Handling beef cattle:

Identifying research needs and knowledge transfer opportunities to improve human safety and animal welfare

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Contents

Executive summary

- As one of its priorities for agriculture in 2001/2002, the UK Health and Safety Executive identified a need to "*reduce the number of fatal and serious injuries in agriculture from cattle handling*"

- Injuries and stress to cattle when being handled also compromise animal welfare, may depress growth performance and can lead to increased trim of bruised tissue or down-grading at slaughter

- Injuries to handlers occur in all parts of permanent and portable handling systems and when handling unrestrained cattle. The most common type of injury is bruising resulting from being kicked or hit with the head

- The international literature base has been examined to provide design solutions to common handling problems encountered whilst using permanent and portable handling facilities in Scotland. If implemented, these recommendations could lead to improved handler safety. The literature would indicate that a concurrent benefit to animal welfare should also be anticipated

- The use of handling facilities for some routine procedures is impractical. There is a need to reduce the flightiness and both self-defensive and maternal defensive aggressiveness of cattle in unrestrained conditions. Evidence would suggest that these traits are under some degree of genetic control and therefore should respond to selection. Before selection can be adopted it is necessary to address several challenges (listed below).

- Several priorities for future research are apparent from this review. There is a need to:
    - ❖ Quantify the risk factors involved with handling unrestrained cattle during a wide range of tasks
    - ❖ Develop recommendations for the design of safe and efficient portable handling systems
    - ❖ Facilitate the integration of selection for temperament traits, especially in unrestrained conditions, within existing selection programmes. Three steps are envisaged to address this priority:
        - ▪ Develop validated and practical methods of recording unrestrained cattle behaviour on-farm
        - ▪ Integrate the assessment of unrestrained behavioural traits into routine data collection at the level of the breeding herd
        - ▪ Quantify the likely behavioural and performance side-effects of selection on unrestrained temperament traits

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<u>Section 1</u>

Introduction

1.1. Rationale

Background

As one of its priorities for agriculture in 2001/2002, the UK Health and Safety Executive (HSE) identified a need to "*reduce the number of fatal and serious injuries in agriculture from cattle handling*" (HSE, 2001). Several mechanisms were proposed to achieve this, including:

1. Critically examining cattle handling practices and the facilities/equipment provided
2. Increasing the level of awareness of practical hardware solutions for manual handling operations
3. Ensuring that adequate training in cattle handling is provided

The challenges to human safety have been exacerbated in recent years by the increasing ratio of cattle to handlers, the need to handle animals at sensitive times to satisfy traceability and meat hygiene requirements and a lack of investment in handling facilities. The use of inadequate facilities by over-stretched handlers also contributes to cattle injuries and poses a threat to animal welfare. Improvements in handling safety and efficiency can be made by changing aspects of the handling facilities and the behaviour of the handler and animal.

Aims

This report describes a review conducted by the Scottish Agricultural College (SAC) into methods of improving the safety of cattle handling in Scotland and to facilitate the uptake of this information by beef producers. The specific aims of the project were:

Aim 1 Review the global knowledge base to identify safe beef cattle handling techniques and safe and efficient facility designs.

Aim 2 Based on this review, to make recommendations on how low-cost solutions can be applied to solving common handling problems in Scotland.

Aim 3 Identify gaps in current knowledge which, if addressed, could lead to long-term improvements in cattle handling and suggest research strategies which could achieve this.

Approach

Sources of information

International literature

The review process considered solutions to handling problems from around the world. The purpose of the review was to identify key features common to good handling techniques and good facility designs which could be implemented in Scotland and the U.K. generally. The information collated in the review was sourced mainly from the four principal beef exporting regions of Australia, the U.S.A., the E.U. and New Zealand which have active research and development activities and extension services. Information from research on sheep and pig handling has been included in a small number of places where common problems between species made its inclusion relevant.

Stakeholder Group

To identify the aspects of cattle handling of greatest concern to Scottish producers, industry representatives were invited to form a stakeholder group whose composition is listed in Table 1.1. This group provided input on which aspects of Scottish handling facilities and practices were inefficient or unsafe. They also advised on the constraints which would limit the implementation in the Scottish industry of best practices from abroad where units are frequently larger and the space available for the development of handling facilities is less restricted by pre-existing buildings. Finally, the group also suggested mechanisms to facilitate the uptake of solutions identified by the review process.

Table 1.1: *Composition of the Stakeholder Group*

British Cattle Veterinary Association	National Beef Association
David Ritchie (Implements) Ltd.	National Farmers Union of Scotland
Health and Safety Executive	Scottish Executive Environment and Rural Affairs Department
Highlands and Islands Health Research Institute	Scottish Agricultural College Advisory and Consultancy and Research and Development Divisions
Limousin Breed Society	

Survey

With the assistance of the Stakeholder Group, Scottish beef producers were surveyed using the form in Appendix 1. In total, 2000 copies of the form were distributed via the SAC publication *Sheep/Beef Notes* (September 2003) and by Quality Meat Scotland. The survey questioned which aspects of the handling systems in use worked efficiently, which were associated with the greatest perceived risk of injury to the handler and which handling tasks resulted in actual injuries. The results of 116 returns are presented in Sections 2 and 4.

Scope of the study

The remit of the project was limited to the handling of beef livestock of all ages and genders when unconfined or in mobile or permanent handling facilities in the farm environment. The handling of livestock during transport, at markets and during lairage and slaughter were considered to be special cases and, whilst some best practices are relevant both on and off-farm, these areas were not specifically considered in the review.

1.2. Introduction

Benefits of optimising cattle handling practices

Benefits for animal welfare, efficiency and profitability

Properly designed handling facilities and correctly motivated staff are essential to ensure animal welfare (Broom, 2000). Appropriate handling of cattle benefits animal welfare by reducing the number of accidental injuries sustained from contact with the facilities and reduces the tendency of producers to use punishment as a means of encouraging movement. Cattle which are less fearful of handling tend to be easier to move leading to an improvement in the efficiency of labour use (Vowles, 1982; Grandin, 1997). Calm movement of cattle can also yield other significant and direct economic benefits (Warriss, 1990; Weeks et al., 2002). Stress resulting from poor handling results in dark cutting and pale, soft exudative meat (Eldridge, 1982; Grandin, 1990). This is probably an even greater cost to the cattle industry than losses through bruising, but these can also be large, particularly where cattle are reared extensively and are unused to handling (Warriss, 1990). The losses resulting from bruising have been appreciated for some time. In the USA, the estimated annual cost of cattle bruising was $22 million as long ago as 1974 (Grandin, 1980a) and in New Zealand it was estimated in 1977 that 1.0% of the country's beef export earnings were lost due to bruising (Marshall, 1977). The level of loss is in the UK is also considerable. For example, in two large UK surveys, bruising sufficient to cause down-grading or rejection of some meat was found at slaughter in between 4.1% (Weeks et al., 2002) and 6.5% (McNally and Warriss, 1996) of carcasses. Whilst some of these bruises would have occurred in auction markets, a detailed analysis of carcasses sourced direct from the farm showed that over half had some level of bruising, amounting to an average of 0.46kg of bruised meat/carcass (Weeks et al., 2002). Much bruising is a result of encouraging animals to move in a forceful manner (Marshall, 1977; Warriss, 1990). Stick marks were identified on 5.6% of carcasses in the study by Weeks et al. (2002) and the estimated incidence of more minor scratching is between 70 and 90% (F.A.I.R., 1999). Although producers can have little impact on the level of bruising which occurs when the animals leave the farm, stress resulting in poor meat quality and losses through bruising can be reduced whilst the animals are on the farm through the use of handling facilities which do not in themselves cause injury and which avoid the necessity of using harsh handling techniques.

Benefits to handler safety

On average, almost one person per week was killed in the UK agricultural sector during work-related activities between April 1992 and March 2002 (HSE, 2003). The estimated number of injuries requiring more than 3 days without work during the period April 2002 – March 2003 was 6310 whilst the estimated number of minor incidents requiring less time off work was 27,800 (HSE, 2003). The annual cost of these injuries and fatalities to the UK economy approximated £122 million of which £15.8 million was lost to the Scottish economy. However, a dramatic reduction in the total number of fatal agricultural accidents occurred between the early 1970s and late 1980s (HSE, 1986). Whilst no data have been collated to examine the pattern of non-fatal accidents, a reduction may also be expected. In contrast, from the 1970s to the present day, no obvious reduction can be identified in the number of fatal accidents involving farm livestock. Improving the design and use of handling facilities has a role to play in improving handler safety whilst there may also be scope for modifying the behaviour of the cattle themselves.

Pressures facing the cattle handler in the UK

Ratio of animals to handlers

The number of holdings with beef cattle fell in the UK from 74,000 in 1992 to 63,000 in 2002 (Defra, 1998; 2003a) despite the number of beef cows remaining at around 1.7 million in both years (Office of National Statistics, 2003). This 15% reduction in the number of holdings has been accompanied by a 12.4% increase in the average size of beef cow herds in the same time period (22.8 cows/farm in 1992; 26.0 cows/farm in 2002; Defra, 1998; 2003a). A UK-wide trend towards a declining number of beef farms can therefore be identified with a concurrent increase in herd size of those remaining.

Whilst these data are not available for Scotland specifically, a similar trend can be inferred. Between 1992 and 2002, the total number of beef cows on Scottish farms fell by 2.0% from 499,000 to 489,000 whilst the number of people in full-time employment in all sectors of Scottish agriculture fell by 18.0% during the same time period (Scottish Executive, 2003). In Scotland this pattern is part of a long-term trend whereby the total number of beef cows rose by 7.0% between 1982 and 2002 whilst the full-time agricultural work-force fell by 35.0% (Scottish Executive, 2003).

In Scotland and throughout the UK, beef producers are being required to manage increasingly large herds. This has the effect of increasing pressure on handlers to work efficiently whilst reducing the frequency of contact between the handler and individual cattle, particularly in less favoured areas (HSE, 2002).

Opportunity for investment in facilities or labour

The opportunities for employing additional skilled staff to offset this workload are restricted by the low profit margin of beef production. For example, the net farm income for Scottish beef farms between 1994 and 2002 was £9,280 (annual range £2,700 - £18,400) (Defra, 2003b). This low net income also limits the opportunity to upgrade old or damaged handling facilities. Rented grazing land has also become more popular in the UK. This land seldom includes handling facilities and there is little incentive for the tenant handler to invest in permanent facilities.

Compliance with new regulations

Compliance with the 1998 Cattle Identification Regulations (Statutory Instrument no. 871) requires all beef calves in the UK to be tagged within 20 days of birth. In reality, this has often meant the handling of calves without the use of handling facilities at a time when the cow is highly motivated to defend her young (Holmes, 1991; HSE, 1999a). Since 1997 many producers have also found it necessary to clip dung and mud from the bellies of cattle before presentation for slaughter to comply with the Meat Hygiene Service Clean Livestock Policy. Concerns have been expressed that injuries are common through human-directed maternal aggression when tagging calves and the trapping of arms and hands when clipping sensitive areas of finished cattle (HSE, 1999b; Hansard, 1999; Task Force on *E. coli* 0157, 2002; Lindsay et al., 2004).

The increasing production of bull beef

The increased use of uncastrated bulls in the British beef industry over the last two decades makes the use of good handling facilities even more important (Warriss, 1990). As these animals are typically more difficult to handle in unconfined conditions, building in safety features to handling pens and the animal's home pens is of importance.

Requirements of Scottish beef producers

Given the falling labour input and the lack of capital for investment in upgrading handling facilities, beef producers throughout the UK require cost-effective methods of increasing the safety and ergonomic efficiency of their facilities such that they can be operated single-handedly wherever possible. Fortunately, improvements in safety and efficiency often go hand in hand as facilities designed for optimum efficiency of stock movement are generally less stressful and safer for both handlers and cattle (Vowles, 1982). Whilst this review aims to provide low-cost solutions to common handling problems, it should be appreciated that savings from reductions in weight loss resulting from reducing handling stress and the labour saved by efficient handling can provide a substantial return on initial investment (Edwards et al., 1995). There is also a need to improve handler safety under on-farm conditions where the use of handling facilities may not be possible. There may be a role for altering the temperament of the cattle themselves, and this issue is considered in Section 6.

Section 2

Incidence and causes of injury whilst handling cattle

2.1. Introduction

Before considering solutions to cattle handling problems, it is first necessary to identify where the risks lie. This section will review the incidence rate of injuries involving cattle and the mechanism and nature of the injury, the task being performed at the time and the area of the farm in which the injury occurred. Section 3 will attempt to interpret these data in terms of the risks associated with handling restrained and unrestrained cattle under various on-farm conditions, and for each will list the requirements for safe and efficient handling.

2.2. Accident statistics

Rate of injury resulting from cattle handling

Fatal injuries
An analysis of Health and Safety Executive (HSE) annual statistics reveals that, during the period of April 1992 to March 2003, a total of 44 people were killed either directly or indirectly by cattle. This represents 8.2% of the total agricultural fatalities during this period (540) and is one of the single greatest causes of agricultural fatalities in the UK. With the exception of horses (9 fatalities), only one other livestock-related death was reported to the HSE during this period (struck by a ram).

Non-fatal injuries
Between April 1992 and March 1994, 71% of all non-fatal injuries sustained whilst handling livestock were caused by cattle (HSE, 2003). This pattern is not unique to the UK but is shared by other cattle-producing countries (e.g. the USA (Myers, 1997), Canada (Canadian Agricultural Injury Surveillence Program, 2003) and New Zealand (Leathers and Williams, 1984)).

A mean of 148 reported non-fatal injuries per year were experienced whilst handling livestock between 1996 and 2001 in the UK. This represents 7.0% of the non-fatal injuries reported in UK agriculture. However, the reporting of non-fatal injuries in agriculture to the HSE, particularly those of a minor nature, is notoriously poor (Monk et al., 1984; Lindsay et al., 2004) and these figures are likely to be a gross underestimate of the actual frequency of injuries sustained during livestock handling procedures. For example, Monk et al. (1984) estimated that 6300 accidents per year occurred in the UK involving cattle other than bulls, yet only 348 (5.5%) of these were reported. These figures include those accidents which resulted in both injury and/or damage to property. Stroud and Walsh (1997) provides further clear evidence that a great majority of injuries sustained in the UK whilst handling cattle are not officially reported. With a sample of 314 UK cattle producers, they found that a mean of 19% of producers per year received an injury whilst handling cattle in the years 1994 and 1995. In the same study, veterinary surgeons experienced a mean of 1.3 injuries per person per year during 1994 (n=330 responses) and 1995 (n=333 responses).

Relationship between farm size and injury rate

Monk et al. (1984) estimated the annual number of non-reported accidents per 100 workers in beef and sheep production in the UK according to the size of the enterprise. These data include those injuries sustained whilst handling cattle and those which occurred whilst performing other tasks on the farm. The size of the unit was defined by the number of man-days worked per annum (small = 250-499, medium = 500-999, large = 1000-1999 man-days). The analysis showed that the estimated rate of non-reported injuries per 100 workers decreased as the size of the farm increased (small = 47, medium = 39, large = 21 injuries/100 workers/year).

Severity of injuries resulting from cattle handling

Fatal and non-fatal injuries

The proportion of livestock-related injuries classified by the HSE as fatal or major is typically higher than that in other sectors of agriculture (e.g. 36% between April 1992 and March 2004) (HSE, 2003). When asked to describe the most serious injury sustained whilst handling cattle during their career, 29.4% of veterinary surgeons classified their worst injury as serious or very serious (Stroud and Walsh, 1997). A total of 57.2% of these injuries required treatment at a hospital or doctor's surgery and 8.3% required more than 14 days off work for recovery. The injuries sustained by UK producers whilst performing two routine beef cattle handling tasks (ear tagging and belly clipping) required local doctor or hospital attention on 11.6% of occasions when ear tagging calves and 25.5% of occasions when belly clipping finished cattle (Lindsay et al., 2004). These injuries resulted in lost time from work on 20.0% (ear tagging) and 23.3% (clipping) of occasions. A survey of 56 cattle enterprises by Bebbington (1987) found that, of 19 incidents resulting in injury by cattle during the careers of those questioned, seven were classed as serious, although the author admits that there is likely to be a significant level of under-reporting of minor injuries.

Nature of injuries sustained

Fatal injuries

Of the 44 fatalities whilst handling cattle during the period April 1992 to March 2003, the majority of people died as a result of multiple crush injuries to the thorax or abdomen (Table 2.1.).

Table 2.1.: *Fatal injuries sustained during cattle handling tasks in the UK, April 1992 – March 2003 (source HSE annual statistics).*

Cause of death	Frequency	%
Thoracic or abdominal crush / internal injuries	27	61.4
Head injury	12	27.3
Pulmonary embolism following fracture	2	4.5
Other secondary cause	2	4.5
Accidentally shot	1	2.3
	Total 44	

Non-fatal injuries

The nature of non-fatal injuries were classified in a similar manner in the studies by Bebbington (1987), Stroud and Walsh (1997) and the HSE (2003) allowing a total of 669 injuries to be examined in a single analysis (Table 2.2, Figure 2.1.). These data show that bruising was the most common injury received and concur with recent findings from Lindsay et al. (2004) whereby 82.0% of all injuries sustained whilst ear tagging calves and 78.3% of injuries whilst belly clipping finished cattle in the UK were bruises. Other reported injuries in this study were fractures (tagging = 3.0%; clipping = 7.2%) and lacerations (tagging = 2.6%; clipping = 5.6%).

Table 2.2.: *Nature of non-fatal injuries sustained whilst handling cattle*

	Stroud and Walsh (1997)				HSE (2003)		Bebbington (1987)		Total Frequency	Mean %
	Producers		Veterinarians							
	Frequency	%	Frequency	%	Frequency	%	Frequency	%		
Bruising	39	*47.6*	171	*44.4*	54	40.6	12	59.1	276	**41.3**
Fracture / dislocation	7	*8.5*	48	*12.5*	82	21.1	5	27.3	142	**21.2**
Laceration	7	*8.5*	80	*20.8*	12	15.2	1	4.5	100	**14.9**
Sprain / strain	3	*3.7*	19	*4.9*	12	5.2	1	4.5	35	**5.2**
Internal / concusion	1	*1.2*	24	*6.2*	3	4.3	0	0	28	**4.2**
Other / unknown	25	*30.5*	43	*11.2*	20	13.5	0	4.5	88	**13.2**
Total	**82**		**385**		**183**		**19**		669	

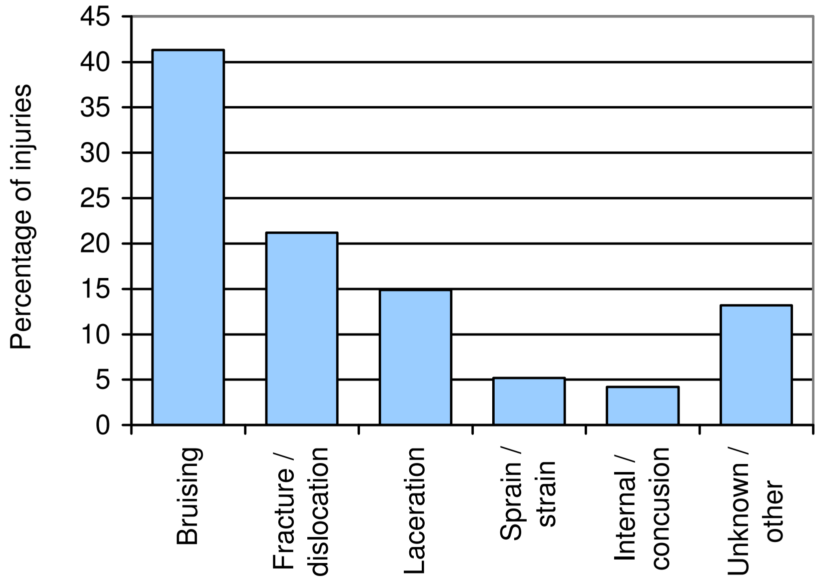


Figure 2.1.: *Nature of non-fatal injuries received whilst handling cattle (sources: Bebbington, 1987; Stroud and Walsh, 1997; HSE, 2003).*

Body area injured

Fatal injuries

As multiple injuries were often sustained in fatal incidents, an analysis of the body areas affected is not particularly helpful for these cases.

Non-fatal injuries

Stroud and Walsh (1997) collated information on the body areas affected by injury from 59 accidents involving producers and 337 accidents involving veterinary surgeons. These data are summarised in Figure 2.2. Both groups appeared to receive a high proportion of injuries to a hand, leg or the torso and these areas also sustained the most injuries amongst US beef, pig and sheep farmers (Myers, 1997). In the British study, however, there is considerable disagreement in the proportion of injuries sustained to the head (producers = 6.1%; veterinary surgeons = 18.4%) and feet (producers = 20.7%; veterinary surgeons = 3.6%). This implies that the different duties performed by producers and veterinary surgeons are associated with different risks and that design features should offer protection not only during daily farm handling, but also during veterinary treatments.

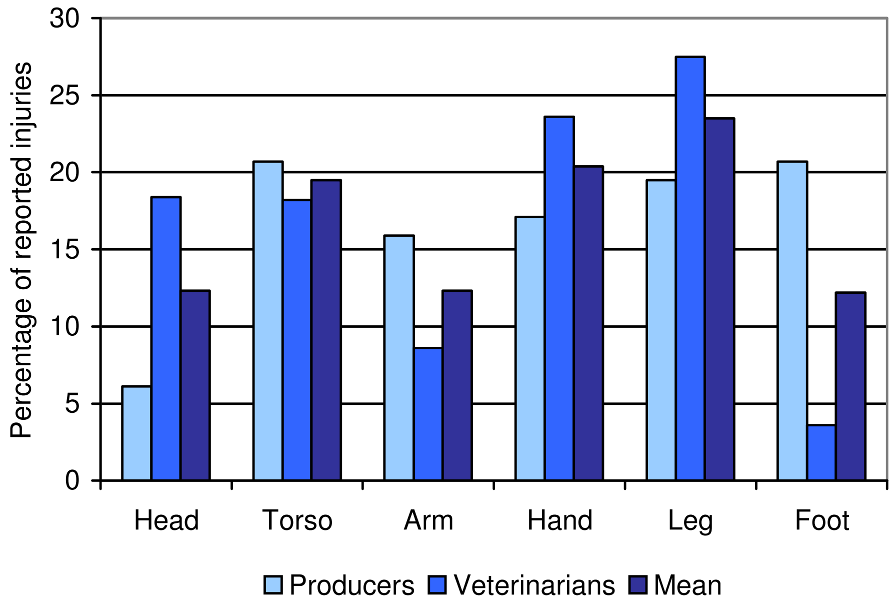


Figure 2.2.: *Location of injuries (source: Stroud and Walsh, 1997).*

Mechanism of injury

Fatal and non-fatal injuries

Figure 2.3. shows the percentage of injuries resulting from being kicked or hit by the head of an animal, being crushed by entrapment, being trampled or attacked, or being knocked over. The data are presented separately for producers, veterinarians and for fatal accidents when the action causing death was known. Injuries recorded under the category of entrapment include both those where the victim was pinned either between an animal and a solid object or between two solid objects whilst handling cattle. Cases of trampling include instances where the victim was stood on, repeatedly butted or repeatedly kicked. Those where the victim was knocked over have been separated from incidents of trampling to indicate the action which caused the principal injuries.

A single kick or hit from the head of an animal was the most frequent cause of non-fatal injury to both producers and veterinary surgeons. Although administering veterinary procedures would be expected to place veterinary surgeons at risk of entrapment injuries, these accounted for only 10.3% of cases. More detailed information is available for the actions resulting in fatalities. Being attacked and trampled by cattle accounted for 18 fatalities (over 40% of deaths) between 1992 and 2003. Several other cases are likely to be attributable to this cause, but the action causing death has not been recorded.

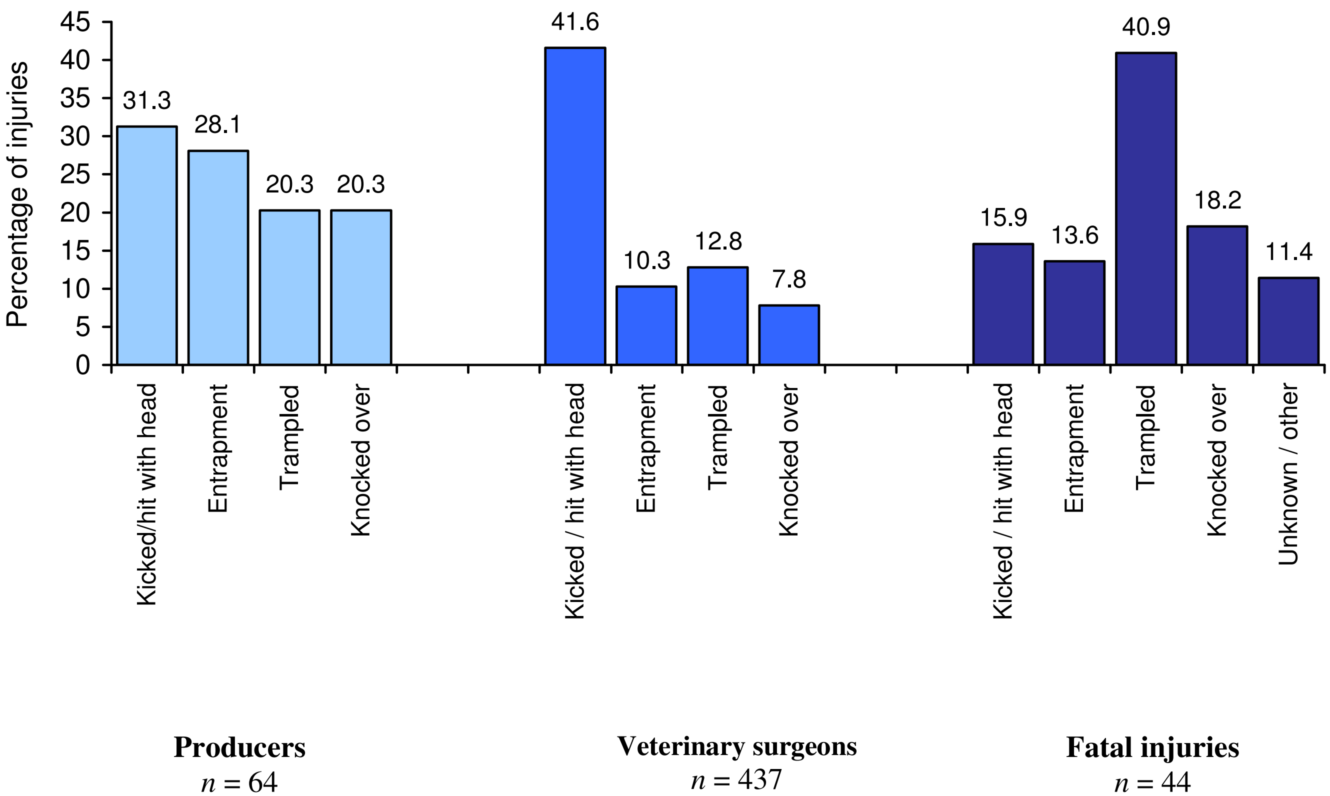


Figure 2.3.: *Actions causing non-fatal injuries to producers and veterinary surgeons and those resulting in death (sources: Bebbington, 1987; Myers, 1997; HSE annual statistics, 1992-2003).*

Area of farm in which injuries occurred

Fatal injuries
No breakdown of non-fatal injury data has been performed to indicate the relative frequency of injuries in fields, yards, covered pens or permanent handling facilities. These data are, however, available for the 44 fatal accidents involving cattle between 1992 and 2003. Two accidents occurred whilst using improvised barriers. Both of these took place in the yard and were classified under this category. The frequency and percentage of injuries sustained in each of the areas listed above is illustrated in Table 2.3.

Table 2.3.: *Area of farm in which fatal injuries occurred (source: HSE annual statistics 1992-2003).*

	Frequency	%
Field	19	43.2
Yard	10	22.7
Covered pen	9	20.5
Handling facilities	3	6.8
Other	3	6.8
Total	**44**	

Agent causing injury

Fatal injuries
Of the 44 fatal injuries which occurred between 1992 and 2003, 20 (44.5%) were attributed to adult cows, 16 (36.4%) to entire bulls, 5 (11.4%) to castrated animals and 2 (4.5%) to heifers. In one case the agent was not specified. A meaningful breakdown into beef and dairy breeds is not possible.

Non-fatal injuries
An analysis of 591 accidents based on the data of Bebbington (1987), Stroud and Walsh (1997) and the HSE (2003) reveals that 92 injuries (15.6% of cases) were attributed to entire bulls. It is more difficult to attribute the remaining 499 accidents to the other classes of cattle. Stroud and Walsh (1997) showed that, of 287 accidents involving veterinary surgeons and cattle other than entire bulls, 10.5% (30 cases) involved castrated animals and the remaining 257 accidents were attributable to cows, heifers and calves.

2.3. Perception of risk

Perceived danger areas

There appears to be no failure of farmers to appreciate that livestock present a potential hazard. In a survey of 925 British farmers, 40% of which held beef cattle, livestock were ranked as the highest perceived on-farm hazard out of a list of 45 options (Knowles, 2002). In a survey of 139 producers conducted by the Scottish Agricultural College (SAC), producers scored the perceived risk of injury whilst handling cattle in various regions of their purpose-made, permanent handling systems on a scale of 1 (no risk) to 5 (severe risk) of injury. Simultaneously they scored the manual difficulty associated with handling in these regions on a scale of 1 (no difficulty) to 5 (severe difficulty). The forcing pen was associated with the greatest perceived risk of injury and was also the area in which handling was felt to be most problematic (Figure 2.4.). The collecting pen was also associated with a high level of perceived risk.

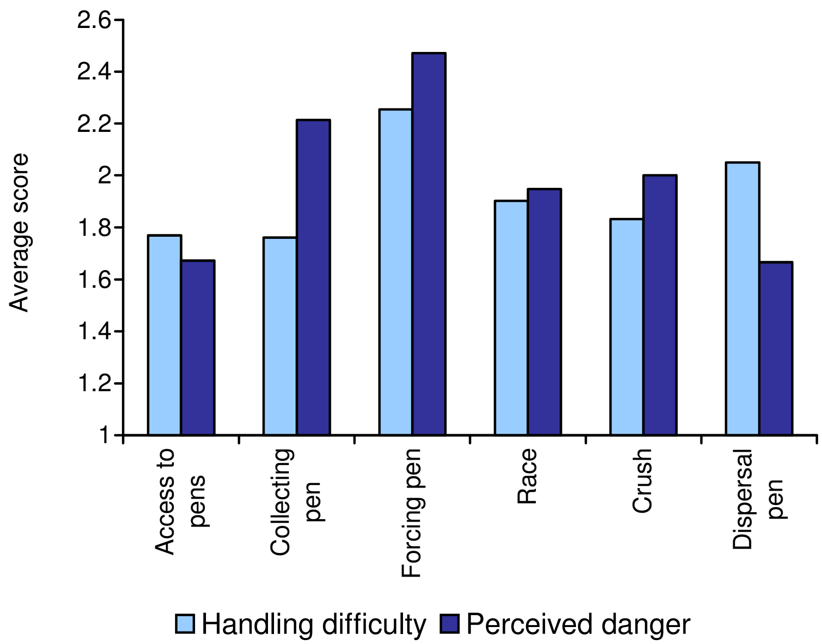


Figure 2.4.: *Areas of greatest handling difficulty and perceived danger in purpose-made handling facilities (source: SAC survey, n=139).*

Perception of risk when performing specific tasks

Based on data from Stroud and Walsh (1997), Figure 2.5. shows that both producers and veterinary surgeons perceived foot trimming as the activity most likely to result in injury. However, these two groups differed in their perception of risks for other tasks, probably reflecting the different roles played during handling. Health inspections, castration and calving were all felt to be associated with a substantial level of risk for veterinary surgeons, but a lower level of risk for producers. Since the publication of this report, the requirement to tag calves by 20 days of age, frequently carried out in the field without handling facilities, and the routine clipping of finished cattle before slaughter have introduced new hazards. A recent survey of British dairy and beef producers (Lindsay et al., 2004) suggests that injuries resulting from these activities are common. Given the high incidence of injuries, discussed in the following paragraph, it is not unreasonable to suggest that producers would perceive tagging and clipping as very risky activities.

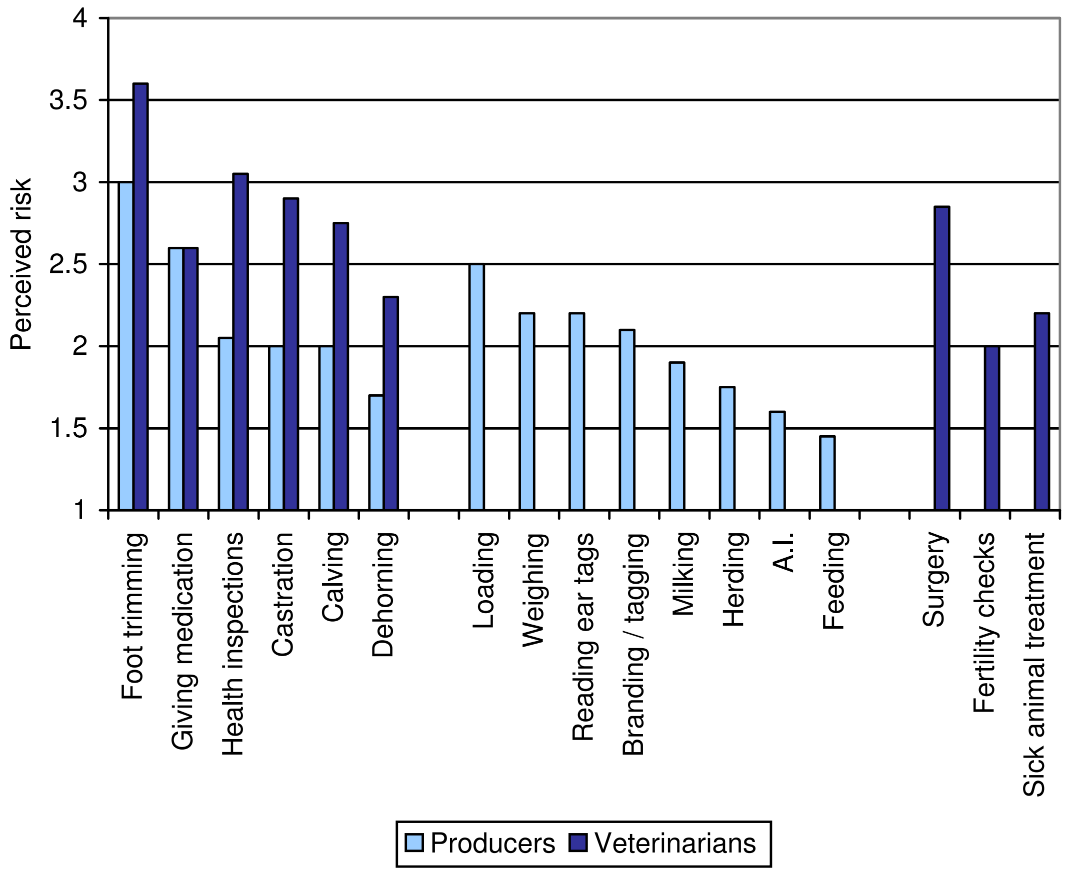


Figure 2.5.: *Perceived risk of injury to producers and veterinary surgeons during routine tasks (1=low risk, 5=high risk. Source: Stroud and Walsh, 1997).*

2.4. Accident statistics classified by task

Task conducted at the time of actual accidents

In the SAC survey, a very high percentage of respondents had experienced injuries whilst clipping the bellies of finished cattle (Figure 2.6.). In a survey of 2439 beef and dairy producers, Lindsay et al. (2004) reported that 17% of respondents had experienced injuries whilst belly clipping, most of which were bruises. This value is substantially less than that in Figure 2.6., probably reflecting differences in the way in which injuries were defined, but still highlights that this task is associated with considerable risk. In Figure 2.6., the low injury rate to producers as a result of pregnancy diagnosing most probably reflects the use of contracted personnel to perform this task.

When 339 veterinary surgeons were asked to state which task was being performed when they experienced their worst cattle-related injury, foot trimming was found to be the most hazardous procedure (Stroud and Walsh, 1997; Figure 2.7.). The same group of veterinary surgeons also perceived the risk of injury to be highest whilst foot trimming.

These surveys provide little information about injuries sustained whilst handling unrestrained animals or those in an open field. An analysis of the 44 fatal accidents which occurred between 1992 and 2003 when handling cattle shows that most deaths occurred whilst checking animals in a field (7 cases), dog walking (6 cases, all members of the public) and driving animals from one part of the farm to another (6 cases). This trend is reflected in Table 2.3. above which shows that most fatal accidents occurred in fields and the fewest in purpose-built handling facilities. Even when using purpose-built handling facilities, producers perceived the greatest risk of injury to exist in the collecting and forcing pens (Figure 2.4.) and Stroud and Walsh (1997) also hinted that a large number of non-fatal injuries were sustained by producers simply whilst herding and moving cattle. In the latter survey, 37.5% of producers reported that their worst work-related injury was sustained whilst herding and moving cattle when milking-related injuries were excluded.

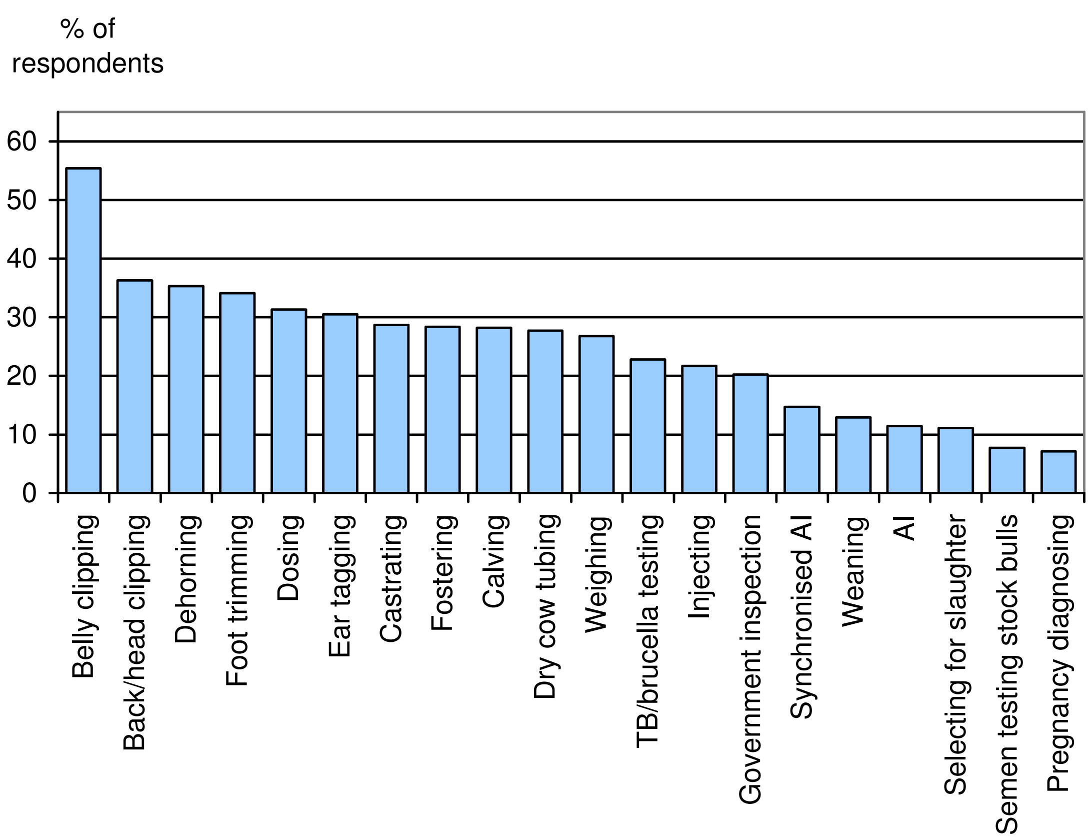


Figure 2.6.: *Percentage of producers who reported receiving injuries whilst performing routine tasks (source: SAC survey, n=139).*

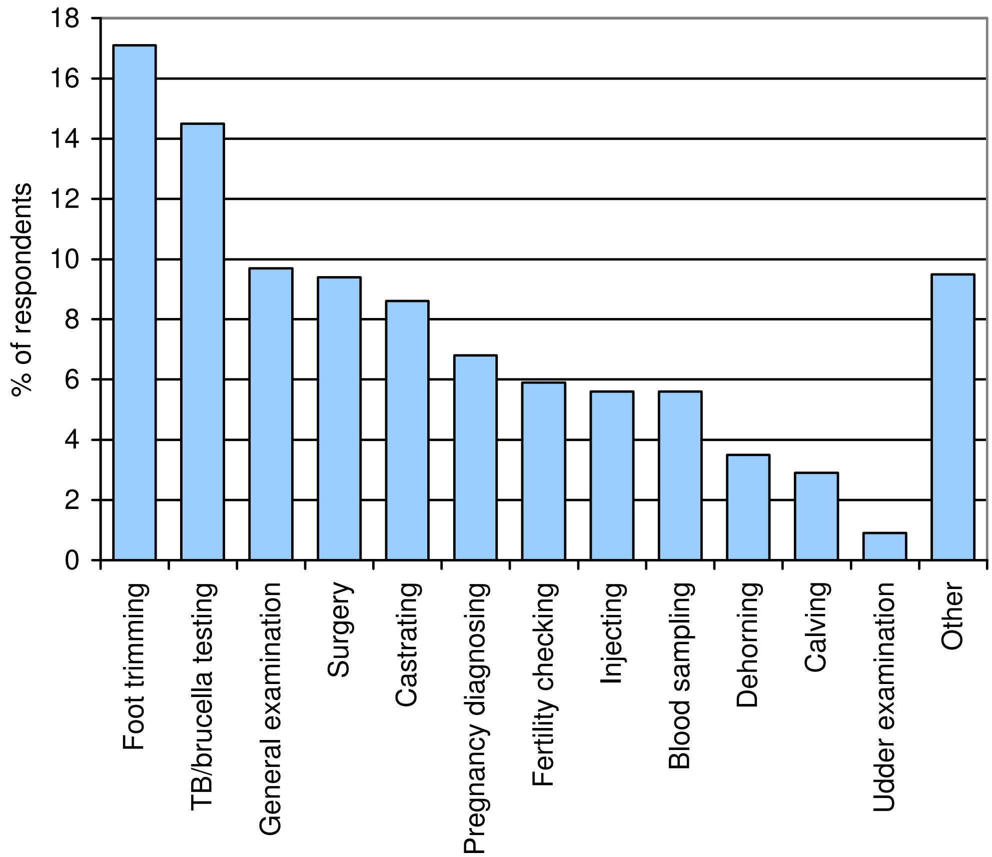


Figure 2.7.: *Task performed when veterinary surgeons experienced their worst cattle-related injury (source: Stroud and Walsh, 1997, n=339).*

2.5. Use of cattle handling facilities

Whilst Stroud and Walsh (1997) found that 87.9% of 313 respondents routinely used a cattle crush whilst handling, only 35.1% used a race. Gates, hurdles, halters, sticks and ropes were also routinely used to restrain cattle. In this survey, the use of suitable handling equipment was regarded as second in importance for the safe handling of cattle after a high level of handler experience. However, only 6.7% of producers attributed their most serious accident to poor handling equipment and only 10% subsequently used handling equipment after an accident which occurred when not using such equipment. In contrast, veterinary surgeons rated suitable handling equipment as the most important requirement for safe cattle handling and failure to use adequate facilities as the greatest cause of their worst injury whilst handling cattle. Veterinary surgeons regarded an improvement in farmer attitude to safe handling as the means by which most progress could be made in improving safety.

The use of handling equipment by Scottish producers is considered in Section 4.

Section 3

Interpretation of risk factors when handling beef cattle under various on-farm conditions

3.1. Introduction

This section will attempt to interpret the statistics presented in Section 2 to highlight the specific risks associated with handling cattle in unrestrained circumstances, in the various components of a permanent handling system and when using portable handling facilities. The requirements for safe and efficient handling are listed for each condition and Section 5 makes recommendations on how these requirements can be met.

As the data in Section 2 suggests, studies have concentrated on injuries involving cattle restrained in purpose-built handling facilities. Under these conditions it is possible to identify tasks associated with a particularly high risk of injury, the types of injury which commonly occur and, on the basis of this, suggest design features which, if incorporated and used correctly, could lead to improved handler safety (see Section 5). For example, the action responsible for most non-fatal injuries in both producers and veterinary surgeons is being kicked or receiving a single knock from the animal's head resulting in bruising, fractures, dislocations and lacerations. However, few data exist on the rate of non-fatal injury when handling unrestrained animals in the field, in pens or in the yard and it is likely that the surveys conducted to date place too little emphasis on the frequency of injury from unrestrained cattle. Certainly, serious and fatal injuries occur much more frequently when purpose-made handling facilities are not used. Even where purpose-made facilities are used, producers perceive the handling of unrestrained cattle in a collecting and forcing pen as more dangerous than when animals are subsequently restrained in the race and crush. Consequently, it is imperative not to ignore the improvement in human safety which may be made by encouraging the use of permanent or mobile facilities which are fit for purpose and improving the design of facilities upstream from the race and crush. Ultimately, the handling of unrestrained cattle will be unavoidable for certain tasks, such as herding. Section 6 considers whether aggressive temperament towards humans has a sufficient genetic basis within a given breed of cattle to allow realistic selection in favour of docility.

3.2. Identification of risks when handling unrestrained cattle

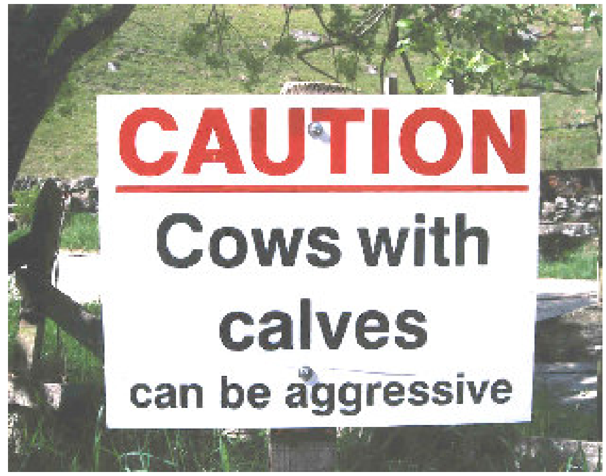
Details of risk factors when handling cattle in the field, pen and loading ramp currently can only be derived from fatal accident statistics.

In the field
Cows with young calves and entire bulls appear to be responsible for a disproportionately high number of deaths. Tasks such as checking, herding and especially ear tagging young calves put the handler at risk of injuries primarily from being knocked to the ground and trampled. There is also a significant risk to members of the public, particularly whilst walking dogs. Some members of the public may not appreciate this risk and there is likely to be a role for the increased use of signs highlighting the danger (Figure 3.1.).

Requirements

1. Availability of more than one person (HSE, 1999a)
2. Animals of calm temperament

Figure 3.1.: *Greater use could be made of signs clearly pointing out the danger posed to members of the public by cows with young calves*



In the home pen

Entering bull beef pens or those with recently calved cows has resulted in several fatal injuries through being kicked or knocked to the ground and subsequently trampled or being crushed against a pen wall. In some cases there was apparently no need for the producer to be in the pen when the design allowed maintenance to be performed from a passageway. Fatal injuries from entire mature bulls in bull pens occur infrequently. Knowles (2002) has shown that 76% of producers seldom or never enter an occupied bull pen alone. Whilst this means that the majority recognise the risk involved, the remaining 24%, estimated to be almost 33,000 producers in England and Wales alone, frequently or sometimes take this risk. That there are not more fatal incidents suggests that the design features allowing separation of the animal from the handler and easy escape have probably prevented many injuries.

Requirements

1. Facilities which minimise the need to enter the pen to perform maintenance tasks
2. Facilities for segregating the pen into an unoccupied and occupied zone.
3. Protection from crushing
4. Easy escape points

3.3. Identification of risks when handling cattle in purpose-built facilities

Collecting and dispersal pens
Moving cattle through a penning system is felt by producers to be a dangerous task due to the risk of crushing from animals turning back from the direction of flow. There is also a risk of being kicked, slipping or being knocked over and trampled.

Requirements
1. Protect handler from crushing
2. Encourage movement through exit and prevent animals from turning

Forcing pen
The forcing pen was associated with the greatest perceived risk of injury and most difficult handling in the survey conducted by SAC (Figure 2.4.). The greatest risk was felt to be posed by cattle retreating from the entrance to the race and crushing the handler against the rear of the pen. As in the collecting pen, there is also a risk of slipping or being kicked or knocked over and trampled.

Requirements
1. Protect handler from crushing
2. Encourage movement towards race entrance and prevent animals from turning

Race
If correctly designed, there should be no requirement for the handler to enter a race in order to encourage an animal to move along it. In the last 11 years there have been no reported cases of fatalities in race systems in the UK. However, it is probable that many crush injuries are caused by cattle reversing back down a race and trapping the handler and many injuries are likely to be received whilst climbing into or out of a race. There is also the danger of crush injuries to the hands and arms as a result of leaning over the race to encourage animals or to operate gates from the wrong side.

Requirements
1. Protect handler from crushing and falling
2. Prevent animals from turning
3. Encourage cattle movement

Crush
There has been one reported fatality whilst using a crush in the last 11 years. Handling in a crush, whilst preventing many causes of injury, is associated with many bruise, fracture and laceration injuries to the hands and arms resulting from entrapment between the animal and a solid component (Figure 2.1.).

Requirements
1. Encourage animal to enter
2. Restrain animal securely and without injury
3. Prevent slipping
4. Allow safe access to the animal's body
5. Allow controlled release of animal

Loading ramp
Occasional fatal injuries have occurred when handlers have been knocked over when loading cattle into a transporter and have subsequently struck their head on the ground. Most cases of injury appear to be caused by cattle retreating back down the loading ramp or tailgate. When a handler stands behind cattle to load them, the animals are at a higher elevation thereby increasing the risk of kicks being received to the head and thorax of the handler. Loading facilities should minimise the need for the handler to be directly in contact with the animals and should maximise the ease of cattle flow into the transporter.

Requirements
1. Prevent cattle from slipping or being injured
2. Encourage cattle movement

3.4. Identification of risks when handling restrained cattle in mobile and improvised facilities

The use of cattle behaviour to aid, rather than hinder handling, apply in both portable and fixed handling facilities (Brockway, 1983). If adequately secured, gates and hurdles temporarily placed to guide or restrain an animal may offer some degree of protection to the handler. However, fatalities have occurred where gates held in position by the handler have been pushed aside by the animal causing the handler to be knocked to the ground. Non-fatal injuries have been described in inadequate detail to allow the cause and incidence of injuries in temporary handling facilities to be assessed, although it is likely that they do occur.

Requirements
1. Provide solid protection to the handler
2. Be easy to erect and dismantle
3. Encourage calm cattle movement

Section 4

Survey results: Current design of Scottish handling facilities

4.1. Design and use of Scottish handling facilities

The following results are based on a survey distributed to 2000 Scottish producers. One thousand copies were sent via the SAC publication *Sheep and Beef Notes* whilst a further 1000 were distributed to a random sample of beef producers registered with *Quality Meat Scotland*. Not all of those receiving copies through *Sheep and Beef Notes* farmed cattle, but it proved impossible to filter these individuals out of the distribution. A total of 139 completed forms were returned, although the response rate varied for each question. The mean herd size managed by the respondents was 77 suckler cows (range 0-430), 69 weaned calves (range 0-412) and 58 finishing cattle (range 0-400).

Are permanent and portable facilities routinely used?

The majority of producers routinely used permanent handling facilities located in the farm steading (Table 4.1.). Around half (49.6%) of the respondents used neither permanent nor portable handling facilities in the fields. Handling facilities incorporated pre-existing buildings in their design on 82.7% of occasions.

Table 4.1.: *Routine use of handling facilities on Scottish beef farms.*

	Yes		No		Total
	n	%	*n*	%	
Permanent handling pens in steading	127	91.4	12	8.6	139
Permanent handling pens in field	53	38.1	86	61.9	139
Portable handling pens	19	13.7	120	86.3	139

Forcing pen design

With a few exceptions, the forcing pens currently in use are designed with straight sides, although over half of them narrow to a funnel where they join the race (Table 4.2.).

Table 4.2.: *Design of Scottish forcing pens.*

	Yes		No		Total
	n	%	*n*	%	
Curved	5	3.8	127	96.2	132
Presence of funnel	72	59.0	50	41.0	122

Race design

The majority of races currently used are of a straight design and lack a handler catwalk. Around half have back-stops in the form of gates to prevent the cattle from reversing back towards the forcing pen (Table 4.3.). Most races were constructed of metal (60.3%) with a smaller number in timber (24.7%) and stone (15.0%). A minority had solid sides (37.0%).

Table 4.3.: *Design of Scottish races.*

	Yes		No		Total
	n	%	*n*	%	
Curved	10	8.3	110	91.7	120
Presence of backstops	64	51.6	60	48.4	124
Presence of catwalk	14	11.7	106	88.3	120

Crush design

Most crushes currently in use incorporate a self-locking head gate, and both a back gate and a rump bar (Table 4.4.). Around one third of crushes allow the sorting of cattle on exit. The average age of the crush was 11 years. Whilst some had invested in new crushes in the last year, the oldest was 50 years old.

Table 4.4.: *Design of crushes currently used in Scotland.*

	Yes		No		Total
	n	%	*n*	%	
Is the head gate self-locking	96	71.1	39	28.9	135
Presence of back gate	106	79.1	28	20.9	134
Presence of rump bar	89	67.4	43	32.6	132
Presence of weighing facility	45	33.3	90	66.7	135
Presence of shedding facility	47	34.8	88	65.2	135

Section 5

Recommendations for the design of permanent and mobile handling facilities

5.1. Introduction

As the ease of handling depends largely on how well the behaviour of the animal is exploited, the starting point in the design process should be understanding what features encourage calm and injury-free movement (Eldridge, 1982; Hargreaves and Hutson, 1997). Gonyou et al. (1996) and Taylor (1997), reporting on surveys of livestock equipment manufacturers from various sectors, concluded that greater access and uptake of information on the principles of animal behaviour would improve equipment design. Producers however, are also responsible for purchasing and constructing facilities of an appropriate design for their needs and siting and using them in the best manner. The results of the SAC survey (see Section 4) are insightful. They suggest that the majority of handling facilities currently in use in Scotland do not take advantage of simple and low cost design principles that make maximum use of cattle behaviour. Fortunately, the basic principles of successful design are the same irrespective of the scale or the purpose for which the facilities are required (Grandin, 1990), and some of these are discussed in Section 5.2. In Section 5.3, recommendations are made for improving the ease and safety of handling at each stage of a complex handling system, from collecting pen to crush or loading ramp. Figure 5.1. gives a diagramatic representation of the components of such a system, shows how they can be orientated to maximise the ease of cattle flow and highlights some of the principles discussed throughout Section 5. On many Scottish farms, components of this system will be missing or much simplified. Even if additional construction can not be justified, Section 5.3 will include low-cost recommendations which can be implemented in almost any facility and the use of some of these principles in the design of mobile handling facilities is detailed in Section 5.4.

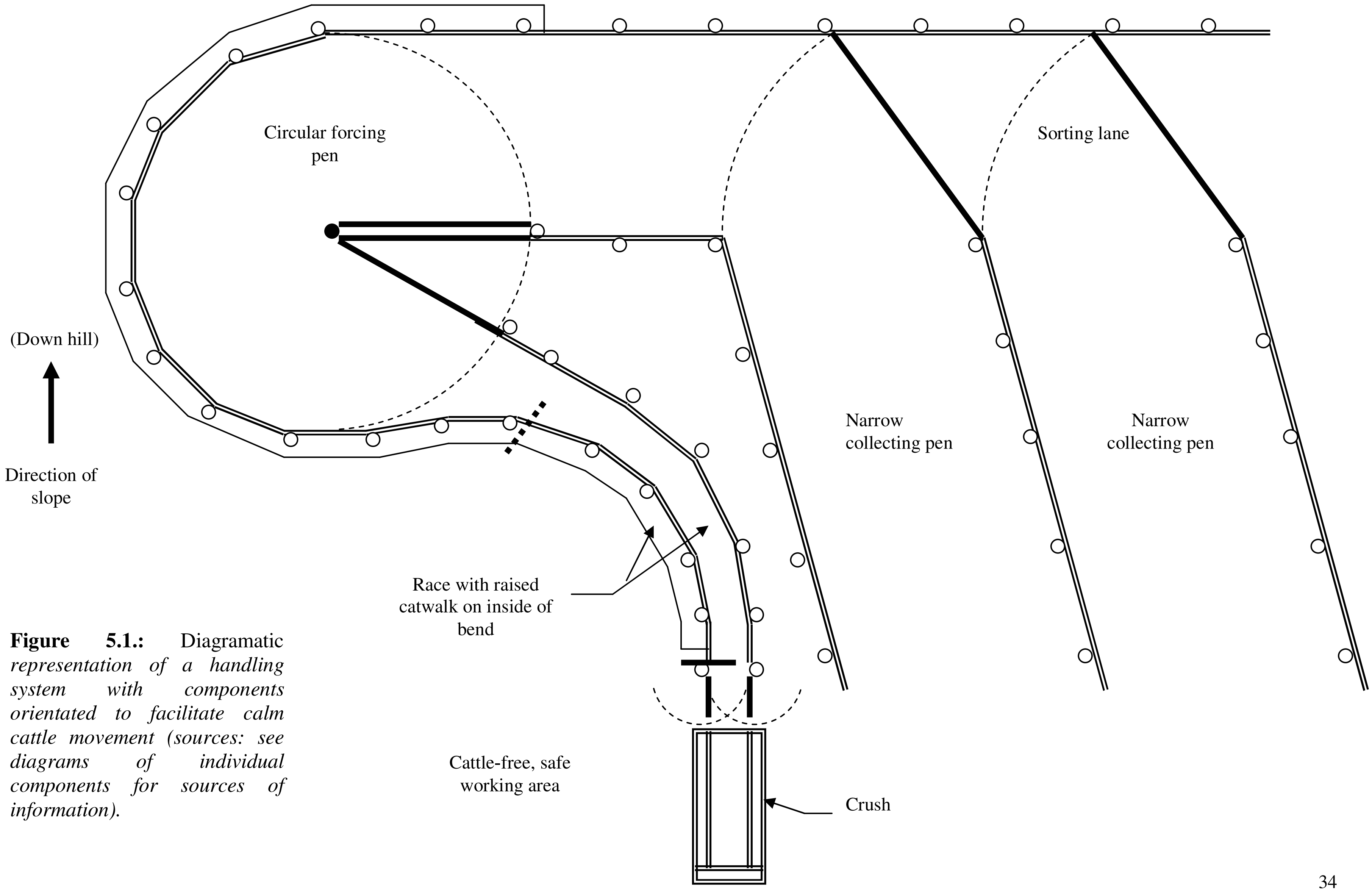


Figure 5.1.: Diagramatic *representation of a handling system with components orientated to facilitate calm cattle movement (sources: see diagrams of individual components for sources of information).*

5.2. General design features

Methods of avoiding disturbing stimuli

Disturbing noises
Fear and stress are common responses to novelty (Lawrence, 1991). Noise during handling may be aversive to cattle due to its novelty or its association with previous negative experiences whilst being handled (Waynert et al., 1999). Cattle hear well, but are poor at locating the source of the noise (Heffner and Heffner, 1992; Boyles et al., no date) and both cattle and sheep hesitate before moving through noisy facilities (Grandin, 1980a; Hargreaves and Hutson, 1997). Waynert et al. (1999) exposed heifers to sounds associated with handling (loud human voices and the sound of metal striking on metal). Cattle responded to both types of noise with an increase in heart rate and, whilst some degree of habituation was evident after five consecutive days of exposure, the authors thought it unlikely that habituation would occur when exposed to less frequent handling. The sound of metal components striking against each other should therefore be minimised and the use of rubber strips to prevent metal-to-metal contact has been recommended (Grandin, 1980a; Waynert et al., 1999; Weeks et al., 2002). Noisy metal crushes have been recognised as a cause of alarm for some time (see White, 1961). Whilst some degree of noise during the opening and closing of gates and the head yoke is inevitable, the design and use of crushes which rattle when entered should be avoided. Handlers should also avoid shouting to encourage movement as this may actually impede movement and make the animals more restless.

Contrasting light levels
Cattle have a very narrow field of binocular vision (25-50°) resulting in poor depth perception, making it difficult for them to differentiate between a shadow and a deep hole in the ground (Vowles, 1982; Warriss, 1990; Boyles et al., no date). Furthermore, as they have only 60° of vertical vision, the head must be lowered in order to focus on something on the ground (Grandin, 2000a; Boyles et al., no date). Consequently, shadows and objects on the ground which present a colour contrast cause both cattle and sheep to pause and cattle have been observed to hesitate before passing drains in the races of British cattle markets (Hargreaves and Hutson, 1997; Weeks et al., 2002). Drains should be sited outside of the areas used by cattle and solid partitions can eliminate the intermittent shadows cast by barred partitions (Grandin, 1980a). The value of solid partitions is considered more fully later in this section and in Section 5.3.3. Grandin (1980a) has also recommended the use of partitions of a uniform colour and a floor surface of a uniform texture and level to further reduce the occurrence of areas of stark contrast.

Cattle are also reluctant to enter a dark area or one which is illuminated by an intense light source (Grandin, 1980a). Where a roof covers part of the handling area, the covered area should therefore be provided with adequate diffuse light.

Methods of utilising positive stimuli which encourage movement

In common with sheep, cattle will move forwards more freely when another animal is in view ahead (Ewbank, 1961; Hitchcock and Hutson, 1979a, Vowles, 1982). Sheep prefer to return in the direction from which they came (Brockway, 1983) and anecdotal evidence suggests that cattle share this tendency. Both cattle and sheep also prefer to move towards a more brightly lit area and away from a poorly illuminated area (Ewbank, 1961; Hitchcock and Hutson, 1979b). Races should therefore be orientated to give the impression that they are directing animals back towards the collecting pen and other cattle being held in the dispersal pen should be visible through the exit of the crush. The area of the crush and dispersal pen should also be well illuminated.

Cattle-free safe working area

Where space allows, an area should be designated as cattle-free (Figure 5.2.). This should allow the handler to work with an animal in the crush without risk of disturbance or injury from other cattle. It also provides an area where equipment can be stored without risk of damage and, if covered, provides a dry working environment.

Figure 5.2.: *A cattle-free area allowing handlers to work in safety.*

Gate design

Gates should open through a full 180° (McNitt, 1983). If they do not lie flat against a pen wall when open, it is highly likely that the cattle will close the gate as they are moved past it, encouraging them to retreat back towards the handler (Figure 5.3.). There is also a risk of bruising as the animals rub against the end of the gate (Boyles et al., no date). Attention should be paid to the location of hinge pintles from which gates are hung. Pintles should not be located where the post on which they are attached will prevent the full opening of the gate (Figure 5.4.) and they should be fitted with split pins to prevent the gates from being lifted off by an animal (Lowman and Watson, 1985). It should be possible to tie back all gates to prevent accidental closure (Grandin, 1990). As gate latches are a common cause of bruising (Marshall, 1977; Boyles et al., no date), care should be taken to make sure that they do not protrude.

Figure 5.3.: *Gates which fail to open 180° impede cattle movement and can cause bruising.*

Figure 5.4.: *The location of hinge pintles on square section posts should not prevent the full opening of the gate.*

Wall design

Where possible, upright structural supports should be located on the outer surface of a wall or partition and, if overlapping sheets are used, the overlap should be in the direction of cattle movement thereby presenting a smooth surface to the animal (Brockway, 1983; Grandin, 1997). Where thin steel sheets are used, the edges should be curved over along the top and bottom horizontal edges to prevent cuts to the animals and handlers and screws should be countersunk (Brockway, 1983). Hardy and Meadowcroft (1990) recommended that the walls of handling facilities should be 1.68m in height. Grandin (1997) suggested that wall height could be tailored according to cattle breed and recommended a height of 1.52m for British breeds and 1.67-1.83 for continental breeds. Solid walls of this height limit visual disturbance (Grandin, 1997) and also reduce the likelihood of an animal jumping and being bruised or impaled on a structural support. Vowles (1982) is unusual in recommending the use of open rather than solid walls, for the reason that cattle may be unwilling to enter an enclosed area which is smaller than their flight distance. More recent work suggests that, on balance, solid walls encourage efficient cattle movement to a better degree than open designs, and this is discussed more fully in Section 5.3.3. However, strategic use of open-sided partitions can be made where cattle may be encouraged to move towards other animals in view (Hargreaves and Hutson, 1997). High, solid partitions may impede the easy escape of the handler from a pen. The inclusion of a toe slot in high-sided solid walls to facilitate escape has been recommended (Grandin, 1999). Alternatively, Borg (1993) suggests the use of a wooden strip fitted 0.6m from the bottom of solid walls as a step to aid climbing over if a rapid escape is needed. The ends of these strips should be beveled to prevent cattle injuries.

Floor surface

Durable, non-slip surfaces should be used in all areas frequented by cattle and handlers. As Figure 2.3. shows, being kicked or hit by the animal was the most common mechanism causing injury in both producers and veterinary surgeons. A proportion of these cases were probably caused by the animal slipping over when walking on an unsuitable surface. If the handler slips over, there is the danger of injury from the fall and from trampling by the cattle. This may contribute to the high perception of risk in areas such as the collecting and forcing pens. A survey of accidental injuries in dairy cattle showed that one of the principal mechanism of injury was falling on slippery surfaces resulting in limb fractures (Blom, 1983). In a survey of UK cattle markets, poorly drained and worn floor surfaces were principal causes of economically significant bruising (Weeks et al., 2002). Grandin (1990) has found the use of 'V' shaped grooves of 2.5cm depth arranged in a 20cm diamond or square pattern to be effective for concrete surfaces. Alternatively, Grandin (1999) has suggested the use of 2.5cm diameter steel rods raised slightly above the level of a concrete floor. Older concrete floors which are worn smooth should be re-grooved. Where possible, floor surfaces should have a slight slope of 4° to facilitate drainage (McNitt, 1983). Suitable floor surfaces for crushes and loading ramps are considered in Sections 5.3.4. and 5.3.6.

Slope aspect

Adequate drainage of the site is necessary to provide a clean, dry working area for both cattle and humans and to prevent slips (Bicudo et al., 2002). Excessive inclines, however, should be avoided, and Bicudo et al. (2002) have suggested a maximum angle of 5%. Hitchcock and Hutson (1979a) found that sheep are more willing to move on a flat than a sloping surface, but that on sloping sites, they were more hesitatnt when moving down hill. Boyles et al (no date) provides anecdotal evidence that cattle also hesitate when moving down slopes. Consequently, the slope aspect should require cattle to move up hill from the forcing pen to the crush, as indicated in Figure 5.1.

Methods of avoiding bruises and leg injuries

The presence of sharp edges or materials with a small diameter increase the likelihood of both cattle and handlers being bruised. Where possible, sharply-angled corners should be eliminated by using round posts and other sharp corners should be padded with rubber (Marshall, 1977; Grandin, 1990, Weeks et al., 2002). Gaps between the floor and walls or gates should be sufficient to allow drainage, but not large enough to allow an animal's leg to become trapped (Weeks et al., 2002).

5.3. Permanent facilities

5.3.1. Collecting and dispersal pens

Requirements

3. Protect handler from crushing
4. Encourage movement through exit and prevent animals from turning

Recommended features

Protect handler from crushing
In all parts of the handling facility, the risk of crushing can be greatly reduced by ensuring that cattle move calmly in the desired direction without retreating. In the collecting and dispersal pens, Borg (1993) suggests the inclusion of 0.36m wide gaps placed at intervals in the pen wall to act as escape passes, although these may attract the attention of cattle and severely slow the rate of movement. Alternatively, safety posts may be positioned 0.9 – 1.2m from each corner of the pen (Midwest Plan Service, 1987) and toe slots may be incorporated into the base of the walls (Grandin, 1999). Where a handler is required to enter a pen holding a mature bull, safety posts are essential and, once in the refuge area, steps in the form of galvanised steel rings should allow the handler to escape from the pen (Lowman and Watson, 1985).

Encourage movement towards exit and prevent animals from turning
One of the most common design faults in cattle handling facilities is having collecting and dispersal pens which are too wide, thereby encouraging animals to escape past the handler (Brockway, 1983; Boyles et al., no date). Borg (1993) recommends the use of rectangular pens one gate in width (around 3.65m) and 15m long for groups of 30 cattle. Excessively narrow pens should be avoided as cattle which do attempt to escape may trample the handler. For large herds, several narrow pens allow cattle to be handled more easily than a single wide pen. If a wide pen is to be used, the gates leading into and out of the pen should be located in a corner, not in the centre of a partition (Boyles et al., no date).

Cattle flow from the pen is enhanced by eliminating sharp corners which may be perceived as a dead-end (Vowles, 1982; Warriss et al., 1992; Figure 5.5.). Where possible, the collecting pen should be in-line with the forcing pen. Where this is not possible, the collecting pen should be orientated on a 60-80° angle from the lane leading to the forcing pen, rather than perpendicular to it (Midwest Plan Service, 1987; Grandin, 1990; Borg, 1993; Bicudo et al., 2002; Figure 5.6.). Pigs have similarly been observed to move more rapidly out of a lairage pen into a lane when the adjoining angle was gentle (Warriss et al., 1992). The use of a gate on the collecting pen which is longer than the width of the lane, will also help to eliminate an obvious corner and has been found to aid both cattle (Grandin, 1990) and sheep movement (Minister, 1983). Grandin (1990) recommends a width of 3.0m for the lane leading between the collecting pen and the forcing pen.

Figure 5.5.: *The exit from this collecting / dispersal pen could be perceived as a dead end*

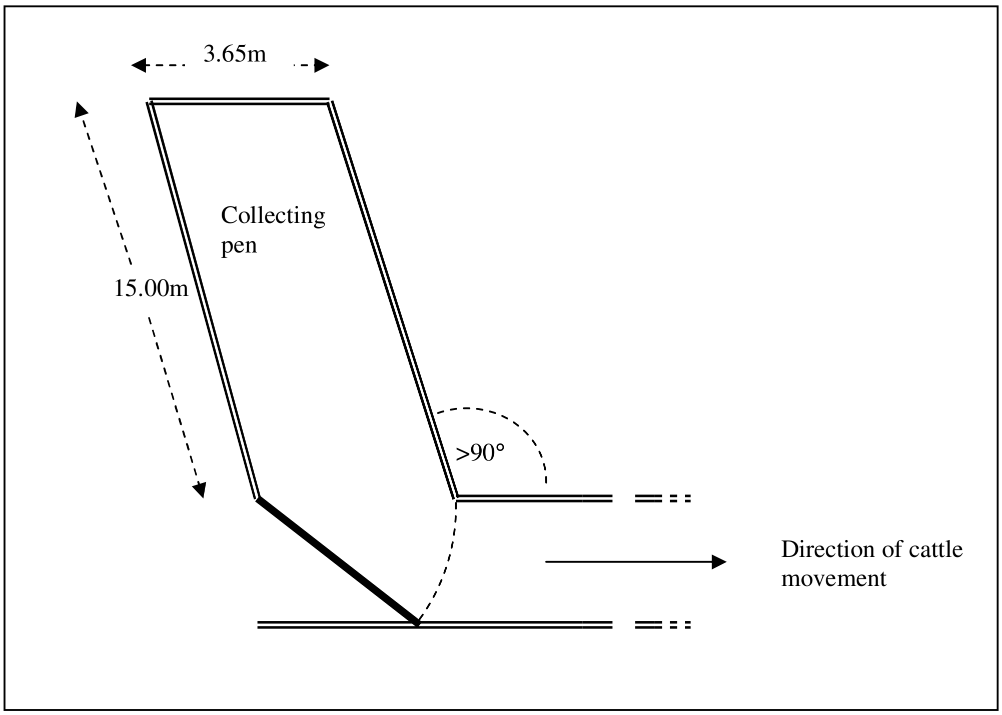


Figure 5.6.: *Diagram of a diagonal collecting pen leading towards a lane with a gate designed to eliminate the sharp corner (sources: Midwest Plan Service, 1987; Borg, 1993; Grandin, 1997; Biucudo et al; 2002).*

Key features

- Narrow pens discourage cattle from escaping past the handler
- The floor area of a pen should not be excessively large
- Where possible pens should not be sited perpendicular to the exit lane
- Use long gates to eliminate obvious corners
- Consider including safety posts or foot steps at the base of walls to facilitate the escape of the handler

5.3.2. Forcing pen

Requirements

3. Protect handler from crushing
4. Encourage movement towards the race entrance and prevent animals from turning

Recommended features

Protect handler from crushing
The forcing gate at the rear of the forcing pen should be operable from outside of the handling system once the animals are inside the forcing pen. This may require an arm extending from the top of the gate and a 0.45m wide catwalk to access it (Borg, 1993). The gate should be fitted with self-locking backstops to prevent it reversing when cattle press against it (Bicudo et al., 2002). A spring-loaded pin locating into holes at intervals along the outer wall of the forcing pen will prevent the gate reversing more than the distance between holes (Borg, 1993; Figure 5.7.). However, this requires the handler to release the pin each time the gate is moved forward thereby distracting their attention. The use of a latch and tooth mechanism (Figure 5.8) may alleviate this problem, although it should be recessed into the wall to eliminate bruising. The use of a latch at both the top and bottom of the forcing gate will provide greater strength and reduce the chance of accidental release. A mechanism to prevent the unintentional reversal of the gate is especially important where it is necessary to move the gate by directly standing behind it throughout the operation. McNitt (1983) and Borg (1993) suggested that handlers are frequently trampled by single animals which are left in the forcing pen when they attempt to join others which have entered the race. Consequently, an animal should not be left on its own in the forcing pen.

Figure 5.7.: *Outer wall of a curved forcing pen with holes for a spring loaded pin to prevent accidental movement of the* forcing gate.

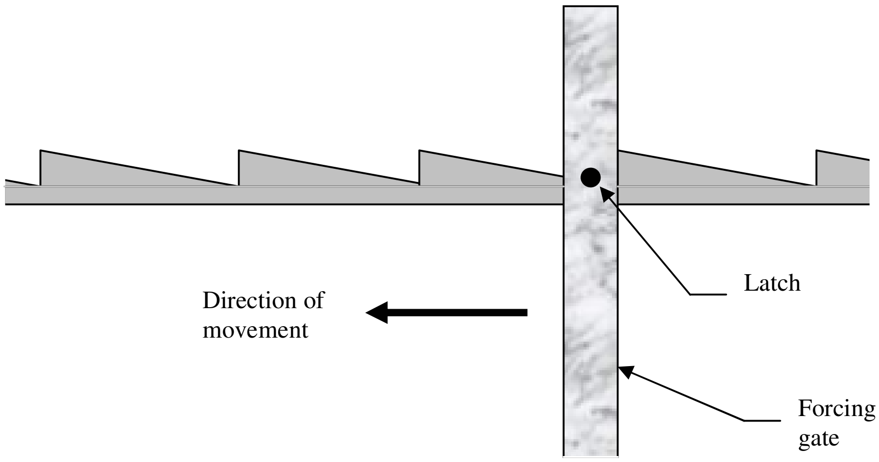


Figure 5.8.: *Latch and tooth mechanism to allow easy one-way movement of a forcing gate*

Encourage movement towards the race entrance and prevent animals from turning
Recommendations for forcing pen design are available from the USA and Australia and from the sheep industries in the UK, New Zealand and Australia. Cattle should be encouraged to face in the correct direction and move towards the race entrance. This can be achieved by using a solid forcing gate (Figure 5.9.) and a circular forcing pen (Figures 5.1. and 5.10.) which prevents animals from collecting in a corner and exploits the animal's tendency to circle around a handler (Daly, 1970; Grandin, 1980b; Brockway, 1983; Hargreaves and Hutson, 1997). Grandin (1997) suggests that a gate 3m in length be used for handling herds of the size found on British farms and the forcing pen should be designed to hold no more than 8-10 cattle (Borg, 1993). A large gap between the forcing gate and the ground should be avoided as this has been identified as a cause of fatal injuries to calves which attempt to escape (Edwards et al., 1995). The combination of a curved race and circular forcing pen has been shown by Vowles and Hollier (1982a) to reduce the time needed to move cattle by up to 50%. Cattle flow is most rapid when forcing pen sides are solid (Vowles et al. 1984a).

Where a curved pen and race system is used, cattle in the forcing pen should be able to see 3m into the race entrance (Grandin, 1997; Figure 5.11.). Cattle move more slowly through straight-edged forcing pens (Grandin, 1997). However, if a straight edged design is required to fit into an existing confined yard layout, one side should be flush with the race and the other should angle towards the race entrance at 30 ° (Grandin, 1997; Hardy and Meadowcroft, 1990; Bicudo et al., 2002; Figure 5.12). Whatever plan of forcing pen is adopted, a sharp angle between the exit from the forcing pen and the entrance to the race should be avoided or the efficiency of movement will be reduced. Furthermore, any gate used to close the entrance to the race should be barred, not solid, to encourage animals to face in the correct direction (Grandin, 1997).

Figure 5.9.: *Solid forcing gate and circular forcing pen*

Figure 5.10.: A c*urved crowding pen with a solid crowding gate on the right. A gate of partially open design at the entrance to the race allows cattle waiting in the forcing pen to see the exit at all times.*

Figure 5.11.: *A gently curved entrance into a race from a forcing pen*

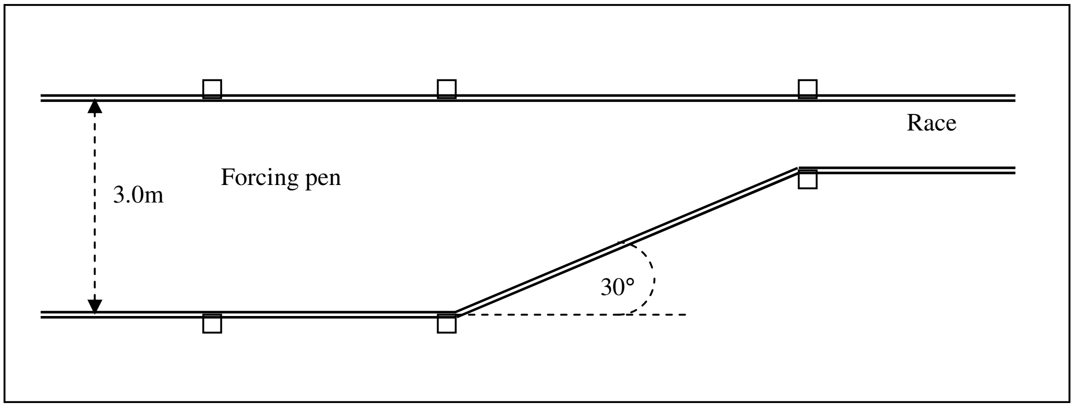


Figure 5.12.: *Diagram of a straight-sided forcing pen with one wall converging at an angle of 30 °(Sources: Grandin, 1997; Hardy and Meadowcroft, 1990; Bicudo et al., 2002).*

Key features

- Operable without the need for the handler to stand directly behind the forcing gate or inside the forcing pen
- Fitted with self-locking back-stops to prevent accidental opening
- Shallow angle into race entrance to encourage cattle to enter
- Circular design to prevent animals from collecting in a corner
- Solid forcing gate to discourage attempted retreat
- High, solid sides to minimise visual disturbance
- Avoid holding one animal in the forcing pen when others have entered the race

5.3.3. Race

Requirements

4. Protect handler from crushing and falling
5. Prevent animals from turning
6. Encourage cattle movement

Recommended features

Protect handler from crushing and falling
If the race is designed correctly, there should be no requirement for a handler to enter it in order to encourage cattle to move. There should be an access gate at the rear of the crush so that tasks such as artificial insemination can be performed without climbing over the sides of the race (Battaglia and Mayrose, 1981; Borg, 1993; Figures 5.13, 5.14.). Whilst treating an animal in the crush, there should be no possibility of injury from an animal in the race (HSE, 1999a). Hence, a solid gate should separate the handler standing at the rear of the crush from the animals waiting in the race. A single gate can perform both the functions of protecting the handler and allowing access (Boyles et al., no date). The animal in the crush should be sufficiently restrained to eliminate the risk of it reversing into a handler positioned immediately behind it. Gates used to control cattle flow should be operable from the working side of the race and not require the handler to reach across the race itself (HSE, 1999a).

Prevent cattle from turning
Races are commonly too wide for the size of the cattle handled (Grandin, 1997). The correct width is likely to vary from breed to breed, but as a guide, Grandin (1997) recommends that the race should be 4 cm wider than the largest animal which will enter it, equating to 66-71cm for adult cows and 51cm for calves in a straight sided race. When the race is to be used to handle cattle of varying weights, it should ideally be tapered into a 'V' shape, either for its full height or for its lower half only, as common in the USA and Australia (Vowles and Hollier, 1982b). For a fully tapered race, the width at floor level should be 38-46cm, whilst at 86cm above ground level, the width should be 71-81cm (Borg, 1993). For half tapered races, the same dimensions apply, but the race sides are vertical above 86cm in height. Table 5.1. provides width measurements for cattle of different weights based on US recommendations. When handling calves, a calf race should be constructed alongside the main race which would alleviate many of the problems associated with race systems (Thompson, 1987). Spinal damage has been reported to occur in calves whilst attempting to turn around in a race designed for adult cattle (Edwards et al., 1995). Where a separate race is not feasible, a low cost method of reducing the width of a race for handling calves is the use of inserts which narrow the width by 15cm and hang over one wall (Borg 1993). Where permanently tapered races are used, there is a danger of cattle becoming wedged if they slip (McNitt, 1983). The use of side panels which can be released rapidly are common in the USA to free animals, but add further to the cost of construction and maintenance (Apple et al., 1994).

The use of an overhead restrainer to prevent cattle from rearing up and turning around has been suggested by Apple et al. (1994) and the Midwest Plan Service (1987). The design proposed by Apple et al. (1994) uses two parallel 2.5cm diameter pipes fitted to overhead cross-members (Figure 5.15.). As for the handling pens, Grandin (1997) recommends a race height of 1.52m for British breeds and 1.67-1.83m for continental breeds. In a recent survey of races commercially available within the UK, the height was a standard 1.50m, which for continental breeds may be too low (Stroud and Walsh, 1997). For solid-sided races, the paneling should not make contact with the ground. Apple et al. (1994) suggests a gap of 8cm to facilitate drainage and prevent slipping.

Table 5.1.: *Suggested race width based on US cattle breeds (source: Borg, 1993).*

	Cattle weight		
	Under 272kg	272 – 544kg	Over 544kg
Straight sided (cm)	46	56	71
Fully tapered			
Width at 81cm (cm)	46	56	71
Width at bottom (cm)	38	41	46

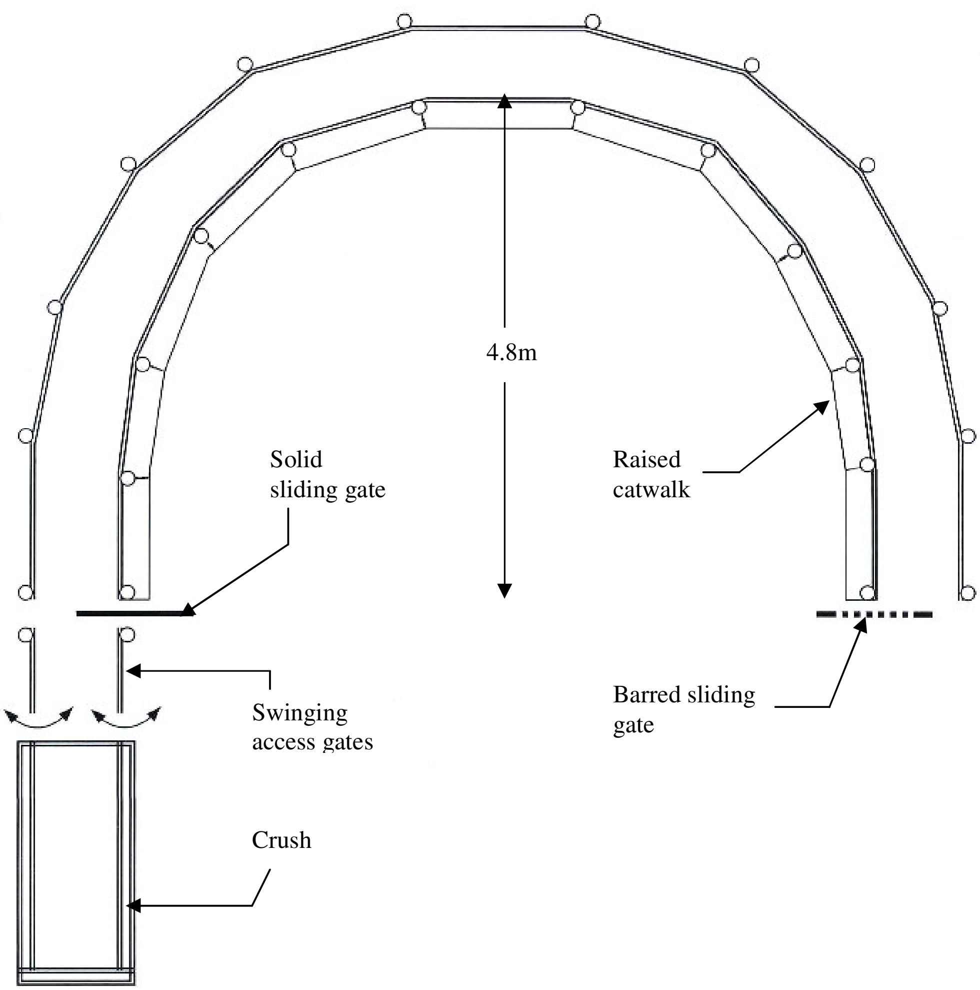


Figure 5.13.: *Diagram of a curved race with raised catwalk and gates to allow access and to protect the handler when standing at the rear of the crush (source: Borg, 1993).*

Figure 5.14.: *Large access gate at the rear of a crush. Note the sliding gate which prevents cattle waiting in the race from injuring the hander.*

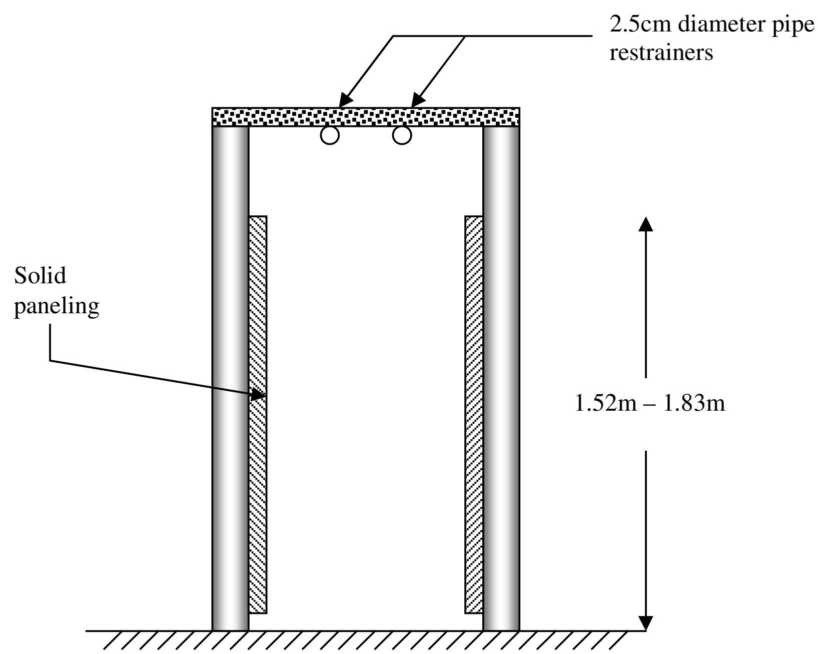


Figure 5.15.: *The use of pipe restrainers to prevent cattle from rearing up when held in the race (source: Apple et al., 1994).*

Encourage cattle movement

<u>Side construction – solid or open?</u>

Races used in the UK appear to predominantly have open sides (Stroud and Walsh, 1997; Figure 5.16, see Section 4) although Warriss (1990) and Weeks et al. (2002) have called for the use of solid sides. Vowles and Hollier (1982a) found no difference in the rate of movement of cattle through a race when the sides were solid or barred above 0.9m height. Grandin (1980a), however, reported that cattle will move more easily through a race with solid sides and empirical studies on sheep have also shown that they move faster when the sides are solid (Hargreaves and Hutson, 1997; Hutson and Hitchcock, 1978). Hargreaves and Hutson (1997) suggested using solid sides for the side of the race where most human activity occurs, thereby hiding potentially disturbing stimuli from sight, but using an open design on the far side to prevent the animals from perceiving the race as a dead end. If the side exposed to most human activity is to be open, Grandin (1997) recommends that the lower 60cm should be solid to prevent injuries to the animal's legs or those of the handlers alongside. Open sided races give small cattle greater opportunity to turn around by allowing them to place their head between the rails. Solid sided races also greatly reduce the risk of the leg of an animal become trapped.

Race shape – straight or curved?

Vowles and Hollier (1982a) found that curved races used in combination with circular forcing pens reduced handling time by up to 50% compared to straight forcing pens and races. In a later paper, Vowles et al. (1984b) observed no difference in movement times in a straight or curved race with a radius of 4.5 or 7.0m. The improvement in operational efficiency found using the combination of a circular forcing pen and curved race was attributed to the forcing pen design alone. However, Grandin (1980a) believes that cattle move through a curved race more rapidly as the crush or loading ramp are hidden from view until the animals approach the end of the race and because the design exploits the tendency of cattle to circle around the handler (Grandin, 1997). Observations on US slaughter plants suggest that curved races require less labour input to move cattle (Grandin, 1984/1985) and extension services in the US now suggest basing races on curved designs with solid sides (eg. Battaglia and Mayrose, 1981; Midwest Plan Service, 1987; Borg, 1993; Apple et al., 1994; Bicudo, 2002; Figure 5.17). Cattle markets in the UK have also recently been advised to adopt curved races due to the improvement in handling efficiency (Weeks et al., 2002). When using curved races the handler should be positioned on the inside of the curve, and ideally on a raised catwalk (Grandin, 1997; Figure 5.18). For any race plan, the handler should be positioned at 45-60° back from the animals shoulder (Grandin, 1980b). Preventing cattle from seeing the crush until they are very close to it appears to be a principal reason for the success of curved races. It is likely that curves which turn cattle through a full 90 or 180° are not necessary to achieve this benefit and it may be easier to incorporate more gentle curves into Scottish systems which are typically constructed alongside existing buildings.

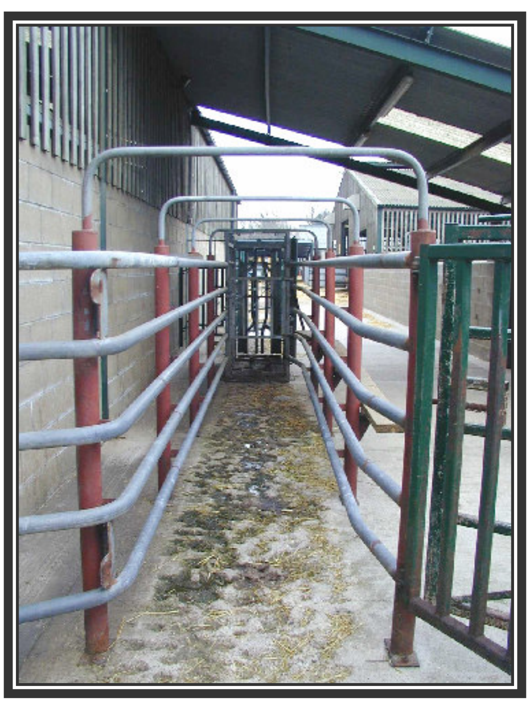


Figure 5.16.: *An open-sided, straight race, typical of the kind most commonly used in the UK. This design allows cattle to see the crush from the moment they enter the race and encourages visual disturbance from handlers and cattle nearby. The crush is also situated under a roofed area which may need to be artificially illuminated to encourage cattle to enter.*

Figure 5.17.: *A well designed curved race with high solid sides and blocking gates which do not prevent the animal from seeing the exit when the gate is closed.*

Figure 5.18.: *A raised catwalk located along the inside radius of a curved race which encourages the handler to stand at the correct position relative to the animal.*

Weeks et al. (2002) found that cattle frequently knocked themselves against the corner and slipped whilst trying to negotiate 90° bends in races in UK cattle markets, resulting in bruising to the hips. Where design considerations necessitate a sharp bend in any part of the facility, a particularly slip-resistant floor surface should be used.

Race length

To prevent the race appearing as a dead end, it should be a minimum of 6m long, allowing 3-4 cattle to held at any time (Midwest Plan Service, 1987; Borg, 1993; Apple et al., 1994; Bicudo et al., 2002) although Grandin (1997) suggests a minimum length of 9m.

Radius of curved races

The Midwest Plan Service (1987) and Borg (1993) have suggested that the maximum curvature on a race should be 15°. This equates to an inner radius of 4.9m which falls into the range proposed by Grandin (1980a; 1997) of 3.5-6.0m. Increasing the radius beyond this does not appear to result in improved cattle movement as Vowles et al. (1982b) found no difference in handling times using races of 4.5m compared to 7.0m radius.

Other considerations

1. Races receive a lot of use and a hard wearing, slip-resistant surface should be provided to prevent injuries to cattle (Midwest Plan Service, 1987).
2. Blocking gates positioned at intervals will prevent cattle from retreating back down the race (Midwest Plan Service, 1987). Weeks et al. (2002) has argued against the use of gates which slide at 90° into the race (Figures 5.17 and 5.19) as these are frequently closed against the flank of an animal either intentionally or accidentally. The authors recommend the use of a pair of vertically separating gates which open in the direction of cattle movement and can be locked open, although they should not in themselves present a risk of bruising when the animals move past them. Where possible, gates should be of an open construction so that the exit is visible at all times (Vowles, 1982).
3. In a curved race design, a straight section may be needed where it leaves the forcing pen to prevent the appearance of a dead end. Any gate used to close off the junction between the forcing pen and race should be barred, to encourage cattle to face in the correct direction for entry to the race (Grandin, 1997).

Figure 5.19.: *A blocking gate which slides at 90° into the race.*

Key features

- A calf race should be constructed alongside the standard adult race
- Gates providing access to the rear of the crush
- A solid gate to close off the end of the race adjoining the crush to protect the handler from injury by animals waiting in the race
- A raised catwalk allows animals to be driven without entering the race
- The race should be the correct width (4cm wider than the largest animal) and height (not less than 1.52m and substantially more for continental breeds)
- The use of inserts hung over one side of the race can be used to reduce the width when handling calves
- A curved design with solid sides and non-slip floor encourages animal movement, whilst a simple, low cost overhead restrainer may prevent cattle from rearing up

5.3.4. Crush

Requirements

6. Encourages animals to enter
7. Restrains animal securely and without injury
8. Prevents slipping
9. Allows safe access to the animal's body
10. Allows controlled release of the animal

Recommended features

Encourages animals to enter
Cattle should be able to see at least 6m of unobstructed space beyond the crush (Holmes, 1991). Siting the crush where fences, walls or hedges appear to block the exit from the crush will make cattle reluctant to enter (Figure 5.20.) and force the handler to enter the race to make the animal move. Additionally, a person standing alongside the crush or in a position which appears to be blocking the exit, will discourage cattle from entering (Ewbank, 1961; McNitt, 1983) and it should be possible for a handler to operate the head yoke whilst standing at the rear of the crush. However, encouraging animals to move too rapidly is the major cause of bruising, choking, escaping and injuries to the legs of cattle when using a crush and allowing animals to run into the head yoke can result in head injuries (Marshall, 1977; Grandin, 1997; Schoonover et al., 2001). Even with the use of modern crushes, bruising which can be attributed to handling in the crush occurs in between 2 and 4% of cattle (Grandin, 2000b). Flighty animals are more willing to enter a crush if the sides are covered thereby preventing sight of the handler alongside (Grandin, 1999). The use of solid sides also reduces the risk of an animal's leg becoming trapped between the crush supports. Cattle should not be encouraged to enter the crush by the use of sticks. These are typically no more effective than being slapped on the rump with the flat of the hand and can cause bruising (McNitt, 1983, F.A.I.R., 1999). The operation of steel crushes is typically noisy, which cattle find aversive (White, 1961; Grandin, 1997) and care should be taken to avoid unnecessarily harsh use of moving parts.

Restrains animal securely and without injury to the handler or cattle
Restraint of the head
The choice of head restraint system must consider both handler and animal safety, the tasks most frequently performed and the number of handlers present. In the UK, the animal's head is typically held by a yoke comprising either two vertical parallel bars (Figure 5.21) or curved bars which provide a smaller aperture both above and below the neck. Curved bars minimise the raising and lowering of the animal's head, thereby reducing the chance of the handler receiving crush injuries to the hands and arms, but are more likely to result in the animal choking if it looses its footing and collapses (Miwest Plan Service, 1987; Grandin, 1997). However, unless the cattle are very calm when handled or little work is envisaged around the front half of the body, curved stanchions are recommended, although it must be possible to open them rapidly if the animal begins to choke (Taylor, 1994; Grandin, 1997). It is essential that cattle are never left unattended in a crush (Grandin, 1999) and when using curved stanchions, it is also necessary to ensure that they are adjusted to the correct height for the cattle being handled to prevent choking (Battaglia and Mayrose, 1981; Taylor, 1994). Grandin

(1997) has recommended that the stanchions be constructed of round pipe with a minimum diameter of 6.2cm to limit bruising to the animal's shoulders.

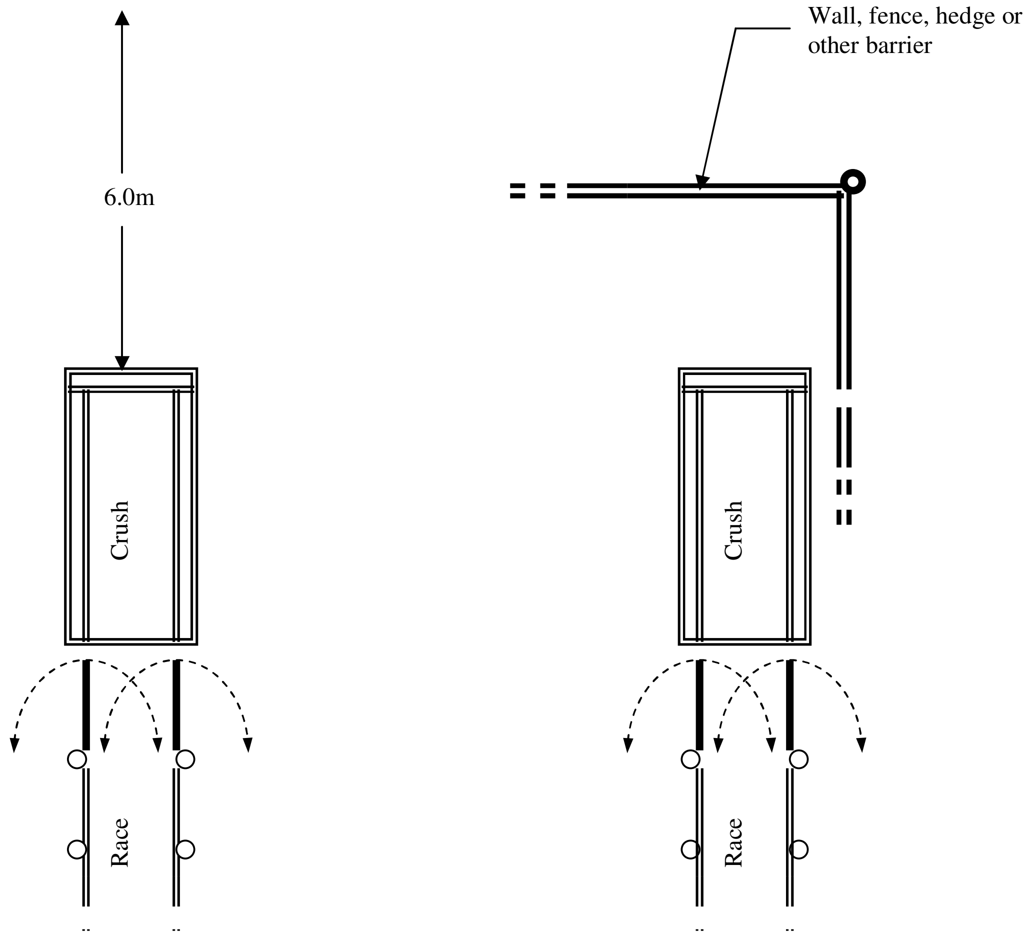


Figure 5.20.: *Correct and incorrect siting of a crush. An unobstructed distance of 6.0m should be provided from the end of the crush to allow the exit to be clearly visible to animals in the race.*

Figure 5.21.: *A self-catching head yoke with parallel stanchions used primarily for cattle of calm temperament.*

Self-catching yokes remove the need for a second person to operate the mechanism and the need for a pair of gates enclosing the animal's head. This also allows easier access to the head of the animal without the risk of receiving crush injuries against the head gates, but removes the opportunity of restraining the head using a halter in the forward facing position (Stroud and Walsh, 1997). Self-catching gates may be difficult to use when handling small or horned cattle and are likely to result in more bruising than manually operated yokes (Midwest Plan Service, 1987). To facilitate handlers working alone with manually operated head yokes, it should be possible to operate the yoke whilst standing at the rear of the crush.

Cattle which refuse to lift their head in order to be in the correct position for restraint generally become more recalcitrant when struck and patience is a better remedy than harsh treatment (Ewbank, 1961). When purchasing a crush, attention should be paid to the release mechanism of the restraint stanchions (Stroud and Walsh, 1997). It should also not be necessary for the animal to withdraw its head backwards before the yoke can be released (Ewbank, 1961).

Restraint at the rump

A bar, or preferably a gate or chain, should be used to minimise the backward movement of the animal (Holmes, 1991; Grandin, 1999). Performance of tasks such as artificial insemination or pregnancy diagnosing which require the handler to stand directly behind the crush should not begin until the head is restrained. The may be a role for the use of a sliding gate in future crush designs to minimise the need for the handler to stand directly behind cattle whilst trying to force a hinged gate closed. If a bar is to be used, a revolving one which automatically locks behind the animal is less likely to slip out of place (Stroud and Walsh, 1997). However, when using a rump bar there is a risk that the arm of a veterinary surgeon or artificial inseminator may be fractured if the animal slips whilst performing an internal examination. If the head is adequately restrained, it may be preferable to remove the bar for the duration of the examination. In a practical appraisal by Stroud and Walsh (1997), operators found that access to the rear of an animal was easier when using a rump chain than a bar.

Belly winch

When operated, a belly winch should hold the body forward into the yoke. It should be possible to move the assembly forward and back to hold cattle of different sizes and be easy to raise and lower (Stroud and Walsh, 1997).

Rear foot winch

The rear winch should be adjustable to suit cattle of different sizes (Stroud and Walsh, 1997).

Front foot blocks

The blocks should be positioned at the correct point along the crush and be angled suitably. They should also not bee too high for smaller cattle and should support the lower leg for its entire length (Stroud and Walsh, 1997).

Rear foot blocks

In an appraisal of three crushes commercially available in the UK, Stroud and Walsh (1997) found that the rear blocks were typically located too far back or were too high for small cattle. The inappropriate positioning caused the animals to move and kick during the handling task.

General

Stroud and Walsh (1997) suggest that a crush design which has inside walls that are angled inwards at the base will reduce the opportunity for cattle movement and kicking. They also recommend the use of a sheeted insert which can be placed within the crush to reduce the width and hold young stock towards one side. Despite being in a crush, an anti-kicking device may also be useful (HSE, 1999a; 1999b). Hydraulic or manually operated squeeze chutes are commonly used in other cattle producing countries (Figure 5.22.) to restrain the entire body of the animal. As these are costly and uncommon in the UK, a full account of their use is not justified. However, consideration should be given to the use of a squeeze mechanism which exerts an appropriate amount of pressure and operates quietly (Grandin, 2000b).

Prevents slipping

Cattle which are unable to walk or stand calmly in the crush risk injuring themselves and the handler. The floor of the crush should prevent slipping and provide enough traction to help an animal stand if it has lost its footing (Holmes, 1991; Bicudo et al., 2002, Grandin, 1999). Floors which are worn should be replaced (Figure 5.23.). Stroud and Walsh (1997) have argued against the use of wooden planks positioned in the same orientation as the main axis of the crush due to the poor grip offered, and the use of transverse raised strips nailed to the floor. The latter were found to cause the animals to frequently re-adjust their foot position.

Figure 5.22.: *A manually operated squeeze chute in use.*

Figure 5.23.: *An example of a badly worn wooden floor in a crush.*

Allows safe access to the animal's body

Side access

The sheeted sides of a solid-walled crush should open along its full length to allow unobstructed access (Battaglia and Mayrose, 1981; Stroud and Walsh, 1997) and there should be a minimum number of frame supports against which a hand or arm may be trapped (HSE, 1999a; 1999b; Figures 5.24., 5.25. and 5.26.). To provide maximum restraint to the animal whilst allowing access to all parts of the body, it should be possible to open individual sections of the crush by use of several small doors, rather than a single large one, as shown in Figure 5.25. Both sides of the crush should open to eliminate the need to stretch under the animal (HSE, 1999b) and therefore the crush should not be located immediately alongside a wall. The side panels should remain closed until the animal is restrained by the head yoke to prevent its legs from becoming trapped (Holmes, 1991).

Figure 5.24.: *Access to the animal is impeded by the rump bar and the location of fixed horizontal and vertical supports (just visible on the right of picture).*

Figures 5.25. and 5.26.: *A crush that provides unobstructed access to the animal with no supports against which a handler may be trapped.*

Rear access

Crushes which are too long for the size of cattle handled require those operating around the rear of the animal to enter the crush itself. This impedes the ability to escape if the animal kicks (Stroud and Walsh, 1997).

Allows controlled release of animals

Where manually operated yokes are used with accompanying head gates, the yoke must be released before the gates are opened to prevent the animal from lunging forward and either causing spinal damage or choking (Battaglia and Mayrose, 1981; Taylor, 1994). For large animals, exit will be assisted by a yoke and head gates which open to the full width of the crush (Midwest Plan Service, 1987).

Other considerations

There has been one reported death in the UK whilst using a cattle crush when the head yoke opened unexpectedly. This incident was attributed to wear and tear and highlights the need for regular maintenance. Cattle crushes should also be securely anchored to the ground to prevent movement or tipping (Battaglia and Mayrose, 1981; Holmes, 1991, HSE, 1999a). Consideration should also be given to design features on the exterior of the crush. Specifically, it should not be possible for cattle to knock a lever and these should be no longer than necessary. Grandin (1999) reported that several fatalities have occurred in the USA through farmers being struck by levers operating poorly maintained ratchets.

Key features

- Correctly sited with clear exit
- Correct position of handlers around crush
- Calm movement of cattle
- Consider covering the sides of the crush to reduce the view of bystanders, as long as access is not impeded
- Chose the correct head yoke design for the flightiness of cattle handled and the tasks most frequently performed
- The head yoke should be adjustable
- Neck stanchions should be of a wide diameter
- When handling young stock, consider using a purpose-made insert to narrow the crush
- Winches and foot blocks should be in the correct position for the cattle handled
- Levers should be short, unlikely to be accidentally released and well maintained
- Use non-slip comfortable flooring which is replaced when worn. Narrow transverse slats nailed to the floor should be avoided
- The crush sides should allow full access to the animal and have a minimal number of supports against which the handler's arm may be trapped
- The crush should not be too long for the size of cattle handled
- Manually operated neck yokes should always be released before the head gates are opened

5.3.5. Sorting gates

Requirements

1. Protect handler from crushing
2. Encourage animals to move in the desired direction

Recommended features

Protect handler from crushing
The sorting gate should be fitted with a handle, ideally via a universal joint, to allow the operator to open or close it without leaning over the race or the head of the animal (McNitt, 1983; Borg, 1993).

Encourage animals to move in the desired direction
When used in a race, a solid, sheeted sorting gate which is operated by a handle will reduce the likelihood that an approaching animal will see the handler working the gate (Brockway, 1983). However, if a solid gate may block the view of the escape, an open design is more appropriate (Brockway, 1983). For example, when positioned directly after a crush, an open gate will encourage animals to enter and exit. It is essential that a sorting gate positioned directly after the crush allows enough space for the gate to swing without coming into contact with the animal's head (Figure 5.27.). The gate itself should be long such that the angle created by the change in direction is gentle (Brockway, 1983; Figure 2.28.). Two methods of incorporating a sorting gate into a single file race are given in Figure 2.29. (a) and (b). In Figure 2.29 (a), Borg (1993) has specified that the sorting gate should be around 2.4m long whilst for Figure 2.29 (b), McNitt (1983) has suggested that the minimum length of the gate should be 3.0m. A barred partition between the two races in Figure 2.29 (b) would allow cattle to see other animals in the adjacent race, and encourage forward movement (Grandin, 1980b; Weeks et al., 2002).

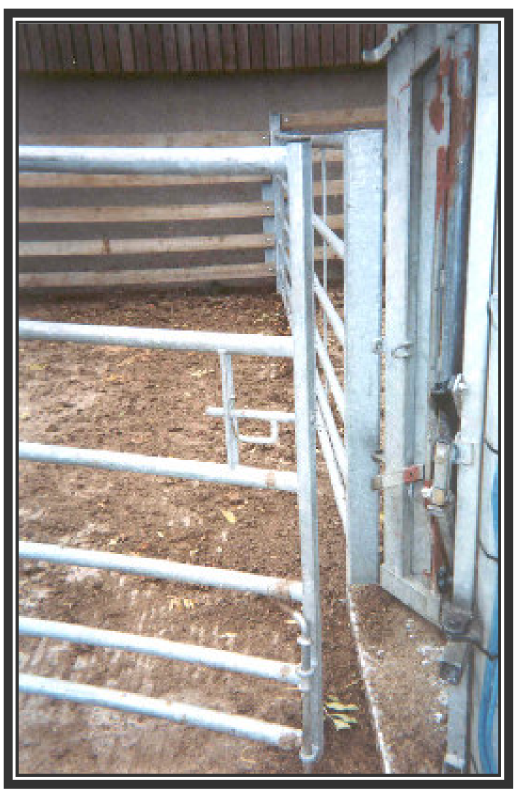


Figure 5.27.: *The position of this sorting gate requires the animal to move backwards in the crush before the gate can be moved past the animal's head.*

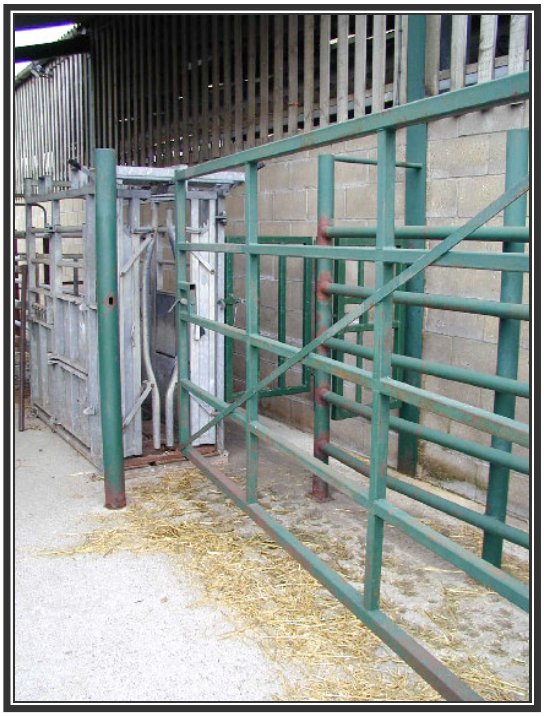


Figure 5.28.: *A long sorting gate of open construction used to draft animals after leaving the crush. The position of the post in this example may impede access to the animal's head. A strong pin that can be securely lowered from the end of the gate into the ground and locked in position would remove the need for a post.*

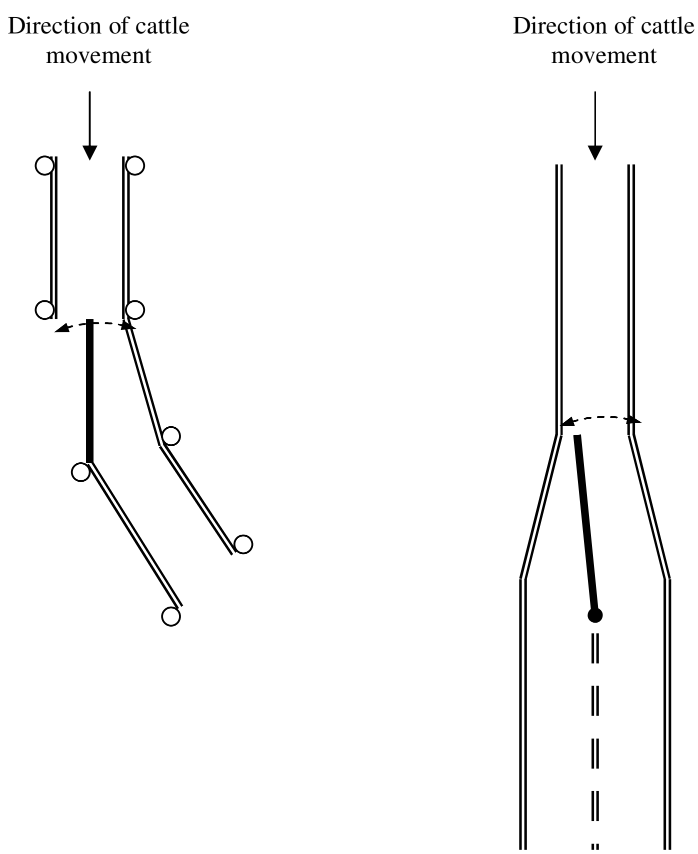


Figure 5.29. (a) and **(b):** *Two methods of sorting cattle in a single file race (Sources: McNitt, 1983; Borg 1993) .*

Key features

- The sorting gate should be fitted with a handle and not require the operator to stand immediately in front of the animal
- Sorting gates be should long to eliminate sharp changes in direction
- Gates positioned immediately after a crush should have sufficient room to swing past the animal's head

5.3.6. Loading ramp

Requirements

3. Prevent cattle from slipping or being injured
4. Encourage cattle movement

Recommended features

Loading and unloading appear to be the most stressful procedures in the transport process (Trunkfield and Broom, 1990), and calm, patient handling and a suitable handling facilities are required. Many recommendations for loading ramp construction are based on the design of transporters in Australia and the USA and are not necessarily relevant for the UK. The features which promote safe, efficient handling and which are internationally applicable are discussed below.

Prevent cattle from slipping or being injured
Both cattle (Boyles et al., no date) and sheep (Hitchcock and Hutson, 1979a) find descending a ramp more difficult than ascending, so particular attention should be paid when unloading. Irps (1983) defined the critical angle at which cattle start to slip on solid flooring as 22° and a maximum angle of 20° has been recommended for loading/unloading ramps used for cattle (McNitt, 1983; Grandin, 1990; Lapworth, 1990; Borg, 1993). Where the tailgates of transporters are lowered directly onto the ground, as common in the UK, the ramp angle frequently exceeds this value. This problem could be rectified by building a raised platform only 40cm high (Grandin, 1990). An angle less than 20° is usually recommended in practice (10° (McNitt, 1983), 12° (Midwest Plan Service, 1987), 16° (Lapworth, 1990; Borg, 1993; Bicudo et al., 2002), 19° (Battaglia and Mayrose, 1981; Grandin, 1990), and 15° is probably a sensible maximum for most farms. With an angle of 15°, a horizontal distance of 3.54m would be required to achieve each metre of height gain (Figure 5.30.).

Steps are preferable to the use of raised cleats (McNitt, 1983; Borg, 1993; Grandin, 1990) as the latter offer less grip when dirty or worn (Grandin, 1990) and because animals tend to slip from cleat to cleat (Hitchcock and Hutson, 1979a). The stairs should have a minimum horizontal width of 30cm, although Lapworth (1990) recommends 50cm, and have a deeply grooved tread pattern (Battaglia and Mayrose, 1981; McNitt, 1983; Midwest Plan Service, 1987; Grandin, 1990). To achieve a ramp of 15°, each step should have a rise of 8cm. Where it is necessary to use cleats, they should be placed 20cm apart, have a width of 5cm and a rise of 2.5cm (Grandin, 1990; Borg, 1993; Bicudo et al., 2002).

Where the ramp is to be used for unloading, a horizontal docking area approximately 1.5m long will prevent cattle from slipping as they step out of the transporter (Grandin, 1990; Lapworth, 1990; Borg, 1993). For both loading and unloading, a self-aligning buffer should be used to eliminate the gap between the ramp and the rear of the transporter, and thereby prevent injuries to the animal's limbs (Lapworth, 1990). The Midwest Plan Service (1987) provides details of a low-cost design where a steel plate can move around a central pivot point. A simplified representation of this design is given in Figure 5.31. while Figure 5.32 shows the construction of the pivot point in more detail. Both the Midwest Plan Service (1987) and Grandin (1990) suggest the use of adjustable gates that can be slid into position against the rear of the transporter.

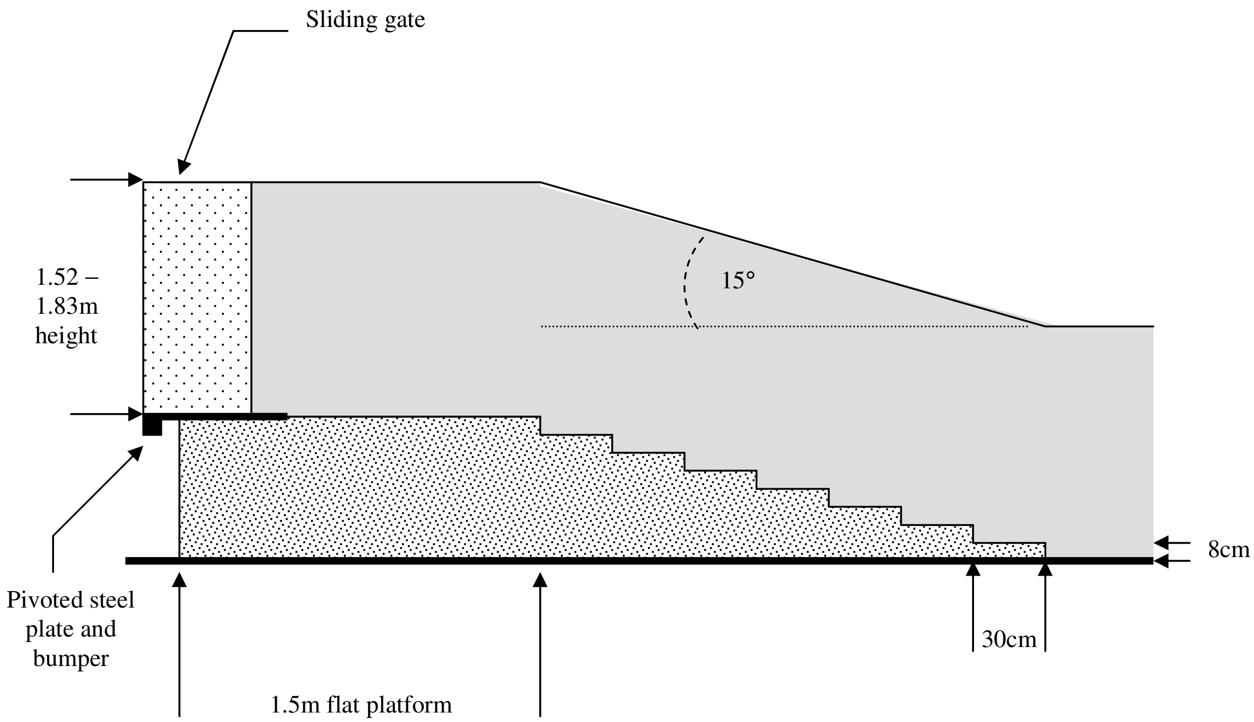


Figure 5.30.: *A stepped ramp with solid sides, horizontal docking platform, sliding gates and buffer at the docking point. (Sources: numerous, see text).*

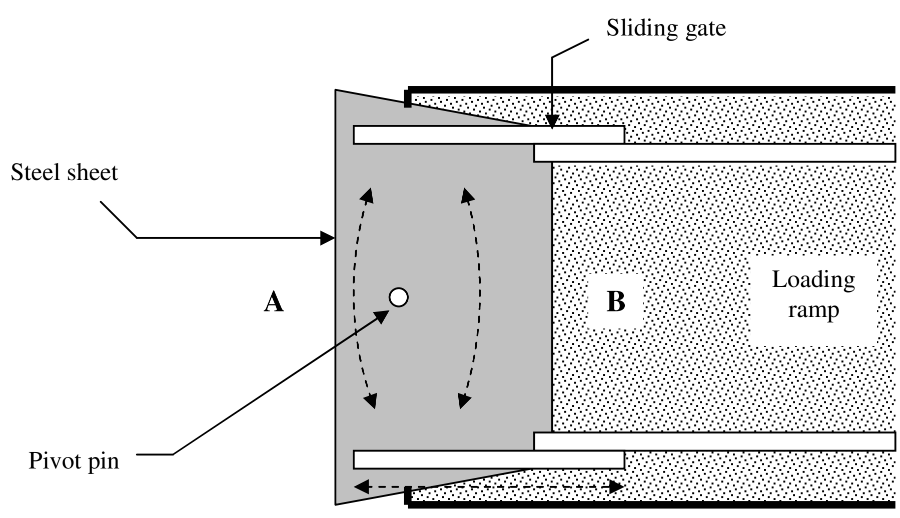


Figure 5.31.: *Plan diagram of a self aligning docking buffer with pivoting plate and sliding side gates. Figure 5.29. shows a cross section between points A and B. (Source: Midwest Plan Service, 1987).*

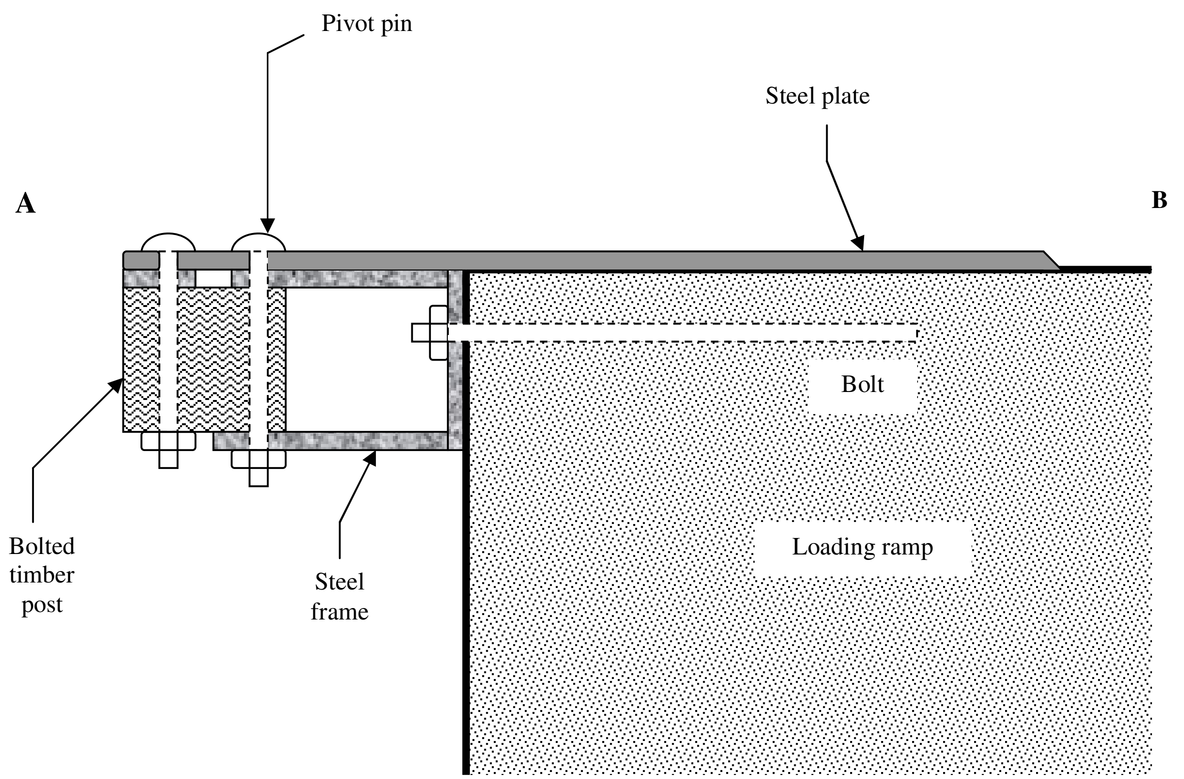


Figure 5.32.: A *simplified diagram of a self-aligning docking buffer. The Midwest Plan Service (1987) provides further details.*

Encourage cattle movement

It is not advisable to build a loading ramp wider than the vehicles likely to use it. Where the width has to be adjustable, the use of a long gate hinged from one side of the loading ramp may be used to create a gentle funnel, in a similar way to that shown in Figure 5.12. Gates orientated at 90° to the direction of cattle movement are likely to disrupt the flow of animals and cause bruising (Figure 5.33.).

Where possible, ramps should be constructed of a material which is unlikely to echo or move when walked on. Ramps which sound hollow cause cattle to stall (Midwest Plan Service, 1987, Lapworth, 1990). Movement towards the ramp can also be encouraged by using a curved lane and solid fences of 1.52-1.83m height, depending on the breed of cattle handled (McNitt, 1983; Grandin, 1990; 1997; Lapworth, 1990).

Figure 5.33.: *These gates which are used to reduce the width of the ramp could impede the movement of animals whilst loading and cause bruising.*

Key features

- The angle of the ramp should not exceed 20° and the aim should be to construct a ramp of 15° or less
- Where a vehicle tailgate is lowered directly onto the ground, constructing a low ramp will reduce the overall slope angle
- Steps are preferable to cleats
- The ramp should terminate in a 1.5m long horizontal docking area
- Adjustable gates and a simple self-aligning buffer will eliminate the gap between the vehicle and the ramp
- Ideally, ramps should not be constructed wider than the vehicles which will use them. Where some width flexibility is required, gates which create a 90° angle to the direction of cattle movement should not be used
- Ramps should not echo or move when walked on, should have high solid sides and ideally be curved

5.4. Portable handling facilities

Requirements

4. Provide solid protection to the handler
5. Be easy to erect and dismantle
6. Encourage calm cattle movement

Recommended features

Provide solid protection to the handler
The HSE suggests that makeshift gates are not sufficient for restraining cattle (HSE, 1999a) and Stroud and Walsh (1997) suggest that the use of gates as a race system offers a false sense of security as they are seldom secure enough to withstand an animal pushing against them or high enough to discourage jumping. It is therefore essential that, whether permanent or portable, facilities are of a sufficient height (see Section 5.2.) and adequately anchored to the ground and to other components of the system (HSE, 1999a). In some cases it may be necessary to lay a concrete pad in a convenient site to provide a stable ground surface (Brockway, 1983). Whenever possible, tasks should also be performed whilst another person is available (HSE, 1999a). Crushes purchased as part of a portable handling assembly should conform to the same safety specifications as static crushes (see Section 5.3.4.; Figure 5.34).

Figure 5.34.: A portable crush which offers protection from animals waiting in the race

Be easy to erect and dismantle
The continual erection, dismantling, and transportation of portable handling equipment makes them more vulnerable to damage than permanent facilities (Brockway, 1983). As such, particular attention should be paid to the maintenance of portable facilities.

Encourage calm cattle movement

The basic principals of successful design are the same irrespective of the scale or the purpose for which the facilities are required (Grandin, 1990). Consequently, many of the features discussed elsewhere in this section which exploit cattle behaviour to facilitate movement are relevant for mobile facilities. In brief, these include the use of solid partitions to prevent visual disturbance, avoiding the use of noisy equipment or sharp corners and the elimination of potential sources of injury to the animals.

Key features

- Components of the mobile facility should be securely fitted together. Holding them by hand or with string is not adequate.
- Each component should be securely anchored to the ground.
- Gates should be of the correct height
- The system should make use of cattle behaviour to aid movement using the principles described for permanent facilities.

Appendix 1

SURVEY INTO CATTLE HANDLING PENS

SAC is undertaking a new SEERAD funded project to identify how cattle handling facilities can be made more efficient and safer for both the operators and the cattle themselves. With aging facilities, a dwindling number of stockpeople and increasing herd sizes, the handling of beef cattle is becoming increasingly difficult and dangerous. The more frequent handling of cattle for calf tagging, state veterinary tests and clipping prior to slaughter exacerbates this problem still further. The first step in the project is to identify which aspects of current handling facilities could be improved and which are succeeding. From this, and using the experiences of beef industries in other countries, we aim to identify low-cost principles and practices which are immediately applicable to the Scottish industry, and identify problems which need longer-term research-based solutions. Finally, the conclusions from this study will be passed on to producers and designers through Sheep/Beef notes and other sources.

However, it is essential that we receive input on the range and effectiveness of the handling facilities in operation, and on aspects of design and operation which work/don`t work from beef producers with first hand experience of using these facilities. If you could to help with this, we would be very grateful if you would complete the survey form below. The form does not require your name or address, so anonymity is assured.

Thank you for taking the time to fill in this form.

Please return the form to: **Simon Turner, Scottish Agricultural College, Sir Stephen Watson Building, Bush Estate, Penicuik, Midlothian, EH26 0PH.**

1. HOW DO YOU RATE YOUR FACILITIES?

Please tick appropriate box 1 – works well 5 – gives problems

	Score					Nature of biggest problem
	1	2	3	4	5	
Access to pens						
Collecting pen						
Forcing pen						
Race						
Crush/crate						

Dispersal pens						

2. INJURIES

How many injuries to cattle and humans have taken place whilst handling cattle on your farm in the last **5 years**?

	Number of incidents requiring medical attention	Number of Minor incidents
Cattle		
Humans		

3. WHERE IN YOUR PENS DO YOU FEEL IN GREATEST DANGER?

Please tick appropriate box 1 – no danger 5 – severe danger

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	Score					Nature of biggest danger
	1	2	3	4	5	
Access to pens						
Collecting pen						
Forcing pen						
Race						
Crush/crate						
Dispersal pens						

4. DURING WHICH ACTIVITIES DO ACCIDENTS OCCUR?

Please tick: N/A – not applicable 1 – no accidents have ever occurred 2 – accidents occur occasionally 3 – accidents occur frequently

	Score				Nature of injuries
	N/A	1	2	3	
Weigh					
Dose/worm/bolus					
Inject etc ill animals					
Clip backs/heads					
Belly clip finished cattle					
SEERAD/MAFF inspection					
TB/Brucella test					
Ear tag					
Dehorn/disbud					
Castrate					
Wean					
Foster calves					
Clip feet					
Dry cow tubes					
Calve cows					
PD					
Select for slaughter					
Normal AI					
Synchronised AI					
Semen test stock bulls					

5. DESCRIBE YOUR HANDLING FACILITIES

Collecting pens	Rectangular/square	☐	Curved	☐	Approx Area	m^2 86
Does it have a forcing funnel?			Yes	☐	No	☐
Race shape	Rectangular/square	☐	Curved	☐	Approx Length	m
Is it fitted with back stops?			Yes	☐	No	☐
Does it have a raised catwalk?			Yes	☐	No	☐
Race construction	Timber	☐	Metal	☐	Stone/brick	☐
	Solid sides	☐	Railings	☐		
Does your handling system use existing buildings in its design?			Yes	☐	No	☐

Crush/Crate

Approximate age	years					
Is the head gate self locking?			Yes	☐	No	☐
Does it have a back gate?			Yes	☐	No	☐
Does it have a rump bar?			Yes	☐	No	☐

Does it have weighing facilities?	Yes		No	
Does it have a shedding gate?	Yes		No	

6. DO YOU HAVE:-

Permanent pens at steading?	Yes		No	
Portable handling pens?	Yes		No	
Permanent pens in fields?	Yes		No	

7. APPROXIMATE TOTAL NUMBER OF CATTLE ON UNIT

Suckler cows:		Weaned calves:		Finishing cattle:	

8. NUMBER OF PEOPLE AVAILABLE WHEN ROUTINELY HANDLING CATTLE

	Approx stock number per handling	Approx time taken	Number of people involved
Weigh			
Clip backs/heads			
Belly clip finished cattle			
Ear tag			
Clip feet			

9. HAVE YOU ANY "TIPS" FOR THE DESIGN OF HANDLING PENS

Thank you for completing this survey.

Please return it to:

Simon Turner, Scottish Agricultural College, Sir Stephen Watson Building, Bush Estate, Penicuik, Midlothian, EH26 0PH

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