CHAPTER 5: DESIGN OF FACILITIES FOR MANAGEMENT OF LIVESTOCK

This chapter will look at the design of handling facilities based on a knowledge of the behaviour of each species. Running animals into yards for various husbandry practices such as shearing, weighing, branding, holding stock in pens, or transporting animals, all cause disruption to the animals' social system and stress to the animals. A knowledge of the behaviour of different species of livestock as well as the behaviour of different breeds within a particular species is essential to the proper management and planning of facilities for the stock (Grandin, 1980).

When handling animals, it is important to remember some general factors that can affect their behaviour, such as:
1. the degree of tameness – this will be reflected in the flight distance,
2. breed and species,
3. the type of environment in which the animals were raised.

This section will review cattle, sheep, pigs and deer under the following topics:

1. BREED DIFFERENCES

2. VISION

3. PERSONAL SPACE

4. DESIGN OF FACILITIES

5. NOISE AND SMELL

CATTLE

1. ***Bos indicus*** (Zebu, Brahman types).

2. ***Bos taurus*** (European breeds, e.g. Hereford, Angus).

BREED DIFFERENCES

When ***Bos indicus*** is compared with ***Bos taurus***, the general pattern is that ***Bos indicus*** types are more excitable, harder to handle and more difficult to block at gates. They also tend to ram fences (Tulloh, 1961). Tail swishing or the tail standing straight up is an indication of agitation.

In the European breeds Angus cattle are more nervous than Herefords or Shorthorns and tend to be stubborn and refuse to move. Holsteins tend to move more slowly (Tulloh, 1961).

Brahman-type cattle, if stressed may lie down and become immobile. If more stressed by prodding, they may go into shock and die (Grandin, 1980).

Experience with extensively grazed cattle in Australia suggests the frequency and manner of handling have a greater effect on behaviour traits than does breed (Evans, 1998).

VISION

The understanding of what an animal can see is essential for correct handling and design of facilities.

Cattle have a panoramic view of 360°, binocular vision of 25-50°, and poor depth perception. This leads to several considerations in design:
1. Lead-up chutes, crowding pens, passages, and curved holding lanes, should have high, solid walls to prevent cattle from seeing and being distracted by moving objects, people and other cattle outside (Grandin, 1980).
2. Cattle tend to monitor each other and maintain visual contact and naturally tend to follow each other. If they can always see the animal in front they will move through a narrow passage (Ewbank, 1961). Because of this following tendency, the transition between the single file-up chute and the crowding pen must be smooth to prevent bunching and jamming up of the animals (Grandin, 1980).
3. The relatively poor depth perception and wide-angle vision of cattle makes them reluctant to cross:
   a. shadows or any area of high contrast,
   b. uneven drains or any uneven piece of ground,
   c. downward slopes.

Cattle are also hesitant to go into a dark area from a light area. In designing floors and lighting, these are all important considerations, and lighting should be even and diffuse to prevent areas of contrast. Also the handler should be in visual contact with the cattle and catwalks should not be overhead. Cattle will often balk and refuse to pass under an overhead walkway or through a door if the entrance appears to be too low for their bodies (Grandin, 1980).

PERSONAL SPACE

In cattle there is a critical distance or 'flight'distance that a handler must maintain between himself and the cattle he is moving. The critical distance is 1.5 m (5') to 7.6 m (25') for fattened cattle and up to 30.5 m (1001) for free-range cattle. Brahman cattle usually have a larger critical distance than British breeds (Grandin, 1980). If the handler gets too close, the animal will either,
1. run past the handler,
2. run from the handler.

A handler should not lean over a single-file chute as this penetrates the animal's personal space and can cause rearing up or jumping. When moving a mob of cattle, an experienced handler can keep the group moving by concentrating on moving the leaders (Grandin, 1980).

If one animal does break from the group it is wise to let several more go with it, as cattle are mob animals and a lone animal can easily panic. It is much easier to round up three or four head than one lone agitated animal (Grandin, 1980).

Regular handling reduces avoidance behaviour and improves handling tolerance of young cattle, although interaction can be improved more effectively when associated with food (Jago et al., 1998)

Trials reported in 1990 have indicated the optimal time for establishing social attachment with young cattle is in the first 4–6 days of life (Fraser and Broom, eds, 1990)

The flight distance in cattle is significantly less from a stationary human in comparison to a moving person (Murphey et al., 1981)

DESIGN OF FACILITIES

1. Solid fences, where animals are crowded together prevent them seeing moving objects that may upset them.
2. A solid crowding gate prevents cattle from seeing light through the gate and turning towards it.
3. Curved chutes and catwalks facilitate natural following behaviour and prevent animals from seeing the stunning pen in the abattoir. A curved single-file lead-up chute should have a catwalk along the inner radius which enables the cattle to maintain visual contact with the handler and facilitates the animal's natural tendency to circle the handler (Grandin, 1980).
4. Pen design: cattle prefer to stand around an edge rather than in the middle of a pen. A long narrow pen has a higher ratio of perimeter than a square pen of the same area (Grandin, 1980), e.g.

The troughs for dairy cattle are best placed around the perimeter to prevent competition.

Long narrow pens built on a 60° angle to eliminate the 90° corner facilitate animal movement in a slaughter plant holding pen. Animals enter through one end and exit through the other (Grandin, 1980), e.g.

The visual contact, entering and leaving of an animal's flight zone and subsequent movement of cattle through a curved single file race can be seen in Figure 5 (Grandin, 1998).

NOISE AND SMELL

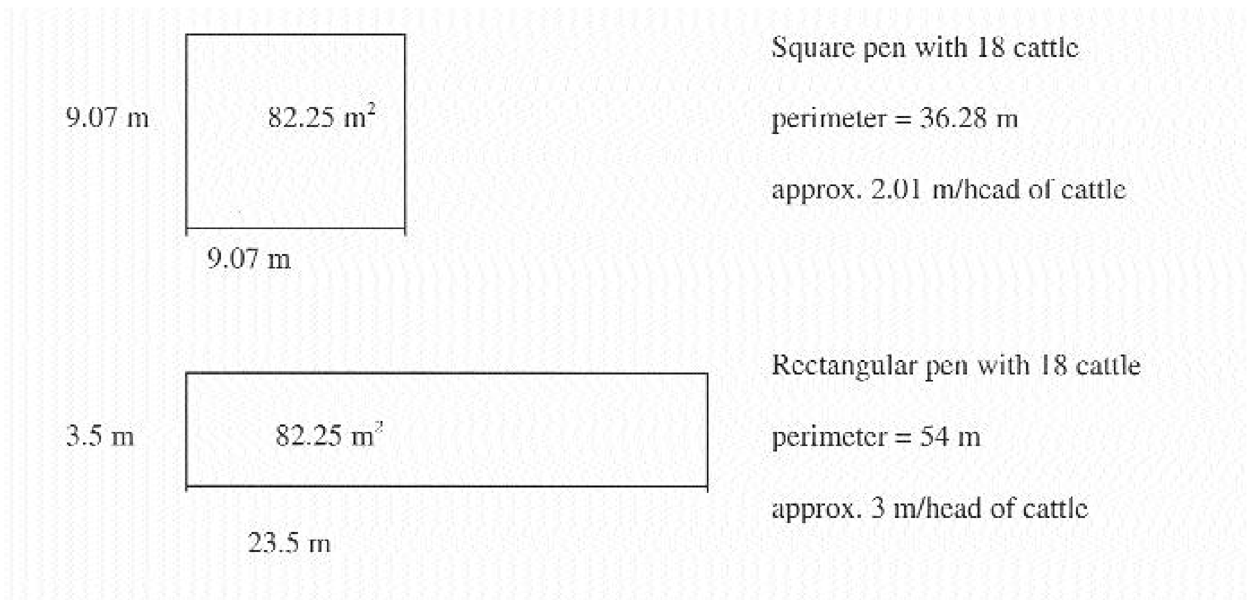
All animals are stressed by noise – banging gates, machinery, people yelling and dogs barking. Cattle appear to be sensitive to the smell of blood and will often refuse to enter a stunning pen if there is blood on the floor (Grandin, 1980).

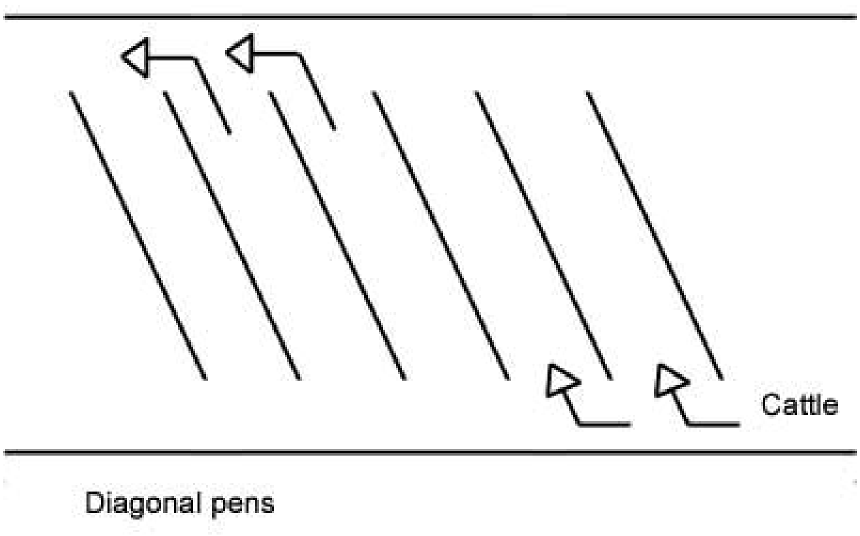
Stress related to noise can be significantly greater in cattle than humans, because cattle can hear sounds of much higher frequencies than humans (Dalton et al., 1994).

It is thought that sudden and unexpected sounds elicit the fear response in cattle (Waynert et al., 1998).

There is evidence that alarm/stress substances exist in the urine and faeces of cattle (Boissy et al., 1997).

Biological sounds arising from another species (e.g. humans shouting) appear to be more stressful for cattle





than mechanical noises (e.g. metal clanging). This is probably because biological sounds would be more significant to a prey species (Waynert et al., 1998).

A simple and economical way to reduce noise levels in handling facilities is to add rubber padding to appropriate areas (e.g. clanging gates) (Waynert et al., 1998).

Cattle may be habituated to noises. This can be demonstrated in the case of dairy cattle at milking time. Music played in the dairy during milking can mask minor foreign noises that may disrupt milk letdown. The level to which cattle become habituated was the focus of a study reported by Albright (1997). The study showed that cows preferred classical music (showing the least reduced or even an increased milk production) to hard rock and country. However, follow-up studies have shown that this response was most likely a function of animal routine rather than the particular music played.

SHEEP

Sheltering activity in pregnant ewes increases dramatically after the birth of lambs. Shelter-seeking is more pronounced in shorn ewes than full fleece individuals (Pollard et al., 2000).

BREED DIFFERENCES

Some sheep tend to bunch tightly as a group, e.g., Merinos, while other breeds, e.g. crossbred Finn sheep, turn to face the handler and maintain visual contact (Grandin, 1980). Romney, Merino-Romney cross and Dorset-Romney cross are difficult to drive. The previous chapter described the mob behaviour of different breeds of sheep.

Different breeds of sheep react differently to handling techniques and systems. The Rambouillet tends to flock tightly together and remain in a group, while the Cheviot is more independent of its flock (Grandin, 1999).

Hansen et al. (2001) has shown that differences of breed affect the anti-predatory response to stimuli (fleeing and bleating), while breeds that are lighter in body weight (such as the Old Norwegian Sheep) flee more readily than heavier commercial breeds (such as the Suffolk).

VISION

Sheep have 360° panoramic vision and binocular vision of 25–50° , and it has been shown that ewes are able to distinguish between a variety of colours and various shades of grey (Alexander and Shillito, 1978). Like cattle, they have poor depth perception so:

1. shadows are important,
2. sheep are reluctant to enter dark areas from lighter areas,
3. any unevenness on the floor can cause sheep to balk,
4. lead-up chutes should have solid walls to prevent distraction.

In general, sheep run faster through races with covered rather than open sides. This seems to be because the covered sides restrict peripheral vision and channel the sheep's sight towards the exit. The sight of stationary sheep will slow down the movement of sheep through an adjacent race (Hutson, 1980). Sheep movement is better on the flat than up or down inclines and so the direction of movement should be across the slope rather than uphill or downhill (Hitchcock and Hutson, 1979). Sheep follow each other and the use of a Judas goat or a trained sheep is recommended to lead the animals into a slaughter plant (Grandin, 1980).

Modern circular and bugle-shaped yard designs are based on the assumption that sheep move more readily around corners but work has shown that in 1.5 m wide races sheep move better straight ahead than around corners (Hutson and Hitchcock, 1978). It is only when sheep move in a single file that corners are superior to straight races.

PERSONAL SPACE

Like cattle, it is important to know the flight distance of your mob of sheep. This is the principle a sheep dog works on when rounding up the sheep.

Sheep tend to move in the opposite direction to handler movement when confined in yards, so long narrow facilities where handlers intrude on the sheep's flight zone provide an effective way of moving stock (Grandin, 1999).

FACILITY DESIGNS

1. One of the most important design criteria for yards is that sheep should have a clear unobstructed view of the exit, or towards where they are meant to move (Hutson, 1980).
2. Sheep move faster through races with covered sides.
3. There are two cases when care should be used with covered sides:
   a. in curved races, where covering the sides may give the sheep the impression of a dead end,
   b. the use of a material such as metal sheeting should be avoided because of the loud noise it makes if sheep bump into it (Hutson, 1980).
4. Shadows can cause sheep to balk, so, ideally, shadows should be avoided or minimised. This is almost impossible unless sheep handling is done in a shed, but a north-south alignment may, at least, minimise them and blinds can be put in trouble spots (Hutson, 1980).
5. Design of shearing shed (Hutson, 1980): most shearing sheds are raised off the ground to allow faeces to fall through. However, sheep movement is better on the flat then up an incline, so ramps should be long with a shallow rise. The ramp should have covered sides so sheep are prevented from looking out, and the floor should allow sheep to get a good grip.

Lighting is important, and sheep will move into a shed more easily if the interior is brightly lit, and where they have a clear view of an escape route or exit.

Flooring is usually made of battens about 16 mm apart and sheep movement is affected by the light intensity below the floor; they are hesitant to step on floors brightly illuminated from below. They also prefer to move at right angles to the direction of the slats as they get a better grip. Pens should be rectangular in shape so sheep are forced to move in only one direction when a dog or shed hand appears.

Exits for shorn sheep can prevent problems. If sheep return to the shed floor via a return race they have to cross paths with unshorn sheep before leaving the shed. If they leave the shed via a chute to underneath the shed they do not enter readily and usually must be pushed down by the shearer. However, chutes are probably better as they allow greater flexibility in forcing- and catching-pen design, and the flow of sheep through the shed is one-way.

6. Design of sheep yards: sheep move better through a set of yards they are familiar with, and ideally should follow the same route for all handling operations, dipping and shearing (Hutson, 1980).

Modern yards are usually curved or circular, but it is a concept that is quite old (Pearse, 1944). A yard was designed by Mr. H.E. Hoad of South Australia, which gave every satisfaction. The sheep could go from the main yard round the curve to the shed and a small ramp. The same applies to lines coming for dipping and branding (Figure 1). The Dee, and bugle are modifications of the curved or circular yards.

1. Dee: most experts say the Dee yard is best for properties where fewer than 6,000 sheep are run. The handling race is built at the end of the drafting race and provides the straight side of the 'D' with circular yards and the drafting facility forming the curved ends to give the yards their characteristic 'D' shape (Barber, 1977), (Figure 2).

2. Bugle: Almost without exception, a good modern yard will include a bugle-shaped forcing pen leading to the draft and forcing race. Again this was described and built about 1944 (Pearse, 1944) and is basically the same today (Figure 3).

From a welfare and economic perspective, it would be beneficial to provide shelter facilities, as ewes with lambs actively seek shelter in inclement weather (Pollard et al., 2000).

The use of races has been shown to increase in efficiency because animals follow the same route for a number of management practices, such as drafting and dipping (Grandin, 1999).

NOISE AND SMELL

In sheep slaughter plants, noise should be minimised wherever possible, as sudden loud noises are particularly frightening to sheep. Air leaks can cause balking problems, also a stream of air from a valve which hits the sheep's face can cause balking (Grandin, 1980). Sheep exposed to 75dB levels gain weight faster than controls or sheep exposed to 100 dB, and the heart rate of sheep exposed to instrumental music is significantly lower than the heart rate of sheep exposed to miscellaneous noises of roller coasters, trains and fog horns (Ames, 1974). Lambs are also stressed by noise, but they will usually not move away from the source.

Sheep may be disturbed by slaughter plant odours (Grandin, 1980).

PIGS

BREED DIFFERENCES

There is no work reported on breed differences in behaviour when being handled. The most common breeds in Australia are the Large White and Large White X Landrace. Intensively kept pigs tend to be balky to drive if forced too quickly. If they are moved slowly and allowed to investigate as they go along, they can be driven along with the handler holding a solid 'pig-board' behind them (Blackshaw, personal observation).

VISION

Pigs have a 310° panoramic field and a binocular field of 30-50° . They are thought to be able to judge distances and may have colour vision. They avoid shadows, although not to the same extent that cattle do, and sheep so lighting should be even and diffuse. They have less of a following instinct than sheep but will follow an established leader in a group (Meese and Ewbank, 1973).

Visual signs play some role in pig communication. For example, boars will make the hair on top of their necks rise up to make themselves look larger and more formidable (Ensminger et al., 1997)

The degree of environmental enrichment experienced by growing pigs directly affects how they perceive and react to novel situations (Boyle et al., 2000).

Like other animals, pigs are likely to move toward brightly lit areas (Dunkin et al., 1990). This tendency can be used to help correct design faults in an existing pig-handling infrastructure.

PERSONAL SPACE

Flight distance is not quite as important with handling intensively housed pigs as they are used to having people close by. They will often come up to and investigate the person who is handling them.

FACILITY DESIGNS

Pigs have difficulty walking on a steep downward slope as their legs are short and they lose their balance. They prefer to walk up steps rather than inclines. Flooring should be made non-slip by providing cross cleats or steps (Grandin, 1980).

1. Solid fences are recommended where animals are being driven past other animals to the stunning area in the abattoir. Pigs tend to stop and sniff others as they pass.

2. Long narrow pens providing more perimeter per animal are preferable to a square pen. Pigs will fight over a spot near a fence when the central portion of a large pen is empty (Grandin, 1980).

3. It has been shown that young weaned pigs, in cool weather, when provided with a box will use the wall of their box to huddle against, and will show a growth rate advantage (Blackshaw,1980). Further work showed that if given a choice, pigs prefer to huddle against a wall on a solid floor section (Blackshaw, 1981).

4. Flooring material of pens can be important for inten-

sively kept pigs. Rubber mats have shown to be best for sow lying comfort, as an epoxy-painted concrete floor was too slippery (Gravas, 1979). Also, in mating pens it is important to have a rough finish on the floor so it can be hosed out without being made too slippery for the sow to stand for the boar (Blackshaw, personal observation).

5. Intensive piggeries have been criticised from the welfare aspect so research is being carried out on alternative systems. One such system contains four families of sows and their offspring housed in a system which provides for nesting, rooting and rubbing (Stolba, reported in ***Int. J. Stud. Anim. Prob.*** 1981). Preliminary results indicate a good fattening performance.

Suckling behaviour and subsequent piglet survival is positively correlated to nest size, that is, increased nest size results in increased survival rates (Cronin et al., 1998).

Sows provided with sawdust-based nesting material have a shorter parturition period, produce more liveborn piglets and are involved in fewer fatal crushing incidents, when compared with sows provided with no bedding (Cronin et al., 1998).

Sows provided with larger nesting areas, perform more maternal 'suckling grunts', resulting in increased nursing time, immunoglobulin intake and subsequent immunity and survival in piglets (Cronin et al., 1998).

An alternative to conventional farrowing crates contains both a farrow nesting region (2.4 m x 1.8 m) that contains features to increase piglet survival, as well as a non-nesting area for feeding and drinking vessels and for defecation (Cronin et al., 1998).

Farrowing nests appear to promote maternal instincts as sows increasingly exhibit 'careful behaviour', such as using their snouts to push piglets aside before lying down (thereby reducing crushing mortality) (Cronin et al., 1998).

Housing production sows in groups is commonly accepted as a means of promoting good animal welfare, although aggression associated with mixing and feeding can result in vulva damage and subsequent diminished production (Boyle et al., 2000).

Trials suggest the reproduction performance of intensively housed sows is superior if they are housed in groups leading up to farrowing. The restriction in area of conventional farrowing crates interferes with the expression of maternal behaviours (Boyle et al., 2000).

The provision of bedding at the time of farrowing not only provides physical and thermal pleasure to the sow but also facilitates recreation and exploration (Arey 1993).

A favoured bedding substrate for farrowing sows was peat moss, which is similar in texture to earth (Beattie et al., 1998).

During mating, space is required to allow courtship. A 3 m square pen has proved the most successful design as this allows the sow to put her head in a corner while being mated (Blackshaw, 1992).

Partial barriers have been employed in group housing systems as an effective means of reducing aggression during feeding (9% of total aggression) (Blackshaw, 1992).

Much criticism of farrowing crate design on the grounds of sow confinement has been observed. However, a 10-year study conducted in Scotland looked at these animal welfare concerns. It was shown that 44% of sows chose these cramped 3 or 4 walled structures over intermediate-sized areas (29%), wide-sized (12%), while the remaining 15% chose to lie elsewhere in the pen. The reason given for the sows' choice was that it possibly satisfied their need for security (Ensminger et al., 1997).

NOISE AND SMELL

Pigs show a frozen alarm reaction when something startles them. Often in an intensive system which has quite a lot of noise in it all day, it is difficult for a human observer to detect the cause of the alarm reaction (Blackshaw, personal observation). In one piggery the telephone bell is a loud horn which does not elicit a response from the pigs but tends to startle the observer. The smell or sight of blood, and other slaughter plant odours do not appear to upset pigs as they have been observed both eating blood and wallowing in it (Grandin, 1980).

DEER

BREED DIFFERENCES

Many components of neonatal behaviour in deer are inherited rather than learned (Endicott-Davies et al., 1996).

Red deer calves exhibit the hiding response in the presence of humans while Pere David deer calves exhibit the flight response. The difference is thought to be connected with the natural migratory behaviour of the Pere David species (Endicott-Davies et al., 1996).

In wild Red deer populations, parturition occurs in comparative isolation, with the hind and calf returning to the main herd after about two weeks (Endicott-Davies et al., 1996).

A fallow deer's sense of smell is poorer than that of Red deer and reindeer. A fallow deer can smell man from about 200 m, while, depending on humidity, Red deer react up to 1,200 m (Reinken et al., 1990).

Fallow deer are more placid than other types of deer and seem to suffer less from a lack of freedom, which makes them the most useful of the wild game for small areas (Reinken et al., 1990).

White-tailed deer are one of the more excitable breeds so their establishment in farming practice has been limited (Haigh, 1991).

Possibly the most timorous species is the Chital deer. It readily panics if not accustomed to the close proximity of man (English et al., 1991).

Between the Fallow and Chital deer, lie the Red and Rusa deer. In comparison to the Red, Rusa deer spend much less time and energy moving and show no tendency to run along fences (Dunning et al., 1991).

VISION

Deer maintain visual contact with each other and should always be handled as a mob. A single deer, if left alone in a pen, may panic.

Deer do not follow each other like sheep and cattle and if attempts are made to drive them in single file they bunch up and climb on top of each other.

Behavioural disturbance in deer was significantly more pronounced in larger groups (Friend et al., 1981).

Trials suggest that deer are just as comfortable in the presence of sheep as they are with animals of their own species (Abeyesinghe et al., 1997).

Deer react most strongly to visual stimuli, which often cause them to take flight. The distance from effective stimuli was greatest in the morning, fell during the day to 2–3 m and peaked during feeding (Reinken et al., 1990).

PERSONAL SPACE

Farmers who walk among their deer can tame them quite easily and so reduce their flight distance.

For male deer, greater space allowance during transport results in increased aggressive behaviour (Jago et al., 1993).

The current UK guidelines for space allowance when transporting deer recommend 0.5–0.6 sq m per animal for yearling stags and 0.3–0.4 sq m per animal for yearling hinds, with no more than 10 animals being penned together (Grigor et al., 1997).

Greater rises in plasma concentrations of cortisol following transport indicates that transport motion is more stressful than confinement alone (Grigor et al., 1997).

If an unfamiliar individual comes closer than 10–15 m, the animals take flight, with an adult doe as the leader. The readiness to take flight and the degree of tameness were correlated with rank, age and body weight. Calves will often take flight before adults (Reinken et al., 1990).

FACILITY DESIGN (ANDERSON, 1978)

Deer are excitable, easily frightened and cannot be driven, so all facilities should be designed with this in mind.

Deer cannot be driven, but are best lured (with the aid of food/recognised noises) or slowly drifted in the direction they are to go (Yerex et al., 1990).

1. Yards should be solid sided for herding purposes, because if deer see daylight in a panic situation they will charge through anything in an attempt to escape. Recommended height for fences is 2.1 m–2.4 m high.

2. Corners should be avoided because deer always try to crush into a corner when yarded (Figure 4).

3. If the handling area is roofed and darkened it will quieten the deer.

4. Deer approaching yards should have a clear view of their path away from the yards; they should not be presented with a dead end.

5. A curved race is useful (5.5 m diameter) for free movement (Figure 4).

6. Concrete is not a good floor as it can become too slippery. Sand, sawdust or even gravel make good yard basis as deer cannot get a foothold to jump or kick.

7. Two types of handling yards are used at Invermay in New Zealand (Figure 4). The top yard has been used with fairly small groups of deer. The octagonal holding pen has no corners for deer to bunch into and harm themselves. A problem is that the race is too long.

The second yard has a semi-circular perimeter runway, which allows small groups to be shut off as a large mob enters the yard.

If facilities are designed with the behaviour of the animal in mind, not only will handling be easier for the husbandman, but the stock will be less stressed.

Many management practices associated with deer (e.g., physical restriant, visual isolation and human proximity etc) have all been shown to be particularly stressful to the species (Pollard et al., 1993).

Deer have a strong instinct to avoid the central location of a yard/enclosure, and this is thought to be due to cover-seeking behaviour (Chamove 1995).

Solid sides to the race, at least 2 m in height, should extend out from the holding yards, which should also have solid sides (Spiers et al., 1990).

It is also a good idea to leave the gates of the yards open when not in use. This allows the deer to wander in and begin to habituate to its surroundings and so become easier to handle (Spiers et al., 1990).

NOISE

Corrugated iron and tubular steel are used by some farmers, but they are very noisy and tend to upset the animals, so this should be avoided.

While not as stressful as mixing, the placing of groups of unfamiliar animals (and species) in close proximity can cause significant stress (e.g., elevated heart rate and blood cortisol levels). In particular deer find cattle and pigs aversive (Abeyesinghe et al., 1997).

A voice call or a whistle associated with feeding may be a useful aid when handling deer. This use of classical conditioning has been observed in numerous farming situations, although under no circumstances should it be attempted during the deer's annual rut (Anderson, 1978).

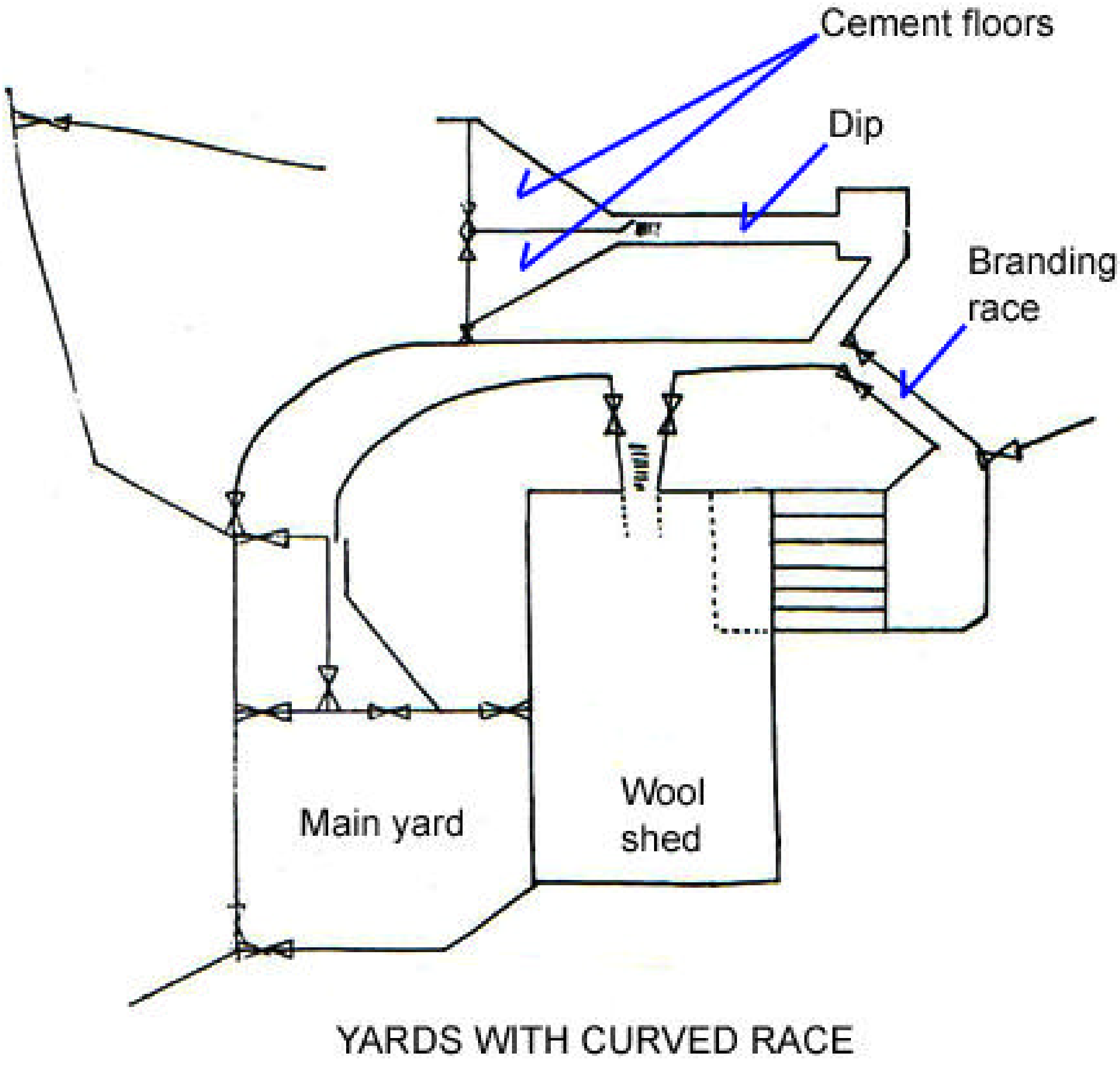


Figure 5.1: A circular yard designed by Mr. H.E. Hoad of ***South Australia.***
(Modified from Pearse, 1944.)

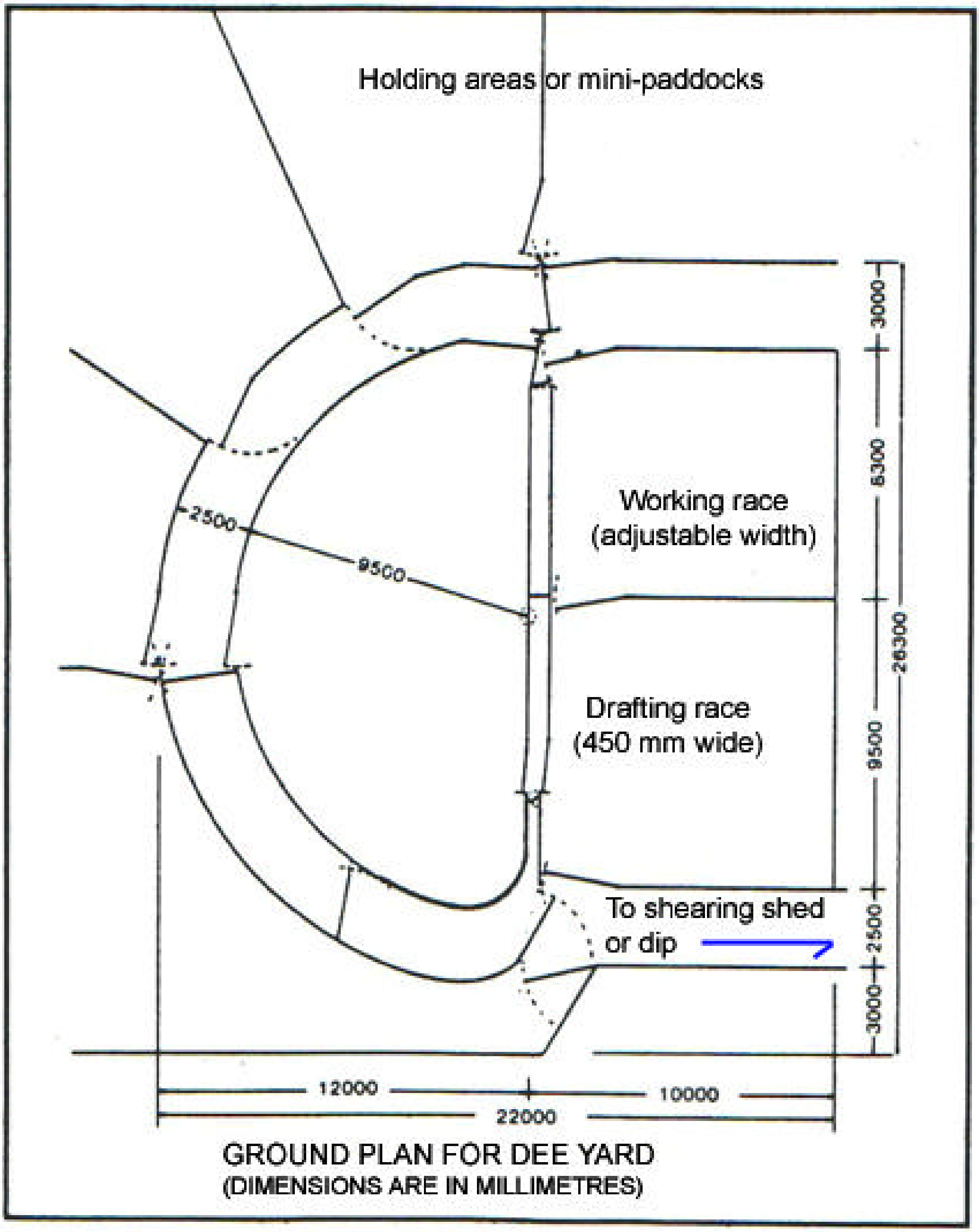


Figure 5.2: The Dee yard.
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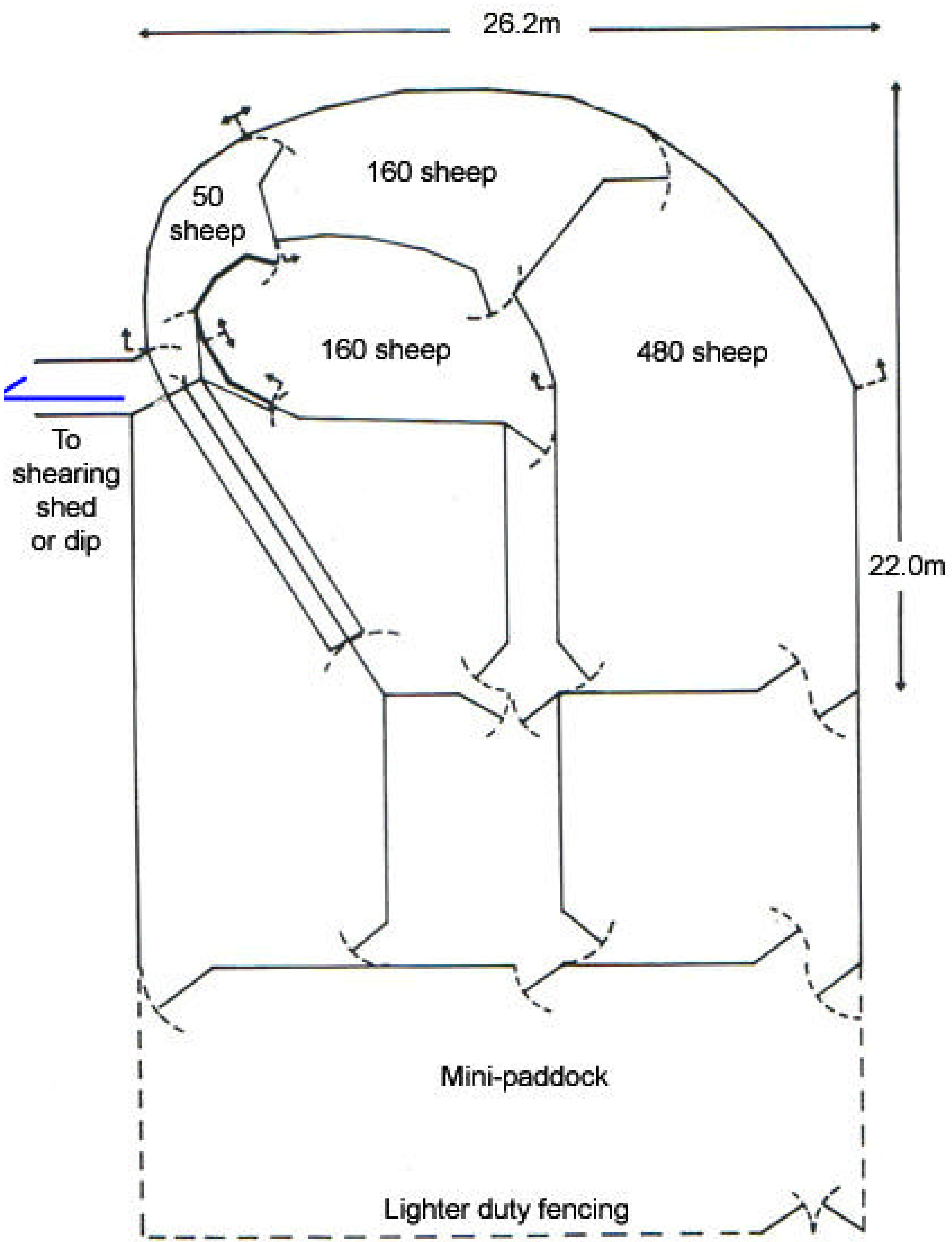

Widths of various elements: gates 1830mm, drafting race 480mm and handling race 600mm (doubled)

Figure 5.3: The Bugle-shaped forcing pen.
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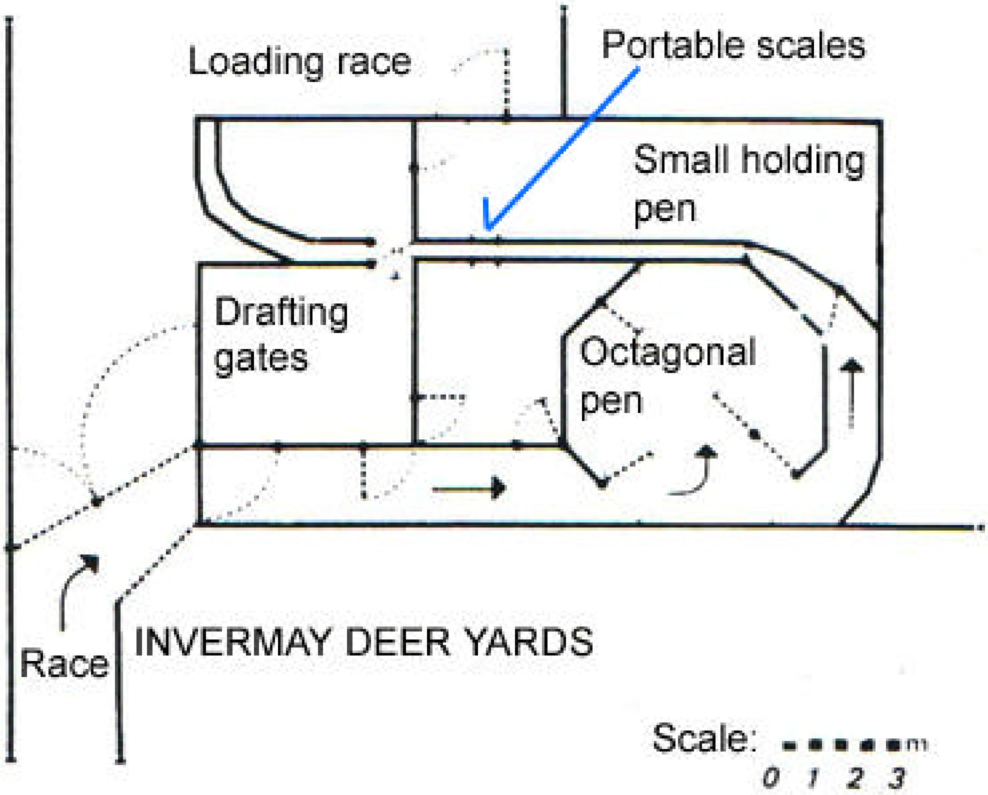

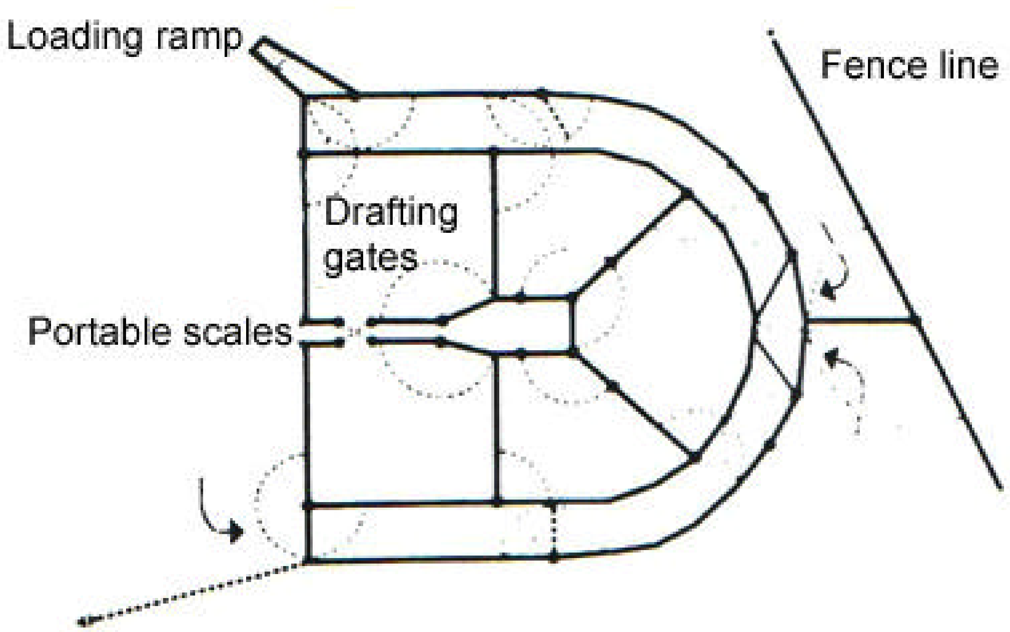

Figure 5.4: Design of deer yards, showing a curved race.
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