Optihouse

Calf House Design Guide

Housing Calves from birth to 14 days post weaning

afbi AGRI-FOOD & BIOSCIENCES INSTITUTE

AgriSearch NI Driving Excellence & Innovation

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PROJECT BACKGROUND

The AFBI Optihouse project was a research project funded by the Department of Agriculture and Rural affairs (DAERA). The objectives of the project were to:

- Gain a better understanding of calf rearing houses within Northern Ireland and key factors linked to poor environmental conditions and failure to deliver expected performance
- Improve understanding of the impacts and interactions between level/type of calf nutrition, management and environmental conditions
- Development and quantification of benefits of independently and robustly proven fixes to existing common calf house designs and rearing systems in Northern Ireland

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- Development of blueprints for new modern and existing calf housing that would maximise delivery on both calf and producer considerations.

The Optihouse project originated from a widespread appreciation that the vital early development stage of dairy calves has not been supported by good calf house design. Gaining a better understanding of conditions in NI calf rearing houses alongside management and hygiene within rearing systems will ultimately improve calf performance, health and welfare. To gain an understanding of on farm conditions, 66 Northern Irish farms were involved in the project. Aspects observed included hygiene of bedding and water, ventilation within calf houses, pen sizes and drainage. From these observations, modifications to calf housing were recommended to improve housing quality.

The information presented within this booklet is provided as a guide to the design and construction of calf housing. The information is based on the known requirements for calves, and the limits of their environment that can help to maintain them in a healthy and productive state. The calf house design guide is one of the outcomes of the interaction of AFBI, DAERA, CAFRE, QUB and the collaborating producers on the Optihouse project.

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TOP TIPS

Ventilation/Draught Reduction

- The principle requirements are to provide a clean, dry and well ventilated environment for calves, with a complete absence of draughts.
- Ventilation is typically provided by the wind. The prevailing wind direction may occur for 2/3rds of the year, but the wind comes from every point of the compass at some time during the year.
- Fresh air delivery at pen level without a draught/increased air speed is a key target. A draught is an air speed above 0.2 m/s.
- The minimum area requirements for outlet in the roof and the inlets in the sidewalls are easy to calculate; a balanced design is most effective.
- Many or most calf houses will benefit from positive pressure tube ventilation (PPTV) to en sure fresh air supply 24/7, and is very cost effective. Ensure competent design.

Calf Pen Dimensions/Design

- The calf house should have sufficient facilities for the maximum number of calves aged from birth to 14 days post weaning expected at any time of the year, plus one empty pen.
- Pen dimensions: define preferred feeding system, then select group size.
- Group size dictates optimum pen area at maximum body weight, and minimum pen width for feeding.
- The number of pens should not include provision for older animals in the same airspace; this always increases the risk of disease spread.
- Calves from birth until 2-3 weeks old will be predictably cold during the winter months. Large volume buildings of concrete and steel are not supportive of good performance and health.
- Modern calf systems are making greater use of plastics, insulation, and mineral fibre roof materials.

Hygiene/Drainage

- Hygiene is compromised by lack of time and space to clean individual pens effectively; design pens to be easily cleaned.
- Consider a calf kitchen area to make the preparation, delivery and cleaning of the feed system a safe and efficient routine process.
- The dryness of a building relies on good drainage in the right locations, and effective ventilation.
- Pen floors should have a minimum 1 in 60 slope for effective drainage after cleaning and an optimum 1 in 20 slope for drainage under straw. Pens should slope towards a simple channel drain located immediately outside the pen front.

CALF HOUSING DESIGN

Calf Housing Location

The location of calf housing is extremely important in order to make it possible to manage airflow within the building. Sheds in exposed locations will require significant draught reduction measures in order to maintain optimal calf house temperature.

Findings from the Optihouse project indicated that **52% of buildings for calves also contained older animals within the same air space.**

This is not ideal as it means calves can be exposed to biological aerosols from older animals which have the potential to cause disease.

The optimum location for calf housing is in a standalone building located upwind of growing and adult cattle and at right angles to the prevailing wind. This will mean that the building is exposed to natural fresh air delivery and can be designed to facilitate air changes but reduce air speeds within the building.

Building construction

The design and materials used for calf housing was massively varied on farms in the Optihouse project. **Concrete pen walls were used on 49% farms, whilst 77% farms used tin as roofing material.**

Buildings with high thermal mass from lots of concrete and steel will stay cooler and damper in UK winter weather conditions than buildings with low thermal mass. Plastics and tubular steel have lower thermal mass than concrete and steel.

Tin cladding, especially as a roofing material, will significantly increase the amount of condensation in a livestock building compared with mineral fibre or other material with a higher U-value such as plastic or insulated sheet.

All materials used within the zone of the calf (floor, pen wall, drains) should be easy to clean, and easy to maintain.

All materials and finishes used in the animal zone must not cause harm by mechanical damage, such as sharp edges, slippery floors.

Roof material should be mineral fibre or similar, with a minimum 15 Degree pitch. If the pitch is less than 15 Degrees, it can cause air to be redirected downwards which leads to draughts.

Building volume per calf is often cited as a major design feature as detailed in Table 1 below.

Table 1. Building volume required for different calf weights from BS5502 Part 40, 2005

Live weight range (kg)	m^3 per head
Up to 50	6
50-84	10
85-140	13
140-200	15

However, this is secondary to the fact that it is the quality and effectiveness of fresh air delivery across all pen areas that is the major design feature, not volume per head.

General construction guidance for livestock buildings can be found in Buildings and structures for agriculture: Code of practice for design and construction of cattle buildings (BS5502 parts 20, 21, 23, 40).

Figure 1: Housed calves on straw

Calf House Flooring

In the Optihouse project 23% of pen floors had a slope that would facilitate drainage after washing and 66% of floors had no slope. 84% of straw bedding was above the minimum guidance dry matter content of 75% DM.

Dry bedding is essential to help insulate calves. Results from the Optihouse project showed that where bedding dry matter was greater than 70%, calves gained an average of 70g more weight per day.

Floors must provide a secure grip, non-slip surface that can be provided by a heavy brush finish on newly laid concrete.

Concrete specification for flooring is C30.
The correct materials ratio is 1:2:3 = cement, sand, gravel, for strong, durable concrete.

Concrete floor thickness 100 mm, unless heavy machinery will be used or underlying ground is not dependable, when 150 mm is recommended.

Calves less than 4 weeks old should not be housed on totally slatted floors. Restrictions in quality assurance scheme specifications should be checked as non-slatted areas may be an essential requirement for all calves, for example Red Tractor Dairy Guidelines indicate that calves up to 200kg should have access to a non-slatted lying area. Rubber covered slats may offer increased comfort compared with plastic or concrete slats.

Table 2. Range of floor slopes recommended for calf housing

Floor slope	
1 in 60	adequate for cleaning out
1 in 40	good for feed storage areas
1 in 20	drainage under straw

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Pens should drain from the back to the front of the pen, with a channel drain perpendicular to the slope, immediately outside the pen.

Channel drains need to be easy to keep clean and a simple means of flushing the drains may be useful.

Where some or all of the floor area is used for individual or double pens of calves, there should be local drainage immediately in front of lines of pens to prevent dirty liquor spreading across the floor area outside the pens.

In calf systems where all calves are started in single/double pens and then moved into group pens, one or more bays of a building can have floor drainage suited for two rows of pens per bay.

Drainage for rows of single/double pens can be provided by making a shallow depression, 75-100m mm wide, in the concrete floor slab during construction.

Floor design might incorporate a concrete plinth for automatic calf feed (ACF) stations with a slope towards a gutter or drain to facilitate regular cleaning. ACFs are commonly located above a small area of slats with a shallow tank beneath.

Drainage of the floor area around an existing feed station can be improved in some pen designs by placing the feed station on a section of concrete grower slats.

Figures 2&3: Examples of good floor drainage

Pen Size

Within the Optihouse project, space allowance per calf was highly variable due to stocking rate at the time of the visits and the different systems used across farms.

The average space allowance for calves in individual pens was **1.5m²** (ranging from **0.9 – 3.2m²**) and **3.4m²** for calves in group pens (ranging from **1.3 – 8.7m²**).

Bedding material from pens with space allowance >2m²/calf was more likely to be within target range for coliforms.

Pen size needs to be related to group size. Group size needs to be related to feeding system which may require, for example, ample length of pen front to allow all calves to feed side-by-side at the same time.

For example, Red Tractor guidelines for individually and group housed calves are detailed below in Table 2. If we consider a group pen for 6 calves up to weaning (i.e. less than 85 kg), then the total area required to meet Red Tractor standards would be 9m², which could be achieved using a 3m x 3m pen.

Table 3. Calf pen space allowances for a range of calf weights

Liveweight (kg)	Space Allowance per calf	Type of Housing
<60	1m x 1.5m	Individual
60-80	1m x 1.8m	Individual
50-84	1.5m²	Group
85-140	1.8m²	Group
140-200	2.4m²	Group

As there are several various recommendations for space allowance requirements, if you are in a specific assurance scheme it is important to check the guidelines. Some alternatives to the Red Tractor guidelines are detailed in Table 4.

Table 4. Alternative space allowance guidelines

Source	Weight class (kg)	Area required per calf (m²)
RSPCA	<100 (female)	3.3
RSPCA	<100 (male)	2
NADIS	<150	2.0 - 4.0

Figure 4: Example of well designed group pen space

Figure 5: Calves in large group pen

Figure 6: Well designed individual calf pens

Pen Detail

A variety of different pen types and details were used throughout the farms on the Optihouse project.

Bedding material from pens with better drainage scores, which takes into account condition of flooring, was more likely to be within target range for coliforms.

Pen walls, floors and divisions should be easy to clean to limit bacterial load – cracked or porous surfaces can be difficult to clean and disinfect properly. Investing in pens that are easily cleanable (e.g. plastic) or rendering walls and covering with an epoxy resin paint can be particularly useful in making the cleaning process more efficient and effective. Pens should always be thoroughly cleaned between calves or groups of calves to limit the spread of bacteria.

Solid pen divisions reduce the risk of disease transmission and draughts at calf height, however, they can also interfere with the dispersion of fresh air into all pens. Ensuring adequate air dispersion is often achieved by having slatted bar pen hurdles, or if using plastic pens, there is often a window on the side panels which can open or shut depending on requirements. As there is a legal requirement for all calves to have direct visual contact with another calf, these features also help to ensure that this requirement is met.

Group pens with teat feeders should permit easy access for the stockperson to help all calves in the group to access a teat. Feed and water troughs should be at an appropriate height for calves and should be located at the front of the pen to allow ease of checking and cleaning. A trough for dry feed should be located more than 2 m from a drinker to reduce the amount of feed that ends up in the drinking bowl. Calves up to 5 weeks of age need minimum 300mm, optimum 350mm feeding space at a feed fence

Provide a trough or rack feeder for good quality chopped straw.

Figure 7: Calf troughs that can be easily cleaned

Figure 8: Plastic wall coatings to reduce cleaning time and bacterial load

Figure 9: Solid wall divisions held to reduce draughts and disease transmission

Figure 10: Large rack for supplying calves with straw

Hygiene

Only 30% of pens in the Optihouse project were rated as easy to clean. Choosing designs and materials that make cleaning easier and making some simple SOPs will help ensure that cleaning is done regularly.

Effective hygiene is a basic design requirement for calf pens and calf buildings. If buildings are not going to be used on an "all-in, all-out" basis, the design must permit effective cleaning of individual pens whilst other pens in the building are still occupied.

All surfaces and joints between surfaces up to 1.4m height should be easy to clean, and preferable sealed.

All wash water from individual pens should drain in such a way as to avoid contamination of other pens. Facilities with drive –through scraped passageways are not suitable for young calf systems.

Covered foot dips located immediately outside isolation and sick pens are strongly recommended to help lower the risk of bacteria being transferred to other pens.

Water

Within the Opihouse project, over 90% of drinking water samples had levels of TVC that were too high. Ecoli and Coliforms, which are linked with faecal matter, were also detected in over 90% of samples.

The source of drinking water (i.e. borewell of mains) had no effect of level of bacterial contamination, this meaning the problem was with cleanliness of drinkers.

Use low volume buckets/containers for water for individual/double penned calves, with daily replenishment. This will ensure water is fresh and facilitates monitoring of water intake.

If using individual buckets, remember that dirty water should be disposed of to drains, not floors.

Water quality into the building should not be an issue with mains water supplies. Water quality from boreholes should be checked for mineral and bacterial levels initially and then annually.

Drinkers should be located below shoulder height of the youngest calf and preferably on the outside of the pen.

The drinker should be easy to clean to local drainage or into a container for external disposal.

Water flow rates are especially important to low volume drinkers; target is 2 l/m.

To allow 10% of calves to have access at one time, trough drinkers should be 300mm per calf. These should be mounted at the front of the pen to make cleaning easier and more regular.

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Figure 11: Good disinfection protocol using foot dips are necessary to maintain good hygiene

Figure 12: Easy to clean, sealed surfaces help to improve calf house hygiene

Ventilation

In the Optihouse project only 9% of calf buildings provided all-round competence of ventilation. The main failings were lack of diffuse inlets in both sidewalls, a lack of sufficient outlet area in the roof, and a lack of supportive mechanical ventilation

The objective is to provide fresh air delivery to all parts of the building, and removal of stale air.

- In naturally ventilated buildings air movement is driven by the wind.
- The target air speed within animal housing is 0.15 m/s to 0.3 m/s.
- Airspeeds within buildings less than 0.1m/s may be considered “airless”, and airspeed more than 0.5 m/s as draughty.
- Air cannot penetrate solid walls.

There will be a predominant wind direction, but the wind comes from all directions at some point during a year. This suggests that competent natural ventilation needs porous cladding above pen height in all four walls.

All ventilation systems need a balance of inlet and outlet. If either is restricted, there cannot be effective ventilation in all pens at calf height.

Aperture size in wall cladding should be less than 25mm, and smaller in exposed locations to reduce air speed at calf height.

Total minimum inlet area in each sidewall, above animal height, should be 0.04m2 per calf.

Large inlet areas are only a problem if incoming air speed is not controlled. In practice large inlet areas need fixed or roller screens that are kept mostly closed unless the opening is protected by nearby structures.

Natural ventilation mostly operates by blowing air in though one sidewall, and out through an opposite wall.

The natural system fails when either wall is solid or partially blocked. When air gains entry into a building at a higher rate than it can easily leave, there will be turbulence and increased air speeds within that building.

Ventilation outlets are required in the roof, above eaves height, to allow warmed stale air to exit the building.

- Outlet area at ridge height = 0.04m² per calf (ballpark).
- Optimum outlet design always has up stands to protect the opening in the ridge whilst providing a negative pres sure at the ridge all the time the wind is blowing.
- Upstand height above ridge height is 75% of the designed width of the ridge outlet.

Figure 13: Well designed calf house with ventilation system

Figure 14: Outlets above eave height are required to release stale air

Positive Pressure Tube Ventilation (PPTV)

Basic minimum ventilation requirement for a building volume is four air changes per hour.

PPTV air intake should be from outside, preferably from the 'cleanest' side of the building. Where the intake is on an exposed site, the preference is to locate the fan intake on the gable end towards the prevailing wind.

The fan air intake should be protected by an external cowl to maintain efficiency and be fitted with a mesh screen. The mesh screen should be routinely cleaned.

The tube design should be provided with knowledge of:

- The length and width of the building
- The eaves and ridge height (to give building volume)
- The number of calves
- The location of the pens within the floor area
- The height above ground level of the bottom of the tube
- The probable location of the fan across the width of the building.

The aim is to locate the fan at a suitable point in a gable end and also be in line with the location of the duct. The duct will need to miss aspects of the roof supports and remain above the height of machinery used for clean-out.

The tubing used on PPTV is low-cost and should be replaced as it accumulates dirt over time, and repaired immediately if holed or torn. Gaffer tape is suitable and easy.

Hanging a fan inside a building is not recommended. It does not distribute fresh air, but pushes stale air along the trajectory of the air plume. It will aid the sharing of dust, gases and microbes.

Figure 15: Example of a PPTV system in operation

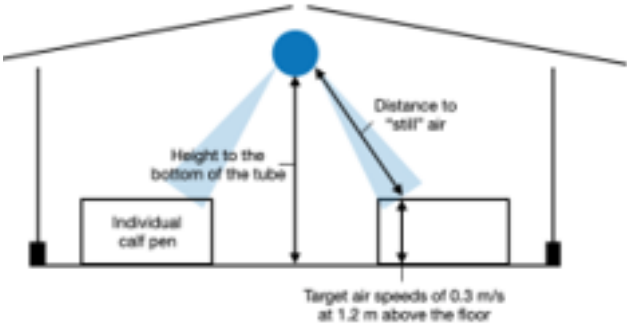


Figure 16: Diagram of the PPTV system concept

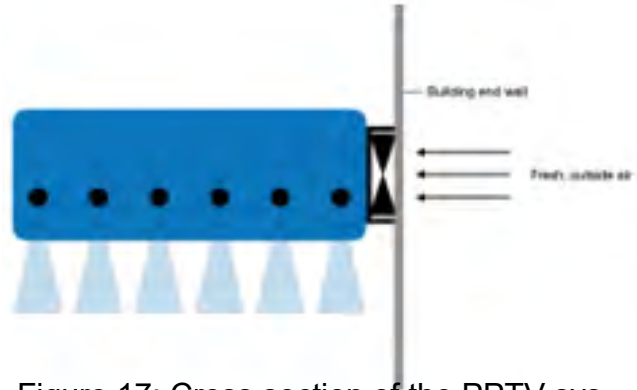


Figure 17: Cross section of the PPTV system concept

Figure 18: Fan and Outlet of a PPTV system

Light

It is important that calves get access to natural light, however including too many translucent materials within the calf house can affect overall insulation, so using 10-15% of roof area as roof lights, and a higher % on north facing roofs is a good compromise.

Where available natural light is not effective, then artificial lighting will be required. Light requirement at calf level is 50 lux, and 300 lux for inspection purposes. Data from other species and for adult cattle is that minimum periods of 'light' per day are beneficial to health and productivity, where 'light' is >200 lux.

Daily periods of darkness are also required, where light is less than 20 lux.

Average light intensity was above 100 lux on 80% of farms within the Optihouse project.

Figure 19: Examples of lighting levels under artificially lit conditions in Lux

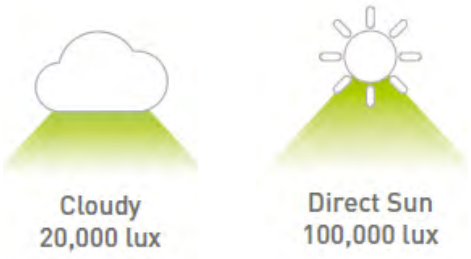


Figure 20: Examples of lighting levels in natural lighting conditions

Heating

In temperatures below 10-15°C, young calves have to use energy from feed to stay warm and this impacts on performance. The Optihouse project found that calves that were housed in temperatures lower than 10°C for more than 50% of the time lost out on an average of 70g/day of potential growth. In order to combat low temperatures 35% of Optihouse farms made use of heat lamps for vulnerable calves.

There is potential to use infra-red or quartz linear heat lamps. Heat lamps should be IP66 rated for moist environments and suspended on a chain, not string, to a height as per manufacturers' instructions. In addition the external insulation of a calf can be improved by use of clean calf jackets as these help to create a microclimate.

Heat lamps can be placed on a ring main with a cold thermostat to maximise efficiency.

Figure 21: Heat lamps are extremely useful for vulnerable calves and in cold conditions

Feed preparation/cleaning area

High bacterial levels were found on feeding equipment and in feed used on farms. Only 38% farms washed milk feeding equipment after each use Failure to clean and disinfect equipment properly can result in transmission of disease causing pathogens to calves as they have a naïve immune system, as such implementing a proper cleaning routine is of key importance to calf health.

A feed preparation area might include:

- All items off the floor to facilitate cleaning
- A sealed floor sloping 1 in 60 to a drain in the floor.
- Adequate racking and shelving for items for immediate use
- A source of heated water, with a volume suitable to provide all hot water requirements within a short period.
- A water heater on a controlled timer so that water is available in the required volume and temperature, at the right time.
- Shelves, racks and wall mounted pegs to allow feed buckets and components to be dried off the floor.
- An area for storage of bagged milk powder and dry feed immediately adjacent to the feed preparation surface, and/or pallets, off the floor.
- A large volume plastic sink or similar with hot and cold water supply for cleaning buckets/teats/troughs as required.
- All sinks or similar to drain direct to waste dirty water system, not to floor.
- Shelves, racks and wall mounted pegs to allow feed buckets and components to be dried off the floor.

Figure 22: Example of a well designed "calf kitchen"

Figure 23: Example of a well designed equipment cleaning area

Automatic milk feeders

The AMF feed station should be placed on a concrete plinth or slope to provide additional, local floor drainage within 2 m of the feeder. This will assist in management of the predictable increase in urination close to the feeder and an increase in localised hygiene/washing around the feeder, if required.

Many AMF will have frequent cleaning cycles of machine components and the teats, and the cleaning water should be directed to underfloor dirty water drainage within or immediately beside each pen.

Dirty water drains are typically 100mm plastic waste pipes connected to an external sump for further export to the farm dirty water system.

The subsurface pipework for clean water supply to AMF machines and water drinkers in pens should also include ducting for the milk delivery pipework between the AMF machines and the in-pen feeders

Figure 24: Well designed drainage for automatic feeders will maintain cleanliness

Figure 25: Well designed floors in feeders will prevent bacteria build up

Figure 26: Automatic feeders should have well designed pipework to direct cleaning water away to drains quickly

Isolation pens.

Isolation pens provide an opportunity for sick calves to be housed away from other calves within the calf house which helps limit the spread of disease and also allows calves to be provided with individual monitoring and treatment where necessary.

42% of farms visited as part of the Optihouse project used sick or isolation pens for calves.

Isolation pens should be available at all times, easy to clean and easy to use.

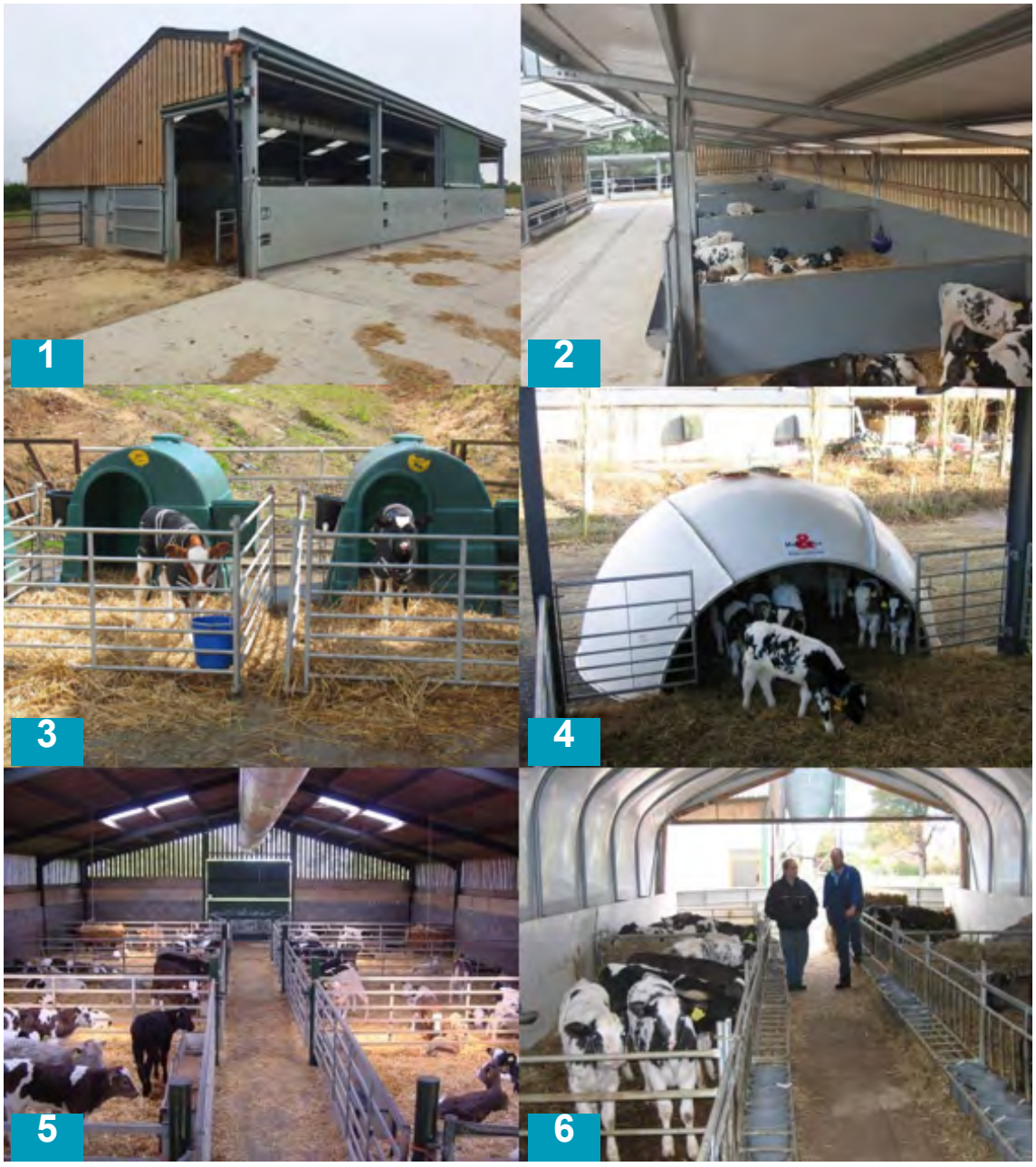
In group housed systems it may be practical to erect an isolation pen in one front corner of the pen. This will make it easy to give individual help but minimise the negative impact of isolation. However, it is preferable for the isolation pen to be outside any shared pen.

Figure 27: Isolation pens reduce disease transmission in group pens

Housing Systems for calves

Housing systems for calves may be grouped into six basic categories.

1. Steel A- frame
2. Mono-pitch
3. Individual / paired Hutches
4. Group hutches / Igloos
5. General purpose building
6. Lightweight structures – such as poly tunnel



1. Steel A Frame

Factor	Benefits	Considerations
Disease control	Excellent if run on an all-in, all -out system (AIAO). Walls and floors easy to clean and disinfect. Adequate falls and good drainage Individual / double / small pens allow low disease transmission Can be made to fit AYR calving.	Group housing increases risk of spread of disease, particularly when stocked constantly. Can lead to inefficient use of space and therefore expensive per calf. Traditional buildings are too often high volume, and more difficult to ventilate effectively.
Ventilation	Newbuild design can maximise natural ventilation. Easy to fit PPTV*.	Will need mechanical ventilation to compensate for low wind speed days.
Shelter	Provides excellent shelter without limiting access to fresh air.	The building can exaggerate weather conditions creating wind tunnels or no air flow due to location next to existing buildings.
Location	Good building design can accommodate most locations. Can maximise labour by consideration of daily tasks at the design stage.	Some locations can increase biosecurity risk. Impaired natural ventilation. Consider labour requirements.
Hygiene	Choice of wall and pen materials has a long term impact on ability to achieve good hygiene levels. Good design will accommodate vehicle access for cleaning.	Hygiene can be compromised if the drainage is poor, surfaces are hard to maintain or hard to clean. Attention to detail when laying floor slab has life-long impact.
Cost	Calf handling and services for inspection, lighting and automation readily available with have a positive impact on variable costs. Efficient use of bedding with low or no ingress of rainwater.	A common issue when a building is considered as multi-purpose is that it can compromise good design for calves. Relatively high capital cost.
Labour	Good logistics if well planned. Working inside during harsh weather. Consumables available at hand.	Challenging to clean mechanically when not used as AIAO system.

2. Mono Pitch

Factor	Benefits	Considerations
Disease control	Similar to steel A-frame. Easy to create a series of smaller spaces. Suitable for AYR calving with suitable protection	Similar to portal frame
Ventilation	If suitably located can obtain maximum benefit from natural ventilation. Low volume air space is beneficial if correctly designed. Easy to fit PPTV.	Not suitable for an exposed site without protection to the front.
Shelter	Considerably better than outside housing for calves, people and consumable costs.	Open front designs will always be compromised by changes in wind direction.
Location	Suitable for most locations. Typically positioned with low sidewall toward the prevailing wind direction. Small build area gives flexibility.	Less suitable for very exposed sites although curtains/ screens will effectively moderate wind impact.
Hygiene	Easy to muck out individual pens; only from the front. Easy to run sections as AIAO.	
Cost	Cheaper than a portal frame. Simple to construct. Easy to start small and add capacity later.	Apparently 'cheap' option but lack of attention to detail is common.
Labour	Similar to portal frame.	Similar to portal frame

3. Individual/Paired Hutches

Factor	Benefits	Considerations
Disease control	Single calves reduce disease risk; small group sizes better than larger groups. Easily moved for cleaning or to a clean site. Hutches can be added to existing systems to reduce overstocking and disease pressure.	Group housed calves grow faster and have higher feed intakes after weeks 1-2 compared with singles. The base /floor can be a serious compromise and difficult to clean properly. Increased scour risk if not free-draining base. Exposure to wind and rain can suppress immune function.
Ventilation	Some hutches have excellent ventilation. Good access to clean air outside	Some designs do not have adequate ventilation holes in the roof. Can be difficult to balance adequate ventilation with risk of draughts
Shelter	Can provide dry cover, fresh air, exercise and sunlight.	External strawed area will frequently be damp, and therefore cold. Extra shade may be needed in the summer. Adjacent hutches can cause wind tunnels. Calves in single hutches in winter below 14 days of age will be cold stressed. Can be too hot in summer.
Location	Orientation can make the most of the surroundings and seasonal changes on weather. Can utilise small areas near to facilities.	Not suitable for all sites due to negative impact of wind and rain. Drainage, high straw costs and poor floor hygiene can be significant problems.
Hygiene	Synthetic materials are easy to clean and disinfect.	Cleaning porous bases presents a hygiene challenge.
Cost	No planning requirements. Can be added in small cost steps. Many additional items; pens, gates, feeders readily available	Not a cheap option per calf if good flooring and drainage is provided. Variable costs high per calf. Straw costs per calf can be high
Labour	Good work environment when weather is good.	Staff work outside in all weathers. Feed and water may need transporting some distance. High labour cost. Poor lighting. Doesn't allow for automatic feeding.

4. Group Hutches/Igloos

Factor	Benefits	Considerations
Disease control	Good for disease control with small batch size lower risk than larger groups. Good access to sunlight and fresh air Easy to run each hutch/igloo as AIAO. Can be removed for cleaning.	Disease can spread if group hutches not cleaned and disinfected thoroughly. Poor drainage can have a major impact on health and growth Visual inspection of calves can be difficult.
Ventilation	Some hutches have excellent ventilation. Good access to clean air outside. Typical igloo systems work well. Area outside the hutches/igloos often under a separate roof cover.	Some designs of group hutches restrict ventilation with inadequate openings in the ridge.
Shelter	Calves can choose their environment. Plenty of fresh air and sunlight. Many designs incorporate a simple roof over the 'outside' pen. Good social interaction beneficial to growth rates.	Outside areas can be a poor quality environment and costly. Some designs have a single large door which encourage turbulent air flow inside the hutch when wind comes from certain directions.
Location	Orientation can make the most of the surroundings and seasonal changes on weather. Can utilise small areas near to facilities.	Not suitable for exposed sites. Poor location can expose calves to high wind speeds. Location needs to be free draining.
Hygiene	Synthetic materials are easy to clean and disinfect. Hutches/igloos can be moved to clean ground.	Cleaning is labour intensive and cleaning porous bases presents a hygiene challenge. Drainage is a major weakness. Prone to flies in the summer.
Cost	No planning requirements. Variety of sizes to choose from Some systems cheaper than a purpose built facility. Expansion can be staged.	Many systems are similar cost or higher per calf compared with fixed buildings. Running costs can be high due to labour and bedding.
Labour	Suited for group feeding system.	Staff work outdoors in all weather.

5. General Purpose Building

Factor	Benefits	Considerations
Disease control	Suited for AIAO systems. All pen fixtures, floors and drains designed for effective cleaning.	Increased risk of cold stress in large volume concrete and steel structures. Flat flooring is a common problem which leads directly to poor drainage. Temptation to clean through pens from gable to gable, which is definitely high risk for spreading disease.
Ventilation	Calf building ventilation always needs PPTV, which is easy to install and can be removed at a later time if building use changes. Sidewalls need ventilation inlets which can support natural lighting.	It can be difficult to provide good ventilation for calves in a large volume building. A large building area increases the risk of keeping multi-age stock in the same air space, which significantly increases risk of pneumonia.
Shelter	Similar to portal frame.	Modifications may be required to reduce drafts.
Location	Good design can accommodate most locations	
Hygiene	Similar to portal frame	Similar to portal frame if falls, drains and floor finish acceptable. Cleaning individual pens a problem. Unlikely to have channel drains suited for single/double pens.
Cost	Initial capital cost relatively high but should have lower variable costs that hutches. May suit block calving herds.	Can turn out to be an expensive calf building if it does not provide a good environment for calf health and growth.
Labour	Should provide a good working environment at all times. Water, power, light available at hand.	Challenging to clean mechanically when not used as AIAO system.

6. Lightweight structures

Factor	Benefits	Considerations
Disease control	Can provide discrete housed conditions for small groups of animals. Variable sizes mean suited for AIAO requirements.	Floor conditions are critical. Respiratory health sometimes an increased risk. Very dependent on the internal layout.
Ventilation	Simple structure to manage.	Long polytunnels suffer from restricted air movements. Reliant on sidewall ventilation, with attendant draught risk. Minimal outlet ventilation in too many designs.
Shelter	Can be good, and low profile building means that the structure can sit low in the environment	Not suitable for exposed sites without additional protection from the wind.
Location	Flexible in layout, shape and size gives good ability to fit most locations	Must be sited in dry, well drained areas or with full concrete floors and drains. Check that orientation does not make shelter too hot in summer.
Hygiene	Structure size can be set up to suit farm batch sizes and make easy to run all in, all out. Suitable structure for batch calving herds	A deep clean protocol is needed for non-concrete floors Depending on the materials used in construction can be hard to clean and disinfect.
Cost	Lower initial capital cost per calf than other systems	The costs associated with concrete flooring, pens and fittings, water and power supply must be considered. Be realistic about maintenance and repair costs and durability.
Labour	Should provide a good working environment at all times.	Higher labour requirements managing fittings and possibly more manual handling than buildings with machine access

Slat Dimension Recommendations

Table 5. Recommended dimensions for slats for young stock*					
Mass and type of animal	Preferred width, mm	Spacing, mm Pass	Not pass	Void ratio, %	Radii of arrises, mm.
Calves and young stock up to 200 kg	880	20	30	18 to 25	3 to 5
All slats must be manufactured to recommendations given in BS5502 : Part 22 The wearing surface must have no edges or protrusions that could cause injury Where possible angles at less than 60° in the plan of the void should not be used. Where angles less than 60° are present, the intersection should terminate in a radius of at least 3mm.					

* - Recommendations from BS5502 Part 51

Space allowance recommendations for calf pens

Table 6. Recommended minimum space allowance for group housed calves			
Live weight range kg	m^2 per head*	m^2 per head**	m^2 per head***
Up to 60	n/a	1.1	
50-84	1.5	1.8	
85-140	1.8	2.4	(<100kg) 3.3
140-200	2.4	3.0	5.0

* - Recommendations from Red Tractor Assurance Beef & Lamb Standards 2020
** - Recommendations from BS 5502 part 40: 2005
*** - Recommendations from Rural economy grant AHW

Foundations

- If foundation trenches are narrow it is easier to fill with concrete almost to ground level
- Do not lay concrete into pools of water within trenches as it will permanently weaken the foundation at that point.
- Drive a line of pegs into the base of the foundation trench so that their tops are at a level to which the concrete should be poured.
- Concrete mix for foundations: 1 part cement: 3 parts sand : 6 parts aggregates
- Foundations for steel framework should be sized as specified by the frame supplier.
- On a sloping site it may be easier to provide stepped foundations, with each step being the height of one con crete block (440 mm)

Table 7. Recommendations for foundation depths for various soil types

Soil Type	Depth	Thickness	Width	
			100mm wall above	280 mm wall above
Clay	3 ft/1000 mm	200 mm	300 mm	600 mm
Soft Soil	2 ft/600 mm	300 mm	500 mm	700 mm
Firm chalk/gravel	1.2-2 ft/ 450-600 mm	150 mm	300 mm	600 mm
Other	2 ft/600 mm	200 mm	300 mm	600 mm

Drainage

- All drainage should comply with BS8301 and BS5502 part 25.
- Aim to keep clean rain water, dirty water, and slurry all separate from each other.
- Direct rainwater to clean water soakaways or for recycling within the building.
- Dirty water drains should be in plastic pipe not less than 110mm diam., bedded in pea-gravel.

Floors

- Slope is all, and the sub-base slope should be the same as the final concrete.
- Typical slope is a fall of 2 in. in 10 ft (50 mm in 3.0 m)
- Remove all loose soil, and compact a sub base layer
- Forms for laying concrete floors should divide the floor into bays, the size of the bays depending mainly on the thickness of the concrete.
- For floors 100 to 150 mm thick, 10ft (3.0 m) bays are suitable bay widths, and should not exceed 12 ft (3.5 m) for 100 mm thickness or 15 ft for 150 mm thickness.

Adding extra water to a mix to make laying a slab easier will weaken the slab for ever.

- A slow cure of 7 days will create the strongest slab. Cover the newly laid concrete with plastic sheet to achieve a slow cure.
- Finishing a floor; the course finish produced by the tamping may be suitable, but can be very invasive to feet when new.
- A less pronounced ripple surface can be produced by a final pass with the tamper held at a slight angle and moved forward slowly on its trailing edge. A brushed finish with a stiff brush before final setting will give a good non slip surface.

Walls

- Concrete blocks should be kept dry to prevent cracking when a wall dries.
- Mortar mix: 1 part cement: 2 parts lime: 9 parts sand. Many masonary cements available.
- Pointing should be shaped to shed water
- Damp proof course not less than 150 mm above surrounding ground height.
- Pen walls typically solid to above animal height. Where external walls are open gates of a feed fence, be aware of the possible need to provide wind breaks.
- Always fit a strip below sheeted gates to eliminate draughts at animal level.
- Minimum inlet areas in wall cladding should be calculated (see https://ahdb.org.uk/knowledge-library/brp-better-cattle-housing-design)
- All manufacturers of cladding and roof sheeting supply advice and technical guidance on correct use.

With thanks to the Cement and Concrete Association

Roof

- Tin/metal roofing materials may be popular on smaller buildings but they are absolutely not recommended for calf housing. Mineral fibre is the default material, insulated panels the optimum.
- An overhang on the roof of e.g. 1000 mm adds significant protection to the sidewalls.
- An open ridge of 100 mm width with upstands is the optimum as they create a negative pressure ‘suction’ at the ridge all the time there is some wind movement; which is >90% of the year.
- **All roof work is inherently dangerous; ensure all persons are aware of the risks and act appropriately.**

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