to use surveying compasses and gain unfair advantage.

Problems solved by compass bearings should observe the following rule:

Bearing estimation should not be required to better than 5 degrees.
(TG 3)

In other words, from the sighting point, which can be accurately fixed on the map, the flags shall not be less than 5^{o} apart in bearing.

Note that the sighting point for precise compass bearings is not necessarily the same as the decision point. The competitor is required to identify a suitable sighting point which can be accurately fixed on the map and on the ground and which maximises the angular separation of the flags.



Example. From the decision point (marked with x) the flags were less than 5^{o} apart in bearing. The track junction, although at a good angle for maximising the angular separation of the flags, was too broad to act as a precise reference point. However, the nearby boulder, added as a map correction, was suitable. The bearing identified two flags but only one was on the centre line of the spur, as circled on the map.

Note. Although the competitors will take bearings using a standard compass, to minimise compound error the planner is advised to fix the flag positions using a surveying compass.

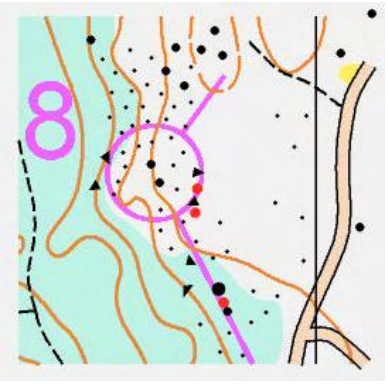
Position by distance estimation

1. Into the terrain

The estimation of distance off the tracks into the terrain can be used in control problems to distinguish between features sufficiently separated in range. It is not a precision technique. The following rule should be observed:

Distance in range estimated by eye should not be required to an accuracy better than 25% ***(TG 4)***

For example, for a distance of 40m into the terrain, an estimate in the range 30-50m should be allowed for.



Example. The two boulder fields each contained a prominent boulder, which could be interpreted as the mapped pair with a flag between. The correct pair, unflagged, were further away at an additional distance more than 25% of the distance to the false control. The answer was 'zero'.

Estimation of distance from the observer (range) should be used with caution, if at all, across 'dead ground'. This is ground which falls out of sight for part of the distance.

2. Along the tracks

Distance along the tracks can be measured by pace counting or wheel turns, for those in wheel chairs, provided the track is reasonably flat and not too rough. In this case a better accuracy than by eye can be achieved. The rule is:

Distance estimation by pacing should not be required to better than 10%. ***(TG 5)***

Example. This is a difficult contour problem solved by distance estimation. The feature was a long, low hill. The form line marking the top of the hill had to have its length determined from the map. This length was then set by pacing its distance and then fitted to the terrain.

This problem had additional difficulty in that the highest point of the hill was not at the centre of the form line contour.

5. CONTROL SPECIFICATION

The key to all trail orienteering competition is accurately locating in the terrain the centre of the circle on the map, as described in the control description.

Since current mapping technology results in the circles on the maps being precisely located, the following IOF definitions apply:

- **The control position is defined by the centre of the circle on the map and the control description.** ***(TG 6)***

- **The control description shall correctly describe the control position.** ***(TG 7)***

The control circles on the map are 6.0 mm in diameter. The circles are broken where essential detail would otherwise be obscured. They are also broken where adjacent control circles overlap.

If control sites are close together in very detailed areas and the above procedures give unacceptably fragmented course markings, then 4.0 mm diameter circles may be used across the map.

CONTROL SELECTION

- **Subject to adequate visibility into the terrain, the controls may be set on any part of the map, provided the centre of the circle can be determined by use of position-fixing techniques and the control feature is correctly described.** ***(TG 8)***

However, at elite level the controls need to be of high quality. In general, this means the use of the detailed terrain features of land form, rock, water and vegetation, as used in classic foot orienteering. Man-made features, such as buildings and fences, tend to be less acceptable, but may be used sparingly to add variety to the overall courses.

A consequence of being able to select any control feature in the terrain is that it is not necessary, when selecting from a group of similar features, to be restricted to the feature in the middle or furthermost in a specified direction. Such selections may still be made, but are not exclusive.

CONTROL DESCRIPTION

Reference: International Specification for Control Descriptions, 2004.

There are some differences in use and interpretation of control descriptions between federations. The conventions used for IOF events are as given below.

The control descriptions used in IOF trail orienteering are the same as those for foot orienteering, as given in the reference. In particular, compound descriptions for the position of the control (Column G), which require more than one symbol are not permitted. Therefore:

- **The position of the control is described by a single symbol (or none) in Column G.** ***(TG 9)***

Since the development of accurate circle printing has made redundant the earlier practice of the description needing to be unique, it follows that:

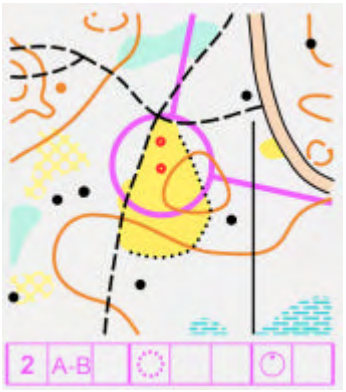
- **The control description may correctly apply to more than one flag.** ***(TG 10)***

Using precision position fixing, the correct flag is determined without the need for further interpretation of the description:

- **The convention that a direction description (such as NW part) requires that the flag *furthermost* in that direction is the correct one does NOT apply in IOF competition.** ***(TG 11)***

Examples of the description correctly applying to more than one flag are:

1. Area feature

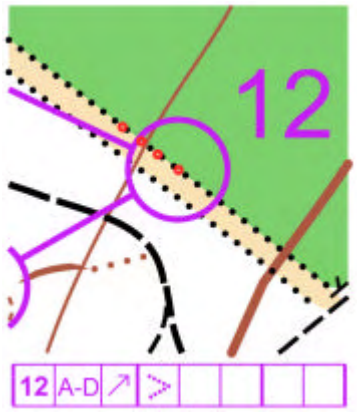


Description: '*Clearing N part*'.

The red dots show the position of the two flags. Both flags fit that description, but the circle is centred on the southern of the two, and fixed by reference to other features.

The low hill draws attention to the correct flag but it can be precisely fixed by sighting lines from two pairs of boulders.

2. Extended linear feature



Description: '*NE Vegetation boundary*'

All four flags fit the description. The correct one at the centre of the circle is fixed by reference to other features. In this case precision compass from the junction of the small gully and the path clearly indicates the required flag.

Difficulties can arise with describing control positions with respect to contour features (such as re-entrants, spurs, hills and large depressions) where the contour lines, drawn to set height intervals, do not represent the limits of the feature, although they may appear to do so on the map.

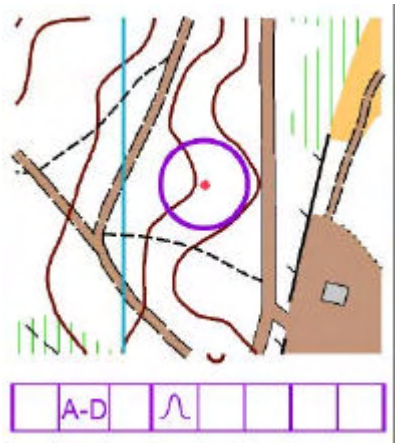
The following procedure should be observed:

- **The description should take note of the visible extent of the feature in the terrain.** ***(TG 12)***

The principle is that the extent and appearance of the feature in the terrain takes priority over its representation in the circle on the map. This may be seen in the following examples:

If the terrain shows, as the map suggests, a re-entrant extending across the two contour lines, although only one is within the circle, the correct description is ‘re-entrant, lower part’.

The direction description ‘northern part’ does not apply in this example because the control is on the centre line of the re-entrant (See later detailed example)



In this second example the control circle is centred above the contour line and outside the re-entrant within the circle. However, if, as the map suggests, the re-entrant extends further uphill, then the control position is correctly described as ‘re-entrant’.

Note that it is technically possible, with very large features, for there to be **no** contour line within the control circle. Provided the position of the control on a large feature can be precisely fixed by reference to other features, it is legitimate.

THE POSITION OF THE FLAG (COLUMN G DESCRIPTION)

Side, edge, foot, part, top, between, upper/lower *and no description*

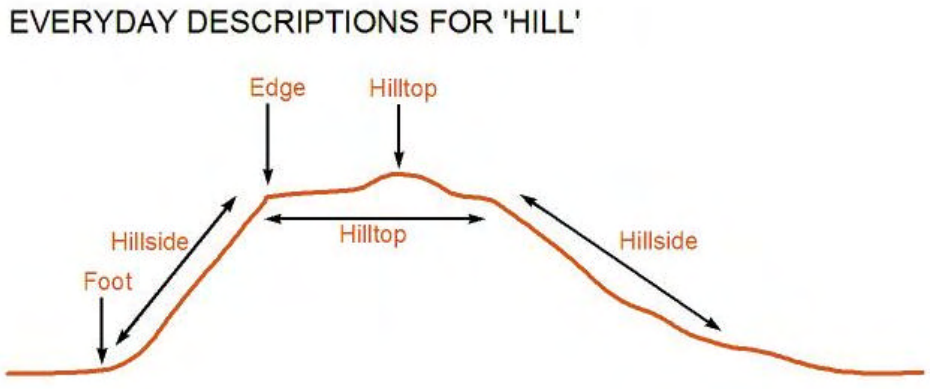
The placing of flags and the description of their positions using these terms has developed into a slightly complicated accepted practice. There is logic but it needs to be understood.

A number of requirements have to be satisfied:

- It must be physically possible to place a standard marker flag in an upright position at the described position. For example, it is not possible to place a flag at the **foot** of a building so it has to be positioned a short distance to one **side**. On the other hand, a flag may be placed at the **foot** of a hill, or knoll.

- The description cannot be used in situations where it has two meanings. For example, the **top** of a hill means both the uppermost area of the hill and its highest point, so the term cannot be used in this context. See the diagram below.

- It is necessary to avoid terms which have different meanings in orienteering and everyday English usage. For example, the **side** of a hill is commonly understood to be all of the slope between top and bottom and the **edge** of a hill, if existing, is considered to be a sharp change in gradient at the top part.



So we have the following conventions in trail orienteering:

DEFINITION OF DESCRIPTIONS USED IN COLUMN G

(**Blank**) – used for the middle of the feature. Additionally for rock faces, it means the foot.

SIDE – Used for features which rise up sharply from the ground (such as building, boulder, wall). The flag is positioned as close to the side of the feature as is reasonably practical, but within a distance not exceeding 0.5m.

FOOT – Used for the edges of features which rise less steeply from the ground (such as hill, knoll, spur). The flag is positioned, as best as can be judged, at the junction of the slope of the feature and the surrounding terrain.

EDGE – used for the edges of features at ground level (such as marsh, clearing) and those below ground level (such as depression). For the former the flag is positioned on the edge. For the latter the flag is positioned as near to the edge as can be achieved, but within 0.5m.

PART – used for any part of an area or linear feature which is not the centre or the edge or an end.

TOP – used for features where the normal flag position is at the base of the feature, e.g. rock face.

BETWEEN – used for the mid-point between the edges of two features.

UPPER/LOWER – used for the upper and lower parts of the feature as existing in the terrain.

Use of these descriptions is illustrated in the following section and plan view diagrams.

EXAMPLES OF FLAG POSITION AND DESCRIPTION

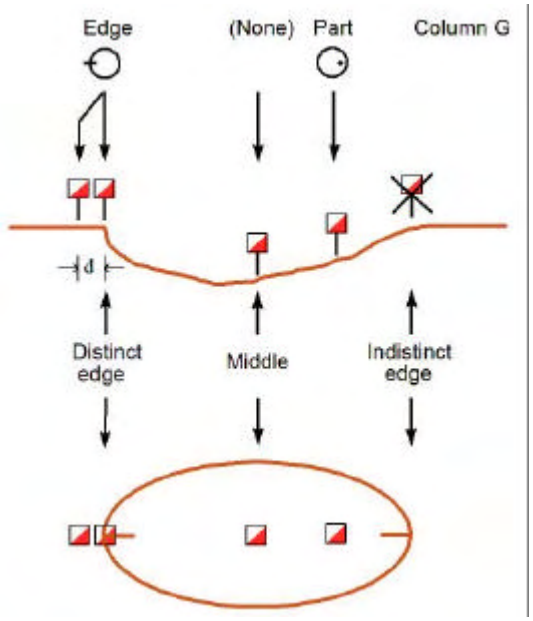
In the diagrams the sections are W to E, looking N. The plan views are conventional, with N at the top of the page.

Depression

If there is no description in Column G, the flag is placed in the centre of the depression. Note that the lowest part is not necessarily the centre.

If the description is **part**, the flag is placed sufficiently removed from the centre and the edge so as not to be confused with them, and also such that its direction can be distinguished from adjacent directions.

If there is a distinct edge, the flag may be so placed and described as **edge.** Again, its direction must be clearly distinguishable from adjacent directions.



If there is a distinct edge, but the flag cannot be placed there for practical reasons, it may be set back a short distance ‘d’, not exceeding 50cm, and the description **edge** continues to apply.

Pit

The same arrangements apply as for ‘depression’ above. Pits, having steeper sides than depressions, are more likely to have clear edges. For small pits, flag positions are the centre and edge. For large pits the ‘part’ description may be used.

Erosion gully

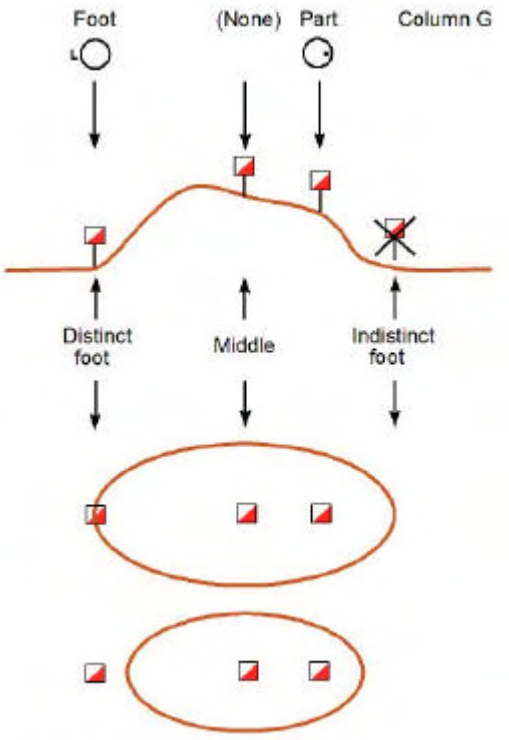
A wide erosion gully can have a section across its width similar to that for a large pit and flags may be placed across the gully in similar manner.

A narrow gully, as with a narrow re-entrant (see below), has flag positions only along its centre line. However, flags may also be placed along its edge, if distinct.

Since gullies have longitudinal dimension, it is necessary to fix the flag positions by reference to other features.

Also, as gullies run down slopes, descriptions 'upper part' and 'lower part' may apply, in similar manner to re-entrants.

Hill



If there is no description in Column G, the flag is placed at the centre of the hill. Note that the highest part part is not necessarily at the centre.

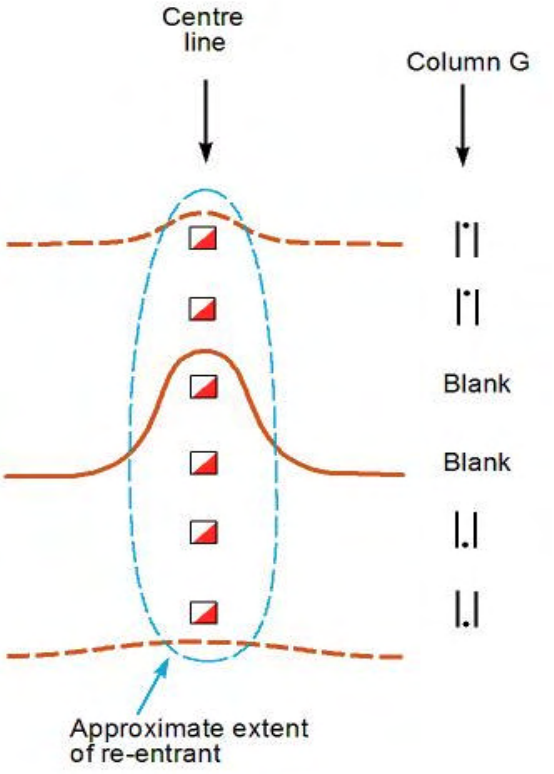
The description 'top' is not used.

If the description is **part**, the flag is placed sufficiently distant from the centre and the foot so as not to be confused with them, and also such that its direction can be distinguished from adjacent directions.

If there is a reasonably distinct foot, the flag may be so placed and described as **foot.** Again, its direction must be clearly distinguishable from adjacent directions.

Note that the contour ring may not necessarily represent the base of the hill (as in the lower plan view above). The flag described as **foot** is placed on the actual foot in the terrain. The centre of the circle on the map has to be consistent with this.

Re-entrant



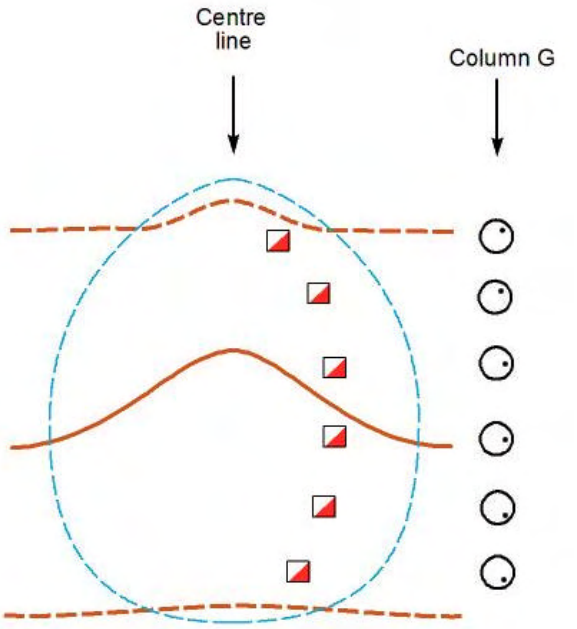
The diagram shows a narrow re-entrant depicted by a single contour line. The visible extent of the re-entrant in the terrain is shown by the two form lines and the broken blue line. The form lines may, or may not, be present on the map.

A narrow re-entrant approximates to a linear feature and the flag positions are down the centre line.

The descriptions match the appearance of the feature in the terrain, not just that part within the contour line.

Since the control description may apply to more than one flag, the control point is located by reference to the contour line and/or other features.

A wide re-entrant is an area feature and flags may be positioned off the centre line and given a direction description. The diagram shows flag positions in the NE, E and SE part of the re-entrant. Other flag positions are possible.



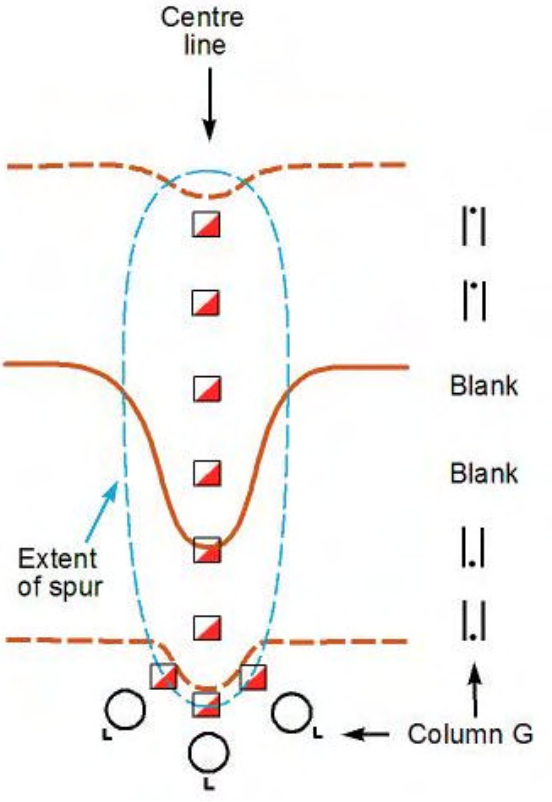
Any flag position so described is permitted provided the flag is clearly within the visible extent of the re-entrant and sufficiently separated from the centre line to avoid confusion with centre line descriptions.

Again, selection of the correct flag among more than one with the same description is by reference to the contour line and/or other features.

Spur

Similar criteria apply to spurs as for re-entrants.

The diagram shows a narrow spur depicted by a single contour line. The extent of the spur in the terrain is shown by the two form lines and the broken blue line. The form lines are not necessarily on the map. The lower form line is at the foot of the spur in the terrain.



On a narrow spur the permitted flag positions are down the centre line.

The foot of a spur refers to its furthest extension down the terrain and a number of flag positions around the foot are permitted, as in the diagram.

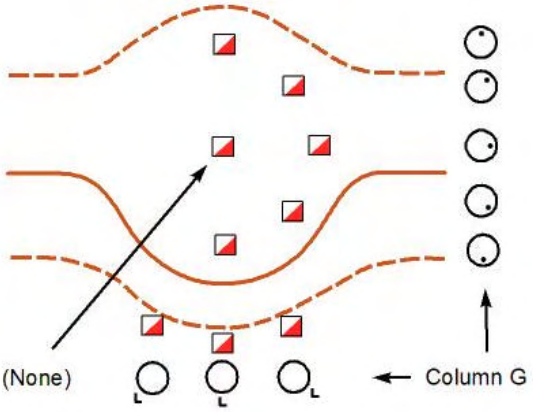
For wide spurs the same principles apply as for wide re-entrants and flags may be positioned off the centre line and given a direction description.

Since the control description may apply to more than one flag, the control point is located by reference to the contour line and/or other features.

Terrace

A terrace is an area of **flat** ground in sloping terrain. A common form arises from the excavation of material from the slope and bringing it forward to make a flat area for charcoal burning or other purpose.

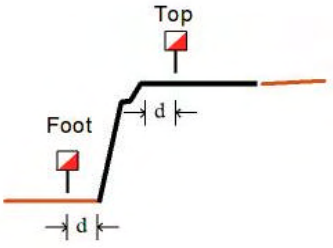
The diagram shows this form which may be regarded as a flat-topped wide spur. The lower form line shows the foot of the spur. The form lines may not be mapped.



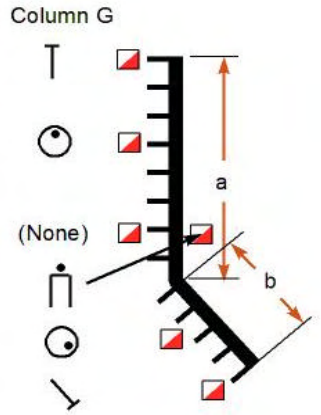
The diagram shows flag positions in the N, NE, E, SE and S part of the terrace. Other flag positions are possible. These have direction descriptions. The centre flag has no description.

The flags at the foot of the spur are positioned at the foot in the terrain. This is separate from the contour line in this example which marks the edge of the flat area further up the slope.

Rock face



Flags positioned at the foot of a cliff /rock face may be placed a short distance ‘d’, not exceeding 50 cm, from the foot, if there are difficulties in fixing the flag stakes.



The flag with no Column G description is placed at the mid-length foot. The length of the rock face includes bends and steps, if mapped. The length of the rock face in the diagram is (a + b). Minor steps and offsets, which are not mapped, are not included.

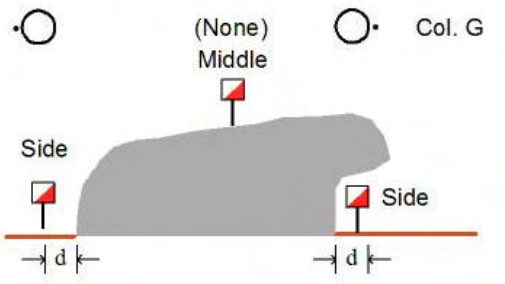
Flags may be positioned at other places along the rock face foot, and described with the ‘part’ and ‘end’ symbols.

A flag may be positioned at the rock face top at mid-length and described by the 'top' symbol. If there is difficulty in fixing the flag stake, it may be set back from the top edge, but not more than 50 cm.

Note that, under current rules, no other flags are permitted along the top of the rock face, because double descriptions would be needed to identify them.

Large boulder

A single flag on the top of the boulder is placed at the middle position and has no Column G description.

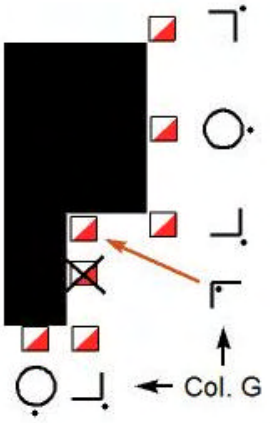


Flags placed around the boulder are positioned as close to the base of the boulder as can be achieved, but no further than a distance of 50 cm.

Where the upper part of a boulder, above flag height, projects further than its base, the projecting part is ignored. For very large boulders, the top flag may be offset from the centre and described with the 'part' symbol.

Building

Flags may be placed round the foot of a building at the mid-length of a projecting side (i.e. that which is furthest in a given direction) or at outside and inside corners. The descriptions are 'side' and 'corner'.

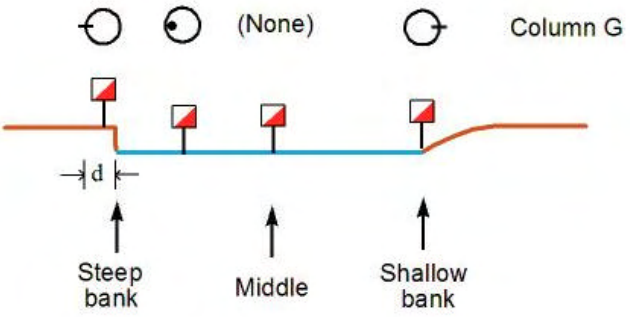


In the diagram the two faces of the building forming the inset cannot be described and therefore cannot be used, apart from the inner corner.

Where an upper part of a building projects further than its foot, the projecting part is ignored (as with boulder).

Watercourse

If Column G is blank, the flag position is in the centre of the watercourse.



If the watercourse is wide, other flag positions are possible and the description 'part' applies.

Flag positions at the water edge are also possible. If the bank is at a shallow angle, the flag may be placed exactly at the water edge. If the bank is steep so that the flag cannot be placed at the water edge, it may be placed at the top of the bank, as close as possible to the edge, within 50 cm.

An advantage of using the top of the steep bank is that this flag position and description does not change if the water level rises and falls significantly.

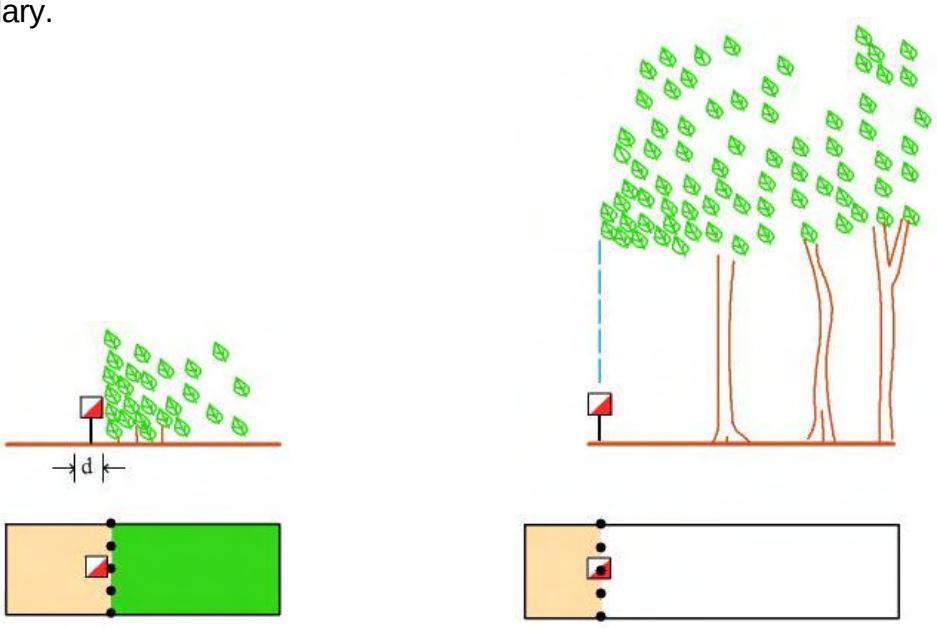
Since a watercourse has linear dimension, unless at a precisely positioned irregularity, the flag positions have to be determined by reference to other features.

Vegetation boundary

A distinct vegetation boundary, such as a forest edge adjacent to open land or an obvious change within the forest from broadleaf to coniferous trees, is mapped, according to IOF practice, in aerial plan view. The boundary at ground level is located directly under the edge or meeting of the canopy vegetation.

When the vegetation extends to the ground, as in the first diagram, the control flag is positioned on, or as close to as possible, the vegetation edge.

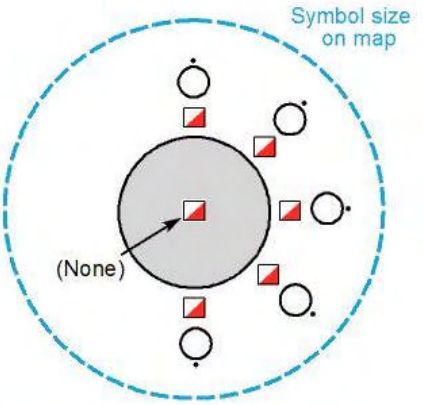
When the trees have grown to the point when the leaf canopy has lifted, as in the second diagram, the control flag is positioned on the line of the vegetation boundary.



Since the vegetation boundary is a linear feature, unless placed at a bend or corner, the control position has to be fixed by reference to other features.

Point features

These are small features where the size of the symbol on the map represents a greater diameter than the actual dimension of the feature in the terrain. Examples are boulders, knolls and small depressions/pits.



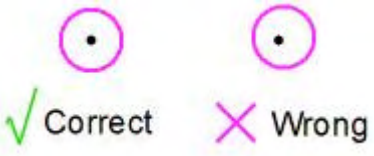
Where there is no Column G description, the control flag is at the centre of the feature.

Otherwise the flags are positioned round the feature, as partly illustrated in the diagram, using direction descriptions as follows:

- Boulder - 'side'
- Knoll - 'foot'
- Pit - 'edge'

Since the map symbol is larger than the feature, positioning the centre of the circle on the control position cannot be precise. The convention in trail-O is that, with point features, the circle is centred on the feature symbol and not offset in the direction of a flag which is on the side or edge of the feature.

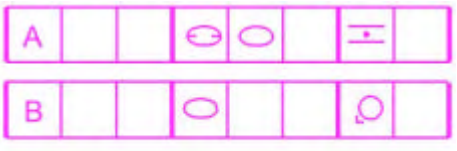
Here is an example with Boulder NE side:

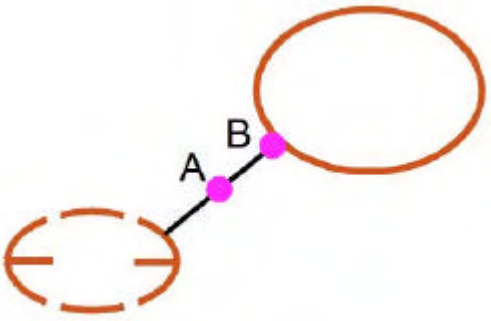


Between

The 'between' description refers to the mid point of the shortest line joining the 'edges' of two features (**not the centres**). Note that flags at or near the ends of the line associate with the adjacent feature.

The descriptions in this example are:





When setting 'between' problems using contour line and/or form line features, it is important to check that the contours and form lines on the map have been drawn to represent the actual edge and foot of the features.

In the case of point features, such as boulders and knolls, whose map symbols are larger than the objects they are depicting, the actual edges of the features are used in defining the separating distance.

DESCRIPTIONS – GOOD PRACTICE

In general, descriptions should not be more detailed than is necessary for the viewing of the problem from the decision point.

It is possible for some controls to have more than one valid description. Whilst one description may be preferred, the others are acceptable and should not be considered as misdescriptions.

It is also reasonable practice to allow some latitude in descriptions, where this does not critically affect the identification of the correct flag. The essentials of good trail orienteering are skilful map reading and terrain interpretation, and not over-precision in control description.

Where misdescription of a control is thought to be critical in the solution of a problem, this can be tested by the complaints and protest procedures. But, particularly:

- **A control flag which is correctly placed in accordance with the centre of the circle on the map, but wrongly described, must NOT result in a zero answer.** ***(TG 13)***

6. OTHER TECHNICAL CONSIDERATIONS

Teamwork

The National Controller and IOF Event Adviser at WTOC (and similar officials at other elite events) need to work with the Planner(s) and Mapper to produce unambiguous control problems of high quality. The careful double-checking of every problem is essential for the success of the event.

Experience has shown that, if there is even a small mistake in the control setting or something that could be misinterpreted, several competitors will be misled and select the wrong answer. These competitors may then argue that the control be voided (see later in this section)

This section contains advice on how to avoid such difficulties.

How long is the course and what time is allowed?

The target time for elite competition is between 2 and 2½ hours.

The time allowed depends on the number of controls and the length of the course. The Rules give a simple base formula for a course which is reasonably flat and well surfaced, and controls which do not require considerable movement away from the viewing position:

Time required = 3 min per control + 3 min per 100 m

If the course is considered to have additional climb over normal practice, an allowance of 3 minutes per 10 metres of additional climb may be added.

Example: 2 km course with 18 controls and 30m of additional climb

Time = (3 x 18) + (3 x 2000/100) + (3 x 30/10)

= 54 + 60 + 9 = 123 min

There may be other reasons for increasing the allowed time.

The Event Adviser has the authority to make such allowances.

The target time should be set to a rounded figure which facilitates the competitors' calculations of their remaining times. For example, the 123 min noted above should be rounded to 120 min.

More ways than one to the solution

When a control problem is designed, there is usually an intended best method of solution.

It may be that, of a number of alternative methods of solution, there is another **of equal or close merit**. It is important that the second or any other method of solution that is a valid way of arriving at the answer is checked for consistency with the intended method.

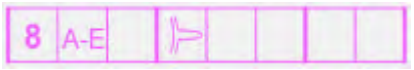
It is not practical to produce maps in which every feature is perfectly represented in exactly its correct position with respect to all the other features. However, the main features which could be used for valid solutions of each problem must be correctly related to each other.

It is the responsibility of the competitor, when considering various methods of solution, to select those likely to give the most precise and accurate answer and reject those likely to give less certain answers.

Equally, it is the responsibility of the planner to ensure that:

- **If there is more than one valid way to solve a control problem, they all give the same answer.** ***(TG 14)***

An example of analysing the possible different methods of arriving at a solution is given below, taken from the first World Cup in trail orienteering.



The intended best solution was to extrapolate the line of the distinct vegetation boundary from across the track. This intersects the centre of the circle.

Supporting aids to solution were the corner of the wide ride and the broad form line spur.

The ends of the low earth wall and the thicket were too indistinct to act as reference points.

Unfortunately, the ditch end was clear but wrongly mapped, ending about 5m further east than as shown and acting as a reference point for precision compass fixing, but identifying the wrong flag.

After a protest the jury decided that the intended best solution was not obvious and that the compass solution from the ditch end was a valid choice. The control was voided.

Zero answers

The zero answer, no marker flag at the centre of the control circle on the map, is a feature of elite trail orienteering. Its use adds an extra dimension to control problem setting but also introduces increased difficulties with marker flag placement. This is because a minor misplacement, real or imagined, of the correct marker could be interpreted as a zero answer.

The solution is to ensure that zero answers are clear. Either the centre of the circle with no flag should be clearly identifiable or the flags can be located and shown to be in positions clearly not at the circle centre.

Unmapped and part-mapped features

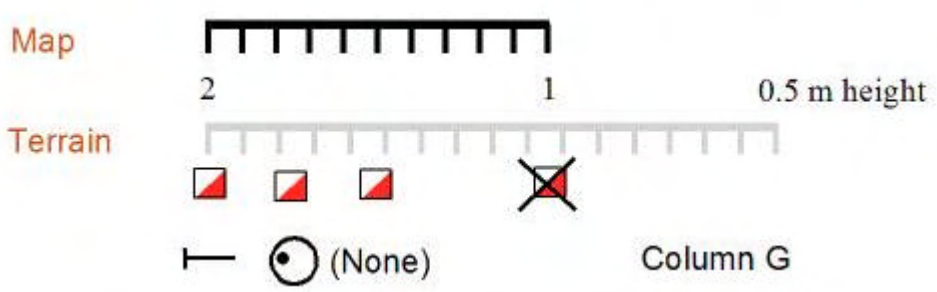
The mapping threshold for size of features for including them on the map can produce problems, especially for linear features.

The minimum height or depth of features to be included on the map is given as 1m in the mapping specifications ISOM 2000 and ISSOM 2005. The mapper may choose, if the terrain has too many features for clear interpretation, to increase the threshold.

Terrain containing features where some are mapped and some are not, requires careful inspection to distinguish between them but, once this is done, there should not be too much difficulty for the competitor.

However, linear features which taper can be much more problematic.

Consider the example of a rock face which is well above the mapping threshold of 1m at one end but tapers to below 1m at the other end. Only that part of the rock face which is above 1m should be mapped. The planner needs to determine whether this is the case and confirm that a competitor viewing the rock face from a distance can correctly identify the mapped section (possibly by reference to the height of a control flag). In this example it would not be acceptable to place a control flag at the lower end of the mapped rock face and describe it as ‘end’:



All flags to have meaning

Do not add marker flags simply to increase numbers in order to reduce the chance of random selection being correct. At elite level flags which have no meaning are instantly rejected. Each flag used should be positioned so that it has some definite connection with the control description. The best incorrect flags are those which are right in several respects but wrong in one.

Decision point

The decision point, from which all flags can be viewed and at which the decision about which flag (or none) marks the feature centred in the circle on the map is confirmed, is marked with a stake. The decision point must be of sufficient prominence to be readily visible and be identified with the number of the control.

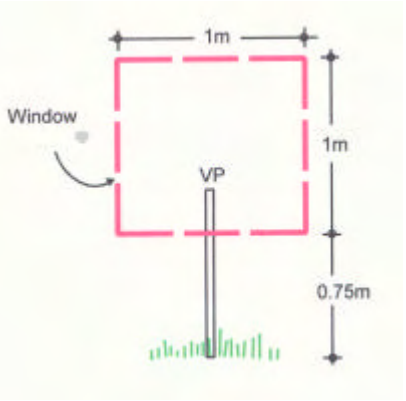
The decision point is not marked on the competition map. If there is possibility for doubt about its general location, the direction of view from the decision point towards the control may be given in Column H of the control description.

In the interests of wheelchair users the decision point should not be located on a steep slope.

The recording point (either a pin punch for marking a competitor's control card or electronic recorders) is sited a short distance from the decision point, normally not less than 5m and on the same side of the track. The recording point is to be readily visible, if necessary by the addition of tapes, and numbered.

It is required to allow for several competitors, including wheelchair users, to be at the decision point at the same time. All must have reasonably equal opportunity to view the flags and the terrain, whether in a wheelchair or standing erect.

It is also required for the marker flags and decision point to be so positioned that a movement by the observer 0.5m either side of the decision point does not change the answer.



These requirements lead to a viewing window rather than a viewing point of the following dimensions.

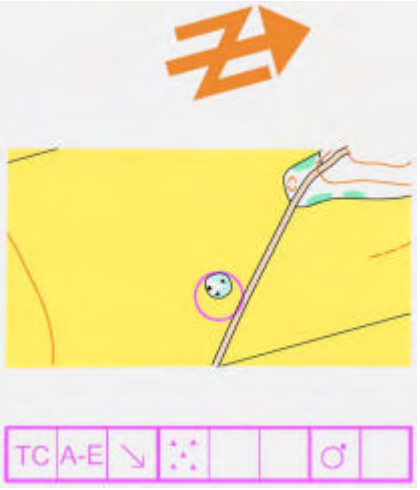
Route choice

Most competitions are unable to offer route choice, but in those where more than one route is possible between a pair of controls, such an option could be considered by the Planner. This does not change the competitive nature of the courses but may add to their general quality.

Timed controls

For timed controls the competitor stays in a fixed position.

The timed control map is a small segment of the competition map at the same scale, printed on a sheet not less than A5 (and stiff-backed to assist with handling), and oriented so that the direction of view to the flags is straight up the sheet. The example is from WTOC 2004.



The competitor has one minute only to give an answer. A ten second warning is given at 50 seconds

A wrong answer is recorded as such and 60 seconds added to the actual time to answer.

To be fair competition the problem should be capable of solution by all competitors in the time allowed. The best outcome for a timed control test is that all competitors give the right answer but the more skilled do so more quickly. Problems which are too difficult because of complexity or poor visibility result in guesswork and this distorts the results. Also, problems which are too easy and solved in less than 5 seconds by the fastest competitors can be subject to uncertainties in the timing procedure. The target time for the best competitors should be 10 - 15 seconds.

- **The zero answer option is not suitable for timed controls in classic trail orienteering competition (but permissible in the Temp-O format).** ***(TG 15)***

There can be a problem with operating timed controls. This is variation of the time during which the flags at a timed control are visible to competitors before the timing starts, and this can lead to attempts to gain unfair advantage.

- The flags may be visible between the call-up point and the viewing position. At some events screening has been erected.
- The flags are visible while the competitor is taking up position at the viewing point. At some events a marshall stands in front of the competitor to block the view until the formal procedure begins.

- This begins with the marshall asking the competitor whether the right number of flags can be seen. At some events the marshall announces the number of flags and presents the map segment to start timing in rapid succession.

A possible solution is to screen the control site until the competitor is settled, then allow 15 seconds, say, for viewing before the map is presented.

Post-competition solution maps

Once the last competitor has finished and the course is closed, the solution maps for all the controls, including time controls, may be issued. These consist of map segments at enlarged scale (usually twice competition scale) showing the positions of the flags at each control, which of the flags is correct or, for zero answers, the unflagged centre of the circle.

It is preferred for the descriptions to be included with the map segments.

It is important that the map segments on the solution sheet agree exactly with the competition map. Late changes to the competition map which are not replicated in the solution sheets produce difficulties and invite dissension (see the next section).

Disagreements, Complaints and Protests

"Trail orienteering is a platform for dissent" (the late Peter Palmer)

Disagreement is a normal condition in orienteering. This is to be expected in a discipline which uses subjective judgment and shades of meaning. To the credit of trail orienteers it is normal for differences to be settled by the opinion of the Event Adviser. Although complaints are submitted from time to time for consideration by the officials, it is rare for any to be raised to the level of protest.

Sometimes the validity of a control needs to be re-examined after it has been questioned by competitors or officials. If it is faulty, there is the option of advising the Organiser to void the control. Unlike in Foot-O this can be done without voiding the whole course.

However, the procedure for voiding a control should be undertaken with great care. If it is decided to void a control, this decision and the reason must be announced to the competitors without delay, so that they have the opportunity to make representations. But caution is advised:

- **Remember that, voiding a control that the better competitors get right and the poorer competitors get wrong, itself introduces unfairness.** ***(TG 16)***

7. PLANNING LOGISTICS

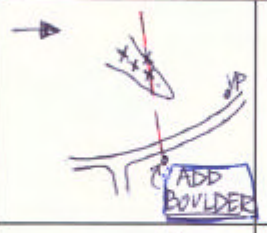
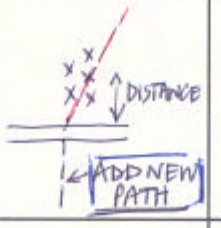
The first stage of planning is to select potential routes8080 of acceptable quality and length and to identify a suitable number of potentially usable control sites.

The best time to do this is when the visibility is good, not necessarily at the time of year of the competition. Seasonal vegetation can be cut, if necessary, to give acceptable visibility round the control sites.

The second stage is to work on each site in detail, using flags, to develop a problem of good standard. Map corrections essential to the solution of the problem need to be identified. The positions of the flags and the viewing point need to be marked in the terrain.

All this information is marked on a planning/controlling sheet. An example of part of the IOF Event Adviser's notes at WTOC 2004 is:

WTOC 2004 PLANNING Competition ..... DAY 1 .....

No	A-?	Which feature	Feature	Sketch	Flag Posn	Notes	Ans
11	A-D		Spur			BEARINGS FROM NEW BOULDER 65° 59° 54° GIVES 2 FLAGS BUT FURTHER FLAG OFF CENTRE OF SPUR	A
12	A-E					ALL FLAGS ON MARSH NW PART ONLY ONE ON BEARING AT RIGHT DISTANCE	D

The third stage is to revisit each control site with enlarged segments of the map and plot in the flag positions. These are needed for the answer sheets.

For an international event the Planner will visit the terrain very many times, the Controller will visit many times and the IOF Event Adviser and/or the

Assistant Adviser will visit at least three times, a preliminary visit to confirm the suitability of the terrain(s) and deliver any technical training necessary, and visits at one year and at three months before the event. At the one year visit the planning proposals should be complete so that the courses can be approved and map corrections identified. At the three months visit the final courses, the detailed flag positions and maps (including the solution sheets) are confirmed. After this point only emergency changes are permitted. It is well understood that late changes almost always produce unforeseen problems (such as differences between the competition map and the map segments on the solution sheets).

Mechanical aids for flag placement

The method of marking the positions of flags by tag or tape is commonly used but can lead to unnecessary difficulties. With multi-day events, such as the world championships, there are very many flags to be placed in position in a very short time. It is essential that the flags are installed in exactly the positions agreed in the final controlling session. This means locating each tag and searching for the hole made earlier. More often than not, the hole is not found and the flag stake/rod has to be driven in afresh. All this takes time.

A much improved method is to use plastic or metal tubing driven into the ground and left in position. With metal rods for holding the flags, these are dropped into the tubes, taking just a few seconds for each. The savings in time and the certainty that the flags are in the correct positions are invaluable.

A particularly useful version of this method with a tube flanged at one end is used in Scandinavia.

8. DOCUMENTATION

This guideline documentation was prepared by Brian Parker (GBR) with input from the Trail Orienteering Commission, Rules Commission, Mapping Commission and other trail orienteers. The assistance provided by the Nordic Federations' *Guidelines for Trail-orienteering controls (2007)* is acknowledged.

Much useful material is available from the IOF web site www.orienteering.org and the trail-O web site www.trailo.org

From www.trailo.org can be accessed notes from technical clinics and much other valuable material, including the Nordic guidelines (in English).

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APPENDIX

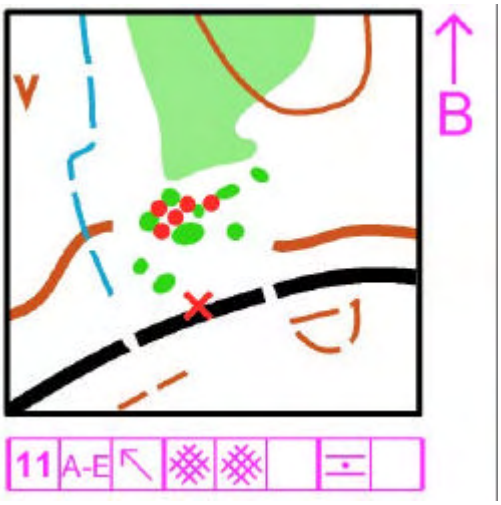
PLANNING EXAMPLES for ELITE TRAIL-O

There is a wide range of different problems which can be set by Trail-O planners to give Elite Trail-O competitors the necessary variety and technical level of challenge.

The examples given here are from World Championship events and will be added to in due course. Submissions of good WTOC examples for possible inclusion in later editions of this Appendix are welcomed.

Between

The mid point may be easily determined between features with clear sides and, in such cases, the degree of difficulty of the 'between' problem is increased by setting it in a cluster of features, some mapped and some not.



Example: WTOC 2005, Japan, Day 2-11.

Here there were a large number of small thickets. All the flags were set at mid points between pairs of thickets. The correct pair could be identified by the centre of the circle on the map and by the control description referring to the NW pair. Carefully checking which thicket was which led to the correct flag.

The 'between' problem is much more difficult with contour line features, as in this example.

Example: WTOC 2004, Sweden, Day 2-12.

The difficulty here is in identifying exactly where the contour line was with respect to the ground. In this case the contour coincided with the open yellow. This indistinct vegetation change helped to locate the contour line. The dot knoll had a reasonably clear foot so it was

possible to determine that flag D was at or very close to the mid point of the line from the knoll to the nearest part of the ring contour.

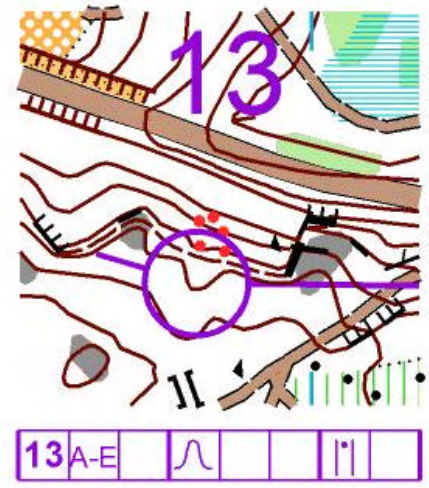
Invisible features

Features (such as pits) which cannot be seen from the viewing point or any other permitted position can be used in elite competition but with very great care. If nearby visible features can be used to locate the flags with the necessary precision, the problem may be acceptable.

A more straightforward option for using an invisible feature is the zero answer in which all the flags are clearly identifiable on other features, as with the following example:

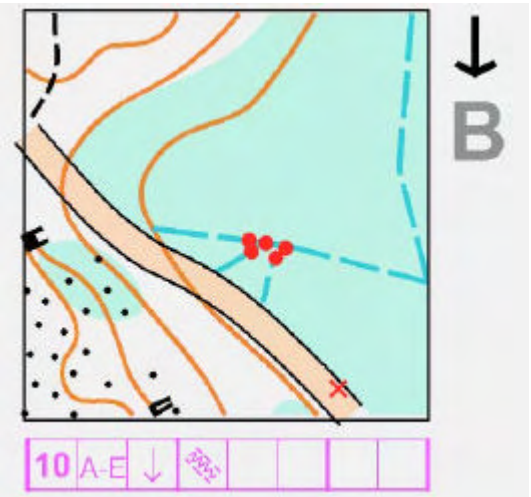
Example: WTOC 2006, Finland, Day 2-13,

The re-entrant could not be seen from the road but, if its position was correctly judged, and not confused with the small, shallow re-entrant down slope, the existence of the five flags in incorrect positions leads to the zero answer.



Partly-invisible features

Features (such as ditches and paths) which cannot be seen from the viewing point but **are** visible from other points along the track can be used for legitimate and testing problems.



Example: WTOC 2004, Sweden Day 2-10

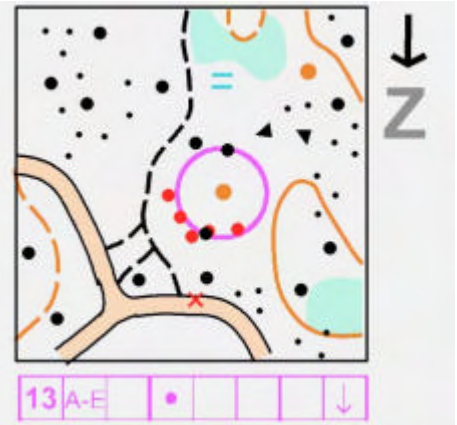
None of the ditches were visible from the viewing point. However, each ditch was visible when viewed along its length. By sighting along the three ditches in turn, it was seen that all flags were marking ditches and the correct flag, just east of the E ditch junction could be identified.

Unmapped features

The use of unmapped features can provide useful problems. These features are legitimately unmapped because they fall below the mapping threshold that the surveyor has set, but there is potential for confusion with similar features which are prominent enough to be mapped. Perhaps the most common, but usable feature, is the small boulder, but there are other possibilities.

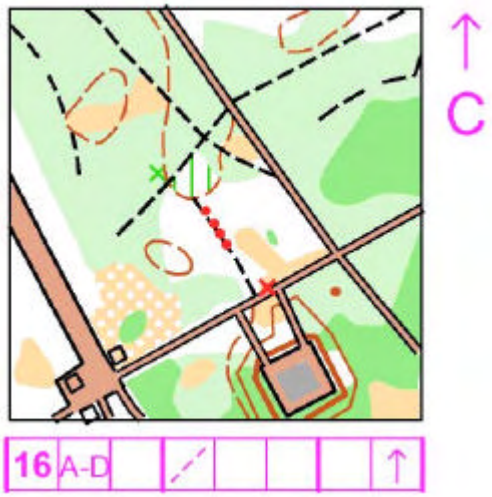
Example: WTOC 2004, Sweden
Day 2-13

This was a particularly testing control. Three flags were on unmapped knolls, one on a mapped boulder and another on an unmapped boulder. Visibility was restricted, even after some clearance work but a good line of sight from the viewing point with estimated bearing and distance showed a good knoll with no flag.



Sighting lines

A single sighting line can be used to fix a point on a linear feature and two such lines intersect to fix a point in an area feature. In both cases the intersecting angle should be sufficiently large to give accurate setting (90 degrees being the optimum). Shallower intersecting will need greater angular separation of the flags.



Example: WTOC 2007, Ukraine
Day 1-16

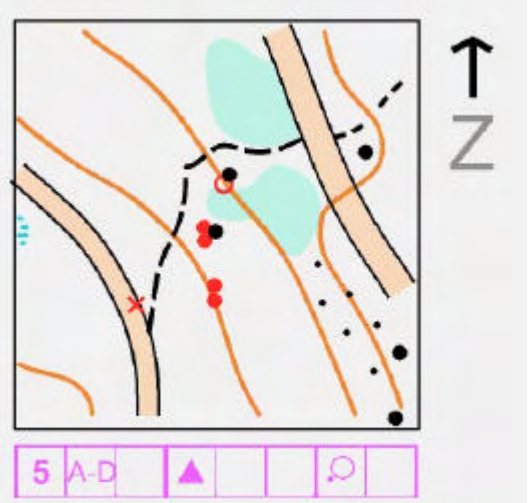
The flags along the path were too close in distance to estimate the position of the correct one. This was fixed by a sighting line from the first small path/ brown path junction north of the viewing point and the centre of the small hill.

Displaced similar features

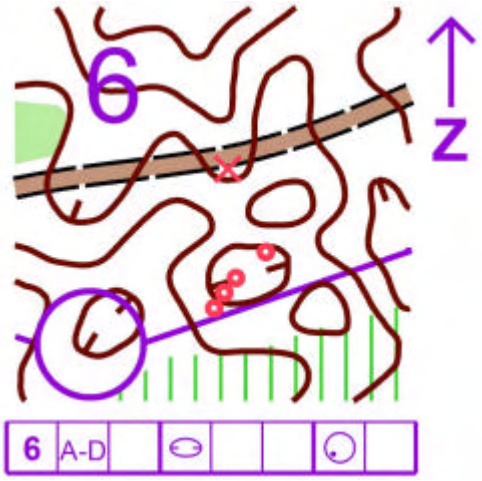
The existence of two or more displaced or **parallel** similar features can be used to set testing problems. The intention is invite misidentification of which feature is which. These normally are set to give a zero result, the correct feature being unmarked with the parallel feature(s) being flagged.

Example: WTOC 2004, Sweden, Day1-5,

The southern pair of flags was on an unmapped (undersize) boulder. The northern boulder was not visible from the viewing point, being hidden by the thicket, but could be seen from further along the track. Careful map reading of the thicket and small path confirmed the boulder to be at the centre of the circle and unflagged (marked o)



A much more difficult version of the parallel feature(s) problem is met when the general features along the track are broad and repetitive and do not permit easy location. In such circumstances it is easy to be misled by the false control, with flags set so as to appear as a problem requiring very careful analysis, as in the following example:



Example: WTOC 2006, Finland Day 1-6

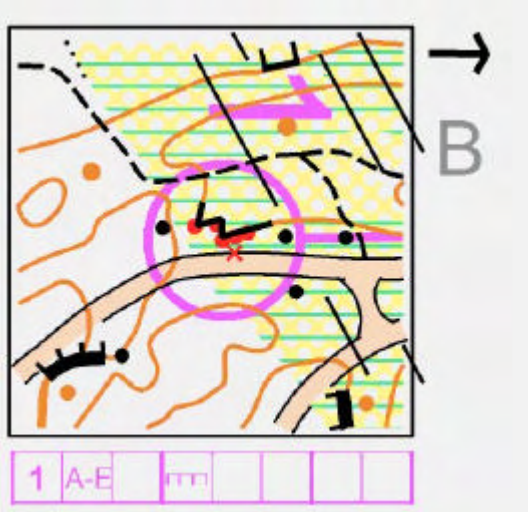
The approach from the west had a number of repetitions of the re-entrant and spur combinations, all with pockets of denser vegetation on the north side of the track. The false depression was surrounded by higher ground which, at first sight, matched that mapped round the correct depression. This control needed careful back-checking along the track to confirm its true position.

Irregular rock face

The mid point foot of a rock face is the middle of the actual **mapped** length, including changes of direction.

Example: WTOC 2004, Sweden
Day 1-1

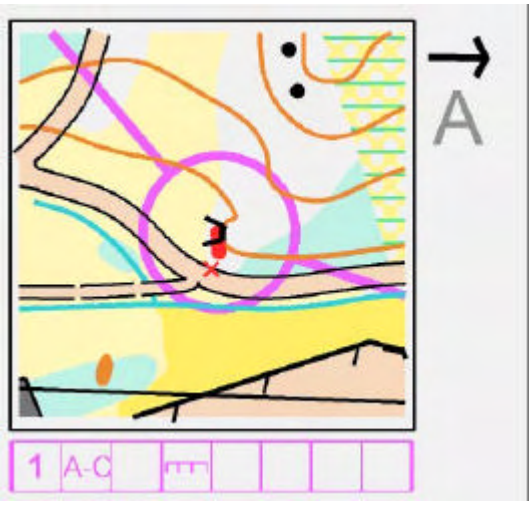
Since Column G has no description, the control is at the mid-point foot. The mid-point of the mapped feature is at the SE corner. The centre of the circle precisely indicates the SE corner and eliminates the distractor flag E at the mid-point of the SE face.



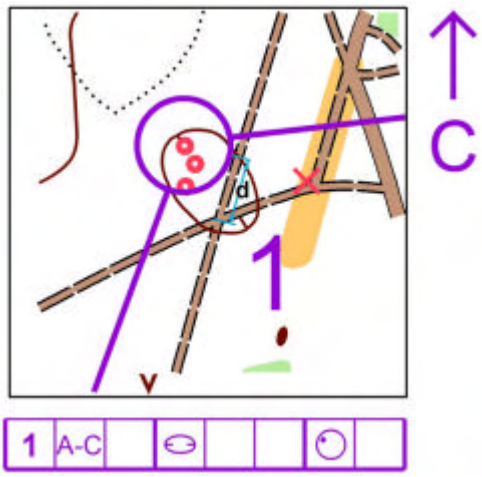
This was set as an easy first control on the first day of the first world championships.

But the last control on the same day, D1-18, also a rock face, was much more difficult.

The mapped rock face was short and curved as indicated so that the western part was not visible from the viewing point, but visible on approach from the south. The rock face extended further east than as shown because this section was below the mapping threshold. Both of these characteristics gave competitors difficulty.



Contour following



Many elite problems have control positions set with respect to contour lines. These problems require the competitor to trace out a contour and relate it to the flags

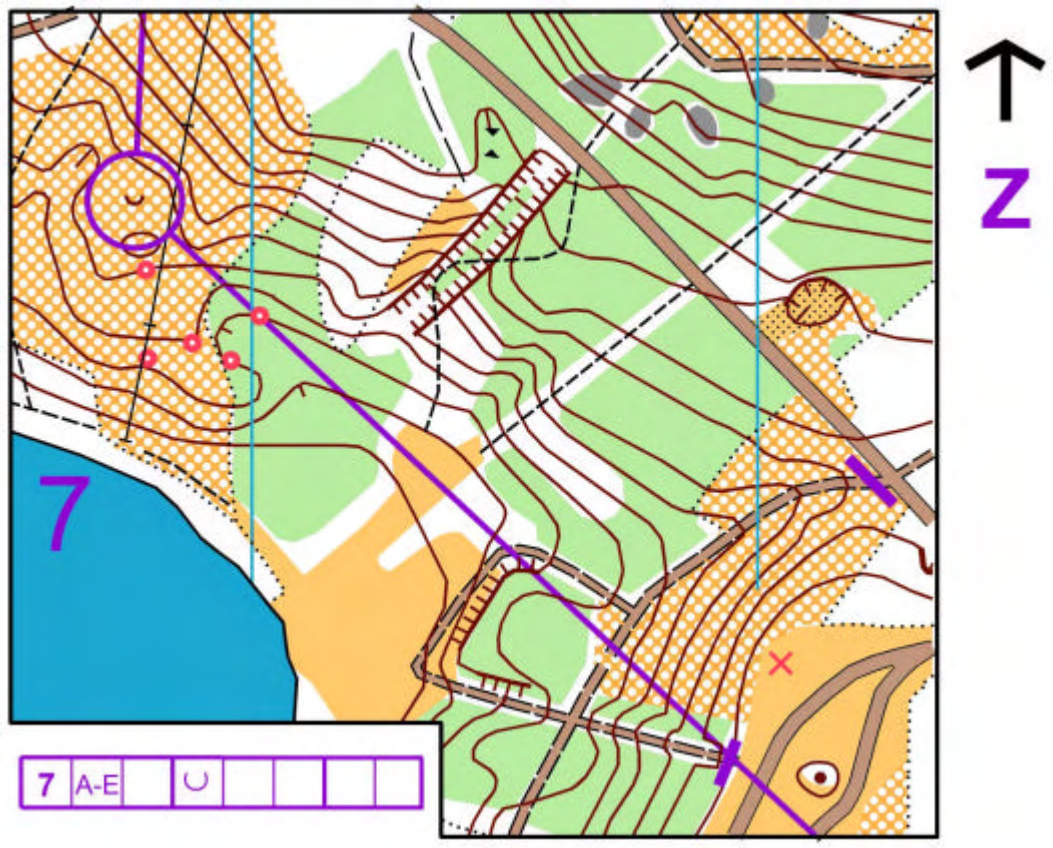
Example: WTOC 2006, Finland
Day 1-1

Compass bearings from the path crossing eliminated flag A. To determine which of the two remaining

flags, or neither, agreed with the centre of the circle, the contour had to be traced out. The point at which it crossed the northern path could be determined by judging or pacing the distance 'd'. The contour, so traced, showed flag C to be in the correct position

Long range control

These are acceptable for occasional use, provided the visibility and contrast is good (and there is no fog on the day). The following is an unusual example:



Example: WTOC 2006, Finland, Day 2 –7

This viewing distance, at 200m, was well beyond normal limits, but the viewing point was elevated, giving an overview of the distant terrain. There was good contrast so that the flags could be picked out against the rough open ground and the trees. The problem was relatively easily solved by the presumption that the small depression could not be identified at that range and, even if flagged, its position could not be confirmed with precision. Therefore the answer must be zero. This was verified by sighting the power line and noting that only one flag was beyond it, this flag being the wrong side of the hill.

Although this problem was only of moderate technical difficulty, it demonstrates that, with care, long range problems can be set up successfully.

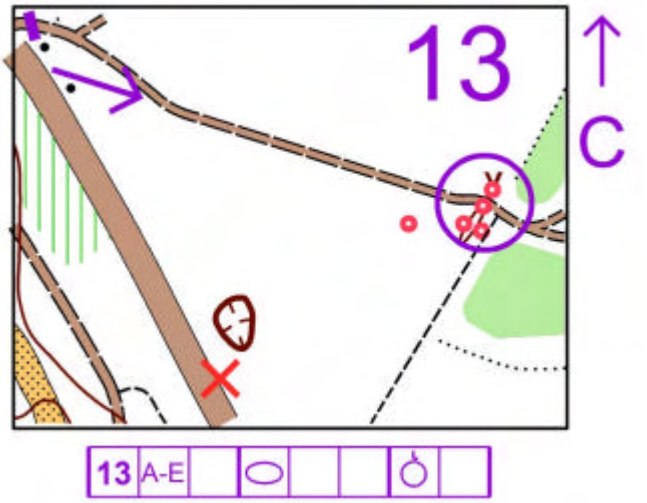
Parallax

Parallax is the 'apparent change in position of objects caused by change in position of the observer'.

This property is used in elite trail orienteering when the sighting point from which the correct flag is decided is distant from the staked viewing point and the relative sequence of the flags is different at the two points. It demands skills of identifying the same flag in the terrain when viewed from the different points, particularly when the correct flag cannot be viewed continuously when moving from the sighting point to the viewing point.

Example: WTOC 2006 Finland Day 1-13.

From the viewing point the precise positions of the two flags north of the knoll could not be seen. However, when viewed along the path (as shown by the arrow), it was possible to see that one flag was at the northern foot of the small hill. From this sighting point this was flag B. The same flag from the viewing point was flag C.



The principle of parallax can be also used to separate nearer and further features which are some distance away and tend to merge together. Viewing the features while moving along the track identifies those which are in front of the others.

Example: WTOC 2004, Sweden, Day 2-1.
This, at 125 m, was another long range control with good visibility and contrast. From a stationary position the copses merged and appeared to be

at the same distance. Moving along the track showed which were in front and which behind. Reference to the building identified the various copses.

Extrapolation

This is the extension of a linear feature, sometimes the other side of the track from control area, to fix the position of the required flag.

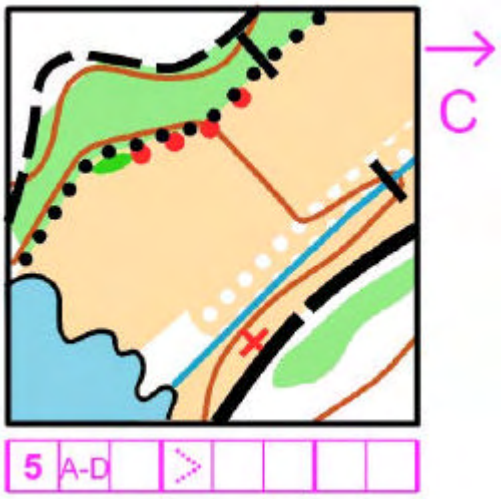
Example: WTOC 2007, Ukraine, Day 1-1.

The contour ring representing the hill had its NE end just intersecting the rough open. The remainder of the contour could then be traced at that height. This could be checked against the long diameter of the ring. The flag at the centre of the circle was just inside this contour, as required.

As a further check, the extrapolation of the line of the path on the other side of the track passes through the centre of the circle.

Precision distance estimation

Lateral distance across the terrain can be estimated accurately, provided there are mapped features at the same range that can act as a base line.



Example: WTOC 2005, Japan Day 2-5

This is a moderately easy example. The base line features across the field of view at the range of the flags are the northern end of the small thicket and the path/ vegetation boundary crossing. The control position was at the mid point between the two. A more testing problem would be use a ratio other than 50:50, perhaps 33:67.

Overlapping sites

This is intentional overlapping where one or more flags in adjacent control sites can be seen from the different viewing points and contribute to more than one flag grouping. It is arranged that not all of the flags are visible from each of the viewing points; the disappearance of flags and fresh ones appearing as the competitor moves from one viewing point to the next can add considerable interest.

When overlapping is not intended and flags from other sites are visible and could confuse competitors, then boundary lines separating the sites may be drawn on the maps and/or separating tapes laid in the terrain and/or at the decision point.

Overlapping control sites have featured in World Cup trail-O but not yet in WTOC events.