Stall and Stable

Canadian Pony Club Education

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Stall and Stable

The origin of the word *barn* comes from *'place to store barley'*. The *stable* (barn designed specifically for horses) came along later to house horses for a variety of reasons.

Today, five general reasons for housing horses are

1. **human convenience**

    horses are closer and more convenient when housed in a stable

    horses typically stay cleaner in a stable

    a stable provides a more comfortable environment for the handler

    horses can be more efficiently cared for, saving on time and labour

    there is greater control over what/how much the horse consumes

    provides an opportunity to implement individualized feeding programs

    in cases of illness or injury, a stable is a more controlled environment to promote healing

    there is reduced danger of injury caused by other horses

    there is a reduced risk of the horse pulling a shoe

2. provides a **less severe environment** than what may be experienced outdoors

    in Canada, a dominant consideration in the construction of a stable is the climate

        extremely cold winter temperatures

        sudden drop in temperatures: for every 10 degree drop in temperature, it takes two weeks for the horse to acclimatize

        snowfall depth

        depth of frost

        high levels of rainfall

Chinook winds that cause extreme rises in temperatures in a very short time, bringing about sudden thaws

summer temperatures and high humidity

types and numbers of insects experienced in the summer

3. **tradition**

traditionally, horses were working animals that spent many hours a day working

today, the average horse works less than one hour a day

historically, horses have been housed primarily for the owner's convenience

this had led people to believe that housing horses is better for the horse compared to turnout at grass

in fact, a horse in a stabled environment is at a disadvantage compared to a horse living at grass:

grass-kept horses self-exercise, so typically suffer fewer soft tissue strains and injuries

grass kept horses exhibit more moderate behaviour, as excess energy can be burned off through self-exercise

comparatively, grass-kept horses have improved lung health

horses living indoors have been found to have higher antibody titers, indicating that they are fighting more infectious agents caused by poor air quality, higher housing density and poor stable hygiene

statistically, grass-kept horses experience fewer digestive disturbances and a significantly lower incidence of colic and ulcers

grass-kept horses experience more stimulation, less boredom and therefore there are fewer (60-90%) stable vices noted in the population

if turned out on adequate, good quality pasture, grass-kept horses will require less supplemental feeding of hay and/or grain so therefore costs less to keep

movement is the most important contributor to long term joint health as complete, weight bearing forward strides bathe the joint cartilage in

synovial fluid; it is difficult for a stabled horse to achieve this type of movement when stabled on a regular basis

4. **economics**

in or near large urban areas such as Vancouver and Toronto, high land values have created a situation where high density equine housing is the norm

if paying help, a larger number of horses can be housed and cared for over a shorter period of time than one would be able to look after in a field situation

5. **behaviour management**

horses are herd animals, and some horses can become herd bound, posing a behavioural management issue both when being ridden and when removed from the herd for other reasons

one study noted that horses kept with other horses in paddocks exhibited a high degree of synchronized behaviour compared to horses kept in loose boxes who behaved independently of each other

Considerations When Planning for Housing Equines

There is no one right way to house horses.

It is easy (and common) to put human needs and preferences before those of the horse.

Remember that equines:

are flight animals

are nomadic and instinctively need to be in almost constant motion

are gregarious, social herd animals and most have an inherent aversion to confinement and isolation

have a digestive system that works best when the animal is constantly grazing

are curious

are easily injured due in part to thin skin, vulnerable tendons and ligaments, and a susceptible respiratory system

have blind spots that can lead to the horse being easily startled

have one of the best photographic memories (significantly better than that of humans) and so do best in an environment that looks the same on a day-to-day basis

are statistically the most dangerous animal to humans, based on hospital admissions and death records

Consequently, when planning equine housing, it is important to consider what we can do to most safely and appropriately house the horse, and to remain safe ourselves when working with our horse.

Most important requirements for equine housing:

Firstly, equine housing must be safe for the horse and the people working with them

there must be sufficient room for the horse to move around

there must be sufficient room for the people to work safely with and around the horse

Other considerations:

we must provide an environment that allows for the horse to move and be exercised daily

we must provide an environment where the horse has an almost constant access to forage

we must provide an environment that has a high level of functionality

provide for movement in and out (within the property lines and off/on the property) of horses and people, including emergency vehicles and personnel

provide for movement into the barn of feedstuffs and bedding, and out with manure

we must provide an environment where the horse's social needs and need for stimulation is met in order to avoid stress

Site Concerns

Qualities to consider when choosing a horse property:

Topography

for the actual building site, flatter is better

for the overall farm location, horses do best on gently undulating fields

consider how much of the land on the property is actually useable prior to purchasing - gullies, swamps, steep hills, etc., all cost money but will not be of much use

use Google Maps in terrain mode to get an idea of the topography

assess low lying areas where stagnant water can potentially collect

drainage of stagnant water will remove the mosquito breeding areas, reduce the mosquito population and consequently reduce the risk of West Nile Virus

find a high and dry location for the barn site

if looking at a hilltop for a building site, depending upon the region and the winds, the brow of the hill might be better than the crest of the hill if high winter winds are common to the area

grade or slope of the land at the barn site: having too steep a grade at the building site will increase the building cost and limit what style of building can be erected on the site

Geotechnical report

provides a report on subsurface soil, rock and water conditions

necessary to choose a safe and cost efficient building site

Climate of region

this will help to determine what aspects such as ventilation and roof types that will be installed in buildings

will partially determine type of grasses will grow, which will influence pasture management

Good soil

a soil map can tell you about soil's texture (proportions of clay, silt and sand) and drainage

- poor soil may require the addition of 10-15 cm (4-6") of topsoil if on a small acreage
- avoid clay if possible

Good natural drainage

- will be strongly influenced by soil type in area
- affected by grade or slope of land
- try to ascertain differences in groundwater flow between summer and winter
- assess low lying areas where stagnant water can potentially collect
- drainage of stagnant water will remove the mosquito breeding areas, reduce the mosquito population and consequently reduce the risk of West Nile Virus

Adequate land

- consider minimum number of acres needed and maximum number of acres that can be bought and maintained on your budget
- stables take up a lot of square footage
- allow for sufficient land to provide for driveways, manure pile, bedding and hay storage which will take up more square footage
- allow land for turn out; good quality pasture is preferable, but failing that, room for paddocks
- potential for future expansion

Good air quality

- no sources of air pollution (such as factories) nearby

Plenty of natural light

- not overshadowed by tall trees or other buildings

Adequate, clean water supply

- determine whether the location is on city water, if a well is present or if one needs to be drilled
- water can be obtained from private well, public water, river, pond, or lake
- with water obtained from municipal water, the suppliers are responsible for water quality

- for all other water sources, the land owner is responsible for water quality
  - water is tested for presence and absence of total coliforms and fecal coliforms
  - water for livestock should have a total bacteria count of less than 200 bacteria per 100 ml. of water
  - water for human consumption should have a total coliform bacteria of less than 5 bacteria per 100 ml. of water
  - fecal coliforms should measure zero for both human and animal consumption
  - total dissolved solids (TDS) - 6500 ppm constitutes mineral contaminants considered safe for horses
  - toxic contaminants include pesticides, herbicides, heavy metals, nitrites and nitrates, industrial pollutants and micro-organisms
  - horses are very sensitive to algae and toxins produced by cyanobacteria (blue-green algae)
- any potential source of contamination such as manure piles or septic tanks should be at least 15 m (50 ') from a drilled well and 30.5 m (100') from a dug well or pond
- assess if the property has hard water or soft water
  - be aware that the effectiveness of certain disinfectants such as Phenols and Cresols (Prosovet, Beaucoup) and Quaternary ammonium compounds (Clinicide, Quatsyl -D) will be inhibited by hard water

Direction of prevailing winds

- for a natural ventilation system to work, the building must be placed perpendicular to prevailing winds
- be aware of which direction the coldest winter winds comes from
- avoid having main door or paddocks in directly in line of cold winds, or the open side of open-sided run-in sheds
- check that where the proposed centre aisle will be is not going to turn into a wind tunnel

Convenience

- Barn should be close enough to the house to be quickly and easily accessible for those working with the horses

- Access to utilities
- Easy access to road
  - main entrance should have no blind spots and good sight lines
  - driveways and bridges should be wide enough for large trucks to access the buildings
  - a 3.65 m (12') width is required for large vehicles
  - any bridges need to be able to bear a weight of 18 144 kg (40 000 lbs.)
  - access for large rescue vehicles - must be able to get within 61 m (200 ft.)
  - access between buildings is important
  - be aware of overhanging trees or other high hazards
- Easy access to towns and utilities
  - cheaper land will be further away and have fewer services

Security

- consider placement of stable in relation to house and road to deter access from unwanted visitors

Zoning restrictions and necessary permits should be noted, as they vary from municipality to municipality

- minimum/maximum number of acres per horse
- minimum distance of buildings from fence lines and overhead power lines
- regulations regarding manure piles and disposal
- regulations regarding drainage onto neighbouring properties
- fire codes will vary from municipality to municipality
- some municipalities will require permits for fill (foundation materials) to be dumped
- municipalities may also have restrictions on removal of existing trees
- some areas have regulations on odours and flies
- regulations regarding disposal of construction waste and fires
- most areas will have regulations regarding having a washroom available for staff

- investigate any deed covenants
- be aware of any regulations on existing heritage buildings
- some areas require a permit if top soil is moved around or if existing water courses (including ditches and small streams) will be altered or re-routed

Budget

- it is cheaper to buy an established property and change it to suit your needs rather than build from the ground up
- generally, the closer one is to large urban and suburban areas, the higher the land price will be
- regional economics will play a role in land prices
- add-ons like drilling a well, installing a septic system, installing fencing, driveways and power poles are all extra costs than can drive up the over-all price

Future operating costs

- research property taxes
- investigate the cost of complying with local ordinances such as manure disposal and environmental concerns
- consider type of discipline and interest/support of it in this area

Aesthetics

- keep placement and direction of buildings in relation to house in mind as this may affect resale price

Neighbours

- having your property beside a school, for instance, might pose some problems if children and horses get too close and someone gets bit, etc.
- research to make sure this is a horse friendly community

Specific stable building site concerns:

Before constructing the stable, create a schematic for where the building will be in relation to property lines, existing trees, fields, paddocks, outbuildings, and rings. Plan the access from the road and how much land will be needed for driveways, lanes, and parking lots, then map out plans for water lines in from the well or water mains, and water out via drains, sewage or septic.

Check with your suppliers (bedding, hay) and any others who regularly come on site (vet, farrier, manure disposal) as they may have suggestions that will make your particular operation more efficient.

A stable should be:

- Close to the house for convenience and security
  - proximity to house makes it easier for routine access
  - being close to the house allows for quick visual checks
  - having a barn situated behind a secure gate or security gate will keep horse from escaping and prevent unwanted individuals from accessing the stable
- Close to parking, main pastures and riding rings and within easily access of road
  - consider proximity to existing buildings, what the function of those buildings will be (e.g., hay barn, etc.), and access for each building
- Positioned close to existing water and electricity
  - consider location of well
  - consider placement of yard hydrants
  - consider electrical poles and wiring placement and protection
  - the further from the road (and the more telephone poles needed), the higher the expense will be as there is an associated cost per pole
- Sheltered from prevailing winds
  - be aware of direction that the coldest winter winds come from as well - this could be different than prevailing winds
  - try to have a solid wall against the prevailing wind
  - build the barn to take advantage of sun exposure in regard to accessing solar heat
- Situated for good natural light and clean air

Not overshadowed by other structures or tall trees

Arrangement of all structures:

best - echelon, large square

worst - small squares

Outbuildings should be at least 15-30.5 m (50-100') from stable

Consider the function of each outbuilding and the traffic flow between buildings

Foundation

with the exception of a pole barn, wood, metal and masonry construction all need a continuous concrete foundation wall

foundation needs to be high and dry, and the ground around the building(s) needs to be dry and sturdy enough to support heavy vehicles

fire trucks can deliver 946 L (250 gallons) of water a minute; the ground can quickly become saturated; footing must be able to support heavy vehicles

Septic

If the barn is not in an area that has public sewage hookup, a septic tank will be necessary if an indoor washroom is being installed

Good drainage

necessary for building site itself as well as all communal areas, paddocks and field access points

site graded so that water flows away from barn

installation of French drain system around barns and a catch basin area for run off

Considerations regarding the soil at the barn site:

Sub-soil of gravel is ideal

Sand needs to be free of excess water year round

Rocky formations are fine

Other good soil types include:

limestone

chalk

granite

Worst soil types:

clay

loam

peat

The Foundation:

Artificial base should be wider than intended structure

poor drainage and frost heaves are the primary problems to foundations

heaving will put stress on the frame of the building

Slightly elevated

improving drainage will help to prevent problems

Extend below frost line as recommended by local building code

Buildings built before 1915 typically will have fieldstone foundations

those built after 1915 will use concrete

Foundation Types

Concrete Piers Foundation

mainly used on post and beam style

very affordable

cannot be used with conventional construction where walls are framed with studs unless a heavy structural grade beam is installed first

Monolithic Foundation aka Slab-on-grade or Flooring Slab

- used in rocky areas where holes cannot be drilled

Conventional

- most common
- very sturdy
- can use cement blocks or a poured concrete wall

Stable Construction

The stable is the most unique building type.

You will require expert help with this project. Consult with industry professionals (plumbers, electricians, roofers, horse footing experts) before you get underway; this will help with your planning.

Careful planning will result in:

- a pleasant home for your horse
- a comfortable place to work with your horse
- a safe place for horses to live and for the people who work with them
    - fewer vet bills
    - a healthy environment that will allow for the support of and accommodate the measures toward care of and recovery for horses that become ill or injured or are in a rehabilitation program
- an efficient operation
    - the stable should be planned so it save steps for those working with the horse
- good aesthetics
    - results in added property value
- lower maintenance and upkeep costs
    - it should be planned so that cleaning and upkeep can be done easily and efficiently

A stable can be as big or small as possible, but has some basic requirements:

- stalls
  - can have as few or as many as needed
- one quarantine/isolation or recovery stall
  - may be located in another building
  - new horses to the stable may need to be quarantined for a time before being exposed to the other horses on the property
  - horses rehabilitating from illness or injury may need a quiet space to hasten healing and for treatment to take place
  - horse owners need to incorporate bio-security measures to prevent the spread of diseases
    - horse populations are highly mobile which can result in a high exposure to diseases
    - horses with infectious diseases need to be quarantined
    - stall needs to be easy to disinfect
  - when constructing a stable, horse owners need to ask themselves:
    - - how can I stop disease agents from spreading from horse to horse?
    - - how can I disinfect the barn?
- centre aisle
  - ideally should be 3.65 m (12') wide
  - free from obstructions
    - to provide an environment that will allow free passage to the horse with no risk of injury
    - to provide an environment where those working with the horse will be at decreased risk of injury
    - wide enough so that machinery can drive through to facilitate efficient cleaning and maintenance
- bedding storage

may be located in another building to minimize fire risk and help maintain air quality

needs to be dry and well ventilated

utility room

secure and organized space for wheel barrows, forks, etc.

can be a smaller space, from 0.9m X 2.4 m (3'X 8')

Photo credit: Shannon Oldham-Dueck (used with permission)

feed room

needs to be horse proof

needs to be rodent proof

rodent proof walls

- rodent proof feed storage containers
- at minimum needs to have enough room to house one week's feed
- located as close to the stalls as possible for convenience
- hay storage for at least one feeding
- advisable that it be located in another building due to fire and insurance concerns
- if in another building, close enough for convenience
- should not be combined with feed room as dust from feeds can make tack dirty

manure bunkers

- will be outside the building but location is integral to building
  - should be away from barn (approximately 30.5 m or 100')
  - should be directly accessible to both barn and road
  - should not be visible from either house or road

a larger stable building may also accommodate a

- tack room
  - when planning size, take an inventory to determine how much space is needed
  - consider the purpose
    - will it only be used to store saddles and bridles?
    - will it also store tack trunks, first aid items, bandages, etc.?
    - will it also be a social area?
  - ideally situated beside grooming stall for convenience
  - ideally beside the wash rack on the other side to aid in the insulation of pipes between the two areas to prevent freezing in cold weather
    - if there is a stairway to the loft, place that between the tack room and the wash rack and house the water heater under the stairs
  - should be insulated and may need to be heated to preserve leather

- other important considerations include being dry and well lit
- security is important: use a key pad entry if in a high traffic barn to eliminate the use of keys

washing and cleaning room with drying facilities

- if the washing and drying room is to be combined with another room, it should be the feed room rather than the tack room, as the moisture generated by the washing will cause mold development on the tack over time

grooming stalls

- ideally located beside or across from tack room
- floor should be slip-proof and easy on the legs
- should have a drain
- the floor should have a 4 degree slope

wash rack

- good drainage and a roughened floor are most important
- ideally located beside tack room to help keep pipes insulated

office

- should be secure as records and financial information will be stored there

viewing/waiting area for clients

- may need to be heated if in a colder climate

washroom

- indoor washroom facilities require a lot of (often unpleasant) cleaning and maintenance
- note that facilities on septic systems often have issues with toilets backing up
  - port-a-johns are an advisable alternative as they are emptied and cleaned by an outside contractor on a regular basis
  - outside contractors are an added expense that balances out by being a great convenience
- barns with staff are required to provide washroom facilities

grooms' room and shower facilities

larger or higher end barns may have shower facilities for guests and staff

hand washing stations and footbaths

garage or covered area for trucks, trailers, tractors, etc.

it is not advisable to have gas or diesel powered machinery stored in the same building as animals due to fire hazard

attached indoor arena

having the indoor separate from the stable area will improve air quality

Building Design

The design or type of buildings used for stabling horses can vary widely

- some are specifically built for horses

- other buildings are retro-fitted for horses

it is much cheaper to change an established building to suit your needs than to build from scratch

Size of building

- how many horses will be housed in it?

Function or purpose

- will the horses live in the building full time, year round?

- will they be in at night and out during the day?

this is called the *combined system*

In the combined system, a stabled horse gets to spend a portion of each day at grass

it provides the best of both systems (stabled and grass-kept) and is considered to be the best of both worlds

In a study done assessing equine living systems, horses were kept in humane conditions that ranged from a slightly small stall, to a larger stall, to a large stall with paddock and field access. Assessed were

microclimate

aerial contamination

box stall dimensions

access to paddock/pasture

Blood was taken from each group, and it was demonstrated through these serum indicators that living conditions significantly influenced the physiological condition of the horse in a positive way

Also ask:

- what job (discipline; level of competition) will the horses be doing?

- are there any special accommodations the horses will require?

- what special accommodations might the owners require or be accustomed to?

Design of building: types

1. pole barn

does not require a continuous concrete foundation wall

- requires pressure treated wood set below the ground in concrete footings

- framing system built of wood roof trusses connected to vertical columns (sidewall posts)

- has secondary structural members like wall headers, roof perlins and wall grits to support the siding and roofing

- easiest and most economical to build

2. post and beam barn

   - requires a continuous concrete foundation wall or concrete piers foundation

   - built using heavy wooden timbers, joined together either with carved wood joinery (pegged mortise and tenon) or metal plates and hardware

   - more expensive than a pole barn

   - uses larger timbers

3. modular barn

   - does not require a continuous concrete foundation wall (requirements may vary in different municipalities) but will require cement footers (pillars, piers, etc.)

   - delivered fully or partially built (partially built will be assembled on site)

   - affordable

   - fast to build and put into use (2-3 weeks from ordering to assembly)

4. steel barn

   - requires a continuous concrete foundation wall

   - most of building's structural components made of steel

     - can carry heavier snow and wind loads than wood

   - cost effective

   - good ability to construct wide clear span building

   - does not require regular painting, weatherproofing or maintenance

   - easier to clean

   - discourages chewing

   - some manufacturers offer a lifetime kick-through warranty

5. stone or masonry

requires a continuous concrete foundation wall

older buildings may have a stone foundation

Design of building: **styles**

Choose a style that suits:

your region

its climate

your property

your purpose for having a barn

private backyard barn

mid-sized training facility

public facility

your discipline

1. **Gable** aka English barn

triangular or A frame shaped roof, on one level typically with a centre aisle

roof built with single sloping roof on each side

pitch varies between 4/12 (8.43 degree angle) and 12/12 (45 degree angle)

roof may be built with different angles

advantages:

cheaper to construct; most affordable way to build a roof

typically provides better ventilation

2. **Round and Polygonal** barns

   circles have greater volume-to-surface ratios so uses less material and saves money

   greater structural stability

3. **Bank barn** aka German bank barn

   built into the side of a hill; allows for utilization of sloping land

   1st and 2nd floors are both accessible from the ground; typically animals are housed on the bottom floor

   to prevent collapse, foundation must be designed properly and walls extra thick

   significantly more expensive to build

   typically built south-facing, with a cantilevered second floor that provides shelter for pastured animals

4. **Gambrel** aka Dutch Style built with double slope on either side

lower slope has a steeper pitch

can be built using any type of construction or framing technique

provide upstairs/loft storage space

more expensive to erect

advantages:

may be less expensive overall if only one building is needed for housing animals and storing feedstuffs

loft affords good insulation

some two storey structures are naturally 'leaky' and provide good ventilation without the need for specific air inlets

allows efficiency when working especially if using drop downs from loft to manger

disadvantages

must consider a means of safely accessing the second floor; this will take up valuable space on the ground floor

increased risk of fire through combustion

100% chance of building being lost if hay storage is in building

extra machinery/effort needed to move hay into loft

ceilings will decrease cubic air space available so aisles and vents. etc. must be accommodate this to provide good ventilation

if a barn is 'leaky' may have issues with drafts

ventilation may be an issue so chimneys may need to be installed

5. **Connected** barn

older style barn common to Quebec and New England

consists of a long rectangle (more common to Quebec) or square with infield area (more common to New England) where everything (animals, bedding, forage, equipment and machinery) is housed under one roof

6. **Monitor** aka Raised Roof barn

centre part of the roof is raised to provide for storage; supported by knee walls

allows storage in centre while maintaining low roof pitch

allows for the installation of windows without dormers

disadvantages

less loft space than some other barn types

more expensive to build than the Gable

Design of Building: Layout

The two most important concerns in stable layout are:

1. safety
2. efficiency

Layout of stalls - options:

Centre aisle barns

have stalls on either side on one centre aisle

are the easiest and most convenient for the person caring for the horse

Shedrow barns

typically have stalls opened to a covered walkway

this may allow more inclement weather into the stable area, being less comfortable for the person caring for the horse

will always have better air quality comparatively

there is more for the horse to see, potentially decreasing the incidence of stable vices

if stalls are to be placed against one wall, have them against the south wall especially in colder areas

Trainer barns

have multiple aisles and rows of stalls

the air quality and ventilation is typically worse the further into the building one gets

these can be seen in large training facilities

also common in larger horse show facilities

The incidence of disease sharing is higher at such facilities unless stringent guidelines are followed

Back to Back or Racetrack

typically have two rows of stabling back to back

stalls share a common back wall

May open out to a covered walkway similar to shedrow style

If enclosed, ventilation will be important as there is no direct access for air from outside coming in via windows and other natural forms of ventilation

Building Materials

Today the trend in stable design is towards more residential style construction

this is not appropriate to maintain healthy horses

horse housing needs to be more like livestock housing

horses produce a large amount of manure and urine

horses are bedded on dusty materials

horses are fed relatively dusty materials

horses respire gallons of water vapour into the air

therefore, the material and design requirements are

very long wearing

non flammable

impervious to moisture/easily cleaned

safe/non toxic

ventilation is one of the utmost design concerns

Concerns regarding building materials

Horses are extremely strong so materials need to be able to withstand a lot of force

Always use fire retardant/resistant materials

The climate and expected snow load will determine the maximum roof loading

trusses should be rated for 13.6 kg per metre (30 lbs per square foot) for snow

some areas will need 18 kg per metre (40 lbs per square foot) in the case of heavy snow followed by rain

Common building materials

wood

wood must be of a strong grain

avoid plywood or particle board

paint or preservatives should be used

should be treated with a fire retardant

metal cladding

can be kicked through

low maintenance

can be used in conjunction with a kicking board

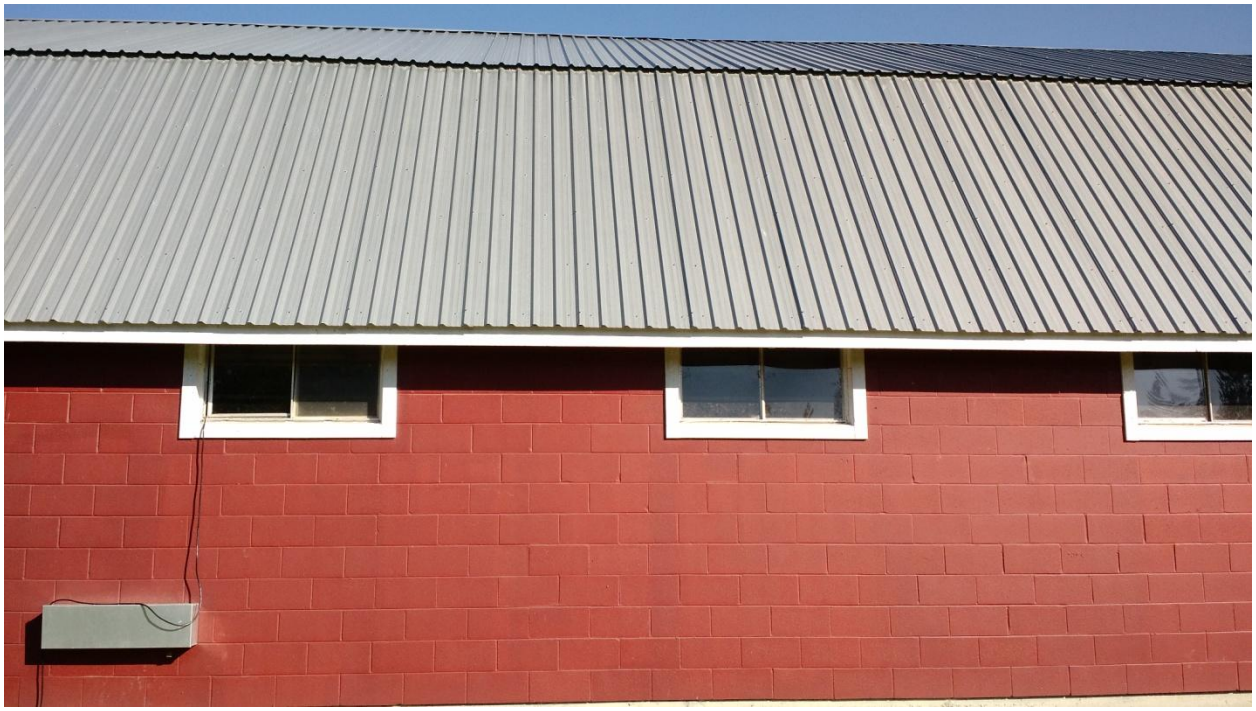
good flame spreading rating

poor fire rating due to metal conducting enough heat to combust materials

brick or concrete blocks

are good but expensive

not advisable in areas of earthquake risk



Materials: Fire Rating

building materials have three rating systems

each rating system compares how well the material behaves in a fire compared to a standard

1. flame spread

    concrete has a rating of 0 and raw wood a rating of 100

    the lower the rating, the longer it takes for fire to traverse the surface of the material

2. smoke development

    low rating indicates the material produces less smoke as it burns

    less smoke means

        higher visibility

        fewer noxious gases

        decrease in fire progression

3. fire rating

    how long (in minutes) the material contains a fire

Flooring

1. Flooring is directly related to the horse's long term health and soundness

    ammonia gases trapped in flooring can lead to respiratory issues

    trapped moisture can lead to thrush

    uneven or hard surfaces can lead to soreness

    slippery flooring can cause slipping resulting in bruising and abrasions

2. Bedding must be used in conjunction with the chosen flooring in order to maintain health and long term soundness

3. An average 1000 lb. (454 kg) horse will produce approximately 13.5 kg (30 pounds) of manure and 3.5-9.5 litres (1-2.5 gallons) of urine daily

    Flooring must allow for a removal of urine from the stable environment via drainage

4. Flooring must be able to withstand the wear given by the horse

Subfloor

a typical subfloor profile will consist of a number of layers:

lowest layer will be the native soil, cleared of all vegetation

above that will be large gravel approximately 30 cm (1 foot) deep

immediately above that will be finer gravel approximately 10 cm (4 inches) deep

have a 5% slope of the area around the stable to divert groundwater

above that will be the flooring of choice

materials for flooring will be approximately 12 cm (4-5") deep

floor should be above the grade at least 30 cm (12 ")

There are two main categories of flooring:

1. Porous

    has an underlying foundation of sand and/or gravel to aid water movement down below the stable

2. Impervious to moisture

    will slope 1.5-2% to allow water and urine to run to a drain

Essentials of Good Flooring*:* Management style and budget will typically determine flooring that ultimately is chosen

Durable

    Stays level

    Resists damage from pawing and areas of high traffic such as doorways

    Long wearing

Has some give

    easy on the legs

    Decreases impact on horse's legs

Dry

    Raised above outside ground

    Slight slope for drainage, no more than 1:48

Impervious to moisture

Non-slippery

    Provides good traction

    Encourages horses to lie down

    Reduces fatigue

Non-odor (ammonia) retentive

    Ammonia will cause respiratory issues

Low maintenance

Affordable

Does not strike cold to the horse when he lies down

Easy to clean and disinfect

A good floor will also inhibit internal parasite survival

Types of flooring

Consider manure and urine management when selecting a floor

Floors that allow urine absorption via urine moving through the various material layers will retain odor

Floors that allow urine absorption will need to be replaced/repaired approximately every 5 years

Bedding will reduce odor as it will in turn reduce the amount of urine being absorbed via flooring

Impervious floors are dependent on the slope of the floor and a good drainage system in order to be effective

1. Porous Flooring Materials:

Clay

Very popular and the most common type of flooring

Advantages	**Disadvantages**
inexpensive	varies greatly from location to location
readily accessible	very subject to wear in areas of high traffic (doorways, by feeders) where horses paw or urinate
easy on the legs	pure clay can pack too tightly and become impervious to moisture
encourages the horse to lie down	packed clay becomes too slippery
noiseless	difficult to clean and disinfect
dust free	high maintenance: needs to be repacked and replaced yearly
helps prevent feet from getting dry	relatively warm
absorbent	can stay damp for long periods of time
	may retain odour

Soil

Advantages	**Disadvantages**
inexpensive	varies greatly from location to location
readily accessible	very subject to wear in areas of high traffic (doorways, by feeders), where horses paw, or where horses urinate
easy on the legs	difficult to clean and disinfect
encourages the horse to lie down	high maintenance: may need to be repacked and replaced yearly
noiseless	can stay damp for long periods of time
dust-free	may retain odors
helps prevent feet from getting dry	may freeze in cold weather
absorbent	
non-slip	

Sand

Advantages	**Disadvantages**
readily accessible	Sand colic is a risk
easy on the legs	May freeze in cold weather
encourages the horse to lie down	Does not pack well so very subject to wear in areas of high traffic (doorways, by feeders), where horses paw, or where horses urinate
noiseless	Difficult to clean and disinfect
excellent drainage	High maintenance: needs to be repacked and replaced yearly
soft and forgiving	Can stay damp in cold climates
	May retain odors

Grid mats: an open grid pattern made of rubber, plastic or pressure treated lumber that supports another type of flooring material such as clay, soil or gravel

Advantages

Good drainage

Prevents uneven surfaces

Durable (more with rubber and plastic, less with lumber

Easy on the legs

Requires less bedding

Low maintenance

Disadvantages

Expensive

Gravel: depending upon where you are, can be composed of crushed limestone, crushed granite mixed with a binding agent such as clay.

Advantages

good drainage

easy to level

packs well

readily accessible

Disadvantages

can be hard on a horse's legs if compacted too much

small rocks may surface

if not compacted well, holes can surface

hard to disinfect

Wood: formerly a common flooring, less common now. Hardwood needs to be used as opposed to softwood; hardwood needs to be 5 cm (2") thick and treated with preservatives

Advantages	**Disadvantages**
low maintenance	hardwood is expensive
level	slippery when wet
easy to clean	difficult to disinfect
durable	retains odors
good drainage between gaps	can cause splinters
roughened wood has traction	gaps between boards may allow for rodent and insect infestation

2. Impervious Flooring Materials

Concrete: very popular; 10 cm (4") thickness is recommended

Advantages	**Disadvantages**
durable	if not roughened, can be slippery
low maintenance	can be hard
easy to clean and disinfect	can be cold
can be sloped towards drains for good drainage	can be hard on a horse's legs
difficult to damage	best used in conjunction with a lot of bedding and/or rubber matting

Asphalt:

Advantages	**Disadvantages**
Can install an asphalt floor yourself	Cost ranges widely from area to area
	Easy to disinfect
	Less concussion than concrete
	Very dark

Rubber Mats: typically used over another type of flooring; does need to be used with bedding, cannot be used alone. Various thicknesses are available with 12.7-19 mm (0.5-.75") being the most common.

Advantages	**Disadvantages**
Decreases slipperiness, coldness and hardness of pre-existing flooring	Expensive
Reduces amount of bedding needed	Hard to move for cleaning and disinfecting
Durable	If not fitted correctly, mats can move, creating gaps and uneven surfaces
	Horses wearing studs can damage mats
	May retain odors

Flooring in Specialty Areas:

Diverse uses mandate different requirements than those found in stalls

Aisle ways are the most high traffic and public areas of any barn

- need to:
  - create a good first impression
  - be durable
  - easy to sweep clean
  - non-slip and skid-proof
  - non-concussive
  - fire resistant
  - Slightly sloped - 4 degrees
  - resistant to water, and able to redirect water towards drainage

Aisle ways need to have drains

- avoid drains in the centre
- avoid drains near hay storage or bedding

Aisle way materials:

Compacted Sand, Gravel or Crusher Dust

very affordable

good drainage

suitable for a lower traffic stable

not easy to clean thoroughly

disadvantage: flooring material will be tracked out on footwear

floor area should be dug out 20 cm-30 cm (8"-12"), subsoil leveled, then the added materials tamped down

Clay

no/low cost if using materials already present on site

not durable

most suitable to a very low traffic stable

cannot be cleaned

becomes uneven

needs to be re-laid every 1-5 years

Asphalt

durable

economical

good shock absorption

good traction with textured, slip resistant surface

highly porous so dries quickly

good drainage

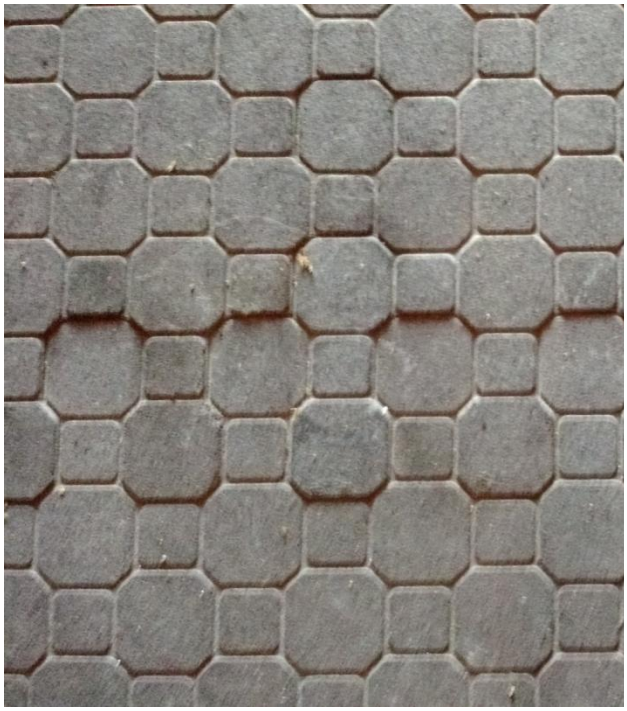
materials may not be readily available in winter as plants shut down due to decreases in road work

rough texture can trap dirt

dark appearance

Synthetics (*Rubber Stable Brick)*

advantages	**disadvantages**
very attractive	hard to sweep
easy on the legs	extremely expensive
resilient	extremely expensive
non slippery	other cleaning methods less than satisfactory



Concrete Pavers

Attractive

Can be expensive

Can be hard to clean

Hay seed can fall between cracks and sprout grass

Pavers can lift over time, becoming uneven

Concrete

- concrete is necessary in areas where there is a high water table and where frost heaves are an issue
- easy to clean
- very durable
- readily accessible
- Can be:
  - noisy
  - very hard on the legs
  - slippery if not roughened
- concrete can be used as a border in conjunction with another flooring, or as a base for rubber mats

combination flooring

use concrete slabs 45.7 cm (18") bordering the aisle, and extending into the stalls, with stall walls on top of the concrete

- this provides a more consistent and level flooring in high traffic areas like doorways
- in the centre of the aisle could have

asphalt:

easier on the legs than concrete

less slippery than concrete

easier to maintain than dirt/clay

concrete or rubber pavers:

attractive

resilient

non-slip

very expensive

sweeping is ineffective

blowers create too much dust

hosing or vacuuming are cleaning options

Concrete floors can be roughened to improve traction.

This sloping concrete floor is roughened and grooved.

Having a concrete floor makes for quick and easy cleaning.

Rubber mats

Need to be used in conjunction with a solid base

Good shock absorption

Hard to move for thorough cleaning

Water can pool on top and moisture can be trapped underneath if drainage is not ideal

Feed rooms:

needs to be impervious to:

moisture

rodents

easy to clean

concrete is very suitable

Wash rack:

non-slip

impervious to moisture

impermeable and durable material such as concrete is best

has to have great drainage

must drain to an approved discharge area

have a slight slope

be roughened or textured

horses may be reluctant to go near drains;

unless horse-specific and properly installed, drains can be a safety hazard

drains need to be installed with clean outs and traps

Roofs

the slope of the roof is critical in directing snow and water, especially over entrances and exits

for snow load, ask for a truss certificate of 13.7 kg per square 2.5 cm (30 lbs per square inch)

some areas will need 18 kg per square 2.5 cm (40 lbs per square inch) if heavy snow load followed by rain is a possibility

roof shapes:

sloping roofs or trusses

lowest height 3.6 m (12 feet) at the spring (lowest point)

the roof pitch indicates the number of inches a roof rises for every 30 cm (12 inches) it runs horizontally; the standard is 1:12

the ratio will be determined by aesthetics, amount of snow and roof run off typical for the area, and the width of the centre aisle

for rafters and trusses in wider barns, the rafters require support from posts and beams on the inside, limiting floor plan flexibility

during snow loads, most roofs fail at the joints - inspect these regularly

failing joints will typically give lots of warning, will be noisy and show signs of rot

shed roof

pitched flat roof, all one plane

used for three sided shelters and smaller stables

flat roofs are not recommended for barns

offers no natural ventilation point

increased risk of leaking in rain or collapse in heavy snow load

if flat interior ceiling is used due to loft or living area above, it must be airtight

Qualities of a roof

slope of the roof should be no more than 45 degrees with the horizon

should maintain an equable temperature in all seasons

durable

noiseless

non-flammable

Roofing materials:

most roofing materials are placed over an inner roofing of wood

tiles

maintains equal temperature

affords good ventilation

easily broken or loosened

can leak

galvanized iron: very common

noisy

- hot in summer
- cold in winter
- inexpensive
- easy to work with
- can become rusty when coating wears off
- sheets can be torn loose or bent in windstorms
- use nails with grommets to avoid leaks

- wooden shingles
  - can be inexpensive to install
  - expensive to maintain
  - will need to be replaced every 5-20 years
  - provides inadequate insulation values if used alone
- asphalt
  - less durable than slate or metal
  - lasts 10-25 years
  - one side may wear out before another due to weathering
  - asphalt can be repaired by putting a new layer of shingles directly over top of worn ones
- slate
  - expensive to install
  - will last hundreds of years
  - does need regular maintenance
  - roof cannot be walked on as slates will crack

Maintenance

- check once a year to make sure it's watertight
  - check the joints for signs of rotting or rust

Ventilation

One of the most important of design concerns

Ventilation in a stable affects both horses and humans

Ventilation is of the utmost importance in a stable

- It is one of the most overlooked aspects of horse housing
- Over a lifetime, horses typically spend more years in a barn environment than do other farm animals
- Fresh air will allow the horse to perform hard work and retain athletic ability
- Horses are typically the only farm animals being asked to perform as athletes
  - therefore, ventilation measures used for other animals are considered inadequate for horses as they do not take into account the physical demands placed upon the horse

Inadequate ventilation is the most common mistake made in the construction of modern horse facilities

- most barns today are built to residential standards rather than agricultural standards

Horses need ventilation while humans need insulation

- stable personnel have been noted to have higher incidences of
  - increased bronchial obstructions
  - increased levels of ECP in nasal lavage, indicating allergic inflammation
  - increased levels of lysozyme and myeloperoxidase(MPO, a marker for neutrophil activity, which may indicate a response to high exposure to bacteria in straw and manure) in the nasal mucosa
  - studies have shown that farmers, farm workers and stable workers have one of the highest levels of occupationally acquired asthma (Lembke et al, 2004; Kristiansen & Lahoz, 1991; Mackiewicz et al, 1996; McGorum et al, 1998; Tutluoglu et al, 2002; Elfman et al, 2009))
- horses are even more susceptible than humans to respiratory complaints
  - Horses that spend more of their time indoors are at greater risk of developing respiratory problems due to an increased cumulative exposure to a variety of potentially irritating components in stable air and dust

much of the focus of the effects of ventilation on horses has been on the development of asthma-like symptoms of recurrent airway obstruction (RAO) in susceptible horses where components of stable air trigger inflammation

initiation of inflammation appears to occur together with the presence of endotoxins that interact with stable and hay dusts to greatly enhance the inflammatory effects on RAO susceptible horses

foals are particularly vulnerable to the effects of high levels of ammonia

foals are subjected to higher levels of ammonia due to being in closer proximity to the ground where ammonia typically accumulates

ammonia can weaken a foal's immune system and will typically present as a respiratory infection

The sensitivity, precision and accuracy of measurement of airway problems in horses in relation to air quality lags far behind that available for humans

conversely, the measurement of airway inflammation in the horse is becoming more sensitive (Riihimake, 2008; Berndt et al, 2010)

The purpose of ventilation in a stable:

1. To replace stale air with fresh air

fresh air availability is one of the key factors in ventilation

ventilation of stables should aim to approach outside air quality

outside air is presumed to be the optimal in air quality for respiratory health

this is crucial because the horse's respiratory system is its weak link

one air exchange per hour (ACH) = the total volume of air in the stable is replaced in an hour

4-8 air exchanges per hour is the average requirement for a stable per day

different seasons require different exchange rates

in winter, we need a ventilation rate of 12-19 L/sec (25-40 CFM, or cubic feet per metre)

in summer, we need a ventilation rate as high as 142 L/sec (300 CFM)

to avoid having to exchange the air too often, 424-566 cubic meters (1500-2000 cubic feet) of airspace per horse is recommended

this will ensure adequate air for all occupants if a barn is closed up due to severe weather

in cold weather, it is best to add blankets and bedding for warmth rather than closing up the barn

horses can withstand cold, and withstand fluctuations in temperature fairly well

frequent air exchange is necessary, but chills and draughts must be avoided

horses less easily withstand drafts

avoiding sudden changes in air temperature is more important than the temperature itself

many stables today are being built to residential standards

this means that there is insufficient air exchange

this is due to architects not understanding the requirements of agricultural housing

if the stable smells stuffy, the ventilation is defective

2. Ensure good air distribution throughout the barn so that it can replace the stale air with fresh air to avoid 'dead air pockets'

maintaining fresh air availability is another key factor in ventilation

do not assume that because the aisle has good air movement that the stalls also do

3. Prevent condensation

condensation occurs when moisture is released from the air as it cools in contact with a cold surface

insulation can help to reduce condensation

unheated barns need R-5 insulation at the roof to discourage condensation on roof steel, even in a well ventilated building

shingle roofs over plywood provide insulation near R-2; adding a 25 cm (1 inch) thickness of polystyrene will provide an R-5 insulation value

condensation occurs in areas where the temperature dips below 2 degrees Celsius (35 degrees F.) for extended periods of time

moisture in the air can make an environment humid in summer and damp in winter

moisture in the air will cause deterioration of the structure (stable or barn)

framing rots

metal structures rust

insulation can be ruined

moisture build up can intensify odours and cause more ammonia release

moisture build up can increase pathogen viability, contributing to respiratory infection

bacterial and fungal growth escalates

a barn with condensation can contribute to stiffness in horses

condensation will cause water dripping onto horses, bedding, tack and feed resulting in spoilage and loss

in cold weather, condensation can turn into ice on roof, windows, and walls

4. Maintain acceptable air quality by removing

carbon dioxide

ammonia

hydrogen sulfide

dust

airborne pathogens

fumes

Particles in the air can affect respiratory organs and transmit pathogens

dust, endotoxins and glucan are considerable in a stable

bacteria and fungal exposures are moderate

Dust, pathogens and gases come from feed, bedding, manure and horses

mould spore formation is a primary concern in stables as it has a direct negative impact on the respiratory tracts of horses and humans alike

particulate matter such as endotoxins are greater risk factors for airway inflammation more than any potential inflammation caused by cold weather

Husbandry practices, and choice of feeding and bedding will influence air quality in a barn

sweeping the floor is the predominant task that adds dust, endotoxins and glucans to the environment

It is recommended to clean barns when horses are turned out to reduce the intake of the increased level of airborne particles and ammonia (Fleming et al, 2008a, 2008b; Sadegh et al, 2009)

feeding the horse is the second biggest cause of added glucans in the environment

Feeding choices can influence air quality

a low dust feed such as ensilage will reduce the markers of airway inflammation (Wyse et al, 2005)

short term water immersion of dusty hay can reduce the air particle load (Clements & Pirie, 2007)

bedding is the third leading cause of poor air quality

elevated levels of volatile organic compounds have been measured in the air from the use of pine pellets

poor ventilation can cause slower drying of bedding in stalls, leading to poor air quality

different beddings have different drying rates:

wheat straw has a more beneficial effect than shavings or straw pellets on the concentration of ammonia in the air (Fleming et al, 2008a, 2008b)

shredded paper and other beddings low in dust are preferable to straw bedding for horses with RAO; reduction in markers of airway inflammation were noted (Wyse et al, 2005)

peat moss can vary widely in dust depending on its source

seasons affect air quality

levels of bacteria in the environment are typically slightly higher in fall and spring

endotoxin levels are typically lower in winter and higher in summer

glucan levels are typically higher in winter and lower in summer

age of horse

Foals are particularly susceptible to high ammonia levels in stables, which will weaken the immune system and lead to respiratory infections

foals are shorter and therefore closer to the ground; they also spend more time lying down, which puts them into closer proximity to ammonia

gases like ammonia (NH_3) and hydrogen sulphide (H_2S) form acids that burn respiratory tissues

5. Remove heat and hold down excessively high temperatures to prevent heat stress

Temperatures ranging from 10-24 degrees Celsius are optimal

there is no need to remove excess heat from stables in northern climates

Barn air humidity should be 50-75%, with 60% being considered ideal

too dry is better than too humid

moisture in the air fuels humidity

a 454 kg (1000 lb.) horse will put two gallons of moisture into the air, not including that coming from urine , feces, and any water source (wash racks, etc.) in the stable

very dry air (low humidity) dries nasal mucosa and can be a source of dust and pathogen infiltration

very moist air (high humidity) combined with low temperatures can reduce the insulation properties of the horse's hair coat

very moist air and high temperatures can cause moisture build up inside the stable, causing deterioration of the structure

For specialty areas such as tack rooms with wood floors, if they have a space between the floor and the ground, foundation vents will remove the humidity

total vent area should be 61 cm squared (2 square feet) for every 30.5 metres (100 lineal feet) of foundation perimeter

Signs that your barn needs better ventilation

Development of respiratory problems in the horses housed in the barn and/or in the humans who work in the barn

Strong smell of ammonia or other odors

Dripping ceilings

Mold on walls

Moisture swollen wood

Foggy windows

Hay and grain spoiling quickly

Tack getting moldy

Development of ice dams on the roof causing snow to melt and refreeze in the eaves

How does a ventilation system work?

1. Moisture Holding Capacity

    air can hold moisture in water vapour form

    the amount of moisture held by a fixed volume of air (RH - relative humidity) increases as air temperature rises

    for every 10 degree increase in air temperature, moisture holding capacity of the air doubles

    by heating the outside incoming air, it can wick up the moisture from the horse

2. Thermal Buoyancy of Air

    Thermal buoyancy means warm air rises

    This is also known as the *'stack effect'* or the *'chimney effect'*, caused by a convention cycle

        This happens because warm air is less dense than cold air

        since warm air rises you want to bring in fresh air down low, and ventilate it up high

    Once the wind speed is above 1.6 km/hr (1 mph), wind driven ventilation will dissipate the effects of a natural ventilation

    Thermal buoyancy of air works well with natural ventilation systems

Methods of ventilation

Ventilation operates either *mechanically* or *naturally*, via convection (upward movement of the air)

all mechanical means of ventilation should be designed specifically for barn use

all mechanical means of ventilation should also have appropriate dust and moisture-resistant covers

natural ventilation is typically built into the barn's structure and requires no labour or additional money to run

the most common form of natural ventilation involves fresh air entering via windows and doors, mixing with the stale air, warming and rising to exit out of vents in the uppermost point of the stable

cold barns and warm barns utilize different natural ventilation systems

Natural Ventilation Systems

Most stables use natural ventilation due to low density (lower population of animals) in the stable compared to the higher density found in buildings used for other farm animals

Animal density and *height of roof* are the two main factors that will determine how well a natural ventilation system works

Wind is the dominant force in horse stables using natural ventilation

The most challenging weather for naturally ventilated structures is hot, windless days

Aspiration is when air blows across the roof creating a low pressure area or vacuum, pulling air out of the vents (and other openings)

For natural ventilation systems to work, the building must be placed perpendicular to prevailing winds

Perflation is when air moves through a barn by passing through openings such as windows and vents on the opposite wall

Condensation can occur with natural ventilation systems

water droplets accumulate on the roof and can deteriorate building components

There is typically very little insulation used with natural ventilation systems

Advantages of natural ventilation

the primary advantage of natural ventilation revolves around economics

theoretically it is planned and built into the building and requires no labour or additional money for it to run

air buoyancy and wind is used to move air

it's quiet

it provides more daylight

Disadvantages of natural ventilation

control of airflow and air distribution is not as good

barn should have heated water lines and tanks to prevent freezing in winter

it is hard to prevent drafts and condensation

barn needs to be at the right angle to prevailing winds in order to work most effectively

it is dependent on wind conditions

Types of Natural Ventilation

1. Vents: this includes ridge and roof vents, chimneys, louvres, continuous slot openings at the eaves, and cupolas

Ridge vent openings at the apex of the roof should match the eave openings with a minimum of 0.09 square meters (1 square foot) of opening per horse

the actual ridge opening is measured at the most restrictive part of the ridge vent assembly

avoid residential and commercial ridge vent assemblies for stables

an open ridge that never closes allows warm air to rise and escape

If continuous roof vent openings are not used, other options include:

cupola

is a square box with louvres on it built over a hole in the roof ridge

louvres

overlapping boards set at an angle to allow for air passage

usually installed in the upper wall, in the soffits (eaves), and in the gables

when fitted under the ridge of the roof, will act as outlets for stale air

need to be sufficiently broad and overlapping and at an acute angle to prevent rain from entering

louvres commonly block 50% of the open area

need to be permanently fixed open

chimneys

The higher the temperature difference between the inside and outside temperatures, the greater the uplift, which carries respired moisture and active gases with it

Buoyancy does not work well in warm weather as there is little temperature difference to pull stale air and gases up and out

Roof vents

continuous roof vents are the easiest to install and most efficient

a pot vent is a dome that covers a hole in the roof

Continuous slot openings at the eaves

a small eve opening will bring in fresh air at the top of the side wall which will reduce drafts but maximize air distribution

will provide fresh air down the length of the building and on both sides

the opening should be 2.5 cm (1 inch) of continuous slot opening per 3 metres (10 feet) of barn width

the spring (or lowest point of the roof) should be 3.65 metres (12'); this will allow the cool air to mix with the warm air and prevent drafts

hinged panels on eave openings may be used and allow the opening to be partially closed in the winter during extreme weather

never cover more than 75% of the opening

Sizing for cupolas and chimneys is the same for continuous ridge vent - 0.09 square metres (1 square foot) of opening per horse

	building width		
	10 m	20 m	30 m
side wall opening (mm)	300	600	900
eave slot opening (mm)	75	100	150
ridge slot opening (mm)	150	200	300

With any naturally ventilated building, a drip barrier (minimum RSI 0.7 (R-4)) should be installed on the underside of roof steel to prevent condensation

2. Doors

Main/Exterior doors

Exterior doors should not be considered a reliable means of ventilation as they are often closed

large doors at the end of centre aisles can be left open during warmer weather

Another option that can be used is large ventilation doors on a sidewall

Having a permanently open side of the barn or shed offers constant ventilation

cold barns are unheated housing often with an open side or end

There is a current trend toward installing garage doors in barns as end/main doors

they provide a clean, minimalist appearance

they do not take up room or get caught up on uneven ground as a swing door might

they do not fall off the tracks as a sliding door might

disadvantages include:

the most expensive type of door

requires professional installation

are very noisy

they cannot be left partially unopened

they are operated by electricity so could become problematic in cases of power outages and fire; would need to ensure a manually operated door is also available

Interior/Exterior stall doors, aka Dutch doors

(photo credit: Shannon Oldham-Dueck)

Dutch doors that open from the stall directly outside are another means of increasing ventilation

Stall doors

interior (stall opening into aisle) doors should be open on top or grated to increase air flow

full length expanded metal (mesh) doors are good options in a hot climate

using stall guards instead of stall doors as often as possible will improve ventilation but may encourage behavioural problems and waste bedding

Disadvantages of doors and windows as ventilation

includes unwanted entry of birds, insects and animals

exterior doors are not a reliable means of ventilation as they are often closed

Dutch doors can encourage chewing

3. Windows

Windows are the primary means of ventilation in a barn

Sherringham pattern windows that open in from the top, are recommended

Windows need to be high enough that the horse will not harm himself, but also convenient for the stable owner to operate

Having the windows on the leeward side of the barn permanently open will improve ventilation

In hot or humid weather, all windows can be left open to get a cross breeze

Inlet space per horse should be at least 0.09 square metres (one square foot)

Having windows on opposite sides of the barns with few interior walls will aid in ventilation

3. Ventilation Cowls and Tubes

cowls and tubes create a vacuum to draw up stale air

choose a design that prevents birds from nesting in them

design must work so that they act equally well regardless what direction the wind is blowing from

4. Interior Walls

the 'breathable wall concept' involves leaving cracks at board junctures to allow for air movement

ensuring that interior walls are not full height to the ceiling will encourage ventilation

open stall partitions: using grills for part of the walls, often at the front of the stall, will improve ventilation

an added benefit of open stall partitions is fewer stable vices due to less boredom/more companionship

5. Orientation of Building

If barns are built so that prevailing winds blow across it, ventilation will be better

Mechanical Ventilation

Mechanical ventilation involves the installation of a mechanical means of ventilating the barn

there is an addition cost to purchase and install

there will be associated costs with the continued operation of this means of ventilation

A mechanically ventilated barn is designed for year round conditions

dependency on this in areas that experience frequent power outages should be noted; generators may need to be purchased as a back-up

The barn must be fully insulated to RSI 3.5 (R-20) to achieve the best results

Mechanical ventilation should be installed at least 3.35 m (11') high to prevent contact with horses

The biggest effect of installing mechanical ventilation in a barn is in the reduction of carbon dioxide by half

other improvements were noted in

increased air exchange rates

reduction of ammonia levels

reduction of horse allergens

reduction of ultrafine particles

reduction of microorganisms (fungi and bacteria) on inner wall surfaces

significant up regulations were observed in IL-6 mRNA expression during winter periods which coincided with increased neutrophils in BAL fluid

a significant decrease in accumulation of tracheal mucous, indicating reduced airway inflammation

factors that did not change were total and respirable dust, and bacteria levels

fungi and median endotoxin levels in air samples were measured to have increased; the reason is unknown

a significant decrease in the accumulation of tracheal mucous indicating reduced airway inflammation was noted (Walinder et al, 2011)

In a study of human personnel working in a stable, it was noted that the addition of mechanical ventilation showed

a growth-related increase of pulmonary function (forced vital capacity increased)

a very slight PEF-variability was observed

levels of biomarkers for nasal inflammation were slightly lower

subjects rated an increase in levels of smell and dustiness in their environment

Types of Mechanical Ventilation

Important to note:

Air velocity is the measurement of the rate of displacement of air at a given location

Volume flow is measured in cubic feet per minute (CFM) or metres cubed per hour

Mechanical Ventilation Systems

mechanical ventilation involves the use of roof mounted fans in trunks and inlets in the side walls

fan speeds should be linked to the aperture of the inlets

a mechanically operated shutter in the roof outlet trunk controls airflow and prevents down drafts

Air Duct Ventilation System

achieved through the installation of fans pressurizing a length of ducting with graduated holes which provide an even distribution of air

this will achieve uniform distribution of air

motorized shutters or openings let air in at one end

air is mixed and uniformly distributed along length of barn via air ducts

ducts are typically made of plywood or plastic

ducts should have hinged bottom to help with clean out

Exhaust Fans

ventilation required per horse ranges from 42.4 metres cubed per hour (25 CFM) in winter to 510 metres cubed per hour (300 CFM) in summer

if there are 15 horses or fewer in the stable, use the smallest fan (510 metres cubed per hour or 300 CFM) for base ventilation rate

the higher rate is necessary since air quality is a function of the rate or air exchange, not of horse population

ideally there should be two air exchanges per hour

a reasonable progression of ventilation stages/steps between seasons is required

at least two exhaust fans with a two speed or variable speed is necessary

having a variable speed fan with a 510-1700 metres cubed per hour (300-1000 CFM) capacity is recommended

Circulation fans

A temporary measure for moving air in a stable

In a fan ventilated building, the air exchange is done mechanically

a well designed horse barn should not require this

Useful in buildings where direct access to outside air is not available

In retro-fitted buildings, internal re-circulation fans can be installed, suspended from overhead beams

these units do not introduce new air into the building, but merely re-circulate existing air

In cold weather, the best way to mechanically ventilate a barn is through the use of a continuously running sidewall exhaust fan

during mild weather, a second fan may need to be run

in hot weather, this will need to be increased again

Temporary Pedestal and Wall Fans and Misting Kits

These are often seen in the stabling areas of horse shows

Provide local cooling

Misters will remove heat by using water vapour and air movement

They reduce the surrounding air temperature

They reduce the fly population in the stable

A secondary advantage in using fans is in helping to combat the irritation cause by flies by keeping the air constantly moving

Air inlets

air inlets are slot type openings on the top of sidewalls and through ceilings from an attic or duct

this can be bought as a pre-manufactured unit

well managed windows can be used for this purpose

this requires frequent adjustments with temperature and wind changes

A properly designed air inlet must be provided to allow air to enter the building

the inlets should be sized to provide 0.09 square metre (1 square foot) of inlet area for every 1020 metres cubed per hour (600 CFM) of exhaust fan capacity

inlets should be evenly spaced throughout barn

Air from the inlet must be heated quickly

this will prevent drafts

heating will also enhance air's moisture holding capacity

Ventilation for Hot Climate Areas

in addition to the above, a few other considerations include:

light colour on roof and exterior, to reflect the heat

covered porches to keep the area and air directly around the barn shaded and cooler

shade trees planted near the barn, on side where the sun is at the hottest time of day

stalls that open directly outside; can use door grates in place of solid doors

interior walls that are full metal grating or primarily made of grating

or stalls with air flow bars on the top half of walls

use solar panels on windows that get direct sunlight

high ceilings/roofs

insulated roof to keep the interior cooler

Supplemental Heating for Cold Climates

when making the decision to heat a barn, consider who will benefit from the heat: the horse or the owner?

horses typically are more comfortable and healthier living outside or in an unheated building

young horses and sick horses are the exception to the above, and could benefit from heating in a stable

another exception is a show barn where horses are kept fully body clipped year round

as well, heating the tack room will prevent tack from rotting and molding

radiant heating in the floor is recommended as a method for heating the tack room

heating will keep a barn above freezing temperatures

heat always moves to cooler areas

heat moves in three ways:

conduction: direct heat exchange through and object like panelling

conductive heat loss is slowed down by mass fibre insulation

convection: the transfer of heat through air

convection heat loss can be solved by making sure there are no holes for heat to be lost

radiation: the movement of heat across open spaces

radiation heat loss can be slowed by using a reflective barrier

ensure heated barn or specialty areas that are heated are fully insulated with a vapour barrier on all sides

insulation keeps heat in winter, heat out in summer, and noise out

steel roofs should be insulated to protect against noise in severe weather

insulating a barn but not heating it will result in a slightly higher inside temperature

the three types of insulation are:

flexible

rigid

reflective

loose fill cellulose insulation is highly flammable and not recommended for barns

vapour barriers are always installed on the warm side of insulation

only one vapour barrier is needed

a vapour barrier can be made of any waterproof membrane including spray foam, plastic sheeting, foil backed gyprock, etc.

the higher the desired temperature, the higher the cost to operate

10 degrees C is a common temperature

normal ventilation rate of 500-1000 watts per horse (1700-3400 BTU/hr/horse)

forced air electric heat is often used but is expensive

propane and natural gas are more economical

conventional forced air furnace

hot water boiler system in a separate room

another option is infrared (radiant) heating or a heat lamp

if these are used, must be well protected from contact with the horse and from contact with any potentially flammable items

if the decision is made not to heat the stalls, two specialty areas may still require heating

tack room: to protect against leather molding

utility room: to protect water tanks, washing machines, water lines, etc. from freezing

warm barns are fully insulated

if no supplemental heat is added, this can be 5-10 degrees warmer than outside

install a heating system rather than reduce or eliminate ventilation

may have a side wall vent opening with insulated panels or double glazed window- type vents

they do not employ continuous peak vent

has one or more chimneys for exhaust

if there is a loft, the chimney will need to be insulated at a minimum of RSI 1.8 (R-10) to prevent deterioration of the building and feedstuffs

air shaft capacity should be 0.5-1.0% of the barn floor area

a control damper with 90% closing capacity will prevent cold down drafts

doors and windows will provide the remainder of the necessary ventilation but will need to be managed during storms

Controls and Monitoring

Most suppliers offer an electronic controller that interlocks the fans and heating system

This will limit heating costs by ensuring the two systems are not running concurrently

Keep the controls out of easy reach to prevent unauthorized setting changes

Monitor barn with

thermometer

humidity level

smoke pencils to check air movement and drafts

gas detection tubes for measuring ammonia, carbon dioxide and other gases

Utilities

Water systems:

Your water system is potentially the single most important aspect in the successful running of your stable and farm

water is essential for the life of your horse

water is important for irrigation of gardens and fields, cleaning, washrooms, watering of arenas

a poor water plan can result in

higher costs

more labour

inconvenience

animal illness or death

plant loss

The size and scope of your water system depends on

the number of horses on the property

ancillary services offered on site like wash racks, indoor washrooms, and hot water

Water may be sourced from

public water (if available)

wells

natural open water sources such as rivers, ponds or lakes

Property owners are responsible for water quality for all water sources other than those from public sources

- refer to pp. 8-9 in this document for more information on this topic

Plumbing consists of two sets of pipes

- water supply pipes from well/public water
- waste water drains
- hot water systems need their own separate, third set of supply lines

Water in the barn

- If there is an indoor washroom, locate it beside the wash rack for plumbing purposes
  - having the washroom in or near the tack room is a good idea as the tackroom is often the only insulated and heated room in a stable
  - Have a water heater located under stairs to loft In cold climates
- Have water spigots every two stalls

To prevent pipes from freezing in cold weather areas

- install drain valves on the pipes
- make sure pipe slopes down to drain valve so water can drain out
- when digging trenches for pipes, deeper trenches will help to prevent freezing
  - 1.2-1.8 m (4-6')
- pipes should be installed below soil frost line
- avoid running water lines in outside walls
  - pipes in insulated walls may freeze
- install pipes where they will be warm, can be seen and fixed easily

Your water system is most vulnerable at winter due to freezing potential

- Put frost free water hydrants (freeze proof water spigots that extend above three feet up above the ground) in as many places as you can for convenience when watering pastures
- You may need to
  - heat the barn

use electrical heat tape on exposed pipes

Drainage:

Good drainage is important for

preserving the structural integrity of buildings

preserving footing around buildings

thereby preserving horse health

maintaining ease in working with and around the horse, paddocks and pastures

Building Exterior

In high rain areas like BC's west coast, the installation of eaves troughs on the roof will be an integral part of the drainage system

Diverting water from the roof into an underground drainage system will help to preserve footing, prevent mud, and help to prevent frost formation around the foundation

use flexible pipe 30.5 cm (12") under the ground, running into a French drain

French drains should be planned during the construction phase, but can be added later if necessary

- to install a French drain, dig a trench 0.6 -1.8 m (2-6') deep and 0.6 m (2') wide
- the drain will employ gravity so the trench should be sloped away from buildings, etc
- perforated pipe should be laid, then rocks on top to promote drainage, and finally the top 15-30.5 cm (6-12") will be brought up to grade with top soil

If the soil in your area is clay, it may saturate more quickly and require extra drainage around the building

- install drainage pipes perpendicular to the barn, running away from the barn, 46 cm (18") under the ground surrounded by 2 cm (3/4 ") clean stone
- pipes will connect to a French drain about 30' on one side of the barn, leading to a water holding area
- areas with a large amount of rain will need two drains, one on either side of the barn

To direct and slow run off around buildings, use

- berms (low mounds of vegetated soil)
- swales (shallow, gently sloped vegetated ditches)
- dry wells (small pit lined with gravel) can direct and slow run off

In areas with high snow accumulation, create a snow removal plan

- snow will need to be removed from driveways/lanes, paths and paddocks
- avoid piling snow along the side of a building as this can create problems during thaw season

Building Interior

In a 24 hour period, a horse will produce 3.5-9.5 litres (1-2.5 gallons) of urine and 13.5 kg (30 lbs) of manure, of which 75% is water

Other sources of water accumulation include:

- water spilled through the process of providing water in a horse's stall
- water used in cleaning and disinfecting stalls
- water used in bathing, including wash racks

The above moisture will be removed in one of the following ways:

1. a gravity drainage system

    In stalls, the floors need to slope towards a drain, typically located at the back of each stall

    a drain at the back of the stall should connect to a gulley outside

    drain hole should be draught proof

    all drains should be free of sharp angles

    a trap should be provided to prevent the return of sewer gas from outside drains

    in areas where freezing is a concern, the expense is high to prevent the water from freezing and to install the system below the frost line

    drainage in a wash rack and aisle way will be very high traffic and must be able to

        accommodate the volume of water that will be produced

        provide a strong area that a horse may stand on and that will bear his weight

        be easily cleaned

2. absorption by bedding materials

    shavings is the most absorptive bedding material

    it will hold moisture until the stall is cleaned

3. filtration through the flooring material

    filtration through flooring is often an attractive option during the construction planning stages as it typically employs native materials, thereby saving on money

    filtration through flooring can result in uneven footing over time

    filtration through flooring can result in odours

    filtration through flooring can cause a building to retain too much moisture, contributing to poor air quality and condensation

    flooring of this type typically needs to be replaced every 1-5 years

Lighting

Is important for

observation

care and cleaning

reduction in development of mold spores

Natural light

is best

natural light will cut down on the cost associated with artificial light

horses are often happier in the presence of adequate natural light

natural light is important for the synthesis of vitamin D

Source of natural light:

Doors

Windows

Sunlight

0.37 square metres (4 square feet) of window space per stall is recommended

glass windows need to be a minimum of 2.4 m (8') high at lowest point

windows should be grated

Sherringham pattern (opening in from top) prevents drafts and allows for exchange of air

Plexiglass is another option

Skylights are an option, but there are two potential problems with them

they cause solar heat gain

can be a source of roof leaks over time

Artificial light

Electric light

aisle lighting is standard

2.4 m (8') fluorescent light tubes are a good option for barn aisles

aisle lighting should have switches at both ends of the barn

- place lights along front wall of stall
  - another option is to have one light in each stall, up high near the back
  - 100W incandescent or 20W fluorescent are both suitable
  - lights should be placed at least 2.4 m (8 feet) high
  - lights should be in shatter proof cages
- wiring housed in metal or hard plastic
- wiring and switches must be out of reach of animals and children
- special 'stable' type switches should be used to prevent electrocution

Exterior lighting

- install lighting in high traffic locations outside

Lighting in an indoor arena

There are three options for lighting an indoor:

- incandescent
  - instant start up
  - will last up to 20 years
- fluorescent
  - instant start up
  - lasts around 5 years
- metal halide (gas filled fixtures)
  - 3-5 minute start up
  - lasts around 5 years
  - considerably cheaper than the other two options

Electrical

From the Canadian Electrical Code:

"Category 1 - the location is one in which moisture in the form of vapour or liquid is present in quantities that are liable to interfere with the normal operation of electrical equipment, whether the moisture is caused by condensation, the dripping or splashing of liquid , or otherwise; and

Category 2 - the location is one in which corrosive liquids or vapours are likely to be present in quantities that are likely to interfere with the normal operation of electrical equipment" (BC Safety Authority)

Stables for horses in rural farm areas are considered Category 1 buildings

Stables for horses are considered Category 2 buildings

All wiring should:

be the type selected for wet locations

the correct size

housed in a rigid steel or rigid non-metallic conduit to protect against rodent damage when installed in locations that rodents can access such as lofts and along horizontal surfaces

electricity flowing through wires produces a salinity (salts) that attracts rodents

PVC is preferred in barns over metal, due to humidity in barns

have UF-B rating

be tight

be well supported

be stapled

be out of reach of horses

Aluminum conductors should not be used

Electric wiring should NOT be concealed unless it is installed in rigid conduit or otherwise protected against rodent damage

Outlets should have protective covers in place

Electrical equipment such as livestock waterers should be bonded to ground by a separate stranded copper bonding conductor not less than No. 6 AWG terminating at a point where the branch circuit receives its supply (Canadian Electrical Code Rule 10-402-4)

If using stock tank heaters, they should be plugged into GFCI protected outlets to prevent shock

For non-electrical equipment, in buildings housing livestock, all metal water pipes, water bowls and other metals that could become energized should be bonded to ground by a separate stranded copper bonding conductor not smaller than No. 6 AWG except that, where it is necessary to control the effects of stray earth current, a device specifically approved for the purpose, connected in series with the bonding conductor, shall be permitted (Canadian Electrical Code, Rule 10-406(5))

According to the National Electrical Code Article 547 -Agricultural Buildings, all horse barns or stables must

use Copper SE, UF, RNMC as the wiring method

enclose any light fixtures over stalls, hay or bedding

in bedding areas, switches and outlets must be dust tight with weatherproof covers

use TEFC motors

use Equi-potential plane

Recommended:

- Outlets should be between every two stalls
- Install 110 volt outlets, but also install one 220 volt for hot water heater, dryer or x ray equipment
- Keep main panels clear of storage
- Fixtures should be
  - tight
  - well supported
- Extension cords are only to be used on a temporary basis

Have a plan for loss of electricity

- in the case of a power outage, water pumps in wells will not work, resulting in no water
- have a back-up plan for water in the case of power outages
- may need to purchase a generator to operate water and heat to prevent freezing

The stall is the basic functional unit of a stable

Purpose

- to provide a suitable environment for both horse and handler
- for the comfort of the horse, providing him with a place to lie down
- gives him freedom of movement
- for the convenience of the owner
- to provide more control over the horse's environment
- to provide an area for care and rehabilitation for ill, injured, or convalescing horses

Photo credit: Shannon Oldham Dueck (used with permission)

Safety is the primary consideration

There are four main types of stalls:

1. box stalls - aka loose boxes
2. tie stalls -rarely seen these days
3. isolation/quarantine stalls
4. foaling stalls

Interiors and fixtures need to be:

smooth

rugged

free of projections

Dimensions

Box stall aka Loose box:

3.6 m square (12 X 12 foot) for a horse

- the more time the horse spends in the stall, the bigger the stall should be

- if there is more than one horse in the stall (e.g., mare and foal) the stall should be larger

3.6 X 3 m (10 X 10 foot) for a pony

Tie stall aka Standing stall: 1.67 m X 3.35 m (5'6" X 11')

Isolation stall

each barn should have at least one, but it may be located in a separate building

needs to be convenient to the caregiver

stall should be located so that the occupant can see other horses

stall should be at least 50% larger than a regular stall

the structure should be able to support a sling attachment

Foaling stall

should be larger than a regular stall

may need to be wired for lights, heat lamp and/or video/closed circuit TV cameras

must have flooring that can be sterilized

Walls or partitions

a stall wall should be 1.5 times the horse's length

the outer wall should be 3.65 m (12') high at the spring (lowest point) of the roof

partitions between walls should be at least 2.28 m (7.5') tall

having an open panel design allows for better ventilation and for horses to see others

partitions in the front and sides of stalls should prevent a horse from contacting its neighbour

prefab partitions are usually 2.1 m (7') tall and are either solid of topped with bars

stall walls that extend up to the ceiling create air pockets that are difficult to move, creating dead air pockets

Wood

dividers or partitions are typically made of 5.08 cm (2") thick rough cut oak or tongue-in-groove pine

walls and dividers or partitions need to be flush with subfloor to prevent horse getting a leg caught

if using 3.65 m (12') long boards, use vertical centre bracing to stabilize boards in case of breakage from kicking or other damage

open panel design will have wood up to 1.2-1.5 m (4-5'), topped with metal dividers

metal used must be reinforced so it won't bend if kicked

use pressure treated wood on bottom 1.5 m (5') due to potential for damage from kicking

cap horizontal edges with metal to protect from chewing

never use thin plywood or particle board due to the danger to the horse if he kicks through it

1.9 cm (3/4") thick plywood will have a better strength to weight ratio than boards, and will be better to use in the case of a kicker

Concrete can be used

Advantages:	**Disadvantages**
strength	poor thermal characteristics
durability	high construction costs
	unyielding to kicks so may cause bruising or concussion related injuries

Kicking Boards

Kicking boards may be placed on the walls to a height of 1.5 m (5') and double the depth of the boarding

Affix so that it is easily attached and remove in the case of damage/repair

Choose strong boards with a strong grain

Doors

doorways

manufactured doors typically come in a standard size of 2.1 m by 1-1.14 m (7' x 42-45")

a half door should be at least 1.1m wide (3'7") and 1.25 m high (4 ft.)

doors should be

sturdy

durable, non-sagging

less than 7.6 cm (3") clearance at bottom

secure

good quality latches

able to be operated with one hand

hinged doors need to swing out into the aisle for safety of the horse in the stall, and for the safety of the person handling the horse

can be hinged or hung on rollers

hinged doors, if hung properly, are typically maintenance free

sliding doors need to have a guide to keep the door on the track

guides need to be rounded and out of the path

horse-proof

free from projections

encourage good airflow via either Dutch doors or grating on top

Ceilings

of 3.65 m (12 feet)

- any lower:

- poor ventilation

- danger of the horse striking its head

if second floor storage is necessary, a suggestion is to have a ceiling in the aisle with storage above, and no ceiling above the stalls for improved ventilation

Fixtures*:* ideally, the fewer the better

consider

cost

durability

ease of cleaning

ease of replacement

safe and free from projections

1. latches

need to be strong and easy to operate

large handles

flush with wall, no projections

avoid anything a horse's jaw can get caught in (such as a horse shoe shape)

should be horse proof

a second latch at foot height is recommended

2. water bucket or automatic waterer

automatic waterer

more expensive to buy and install

time saving

labour saving

locate away from feed buckets and hay source

select based on:

strength

maintenance requirements

smoothness of surfaces

water refill mechanism

ease of cleaning

in cold climates, water lines for automatic waterers may need some form of heat

water bucket

horses will drink more water from a bucket

allows you to monitor horse's water consumption more easily

attach to a ring 1 m (3') from floor situated in a corner

automatic waterers can encourage the stable management to become lazy and complacent about checking and cleaning - this needs to be done daily

3. feed tub

fastened to wall to prevent waste/spillage

if permanently affixed to the wall, can be hard to clean

positioned between chest and nose level

4. rings for tying

one at or above breast height for typing

at or above wither height for short racking or tying haynets

place away from feed and water buckets

place near back wall of stall

make sure wall ring is attached to is strong

the average horse can exert a pull of 680 kg (1500 lbs) of pressure on a ring

5. rings and fixtures to attach buckets, etc.

smooth

free of gaps

rings should be equally safe whether buckets are present or not

fastened securely to the wall

if double ended snaps are used, face snaps away from the horse

should allow for easy removal

6. optional:

a. toys

to alleviate/prevent the development of stable vices

up to 40% of stabled horses have stable vices

b. methods for feeding hay

i. manger

designed so that it is flush with the floor and ends nears the horse's chest

should be smooth with rounded corners

rim should be broad enough to discourage cribbing

less dust fall

less likely for horse to get trapped

horse eats in a more natural position

chaff and dust may accumulate and need cleaning

ii. hay rack

disliked by some as it may drop hay in horse's eyes

horse's leg may get caught if he kicks

iii. ring for haynet

haynets disliked by some as it may drop hay in horse's eyes

horse's leg may get caught if he kicks

iv. corner apron of concrete

v. slow feeder

can be re-positioned easily

Consider:

cost

durability

ease of replacement

ease of cleaning

Placement:

separate feeders from waterers

Ventilation specific to the stall

Do not assume that because an aisle way has good ventilation that the stalls have the same level of ventilation

There are some common methods for achieving good ventilation in a stall

1. windows

    windows are the primary means of accessing ventilation in a stall

    Sherringham pattern windows - open in from the top to allow the exchange of air while preventing draughts

    In barns with interior stall aisles, it has been proven that the air quality is poorer in the interior stalls than it is in the exterior stalls as they do not have window access

2. doors

    Dutch doors in stalls, doors that open to paddocks will improve ventilation

    Distance from exterior door to stall will influence quality of ventilation

3. insulation: conserves heat in cold weather and in the heat, helps to keep the barn cool

    ceilings and walls are insulated and have a vapour barrier on the warm air to prevent condensation of warm air against cold surfaces

    insulation also prevents deterioration of wooden structural material and corrosion of metal fittings

4. ventilation - may be natural or mechanical

    warm air rises

        exits through louvres on four sides of a ventilator on the roof

        exits through vents, cowls, or chimneys

    mechanical systems using fans can be utilized in stalls

5. building design:

    boards in dividers/partitions between stalls can be up to 3.8 cm (1.5") apart to enhance air movement

    use an open panel design rather than having dividers or partitions extend up to the ceiling

Drainage Within Stalls

Safe open channel along stall wall is recommended

Open channel drains are subject to emitting odors and freezing in cold weather

Stall floor should slope 1.5-2% toward outer wall

other options include:

single slope to aisle with aisle channel sloping to drain

double slope to aisle with main aisle channel sloping to drain

Avoid drains in the middle of stalls as they will clog

Fire Safety

Fires need a fuel source

A stable is a fuel source rich environment

often wooden construction

bedding

hay and hay storage

grain dust can be highly combustible

used burlap bags

fertilizers

rags contaminated with organic oils (linseed, neatsfoot, cod liver, etc.)

Smouldering fires are common

smouldering can vary from minutes to hours

they can be hard to detect

they can be difficult to extinguish

hay and shavings insulates the fire and prevent water penetration

Horse barn fires burn with moderate to high heat production

Have a fire safety plan

evaluate location of the buildings, access points, water sources and paddocks

create an evacuation plan for the stable

how to get horses out

where to put them upwind where they will/can stay out of and away from the building

have an entrance plan for the fire department

street address visible from the road

security gates will need to be opened

always have fire department, vet information, a list of any chemicals stored and their location, and barn address posted in a conspicuous location

having a site map that can be forwarded remotely to the fire department that shows

entrance

location of buildings

where animals are housed

location of any chemicals or fuel sources

location of secondary water sources

install smoke detectors

have master switches for lights near entrances so that light is available for rescue and fire suppression

have fire extinguishers in conspicuous locations every 15.24 m (50')

there are three types and codes for fire extinguishers

many extinguishers can be used on different types of fire and will be labelled accordingly

1. *Class A extinguisher*

will put out fires in ordinary combustibles

contains water and compressed gas

should only be used on ordinary combustible fires

2. *Class B extinguisher*

to use of fires involving flammable liquids

carbon dioxide extinguisher

gas disperses quickly so only effective from 0.9-2.4 m (3-8 feet)

helps to cool surrounding air

3. *Class C extinguishers*

suitable to use only on electrically energized fires

Halon* extinguisher

limited range of 1.2-1.8 m (4-6 feet)

4. *Class D extinguisher*

designed for use on flammable metals

often specific for the type of metal in question

have a fire drill

let any staff, boarders and neighbours know of your fire safety plan

Fire prevention

The best barn fire prevention systems use

building design

early warning devices

fire suppression mechanisms

Remember, there is no such thing as a fireproof building

agricultural buildings and workshops are highly susceptible to fire

always use fire resistant/retardant building materials

masonry will not burn but is expensive and can obstruct air flow

heavy timber construction resists fire

fire retardant wood decreases flame spread by 75%

sprinkler systems can be installed but are not common in rural, non-commercial stables

adequate water supply is necessary

effective fire suppression can be achieved with just two sprinkler heads

in freezing environments, a dry pipeline would need to be employed

water mist systems are used extensively in Europe and can be effective in suppression

Building design is one of the most important aspects of fire prevention

Having two or more smaller stables as opposed to one large building will reduce loss

try to have a stable design that incorporates two exits for each stall

Ensure easy entrance and exit from all stalls and rooms

Swinging stall doors must open out into the aisle

Compartmentalization is not common but is extremely useful in cases of fire

the stable is divided into 'rooms' no longer than 45.7 m (150 feet)

between rooms are fire resistant barriers

these barriers prevent the spread of fire and allow time for fire suppression

Fire curtains or fire barriers are walls that divide the open spaces in the truss area to prevent fire spread

- Fire ventilation removes gases from occupied areas - roof vents can perform this function
  - have 0.09 square metres (1 square foot) of ceiling vent space for every 9.29 square metres (100 square feet) of floor area

Barn management is the close second most important aspect of fire prevention

Hay fires are unique to the horse/agricultural industry

- baled hay can be its own ignition and fuel source
- the majority of hay fires occur within 6 weeks of baling
  - the usual cause is excessive moisture/improper curing of hay
  - ideal moisture range for hay at bailing is 15-18%
  - microorganisms can grow if the internal temperature reaches 54-60 degrees Celsius (130-140 degrees F) and then does not cool
  - once thermophilic micro-organisms take over, if the bale temperature reaches in excess of 77 degrees Celsius (170 degrees F.), ignition can occur

Have a water source such as hydrants, hoses, or ponds

- the major reason for fire suppression problems in rural areas is lack of water supply
- any potential water source must be no lower than 6 m (20') below the pump truck elevation

Ensure all electrical is up to code

- Faulty electrical systems are the second leading cause of preventable barn fires
- Inspect and clean electrical panels, wiring and fixtures frequently due to dust and spiderwebs

Lighting fixtures and fans should be designed for the harsh barn environment

Most barn fires occur in the winter

- hay and bedding supplies are high
- electrical use is high
- heating sources may be being used to prevent water from freezing
  - space heaters should not be left unattended
- equipment repairs and upgrades are often made to buildings in winter, which can spark fires

Flammable liquids should be segregated to a separate building

No smoking allowed in and around barns

- 95% of preventable barn fires are due to smoking

Hay storage preferably in separate building

- if hay is stored in the stable
  - keep area tidy
  - storage should be a minimum of 0.45 m (18") from light bulbs and other heat producing fixtures
  - some insurers will not provide insurance if hay is stored in the stable

Workshops should be separated from barns with gyproc walls

- Cutting, welding and grinding should not take place anywhere near stables

Outdoor burning needs to be at least 30.5 m (100 ft.) from the barn

- avoid burning in summer months/times of drought

Farriers hot shoeing need to have furnace outside of barn

Mow grass and keep weeds down -these are often an overlooked fuel source

Water heaters, furnaces etc. need to be in dust free areas

Vehicles should not be started in stable areas

Spontaneous heating of hay is a potential hazard in a stable area

- Ensure hay is well cured before bringing into the barn
  - 15-18% moisture in the hay is ideal; higher can lead to combustion
- Check newly baled hay twice a day for heating
  - temperature probes are available for this
- Add rock salt to reduce the moisture in hay
- Stack hay so that it can breath
  - Stack bales on their sides to allow convection ventilation
  - The greener or moister the hay, the looser it should be stacked
  - Use a pallet under hay

Dust and cobwebs can help a fire to spread - clean regularly

Keep all areas clean, tidy and free of debris

All doors and access areas should be free of debris and have operating latches

Lightning rods will protect barns from lightning storms

Practice good horse training techniques so that horses

- are used to being handled by strangers
- are used to smoke
- can be turned out with other horses
- are used to hoods, blankets and water

Many Fire Departments will come and inspect your barn and do a fire drill

Equipment to have on hand in case of fire

If the horse is to survive unharmed, he must be removed within 30 seconds

- quick rescue is key

have readily available:

- lead ropes - it may be difficult to get a halter on a horse and may be easier to get a rope over the neck to lead the horse
- halters
- gloves
- towels, blankets, hoods
- special release for Red Hot Metal Latches
- flashlight
- shovel
- crowbar
- axe
- fire extinguisher

Remember, in the case of a fire: ***when in doubt, stay out***

In most cases, if you see flames, it is already too late

Once flames are present:

fire is extremely dangerous and unpredictable

will grow rapidly and the heat becomes intense

capabilities of fire extinguishers will be surpassed at this point

it takes only three minutes for ceiling temperatures to exceed 982 degrees Celsius (1800 degrees F)

as temperatures continue to rise, the building acts as a boiler

'flash point' is then reached

this occurs in 3-5 minutes

hot air temperature ignites all combustibles

at flash point, survival within the structure is unlikely

Smoke is one of fire's killing attributes

smoke contains noxious gases and vapours specific to the fuel

smoke damage can occur before flames are visible

fire consumes oxygen and release carbon monoxide

carbon monoxide combines with blood hemoglobin resulting in suffocation

this increases respiration

increased respiration results in the inhalation of more deadly gases

when the super-heated mix of gases is inhaled, the respiratory tract is seared

Electrical space heaters should

be kept clear of combustibles

be equipped with automatic tip switches

be unplugged when not in use or when no people are around

Other Building Concerns

In addition to housing (stable) and turnout of some type (paddocks and or fields), other things that one may find in and around the stable itself are:

riding rings

- indoor
  - may be connected to stable, in which case a less dusty footing is desirable
  - separate from stable, consider direct line access between stable and arena for inclement weather
- outdoor

round pens

parking lot

secure long term storage area for trailer and equipment parking

- good access
- circular driveway is appreciated by some clients
- solid year round base

outdoor wash stalls

- outdoor wash stalls are often more pleasant in good weather than indoor wash racks, which are often damp and dingy
- outdoor wash racks can be drained in such a way that the excess water can be used for watering grass

exercise and cool out machines

- Dutch mills
- hot walkers

outbuildings for

- hay storage
  - pallets on the floor will allow bottom layer of the hay to breath and prevent spoiling
  - accessibility to barn

good lane access for trucks turning and unloading

bedding

ventilation will keep dust down

good lane access for trucks turning and unloading

adequate door size if trucks need to back in and unload

equipment storage

First impressions

main entrance should be well marked with address

for clients and visitors

for industry professionals

for deliveries

for emergency personnel and their vehicles

main entrance driveway should be wide enough where it meets the road that large trucks can turn in with no danger of losing a wheel in the ditch

if main entrance has a security gate, gate should be set far enough back off of the main road that large trucks and trailers can completely clear the road

having substantial gates that can be secured will keep horses in and help to keep unwanted visitors out

if main entrance has a buzzer or key code plate, it should be accessible directly from the car

the choice of road surface needs to be easily maintained and well drained

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