

# Aerial Runway Code



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This code is designed to assist Leaders and other responsible adults with the construction of aerial runways as part of the programme.

This code provides details of a safe way to build and run an aerial runway. Any other techniques or equipment used need to be shown as being of the same or higher standard as those in this code.

## General

No part of an aerial runway can be said to be more important than another and all require an equal amount of attention. Nevertheless, an analysis of accidents occurring on aerial runways suggests that in almost every case where serious injury has resulted, the fault lay in either the seat and/or the method of attachment to the travelling block or in the braking system. At the outset therefore, it must be clearly understood that:

- The seat or harness used must comply with the guidance given in this Code
- The travelling block must be to the approved design and must have eyes or rings. Hooked blocks, however carefully moused, are completely unacceptable.
- The seat, harness or chair must be attached to the travelling block in the approved method as described in the Code.
- The main brake must be capable of controlling a steady and safe rate of deceleration of the passenger.
- An emergency brake must be fitted, in case of failure of the main brake.

The Code is based on long experience and should provide Leaders with useful guidelines for the

training of their Scouts. However, no such Code replaces common sense.

Responsible adult leadership and the need for adult control will always be present when risk to the person is involved.

## Supervision

The planning, construction and use of an aerial runway should be directed and constantly supervised by a responsible and competent adult.

## Equipment

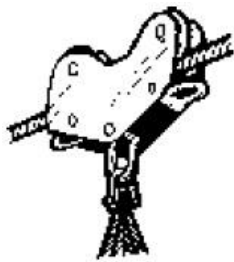
All equipment should be inspected before, during and after use. Apart from the important matter of security, this is in itself a valuable exercise in training in responsibility.

## Main hawser - the supporting rope

This should be natural fibre (manila or sisal), staple spun polypropylene, polyester or nylon. The recommended size is 24mm diameter and in no case should a rope under 20mm diameter be used. If the rope has not been in use for any length of time even when stored in ideal conditions, it should be checked for wear and tear along its entire length. If natural fibre is used, a spot check should be carried out by opening the lay at intervals to make sure that the fibres are free from mildew. Similarly, in a man-made fibre rope, if at inspection extensive powdering is discovered, the rope should be discarded. This usually occurs in the heart of the rope and is not always immediately detectable. A suspect rope should not be used in this or any other pioneering activity. It should preferably be cut into short lengths to prevent misuse.

The use of a wire hawser is not normally appropriate for the construction of aerial runways. An aerial runway should be capable of being constructed by a group of Scouts under the supervision of adult leadership. The skills and strengths required to handle wire hawsers would not normally be expected in Scouts or indeed the average Scout Leader or Instructor.

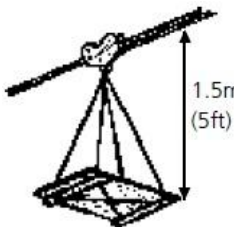
### Travelling block



The travelling metal block must be a double pulley, man-carrying block of the correct size and type.

These blocks are fitted with a closed ring to attach the seat or shackle and further closed rings to attach the braking and hauling lines. Under no circumstances should hooked blocks or hooked blocks that have been converted to closed eyes through the use of brazed metal straps or jubilee clips be used.

### The seat



There are a number of different ways by which the passenger can be attached to the double pulley man-carrying block. If a purpose-built seat is the chosen alternative, great care

should be taken in its preparation. A stout board of approximately 600mm x 250mm x 24mm thick will be needed, reinforced with bracing battens across the grain. Holes should be bored through the board to take suspension ropes. Apply figure of eight stopper knots and join the tails with reef knots.

If a commercially available full body harness is selected, care will need to be taken to ensure that the harness used fits the passenger correctly. It is not acceptable to pad the harness to fit the individual. The harness must be securely fastened and attached to the man-carrying block so that it cannot be accidentally released. The harness

must be a full body harness; a waist harness designed for climbing is not adequate as the user may become inverted and lose support from the harness. An alternative is a combination of a sit-in and a chest harness connected with a strop.

The third alternative is a commercially available bosun's chair.

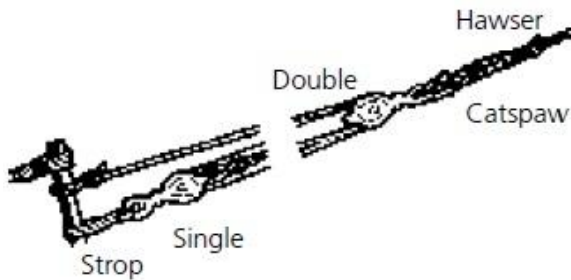
Devices such as battens or strops, which require the passenger to dangle from the hands or wrists, should not be used.

The method of attaching the seat, harness or chair to the travelling block, and the travelling block itself are to be regarded as potential accident black spots in any runway. They should be checked and double-checked as a matter of routine before the runway is declared operational and after each run. Two climbing strops each with a screw gate karabiner at each end will normally be adequate to attach the seat, harness or chair to the travelling block. Each strop will be 1.5m long which will give a double attachment to the main riding block for safety. Alternatively a 3/8 shackle could be used; care should be taken to ensure that the direction of the strain is compatible with the design of the shackle. It is possible for these devices to fail if the direction of strain is different from that for which they were designed. Any shackles used throughout the construction should be tested and stamped. Cheap fencing or yachting shackles are not suitable. It is essential that the passenger is separated from the hawser by an adequate distance, to avoid the possibility of a hand being placed on the hawser in front of the double, man-carrying block. Minimum distance of 1.5m is recommended (see diagram on previous page).

### Other blocks and tackle

To tension the main hawser, a luff tackle, defined as a tackle comprising one single and one double block, will be needed. These blocks should be metal blocks and should be reeved up with an 18mm diameter rope. This will provide a purchase of 4:1. When selecting the correct size of block to match the size of rope, ensure that:

- No rope is reeved through the block where the width of the sheave grooves is less than the diameter of the rope.
- The ratio of the diameter of the sheave (the rotating part of the block) to the diameter of the rope is not less than 5:1, measured at the bottom of the sheave groove.



Wherever possible in the construction of the aerial runway, blocks and pulleys with rings or closed eyes should be used in preference to hooks. Mousing is never absolutely reliable with the shock load experienced on this type of construction.

### Pickets and spars

Where wooden pickets are used, they should be in good condition, free from cracks and rot and of adequate length and thickness. A lot depends on the nature of the ground and the anchorage selected but pickets of 1m x 75mm butt diameter should be regarded as a minimum. Ideally the picket length should be 1.5m but these are not always available. In use, they should be driven with a maul rather than a sledge hammer for two-thirds of their length, at right angles to the direction of the strain, which for obvious reasons should be secured close to the ground. Note that if the strain is allowed to ride up the pickets, they will be subject to a greater degree of leverage and are more likely to break or become loose in the ground.

Spars should be equally sound, free from cracks and should be readily tested by gripping the tip and ringing the butt on any hard surface. A sound spar will give a reassuring ringing sound, while a suspect spar will give a dull thud. 130mm butt diameter should be regarded as a minimum irrespective of length.

### Other cordage

The main braking system, a design of which is described later, will require a 12mm diameter rope, some 10m longer than the length of the runway. In addition, approximately 10m of 10mm diameter elasticated shock cord (sometimes known as 'bungee rope') will be required. Lashing ropes of 6m - 8m length, guy lines for sheer legs, a strop loop of 18mm diameter of sufficient length to secure the tackle to the anchorage, twine and sisal will also be required.

### Tools and accessories

Sacking or old canvas will be needed to act as protection for trees, a saddle in the crutch of sheer legs and so on. Tools will include a heavy maul, a clasp knife and depending on circumstances, a spade or entrenching tool, an extending ladder or rope ladder and a throwing line to facilitate tree climbing.

### Location and angle of slope of the runway

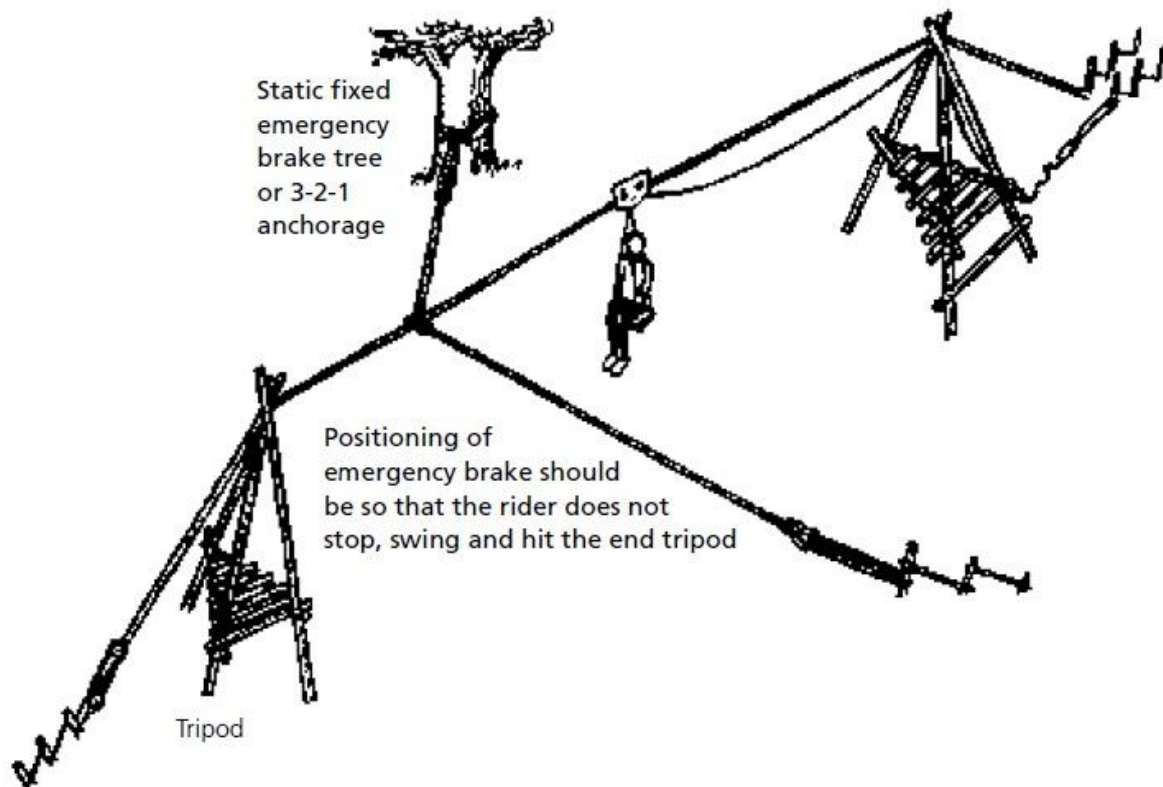
Natural features like trees and the slope of the ground will determine the length of run and the speed of descent.

However the height and angle of the slope should be such that a safe, steady descent is possible.

No exact formula is possible to determine the speed of descent. As well as the length of run and the slope, the speed will depend on the tension in the main hawser, the performance of the running block, the weight of the passenger and so on. The person in charge is responsible for ensuring that the appropriate tests are completed before any passengers are allowed on the runway - see 'Factors of safety and testing'.

The illustration overleaf shows a typical construction, but the points raised below apply equally to the horizontal runway where the travelling block is pulled by people on the ground or to runways of any kind.

In the planning stage, careful consideration should be given to the ease of mounting and dismounting from the seat since these are the causes of many accidents.



### The main hawser

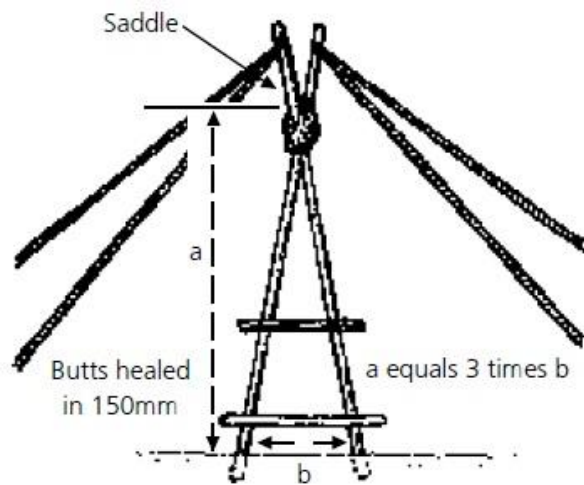
Depending on the terrain, there are various methods of supporting the main hawser:

- Where a tree is available at the head of the runway, make sure that it is sturdy and that, with adequate protection, it will suffer no ill effects. Use the main trunk in preference to a branch but if a branch is used, select the strongest within reach and make fast the main hawser with a round turn and two half hitches, leaving a long tail hanging close to the trunk. If the hawser is passed over a suitable high fork and the end secured to a lower branch, this makes it easier to examine the knot during use. Secure the padding of sacking or canvas with sisal before making fast the main hawser.
- Rope work at ground level is one thing but handling a 24mm diameter hawser whilst sitting astride a branch half way up a tree is another matter altogether! Procedures must be put in place to safeguard the safety of those constructing the runway.
- If no suitable tree can be found when operating on flat ground, a manually operated fore and aft

runway between two sets of sheer legs can be excellent fun.

- The tail or lower end of the runway could be a tree, sheer legs or tripod. Care must be taken to ensure that the point where the main hawser is attached to the tree or passes over the sheer legs or tripod is not the lowest point of the runway, or the passenger may be put at unnecessary risk.
- Sheer legs can be used to take full advantage of the natural slope to increase the length of the run and to reduce the height hazard. Spars of 4m are suitable for the sheer legs. Several 6m to 8m lashings of 12mm or 18mm diameter rope will be needed. The sheer lashing should be applied first about 500mm from the top with the two spars in the closed position. They can be opened slightly like scissors when the frapping turns are put on. They should then be opened out with the butts no further apart than one-third the height from the lashing to the ground and the third spar square lashed between them about 300mm from the butts. The saddle of hessian or canvas should be lashed in the crutch with sisal twine and fore and aft guy lines secured to the tops of both spars.

## Sheer legs



To minimise the danger of keeling over, ever present in a construction subject to variable stresses and strains, the feet of the two legs should be heeled into the ground to a depth of at least 150mm. The lower ledger (cross bar) should then be well clear of the ground.

All this work should be done before the hawser is finally positioned. When the tackle is being operated to tension the main hawser, the sheer legs may tend to move from the vertical position although this can usually be corrected without difficulty if caught in time. Constant vigilance should be the key note. Mounting and dismounting from the seat can be tricky from sheer legs but additional cross bars (ledgers) are helpful.

Tripods may be used in preference to sheer legs. Greater stability is ensured although guying is still useful. An additional advantage is that mounting and dismounting platforms can be incorporated into the design.

For both sheer legs and tripods, the main hawser may, with suitable packing, pass over the crutch. It is also possible for the main hawser to pass over a pulley of suitable diameter, suspended from the crutch. A double loop of 18mm diameter rope should be used to support the pulley.

- In all three methods of support, (trees, tripods, or sheer legs), due allowance must be made for the inevitable sag in the main hawser. This will depend on the length of run and the load, as well

as the tension. But it should never be such that the feet of a passenger can touch the ground.

- To tension the hawser, a luff tackle comprising one single block attached to an anchorage and one double block attached to the main hawser is necessary. The main hawser should be connected to the closed eye of the double pulley using a catspaw. Sacking around the closed eye will help protect the hawser. The single block should be attached to the main anchorage using a double loop of 18mm diameter rope. When reeved with 18mm rope, the luff tackle provides a purchase of 4:1 and when operated by half a dozen Scouts should give all the tension required. More forceful methods of straining the system not be used. The tension is maintained by securing the strain to the same anchor point as the single block using a round turn and two half hitches.

## Anchorage

In all anchorages, their precise position in relation to the main structure is of great importance. The hawser must run in a true line from end to end. Any deviation will impose a sideways strain on sheer legs and might cause them to topple.

A well grown tree can make an excellent anchorage, although they are seldom to be found in just the right spot! If a tree is used, make sure that it is secure, protected near the base with a good pad of sacking and prepare the luff tackle ready for use. Take in most but not all of the slack in the hawser and pass it through the eye of the fore block. Lay the sheer legs on the ground with the butts at the correct distance from the anchorage. This distance should be twice the height of the crutch of the sheer legs. The hawser should be lying over the crutch. Raise the sheer legs and hold them in place while the slack is taken up on the hawser. Adjust the position of the sheer legs as necessary to ensure a true line. Mark the position of butts with tent pegs, so that foot holes can be dug in exactly the right place. The sheer legs can then be erected and the necessary strain applied on the luff tackle.

A different procedure is recommended when other types of anchorage are used. The sheer legs



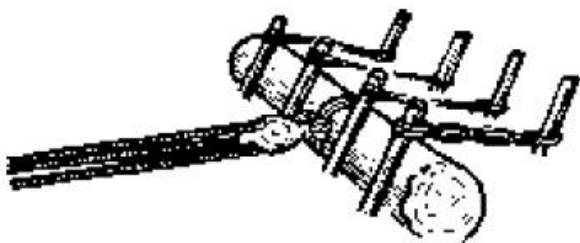
should be erected first so that the hawser can be drawn over the crutch and hand strained to pinpoint the position of the anchorage which will always be twice the height of the sheer legs away and in line with the strain.

### 3-2-1 anchorage



This consists of a line of six pickets in the order of 3-2-1, running true to the line of the main hawser. It is ideal in heavy, stone free ground. For best results the pickets should form an angle of approximately 60 degrees to the ground. The main hawser should be attached at ground level via the luff tackle to the front three pickets at right angles to the pickets. The three groups of pickets should be so spaced that the lashings between them run at right angles from the top of the forward to the base of the next in line. Lashings 8m long will be needed. Start with a clove hitch around one set, followed with a number of tight turns and frap with overhand knots. No attempt should be made to firm up the pickets with a few extra blows from the maul after the lashings are in position. This will merely loosen the turns and defeat the object of the exercise. It is essential that with this and all other types of hold fast, they should be kept under close observation when the strain is first applied and thereafter inspected at frequent intervals when the runway is in use.

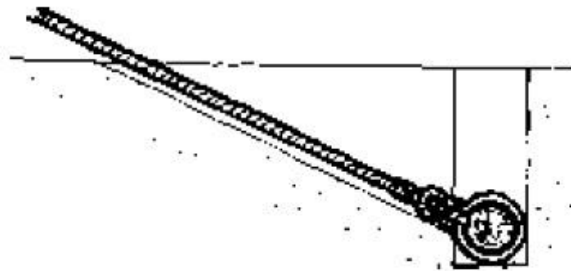
### Log and picket anchorage



For this, use eight pickets and a log of not less than 150mm diameter and 1m in length. The log

should lie at right angles to the line of the strain and care must be taken to see that it bears equally on each of the forward pickets. The angle between the hawser and the ground should be similar to that for the 3-2-1 picket and certainly no more than thirty degrees.

### Dead-man anchorage



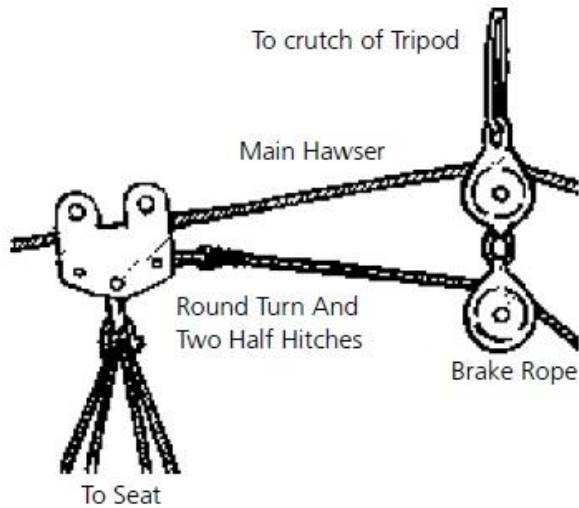
This is most suitable in the lighter ground or where the presence of stones would make the driving of pickets difficult. The log should be at least 150mm in diameter x 1m in length and should lie at right angles to the strain in a trench at least three times its own diameter in depth. A stop made from a double loop of 18mm rope is secured to the exact middle of the log and brought up a narrow channel cut in the soil in line with the strain so that the single block of the tackle can be secured. Again, the angle between the hawser and ground should be no more than 30 degrees. Before any earth is returned to the trench, it is as well to complete the job and take up the strain on the tackle so that any undue movement of the dead-man, for instance, the tendency to ride up the side of the trench, can be corrected before the final burial. The ground should then be trampled to make it firm.

### The main brake

This must provide a steady and safe deceleration of the travelling block. Any system that meets this requirement is acceptable. Brakes which bring the system to an instantaneous stop must be avoided at all costs as there is a very great risk of the passenger being thrown off at great speed.

A preferred method is to trail a rope of 12mm diameter from the rear closed eye of the travelling block. This rope passes over a pulley which is suspended from the crutch at the head of the

runway. If there is sufficient head room on the loading platform, this pulley may be suspended from the closed eye at the bottom of the pulley which supports the main hawser at the crutch.

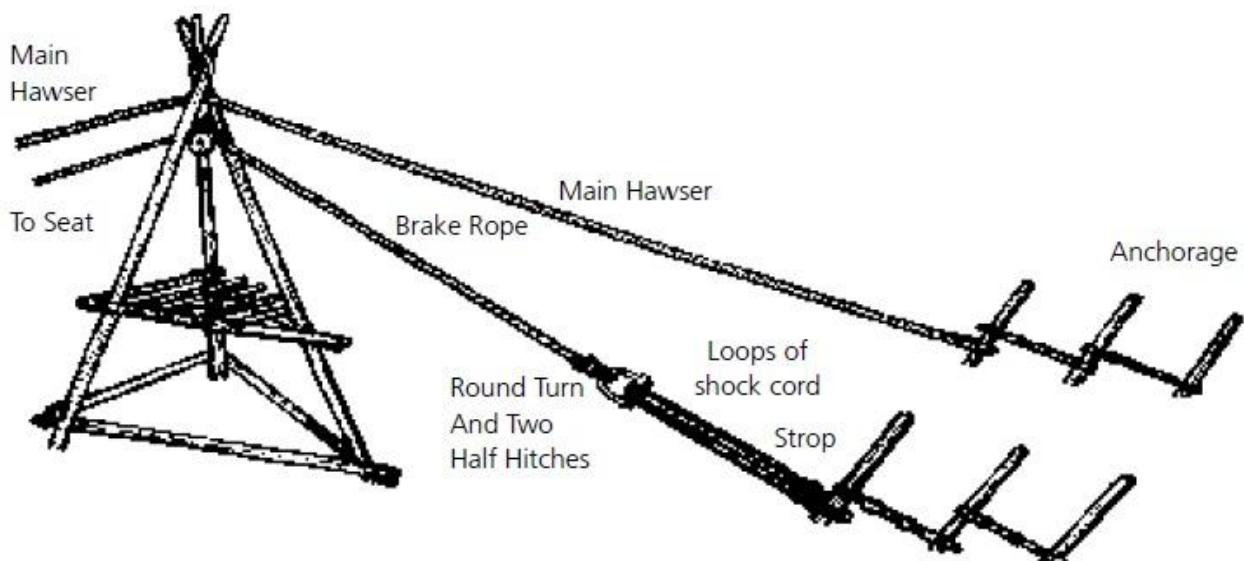


With the seat at the point on the runway where braking is to commence, the brake rope is tied to a shackle using a round turn and two half hitches approximately 10 metres on the anchorage side of the mounting point. The shackle is used to connect the brake rope to the anchorage point using loops of 8mm or 10mm diameter shock cord as shown in the diagram below. The length of the shock cord loop will determine the braking distance since, under no circumstances, should the shock cord be allowed to extend beyond twice its normal length.

It will be necessary to experiment with a number of loops because braking will depend upon the speed of descent and the load but a double loop of approximately 5 metres length, that is, a 20m length knotted to form a double loop, is a good starting point for most loads up to 75 kilograms. A further short double loop of 18mm rope can be used to connect the shock cord to the anchorage point. Once the passenger has come to rest, this rope loop can be removed from the anchorage to lower the passenger down the runway to the dismounting point. The passenger should be warned not to dismount until told to do so and that the braking system will inevitably result in some forward swing of the seat as braking commences, followed by a short period of reverse travel back up the runway as the elastic reached the equilibrium position.

Once the passenger has dismounted, the brake rope can be used to haul the seat up to the top of the runway. It is important to lay out the brake rope carefully as any snag during running will jam in the pulley at the head of the runway causing a sudden stop.

It should be noted that before the run is commenced, care must be taken to ensure that the brake rope is clear of the passenger. In addition, the loader on the platform must also keep clear of the brake rope during the run as the brake rope feeds through the crutch pulley.



## The emergency brake

In case of failure to any part of the main brake, an emergency brake should also be fitted in such a position that the passenger can be decelerated smoothly without colliding with the lower sheer legs or tripod. The emergency brake may consist simply of a shackle on the main hawser, with the two ropes attached being fixed to static points or held by two brake people as shown in the diagram. Lengths of 8mm or 10mm elasticated shock cord may be used instead of rope to reduce the shock loading if necessary.



In normal operation, the people operating the emergency brake will assist the passenger to dismount at the completion of each run. As with the main brake, testing of the emergency brake is essential before the first passenger embarks.

The angle of the rope of the emergency brake to the shackle on the main hawser must be held such that when the main hawser is sagging under load as the passenger approaches, there is no chance of the emergency brake ropes or shock cord becoming entangled with the head or neck of the passenger.

## Factors of safety and testing

When ready for use, the runway should be subjected to a number of rigorous tests to ensure a high factor of safety before the first passenger is allowed to embark. As good practice, these tests should impose a higher strain on all parts of the apparatus than is likely to be experienced during normal use. The following tests should be carried out under adult supervision with observers posted to watch every part of the runway, especially the anchorages, pickets, sheer legs, running block and seat and the braking systems:

- Attach a temporary rope to the empty seat. Starting at the head of the run, a vigorous bouncing strain from ground level should be applied. This should be repeated at intervals throughout the entire length of the run, especially

around the mid-point where maximum sag in the hawser will be experienced.

- The seat should then be drawn to a convenient point and loaded with at least two five gallon containers full of water.
- This load represents a body weighing approximately 50 kilos. Three full containers should be used to represent a body of 75 kilos. At the mid-point of the runway, the sag in the hawser under load must not allow the feet of a passenger to strike the ground. If this happens, adjust the tension on the main hawser.
- The loaded seat should then be drawn to the head of the runway. The speed of descent and the main braking system should now be tested. The load should be brought to a stop short of the lower sheer legs or tripod with an adequate margin of safety. At the same time, the elasticated shock cord should not be allowed to extend beyond twice its natural length.
- Finally, the main braking system should be disconnected and the emergency brake tested, again using a loaded seat running from the head of the runway. The position of the emergency brake operators, if used, should be marked so that there is no tendency to drift towards the bottom of the runway during normal operation.
- After all these tests, all knots, lashings, anchorages, pickets and so on should be thoroughly inspected.

## Mounting and dismounting

When the take off at the head of the run is at some height about the ground, for instance, from the branches of a tree, adequate means of climbing to the mounting point must be provided. It might be safer in this situation for passengers to embark at the foot of the run, where safety and comfort can easily be checked, before being drawn up by the brake line.

A disturbing number of accidents occur during mounting and dismounting. When dismounting many passengers find that strength has drained from their muscles and their knees are trembling. To climb down sheer legs or a tripod using



ledgers therefore requires extra care and supervision.

## Operation

It is strongly recommended that a minimum of four people operate the runway. The loader at the head of the runway is in charge and should be able to see the whole runway at any time. No passenger is released on a run until checks have been made with the person looking after the main brake. Ideally there should also be a person to control those waiting for their turn on the runway.

It is the loader's responsibility to brief passengers before release. If a traditional seat is being used they should be told to sit well back in the middle of the seat, to hold onto the front supporting ropes (youngsters hold on to both ropes, arms crossed over their chests), to relax and keep still. If a full body harness or commercial bosun's chair is being used they should be advised to relax and keep still. They should be reminded that when the brake comes into action near the bottom of the run, they will probably swing forward and on no account should they attempt to jump off. The passengers should also be briefed that once they have come to rest, the carrying system will be towed to the dismounting point and the people at the emergency brake will tell you when to dismount.

In order to maintain the concentration and interest of the operating team they should rotate duties at regular intervals.

Leaders should note the dangers of leaving runways erected for long periods, for instance, at summer camp. In such circumstances, the system should be immobilised as far as possible by releasing the strain on the tackle, by removing or tying back the travelling block and by whatever further method is appropriate to the conditions.

## Public Events

If an aerial runway is to be included as an attraction at a fund raising event it must be used for purposes of demonstration only by fully trained Members of The Scout Association under adult supervision. On no account may an aerial runway

be made available for use by members of the general public. When not in use, the runway must be immobilised as above and must remain under constant adult supervision.

## Checklist during use

Even when the provisions of this Code have been closely observed in the building of the structure, the runway will inevitably suffer severe stresses, strains and shocks while in operation and constant vigilance will be needed. This is the responsibility of the person in charge but all engaged in the activity should be involved with safe operating procedures.

The following items should receive frequent attention:

- All knots and lashings. If any are found in need of attention, suspend operations until the work is completed.
- Pickets and anchorages. Movement under strain must be monitored. Any undue movement and the operations must be stopped until anchorages are replaced and tested using dummy loads.
- Blocks and tackle. Check blocks, and if any heat is generated, blocks should be re-oiled or replaced.
- The seat, harness or chair requires regular inspection especially at the point of attachment to the travelling block. Every part of this requires regular inspection but especially at the point of attachment to the travelling block.
- The main hawser. Anchorages at both ends must be regularly checked. It may be necessary to take up additional slack during operation as some stretching is inevitable. At no time should the feet of a passenger be allowed to touch the ground. Alternatively, excessive speed of descent can be slowed by decreasing strain on the main hawser. After any modifications during use, testing with dummy loads should be conducted before any passenger is allowed on the runway.
- The sheer legs or tripods. Any movement from the vertical position or any tendency to rock or tilt should be checked before the runway is used again.

- The braking system. Check the attachment of the brake rope to the travelling block, the means by which the shock cord is attached to the anchorage point and so on.
- Mounting and dismounting. Can this tricky operation be made easier for the passengers, perhaps by the addition of extra ledges on sheer legs or tripods, the re-positioning of a rope ladder or mounting frame?
- The briefing of passengers. Is this working satisfactorily? None of this need involve much fuss and bother. Full advantage should be taken of the exercise to alert Scouts and, in particular, Patrol Leaders and Explorer Scouts of the dangers inherent in activities of this sort and to increase their awareness of personal and corporate responsibilities.

### **Record of equipment usage**

As with all potentially hazardous activities the care and maintenance of the equipment used is paramount. A formal written record of the use of the ropes, blocks and other equipment should be maintained. Such a record must detail; date of acquisition, usage, inspections carried out and maintenance along with method of disposal for time-expired or damaged equipment.