American Radio Relay League

Radio Orienteering Courses: Design and Set Guidelines

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ARRL Radio Orienteering Committee

Objective

In Radio Orienteering, often described as "chess in the woods," success hinges on a blend of physical fitness, mental acuity, and proficiency in radio techniques. The course designer plays a pivotal role in this sport, crafting courses within the constraints of the map and terrain. While ensuring a course is physically demanding is almost a given, provided the course length is appropriate, the bigger challenge for the course designer lies in devising a mental challenge that matches the skill levels of the intended participants.

This is not a rules document. This document describes strategies for achieving the spirit of Radio Orienteering rules, especially regarding fairness principles. Rules documents have priority and override the contents of this document in case of any discrepancies.

Skill not Luck

In Radio Orienteering, the placement of foxes isn't necessarily tied to prominent map features. Often, the most strategic locations for foxes might not be adjacent to any mapped features. However, fairness is paramount in fox placement. It's important to ensure that the location of a fox doesn't inadvertently give an advantage to competitors who happen to choose a certain route or approach from a specific direction by chance. The skill in locating a fox should stem from using radio direction-finding techniques rather than serendipitous route selection or accidentally spotting the orienteering flag.

When setting up a Radio Orienteering course, each fox placement should be evaluated critically: Can a competitor effectively utilize their radio direction-finding skills and map reading to pinpoint the fox's location more efficiently? The key consideration is fairness, focusing on skill rather than luck. Placing a fox beyond an unmapped dense forest area can unfairly favor luck over skill, as neither the map nor signal bearings offer clear guidance on whether traversing through the dense area or detouring around it is the faster option. Dense areas can be suitable for fox locations if the terrain is accurately represented on the map and if precise bearings can assist competitors’ decision-making. However, positioning a fox deep within a dense, impenetrable area should be avoided, as it forces competitors to navigate through an area lacking a discernible, optimal path, relying more on chance than on navigational expertise.

Start-Finish Location

When determining the placement of start and finish locations in Radio Orienteering, it's important to adhere to the rules regarding their minimum separation. The start should be positioned such that competitors navigating between foxes are not tempted to run through or near the start area. This avoids the risk of competitors who haven't started yet observing and gaining insights into the course layout.

Additionally, consider the practicalities of setting up start and finish corridors, as well as the logistics of transporting equipment and competitors to and from these locations. These logistical considerations can significantly impact the flow and timing of the event.

Design the start corridor(s) with care. The direction of a start corridor should not provide clues about the direction of the first fox that competitors should find. In fact, the corridors' orientation should be as unhelpful as practical and long enough to ensure that all competitors arriving at the exit are out of sight of other competitors who have not yet started. When two (or more) start corridors are used, ensure their exits are well out of sight of each other.

Placing the start at a higher elevation can reduce the total climb on the courses. A higher start elevation on a 2m band course may give competitors clearer initial bearings. However, course designers should use the available terrain and the start corridor layout to discourage competitors from congregating near the start corridor exit to take their initial bearings.

Positioning the finish at a higher elevation can increase the physical demands on competitors, emphasizing fitness and endurance. In the context of a 2m course, a higher finish location can also enhance the transmission range of the finish beacon, making it more detectable from various points on the course.

The flag for the finish beacon should be placed in accordance with the rules documents and should be as close as practical to the entrance to the finish corridor. The finish beacon flag should be clearly visible from all angles of likely approach. Competitors should be able to efficiently register at the finish beacon and enter the corridor, thus minimizing the chances of anyone having to wait for access to the registration station. The entrance to the finish corridor should be made obvious to all who approach it.

Avoid Doglegs

When designing a Radio Orienteering course, avoid routes that lead competitors back through the area they used to approach a fox. This is important because a leading competitor might inadvertently reveal a control's location to a competitor behind, creating an unfair advantage. Additionally, be cautious when using the same fox for multiple courses. If competitors from different courses converge at the same fox from opposite directions, it can lead to similar issues of unfair advantage.

Avoid Dangerous Areas

Ensure your Radio Orienteering course avoids hazardous areas, such as cliffs with limited visibility, sinkholes, extensive poison ivy or poison oak patches, and deep swamps. This is crucial as beginners might unintentionally enter these areas, and advanced runners might be tempted to take risky shortcuts. Deep creek crossings should also be avoided for the same reason, but also because an unlucky fall could potentially destroy a receiver, even one designed to survive in heavy rain.

Optimum Route and Climb

When designing a Radio Orienteering course, elevation gain and effective length are critical factors. Effective length is the adjusted course length considering both the actual distance and the added difficulty due to elevation gain. It's calculated by adding a factor (typically 10 times the total climb) to the actual course length. This calculation provides a more accurate representation of the course's physical demand. For example, a 5 km straight-line course with 100 meters of climb has an effective length of 6 km (5 km + 10 x 0.1 km).

In Radio Orienteering, specifically for Classic courses, the total climb (elevation gain) along the shortest viable route is limited to no more than 6% of the course length. This rule helps ensure that the physical demands of the course are balanced with the technical skills required for radio direction finding.

Field Check (Vetting)

It's essential to verify the planned fox locations on-site. Often, sites that appear suitable on the map may be impractical due to inaccuracies or issues with the map. Typically, a suitable alternative location can be found nearby, allowing the leg of the course to remain as initially planned. Whenever possible, make map corrections to correct inaccuracies that might affect competitor safety or route selection (e.g., dark green “fight” or black lines indicating uncrossable creek or swamp).

Hidden Controls

In Radio Orienteering, the flag's purpose is to clearly mark the fox's location and indicate where to find the punch or marking device. Non-mapped features should never obscure control flags, as it can be very frustrating for competitors to reach a fox but struggle to locate a concealed flag.

Unlike traditional orienteering, the flag should be the first thing a competitor sees, not a feature, the transmitter, or its antenna. The rules state that a flag must be plainly visible once a competitor has navigated near a fox’s antenna. But if the flag is also visible from other likely directions of approach, an attempt should be made to have the flag be equally visible from all those directions so competitors approaching from specific angles are not given an advantage.

While flags are designed to be viewed from all angles, foxes generally are not. By design or by their placement, transmitters and their antennas should be made as inconspicuous as possible. Ideally, the flag (or striped pole in the case of Sprint) should be the first fox-related object a competitor sees when approaching a fox.

QRM and QRN

Noisy environments can make it difficult for competitors to hear the foxes. Avoid courses that require competitors to spend significant time near busy freeways, construction areas, operational HVAC systems, or other locations with continuous audio noise that is loud enough to drown out the sounds in competitors' headphones.

Sources of radio interference should be avoided. Locations with high static or intermodulation conditions, like suburban neighborhoods, industrial areas, electrical substations, broadcast towers, etc., are not good locations for placing courses.

"Skip" propagation conditions (signals from distant stations) can interfere with 80m fox signals if a competition is held near sunset, sunrise, or overnight. Local "nets" (on-the-air meetings of radio amateurs) or similar Amateur Radio operations should also be avoided, if possible, by selecting alternative frequencies or competition times.

Band Considerations

On the 80m band, certain fox locations should be avoided because they can adversely affect the transmit antenna's radiation pattern, resulting in a directional transmit pattern that can add an unwanted element of luck to the competition. Such locations include metal fences, telephone and power lines, railroad tracks, and pipelines. If they are known to exist, shallowly buried metal wires and pipes should also be avoided. Ideally, 80m transmit antennas should be kept at least 20 meters away from such objects.

The nature of 144 MHz radio wave propagation unavoidably introduces some degree of luck into a competition held on that band. However, learning to identify situations and conditions that indicate the likelihood of multipath wave propagation is one of the skills that competitors must master in order to become proficient on that band. Even so, 2m foxes should not be placed in close proximity to large metal objects that might affect their radiation patterns. The distance to be maintained from such objects depends on the size of the object: a grain silo requires more separation than an automobile. If the palm of your hand held at arm's length can block your view of the object, that's probably an adequate distance. Wires and other conductors (especially horizontal ones) should be kept at least 10 meters away from a 2m fox antenna.

Competition Type Considerations

Beginner & Practice Courses

Beginner courses should be made shorter and less physically challenging, but the foxes and their placements should generally be identical to those used on regulation courses. To avoid frustration, the courses should be short enough that choosing the wrong order to find the foxes doesn't result in a beginner being unable to complete a course or going OT.

Classic Courses

Approximate winning time: ~60 minutes

Classic course requirements, including effective length and transmitter assignments for each age/gender category, are detailed in the rules documents and are not covered here.

Flags should be hung within 4 meters of the transmitter antenna and clearly visible to a competitor at the antenna. They should be equally visible from all directions of approach, ideally only becoming visible within 30 meters of the flag. Flags should be fully unfurled and never placed on the ground. Short posts (~1 meter tall) are often used to support both the flag and the registration device, although the use of such posts is optional.

The choice of which fox number to assign at each location is important in Classic courses, so the number of each fox should not be assigned arbitrarily. In order to prevent top competitors from congregating near foxes while waiting for them to resume transmissions, Classic courses should be carefully analyzed before assigning fox numbers. Adjustments should be made to minimize waiting times, aiming for a course that rewards efficiency. This process starts with the first leg and continues through the course. Starting with the first leg of the ideal route, determine which fox will start transmitting closest to the ideal arrival time. Assign that fox number to the first fox. Then examine the second leg: using its ideal time, estimate which fox will start transmitting closest to the arrival time, and assign that fox as the second in the ideal order. Continue the analysis of each leg to the last fox. Usually, at some point in the analysis, an already-assigned fox is found to be the one starting a transmission closest to arrival time. When that occurs, it is necessary to tweak the course, lengthening or shortening one or more legs until all the fox numbers have been assigned so that an elite competitor making no mistakes will complete the course without ever having to waste time waiting for a fox to resume transmitting. The result is a course that benefits the best competitors: those who can complete the most legs in the ideal time. This way, the role of luck is minimized by ensuring that the most efficient runners are the ones rewarded with better course times.

Initially, conduct the above fox-assignment analysis for the fastest, elite categories like M21 or W21. Then, other categories should be assessed, recognizing that not all courses can be optimized due to shared foxes. While elite competitors will appreciate your optimization efforts, other participants might not notice, as they less frequently achieve ideal times.

Because dividing five foxes into five or more different courses of different lengths results in numerous course-design compromises (not just in assigning fox numbers), it is desirable to devote all five fox transmitters to just the long courses and five others to just the shorter courses. Doing so will allow for better course designs with fewer compromises. As most organizers lack resources for two simultaneous courses on the same band, using different bands on consecutive days is a common solution (e.g., shorter 80m and longer 2m courses on one map the first day and the reverse the next). This approach requires more effort on the part of the organizers but can result in higher-quality courses.

Try to have the course layout make it challenging for competitors to determine the optimal order. It must be possible for competitors to determine the optimal order using accurate bearings and skillful map reading, but the order should not be obvious to runners without careful analysis. Ideally, competitors taking foxes in the wrong order should pay a significant price in terms of lost time and needless effort - but fairness dictates that competitors must be able to avoid those costs by taking careful bearings and understanding the map.

Classic course designs benefit from having multiple route choices along each leg. Avoid having an obvious navigational feature (e.g., a road or a trail) connecting adjacent foxes. While trails or roads can be useful for portions of a leg, try to avoid situations where a single trail can be followed for the majority of any leg.

Foxoring Courses

Approximate winning time: ~60 minutes

Foxoring course requirements, including effective length and transmitter assignments for each age/gender category, are detailed in the rules documents and are not covered here.

Despite Foxoring being the radio orienteering format most similar to regular orienteering, no orienteering flags are used to mark the foxes or their nominal positions. Typically, short posts (~1 meter tall) are used to support the registration devices, though such posts are optional. The registration device must be located within one meter of the fox antenna and should be easily identified when standing at the fox antenna.

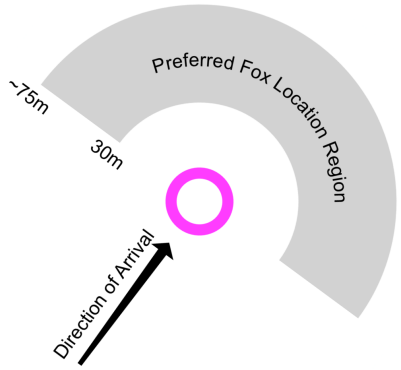
By assigning different frequencies to the foxes, it is easier to design courses on which competitors are unlikely to receive signals coming from foxes that are not on their course. If multiple frequencies (up to three) are used, adjacent foxes should be assigned to different frequencies. Competitors must tune their receivers as they move along their course, always listening for the next fox. If they pass near other foxes along their route, they are unlikely to notice them since they occupy a different frequency. Using more than one frequency for the foxes is recommended but not required by Foxoring rules.

Depending on their transmit strength, foxes should be placed within approximately 30m to 75m of the center of their nominal locations indicated on the map. Stronger fox transmitters can be placed a greater distance from their nominal positions. While the nominal locations need to be centered on a real feature visible to competitors, the foxes do not need to be placed at any mapped feature. The same visibility principle as Classic foxes should be applied: Foxoring foxes and their download stations should be equally visible (or equally invisible) when approached from any likely direction. They should not be hidden or obscured by objects in the terrain.

Nominal positions shown on competitor maps should always be centered on map features that have been verified to be accurately mapped. Place the foxes in locations that competitors are unlikely to traverse as they navigate toward the nominal locations (see diagram). Ideally,

competitors should arrive close to each nominal position at about the same time they are able to discern the fox on their receiver.

If there are multiple ideal routes and, therefore, multiple potential directions of arrival at a nominal fox location, try to place the fox so as to provide no significant advantage to any route.



An orienteering flag is used to mark the Foxoring finish beacon location, and the beacon flag should be placed in accordance with the same recommendations that apply to Classic course beacons.

In other respects, Foxoring courses should be designed using the same principles applied to regular advanced (brown or higher) orienteering courses. See General Considerations For Cross Country Orienteering Courses: Design and Set Guidelines.

Sprint Courses

Approximate winning time: ~15 minutes

Radio Orienteering Sprint course requirements, including length and transmitter assignments for each age/gender category, are detailed in the rules documents and are not covered here.

The goals of Sprint course design are best described in the ARDF Sprint Handbook 2017 published by the IARU Region 1 ARDF Working Group. It is highly recommended that championship Sprint course designers study it thoroughly.

No flags are used to mark Sprint foxes: candy-striped posts are used to mark the fox locations in the field and are mandatory. The red-and-white posts are used to support the registration devices and must be placed within one meter of the fox transmitter.

Sprint foxes should be located so that their red-and-white posts are not visible from a great distance, but they should not be totally obscured or placed in a location that is difficult to reach. As much as possible, the course should be designed so that competitors on the course cannot readily see other competitors arriving at or leaving the foxes.

An orienteering flag is used to mark the Foxoring finish beacon location (and the spectator beacon if used), and the beacon flags should be placed in accordance with the same recommendations that apply to Classic course beacons.