Better management of Bovine Respiratory Disease (BRD/Pneumonia)

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Photos courtesy of RAFT Solutions, Synergy Farm Health Ltd, Jamie Robertson and Bishopton Veterinary group.

Key messages

+ Managing the animal-environment-pathogen interaction is key to controlling BRD.
+ Calf health hinges on providing good quality colostrum at birth.
+ The negative effects of stress are additive.
+ Strict biosecurity is required to manage the risk of buying in BRD.
+ BRD often results from infection with a primary agent first, usually a virus. The resulting lung damage allows a second bacterial infection to develop.
+ There are no anti-viral treatments available. The usual treatment is antibiotics and NSAIDs.
+ In some cases vaccination against four key viruses can dramatically reduce outbreaks.
+ Moisture levels, air quality and air speed in a building can significantly affect the prevalence and severity of BRD.
+ There is an absolute requirement for an outlet in the roof to let warm, moist, foul air escape.
+ Inlet area, ideally spread across both sidewalls, needs to be at least twice and ideally four times the outlet area.
+ Floors must be safe, durable and carry liquid away from the animals.
+ Do not use straw choppers in buildings with stock below three months of age.
+ Good hygiene is essential when managing youngstock.
+ Mycoplasma spp. are widespread and often implicated in BRD. There is no vaccine and success of treatment is threatened by increasing antimicrobial resistance.

Keywords:
Bovine respiratory disease, BRD, pneumonia in cattle, cattle building design, building ventilation to prevent pneumonia
Introduction

Bovine respiratory disease (BRD or pneumonia) is common in commercially reared beef calves and yearlings. It causes inflammation of the lung tissue and airways. Damage may be irreversible in severe cases.

Pneumonia is one of the most significant diseases affecting English beef producers, costing the UK cattle industry an estimated £50 million a year. It is the most common reason for deaths and poor performance in young cattle from weaning to ten months of age.

Cattle succumb when the disease pressure overcomes their immune system. Strategies to reduce pneumonia should therefore target improving cattle immunity and reducing stress, as well as treating any concurrent disease present.

Studies show that when 30% of cattle in a group show actual signs of respiratory disease, a further 40% can exhibit lung damage at slaughter. So it is likely that many cases go unnoticed, yet cause significant performance loss.

A large proportion of the costs associated with pneumonia are hidden, such as reduced liveweight gain and feed conversion efficiency (FCE).

Costs per affected animal range between £30–£80, but increase to £500 or more if an animal dies because of the disease.

Impacts of BRD on a beef enterprise include:

- Failure to reach growth targets
- High vet/medicine costs due to treatment of secondary infections, usually bacterial
- An additional 14 days taken to reach breeding weights
- Average daily liveweight gains reduced by up to 0.2kg/day
- Increased mortality and culling
- Increased replacement costs due to culling of young breeding animals
- Risk of bringing in disease with purchased replacements

Mortality in the grower/finisher stages represents the maximum financial loss per beef animal, because a great deal of time and money has been invested in the animal for no return. While numbers are not high, the risk of losses in 12–18 month old cattle increases if animals have been infected as young calves.
Recognising BRD

BRD is a complex multifactorial disease. Although the symptoms are obvious in more severely affected animals, often the whole group may be affected sub-clinically, only showing itself through reduced feed intake, growth rates and FCE.

The symptoms of BRD include:
+ Reduced feeding
+ Raised temperature (above 39.5°C or 103°F)
+ Increased breathing rate and effort
+ Head down, looking depressed
+ Coughing
+ Nasal discharge (clear mucus initially, may become thick and purulent with time and secondary infection)
+ Death

Testing for disease

Blood sampling, to determine the level and type of antibodies present, can be used at the end of housing in six to twelve-month old cattle. Sampling six calves will indicate which viruses have been circulating in the group and help target a treatment protocol for other groups.

Alternatively, new acute infections may be investigated by taking two blood samples over a two to three week period. This ‘paired serology’ test, where two samples are taken from the same animal and compared, shows whether the infection is increasing and therefore ‘current’, or not.

Bronchoalveolar lavage (BAL) is often considered the gold standard test for identifying the infectious agents responsible for pneumonia cases.

BAL involves passing long, thin tubes directly through the nose and down into the lungs. An area of lung is ‘washed’ with fluid and sucked back through the tubes. The fluid is then examined in a lab for viruses and bacteria.

The animal needs to be restrained, but not anaesthetised. Sampling must be from calves in the early stages of infection with high temperatures but before they develop runny noses and advanced coughing. They must not have received any treatment before testing.
Preventing and controlling BRD

A fundamental appreciation of the animal-environment-pathogen interaction is key to understanding the success or failure of control strategies.

Managing just one of these issues in isolation will not prevent or control the disease – they must be tackled together.

BRD occurs when the challenge of infection from pathogens overwhelms the immune defences of the animal. Many factors influence this including many non-specific stressors such as:

**Nutrition**
- Colostrum intake at birth
- Nutritional requirements for growth
- Trace element status, especially vitamin E/selenium

**Physiological stress**
- At weaning
- During castration/disbudding
- In transport

**Exposure**
- Mixing/changing groups
- High stocking rates

**Environment**
- Inadequate environment, eg poor air quality, wet bedding, draughts at animal level
- Temperature variation and extremes

**Concurrent disease**
- Such as Bovine Viral Diarrhoea (BVD), coccidiosis
Animal

Species differences
Cattle have smaller lungs relative to body size when compared to other mammals. This may decrease resistance to respiratory infection.

This is particularly an issue in very fast growing continental bred cattle which have high metabolic requirements and relatively low lung capacity. These types of cattle tend to be more susceptible to challenge in poorly ventilated buildings. There is also a risk of a rapid increase in stocking rate as they grow and become bigger and heavier.

Colostrum management
Calf health hinges on adequate intake of good quality colostrum as soon after birth as possible. Passive immunity is passed from mother to calf through her colostrum, providing the only means of protecting the newborn against disease.

The effectiveness of colostrum is down to quality, quantity fed and how quickly the calf receives it.

Opportunities for human intervention differ in extensive beef suckler systems compared to beef calves born to dairy dams. The latter may be easier to supplement after birth if there are problems.

In suckler herds the calf may not be observed until a while after calving, so suckling is often assumed rather than observed. There are signs to look out for that indicate successful suckling:

+ Abdominal distension in the calf
+ Calf active and alert
+ Dam’s udder empty

Three point plan:

1. Quantity – deliver sufficient colostrum into the calf

Dairy calves should be given 3-4 litres (approximately 10% of bodyweight) of colostrum as soon as possible after birth and ideally within two hours. If suckling this intake usually requires 20 minutes of the calf suckling on its dam. The aim should be to repeat this level of colostrum feeding within eight to twelve hours. The more colostrum a calf drinks as soon as possible after birth (and within its first 24 hours of life) the better its protection against disease will be.

In situations where suckler calves are too weak to suckle or cannot suckle due to the dam or other reasons, they should be hand fed 3-4 litres of colostrum by stomach tube (oesophageal feeder), nipple bucket or bottle, as soon as is safely possible after birth.

Intervention in extensive systems is often impractical. However, if it is possible to supplement poor looking animals, calf weight and colostrum quantity should be measured accurately to make sure enough is given.

Calves which experience a difficult birth need extra colostrum.
2. **Quickly** — every minute counts

The efficiency of antibody absorption from colostrum declines rapidly during the first few hours of life. It is very important that calves receive their first colostrum feed as soon as possible after birth, ideally within two hours, to maximise the immunity it can provide.

The Welfare of Farmed Animals (England) Regulations 2000 require every calf to receive bovine colostrum within the first six hours of life.

3. **Quality is key** — colostrum quality varies widely

Cows in poor body condition are likely to produce poor quality colostrum. Body condition scoring prior to calving, and vaccinating against scour viruses and bacteria during pregnancy, can boost colostrum quality. Generally, heifers produce lower quality colostrum than cows.

A colostrometer can be used to measure supplemental colostrum quality.

Hygiene is very important when giving supplementary colostrum. Use clean equipment and do not use mastitic or dirty milk, as high bacterial loads may significantly reduce absorption of colostrum through the gut. Similarly do not feed colostrum/milk containing antibiotics.

For orphan calves, use colostrum from cows in second or later lactation with a known Johne’s disease status. Freeze excess colostrum from separate cows, unless it is to be used immediately.

Bacteria proliferate rapidly in warm colostrum which can be harmful to the calf. Rapid cooling in iced water or a farm refrigerator to less than 5°C will reduce the risk if it is not to be used immediately. Cooled colostrum will remain usable for up to 48 hours.

Bought-in colostrum increases the risk of importing diseases such as Johne’s disease. Try to source it from low-risk herds with known health status.

**Providing adequate nutrition**

The immune system of malnourished animals is weak. A calf’s defences can be improved by supplying the correct nutrition to meet their requirements at every stage of development.

The impact of the weather also needs to be considered.

In cold, wet, windy conditions energy requirements are higher and therefore energy intake of youngstock may need to be increased.

The opportunity to give additional feed to poorly performing calves in beef suckler systems is more challenging than in intensively reared calves. However, creep feed may be offered to growing beef calves.

Monitoring adult beef cow body condition can give an early warning that grazing or forage is inadequate for milk production, as can monitoring sward heights. In these cases supplementation with feed or early weaning can be considered.

Creep feeding suckling calves is also a good way of reducing calf stress at weaning and getting them used to the housed ration. A creep feeding station offered to autumn-born calves in their first winter enables them to feed away from the cows. Scouring in the calves can be reduced by doing this, as the creep area should be kept clean and relatively free from contamination.
Reducing management stressors

The negative effects of stress are additive, so the more stressors there are in a calf’s life, the lower performance will be.

The highest risk period is usually at weaning, but risk is farm specific and may result from some or all of the following:

**Exposure**

- Mixing different groups of cattle, especially of different ages or from different sources
- Housing after grazing pasture, assembling in yards, congregating around feed troughs, etc
- Disease transmission from other animals

**Physiological stress**

- Castration
- Disbudding
- Loss of contact with dam

**Environmental stress**

- Insufficient feeding space or water provision
- Transport and handling
- Change of environment
- Change of diet, unfamiliar feeds

Calves are better able to fight disease when less stressed, so avoid disbudding and castration at key times such as weaning. These procedures should be performed when calves are young, and still have circulating immunity from the colostrum they consumed. Disbudding very young calves also avoids the more stressful procedure of dehorning later on.

Keep herd groups stable, handle calves quietly and maintain a regular routine.

Avoid disbudding at key times such as weaning to keep stress levels down.
Strategies for reducing stress at weaning

Table 1: Strategies for reducing stress at weaning

<table>
<thead>
<tr>
<th>Suckled beef calves</th>
<th>Dairy beef calves</th>
</tr>
</thead>
<tbody>
<tr>
<td>Winter/spring-born calves</td>
<td></td>
</tr>
<tr>
<td>Allow access to creep feed (housing diet) in field before housing</td>
<td>Ensure all calves in group have good dry feed intake before weaning</td>
</tr>
<tr>
<td>Check need for lungworm or liver fluke control for the particular year</td>
<td>Ensure calves are eating at least 1kg/head/day of early weaning compound for three consecutive days before weaning</td>
</tr>
<tr>
<td>Vaccinate before housing if risk of BRD is high. Discuss risk management with vet</td>
<td>Ensure easy access to clean drinking water at all times</td>
</tr>
<tr>
<td>Initial housing at night only</td>
<td>Retain in building ideally for two weeks after weaning</td>
</tr>
<tr>
<td>After weaning leave cows outside and bring calves inside</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Autumn-born calves</td>
<td></td>
</tr>
<tr>
<td>During housing allow access to clean air/outside area</td>
<td></td>
</tr>
<tr>
<td>Wean outside: allow (partial) access to building and original diet</td>
<td></td>
</tr>
<tr>
<td>Maintain flexible attitude in response to poor weather conditions (offer supplementary feed and/or access to housing if necessary)</td>
<td></td>
</tr>
</tbody>
</table>

The presence of cows has a calming effect and can reduce stress in suckled calves at weaning. One option is to wean most of the calves at housing but leave a few, fitter cows that can afford to lose some body condition in with the calves for a week or so. Where there is plenty of shed space available, all the calves can be left with their mothers at weaning. A creep area can be created where the young animals can be shut into for an increasing period of time over a two week period. The calves will gradually wean themselves.

Purchased weaned calves/stores

For producers buying weaned calves and store cattle grower/finishers, lack of knowledge about the health status and history of the herd of origin represents a major challenge for BRD control. There are inevitable risks if the purchaser has little knowledge about their colostrum intake, the feed quality and quantity fed, and treatment history.

These risks can be proactively managed by applying strict routines to all animals entering the unit.
The aim is to reduce the chance of an unknown, susceptible animal succumbing to infection after the stress of being sold and transported – and then becoming a source of active infection to the rest of the animals in the group. To reduce stress:

- Prepare penning and handling facilities in good time
- Provide immediate unloading into a clean, separate area with clean water access
- Leave the group to settle quietly
- Provide feed in clean feeders. Note: diet change is always a significant stress factor

Once settled, watered and fed, apply a health management strategy agreed with a vet. This may include:

- Routine checking of weight and condition
- Vaccination, possibly intranasal for BRD pathogens
- Testing for key pathogens

Schemes are available that certify cattle being sold have been vaccinated against certain diseases.

Maintaining a closed herd is the optimum strategy to prevent buying in infectious disease. Sourcing animals from herds which belong to a cattle health scheme operating fully under the requirements of the Cattle Health Certification Standards (CHeCS), can reduce the risk from purchased stock. Further information can be found at [www.checs.co.uk](http://www.checs.co.uk).

A basic cattle purchasing checklist can also be accessed from [beefandlamb.ahdb.org.uk](http://beefandlamb.ahdb.org.uk). Going through the simple questions will enable risk areas to be identified. Always discuss stock sourcing policy with the vet.

**Concurrent disease stress**

Diseases such as Bovine Viral Diarrhoea (BVD) and coccidiosis specifically suppress the immune system in the growing calf.

Concurrent infection with these diseases represents a large risk for BRD. BVD specifically targets the lung cells so has a direct respiratory effect and is a major risk factor for BRD.

Any disease such as scour or joint ill also increases susceptibility to respiratory disease.

**Management of BRD calves**

Affected BRD calves should be isolated to:

- Reduce the disease challenge to the rest of the group
- Provide an opportunity for more effective observation, nursing and treatment

Bringing in disease is a major threat for farms purchasing cattle of unknown health status.
Vaccination protocols are an essential part of herd health planning and should be developed by the farmer and vet together.

The exact treatment programme will differ for each situation but will need to address the following question: What do I want to protect against?

This will depend on the disease and biosecurity status of the holding, and how long animals are kept on the farm. Animals already on the unit should be vaccinated to protect them from potential bought-in infections. Animals coming onto the farm need to be vaccinated to protect them from infections that already exist there. If calves are bought-in, a broad multivalent vaccine will be required to cover any potential infectious agents they may bring with them.

**Vaccination**

Infection frequently starts with primary agents such as viruses or *Mycoplasma* spp. Once these have caused initial damage, bacteria can enter as secondary invaders causing extensive damage to the lungs. In some cases vaccination against four key viruses can dramatically reduce calf pneumonia outbreaks.

Currently available vaccines protect against lungworm, Infectious Bovine Rhinotracheitis (IBR), BVD, Respiratory Syncytial Virus (RSV), Parainfluenza Type 3 (PI3) and *Mannheimia haemolytica*, but not against *Histophilus somni*, *Pasteurella multocida* or *Mycoplasma bovis*. This means vaccination should only be used alongside other management procedures.

Vaccination increases resistance to disease and reduces the shedding of infection from affected animals, thereby reducing the overall pathogen load within the environment.

When using vaccines it is vital to follow manufacturers' instructions. Poor storage, wrong dosage rate or timing reduce their effectiveness significantly.

**Antibiotics and NSAIDs**

There are no anti-viral products available for use in cattle, so treatment is with antibiotics for secondary bacterial infections and non-steroidal anti-inflammatory drugs (NSAIDs).

NSAIDs reduce fever and relieve pain and importantly help reduce damage to the lungs. Antibiotics have a role in treating both secondary infection and primary bacterial pathogens such as *Histophilus somni*.

Careful choice of antibiotics is essential, and cost per dose must be balanced against the duration of protection provided.

Successful treatment should result in rapid clinical improvement to minimise lung damage and also avoid relapses. Keeping good records will enable the efficacy of treatment regimes to be assessed.

In-contact calves may also benefit from treatment, due to sub-clinical disease. Discuss this with the vet before undertaking any BRD treatment programme.
Vaccination top tips

Vaccines sold in the UK are proven in terms of efficacy and safety and are valuable tools for the prevention of infectious diseases. Despite this, money spent on vaccines can be wasted if the manufacturers’ instructions are not followed precisely because they will not provide full protection.

Store and handle correctly

Vaccines are particularly vulnerable to temperature damage. There is little margin for error so vaccines must be kept in reliable fridges and kept cool during transit. They must not be used after their expiry date.

Use at the right time

Where a course of vaccination is necessary, this must be completed for it to be effective. Where a booster is required after a year, delaying beyond this will result in vaccine failure.

Timing relative to disease challenge is also important, e.g., BVD vaccination in cattle must be completed ahead of first service to prevent the birth of persistently infected (PI) calves.

Inject correctly

Injecting via the wrong route or with dirty equipment may interfere with vaccine effectiveness.

Consider the health status of the calf

Vaccinating ill or run-down/stressed animals may result in vaccine failure, as will using too many vaccines together. Always seek veterinary advice before combining vaccines or treatments.

For a vaccine to be effective it needs to be used under normal environmental conditions. Effectiveness will be reduced if the animal is under stress, particularly if housed in a poor-quality environment.
The environment in which animals live has a large part to play in optimising health and performance.

The environment in which animals live has a large part to play in optimising good health and performance. There are two routes of influence:

- Impact on the animal
- Impact on the pathogens that cause disease

For example, damp conditions can favour some pathogens as well as affecting animal behaviour and forage quality, which all contribute to the risk of BRD infection.

**Comfort zone**

The lower critical temperature (LCT) of an animal is the temperature below which it has to divert additional energy towards keeping warm. At this point less of the feed consumed is available for growth than at temperatures above the LCT. The immediate impact is to reduce daily liveweight gain because feed efficiency is reduced.

The relevance for BRD is that prolonged exposure to ambient temperatures below LCT becomes a physiological stress on an animal so they are more likely to succumb to disease.

If respiratory pathogens are present in a group of animals where one or more are below their lower critical temperature (LCT), there will be a predictable increase in the risk of BRD.

Table 2 shows that 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 2: Lower critical temperature (LCT) °C of continental bred steers (wind speed 0.5m/s)**

<table>
<thead>
<tr>
<th>Diet quality (MJ/kg DM)</th>
<th>Growth rate (kg/d)</th>
<th>Liveweight (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>100</td>
</tr>
<tr>
<td>9.4</td>
<td>0.50</td>
<td>4.7</td>
</tr>
<tr>
<td>11.3</td>
<td>1.00</td>
<td>-0.8</td>
</tr>
<tr>
<td>13.2</td>
<td>1.25</td>
<td>0.2</td>
</tr>
</tbody>
</table>

**Key environmental factors**

The key environmental factors that can influence the prevalence and severity of BRD are:

- Moisture levels
- Air quality
- Air speed

Temperature can have an influence at particularly low and high temperatures, but is not a consistent factor.

Floor design and bedding contribute to how the three key variables above may be managed.
<table>
<thead>
<tr>
<th>Factor</th>
<th>Condition</th>
<th>Contribution</th>
<th>Signs to look out for*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture</td>
<td>Too much</td>
<td>+ Supports microbial activity</td>
<td>+ Dirty water lying</td>
</tr>
<tr>
<td></td>
<td></td>
<td>+ Promotes bacterial growth (some species)</td>
<td>+ Dirty cattle</td>
</tr>
<tr>
<td></td>
<td></td>
<td>+ Absorbs energy</td>
<td>+ Damp floors in areas that could be dry</td>
</tr>
<tr>
<td></td>
<td></td>
<td>+ Acts as a transport medium for pathogens</td>
<td>+ Water ingress</td>
</tr>
<tr>
<td></td>
<td></td>
<td>+ Increases slippery floors which causes stress</td>
<td>+ Leaking drinkers</td>
</tr>
<tr>
<td></td>
<td></td>
<td>+ Increases lct</td>
<td>+ Condensation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>+ Increases slippery floors which causes stress</td>
<td>+ Staining on underside of roof</td>
</tr>
<tr>
<td></td>
<td></td>
<td>+ Increases slippery floors which causes stress</td>
<td>+ Animal health problems</td>
</tr>
<tr>
<td>Fresh air</td>
<td>Too little</td>
<td>+ Lack of fresh air increases survival time of airborne pathogens</td>
<td>+ Smell of ammonia, dampness</td>
</tr>
<tr>
<td></td>
<td></td>
<td>+ Lack of fresh air increases concentration of gaseous emissions</td>
<td>+ Dark corners – no light, no ventilation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>+ Lack of fresh air can reduce oxygen concentrations</td>
<td>+ Elevated air temperatures</td>
</tr>
<tr>
<td>Air speed</td>
<td>Too much</td>
<td>+ Too much: associated with excessive energy losses</td>
<td>+ Animals avoiding certain areas</td>
</tr>
<tr>
<td></td>
<td>or too little</td>
<td>+ Increases lct</td>
<td>+ Huddling</td>
</tr>
<tr>
<td></td>
<td></td>
<td>+ Too little: associated with lack of fresh air</td>
<td>+ Hairy coat</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>+ High intake/ low production rates</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>+ Animal health problems</td>
</tr>
</tbody>
</table>

* Consider the whole housing season, not only the current situation
Moisture

Moisture is ever-present in animal housing. Many respiratory and intestinal pathogens thrive in moist environments, generally finding it hard to survive in dry conditions. So a primary aim of healthy animal production is to prevent the accumulation of excess moisture (see Table 4).

Table 4: Options for improved moisture management and control – design considerations for existing and new buildings

<table>
<thead>
<tr>
<th>Competent drainage</th>
<th>1 in 20 slopes under straw, channels in floors to intercept excess liquids</th>
</tr>
</thead>
<tbody>
<tr>
<td>Competent ventilation</td>
<td>Heat and moisture are continually produced and must be constantly removed, along with circulating bacteria, viruses and gases</td>
</tr>
<tr>
<td>Dry bedding</td>
<td>To maintain thermal comfort and to absorb excess moisture at animal level</td>
</tr>
<tr>
<td>Sympathetic building materials</td>
<td>Cold surfaces promote condensation, keeping moisture in the building. Tin may be low cost but can be an expensive material in youngstock systems due to poor thermal properties</td>
</tr>
<tr>
<td>No additional moisture</td>
<td>Moisture can be prevented from entering a cattle building by attention to downpipes and gutters, good building maintenance, and keeping groundwater away by sensible drainage</td>
</tr>
</tbody>
</table>

A second problem for UK farmers is that damp environments are invariably cold. Damp conditions increase the rate of heat loss from a warm body, with negative effects on health and performance, particularly for youngstock.

The impact on a calf’s LCT of lying on a damp bed is shown in Table 5. A small calf lying on wet straw diverts energy from growth to maintaining body temperature at a higher temperature than if it was lying on dry straw.

Table 5: Lower critical temperature (LCT) for a calf lying on different surfaces (well-fed and in calm air)

<table>
<thead>
<tr>
<th>Relationship with floor</th>
<th>Lower critical temperature °C for a 50kg calf</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calf lying on dry concrete</td>
<td>17</td>
</tr>
<tr>
<td>Calf lying on dry straw</td>
<td>8</td>
</tr>
<tr>
<td>Calf lying on wet straw</td>
<td>&gt;10</td>
</tr>
</tbody>
</table>

When bedding is damp youngstock spend more time standing up than lying down, with reduced liveweight gain and feed conversion efficiency as a consequence.

Prolonged periods of exposure to damp conditions can also lead to calves becoming more prone to BRD and other infections.

Deep, dry straw has good insulating properties which makes it a good bedding material for young calves.
**Fresh air/air quality**

Providing fresh air for animals to breathe is vital for successful animal production. It not only promotes respiratory health, but also maximises growth rates and feed conversion efficiency.

Aerial transmission is an important route of infection for BRD. The bacterial and viral pathogens involved have to survive moving through the air in substantial numbers to infect new hosts.

One hundred per cent clean, fresh air can kill airborne bacteria and viruses 10–20 times quicker than 50% fresh air.

Providing adequate ventilation is essential for keeping housed calves healthy. For more on ventilation see page 16.

**Wind chill/air speed**

Increased air speed at animal height:

+ Increases the risk of immune suppression

+ Severely increases the negative impact of low temperatures on youngstock

The air temperature at which young calves are physiologically comfortable is seldom applied as a design consideration in UK housing systems.

Table 6 shows that under typical UK winter conditions, air temperature will be below the LCT of young calves. Furthermore, the LCT increases when an animal is exposed to drafts.

**Table 6: Effect of air speed and calf weight on the LCT of a standing calf**

<table>
<thead>
<tr>
<th>Calf weight</th>
<th>Lower critical temperature (LCT) °C at two different air speeds</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.2m/s</td>
</tr>
<tr>
<td>35kg</td>
<td>+9</td>
</tr>
<tr>
<td>50kg</td>
<td>0</td>
</tr>
<tr>
<td>100kg</td>
<td>-14</td>
</tr>
</tbody>
</table>

The longer an animal is exposed to environmental conditions below the LCT, the greater the risk the animal’s immune system will be depressed, increasing the risk of disease.

Table 6 shows even a small increase in air speed at animal height increases LCT significantly, and is even more of a thermal stress than lying on a wet bed.

Note the air speed applied in the research reported here is at 2 metres per second (m/s), which is only half the average air speed around the UK. Higher air speeds in a draft will increase the negative effect.

Ideally air speeds should not exceed 0.5m/s, because of the effects on increasing LCT and increasing stress. However, this may not always be possible and a maximum of 2m/s may be a more practical higher air speed limit, particularly for animals above six months old.

Use windbreak material to protect large openings.
Design detail – ventilation

The competence of the ventilation system is a key factor in managing moisture. The absolute requirements of a ventilation system are:

+ Removal of foul air containing gases, odours, dusts and airborne bacteria/viruses
+ Removal of excess water vapour
+ Removal of excess heat (energy)
+ Introduction of clean fresh air

And

+ To provide all the above across the whole area of a building, whilst preventing the introduction of additional moisture (as rain) and excessive air speeds (wind)

The design requirements are not easy to achieve given that most buildings have no moving parts except the doors, the weather is changeable and can come from all directions, and the internal conditions including numbers and weight of animals constantly change.

However, a few basic rules can be applied to assess whether the ventilation of a building is providing a healthy environment for the animals living inside it.

+ There is an absolute requirement for an outlet in the roof to let warm, moist, foul air escape
+ Rule of thumb: outlet area needs to be 0.04M² per calf and 0.1M² per growing or adult animal
+ Outlets work well at ridge height, but can be spread across the roof area
+ Inlet area, ideally spread across both sidewalls, needs to be twice the outlet area (minimum), and ideally four times the outlet area
+ Inlet area must be able to control air speed, ie reduce wind speed
+ Gap size in spaceboard should never exceed 25mm (1 inch)
+ Air speed must be controlled at animal height
The stack effect

Most UK cattle buildings have natural ventilation, meaning they are ventilated by wind energy most of the time. But when wind speeds drop, it is essential for a building to be able to ventilate itself by the ‘stack effect’ (Figure 1).

This occurs when an accumulation of warmer air, from the body heat of the animals, is able to rise and leave a building, drawing clean fresh air into the building through the side inlets.

Figure 1: The stack effect inside a naturally ventilated building

To allow this to happen, it is essential to have an adequate outlet area in the roof. If there is no hole in the roof or this is not big enough, heat, moisture and foul air will accumulate inside the building faster than they can leave. The resulting environment will be perfect for bacterial and viral survival, which is why there is a clear association between BRD incidence and still, damp weather.

The precise detail of ventilation areas in cattle buildings is refined by attention to the slope of the roof, stocking density, liveweights and building materials. However, the rules of thumb expressed above are robust enough for assessing whether the current ventilation within a building is increasing the risk of BRD. A method for calculating the exact area of outlet for any naturally ventilated cattle building is shown in the Appendix A1.

Inlet designs

Well-designed inlets have two principle design requirements.

Firstly, they allow adequate fresh air in along both sidewalls of the building so that the exit of stale air through the roof is not restricted.

Secondly, inlets should reduce wind speed at animal height so that draughts and excessive heat loss do not occur.

Whilst large single inlet areas such as open gates and doors may provide sufficient fresh air to an area within a building, they are not suitable for controlling wind speed across the animals. Note that uncontrolled air speed at animal height is only likely to be beneficial in the UK during warm, summer months.
Outlet designs

The outlet area is best provided by a narrow opening (Figure 2: width Y) along the length of the ridge, 150mm (6 inches) to 350mm (14 inches) wide dependant on stocking and building design. For accurate requirements refer to Appendix A1. The wider the opening the more likely rainwater is to come in. In this case a covered open ridge (shown in Figure 2) is appropriate. A ridge like this should also be used above cubicles or anywhere rainwater entry could be a problem.

Figure 2: A covered open ridge

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

An open ridge (see Figure 3) is usually between 200–350mm (8–14 inches) wide and should be unrestricted.

Figure 3: An open ridge

The lightridge or similar design, is a useful ridge 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.

Slotted roofs, where roof sheets are inverted and fitted with a space of around 10-20mm between each adjacent side sheet, can be very useful, particularly where housing 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 uses.

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

The floor must provide a safe durable base to the pen and surrounds which can be cleaned effectively. It should have a non-slip surface but not be abrasive to the animals’ feet. In terms of supporting a healthy environment for BRD the key factor relating to floors is drainage. The target is either:

- To keep all the moisture under the bedded area
- To allow excess moisture to be channelled away from bedding and livestock

Health problems arise when moisture accumulates at floor level or on the bedding surface. Pooled liquid adds moisture to the air in the building, increases bedding costs, and creates a colder surface for animals to lie on.

For a young animal, damp bedding may take it below its LCT, bringing the risk of suppressed immunity. Damp bedding and cubicles also provide a supportive environment for the proliferation of bacteria and viruses.

Good flooring design takes into account where excess water might accumulate:

- Around water troughs
- Within 2–3 metres (6.5–10Ft) of an automatic calf feeder
- Along the front of single calf pens

These areas should be provided with additional slope and channels to specifically gather and remove excess liquid from the animals’ environment.

Naturally a calf wants to spend more time lying down than standing up. A dry bed is essential to maintain health and minimise stress levels. The aim should be to provide competent floor drainage under straw by:

- Having drainage channels to collect and carry away excess moisture
- Having a porous surface under the straw, such as slats or hardcore
- Regular bedding up

Use the best straw on the unit for bedding youngstock. Damp bedding materials reduce thermal comfort, do not absorb urine well, and contain large concentrations of mould spores and toxins. Dusty, mouldy materials in bedding are a risk factor for BRD.

Note: straw choppers should not be used in buildings with stock below three months of age, as the normal clearance mechanism of the lungs in these animals is not fully developed. Straw choppers should also be used with caution where older stock are showing respiratory symptoms.
Troughs and feeders

The role of troughs and feeders in the spread of respiratory disease is not well understood. However, it has been shown that the virus causing IBR can survive for 30 days inside them.

So these essential facilities, which act as focal points of contact between all animals in a group, pose a high risk for pathogen transfer. The aim should be for routine cleaning to remove contamination.

There is also a high risk of disease spread with the use of automated calf feeders. Whilst the cleaning systems of the machines are very good, the design and cleanliness of the immediate environment of the machine must not be overlooked.

Hygiene

Cleaning is very important, requiring the right materials and the right amount of time to do the job. There should be zero tolerance to poor hygiene for youngstock.

The most important part of a good hygiene policy, especially in modern production systems, is time – not only to carry out the work, but also to allow floors, pens, fittings and utensils to dry after wetting.

Allowing to dry for a short period helps kill bacteria and viruses that survive the active cleaning process, and is a vital part of biosecurity.
Pathogens

Main agents

Bovine respiratory disease is a complex problem. It is not caused simply by the introduction of a specific infectious agent into a susceptible group of animals. Indeed many of the causal agents are often already present in the animals.

Frequently respiratory infection results from the calf becoming infected with a primary agent first, usually a virus; then the resulting lung damage allows a secondary bacterial infection to develop.

Table 7: The main agents of BRD

<table>
<thead>
<tr>
<th>Bovine Respiratory Disease - main agents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Viruses</td>
</tr>
<tr>
<td>• Parainfluenza virus (PI3)</td>
</tr>
<tr>
<td>• Bovine respiratory syncitial virus (RSV)</td>
</tr>
<tr>
<td>• Bovine Herpes Virus-1 (IBR)</td>
</tr>
<tr>
<td>• Bovine Viral Diarrhoea (BVD)</td>
</tr>
<tr>
<td>Bacteria</td>
</tr>
<tr>
<td>• <em>Histophilus somni</em></td>
</tr>
<tr>
<td>• <em>Mannheimia haemolytica</em></td>
</tr>
<tr>
<td>• <em>Pasteurella multocida</em></td>
</tr>
<tr>
<td>Mycoplasma</td>
</tr>
<tr>
<td>• <em>Mycoplasma dispar</em></td>
</tr>
<tr>
<td>• <em>Mycoplasma bovis</em></td>
</tr>
</tbody>
</table>

Table 8 outlines the common disease syndromes. Disease patterns exhibited are often different in suckled beef calves compared with dairy calves.

Table 8: Common respiratory disease presentations and likely disease agents

<table>
<thead>
<tr>
<th>Management group</th>
<th>Clinical syndrome</th>
<th>Likely pathogens</th>
</tr>
</thead>
<tbody>
<tr>
<td>Housed dairy-born calves less than six months old and housed suckled calves born indoors and housed from birth</td>
<td>Severe acute pneumonia</td>
<td>RSV, PI3, <em>M. bovis</em>, <em>H. somni</em>, <em>M. haemolytica</em></td>
</tr>
<tr>
<td></td>
<td>Chronic coughing</td>
<td><em>Mycoplasma spp.</em></td>
</tr>
<tr>
<td>Suckled calves at foot housed after summer</td>
<td>Severe acute pneumonia</td>
<td><em>M. haemolytica</em>, RSV, PI3, <em>H. somni</em></td>
</tr>
<tr>
<td>Housed weaned suckled calves</td>
<td>Acute upper respiratory tract disease</td>
<td>IBR</td>
</tr>
<tr>
<td>Housed weaned dairy-bred calves after summer</td>
<td>Severe acute pneumonia</td>
<td>RSV, PI3, IBR, <em>M. bovis</em>, lungworm</td>
</tr>
</tbody>
</table>
Although the main viral pathogens of BRD are potentially well controlled with vaccines, other pathogens are emerging with increased significance for which there is currently no vaccine available.

Lungworm (*Dictyocaulus viviparus*), may be responsible for severe outbreaks of BRD in animals which were exposed to high levels of worm challenge at pasture. Proactive control is available through the use of a pre-turnout oral vaccine, or through a strategic use of wormers as part of herd health planning.

The bacterial causes of BRD include *Mannheimia haemolytica, Pasteurella multocida, Histophilus somni* and *Mycoplasma spp.* This last group are bacterial pathogens that can play a role in a number of cattle diseases such as BRD, arthritis and mastitis, but are often underestimated and less well monitored than other causes.

*Mycoplasma spp.* are widespread and can be present in the respiratory tracts of non-BRD animals, with implications for those purchasing cattle. Transmission of disease is via nasal shedding and spread on contaminated objects such as clothing and equipment. However, the bacteria cannot survive for long outside the host, so spread is more likely where there is direct, close and repeated contact with other animals.

Infection can cause mild disease in uncomplicated cases or acute respiratory signs in more severe infections. Infected cattle can also shed and act as reservoirs for the bacteria whilst often appearing clinically healthy. These animals are often associated with chronic infection and relapse due to unresolved lung lesions.

There are currently no vaccines licensed for use against *Mycoplasma spp.* in the UK and treatment is continually threatened by antimicrobial resistance. Early recognition and prolonged therapy is therefore necessary, keeping a close eye on the possible development of antimicrobial resistance. Screening purchased stock to prevent buying this pathogen into a herd, together with good management of animals and their environment is essential.

A better understanding of biosecurity and how to support animals’ immune defences is vital to minimising the effects of BRD.

### Post-outbreak actions and repeat cases

Following an outbreak of respiratory disease, two principal objectives are to:

- Resolve the consequences of the outbreak on the affected animals
- Investigate to inform future management decisions

Although many animals may apparently recover completely, feed conversion efficiency may be affected which reduces daily liveweight gain. Furthermore, some affected animals may suffer a relapse of clinical signs and require repeated treatments.

Chronic cases become uneconomic and represent a risk to unaffected animals. They should be isolated in hospital facilities and culled if they respond poorly to treatment. Investigating outbreaks should be carried out in partnership with the farm vet. The aim is prevention of respiratory disease and to assess if specific measures such as targeted vaccination programmes or building improvements, may be appropriate.
Pneumonia MOT

There are a number of areas of management that can affect the incidence of respiratory disease on a farm. This check list provides guidance on identifying problem areas.

<table>
<thead>
<tr>
<th>Action</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trace element profiling</td>
<td>Deficiencies or excessive levels of trace elements can be responsible for impaired immune performance; especially vitamin E and selenium.</td>
</tr>
<tr>
<td>Ask vet to take blood tests for copper, cobalt, vitamin E and selenium from seven to ten month old youngstock (eg six to ten healthy animals, on grass at the end of the summer).</td>
<td></td>
</tr>
<tr>
<td>Body condition scoring (BCS)</td>
<td></td>
</tr>
<tr>
<td>Manage dry cows and heifers to ensure correct body condition at calving, and throughout the year.</td>
<td>Aim for BCS 2.5-3.0 for spring-calvers and BCS 3.0 for autumn-calvers at calving. Ideally the cows should be in correct body condition six weeks before calving.</td>
</tr>
<tr>
<td>Growth rate of calves</td>
<td>Growth rates lower than 0.7kg/day indicate sub-optimal nutrition or health. Growth rates higher than 1.3kg/day indicate increased susceptibility to BRD. Note that fast growing double-muscled cattle tend to be more susceptible to BRD than less muscular cattle.</td>
</tr>
<tr>
<td>Weigh calves regularly to calculate growth rate.</td>
<td></td>
</tr>
<tr>
<td>Environment/Housing</td>
<td></td>
</tr>
<tr>
<td>Bedding</td>
<td>The bedding should not be wet or make a noticeable squelch when a welly boot is lifted up. Supply plentiful, clean, dry bedding.</td>
</tr>
<tr>
<td>Is the bedding clean/dry/sufficient?</td>
<td></td>
</tr>
<tr>
<td>Design and dimensions</td>
<td>The required outlet area depends on the stocking density (kg LW/m²), the average animal weight in kg, and the difference in heights between the inlets and the outlets.</td>
</tr>
<tr>
<td>Ensure adequate air inlet and outlet areas.</td>
<td>To calculate required outlet and inlet areas see calculations in Appendix A1.</td>
</tr>
<tr>
<td>Are any water leaks evident?</td>
<td>Avoid water leaks from gutters and water troughs.</td>
</tr>
<tr>
<td>Ventilation</td>
<td>Observe smoke to identify good and poor areas of ventilation within a building. The smoke should ideally travel up and out of outlet areas. Slow movement throughout the building indicates a high risk for transfer of pathogens from one affected animal to an entire group due to poor air flow.</td>
</tr>
<tr>
<td>Ignite at least two to three smoke emitter pellets at different points within a building, not just at entrance/exit points affected by door ventilation. Measure smoke clearance times. Observe smoke clearance patterns.</td>
<td>The rate of clearance crudely indicates how frequently air is being changed within a building. Smoke should clear in 30−45 seconds.</td>
</tr>
<tr>
<td>Observe general cleanliness of the building, eg cobwebs/dust etc.</td>
<td>Obvious cobwebs or dust build-up are a clear sign that ventilation is inadequate with insufficient air changes occurring.</td>
</tr>
<tr>
<td>Humidity</td>
<td>Relative humidity levels below 75% are key to reducing spread of disease.</td>
</tr>
<tr>
<td>Assess humidity by looking for signs such as rusting and stained roof structures.</td>
<td>Dark stains on purlins or roof sheets, and corrosion on steelwork indicates excess humidity.</td>
</tr>
</tbody>
</table>
**Draughts**

Measure air speed at calf level at multiple points in the shed if possible and use smoke pellets to observe smoke patterns. Observe bedding.

Ideally air speeds should not exceed 2m/s. There should be air movement but NOT draughts. Air speeds over 1m/s need to be controlled for youngstock < 100kg. Air speeds over 2m/s will impact on youngstock (<300kg) growth rates in cold weather. Air should not be able to move bedding.

**Stocking rates**

Measure area of building (length x width). Record number of animals in each weight range. Then calculate m²/head.

Eg 325m² shed area containing 50 x 400kg cattle = 6.5m² per head.

For benchmarks see Appendix A2.

**Pathogen**

**Blood tests**

Ask the vet to blood test for IBR, BVD, RSV, PI3, *Histophilus somni*, *Mycoplasma bovis*, as appropriate.

Blood sampling cohorts of youngstock that are eight to fourteen months old and are unvaccinated, can reveal current herd health status for infectious diseases.

By this age circulating antibodies that were passively transferred from dams via colostrum have disappeared. This means any antibodies detected represent pathogens currently encountered by the animals in the herd if homebred, or also from the herd of origin and in transit if purchased.

**Faecal sampling**

Test faeces for liver fluke, enteric worms, coccidiosis, lungworm, as appropriate.

Faecal samples can identify the presence of parasitic pathogens and how large the burden may be.

Some pathogens such as lungworm (*dictyocaulus vivparus*) may represent a direct challenge to respiratory health. Others such as coccidia and liver fluke compromise immune function.

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**Appendix – Pneumonia MOT Reference Tables**

**A1: Ventilation calculations**

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

Insert your own figures in the tables below.

**Step 1.**

The calculations are shown for the example building:

- **Building length** = 22.86m [A]
- **Building width** = 18.29m [B]
- **Floor area** = A x B = 418m² [C]
- **Stocking density** = 46 cattle [D], at average 400kg LW

Where a range of animal weight occurs, use an average weight. Where there are suckler cows and calves, again use an average weight but consider calves at their heaviest weight. Similarly for growing animals use the expected maximum liveweight that the building will be required to house.

**Floor area per animal** = 418m² [C] ÷ 46 [D] = 9m² per animal [E]

**Ventilation calculation key**

- [A] = Building length
- [B] = Building width
- [C] = Floor area of the building
- [D] = Number of animals
- [E] = Floor area each animal has
- [F] = Outlet area in the roof per animal
- [G] = Eaves to ridge height difference
- [H] = Building height factor
- [I] = Outlet area required
Step 2.

Outlet area per animal - (use Figure A1a to calculate)

Read along the horizontal axis of the graph in Figure A1a to the floor area/animal [E] and find the line for the relevant weight of animal. Read across to the vertical axis.

| For example, a floor area of 9m²/animal at 400 kg average liveweight requires an outlet area in the roof per animal of 0.12m² [F] |

Step 3.

Eaves to ridge height difference (use A1b below or use own measurements)

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

To calculate the height difference between the eaves and the ridge of a building, either make own measurements, extract the measurement from building plans, or estimate by counting reference points in the gable ends, such as rows of blocks. An alternative is to estimate the slope of the roof and use the multiplier for roof slope in Figure A1b.

Figure A1b Multiplier to estimate roof height difference [G] from roof slope

<table>
<thead>
<tr>
<th>Roof slope</th>
<th>Multiplier</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 degrees</td>
<td>0.176</td>
</tr>
<tr>
<td>12 degrees</td>
<td>0.213</td>
</tr>
<tr>
<td>15 degrees</td>
<td>0.268</td>
</tr>
<tr>
<td>17 degrees</td>
<td>0.306</td>
</tr>
<tr>
<td>20 degrees</td>
<td>0.364</td>
</tr>
<tr>
<td>22 degrees</td>
<td>0.404</td>
</tr>
</tbody>
</table>

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.

Outlet area required (use Figure A1c to calculate)

Read along the horizontal axis of the graph in Figure A1c to the height difference of the building. A height difference of 2.8m (the horizontal axis of figure A1c) corresponds to a height factor (on the vertical axis of figure A1c) of 0.60 [H]

The actual outlet area required [I] for this example is:

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

Outlet area required is 0.12m² [F] x 0.60 [H] x 46 [D] = 3.31m² [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 ridge gap is 3.31m² [I] ÷ 22.86 [A] = 145mm

The inlet area, ideally split evenly across the two sidewalls is an absolute minimum of twice the outlet area and better at four times the outlet area. In this example, the inlets should be 145-290mm across each side wall. Use the lower figure for youngstock and for exposed sites.
Figure A1a: Outlet area per animal [F]

Figure A1c: Building height factor [H]
**A2: Housing space allowance guidelines**

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

**Table A2a: Loose housing (Red Tractor Assurance Standards 2011)**

<table>
<thead>
<tr>
<th>Liveweight (kg)</th>
<th>Solid floors (m²/head)</th>
<th>Slatted floors (m²/head)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Bedded area</td>
<td>Total area (incl. feeding and loafing)</td>
</tr>
<tr>
<td>Suckler cows</td>
<td></td>
<td></td>
</tr>
<tr>
<td>400</td>
<td>3.50</td>
<td>4.90</td>
</tr>
<tr>
<td>500</td>
<td>4.25</td>
<td>5.85</td>
</tr>
<tr>
<td>Growing/finishing cattle and youngstock</td>
<td></td>
<td></td>
</tr>
<tr>
<td>200</td>
<td>2.00</td>
<td>3.00</td>
</tr>
<tr>
<td>300</td>
<td>2.75</td>
<td>3.95</td>
</tr>
<tr>
<td>400</td>
<td>3.50</td>
<td>4.90</td>
</tr>
<tr>
<td>500</td>
<td>4.25</td>
<td>5.85</td>
</tr>
<tr>
<td>600</td>
<td>5.00</td>
<td>6.80</td>
</tr>
</tbody>
</table>

**Table A2b: Cubicle dimensions (Red Tractor Assurance Standards 2011)**

<table>
<thead>
<tr>
<th>Liveweight (kg)</th>
<th>Dimensions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Length (m)</td>
</tr>
<tr>
<td>Cows</td>
<td></td>
</tr>
<tr>
<td>400 - 600</td>
<td>2.4</td>
</tr>
<tr>
<td>Over 600</td>
<td>2.5</td>
</tr>
<tr>
<td>Growing/finishing cattle and youngstock</td>
<td></td>
</tr>
<tr>
<td>75 - 150</td>
<td>1.2</td>
</tr>
<tr>
<td>150 - 250</td>
<td>1.5</td>
</tr>
<tr>
<td>250 - 375</td>
<td>1.7</td>
</tr>
<tr>
<td>Over 375</td>
<td>2.1</td>
</tr>
</tbody>
</table>

**A2c: Bedded area allowances for suckler cows and calves (excluding creep area) (BS5502: Part 40*)**

<table>
<thead>
<tr>
<th>Cow weight (kg)</th>
<th>Bedded area per single cow and calf</th>
<th>Slatted area per single cow and calf</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Bedded (m²)</td>
<td>Total (m²)</td>
</tr>
<tr>
<td>Up to 500</td>
<td>3.75</td>
<td>5.00</td>
</tr>
<tr>
<td>500 to 600</td>
<td>4.05</td>
<td>5.50</td>
</tr>
<tr>
<td>Over 600</td>
<td>4.35</td>
<td>6.00</td>
</tr>
</tbody>
</table>

**A2d: Bedded area allowance for group housed calves**

<table>
<thead>
<tr>
<th>Calf weight (kg)</th>
<th>Minimum area² (m²)</th>
<th>Recommended# (m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Under 150</td>
<td>1.5</td>
<td>2.0-4.0</td>
</tr>
<tr>
<td>150 to 200</td>
<td>2.0</td>
<td>5.0</td>
</tr>
</tbody>
</table>


# Source: NADIS Calf Housing. Ian Ohnstad (2013)

**Table A2e: Bedded area allowances for calves in calf creep (BS5502: Part 40*)**

<table>
<thead>
<tr>
<th>Calf weight (kg)</th>
<th>Area per calf (m²/head)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 250</td>
<td>2.5</td>
</tr>
<tr>
<td>400</td>
<td>3.8</td>
</tr>
</tbody>
</table>

Note: It is acceptable to interpolate between 250 and 400kg but not outside this range
