BETTER RETURNS PROGRAMME+

Better cattle housing design

Key Messages

- Air speed within a building is critically linked to animal health and welfare
- Careful consideration of the logistics of daily tasks at the design stage can significantly improve the output and financial returns generated from the building
- Visit other farms to gather ideas about building design and fittings
- Floors should provide a comfortable footing, be firm and durable and should direct excess liquids towards competent drainage, to provide a relatively dry walking surface
- The target for most cattle buildings is to ensure a design that maximises ventilation potential on a still day, without exposing livestock to elevated wind speed when the wind is blowing
- When designing a new building or improving an old one, it is critical to calculate the area of outlet required in a roof to allow heat and moisture from the livestock to escape by natural convection
- The inlet area, ideally split evenly across the two sidewalls, should be a minimum of twice the outlet area, and ideally four times the outlet area
- There are a number of methods to achieve adequate outlet ventilation, including various ridge designs or slotted roofs
- Buildings should be designed, constructed and maintained so that they can be effectively cleaned

BEEF & LAMB

Contents

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Introduction

Improving existing buildings, or designing new builds to best standards, has a lasting and positive impact on animal health and productivity. Consequently this has a beneficial effect on farm viability and economic growth through:

- Reduced disease cost, improved animal welfare and performance
- Improved efficiency of labour (time) and inputs (bedding, feed, etc)
- Improved sustainability and competitiveness in the market
- Better and safer environment for staff to work in

Farmers should insist that any new livestock building is designed specifically for livestock and not as a general-purpose building, as these often have an insufficient ridge opening to ensure effective ventilation.

Environmental considerations in livestock building design

There are many building designs, but in all cases, the accommodation must control three key environmental parameters:

- Air speed
- Moisture
- Fresh air

Air speed (draughts)

Air speed within a building is critically linked to animal health and welfare.

Air movement is essential to bring fresh air into the building and remove moisture, heat, and gases, although too much air movement is counter-productive.

Excessive air speed at animal height causes wind chill and should be avoided, particularly for young animals. This is because the speed of the air around an animal reduces the insulation properties of its hair coat, increasing the rate of heat loss from the body. If sustained or excessive, it will have a direct, negative impact on productivity and immune competence.

Draughts at animal height should be avoided, particularly for young animals.

Air speed has a direct impact on the temperature at which an animal has to burn additional energy to keep warm. This point is referred to as the Lower Critical Temperature (LCT). LCT for healthy calves between 0–2 weeks old is in the range 10–15°C.

Air speed within a building is critically linked to animal health and welfare.

The LCT is affected by a number of factors including coat length and whether the coat is wet or dry. As cattle grow and become heavier, their LCT reduces, enabling them to withstand lower temperatures without becoming stressed. Similarly, as growth rates increase, LCTs tend to reduce (Table 1).

Younger animals are more likely to suffer from cold temperatures due to their higher LCT than older animals

Table 1. Lower Critical Temperature (LCT) °C of continental-bred steers (wind speed 0.5m/s)

Diet quality	Growth rate	Liveweight (kg)		
MJ/kg DM	(kg/d)	100	300	500
9.4	0.50	4.7	-2.5	-7.5
11.3	1.00	-0.8	-7.4	-12.8
13.2	1.25	0.2	-6.1	-11.2

Moisture

Moisture is produced by all livestock in their breath, urine, faeces and sweat. The aim of good building design is to prevent any build-up of moisture by ensuring competent drainage and manure management, and effective ventilation that works in all weather conditions.

Excess moisture:

- Increases the risk of bacteria and virus survival
- Increases the risk of dirty water transmitting infection
- Increases the requirement for bedding
- Reduces ambient temperatures

Damp buildings generally feel cold. However, in warm or hot weather, dampness can be used beneficially to cool down livestock and buildings.

The effect of low temperature on cattle is exacerbated when combined with increased air speed or high levels of moisture.

Timber sidewall with ventilated cladding delivers clean, fresh air into the building

Building design should aim to deliver clean, fresh air to as much of the building as possible to maximise health and productivity.

Space boarding with a simple additional inlet area allows fresh air to enter

Temperature is often considered to be a key environmental factor, but this is only so in severe cold weather (<0°C), or for youngstock less than four weeks old.

More importantly, the negative impacts of increased air speed or high moisture levels become greater when combined with cold temperatures.

Fresh air

Fresh air is a primary requirement for maximising health and productivity. It facilitates the removal of heat, moisture, dusts, gases and micro-organisms from the building.

Fresh air plays a vital role in eliminating pathogens, bacteria and viruses. 100% clean, fresh air can kill airborne bacteria and viruses 10–20 times quicker than 50% clean, fresh air.

A crucial design aim for existing and new buildings is to deliver clean, fresh air to as many parts of a livestock building as possible, but to do so without exposing stock to excessive wind speed.

A lack of fresh air is sometimes indicated by an increase in airborne ammonia concentrations, which can be smelled when entering the building. Elevated ammonia concentrations come from the mixing of faeces and urine. Poor drainage and/or damp bedding can also contribute to the problem.

Welfare requirements

Welfare is the physical and mental well-being of an animal and can be influenced by the building in which it is kept.

Building design, construction and maintenance should all address the five freedoms that have come to define the ability of a system to provide good welfare.

The five freedoms are:

- Freedom from hunger and thirst – by ready access to fresh water and a healthy diet
- Freedom from discomfort – providing an appropriate environment that includes shelter and a comfortable resting area
- Freedom from pain, injury and disease – by prevention or rapid diagnosis and treatment
- Freedom to express normal behaviour – by providing sufficient space, facilities and company of the animals' own kind
- Freedom from fear and distress – by ensuring conditions and treatment that avoid suffering

Good design will support good health and welfare to the financial benefit of the farm business. Adequate stocking densities for feeding, drinking, loafing or lying down will all impact on positive health and performance. Surfaces and materials that provide adequate drainage, control wind speed, minimise sharp edges, provide non-slip floors, and are easy to clean, will all contribute.

The five freedoms can be applied to assess current and planned buildings to see where improvements can be made.

All animal housing must conform to the following regulations:

- Animal Welfare Act 2006 and subsequent amendments
- Council Directive 98/58/EC
- Extracts from the Welfare of Animals (England) Regulations 2007, (Scotland) 2000, and (Wales) 2007
- Control of Pollution (Silage, Slurry and Agricultural Fuel Oil) Regulations 1991, SI No. 324, as amended 197 (SI No. 547)
- EU Water Framework Directive, 2000/60/EC

Building costs

This building is of modern design and has high standards of construction

Building design decisions are frequently influenced by cost considerations. Long-term investment in a structure that will optimise animal health and performance should take priority over any short-term cost savings.

It will usually appear cheaper to self-build than use a building contractor. However, it is essential to budget a realistic cost for family labour/staff time and incidental expenses, and consider the time it will take to complete. Also, will the skill set within the farm produce a building of the required standard?

Table 2 offers a guide to the costs of building a range of cattle housing.

Table 2. Building cost guide 2012/13 (based on SAC Farm Building Cost Guide 2009/10, assuming cost increases of 3% per annum)

Cattle – suckler cows and calves	£/m^2
Bedded court with calf creeps and tractor passage/bunker	240
Kennels with calf creeps, feeding and tractor passage/bunker, excluding feeding and slurry facilities	115
Portal-framed cubicle house with calf creeps, solid floors, feeding and tractor passage/bunker, excluding slurry facilities	202
Cattle – feeding cattle	
Bedded court with tractor passage/bunker	240
Bedded court with single-sided external tractor passage/bunker	213
Slatted court (2.0m deep cellar) with solid tractor passage/bunker	333
Slatted court with suspended tractor passage/bunker – 2.0m deep cellar, blockwork construction – 2.0m deep cellar, reinforced concrete construction	 404 727

The range of potential buildings for cattle is large, and the cost is influenced by location, terrain, design specification, build quality and the builder.

Table 3 indicates the relative range of costs for different types of building. The variable costs for elements such as bedding, labour, slurry handling, feeding and removing feed waste, all have to be considered in the costs.

Table 3. The relative costs of different housing systems

Housing system	**Relative capital cost %**
Slats with storage tanks	100
Slats with scrapers underneath	85
Cubicles with calf pens	80
Bedded court with outside walling	75
Bedded shell with open sides	60
Open corral with feed stance	20

The Roundhouse offers a viable alternative on suitable sites

Roundhouse

The Roundhouse is designed to provide a number of proven benefits to housed cattle. Ventilation is as good as it can be, as the building is ventilated equally well from all directions. The centre of the building has a designed outlet for the stack effect, and the combination of competent inlet and outlet provides reduced straw costs and labour, and maximum air quality.

The circular and open design means that cattle are always able to see others in the group even when in separate pens. Open sides allow cattle to see outside the building, which is associated with reduced stress levels compared with cattle housed in conventional housing.

The pen layout in the Roundhouse provides a feedfence on the outside and access to a handling system in the centre, both of which provide safe and efficient operation. The central area links directly to a loading ramp. The open sides of the Roundhouse mean the negative aspects of wind speed on cattle should be incorporated in the choice of location, or the requirement for external windbreaks.

Straw use

The cost of straw and the way it is used vary considerably. It is important that aspects of building design and use, such as competent drainage and ventilation, are applied so straw can be used efficiently. Different classes and ages of stock require different amounts of straw (Table 4).

Table 4. Guidelines for bedding straw requirements

Cattle type	Amount (tonnes)*
Suckler cow (650kg dry cow)	1.0–1.5
Autumn-calving suckler cow and calf (650kg)	1.2–1.7
Heavy store/finishing cattle (450–650kg)	0.7–1.0
Yearlings (300kg–400kg)	0.5–0.7
Calf rearing to three months	0.2

*Based on 25-week bedding period, except where stated otherwise

Cattle on a straw-bedded lying area

Managing straw yards

Straw yards should have a scraped concrete feed/loafing passage as well as the bedded lying area. This concrete helps promote hoof wear and prevent the cattles' feet becoming overgrown.

Passages should be scraped regularly. Aim for a passage width of at least 2m for animals less than a year old. Where the yard houses both suckler cows and calves, the scraped passage needs to be at least 3.5m wide. This allows cows to feed through the barrier, while other animals have room to move behind them.

It can be useful to put in a small step (max 0.3m high) between the feeding/loafing area and the straw-bedded area. This helps retain the straw in the lying area and prevent manure flowing on to it. It also provides a solid edge against which to scrape when cleaning out the loafing area.

For autumn-calving herds, it is important to allow room for a calf creep area.

External straw yards

Locations with lower rainfall and good access to straw bedding or woodchip have used unroofed yards successfully for decades. Outdoor yards must:

A) Have a windbreak

B) Be kept well bedded

C) Manage the diffuse pollution

For further information please see the BRP+ document **Managing outdoor straw pads for beef cattle**.

Alternative bedding materials

The BRP **Bedding materials directory** is a guide to all the main alternative types of bedding, from woodchip to sand and pea haulm. For each there is an outline of availability, absorbency, benefits, storage, disposal, and any animal health or welfare issues.

Delivery records of waste materials used for bedding must be kept eg recycled woodchip or paper.

Design principles

A new building, designed to meet cattle requirements

The design process for a new building should take a series of steps that address the:

- Needs of the farm business – now and in the future
- Requirements of the cattle to be housed
- Available space on the farm
- Finances to fund it

The same process should be applied when renovating existing buildings. First assess their current state and functionality, considering whether:

- They provide a competent facility that is safe and easy to work in
- They reduce business performance through poor animal health and lost productivity
- The building could be improved to the benefit of the livestock, staff and business

Elements to consider

1. Decide what the building is going to be used for, then define and record:

- Number and liveweight of stock
- Maximum group sizes
- Maximum/minimum pen sizes
- Length of feed barriers
- Width of feed passages
- Access points
- How materials will be moved in/out and stored

2. Make sure the planned internal layout will suit the intended occupants:

- Check the appropriate livestock assurance/welfare standards
- Check the appropriate building standards (BS5502: Part 40)

Modern cattle building with a large area of diffuse inlets

3. Assess location in relation to:

- Local weather, prevailing winds, exposure, etc
- Other buildings nearby that may create wind tunnel effects
- Other livestock for biosecurity and disease risks
- Storage facilities for feed, bedding and muck removal and storage
- Cattle-handling facilities

4. Consider carefully:

- The new building's footprint
- How the animals will be fed
- How the animals will move around and be handled for management tasks
- How the lying areas will be bedded up and cleaned out

5. Plan feeding routines

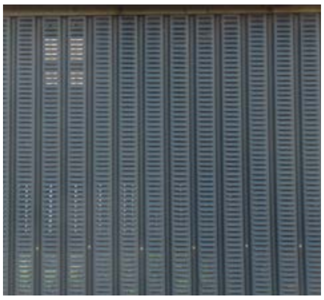
Careful consideration of the logistics of daily tasks at the design stage can significantly improve the output and financial returns generated from the building.

This is an area with significant potential for improved performance. Labour and time are valuable resources. Careful consideration of the logistics of daily tasks at the design stage can significantly improve the output and financial returns generated from the building.

6. Building design

All the elements of construction must be worked out in detail to ensure the building protects the animals inside while delivering the desired outputs. Consider:

- Length, width and height to the eaves
- Roof slope/pitch. A higher pitch will ventilate more efficiently than a lower pitch, and provide greater protection from solar gain (heating caused by the sun)
- Wall heights at animal height
- Ventilation outlet and inlet areas. It is critical to get these right to prevent diseases such as pneumonia, to which housed cattle are particularly susceptible
- Roof cladding materials
- Wall cladding materials
- Appropriate floor slopes and drainage



A ventilated sidewall

7. Check planning regulations and local issues before starting any work

8. Produce detailed drawings and specifications

Design limits

In buildings wider than 27m, it becomes increasingly difficult to deliver clean, fresh air into the centre.

Correct ventilation inlet and outlet areas are vital for good animal health and more important than building height and volume.

Correct ventilation inlet and outlet areas are vital for good animal health and more important than building height and volume.

High-volume buildings will be more exposed to extreme weather conditions than those of low volume, and are generally not suitable for housing young, milk-fed calves.

A roof with a low pitch (<12°) will be subject to higher snow loads and greater solar gain than roofs with a higher slope. Solar gain can cause wide daily variation of temperatures within a building in winter, and can increase temperatures to uncomfortable levels during summer.

Do your research

Visit other farms to gather ideas about building design and fittings. Discover what works well on other sites.

When thinking about putting up a new building, or altering an existing one, take time to go and see buildings on other farms. Discuss the advantages and disadvantages of different designs and features with other farmers, and carry out research on the internet. There may be ideas from farms in other countries that may be applicable.

Internal shed design

Floors

The floor of a livestock building is subjected to substantial physical and chemical stress. If a floor is well constructed and maintained, it will benefit the business by maximising animal comfort. Surfaces should be slip-resistant and free of edges or fittings that may cause injury.

Characteristics of a good floor are that it:

- Provides a relatively dry walking surface
- Provides firm and comfortable footing
- Is durable

Floors should provide a comfortable footing, be firm and durable and should direct excess liquids towards competent drainage, to provide a relatively dry walking surface.

The ability of the floor to cope with, contain and direct excess liquids towards competent drainage is a key design feature. Floor slope, floor surface and linkage to drains are all relevant to cattle comfort and management of moisture within the building.

A slope of 1 in 20 is used where drainage under straw is needed, or around drinkers. This is a particular requirement around automatic milk feeders to cope with the expected higher urine loads around the area.

Table 5. Ideal floor slopes for different areas of the building

Area of floor	Gradient	Angle
Passageways	1 in 80	1 to 2 degrees
Under straw – no drainage	Nil	0 degrees
Under straw – drainage areas	1 in 20	5 degrees

Concrete floors


Grooved concrete flooring is used successfully in the dairy sector

The quality of the floor construction is important for both comfort and durability.

The quality of the concrete mix and the amount of water added are linked to how durable the floor will be.

Rough-finished floors can speed foot wear by up to 20%. Smooth surfaces increase the risk of slippages and injuries, and are especially dangerous in high-traffic areas or where cows/heifers may exhibit bulling behaviour.

Cattle are less confident moving over smooth floors. Grooved concrete flooring is used successfully in the dairy sector to improve cow comfort and drainage.

Basic design parameters for creating a grooved floor that provides confident footing include:

- Parallel grooves spaced 35mm apart
- Grooved edges that are smooth
- Lateral grooves (that run from side to side of a cow) produce less slip than longitudinal grooves (that run from head to tail)
- Groove width should not exceed 10mm

All concrete flooring becomes worn over time. Professional concrete services can groove existing floors, which is a positive financial investment that supports good cattle behaviour and health.


Slatted floor without rubber matting

Slatted floors

Slatted floors are a means of removing the need for straw or other bedding materials The faeces and urine are trodden through the slats into a tank below. Slats can be covered with rubber to increase comfort.

Table 6 gives recommended dimensions for slatted floors for different ages of cattle.

These dimensions avoid excessive pressure on the sole of the foot and help to prevent faeces build-up on the slats.

Table 6. Dimensions of slatted floors for cattle (BS5502: Part 51)

Weight and type of animal	Preferred slat width (mm)	Preferred spacing between slats (mm)		Void ratio* %
		Min	Max	
Calves and youngstock up to 200kg	80	20	30	18–25
Beef animals and youngstock 200–550kg	100	25	35	18–25
Adult cows and cattle over 550kg	125	30	40	18–25

*Void ratio is the percentage of the floor area that is open for faeces to get trodden through

When using slats make sure that they are not slippery and the gap is narrow enough to prevent foot injuries. You should not use fully slatted concrete floors for breeding cows or replacement heifers.

Part of the accommodation should be a solid-floor area with straw or some other suitable bedding material. That way the animals will be comfortable and less likely to injure themselves, especially their udders.

Severe health warning!

Hydrogen sulphide is an extremely toxic gas that can be released by slurry stored below slats. A number of farmers have died from inhaling fumes released into sheds with slatted floors.

The initial smell is similar to rotten eggs, but at high concentrations smell is not a good indicator as the gas causes a loss of the sense of smell. The main risk occurs when slurry is agitated, usually before slurry extraction and spreading. Agitation can also occur should an animal fall into the slurry.

A secondary risk of hydrogen sulphide release occurs if an alkaline product such as limestone dust or gypsum from bedding products is mixed into the slurry.

Where slurry has to be agitated to facilitate removal, only agitate on a windy day, consider removing stock from the building, and open all doors and ventilators. Ensure more than one person is aware that the operation is being carried out and everyone understands the risks.


Rubber slatted floor

Rubber flooring

Rubber flooring is more comfortable for cattle than slats. This is because:

- There is less mechanical force on their feet when they are standing
- They are more confident when getting up or down
- There is increased thermal comfort when they are lying down

Cattle also show behavioural preferences for slats with rubber flooring compared with slats with no rubber.

Rubber mats are extensively used in the dairy sector and present an opportunity for the beef sector, especially if the cost of traditional bedding materials is high.

Cutting channels into the existing floor can improve drainage

Floors in existing buildings

If current flooring is poor at eliminating excess moisture and/or impacting on animal health and performance, intervention to improve the situation is essential.

Cutting channels into the existing floor to improve drainage, re-surfacing small, smooth areas with epoxy resin/concrete mixes, or adding a new surface screed are all worthwhile investments.

Smooth areas of concrete floor can be significantly improved by mechanical grooving and etching the surface, commonly referred to as 'scrabbling'. Relevant equipment can be hired with, or without labour.

Cubicles

Cubicles with rubber matting

Placing cubicles in buildings is an efficient use of space and bedding when housing female cattle. They are not suitable for male cattle because they urinate in the centre of the cubicle.

The design requirements for cubicles are as follows:

- Allow at least 5% more cubicles than animals in the group to reduce bullying and increase lying times
- Allow the animal to lie down and stand up without touching the partitions
- The length must accommodate the animal's body space, head space and lunging space (the forward movement cows make when they stand up)
- Lunging space of 0.7m to 1m should be provided at the front of the cubicle
- A brisket board in front of the cow will help her to get up and down
- Movable brisket boards give best flexibility to stop cows of different sizes dunging on beds
- Cattle prefer a slight fall of 2–3% from front to back of cubicles, which also aids drainage
- Cubicle widths will depend on partition design. Those with a rear leg should be 1.2m apart
- Passage widths between rows of cubicles should be a minimum of 3m wide
- Feed passages should be at least 4.6m wide behind cubicles

Table 7. Guidelines on cubicle length depending on the size of cow

Weight of cow (kg)	Total length of bed (m)		
	Open front	Closed front	Head to head
550	2.10	2.40	4.2
700	2.30	2.55	4.6
800	2.40	2.70	4.8

Extensive guidance on cubicle designs can be found in **Dairy Housing – a best practice guide** available on the AHDB Dairy website. Information includes details on kerb height and materials for cubicle lying surfaces.

Observation of cow lying behaviour, cubicle hygiene and abrasions of hocks and knees, or swelling in the lower leg, may indicate poor cubicle design.

Lighting

For efficient and safe working, provide adequate lighting that is evenly dispersed throughout the building and can be controlled. Light intensity is measured in units of lux.

Controlled lighting and light intensity is not only important in providing an efficient and safe working environment but also affects the hormone balance and productivity in cattle.

A daily period of darkness (less than 30 lux) is essential to maintain hormone balance in cattle. Long day lengths of 16–18 hours of light at +170 lux, interspersed with six to eight hours of darkness, have been shown to increase liveweight gain, advance onset of puberty in heifers, and increase milk yield in cows. More detailed information can be found in **Dairy Housing – a best practice guide**.

Cattle housing with adequate lighting

Table 8. Lighting requirements for different tasks and locations within a shed (Other lux levels: bright sunlight 80,000; office lighting 500; street lighting 5)

Task or location	Lux level required	Control	Comments
Lying and feeding area during photoperiod effect	170–200 lux	Timed, with light level sensing	High-pressure sodium, metal halide lights or multiple fluorescent fittings
Lying and feeding area (not during photoperiod effect)	50 lux	Timed, with manual override	
General use	50 lux	Timed, with manual override	–
Inspection	300 lux	–	Local or portable light
Outside areas	20 lux	Timed, with option of passive infrared (PIR) movement sensors	High-pressure sodium, metal halide lights

Light levels (lux) are very easy to measure, with meters costing less than £30.

External shed design

Modern livestock building with a covered open ridge

The roof

Roof slope and design should be influenced by the type of stock in the building and how exposed the site is.

A roof slope of 17° to 22° will ventilate better than one of between 7° and 10°. Once the slope of the roof is set, the ventilation outlets can be chosen – commonly either an open or covered open ridge, or slotted roof.

Many livestock buildings in the UK are roofed with fibre cement, profiled sheeting. This is a preferred material as it is durable, has limited absorbency of condensation, and produces a more stable internal temperature than steel roof sheeting, often referred to as ‘tin’.

Tin is the least appropriate material for animal house roofing because it increases the risk of condensation compared with most other roofing materials. Condensation is moisture that would have left the building if the ventilation specification and the roof materials were more appropriate.

A number of new roof sheets are available that use a self-adhesive polyester fleece designed to be applied to single-skin metal roof panels. They provide enough insulation to reduce the rate of condensation, and reduce the amount of moisture dripping on to bedding.

Slotted roof made of fibre cement profiled sheeting

The addition of a light ridge will improve ventilation and increase the amount of natural lighting

Roof lights

Translucent, single-skin roof lights are a good source of natural light within a shed. Requirement is for 10–15% of the total roof area to be roof light, possibly up to 20% on the north-facing side of a roof or on the roof of calf housing.

Where roof lights are more than 10% and cattle are housed in the summer, use a water-based paint to reduce incoming solar energy.

CAUTION

All roofwork is dangerous and should only be carried out by competent persons and after assessment of the risks.

Roof refurbishment

Clean or replace faded roof lights to improve the environment within a shed. Traditional steel or concrete livestock buildings with a few roof lights and poor ventilation can be completely rejuvenated by installing a light ridge (see photo, left).

Sidewalls

Many calf and cattle buildings require sidewall cladding that is solid to animal height, with some form of air inlet above animal height.

Table 9. Void area (% space) for different cladding materials

Material	Specification	Void area
Ventair sheeting	–	4.5% void
AS24 vented sheet	–	12% void
Space boarding*	152mm board, 20mm gap	11% void
	152mm board, 25mm gap	14% void
	100mm board, 25mm gap	20% void
Yorkshire boarding*	As above, plus: 152mm board, 50mm gap	25% void
Galebreaker	Standard	25% void
Highlight™ ventilated cladding	–	25% void

*Space boarding and Yorkshire boarding provide different benefits. See page 21

Many calf and cattle buildings require sidewall cladding that is solid to animal height to prevent draughts, with some form of air inlet above animal height.

The requirements of sidewall cladding are to:

- Reduce wind speed at animal height
- Provide adequate openings to supply fresh air into the building

Buildings where feeding occurs along an outside wall should be protected to above animal height with an external bund or windbreak, to moderate the negative impact of wind chill on animal health and performance.

The conflict between reducing wind speed into a building to prevent wind chill, while allowing adequate fresh air to maintain a healthy environment, is a crucial part of building design. Getting this balance wrong often leads to poor health and performance in housed cattle.

Design/assessment

Space boarding with simple additional inlet area above

The minimum inlet area for the number and maximum liveweight of animals in a building is defined by the calculations shown on page 16.

Thereafter, the choice of materials to be used above the solid wall of the building depends on the area left between the top of the wall and the eaves, and the degree of exposure to wind, rain and snow.

If only a small area of sidewall is available, more openings will be needed compared to a large area of sidewall to achieve the same inlet area. The design key is to provide the required area of openings without losing control of air speed into the building.

Rule of thumb

- Do not create openings wider than 25mm on the windward side of a building. The gap used for space boarding depends on the inlet area required on the sidewall, not by the thickness of the board
- Where a gap wider than 25mm is required to give adequate inlet, use Yorkshire board

A ventilated roller blind offers protection against draughts

Protection from wind speed

The horticulture industry has long understood the effects of excessive wind speeds, and uses windbreaks to protect crops and reduce the costs of production.

For cattle, the impact of wind speed can vary from very little, through to reduced feed conversion and immunity suppression, to severe disease.

Draughts hitting animals cause them to lose heat energy. Energy loss will double at wind speeds of 6.8m/s (15mph), compared to when wind speed is 0.

Basic rules for using windbreaks:

- The purpose is to reduce air speed, not to stop it
- A badly located or poorly finished windbreak is often worse than no windbreak
- The optimum porosity/permeability of a windbreak is 50%
- The minimum ratio of length to height of a windbreak is 12:1. This will minimise the effect of the increased wind speed coming around the ends of the windbreak
- Wind speed will be reduced downwind of a permeable windbreak by up to 30 times the barrier height
- Support structures for windbreaks should be at approximately 3m intervals

A mono-pitched building

Mono-pitched buildings

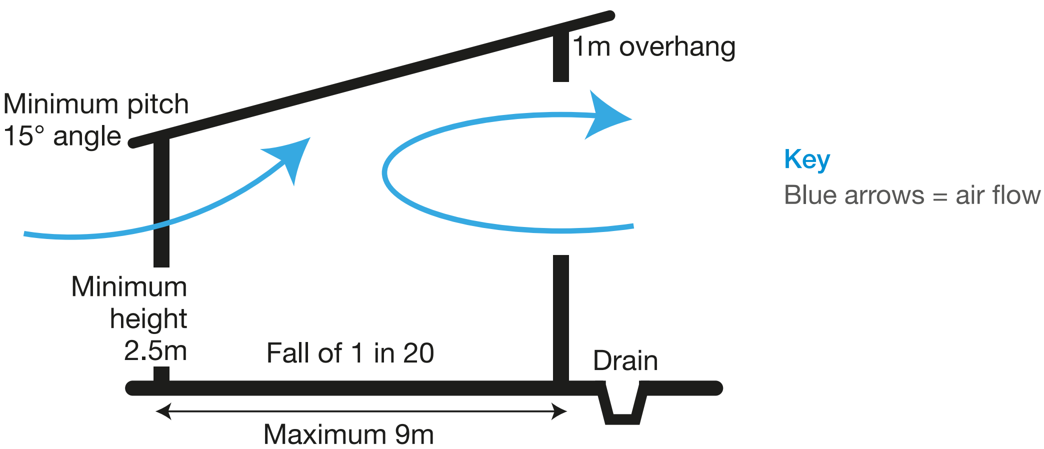


Figure 1. Side profile of a mono-pitched building

Guidelines for a mono-pitched building

- A building with a larger sloping roof should not exceed 9m in depth (see Figure 1). If the building needs to be larger, a pitched roof is required
- There should be a minimum height of 2.5m from floor to roof at the lowest point
- The roof should have a minimum 15° pitch. Below this pitch, airflow is poor at most wind directions. A steep pitched roof over 22° provides the ideal airflow pattern
- Buildings should face the sun so natural light can enter the pens, ideally with the back against the prevailing wind
- The floor should slope from back to front with a drain outside the pens to avoid cross-contamination between pens
- If housing calves, ensure the gates to the front, or an internal division, provides full protection against draughts at calf height. Consider provision of an internal kennel for milk-fed calves during winter months

Ventilation

Cattle produce heat and moisture that rises up from their bodies

Ventilation is the exchange of stale air with fresh air and is measured as a rate (volume per unit of time).

Naturally ventilated buildings are ventilated by the wind most of the time, if the design and location of the building allow it. Wind speeds more than 1m/s will drive the air through gaps in the sidewalls, meaning stale air leaves the building on the opposite side.

The main failings of natural ventilation are:

- Solid sidewall, often created by adjacent structure
- Sidewall inlets less than required (see page 23)
- Sidewall increasing ambient air speed and creating draughts

The target for sidewall design is to provide diffuse inlets along the maximum length of both sidewalls. Sidewalls are commonly solid to above animal height to protect from draughts. Where stock are fed on an outside wall of a building, due consideration should be given to moderating the negative impact of increased air speeds at animal height.

The target for most cattle buildings is to ensure a design that maximises ventilation potential on a still day, without exposing the livestock to elevated air speed when the wind is blowing. This is possible for many, but not all buildings, and usually relies on ventilation via the stack effect.

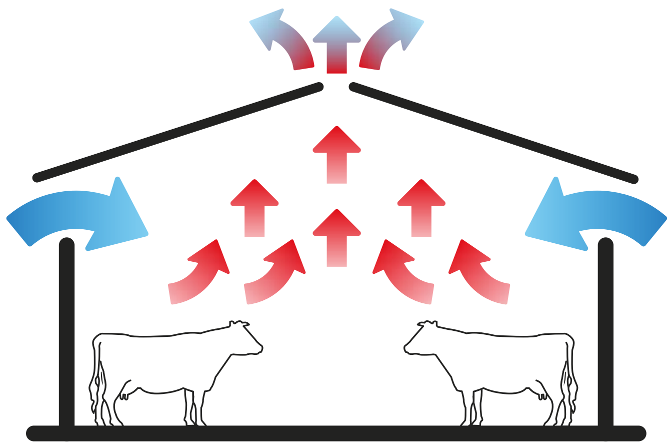


Figure 2. The stack effect inside a naturally ventilated building

The target for most cattle buildings is to ensure a design that maximises ventilation potential on a still day, without exposing livestock to elevated air speed when the wind is blowing.

Heat generated by the livestock in the building warms the air, which rises, to be replaced by fresh air coming in at a lower level through the eaves. Lack of air movement can be tested on a still day by using smoke pellets to track air circulation.

When designing a new building or improving an old one, it is critical to calculate the area of outlet required in a roof to allow heat and moisture from the livestock to escape by natural convection.

Ventilation calculations

When designing a new building or improving an old one, it is critical to calculate the area of outlet required in a roof to allow heat and moisture from the livestock to escape by natural convection.

The inlet area required in the sidewalls to support the natural ventilation can be set once the outlet area has been calculated.

Ballpark figures for ridge outlet areas can be used for assessing existing buildings to give a rough appraisal of their ventilation capacity.

That is, a ridge outlet area of $0.04m^2$ per animal up to 100kg liveweight, rising to $0.1m^2$ for fast-growing and adult stock. Note these figures are modified by stocking densities and roof pitch.

Inlet areas need to be at least twice, but ideally four times, the calculated outlet areas.

Example ventilation calculation

The calculations below estimate the area of outlet and inlet required in a building to ventilate naturally by the stack effect.

If it is easier to collect building measurements in feet, do so and convert later when doing the calculations (distance in feet x 0.3048 = distance in metres).

Print out these pages and add your figures alongside the worked example.

Step 1

The calculations are shown for an example building, with space to add in your own workings in the right hand column:

Building length = 32m **[A]**	
Building width = 18.29m **[B]**	
Floor area = A x B = $585m^2$ **[C]**	
Stocking density = 50 cattle at 600kg and 50 calves up to 250kg Total 100 cattle averaging 425kg **[D]**	

Where a range of animal weights occur, use an average weight. Where there are suckler cows and calves, also use an average weight, but consider calves at their heaviest.

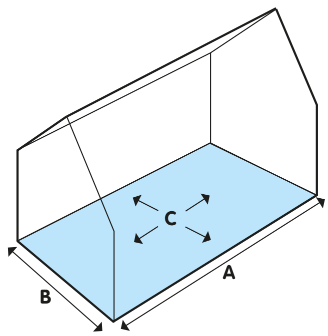


Figure 3. Floor area of building

Ventilation calculation key	
[A] = Building length	**[G]** = Eaves to ridge height difference
[B] = Building width	**[H]** = Building height factor
[C] = Floor area of the building	**[I]** = Outlet area required
[D] = Number of animals	**[J]** = Total outlet area required
[E] = Floor area each animal has	**[K]** = Available area for cladding
[F] = Outlet area in the roof per animal	

Step 2

Outlet area per animal (Use Figure 4 to calculate).

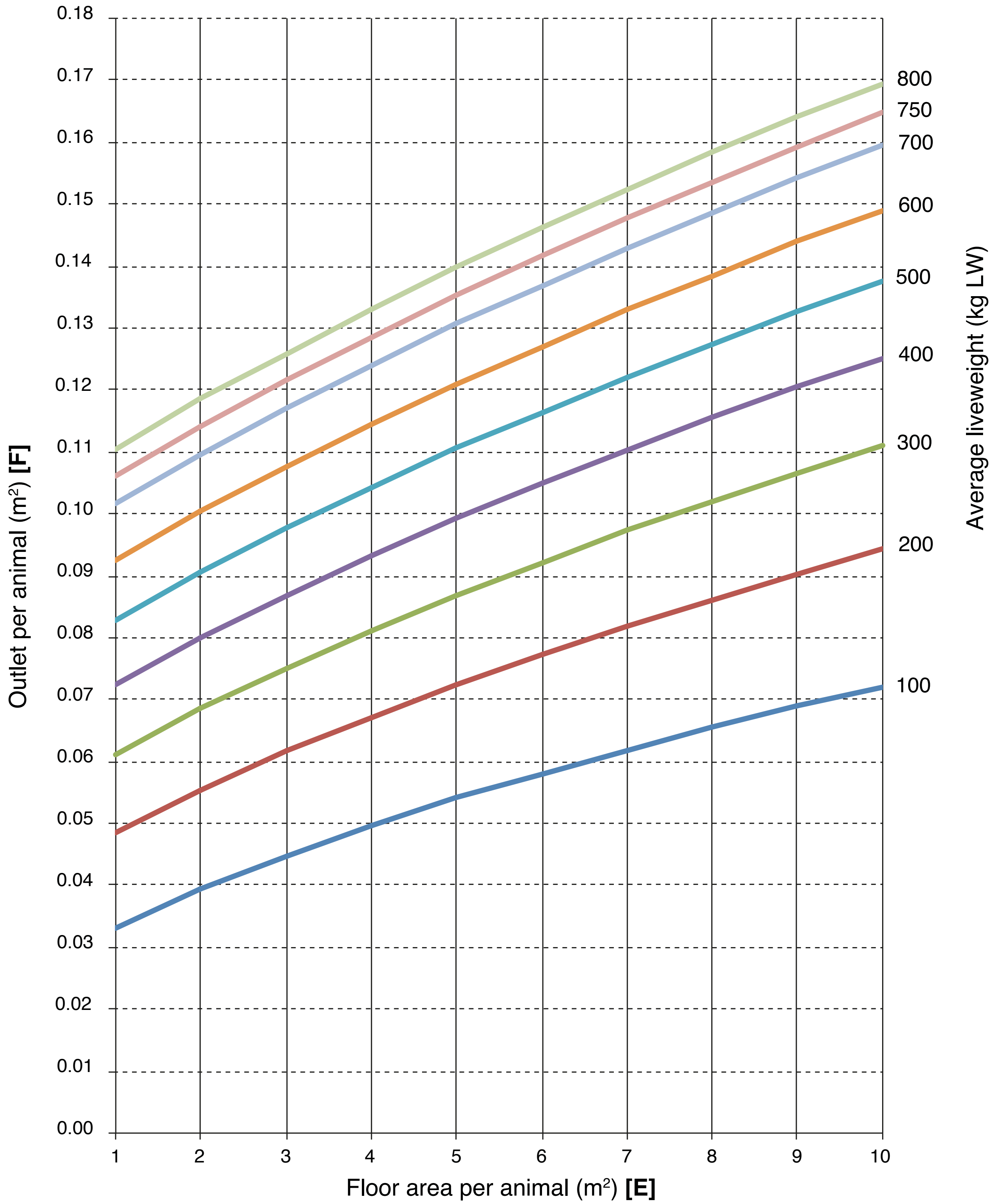


Figure 4. Outlet area per animal **[F]**

Read along the horizontal axis of Figure 4 to the floor area/animal **[E]** and find the line to the relevant weight of animal. Read across to the vertical axis.

A floor area of 5.85m²/animal **[D]** at an average liveweight of 425kg requires an outlet area per animal of 0.108m² **[F]**.

Step 3

The outlet area in the roof per animal **[F]** needs to be modified by the influence of the pitch of the roof; in effect, the difference in height between the eaves height and the ridge height **[G]**.

To calculate the height difference between the eaves and the ridge of a building **[G]**, either measure or take the measurement from building plans, or estimate by counting reference points in the gable ends, such as rows of blocks. An alternative approach is to estimate the slope of the roof and use Table 10 to estimate the roof height difference **[G]**.

Table 10. Multiplier to estimate roof height difference [G] from roof slope

Roof slope	Multiplier
10 degrees	0.176
12 degrees	0.213
15 degrees	0.268
17 degrees	0.306
20 degrees	0.364
22 degrees	0.404

Height difference **[G]** = roof slope multiplier x half the building width **[B]**

With a 17° pitch, the eaves to ridge height difference of the example building is 0.306 x (0.5 x 18.29 **[B]**) = 2.8m **[G]**

Step 4

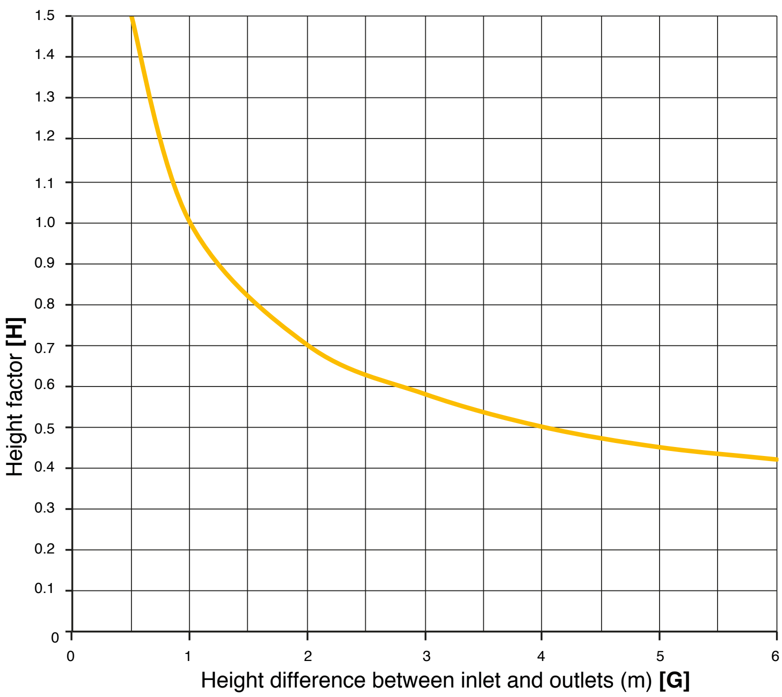


Figure 5. Building height factor **[H]**

Outlet area required (Use Figure 5 to calculate)

Read along the horizontal axis of the graph in Figure 5 to the height difference in the building. A height difference of 2.8m (the horizontal axis of Figure 5) corresponds to a height factor (on the vertical axis of Figure 5) of 0.60 **[H]**. The actual outlet area required for this example is:

Outlet per animal [F] x height factor [H] x number of animals [D]

Outlet area required is
0.108 **[F]** x 0.60 **[H]** x 100 **[D]** = 6.48m² **[I]**

Step 5

The outlet area required is a defined value; how this area is achieved in the ridge is flexible. A common solution is to provide a continuous gap along the ridge, in which case the required gap width is the outlet area required **[I]** divided by the building length **[A]**.

In this case, the required gap is
$6.48m^2$ **[I]** ÷ 32 **[A]** = 203mm

The inlet area, ideally split evenly across the two sidewalls, should be a minimum of twice the outlet area, and ideally four times the outlet area. Use the lower figure for youngstock and for exposed sites.

This is a precise minimum gap size. In reality, it would be practical to provide a gap of 210mm or 250mm, if in future the building might be used for heavier stock. The inlet area, ideally split evenly across the two sidewalls, should be a minimum of twice the outlet area, and ideally four times the outlet area. Use the lower figure for youngstock and for exposed sites.

The gable ends of buildings less than 24m wide are not typically considered as inlets. The gable ends, suitably clad to protect from wind chill, can be useful as inlets where the sidewalls are restricted in some way, for example by an adjoining building.

When the required area of inlet for a building is known from the above calculations, but the sidewalls are naturally restricted in some way, the gable end should be considered the only natural inlets and cladding should be designed for above the solid gable wall (see page 21). The main additional requirement where the gable end is facing the predominant wind direction (eg SW) is that space boarding is not suitable, and Yorkshire boarding or perforated sheets should be used.

Frequently asked questions on building ventilation

Use the animals' expected maximum weight when calculating ventilation requirements

Q How accurate do we need to be with measurements and calculations?

A Stay practically accurate throughout; round values up, not down, if necessary. Calculate building lengths by counting numbers of bays; most buildings have 4.6m or 6m bays. Building widths are more difficult. If no long tape measure is available, measure a stride and pace the width.

Q What part of the building do I include in the calculations?

A Measure the entire floor area that is covered by the single relevant roof span, ie the bedded area, the feeding area and the feed passage, if all these are under the roof area.

The main aim is to define the area of a building that the body heat from the animals is influencing. However, where all the livestock are kept down one end of a building, with the other parts of the building used for storage, restrict the area calculations to that part influenced by the animals.

Ridge capping has been removed on this shed to allow stale air to escape

Q How do we input animal numbers and liveweights when there are different types of animal within the one air space?

A Where a range of weights occur, use an average liveweight. Where growing animals are involved, always use their expected maximum liveweight.

The target is to estimate the maximum expected liveweight (and therefore the maximum expected body heat production and respiration) that the single air space and building is required to house effectively.

Q Do I need to worry about making a hole or holes in the roof?

A The building will never provide the benefits of fresh air ventilation unless there are holes in the roof.

The force of the air leaving through the roof will keep much of the rain out in low and medium rainfall areas. If there is a need to cover the outlet areas in the roof because of high rainfall, or the ridge is over cubicle beds or calves, provide a covered open ridge.

Q What inlet designs are most suitable?

A The design requirements are:

a) To allow adequate fresh air in along both sidewalls of the building, so that the exit of exhaust air from the building through the roof is not restricted.

b) To reduce wind speed across the animals so that draughts and excessive heat loss do not occur.

Note that large single inlet areas such as open gates and doors may meet the requirements of a) for a small area within the building, but cannot meet the requirements of b).

A slotted roof is good where animals are housed all year

Outlet designs

The outlet area is best provided by a narrow opening (Figure 7: width Y) along the length of the ridge, 150–350mm wide dependant on stocking and building design. Width Y is defined by the calculations on p19. The wider the opening, the more likely rainwater is to come in. In this case, a covered open ridge (shown in Figure 7) is appropriate. A ridge like this should also be used above cubicles or anywhere rainwater entry could be a problem.

An open ridge (see Figure 6) is frequently between 200–350mm wide and should be unrestricted. The optimum ridge design is to provide upstands, which significantly reduce rain water ingress and additionally improve exhaust ventilation. These are suitable where the ridge is located above passageways, feed passages and collecting yards, and in locations where rainfall is not high.

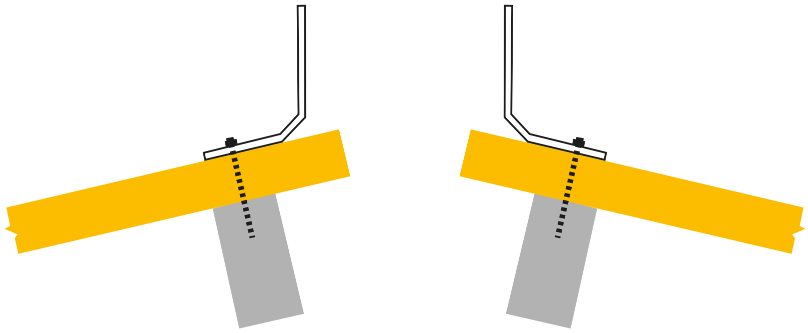
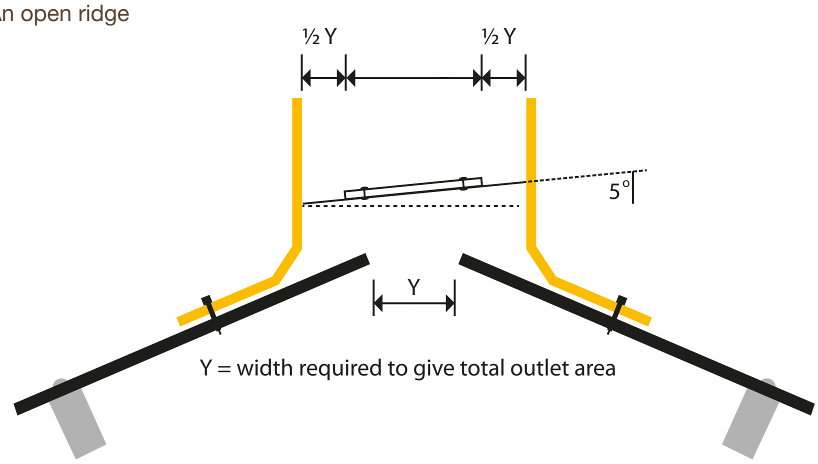


Figure 6. An open ridge



A covered open ridge

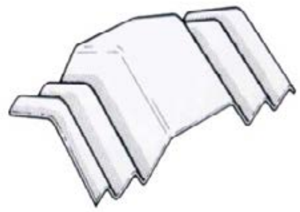
Figure 7. A covered open ridge

A covered open ridge is for use where water ingress is completely undesirable (for example above cubicle beds), where rainfall is high, or where stocking density is low such that the pressure of exhaust air leaving through the ridge vent is also low.

There are a number of methods to achieve adequate outlet ventilation, including various ridge designs or slotted roofs.

There are a number of methods to achieve adequate outlet ventilation, including various ridge designs or slotted roofs.

The **lightridge** or similar design, is useful as it provides adequate outlet area and additional natural light within a building. It is particularly useful for improving existing buildings where the two sets of purlins supporting an existing enclosed ridge are widely spaced (>700mm apart) and fixing a 200–300mm open ridge would normally be difficult.



Cranked ridges do not allow enough air to escape and should not be fitted

Slotted roofs, where roof sheets are inverted and fitted with a space of 10–20mm between each adjacent side sheet, are particularly suited to systems where cattle are housed all year, or on lean-to roofs with a low pitch. They are not suitable for youngstock <150kg. However, they do reduce the flexibility of the use of the building for non-livestock purposes. Trimmed sheets specifically for slotted roofs are available.

Cranked ridges are not suitable as they only offer around 20% of the required outlet, although they are still commonly fitted.

Inlet designs

The aim of inlets is not to restrict airflow but to reduce air speed at animal height. Uncontrolled air speed at this level is only likely to be beneficial in the UK during the warm, summer months.

Inlets should aim to reduce air speed at animal height and where possible, ventilate the building from the sides.

The aim should be, where possible, to ventilate the building from the sides. Inlet areas in the gable ends are only recommended where the building is excessively wide (>25m), or where there are restrictions in the inlet areas along one or both sides of the building.

A cladding material with many small openings is suitable for inlets in the UK for winter housing. The design requirement is to match the available materials with:

- The calculated optimum area of inlet for each sidewall
- The available area in the sidewall for cladding
- The degree of exposure to the weather of the sidewall

Perforated wall cladding

The example building used on page 16 requires an optimum of 13m^2 (2 x 6.48m^2 **[I]**) of inlet area in each sidewall **[J]**.

If there is 2m height between the top of a solid concrete/block wall and the eaves, in a building 32m long, the available area for cladding is 64m^2 **[K]**.

Therefore approximately 20% **[J]** ÷ **[K]** of the cladding area must be void, ie let air through.

The inlet area can be greater than the calculated opening as long as due consideration is given to air speed at animal height.

The required inlet area for the example building could be covered with:

- A horizontal slot 410mm deep, below the eaves, the full length of the building
- Space boarding (100mm board, 25mm gap) the full length of the building
- Yorkshire boarding (152mm board, 38mm gap) the full length of the building
- Plastic or woven cladding with at least 20% void
- Perforated metal sheeting with at least 20% void

Moving curtains provide flexible inflow of fresh air

A horizontal slot inlet needs to be further protected from wind penetration, for example with overhanging eaves.

Space boarding should not be used with a gap larger than 25mm, otherwise wind, rain and snow will penetrate the cladding.

Yorkshire boarding can be used on exposed sides of buildings when driving rain causes a problem with wet bedding. The two rows of vertical boards are placed offset on either side of the purlins, with the inside boards positioned at the centre of the gaps between the outside boards. The maximum gap width between the boards is 50mm.

Space boarding can be easily upgraded to Yorkshire boarding by fixing a second line of boards in parallel to the originals, separated by horizontal battens of minimum 25mm thickness. The second line of boards should be fixed opposite to the spaces between the original boards.

Consider carefully if inlet areas require a covering and which option best suits the building design and environmental conditions.

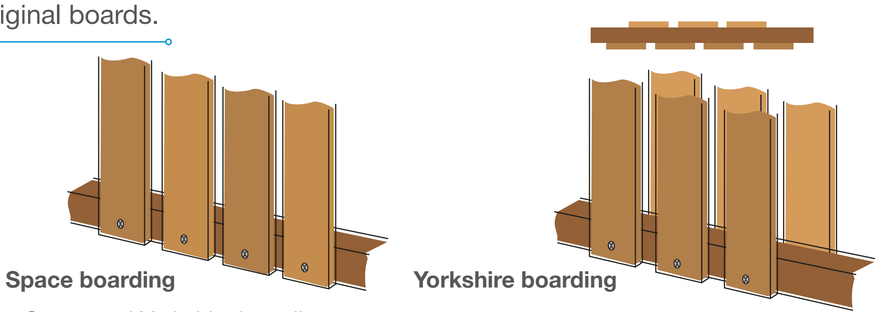


Figure 8. Space and Yorkshire boarding

Mechanical ventilation

There are a number of situations where mechanical ventilation is valuable.

Often, the layout and development of farm buildings leaves areas that cannot be naturally ventilated – known as 'dead spots'.

These areas can be significantly improved by either blowing air into the space (positive pressure ventilation) or sucking air out (negative pressure ventilation). In either case, it is still essential to provide adequate inlet and outlet areas.

Calf housing will nearly always benefit from some form of mechanical ventilation.

Positive pressure ventilation is the most common mechanical ventilation system used in cattle buildings. In effect, it provides an additional inlet to a livestock building. The fan should be used with an air straightener and a duct so that fresh air can be distributed along the full length of the duct. Typical systems support ducts up to 30m long.

Negative pressure ventilation is less common, but can be well-suited to low-volume areas such as small calf houses, buildings with low roof heights and old traditional buildings with roofing that is difficult to change.

The areas of inlet are particularly important in negative pressure ventilation systems as the fans will draw air from the easiest source, which may not be of benefit at animal height.

Calf housing will nearly always benefit from some form of mechanical ventilation. This is due to the absence of heat produced by adult cattle within the building space. Young calves will not be able to generate sufficient heat to drive the stack effect.

Positive pressure ducting in a calf house

Design requirements for positive pressure ducted ventilation include:

- Adequate fan capacity
- Calculation of tube diameter and hole diameter so there is no draught created at animal height
- Ridge outlet or extraction

Calculating fan capacity

A broad calculation for estimating the fan capacity required for a building is based on the liveweight of the livestock housed:

Max ventilation rate	**3.5m³/s kg 10⁻⁴**
Min ventilation rate	**1.1m³/s kg 10⁻⁴**

Using an example of a calf house for 25 calves up to 100kg:

Max ventilation rate (Q) $\frac{(3.5 \times 25 \times 100)}{10{,}000} = 0.875\text{m}^3/\text{s}$

Min ventilation rate $\frac{(1.1 \times 25 \times 100)}{10{,}000} = 0.275\text{m}^3/\text{s}$

Use the technical performance data sheets provided with all fans to choose one that meets your requirements (eg a 400mm diameter fan operating at 50 Pascals (Pa) pressure may give 1.022m³/s).

High-volume, low-speed (HVLS) ceiling fans are sometimes used in the UK. Their main function is to increase air speed at animal height and can therefore be suitable for high yielding cattle housed in summer conditions. Smaller, ceiling mounted fans are sometimes used by bull breeders as the increased air speed influences hair coat depth.

Inlet sizes when using a fan

It is good practice to have inlets of an appropriate size to match the performance of the chosen extractor fan. The aim is to have an inlet area that does not restrict airflow rates, and does not create an air speed (Vmax) of more than 2.5m/s at the inlet (to prevent chilling).

Use a smoke test to show the flow of air within a building

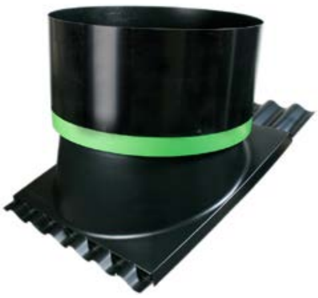
Max ventilation rate (Q)	= 0.875 m^3/s (from example on page 22)
A (area of inlets)	= **Q** ÷ **V** (ventilation rate ÷ air velocity)
	Vmax = 2.5m/s (to prevent chilling)
Therefore	**A** = 0.875 ÷ 2.5 = 0.35m^2

Inlet area should be 0.35m^2 = eg six openings 0.600m x 0.100m in size

Dead spots

Dead spots can be identified by using smoke tests to visualise the movement of air in a building. Ideally, smoke should rise towards the ridge and be cleared from the building in 45–60 seconds. Suitable smoke pellets can be purchased from plumbing suppliers.

Traditional buildings with a loft above a livestock area can sometimes be improved by removing one or two boards in the loft floor and covering the subsequent holes with weldmesh. Alternatively, a chimney can be added from the loft floor to the outside, or a negative pressure fan placed in the loft floor to extract stale air.



Fitting a chimney can help extract stale air

Chimneys

Simple chimneys are widely used in the pig and poultry industry for ventilation. The main potential for the cattle sector is in buildings where the roof ridge cannot be opened up, or where the roof abuts the wall of an adjacent building.

The requirement is an outlet in the roof below ridge height that does not let in water. If a slotted roof is not suitable, a chimney can be fitted retrospectively. Products are available with a combined roof plate that fits the profile of most standard roof sheets.

Feeding and water

The aim of the feeding system is to:

- Keep clean feed in front of the cattle and within reach
- Incur the minimum amount of labour to push feed up and clean old feed out
- Minimise bullying

A feed trough designed to keep feed in front of cattle at all times

Feed barrier design

The specific dimensions and design of the feed barriers will depend on cattle size, group size, feed type and labour availability. Ideally, they should be flexible to accommodate a range of cattle types and sizes.

Width of feed barrier depends on the size of animal, the method of feeding and degree of competition between cattle.

An open horizontal barrier increases the risk of dominant cattle poaching feed from others. Diagonal barriers reduce the risk of bullying, and both tombstone and dovetail barriers provide a discrete feeding space for individual animals. Feed wastage can be increased and feeding times reduced if animals can be easily disturbed while at the feed fence.

It is useful if the top brisket board or top rail can be adjusted to suit cattle of different ages.

Diagonal feed barriers

Feed barriers with locking yokes

Straight bar feed barrier

Table 11. Feed barrier width requirement for different weights of cattle

Animal weight (kg)	Width of feed barrier (mm per animal)	Ad-lib feeding (mm)
200	400	150
300	500	150
400	550	190
500	600	240
600	650	280
700	700	320
800	750	320

Source: Adapted from Red Tractor Beef & Lamb Assurance Standards 2017

The key requirements for feeding areas are:

- The bottom of the feed trough should be no more than 100mm above animal foot level and be smooth to encourage feeding and make cleaning easier
- The trough or brisket board should be around 500mm high for adult cattle, with a smooth finish
- The neck rail height should ideally be adjustable from 1150–1250mm above floor level for adult cattle (900–1100mm for younger cattle). The neck rail should be high enough so that an animal's neck should rarely touch it
- The maximum reach of cattle varies with age, but can be up to 1.0m for adult cattle. Reach can be improved by fixing feed rails and diagonal barriers at a slight forward angle (about 20°)

Look out for tell-tale signs of feed barriers that need adjusting, such as hair being rubbed off the back of the cattle's neck. An animal's neck should not touch the top rail while feeding.

Drinkers located outside pen

Water troughs

Provision of clean drinking water is a primary requirement of all animal housing and it must be available at all times and with adequate supply to cope with peak demands. Red Tractor standards require a back-up supply of water if private water supply (eg borehole) is used. It is recommended that private water supplies are tested annually.

Water is frequently spilt at and around water feeders. It is therefore sensible to locate drinkers above an area that drains freely, so as to not cause a build-up of moisture either in bedding or by creating an increased area of damp floor.

Tipping troughs, or troughs with large emptying valves that can be emptied onto crossover passages, help keep the water and floors clean. However, water must be able to drain away effectively.

Water consumption by cattle varies widely according to factors such as liveweight, ambient temperature, milk yield and ration moisture content (see Table 12).

Water troughs should be designed and positioned to minimise contamination from food and protect from fouling. They should be placed so there is a low risk of freezing in cold weather and where cattle can access them easily ie not in a dead end.

The water trough should be located at the correct height for the cow. The edge of the trough should be 850mm from the floor. The water level should be 50–100mm below the edge of the trough to minimise splashing.

Table 12. Water allowance guidelines for different classes of beef cattle

Stock type	Estimated drinking water allowance (l/head/day)
Early lactation suckler cows	50–70
Mid to late lactation suckler cows	40–60
Dry suckler cows	14–40
Stock bull	30–80
Growing cattle	15–50
Finishing cattle	25–75

Note: Cattle must have free access to clean water at all times.

Research has shown that milk-fed calves will drink 0.75–2.0 litres of fresh water per day.

Adequate water trough space or water bowls must be provided to allow at least 10% of the group to drink at any one time. These should be located at the correct height for the animals, which can be a challenge with rapidly growing animals.

Roof water collection

Rainwater harvesting (RWH) is the collection and use of rainwater falling on to buildings which would otherwise have gone down the drains, been lost through evaporation, or soaked into the ground.

Such systems can be fitted to new or existing buildings and range in their complexity They offer a means of reducing water costs.

For more information see: **Rainwater Harvesting: an on-farm guide** available on the Environment Agency website or view the BRP+ **Water use, reduction and rainwater harvesting on beef and sheep farms** available on the AHDB Beef & Lamb website.

Other considerations

Remember biosecurity

Hygiene

Buildings should be designed, constructed and maintained so that they can be effectively cleaned.

Smooth wall surfaces, competent joints between the floor and the walls, and the ability to drain well are essential. There is significant potential to improve the hygiene within existing buildings, by measures such as renewing floors and creating slopes and gutters to control drainage.

Maintenance

Maintenance is a sound business investment. The aim of housing animals is to maximise cattle health and financial productivity. A building cannot be expected to provide a continuous productive environment without maintenance.

Floors, and how well they drain, is one area that requires regular maintenance, as are all fittings and moving parts.

Gates that are difficult to open and shut, or feed troughs and drinkers that do not work properly increase labour costs as well as the risks of injury to animals and people.

The biggest losses are created by broken downpipes and gutters, whereby clean rainwater falls uncontrolled around the buildings, creating animal health and welfare issues.

Outside the shed

Facilities around a cattle building also have specific design requirements and should not be overlooked.

Loading ramp with height suitable for both trailers and HGV

Loading banks/ramps

More information on design requirements for handling facilities can be found in Beef BRP Manual 3 – **Improving cattle handling for Better Returns**.

Loading and unloading are the most stressful part of animal transport. On-farm facilities can be provided that improve both animal welfare and human safety.

Cattle ramps should have a slope of no more than 15° and steps with a horizontal depth of at least 400mm are recommended. All steps or slopes should be heavily grooved and easy to clean. All sides to the loading bank and gates must be constructed and maintained to provide secure and safe working.

Whole-yard approach

Always consider the whole package of farmyard buildings, and how they combine with each other, not just a single building in isolation. Bad positioning decisions will be evident for the next 20 to 40 years.

A good yard design will incorporate four basic principles:

- Keep animal and machinery routes separate as far as possible
- Minimise the amount of rainwater that becomes soiled and collect this in one tank if possible
- Site buildings for good ventilation but avoid draughts
- Optimise animal health and welfare as well as efficient and safe working

Appendices

The tables below provide guideline space allowances. Cattle and building type will influence the most appropriate space allowances on a particular farm.

Table A1. Loose housing space allowances

	Liveweight (kg)	Solid floors (m²/head)		Slatted floors (m²/head)*
		Bedded area	Total area (incl. feeding and loafing)	
Suckler cows	400	3.50	4.90	n/a#
	500	4.25	5.85	n/a#
Growing/ finishing cattle and youngstock	200	2.00	3.00	1.10
	300	2.75	3.95	1.50
	400	3.50	4.90	1.80
	500	4.25	5.85	2.10
	600	5.00	6.80	2.30

Source: Red Tractor Assurance Standards 2017. Notes: #Non-slatted lying area must be provided. *Fully slatted concrete floors should not be used for breeding cows or in-calf replacement heifers

Table A2. Cubicle dimensions

	Liveweight (kg)	Dimensions	
		Length (m)	Width (m)
Cows	<600	2.40	1.15
	>600	2.50	1.20
Growing/ finishing cattle and youngstock	200	1.45	0.70
	300	1.70	0.85
	350	2.05	1.05
	>350	2.10	1.10

Source: Red Tractor Assurance Standards 2017

Table A3. Bedded area allowances for suckler cows and calves (excluding creep area)

Cow weight (kg)	Bedded area per single cow and calf		Slatted area per single cow and calf
	Bedded (m²)	Total (m²)	Area (m²)
Up to 500	3.75	5.00	2.50
500–600	4.05	5.50	2.75
Over 600	4.35	6.00	3.00

Source: From BS5502: Part 40 Buildings and Structures for Agriculture. Code of practice for design and construction of cattle buildings. British Standards Institution

Table A4. Minimum space requirements for calves in group housing (Red Tractor Standards, 2017)

Calf weight (kg)	Space requirements per calf
50–84	1.5m^2
85–140	1.8m^2
140–200	2.4m^2

Table A5. Bedded area allowances for calves in calf creep

Calf weight (kg)	Area per calf (m^2/head)
Up to 250	2.5
400	3.8

Source: From BS5502: Part 40 Buildings and Structures for Agriculture. Code of practice for design and construction of cattle buildings. British Standards Institution. Notes: It is acceptable to interpolate between 250 and 400kg but not outside this range

Further reading

BS5502: Part 40 (2005). Buildings and Structures for Agriculture. Code of practice for design and construction of cattle buildings. British Standards Institution.

Dairy Housing – a best practice guide. **dairy.ahdb.org.uk**

AHDB Beef & Lamb Beef BRP Manual 3 – Improving cattle handling for Better Returns. **beefandlamb.ahdb.org.uk**

AHDB Beef & Lamb Beef BRP Manual 6 – Improve beef housing for Better Returns. **beefandlamb.ahdb.org.uk**

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