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MINISTRY OF AGRICULTURE

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Ministry of Agriculture

Quarantine Import Export Inspection and Certification Directorate

Construction Guidelines for Live Animal Export and Post-Entry Quarantine Facilities

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Acronyms

ECTAD: Emergency Centre for Transboundary Animal Diseases

FAO: Food and Agriculture Organization of the United Nations

m: Meter

cm: Centimeter

mm: Millimeter

m^2: Square meter

IATA: International Air Transport Association

L: Liter

Kg: Kilogram

TDS: Total dissolved salts

Mg: Milligrams

Km: Kilometer

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Foreword

This technical document entitled “Construction Guidelines for Live Animal Export and Post-Entry Quarantine Facilities” is one of the documents in a series of guidelines and Standard Operating Procedures that were developed by the Ministry of Agriculture in collaboration with the FAO-ECTAD Ethiopia, “Improving Sanitary Capacity and Facilitating Export of Livestock and Livestock Products from Ethiopia Project”. The main goal of the project is to increase exports of meat and livestock to benefit Ethiopian livestock producers and exporters and to promote national economic development.

This guidelines document is intended to provide guidance for Quarantine Import Export Inspection and Certification Directorate inspectors, live animal exporters and livestock export quarantine services providers with broad principles and minimum standards required to be licensed as operator of livestock holding facilities to be located along the different stages of live animals’ export value chain.

The guidelines include criteria for site selection, layout and design, construction as well as other general and specific requirements for establishing and operating livestock export and post entry quarantine facilities in Ethiopia. At this point, the Quarantine Import Export Inspection and Certification Directorate of the Ministry of Agriculture would like to thank the FAO-ECTAD Ethiopia, Improving Sanitary Capacity and Facilitating Export of Livestock and Livestock Products from Ethiopia Project, for providing the necessary technical and financial support required for reviewing, updating and publishing this guidelines document.

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1. Introduction

Livestock export is one of the valuable export trade avenues that generate foreign currency to Ethiopia and supports the livelihood of many people involved in the livestock production and export activities. Animal disease status remains an important consideration for trade in livestock and livestock products, with notifiable diseases influencing market access.

The importation of animals and animal products involves a degree of risk to animal and human health in an importing country. However, significantly different systems and measures may achieve equivalent animal and human health protection for the purpose of international livestock trade. Before trade in animals or their products occurs, an importing country should be assured that animal and human health in its territory will be appropriately protected. In most cases, the risk management measures adopted will rely in part on judgements made about the animal health management and animal production systems in the exporting country and the effectiveness of sanitary measures applied there.

To facilitate the live animals export, the Ethiopian government has established an export quarantine and certification system where by different animal health measures are applied to exclude diseased animals entering in to the live animals export trade chain. The risk minimizations measures are applied at different stages along the export quarantine and certification system. To minimize introduction of exotic and transboundary diseases in to the country, through importation of live animals and their products, the import inspection and certification system is also put in place.

1.1 Objective

The objective of this guidelines document is to outline basic construction requirements that can serve as a reference guide for constructing live animals export and post-entry quarantine facilities where different animal health measures will be applied in order to get final approval and certification for export or import of live animals.

1.2 Scope

The guidelines cover basic construction requirements of all facilities along the livestock export quarantine and certification system including holding grounds, pre-quarantine facilities, main export quarantine stations, principal export quarantine and border control posts. The guidelines also

address construction requirements for post-entry quarantine facilities that may be constructed in identified areas where imported live animals may enter in to the country.

2. Definition of terms

Quarantine: is an animal health measure applied on animals isolated and kept in a certain confined facility for a specified period of time for observing their health status as a preventive measure against the spread of infectious diseases.

Main (principal) export quarantine station: an officially recognized facility where livestock coming from pre-quarantine facilities and feedlots are being held in isolation for a specified period of time for purposes of veterinary observation and final certification as per the international livestock trade and importing country requirements

Pre-quarantine facility: is an officially recognized facility located close to the export quarantine station where animals from holding grounds and feedlots are assemble for screening before entering to the export quarantine station

Border control post: is any airport or road check-point open to international trade of commodities, where import and export veterinary inspections can be performed.

Post-entry quarantine facility: refers to facilities constructed for keeping imported animals for specified period of time to observe their health status in order to prevent introduction and spread of disease-causing agents in to the country.

Livestock resting pen: is a facility located within the premises of an airport where animals coming from main export quarantine stations for export via plane are allowed to rest until they are loaded to the plane.

Holding ground: It is a facility owned and managed by private company where animals purchased from nearby markets are assembled for a short period of time to enable the clients and the traders to complete the consignment

Biosecurity: means a set of management and physical measures designed to reduce the risk of introduction, establishment and spread of animal diseases, infections or infestations to, from and within an animal population.

Stocking density: the average facility pen area in square meters allocated to each animal.

A masonry wall (fence): is an outdoor wall or fence made with blocks or bricks of materials such as cement or natural stone that can be considered as an alternative perimeter fence types for pre-quarantine and quarantine stations.

3. The livestock export certification system

The national live animal export certification system is based on the addressing the concerns of global trade issues by minimizing the risk of spreading transboundary diseases along the different stages of the certification system applied in the live animal export trade chain. For this a number of stages in which screening of diseased animals is to be conducted are identified as follows:

- Sourcing animals from lower disease risk areas
- Handling livestock in holding grounds in which animals are treated for common ailments and identification is made for those animals that were not identified previously
- Transporting animals to the nearest feedlot or pre-quarantine facilities without direct contact with other animals along the way
- Providing appropriate animal health measures including vaccination, treatment
- Transporting to the main export quarantine facility for testing, inspection and final certification
- Transporting to the port of exit by dedicated transport trucks

Apart from the basic animal health management practices being conducted at the different stages of the live animal export trade, standard guidelines on siting, construction and management of the facilities in which the animals are to be kept are required.

Construction requirements for feedlot operations are addressed in a separate document. This guidelines document addresses those construction requirements starting from holding ground to pre-quarantine facility, main quarantine station, border control post and post-entry quarantine facilities.

4. Construction requirements for holding grounds

- ❖ It is a facility owned and managed by private company where animals purchased from nearby markets are assembled for a short period of time to enable the clients and the traders to complete the consignment.
- ❖ Animals are fed, watered, rested, identified by using ear tags or some other appropriate identification methods that are approved for use by the regulatory authority and provided limited veterinary interventions such as treatment for internal and for external parasites until they are to be transported either to pre-quarantine or feedlot facilities.
- ❖ Livestock movements permit to enter pre-quarantine or feedlot facility is issued.
- ❖ Only healthy animals are allowed to enter the value chain from this point.

4.1 Site selection

- ❖ Holding grounds should be located outside the nearby market areas
- ❖ It should be away from residential areas, main roads, livestock farms where direct contact with domestic or wild animals is to be avoided.
- ❖ The area should not well drained and not prone to flooding
- ❖ Should be accessible by vehicle throughout the year

4.2 Construction requirements

- The site must be fenced to prevent the entrance of wildlife and stray persons and contain the animals should they escape from the holding facility
- The fencing should of be of construction (material, mesh type and size) sufficient to prevent susceptible species passing through
- The holding ground should have the capacity to receive and hold the total number of animals to be purchased at any one time
- The facility should have a reliable source of clean water, adequate for the consumption of the animals to be kept there
- Feed storages must prevent spoilage and access by susceptible species
- Facilities are required to adequately restrain animals for treatment and identification
- Rooms dedicated for animal health personnel and some other administrative works as well as storage rooms for veterinary equipment and drugs should be available.

- Watering and feeding troughs should be available accessible to all classes and species of animals
- Partition should be made to house different species of animals, cattle, camel, small ruminants
- There should be loading and unloading rumps constructed to fit the different sizes of vehicles that transport animals

5. Pre-quarantine facility construction requirements

A pre-quarantine is an officially recognized facility located within a radius of 5-10 kms from the export quarantine station where animals from holding grounds and feedlots are assemble for screening before entering to the export quarantine station. During their stay in the pre-quarantine facility, for a period of 15 days, veterinary interventions such individual or group identification (by using ear tags or some other appropriate identification methods that are approved for use by the regulatory authority), sampling and testing, vaccinations, treatments, and monitoring for presence of diseases will be conducted. Time spent in the pre-quarantine facility is to be considered as a component of the required total quarantine period;

The facility must be isolated and securely fenced for purposes of sufficient biosecurity and to avoid close contact with other animals outside the facility. Human contact with the animals should be limited to facility personnel only. Regardless of ownership, all pre-quarantine facilities shall be under regulatory control of official veterinary authorities.

5.1 Site selection

Many factors must be considered when selecting a site for establishing a pre-quarantine facility.

Issues to be considered include the following:

- ❖ Bio-security considerations to prevent disease transmission and spread.
- ❖ Infrastructure support issues such as access to roads and water sources.
- ❖ Suitability of climate for easy operation of facilities without the provision of expensive protection measures.
- ❖ Site features such as suitable topography and availability of suitable construction materials.
- ❖ Environmental impact issues such as the protection of water quality and protection of community amenity.
- ❖ Distance between the site and human habitation, non-compatible industries, etc.

- ❖ Available land resources (on and/or off site) capable of utilizing the effluent and manure from the facilities.

5.2. Site selection criteria

5.2.1. Geographic location

To be economically viable, pre-quarantine facility must be located close to supplies of feed resources, slaughter animals, labour, all weather access roads.

5.2.2. Climate

- Climatic conditions have an impact on the environment, performance of animals and their welfare. Most environmental problems are associated with wet conditions. For this reason, sites with a high annual moisture deficit are desirable.
- Design and management changes can be adopted for sites with high rainfall. Facilities established in these areas often require the construction of higher capacity drains, sedimentation systems and holding ponds. Larger effluent utilization areas are also often required. Higher standards of pen foundation construction may be required to ensure durability in these wetter climates.

5.2.3. Topography

It is desirable that the feed yard area has a natural slope of 2% to 6%. For sites with fewer slopes, earthworks can be undertaken to create slope in the yards. Yard slopes greater than 6% are undesirable due to the excessive manure movement from the yards during rainfall and possible erosion of the manure-soil interface. Similarly, yard slopes less than 2% are also undesirable due to the slow drying of manure and little drainage from yards during and after rainfall.

It is generally undesirable for pre-quarantine facility to be established on hillsides, above residences or towns due to the potential for odour nuisance. This is particularly an issue if the down-hill air movement can be concentrated or confined by valley walls. As a general rule, offensive odours are less likely to be detected at residences situated at a higher elevation than the facility.

5.2.4 Risk of disease transmission

The risk factors for infectious diseases are mainly related to the environment that puts them into contact with the disease agent. As a result, a pre-quarantine facility should be established away

from high livestock density areas, human habitations, game reserves, livestock trekking routes and markets.

5.2.5 Pens location

A soil with 25 percent or more clay is preferred to sand or fractured rock structures. It is desirable to locate the pen area on a compacted, smooth, well-drained site. Hence, the following areas are not suitable:

- Rocky areas.
- Areas where natural springs occur.
- Areas with light sandy soils.
- Areas with highly expansive heavy clays overlying shallow groundwater aquifers.

5.2.6 Sedimentation systems, holding ponds, drains, manure stockpile and composting areas

A site must be available where sedimentation systems and holding ponds can be economically constructed and will fill by natural drainage from the pre-quarantine yard area. The soils underlying the ponds, drains, manure stockpile and composting areas should have a sufficient clay content to ensure that they are not permeable. If the available soil types are not suitable, imported clay may be used.

5.2.7 Effluent utilization area

Productive agricultural soils are required for the long-term application of water, nutrients, salts and organic loads in the effluent. These soils should preferably be deep, free draining and should not be overloaded with nutrients or salts. Ideally, the effluent application area should be close to the holding ponds. The best agricultural soils should be set aside for this purpose. The availability of clean irrigation water for effluent dilution and supplementary irrigation enhances the productivity of effluent irrigation schemes. The lack of good soil for effluent irrigation cannot be overcome by engineering works or the importation of material.

5.2.8 Manure utilization area

Manure can be economically spread over a much wider area than the liquid effluent. Nevertheless, manure spreading area must not be too far from the facility premise. Most soils will benefit from the well managed application of manure. The actual application rate should be

determined after analyses of both the soil and the manure, in light of the proposed cropping program. The addition of inorganic fertilizers to balance nutrients is often required. Most soils suitable for cropping or pasture production will be suitable for manure spreading, provided sufficient area is available.

5.2.9 Land requirements

When selecting a site for a pre-quarantine facility, it is essential to ensure that there is sufficient land available. The provision of adequate land for all present and future facility activities is an essential part of site selection. Land is required for feed yards, feed handling and storage facilities, animal handling yards, isolation pens, water storage and tanks, manure stockpiles, ponds, effluent and manure utilization areas, roadways, animal lanes and drains, carcass disposal areas and buffer zones.

Buffer zones include double fences, tree belts and windbreaks around the facility yards, screens or tree belts to visually screen them from the public and buffer strips between land utilization areas and water courses.

The total area required will depend on animal numbers and size, methods of waste utilization, local climate, soil types and topography, cropping programs and availability of existing buffer zones. The area required for waste utilization will depend on whether the material is to be used on or off site, the soil type and cropping program. It is generally necessary to have sufficient land area available on the facility property to utilize the liquid effluent produced by the facilities. In the case of manure, it is desirable for facilities to have some productive dry land or irrigated cropping or pastures areas available for application.

When establishing a pre-quarantine facility, attention must be given to future expansion plans. Future expansion should be considered in the development application for new pre-quarantine facility with thought being given to the availability of suitable land for separation distances as they would be required for the future expansion options. Where practical, this land should be owned by the developer as future change of land use within the separation distance may reduce the opportunity to expand.

5.2.10 Water supply

A pre-quarantine facility requires a continuous supply of good quality water for uses such as drinking water, dilution of effluent water for irrigation, dust control, fire control and feed preparation. Water for pre-quarantine facility can be obtained from surface water, groundwater or municipal supplies or a combination of all three. Wherever possible, a pre-quarantine facility should have more than one water supply source (e.g. river plus bore or bore plus dam). If one source fails, the pre-quarantine facility can change to the other.

The volume of water required will depend on animal numbers and weights, local climate, irrigation requirements and feed preparation requirements. Hence, an individual estimate is required for each site. When assessing the suitability of a water supply, it is necessary to determine total annual requirements, peak short-term flow rates and emergency reserves in case of supply breakdowns. Bores provide a constant source of water provided that the quality is suitable.

The reliability of the water supply must be assessed to ensure that the intended water source(s) are sufficient to meet both the average pre-quarantine facility water requirements throughout the year, as well as the peak demand days and times of the day.

5.2.11 Surface waters

Flooding: Pens, manure stockpiles, effluent irrigation areas, sedimentation basins and holding ponds should not be located in flood prone areas unless adequate safeguards are incorporated. Consideration should also be given to vehicle access to the site during periods of prolonged flooding.

Protection of surface water quality: The facilities should be sited, designed and managed so that the quality of surface waters in the vicinity are not degraded by runoff, leaching or seepage from the facility yards, ponds or waste utilization areas. To achieve this, a reasonable buffer should be provided between the facility complex (including waste utilization areas) and streams, rivers and other watercourses. The separation distance chosen should be a function of the intervening topography, vegetation, natural gradient, management practices employed by the facility operation and other site-specific factors.

Protection of ground water quality: Pre-quarantine facilities should be sited, designed and managed so that the quality of groundwater is not degraded by the movement of pollutants or pathogens into the water resource. To achieve this, facilities should not be sited above ground water recharge areas or above ground water resources that are deemed to be vulnerable, unless those resources can be demonstrably protected. Such protection may be provided by one or more impervious geological strata and/or because the water is at considerable depth. Sites to be avoided include those where:

- there are existing shallow or rising water tables.
- there are shallow perched water tables.
- useable underground water resources are already partially degraded; or
- where there are major faults that might provide a short circuit for pollutants to the groundwater resource.

Waste utilization areas should be sited away from bores and wells. Effluent or manure should not be applied within 25 m of a bore or well which is used for domestic consumption.

5.2.12 Infrastructure and staff

Access: The site must be selected so that there is suitable vehicular access all year round. Consideration should be given to the preferred routes for vehicles entering and leaving the facility. Permanent all-weather access is required and should not be limited by flooding or other similar occurrences.

Staff: While it is necessary to locate pre-quarantine facilities away from residential areas so as to maintain community amenity and bio-security, it is also undesirable to locate them in an extremely remote area. In such instances, availability of manpower may be a problem.

5.2.13 Community amenity

The environmental impacts of a pre-quarantine facilities such as water quality degradation, dust and odours can be controlled firstly by good design and management practices and secondly by maintaining suitable separation between pre-quarantine facility and impact areas. All activities which are likely to cause the increased emission of odours, such as manure spreading or effluent irrigation, should be performed when the prevailing weather conditions and the time of day will cause the least odour emission and impact on sensitive receptors.

To protect community amenity, facilities should be established at an appropriate separation distance from sensitive community receptors. The desirable separation distance between the point of generation of the odour and each sensitive receptor will be a function of the source and intensity of the odour, the prevailing meteorological conditions at the site, and the nature of the intervening terrain and vegetation. Wherever possible, it is desirable to utilize existing topography and vegetation to screen new facility developments from roads, towns and nearby residences. The value of these natural features as buffers against odour, dust and noise should be utilized wherever possible.

Fixed separation distances shall be the least horizontal distance between the boundary of the pre-quarantine complex and each of the relevant features as shown in table 1 below:

Table 1. Fixed separation distances of physical features with a pre-quarantine facility

Physical feature	Separation distance from pre-quarantine in meters
Public road - except as below	200
Public road - unsealed with less than 50 vehicles per day	50
Major watercourse	200
Other watercourse as defined by a blue line on a 1:50000 100 m current government topographical map	100
Property boundary	20

5.2.14 Community consultation

Community consultation in the decision-making process is important in the management of odour. public's perceptions and concerns associated with the emitted odours and other environmental concerns should be addressed as part of the planning process. It is usually appropriate to meet with the neighboring residents and discuss the proposal before a development application is lodged with the appropriate planning authority.

5.3 Layout and design

The following general principles should be followed when considering the layout and design of pre-quarantine facilities.

- Receiving, dispatch and isolation yards, manure stockpile and feed storage and processing areas should be included in the facilities-controlled drainage area. Runoff from this area should be treated and collected in the sedimentation and retention pond system.
- The size of the controlled drainage area should be kept to a minimum by diverting any runoff from areas that have not been affected by manure, away from the site. This will minimize the required pond sizes and effluent utilization areas.
- Pen rows should run parallel with the contour of the site to minimize pen to pen drainage. The maximum acceptable pen to pen drainage occurs when the cross slope is equal to the slope down the pen
- Staged development/future expansion should be considered
- Any existing topographic features or vegetated areas should be utilized wherever possible to screen the facilities from the public and/or neighboring landholders.
- The layout for pre-quarantine facilities should be shown with an explanation. Landscaping and grading of these facilities should consist of general site grading and detailed grading in the pens and road areas in order to direct water towards the runoff retention area.
    - The overall area of these facilities should be graded at a minimum 0.5% slope toward the runoff retention area.
    - Pens should be graded at a 2% slope toward the rear of the pen and subsequently into the drain alley.
    - Livestock alleys should be sloped at 2% toward the drain alley.
    - The drain alley center line should be sloped at 0.5% toward the runoff retention area.
    - Feed and inspector alleys should be constructed with a negative crown of 2% to the middle of the alley.
    - The center line of the feed alleys should be sloped at 0.5% toward the runoff retention area.
    - There should be a perimeter interceptor ditch around the facilities, sloped at 0.5% toward the retention area.

5.4 Blue prints (plans and specifications)

- Drawings must be scaled to not less than 1:100, except for the "Site Plan".
- Drawings must have a title block providing the legal address of the establishment, date, designing company name, the scale, and the compass North point.
- The "Site Plan" shall show the entire premises. It must include:
    - The boundaries of the plant property,
    - Location of all section and location of the plant in respect to other structures in the surrounding,
    - Loading and unloading areas,
    - Receiving pens,
    - Inspection crush,
    - Pens with their partitioning,
    - Alleys,
    - Locations of foot baths,
    - Feed and water troughs,
    - Shades,
    - Feed store,
    - Offices,
    - Sick pen,
    - Recovery pens,
    - Emergency slaughter,
    - Gates and doors,
    - Fences, fence types, internal and external and their distances,
    - Potable water sources (wells, dams, rivers, lakes, reservoirs, etc),
    - The route of water and sewer lines and drainage systems,
    - Surfacing materials e.g. packed earth etc.
    - Roads,
    - Effluent treatment sites,
    - Neighboring businesses,
    - Power lines

- Relationship of all the different levels of the establishment e.g. receiving, pens, effluent, etc,
- The limits of the official premises.

❖ A floor plan showing:

- The purpose for which each area is going to be used,
- Holding capacities of facility/pens,
- Location and size of floor drains,
- Gutters and slope of floor towards drains,
- Location of fences, partitions, gates, posts,
- The elevations of the fences,
- Flow of animals,
- Employee traffic in the facility.

❖ A cross section of the facilities showing fence, shade, office ceiling, walls, feed and water troughs, crushes, loading and unloading ramps and feed store heights,

❖ Plumbing plan(s) shall show:

- The location of all sewage lines (including their sizes), hand wash facilities, toilets, floor drains (including their size and connections),
- Gutters, slope of floors towards drains,
- Water storage tanks (including location, size and construction material).

5.5 General requirements

5.5.1. Feed supply

The animal feeder must formulate feeds based on the species, sex, age, weight gain desired and the moisture content of available roughage and feeds. The feed ration should be adjusted to the requirements for species based on the availability of feed materials in the locality.

5.5.2 Water supply

Lack of water reduces feed intake and causes stress on animals.

❖ Animals must have access to an adequate supply of clean and suitable quality drinking water.

❖ As a guide to cattle drinking water requirements, a 400 kg animal requires about 35 L/day in cold weather and 70 L/day in hot weather. Over a year, an average of 5 L per 50 kg live weight per day is reasonable for planning annual consumption. In addition, where water is

required for dust control, an additional application of 5 liters plus 2 liters per day may be required per square meter of pen floor. In very dry conditions, 15 liters per square meter is recommended every 10 days. This is an extra requirement of 22.5 liters per animal per day at normal stocking densities. Cattle daily requirements of water approaches a maximum of 100 liters per day during hot weather.

- ❖ In addition, where water is required for dust control, an additional application of 5 liters plus 2 liters per day may be required per square meter of pen floor. In very dry conditions, 15 liters per square meter is recommended every 10 days. This is an extra requirement of 22.5 liters per animal per day at normal stocking densities. Cattle daily requirements of water approaches a maximum of 100 liters per day during hot weather.
- ❖ Daily requirements for water can also be calculated for each other species of animals to be kept in the pre-quarantine facility by considering their daily requirement/head/day as 30-40L/head/day for camel; 10 L/head/day for goat and 6 L/head/day for sheep.
- ❖ The daily water requirement for each species required should be delivered to the pens over an 8-hour period.
- ❖ Cattle are reasonably tolerant to water with high levels of salts. They can tolerate up to 10,000 mg/l TDS for limited periods, but the recommended maximum for growth is 5,000 mg/l TDS. Goats may adapt to high salt levels greater than 5000 mg per litre, but generally prefer saline levels less than 2000 mg per litre while sheep prefer saline levels less than 4000 mg per litre.

5.5.3 Drains

- Adequate drainage must be available throughout the establishments.
- Drains should be located outside main drive alleys, chutes and crowd pens.
- The floor of pens should be made in such a manner that effluent including manure runs off at the lowest point down the stock lanes between the pens and channeled into broad drains and ultimately into anaerobic ponds or evaporation ponds.
- Drains must be lined with material of sufficiently low permeability to minimize the potential for leaching of contaminants into the soil or underground water resources.
- They must have sufficient flow capacity to avoid overtopping.
- They must be free flowing to avoid excessive sediment build up.
- They must be easy to maintain them in a clean weed free condition.

- They must have sufficient bed gradient to effectively convey suspended sediments to the sedimentation system without excessive scouring of the drain bed. Flow velocities will be affected by the drain cross section profile, dimensions, slope and drain bed material.

5.5.4. Floors

The adoption of a suitable floor slope is essential for ensuring good drainage. By ensuring that the floors dry out rapidly after rainfall, odor generation is minimized and animals are not subjected to muddy conditions, which could adversely affect their health, welfare and performance in the facilities.

- Slopes are often described as percentages, for example a 3% slope is a uniform fall (or rise) of 3 meters over a horizontal distance of 100 meters.
- The pen slope may utilize the natural slope of the site, or the slope may be artificially constructed.
- The flooring of pre-quarantine facilities should be graded and can include compacted soil, limestone outcrops or ridges or a compressed rubble base.
- The floor slope should be in the range of 2 to 6% with 3% considered optimal in order to facilitate drainage and minimize erosion.
- The pen floor should have a slope of between 2 – 6% away from the feed bunks.

5.5.5 Stocking density

The stocking density is generally defined as the average facility pen area allocated to each animal. It can influence the performances of animals in addition to their general health and welfare. Furthermore, it has important implications for the environmental management of the facilities, as it affects the moisture content of the pad and therefore its potential to produce odor and dust.

- Stocking densities should take into account the local climate and the size of the animals to be kept at any one time in the pre-quarantine facility.
- There needs to be a compromise between the higher odor generation potential at heavier stocking densities and the higher incidence of dust problems at lighter densities.
- In general, a range of 12 to 25 m^2 /head is recommended for cattle, 1.0-1.3 m^2 /head for sheep, and 4.6-5 m^2 /head for goat.

- The space requirement for camels is 100 m^2 for 1 camel plus 50 m^2 for each additional camel with a minimum width of 6m.

5.6. Specific requirements

5.6.1 Receival and dispatch facilities

Receival and dispatch facilities include various associated components including holding pens, races, loading ramps and vehicle maneuvering areas. Receival and dispatch facilities should:

- be able to accommodate varying types of livestock transport vehicles expected
- be able to accommodate the type and number of livestock to be handled
- provide access to holding pens and processing facilities
- prevent injuries to and minimize stress on livestock
- prevent injuries to operators
- provide feed and water for unloaded animals
- provide water for livestock to be loaded
- have lockable slide gates to prevent accidental escapes, illegal/unauthorized livestock delivery or removal
- provide drainage
- provide non-slip surfaces
- consider access for truck drivers
- position ramp so that the truck driver may back in with a good view from the driver's side of the vehicle.
- consider the direction of sun in morning and evening; avoid walking livestock directly towards bright light (artificial or sun)

Moreover;

- The location of the receival and dispatch facilities within the overall site layout should provide good access for trucks and trailers and appropriate traffic flow of livestock transport vehicles.

- If night time loading or unloading is likely, the area should have appropriate lighting. Lighting should cover all areas including the holding pens and personnel access areas, with a number of lights to prevent shadows
- If receiving or dispatching a large number of animals requires a number of trucks, a suitable stationing or parking area should be available for the waiting trucks.
- Adequate space required for turning and reversing, depending on the size of the trucks and the number of trailers should be available.

5.6.1.1 Loading & unloading ramp

Well designed and constructed loading facilities result in quicker, safer loading with less stress on livestock carriers, stock and owners.

- ❖ The reception and dispatch areas should have offloading and loading platforms, respectively.
- ❖ Docks of different heights or adjustable ramps should be provided to accommodate vehicles of varying heights.
- ❖ The unloading and loading facilities shall be so constructed that unloading and loading can be carried out without having a gap between the vehicle and the dock or ramp.
- ❖ The sides of any ramps or dock should be high enough to prevent the escape or injury of animals.
- ❖ The loading and unloading dock area should be leveled and non-slippery.
- ❖ Stock will generally flow well with a gentle stepped ramp of around six meters in length to reach the 1.2 m loading height.
- ❖ The loading and unloading ramp should have a slope of no more than 20 degrees with a floor of concrete, steel or timber;
- ❖ Ramp floors should give good grip, be easy to walk on, not flexible and bouncy, and should not resonate or create undue noise
- ❖ Unloading ramp should have a horizontal docking area approximately 1.5m long to prevent livestock from slipping as they step out of the transporter.
- ❖ Loading height will vary slightly with the type of livestock transport vehicle to be used, but is generally 1.1–1.2 meters for most body trucks and semi-trailers.
- ❖ At the top of the ramp, a level platform of about 2–3 m long will allow livestock to balance and gain more confidence to move onto the different flooring material of the trailer.

❖ Sheeting the sides of the lead-up race and the loading and unloading ramp should be done to make animals focus on the exit, eliminates baulking from visual distractions and thus improves flow.

5.6.1.2 Receiving pen

- The receiving pens hold livestock for a relatively short time before processing
- The holding pen size is typically for a single deck of livestock, which is generally an easier quantity to process at a time. This capacity will need to be able to fill the race for feeding into the crush.
- Space requirement for holding pens is 1.8 - 2 m^2 for cattle, 2 m^2 for camel and 0.5 m^2 for sheep and goats.
- The holding pens should have direct access to the crush.

5.6.1.3 Race

A race is a narrow lane to single file livestock for further processing, batch treatment or visual inspection. It can be used in conjunction with crushes, loading ramps. Livestock are forced into single file to direct them towards the crush or weigh box, and to overcome their natural instinct to return to where they came from. The aim is to maintain a constant and continuous flow without involving many workers in the process. The pre-quarantine race should fulfil the following:

- A race is to be located before a crush.
- Races may be parallel-sided, V-shaped or with adjustable width.
- Races can be curved but needs to be straight for at least 3.5 – 4 m lengths at the start, as an immediate curve would look like a dead end to the lead animal.
- The height should be 1.8 m for cattle and camel, 1.2 m for sheep and 1.4 to 1.5m for goat
- The race length will depend on the number of livestock being handled – about 1.6–2.4 m per head is required for cattle.
- The width of the path (race) shall not be greater than 90 cm for cattle and 35 cm for sheep and goats (should not allow the direction reversal of animals).

- The outer panel of the race needs to be sheeted to aid good livestock flow by overcoming external visual distractions that will frighten them

5.6.1.4 Inspection crush

In order to precisely inspect and differentiate diseased and injured animals, it is important that each and every animal pass through crushes at the gate of the facilities.

- ❖ Each pre-quarantine facility needs to have inspection crushes next to receiving pens along the entry into the pens and also at the end of the alley which leads to the loading ramp.
- ❖ The crush needs to be well designed so that it has pre-inspection collection pen and also detaining pen for rejected animals.
- ❖ The length of the crush is determined by the number of animals that must stand in the crush simultaneously. The recommended length is 2 m per animal for cattle.
- ❖ The width of the crush requires careful consideration as a crush that is too wide, will allow animals to turn around. The inner dimension should be around 0.68 to 0.75m for cattle but for a V shaped crush, the inside width at the base of the squeeze should be 0.28 to 0.4m for cattle.
- ❖ For sheep and goats, where V-shaped crushes are used, a base width of 0.2 to 0.3 m and a top width of 0.45 to 0.68 m is recommended.
- ❖ The height of a crush should be 1.6 to 1.8m for cattle, 1.8m for camel, 1.2 m for sheep and 1.4-1.5 m for goats.
- ❖ There should be no sharply contrasting shadows or bright patches that may baulk animals.
- ❖ Animals should be able to see well ahead.
- ❖ There should be no distractions to forward movement.
- ❖ Crushes must be well maintained and kept free of loose objects.
- ❖ Must be so constructed to render the floors and drain covers non-slippery.
- ❖ To encourage entry, livestock should be able to see at least 6 m of unobstructed space beyond the crush.
- ❖ Animals are more willing to enter a crush if the sides are covered, thereby preventing sight of the handler alongside. The use of solid sides also reduces the risk of an animal's leg becoming trapped between the crush supports.

5.6.2 Pens

The holding pens are the main animal housing unit for a pre-quarantine facility. Sound design will ensure optimum animal performance, good animal welfare and high standards of environmental performance.

The design objectives for a pre-quarantine pen are to:

- Provide an environment for animals where their welfare is maximized
- Promote safe access for animals to and from the pen
- Minimize environmental impacts such as odour and dust
- Promote drainage to provide a comfortable environment for livestock and minimize environmental impact
- Optimize the management and removal of manure from the pens
- Provide a safe working environment for pre-quarantine personnel.

For this, pens in a pre-quarantine facility must fulfil the following requirements:

- Pen rows should run parallel with the contour of the site to minimize pen to pen drainage.
- A smooth, consistent pen slope promoting the runoff of storm water.
- Pens be constructed with slopes of 2 – 6%.
- Be constructed and maintained to avoid injury of animals.
- Pen fences should be 1.6 to 1.8 m high for cattle; 1.8m for camel; 1.2 m for sheep and 1.4-1.5 m for goats.
- Compact floors that are curbed and drained and non-slippery.
- Should be fitted with gates which have a minimum width of 0.8 m wide for sheep and goats; 1.8 m for cattle and 1.8m for camel.
- Well drained manure slabs for manure prior to removal
- Isolation area for suspect animals must have solid walls and gate and must not drain across other pens or pose any other contamination risk.

5.6.2.1 Pen size

- It is convenient to size pens to match multiples of deck sizes of livestock transport vehicles.

- Pen sizes may range from 50 to 300 head in capacity for cattle and not more than 500 for sheep and goats.
- A range of available pen sizes can be useful where different sized consignments are commonly received.
- Pen sizes can also be matched to transport arrangements, eg. 1 x 50 head pen per double deck trailer load for cattle.
- Pen depth should be restricted to a maximum of 65 m to limit the distance to feed facilities and minimize erosion.
- Pen depth should be decreased for steeper pen slopes to reduce the potential for erosion of the pen surface, e.g. 50 m maximum depth recommended for 6% pen slope.
- The pen width must be adequate to provide the required trough length for the number, size and species of animals being fed in the pen and should allow sufficient room for ease of operation and cleaning.

5.6.2.2 Pen orientation

Adverse climatic effects can sometimes be alleviated by studying the local climate, e.g. prevailing winds, and taking advantage of the local topography. A northerly aspect is generally desirable for maximizing exposure to the sun.

5.6.2.3 Pen floor construction

The pen floor must not break down during rainy season. The following general specification for pen floor construction is the minimum preparation for pre-quarantines:

- The area should be cleared of trees, scrub, and stumps.
- Tree roots should be grubbed to 300 mm below natural ground surface.
- Topsoil should be stripped from the area and stockpiled for later reclamation work.
- All holes should be back-filled with suitable clay or gravel
- If the exposed material is of a suitable quality for pen floor foundations ie clays having low, intermediate and high plasticity, clayey sands and clayey gravels, the area should be ripped,

brought to optimum moisture level for compaction, and compacted to 95% of standard maximum laboratory dry density with a suitable roller.

- ❖ Cut, fill and grade the foundation to a smooth 3 – 6% slope away from the feeding areas.
- ❖ The top 300 mm surface fill should consist of a suitable gravely clay to provide a sufficiently durable pen surface. This should be laid in even layers having a maximum thickness of 200 mm prior to compaction, brought to optimum moisture level for compaction, and compacted to 95% of standard maximum laboratory dry density with a suitable roller.

For pre-quarantines built on sandy soils the following method is suggested for the construction of the pen floor foundation:

- ❖ The area should be cleared of trees, scrub, and stumps. Tree roots should be grubbed to 300 mm below natural ground surface.
- ❖ All holes should be back-filled with coarse sand.
- ❖ The sand base should be graded, watered and compacted to form a smooth 3 – 6% slope away from the feeding area
- ❖ The top 450 mm surface fill should consist of a suitable gravely clay to provide a sufficiently durable pen surface. This should be laid in even layers having a maximum thickness of 200 mm prior to compaction, brought to optimum moisture level for compaction, and compacted to 95% of standard maximum laboratory dry density with a suitable roller.

5.6.2.4 Pen signage

All pens should have a small sign with the pen number. This sign should be at the top end of the pen along the feed bunk so that feed truck operators can locate the correct pen when delivering feed. It is also useful to be able to identify the pen number from the cattle lane with another sign on the entrance gate from the stock lane to the pen.

5.6.3 Feed troughs

Feed troughs should be designed to allow sufficient space for all livestock to eat without competition.

For cattle, the following points should be considered:

- Feed troughs should always be located along the fence line, never within the pen.

- They should be located along the higher end of the pen with drainage away from the trough on both the feed road and pen sides. This minimizes boggy conditions on the pen side of the trough and keeps the feed road firm and accessible.
- The bed of the trough should be 17.5 cm above the level of the apron to facilitate a natural feeding stance.
- Feed trough length will depend on the number of livestock to be fed within the pen. Cattle of 600 kg live-weight require a minimum of 30 cm of trough space/head when fed once daily. More frequent feeding will allow the trough space per head to be reduced. An average market size bull with a weight of 250-395 kg may require a minimum of 18 cm trough space and a younger cattle of less than 250 kg body weight may require 15 cm trough space.
- Open troughs should incorporate 2.5 to 3.0 m wide reinforced concrete aprons sloping away from the feed source.
- Feed troughs should be constructed of durable material which is not easily damaged and cannot be moved by animals.
- They should have an internal profile which can be easily cleaned, and the external sides should meet the ground at right angles.
- To prevent manure and spilt feed accumulating beneath the trough and to improve the ease of cleaning, troughs should have vertical external sides.
- The ends should be open, and long runs of troughs should include drainage points to allow drainage after rainfall.
- The inside surfaces of feed troughs should be smooth with well-rounded corners to facilitate easy cleaning.
- To prevent livestock from entering the feed trough and possibly escaping, cables should be strung out over the feed trough.
- The cross-sectional area of the trough determines the amount of feed that can fit into the trough per unit length. If the cross-sectional area is too small frequent filling will be necessary. If the feed trough is too wide, feed pushed to the back of the trough is less accessible and animals are tempted to step into the trough to try to reach it.

- Feed troughs should allow rainwater to drain, preferably by having drain holes or slots at intervals along the length of the trough. These drainage points need to be large enough that they do not get blocked.

Table. 2. Sample feed trough dimensions for cattle

Description	Dimension
The height of the back wall above the feed apron.	500 mm
The height of the front wall above the feed road.	700-750 mm
The height of the livestock restraint rail above the apron	1000–1150 mm
The width of the feed storage area of the trough	715 mm
The thicknesses of the front walls	135 mm
The thicknesses of the back walls	120 mm
The cross-sectional area of feed per meter length of trough	0.196 m^2
The cross-sectional area of concrete for the trough per meter length of trough	0.219 m^2

- Trough space for camels should be managed on the same basis as for cattle.
- For sheep and goat, the following should be done:
    - Troughs can be designed so that sheep and goats have access to one or both sides – it is important that the correct feed space is provided to reduce shy feeding.
    - For double-sided access to feed troughs length of 20cm per adult sheep or goat and 15cm trough length for a kid or lamb of less than one-year of age.
    - For single sided access to a trough, 30cm per lamb or kid and 40cm per adult sheep or goat of trough space should be allowed.
    - Troughs should be raised off the ground to reduce fouling. Lift the top edge up to 40–45cm for lambs and kids and 50–55cm for adults.

Fig. 1 Sample cattle feedlot trough

Fig. 2 Sample sheep and goat feed trough.

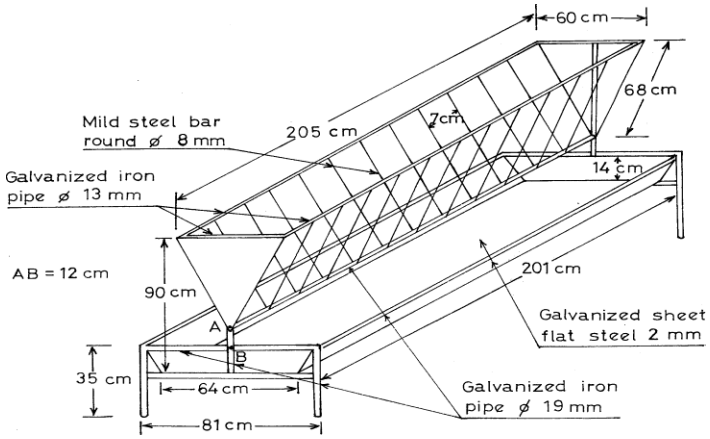

Figure 3 – Sample sheep and goat grain and hay feeder. Hay is placed on the top.

5.6.4 Water troughs

- Access to an adequate supply of good quality water is essential for the survival, welfare and performance of animals.
- Water troughs should be large enough and designed in such a way that all livestock have easy access.
- Each pen should preferably have access to two water troughs so that livestock can have access to water if one trough blocks
- Animals must be prevented from stepping or falling into water troughs by sides extended high enough from the ground and an exclusion bar (steel or timber frames) over the surface of the trough.
- Low volume shallow troughs are preferred to reduce the flushing volume generated during regular cleaning operations. A good quick supply of water is essential for low volume troughs.
- Water troughs should be in the lower half of the pens, with provision for any spillage and water discharged during cleaning to drain directly to the drainage system to avoid creating wet spots.
- Water troughs should have vertical external sides which meet the ground at right angles to prevent manure accumulating beneath the trough.
- Troughs should not be shared between pens to avoid disease transmission.
- The water source should not be close to the feed source, to avoid more feed is deposited in the water trough or vice versa.
- Water troughs should incorporate at least 3.0 m wide reinforced concrete aprons all around the trough sloping away from the trough at 2 to 3%.
- Water troughs may incorporate shade structure as hot water reduces intake. The size of the trough shade structure should be limited to the need to protect the water trough from direct sunlight but not to provide shade for animals standing underneath.
- Water troughs should have a height of 0.9 m for cattle and camel and 0.3 m for sheep and goats.
- A minimum of 25-30 cm of water trough length per head is required for cattle and 30 cm for camel;

- For sheep and goat, at least 30cm of trough for the first animal and 1.5cm for each additional animal is recommended. For example, a trough length of 7.6m is the minimum requirement for a size of 500 sheep and goat.

5.6.5 Pen shade

Shade can have a large impact on the body heat load experienced by animals by reducing solar radiation and slowing the rate of gain of body heat. Shade can improve animal comfort and productivity. The design of shade structures should ensure that ventilation beneath the structure is maximized and where possible, air temperatures are kept below body temperature.

5.6.5.1 Orientation of shade structures

- ❖ The optimal alignment of shade structures is north-south. This allows the shade to move across the pen throughout the day and assist the drying of the pen floor beneath the structure.
- ❖ A slope of 15^{o} rising to the east provides two extra benefits – the shade roof will create its own passive air movement as air heated beneath the roof rises, and the slope will allow a larger area to be shaded during the mid to late afternoon when the day temperature is usually highest.

5.6.5.2 Size of shade structures

- ❖ The minimum requirement is that the area of shade be sufficient to cover all animals.
- ❖ Recommended shade areas per head range from 1.9 square meters to 6.0 square meters for cattle and camel, 0.55-1 m^2 for sheep and goat.
- ❖ Higher shade structures provide more cool air for the animals, and allow the shade to move across the pen faster.
- ❖ Minimum suggested height is 5.0 meters on the western side rising at a slope of 15^{o} towards the eastern side to the maximum height of 8.1 meters.
- ❖ Most shade structures are 12 meters wide.

5.6.5.3 Positioning of shade structures

- ❖ Shade structures should be erected towards the center of the pen so that animals can follow the shaded area as it moves across the pen during the day.
- ❖ Shade positioning should take advantage of the morning sun for drying while maximizing the shaded area in the afternoon summer sun.

- ❖ Shade should not be positioned over water or feed troughs

5.6.5.4 Shade materials

The most common shade materials are galvanized sheeting or shade cloth due to availability and relatively low cost. Shade cloth has the advantage of allowing air to pass through the material, but shade cloth can be affected by degradation of the material, bird damage, and vermin damage if furled during the rainy season. Galvanized sheets have a longer service life and can allow free flow of air if spaces are left between the sheets. They are generally heavier than shade cloth to erect and support, requiring more substantial structures.

5.6.5.5 Management of shaded areas

The use of shade structures will result in a moist area beneath the shade due to deposition of faeces and urine. This area, if not managed to limit manure accumulation and moisture build up, may result in increased humidity and elevated ammonia levels beneath the shade and in the pen. Repair and maintenance of the pen surface will also be high in this area.

The area should be regularly cleaned of wet manure to limit odour production and ammonia emissions. Shade structures of the dimensions outlined above allow access by sunlight to the pen floor as the shade moves across the pen throughout the day. This will assist in reducing the occurrence of shade related wet pen conditions.

5.6.5.6 Structural design of shade structures

Shade structures need to be designed carefully with attention paid to the loads that the structure must bear. Wind blowing against the structure results in directional loads. Side loading is caused by wind action against walls and posts, while wind action on a sloping roof can cause the roof to act either as a wing or an aerofoil depending on wind direction.

These forces must be taken into account when designing the structure. The mass of material supported by the structure is called the “dead load”. The dead load of galvanized sheeting is higher than for shade cloth, so the support structures need to be more substantial. The dynamic load of the shade structure is a load that varies in character. It typically results from movement of a structural member or other variable or oscillating force. It is recommended that engineering advice be sought in the design and placement of pre-quarantine shade structures.

5.6.6 Feed storage

Feed storage should be constructed on the opposite side of the area where the isolation and recovery pens are located. Animal feed store must be vermin proof.

5.6.7 Fences, gates & lanes

Fences, gates and lanes should be designed to enable efficient movement of livestock and cleaning machinery. No single fence type appears better than others and this decision is left to the producer and availability of local materials. Access into the pens may require 1 or 2 gates. Consideration should be given to moving livestock, cleaning of pens and removal of manure.

5.6.7.1 Perimeter fence

The external fence should be fenced with 5 cm diameter wire mesh, woven wire or using masonry walls as may be considered appropriate. The type of fencing needed for livestock confinement depends on several factors including animal species, age, breed, and production system. Factors for selecting fencing type include affordability, maintenance, durability, and effectiveness of containing livestock.

A. Mesh wire fences

Mesh wire fences are strong and provide great safety to animals. Mesh wire fencing is made in 11, 12 ½, 14 and 16 gauges, and fences are available in diamond-mesh and square knot designs. The square knot wire design is formed from single line wires spaced 10 cm apart and stay wires spaced 5 cm apart. The joints are held by a piece of short wire formed into a knot.

The diamond-mesh wire design uses two smooth wires spaced 10 cm apart, which are twisted together for all line wires. Stay wires consist of single smooth wires the same size as the line wires. These stay wires are wrapped around adjacent line wires to form a triangle with a 5 cm base. The diamond shape is formed when two of these triangle bases are fitted together. Both

mesh fence designs are strong and highly safe for animals.

Fig.4 Sample wire mesh fence

- ❖ The metal or wooden stands or poles need to be interconnected by tensile barbed wire strands which may be reinforced with plain wire meshes.
- ❖ The fencing for cattle and camel should be built with metal poles standing at intervals of about 10-15m with wooden poles in between.
- ❖ The spacing of posts for sheep and goats should be 3.7 to 6m apart.
- ❖ The height of the fence may be 1.4 - 1.5 m for cattle (which may be 1.6-1.8 for cattle not accustomed to handling); 1.2 m for sheep; 1.4 – 1.5 m for goats and 1.8 m for camel.

B. **Woven wire fences**

Woven wire fences consist of a number of horizontal lines of smooth wire held apart by vertical wires called stays.

B.1 Cattle

- Barbed and woven wire fences have traditionally been used for cattle. However, barbed wire fences require higher maintenance and have shorter lifespans than woven wire fences.
- 5-strand woven wire fences with one or more strands of barbed wire above the fence are excellent for cattle.
- Fence height should be at least 1.4 - 1.5 m for cattle (which may be 1.6-1.8m for cattle not accustomed to handling) and 1.8 m for camel. Though the initial cost of woven wire fence is

higher than the cost of a 5-strand barbed wire fence, woven wire fences require less maintenance and last longer that barbed wire fences.

- Standard galvanized woven wire with the top and bottom strands of number 12 1/2 gauge or larger are recommended.
- Vertical stay wires shall be 14 ½ gauge or larger and spaced not more than 30 cm apart.
- One or more strands of barb wire spaced approximately 10 – 15 cm apart shall be added at the top.
- Posts spacing should be not more than 4.8m for standard galvanized woven wire.
- Fences for camel can be made with similar materials and specifications with that of cattle by considering the specific height requirement of 1.8 m.

B.2 Sheep and goat

- Several options currently are available that include barbed wire, cable, woven wire, net wire. Factors for selecting a fencing type include affordability, maintenance, durability and effectiveness of containing livestock.
- Woven wire fencing, shown below, are excellent for goats. Depending on the breed types to be confined, fence height should be at least 1.2 m for sheep; 1.4 – 1.5 m for goats high.
- Woven wire fencing consists of smooth horizontal (line) wires held apart by vertical (stay) wires.
- Spacing between line wires may vary from 4 cm at the bottom to 20 cm at the top. Wire spacing generally increases with fence height.
- Stay wires should be spaced 15 cm to 30 cm apart depending the size of the animals.
- Woven wire fencing is excellent for predator control. The fence bottom should be placed on the ground to allow for the use of snares where predators dig under the fence.

Fig.5 Sample woven wire perimeter fence for sheep and goat

7.7.2 Pen fence

Pen fence must be economical to build and maintain; they must contain stock but not hinder pen drainage or cleaning.

A. Cattle

- The height of the fence may be 1.4 to 1.5 m for cattle (which may be 1.6 to 1.8 for cattle not accustomed to handling) and 1.8 m for camel.
- Pen fence posts are generally made from either steel or timber. Wooden posts should be at least 25 cm in diameter with corner and gate posts 30 to35 cm in diameter.
- The posts may be of steel or timber, and should be set into the ground at least 90 cm, and at least 4.5 to 9m for cattle and camel;
- If timber posts are to be concreted into position, the post should protrude below the bottom of the concrete to allow water to drain out and prevent the post from rotting.
- Steel posts need to be set in concrete 90 cm below ground level with the concrete finishing about 20 cm above ground level
- Pen fences constructed with cables are stronger than wire fences.
- Fences should include five rows of cables and rails to allow under-fence cleaning while preventing animals escaping by rolling under the cable.
- Cables should be attached to, or directed through, fence posts so that no sharp edge can deteriorate the cable as it moves constantly back and forth under pressure from the animals.

- ❖ Cables can be run through holes in wooden posts; steel posts require hollow sleeves or external eyelets
- ❖ The bottom cable or wire should be 40 cm above the pen surface to enable under fence cleaning with a push bar.
- ❖ Top rails and belly rails are required to add strength to a fence.
- ❖ Top rails and belly rails and posts can be either wood or steel. Wooden rails should be at least 150 mm in diameter and steel rails at least 100 mm in diameter
- ❖ The parameters indicated above can be adapted to camel by giving consideration the relative height differences

B. Sheep and goats

- Woven wire fencing is the most reliable form of sheep and goat fencing because it provides a strong but flexible barrier.
- Individual knots are tied to the horizontal and vertical wire intersections, creating a mesh that holds tight and won't slip. The knots create a springy texture, so the fence will flex when challenged, rather than snap the way welded wire can.
- Wire fence spacing should be no more than 10 cm high and 10 cm wide to keep goats from breaking free.
- The height of the fence may be 1.2 m for sheep and 1.4 to 1.5 m for goats
- Install H-braces at each corner of the pen and at gate entrances to bolster their strength.
- Brace and corner posts should be made of 15-20 cm diameter treated lumber and set in the ground a minimum of 100 cm to prevent movement.
- Line posts hold the fence in place between the corners and gates and are typically wood (10 cm treated lumber), steel t-posts, or a combination of these.
- Steel t-posts are a good alternative to wooden posts and make for easier installation. Various weights are available to meet different needs for strength and durability.
- Recommended spacing of line posts is between 2.5 - 3.65 m depending on the material that the posts are supporting and the anticipated amount of pressure on the fence.

- To assure stability, line posts should be set at least 60 to 75 cm deep, and tall enough to accommodate a top-line wire if desired.
- Install posts on the outside of the fence line so that pressure from animals pressing against the material is supported.
- The bottom wire of the fence should be as close to the ground as possible. Stake it securely to prevent goat and sheep from trying to go under the fence.
- Woven wire fences consist of smooth horizontal (line) wires held apart by vertical (stay) wires. Spacing between line wires may vary from 4 cm at the bottom to 20 cm at the top. Wire spacing generally increases with fence height.
- It's important to keep the crimps intact on the horizontal line wires. This allows the fence to expand and contract during fluctuating weather conditions. Avoid using too much muscle when stretching the fence.

Fig.6 Sample woven wire pen fence for sheep and goats

5.6.7.3 Gates

- ❖ The size and location of gates are important; they must provide good, safe access to the pens for both pen cleaning equipment and stock
- ❖ Pre- quarantine facilities require a gate at the rear of pens for movement of stock and pen cleaning equipment, and another across the feed trough apron for easy cleaning of aprons
- ❖ Stock movement gates are usually located at the bottom of the pens
- ❖ Gates should be lightweight but strong

- Gates should not have sharp protrusions that livestock can bump into and be bruised by as they move in and out of the pen.
- All gates should lay flat against the fence line when open and should be long enough to block the livestock laneway when open.
- Gateways should be set at an angle so that tight turns into pens are avoided.

5.6.7.4 Laneways

- A good lane system will promote efficient movement of livestock and pen cleaning equipment
- Lane widths of between 4 and 5 meters are generally suitable for moving livestock and machinery into and out of pens.
- Laneway fences should be constructed with cable or plain wire.
- The use of barbed wire should be avoided.

5.6.8 Isolation pens (sick & recovery)

Early detection and treatment of ill or injured animals will optimize welfare and productivity and minimize mortalities. Returning treated animals straight back to production pens may increase the risk of cross infection.

- Sick animals should be separated from their congeners and held in special pens.
- Isolation pens should be sited and constructed in such a way that waste and effluent from them cannot contaminate adjacent pens in the facility or passageways.
- Isolation pens should have separate drainage systems and should be away from the main passageways used by people and animals.
- The isolation and recovery pens should have separate facilities such as water and feed troughs.
- The distance between isolation and recovery pens and the rest of the facility shall be at least 60 meters.
- Isolation and recovery pens can be constructed adjacent to each other for an easy transfer of convalescent animals.

- ❖ The Isolation pens should have a minimum space allowance of 14 m^2 per head for cattle; 1.0-1.3 m^2 for sheep; 4.6 – 5 m^2 for goats and 100 m^2 for 1 camel plus 50 m^2 for each additional camel with a minimum width of 6m.

5.6.9 Foot bath

Each pre-quarantine facility should have 0.5 x 1.5 m foot bath made of 10 cm thick mass concrete along the following alleys:

- At the gate of the entry into the facility compound, offices and feed stores.
- At the end of the crush after animals are received.
- Along the exit alley from the recovery pen.

5.6.10 Effluent management system

- ❖ There should be a sedimentation system where the base should be constructed from compacted gravel to enable cleaning operations to proceed under wet conditions. Basin embankments and beds should be impermeable to prevent seepage of effluent into ground or surface water resources.
- ❖ Holding ponds should be constructed so as to ensure impermeability.
- ❖ A cut-off trench and compacted clay core are generally required beneath and within the embankment respectively.
- ❖ The embankment crest width should be at least 3 m.
- ❖ The upstream and downstream batters should be no steeper than 1 in 3.5 and 1 in 2.5, respectively, if clay construction materials are used.
- ❖ A by-wash should be provided to ensure that the embankment is not overtopped following extreme rainfall events.

5.6.11 Manure management system

- ❖ Manure stockpile areas should be established within the facilities along the controlled drainage area and with a regular 1-3% slope.
- ❖ Manure stockpile areas should incorporate a stable compacted base to enable manure handling operations to proceed under wet weather conditions.
- ❖ The foundation of the area should be prepared to the same specifications as the facility pen foundation, and the surface should be finished with a layer of compacted stones to ensure all weather access.

- The manure stockpiles should be constructed up and down the slope of the area, not across the slope. This will assist drainage.

5.6.12 Emergency slaughter pen

- Pre-quarantine facilities should have well separated areas to slaughter accidentally injured or severely sick animals.
- The facility should be fitted with carcass burning pit.
- The cattle and camel unit would be equipped with floor pulling ring, hoist and rail system, cradles and equipment sterilizer and hand washing facilities.
- The sheep and goat unit would be the same except that it would not have a pulling hoist or rail system.
- The units should be equipped with stainless steel table, drain hole, pressurized cold and hot water supply.

5.6.13 Emergency water storage

- Water supply may be interrupted for many hours or even days due to natural disasters (damage to infrastructure), electricity blackouts, pump or pipeline failure.
- Animals kept at pre-quarantine facility should have an uninterrupted supply of clean water.
- Every pre-quarantine station should have contingency plans for pump or pipeline failure.
- A temporary emergency (back-up) water supply and suitably sized water storage close to the pre-quarantine facility are essential.
- Pre-quarantine facilities need an onsite water storage to overcome differences in supply and demand and to also provide an emergency storage for temporary supply failures.
- Emergency water storages can be made of steel or concrete above-ground tanks or earthen embankment storages.

Earthen embankment storages: Earthen embankment storages are filled by pumping water from some other source. The ring tank is in the shape of a ring (or square or rectangle) bounded by a compacted earthen embankment and usually located on relatively flat ground. The material required for the embankment is excavated from inside the embankment, hence water can be stored above and below the natural ground level.

As all water is stored above natural surface level it can be gravity fed to the point(s) of usage. Each earthen embankment storage is unique in size, shape, capacity, location, soil and environmental characteristics and hence has to be designed individually.

Above-ground tanks: Above-ground tanks are an alternative to earthen embankment storages. They can be constructed from various materials (e.g. concrete, polyethylene, corrugated iron), are available in various sizes and generally have an enclosed roof. Most steel or concrete tanks can be supplied with a cover. When located on a stand or high point above the pre-quarantine pens, gravity assists flow of water to the off-take points. The cost per volume of storage of these tanks is much higher than from earthen storages.

Temporary supply: Trucking emergency water is expensive and requires intensive management. It should be considered only as a temporary solution or in extreme emergencies.

Storage size: Emergency or back-up water sources sufficient to meet the basic water requirements of animals during peak demand days and the anticipated emergency period must be incorporated in the design and planning process. This supply or storage should be of sufficient capacity to supply water to cattle under emergency conditions until breakdowns can be repaired.

Emergency supply should be capable of supplying basic water requirements for at least 48 hours. Where some infrastructure (e.g. deep artesian bores) may take much longer than 48 hours to repair, a secondary water supply source or large temporary supply is essential. The number of days of storage required depends on the anticipated time needed for pumping systems to come back online.

The following formula can be used to determine the emergency storage volume. Storage Volume (L) = Peak drinking water (L/head/day) × Pen capacity × No. of supply days. For example, a pre-quarantine with 1000 head on feed needs a two-day emergency supply volume of = 40 L/head/day × 1000 head-on-feed × 2 = 80,000 L.

The same formula can be used to calculate emergency water requirements for other species of livestock by considering the daily water requirement for camel = 30-40L/head/day; for sheep = 6L/head/day; for goat =10L/head/day.

5.6.14 Offices and related facilities

Pre-quarantines should have adequate offices accommodations for operators and government inspectors.

- Offices for pre-quarantine personnel should be available.
- Office amenities and facilities for the protection and storage of clothing, equipment and supplies of inspectors should be provided. The room should be furnished with shelves and lockers.
- Employee welfare rooms **s**hould have separate washrooms and dressing rooms for both sexes. The lunchroom and cafeteria may be combined.
- Dressing rooms should be separate from but communicate directly with washrooms.
- There should be separate changing room(s) and shower(s) for male and female workers.
- Equipment and drugs store rooms should be so constructed as to be readily maintained in a clean and sanitary condition and also to protect against dust, moisture and other undesirable conditions.

5.6.15 Incinerator

- The incinerator should be built on the leeward of the pre-quarantine.
- The incinerator could be built either from metal or bricks.
- Its size should be enough to incinerate whole carcass of cattle or camel at a time and should be at least 50 m away from the livestock pen and service facilities

5.6.16 Energy production unit

- ❖ Packaged boiler, refrigeration units and an electric generator or connections to the public supply should be housed in separate rooms.
- ❖ Hot water heaters or heat exchangers for the pre-quarantine supply shall be located in a central boiler room.
- ❖ The diesel engine room should be built separately on the leeward of the pre-quarantine station.

6. Main Export quarantine construction requirements

Main export quarantine is a facility under the regulatory control of official veterinary authorities where animals are being held in isolation for a specified period of time for purposes of veterinary

observation, and final certification as per the international livestock trade and importing country requirements.

In the main export quarantine, animals which have been identified (by using ear tags or some other appropriate identification methods that are approved for use by the regulatory authority), vaccinated and treated for specific diseases either in feedlot or pre-quarantine facilities will be accepted to stay for some specified days to conduct health inspection and make final preparation for issuing international certificates. Laboratory testing may also be conducted if that is the requirement of the importing country where the livestock are to be exported and was not done while the animals were in feedlot or pre-quarantine facilities.

Most of construction requirements indicated above for pre-quarantine facilities are also applicable for export quarantine construction. The few additional requirements that includes laboratory and others are also outlined as indicated below:

6.1 Site selection

Many factors must be considered when selecting a site for establishing an export quarantine facility. Issues to be considered include the following:

- Bio-security considerations to prevent disease transmission and spread.
- Infrastructure support issues such as access to roads and water sources.
- Suitability of climate for easy operation of facilities without the provision of expensive protection measures.
- Site features such as suitable topography and availability of suitable construction materials.
- Environmental impact issues such as the protection of water quality and protection of community amenity.
- Distance between the site and human habitation, non-compatible industries, etc.
- Available land resources (on and/or off site) capable of utilizing the effluent and manure from the facilities.

6.2. Site selection criteria

6.2.1. Geographic location

To be economically viable, export quarantine facility must be located close to supplies of feed resources, slaughter animals, labour, all weather access roads and, if applicable, closer to the port of exit.

6.2.2. Climate

- Climatic conditions have an impact on the environment, performance of animals and their welfare.
- Most environmental problems are associated with wet conditions. For this reason, sites with a high annual moisture deficit are desirable.
- Design and management changes can be adopted for sites with high rainfall. Facilities established in these areas often require the construction of higher capacity drains, sedimentation systems and holding ponds. Larger effluent utilization areas are also often required. Higher standards of pen foundation construction may be required to ensure durability in these wetter climates.

6.2.3. Topography

It is desirable that the feed yard area has a natural slope of 2% to 6%. For sites with fewer slopes, earthworks can be undertaken to create slope in the yards. Yard slopes greater than 6% are undesirable due to the excessive manure movement from the yards during rainfall and possible erosion of the manure-soil interface. Similarly, yard slopes less than 2% are also undesirable due to the slow drying of manure and little drainage from yards during and after rainfall.

It is generally undesirable for export quarantine facility to be established on hillsides above residences or towns due to the potential for odour nuisance. This is particularly an issue if the down-hill air movement can be concentrated or confined by valley walls. As a general rule, offensive odours are less likely to be detected at residences situated at a higher elevation than the facility.

6.2.4 Risk of disease transmission

The risk factors for infectious diseases are mainly related to the environment that puts them into contact with the disease agent. As a result, export quarantine station should be established away

from high livestock density areas, human habitations, game reserves, livestock trekking routes and markets.

6.2.5 Pens location

A soil with 25 percent or more clay is preferred to sand or fractured rock structures. It is desirable to locate the pen area on a compacted, smooth, well-drained site. Hence, the following areas are not suitable:

- Rocky areas.
- Areas where natural springs occur.
- Areas with light sandy soils.
- Areas with highly expansive heavy clays overlying shallow groundwater aquifers.

6.2.6 Sedimentation systems, holding ponds, drains, manure stockpile and composting areas

A site must be available where sedimentation systems and holding ponds can be economically constructed and will fill by natural drainage from the export quarantine yard area. The soils underlying the ponds, drains, manure stockpile and composting areas should have a sufficient clay content to ensure that they are not permeable. If the available soil types are not suitable, imported clay may be used.

6.2.7 Effluent utilization area

Productive agricultural soils are required for the long-term application of water, nutrients, salts and organic loads in the effluent. These soils should preferably be deep, free draining and should not be overloaded with nutrients or salts. Ideally, the effluent application area should be close to the holding ponds. The best agricultural soils should be set aside for this purpose. The availability of clean irrigation water for effluent dilution and supplementary irrigation enhances the productivity of effluent irrigation schemes. The lack of good soil for effluent irrigation cannot be overcome by engineering works or the importation of material.

6.2.8 Manure utilization area

Manure can be economically spread over a much wider area than the liquid effluent. Nevertheless, manure spreading area must not be too far from the facility premise. Most soils will benefit from the well managed application of manure. The actual application rate should be determined after analyses of both the soil and the manure, in light of the proposed cropping

program. The addition of inorganic fertilizers to balance nutrients is often required. Most soils suitable for cropping or pasture production will be suitable for manure spreading, provided sufficient area is available.

6.2.9 Land requirements

When selecting a site for an export quarantine facility, it is essential to ensure that there is sufficient land available. The provision of adequate land for all present and future facility activities is an essential part of site selection. Insufficient land may also limit future expansion of the facility.

Land is required for feed yards, feed handling and storage facilities, animal handling yards, isolation pens, water storage and tanks, manure stockpiles, ponds, effluent and manure utilization areas, roadways, animal lanes and drains, carcase disposal areas and buffer zones.

Buffer zones include, double fences, tree belts and windbreaks around the facility yards, screens or tree belts to visually screen them from the public and buffer strips between land utilization areas and water courses.

The total area required will depend on animal numbers and size, methods of waste utilization, local climate, soil types and topography, cropping programs and availability of existing buffer zones. The area required for waste utilization will depend on whether the material is to be used on or off site, the soil type and cropping program. It is generally necessary to have sufficient land area available on the facility property to utilize the liquid effluent produced by the facilities.

In the case of manure, it is desirable for facilities to have some productive dry land or irrigated cropping or pastures areas available for application.

When establishing an export quarantine facility, attention must be given to future expansion plans. Application for new export quarantine station should give consideration to the availability of suitable land for separation distances as they would be required for the future expansion options. Where practical, this land should be owned by the developer as future change of land use within the separation distance may reduce the opportunity to expand.

6.2.10 Water supply

A main export quarantine station requires a continuous supply of good quality water for uses such as drinking water, dilution of effluent water for irrigation, dust control, fire control and feed preparation. Water for export quarantine station can be obtained from surface water, groundwater or municipal supplies or a combination of all three. Wherever possible, an export quarantine facility should have more than one water supply source (e.g. river plus bore or bore plus dam). If one source fails, the export quarantine station can change to the other.

The volume of water required will depend on animal numbers and weights, local climate, irrigation requirements and feed preparation requirements. Hence, an individual estimate is required for each site.

When assessing the suitability of a water supply, it is necessary to determine total annual requirements, peak short-term flow rates and emergency reserves in case of supply breakdowns. Bores provide a constant source of water provided that the quality is suitable.

The reliability of the water supply must be assessed to ensure that the intended water source(s) are sufficient to meet both the average export quarantine facility water requirements throughout the year, as well as the peak demand days and times of the day.

6.2.11 Surface waters

Flooding: Pens, manure stockpiles, effluent irrigation areas, sedimentation basins and holding ponds should not be located in flood prone areas unless adequate safeguards are incorporated. Consideration should also be given to vehicle access to the site during periods of prolonged flooding.

Protection of surface water quality: The facilities should be sited, designed and managed so that the quality of surface waters in the vicinity are not degraded by runoff, leaching or seepage from the facility yards, ponds or waste utilization areas. To achieve this, a reasonable buffer should be provided between the facility complex (including waste utilization areas) and streams, rivers and other watercourses. The separation distance chosen should be a function of the intervening topography, vegetation, natural gradient, management practices employed by the facility operation and other site-specific factors.

Protection of ground water quality: Export quarantine station should be sited, designed and managed so that the quality of groundwater is not degraded by the movement of pollutants or pathogens into the water resource. To achieve this, the export quarantine should not be sited above ground water recharge areas or above ground water resources that are deemed to be vulnerable, unless those resources can be demonstrably protected. Such protection may be provided by one or more impervious geological strata and/or because the water is at considerable depth. Sites to be avoided include those where:

- there are existing shallow or rising water tables.
- there are shallow perched water tables.
- useable underground water resources are already partially degraded; or
- where there are major faults that might provide a short circuit for pollutants to the groundwater resource.

Waste utilization areas should be sited away from bores and wells. Effluent or manure should not be applied within 25 m of a bore or well which is used for domestic consumption.

6.2.12 Infrastructure and staff

Access: The export quarantine station site must be selected so that there is suitable vehicular access all year round. Consideration should be given to the preferred routes for vehicles entering and leaving the facility. Permanent all-weather access is required and should not be limited by flooding or other similar occurrences.

Staff: While it is necessary to locate an export quarantine station away from residential areas so as to maintain community amenity and bio-security, it is also undesirable to locate them in an extremely remote area. In such instances, availability of manpower may be a problem.

6.2.13 Community amenity

The environmental impacts of an export quarantine station such as water quality degradation, dust and odours can be controlled firstly by good design and management practices and secondly by maintaining suitable separation between export quarantine facility and impact areas. All activities which are likely to cause the increased emission of odours, such as manure spreading or effluent irrigation, should be performed when the prevailing weather conditions and the time of day will cause the least odour emission and impact on sensitive receptors.

To protect community amenity, facilities should be established at an appropriate separation distance from sensitive community receptors. The desirable separation distance between the point of generation of the odour and each sensitive receptor will be a function of the source and intensity of the odour, the prevailing meteorological conditions at the site, and the nature of the intervening terrain and vegetation. Wherever possible, it is desirable to utilize existing topography and vegetation to screen new facility developments from roads, towns and nearby residences. The value of these natural features as buffers against odour, dust and noise should be utilized wherever possible. Fixed separation distances shall be the least horizontal distance between the boundary of the export quarantine station and each of the relevant features as shown in table 1 below:

Table 1. Fixed separation distances of physical features and main export quarantine station

Physical feature	Separation distance from export quarantine in meters
Public road - except as below	200
Public road - unsealed with less than 50 vehicles per day excluding export quarantine traffic	50
Major watercourse	200
Other watercourse as defined by a blue line on a 1:50000 100 m current government topographical map	100
Property boundary	20

6.2.14 Community consultation

Community consultation in the decision-making process is important in the management of odour. public's perceptions and concerns associated with the emitted odours and other environmental concerns should be addressed as part of the planning process. It is usually appropriate to meet with the neighboring residents and discuss the proposal before a development application is lodged with the appropriate planning authority.

6.3 Layout and design

The following general principles should be followed when considering the layout and design of export quarantine facilities.

- Receiving, induction, dispatch and isolation yards, manure stockpile and feed storage and processing areas should be included in the facilities-controlled drainage area. Runoff from this area should be treated and collected in the sedimentation and retention pond system.
- The size of the controlled drainage area should be kept to a minimum by diverting any runoff from areas that have not been affected by manure, away from the site. This will minimize the required pond sizes and effluent utilization areas.
- Pen rows should run parallel with the contour of the site to minimize pen to pen drainage. The maximum acceptable pen to pen drainage occurs when the cross slope is equal to the slope down the pen
- Staged development/future expansion should be considered
- Any existing topographic features or vegetated areas should be utilized wherever possible to screen the facilities from the public and/or neighboring landholders.
- The layout for export quarantine facilities should be shown with an explanation. Landscaping and grading of these facilities should consist of general site grading and detailed grading in the pens and road areas in order to direct water toward the runoff retention area.
    - The overall area of these facilities should be graded at a minimum 0.5% slope toward the runoff retention area.
    - Pens should be graded at a 2% slope toward the rear of the pen and subsequently into the drain alley.
    - Livestock alleys should be sloped at 2% toward the drain alley.
    - The drain alley center line should be sloped at 0.5% toward the runoff retention area.
    - Feed and inspector alleys should be constructed with a negative crown of 2% to the middle of the alley.
    - The center line of the feed alleys should be sloped at 0.5% toward the runoff retention area.
    - There should be a perimeter interceptor ditch around the facilities, sloped at 0.5% toward the retention area.

6.4 Blue prints (plans and specifications)

- Drawings must be scaled to not less than 1:100, except for the "Site Plan".
- Drawings must have a title block providing the legal address of the establishment, date, designing company name, the scale, and the compass North point.
- The "Site Plan" shall show the entire premises. It must include:
    - The boundaries of the plant property,
    - Location of all section and location of the plant in respect to other structures in the surrounding,
    - Loading and unloading areas,
    - Receiving pens,
    - Inspection crush,
    - Pens with their partitioning,
    - Alleys,
    - Locations of foot baths,
    - Feed and water troughs,
    - Shades,
    - Feed store,
    - Offices,
    - Sick pen,
    - Recovery pens,
    - Emergency slaughter,
    - Gates and doors,
    - Fences, fence types, internal and external and their distances,
    - Potable water sources (wells, dams, rivers, lakes, reservoirs, etc),
    - The route of water and sewer lines and drainage systems,
    - Surfacing materials e.g. packed earth etc.
    - Roads,
    - Effluent treatment sites,
    - Neighboring businesses,
    - Power lines

- Relationship of all the different levels of the establishment e.g. receiving, pens, effluent, etc,
- The limits of the official premises.

❖ A floor plan showing:

- The purpose for which each area is going to be used,
- Holding capacities of facility/pens,
- Location and size of floor drains,
- Gutters and slope of floor towards drains,
- Location of fences, partitions, gates, posts,
- The elevations of the fences,
- Flow of animals,
- Employee traffic in the facility.

❖ A cross section of the facilities showing fence, shade, office ceiling, walls, feed and water troughs, crushes, loading and unloading ramps and feed store heights,

❖ Plumbing plan(s) shall show:

- The location of all sewage lines (including their sizes), hand wash facilities, toilets, floor drains (including their size and connections),
- Gutters, slope of floors towards drains,
- Water storage tanks (including location, size and construction material).

6.5 General requirements

6.5.1. Feed supply

The animal feeder must formulate feeds based on the species, sex, age, weight gain desired and the moisture content of available roughage and feeds. The feed ration should be adjusted to the requirements for species based on the availability of feed materials in the locality.

6.5.2 Water supply

Lack of water reduces feed intake and causes stress on animals.

❖ Animals must have access to an adequate supply of clean and suitable quality drinking water.

❖ As a guide to cattle drinking water requirements, *a 400 kg animal requires about 35 L/day in cold weather and 70 L/day in hot weather*.

- ❖ In addition, where water is required for dust control, an additional application of 5 liters plus 2 liters per day may be required per square meter of pen floor. In very dry conditions, 15 liters per square meter is recommended every 10 days. This is an extra requirement of 22.5 liters per animal per day at normal stocking densities. Cattle daily requirements of water approaches a maximum of 100 liters per day during hot weather.
- ❖ Daily requirements for water can also be calculated for each other species of animals to be kept in the quarantine station by considering their daily requirement/head/day as 30 - 40L/head/day for camel; 10 L/head/day for goat and 6 L/head/day for sheep.
- ❖ The daily water requirement for each species required should be delivered to the pens over an 8-hour period.
- ❖ Cattle are reasonably tolerant to water with high levels of salts. They can tolerate up to 10,000 mg/l TDS for limited periods, but the recommended maximum for growth is 5,000 mg/l TDS. Goats may adapt to high salt levels greater than 5000 mg per litre, but generally prefer saline levels less than 2000 mg per litre while sheep prefer saline levels less than 4000 mg per litre.

6.5.3 Drains

- Adequate drainage must be available throughout the establishments.
- Drains should be located outside main drive alleys, chutes and crowd pens.
- The floor of pens should be made in such a manner that effluent including manure runs off at the lowest point down the stock lanes between the pens and channeled into broad drains and ultimately into anaerobic ponds or evaporation ponds.
- Drains must be lined with material of sufficiently low permeability to minimize the potential for leaching of contaminants into the soil or underground water resources.
- They must have sufficient flow capacity to avoid overtopping.
- They must be free flowing to avoid excessive sediment build up.
- They must be easy to maintain them in a clean weed free condition.
- They must have sufficient bed gradient to effectively convey suspended sediments to the sedimentation system without excessive scouring of the drain bed. Flow velocities will be affected by the drain cross section profile, dimensions, slope and drain bed material.

6.5.4. Floors

The adoption of a suitable floor slope is essential for ensuring good drainage. By ensuring that the floors dry out rapidly after rainfall, odor generation is minimized and animals are not subjected to muddy conditions, which could adversely affect their health, welfare and performance in the facilities.

- Slopes are often described as percentages, for example a 3% slope is a uniform fall (or rise) of 3 meters over a horizontal distance of 100 meters.
- The pen slope may utilize the natural slope of the site, or the slope may be artificially constructed.
- The flooring of export quarantine facilities should be graded and can include compacted soil, limestone outcrops or ridges or a compressed rubble base.
- The floor slope should be in the range of 2 to 6% with 3% considered optimal in order to facilitate drainage and minimize erosion.
- The pen floor should have a slope of between 2 – 6% away from the feed bunks.

6.5.6 Stocking density

The stocking density is generally defined as the average facility pen area allocated to each animal. It can influence the performances of animals in addition to their general health and welfare. Furthermore, it has important implications for the environmental management of the facilities, as it affects the moisture content of the pad and therefore its potential to produce odor and dust.

- ❖ Stocking densities should take into account the local climate and the size of the animals to be kept at any one time in the export quarantine facility.
- ❖ There needs to be a compromise between the higher odor generation potential at heavier stocking densities and the higher incidence of dust problems at lighter densities.
- ❖ In general, a range of 12 to 25 m^2 /head is recommended for cattle; 1-1.3 m^2 /head is recommended for sheep and 4.6-5 m^2 /head for goat.
- ❖ The space requirement for camels is 100 m^2 for 1 camel plus 50 m^2 for each additional camel with a minimum width of 6m.

6.6. Specific requirements

6.6.1 Receival and dispatch facilities

Receival and dispatch facilities include various associated components including holding pens, races, loading ramps and vehicle maneuvering areas. Receival and dispatch facilities should:

- be able to accommodate varying types and configurations of livestock transport vehicles expected
- be able to accommodate the type and number of livestock to be handled
- provide access to holding pens and processing facilities
- prevent injuries to and minimize stress on livestock
- prevent injuries to operators
- provide feed and water for unloaded animals
- provide water for livestock to be loaded
- have lockable slide gates to prevent accidental escapes, illegal/unauthorized livestock delivery or removal
- provide drainage
- provide non-slip surfaces
- consider access for truck drivers
- position ramp so that the truck driver may back in with a good view from the driver's side of the vehicle.
- consider the direction of sun in morning and evening; avoid walking livestock directly towards bright light (artificial or sun)

Moreover;

- The location of the receival and dispatch facilities within the overall site layout should provide good access for trucks and trailers and appropriate traffic flow of livestock transport vehicles.
- If night time loading or unloading is likely, the area should have appropriate lighting. Lighting should cover all areas including the holding pens and personnel access areas, with a number of lights to prevent shadows

- If receiving or dispatching a large number of animals requires a number of trucks, a suitable stationing or parking area should be available for the waiting trucks.
- Adequate space required for turning and reversing, depending on the size of the trucks and the number of trailers should be available.

6.6.1.1 Loading & unloading ramp

Well designed and constructed loading facilities result in quicker, safer loading with less stress on livestock carriers, stock and owners.

- ❖ The reception and dispatch areas should have offloading and loading platforms, respectively.
- ❖ Docks of different heights or adjustable ramps should be provided to accommodate vehicles of varying heights.
- ❖ The unloading and loading facilities shall be so constructed that unloading and loading can be carried out without having a gap between the vehicle and the dock or ramp.
- ❖ The sides of any ramps or dock should be high enough to prevent the escape or injury of animals.
- ❖ The loading and unloading dock area should be leveled and non-slippery.
- ❖ Stock will generally flow well with a gentle stepped ramp of around six meters in length to reach the 1.2 m loading height.
- ❖ The loading and unloading ramp should have a slope of no more than 20 degrees with a floor of concrete, steel or timber;
- ❖ Ramp floors should give good grip, be easy to walk on, not flexible and bouncy, and should not resonate or create undue noise
- ❖ Unloading ramp should have a horizontal docking area approximately 1.5m long to prevent livestock from slipping as they step out of the transporter.
- ❖ Loading height will vary slightly with the type of livestock transport vehicle to be used, but is generally 1.1–1.2 meters for most body trucks and semi-trailers.
- ❖ At the top of the ramp, a level platform of about 2–3 m long will allow livestock to balance and gain more confidence to move onto the different flooring material of the trailer.
- ❖ Sheeting the sides of the lead-up race and the loading and unloading ramp should be done to make animals focus on the exit, eliminates baulking from visual distractions and thus improves flow.

6.6.1.2 Receiving pen

- The receiving pens hold livestock for a relatively short time before processing
- The holding pen size is typically for a single deck of livestock, which is generally an easier quantity to process at a time. This capacity will need to be able to fill the race for feeding into the crush.
- Space requirement for holding pens is 1.8 - 2 m^2 for cattle, 2m^2 for camel and 0.5 m^2 for sheep and goats.
- The holding pens should have direct access to the crush.

6.6.1.3 Race

A race is a narrow lane to single file livestock for further processing, batch treatment or visual inspection. It can be used in conjunction with crushes, loading ramps. Livestock are forced into single file to direct them towards the crush or weigh box, and to overcome their natural instinct to return to where they came from. The aim is to maintain a constant and continuous flow without involving many workers in the process. The quarantine race should fulfil the following:

- A race should be located before a crush.
- Races may be parallel-sided, V-shaped or with adjustable width.
- Races are can be curved but can be straight. However, the race needs to be straight for at least 3.5 – 4 m lengths at the start, as an immediate curve would look like a dead end to the lead animal.
- The height should be 1.8 m for cattle and camel, 1.2 m for sheep and 1.4 to 1.5m for goat
- The race length will depend on the number of livestock being handled – about 1.6–2.4 m per head is required for cattle.
- The width of the path (race) shall not be greater than 90 cm for cattle and 35 cm for sheep and goats (should not allow the direction reversal of animals).
- The outer panel of the race needs to be sheeted to aid good livestock flow by overcoming external visual distractions that will frighten them

6.6.1.4 Inspection crush

In order to precisely inspect and differentiate diseased and injured animals, it is important that each and every animal pass through crushes at the gate of the facilities.

- Each quarantine facility needs to have inspection crushes next to receiving pens along the entry into the pens and also at the end of the alley which leads to the loading ramp.
- The crush needs to be well designed so that it has pre-inspection collection pen and also detaining pen for rejected animals.
- The length of the crush is determined by the number of animals that must stand in the crush simultaneously. The recommended length is 2 m per animal.
- The width of the crush requires careful consideration as a crush that is too wide, will allow animals to turn around.
- The inner dimension should be around 0.68 to 0.75m for cattle but for a V shaped crush, the inside width at the base of the squeeze should be 0.28 to 0.4m for cattle.
- For sheep and goats, where V-shaped crushes are used, a base width of 0.2 to 0.3m and a top width of 0.45 to 0.68m is recommended.
- The height of a crush should be 1.6 to 1.8m for cattle, 1.8m for camel, 1.2 m for sheep and 1.4-1.5 m for goats.
- There should be no sharply contrasting shadows or bright patches that may baulk animals.
- Animals should be able to see well ahead.
- There should be no distractions to forward movement.
- Crushes must be well maintained and kept free of loose objects.
- Must be so constructed to render the floors and drain covers non-slippery.
- To encourage entry, livestock should be able to see at least 6 m of unobstructed space beyond the crush.
- Animals are more willing to enter a crush if the sides are covered, thereby preventing sight of the handler alongside. The use of solid sides also reduces the risk of an animal's leg becoming trapped between the crush supports.

6.6.2 Pens

Pens are the main animal housing units for an export quarantine facility. Sound design will ensure optimum animal performance, good animal welfare and high standards of environmental performance.

The design objectives for an export quarantine pen are to:

- Provide an environment for animals where their welfare is maximized
- Promote safe access for animals to and from the pen
- Minimize environmental impacts such as odour and dust
- Promote drainage to provide a comfortable environment for livestock and minimize environmental impact
- Optimize the management and removal of manure from the pens
- Provide a safe working environment for export quarantine personnel.

For this, pens in an export quarantine facility must fulfil the following requirements:

- Be constructed and maintained to avoid injury of animals.
- Pen fences should be 1.6 - 1.8 m high for cattle; 1.8m for camel; 1.2 m for sheep and 1.4 -1.5 m for goats.
- Compact floors that are curbed and drained and non-slippery.
- Should be fitted with gates which have a minimum width of 0.8 m for sheep and goats; 1.8m for cattle and camel.
- Well drained manure slabs for kraal manure prior to removal
- Isolation area for suspect animals must have solid walls and gate and must not drain across other pens or pose any other contamination risk.
- Pen rows should run parallel with the contour of the site to minimize pen to pen drainage.
- A smooth, consistent pen slope promoting the runoff of storm water.
- Pens be constructed with slopes of 2 – 6%.

6.6.2.1. Pen size

- It is convenient to size pens to match multiples of deck sizes of livestock transport vehicles.
- Pen sizes may range from 50 to 300 head in capacity for cattle, and not more than 500 for sheep and goats.
- A range of available pen sizes can be useful where different sized consignments are commonly received.
- Pen sizes can also be matched to transport arrangements, eg. 1 x 50 head pen per double deck trailer load for cattle.

- Pen depth should be restricted to a maximum of 65 m to limit the distance to feed facilities and minimize erosion.
- Pen depth should be decreased for steeper pen slopes to reduce the potential for erosion of the pen surface, e.g. 50 m maximum depth recommended for 6% pen slope.
- The pen width must be adequate to provide the required trough length for the number, size and species of animals being fed in the pen and should allow sufficient room for ease of operation and cleaning.

6.6.2. 2 Pen orientation

Adverse climatic effects can sometimes be alleviated by studying the local climate, e.g. prevailing winds, and taking advantage of the local topography. A northerly aspect is generally desirable for maximizing exposure to the sun.

6.6.2.3 Pen floor construction

The pen floor must not break down during rainy season. The following general specification for pen floor construction is the minimum preparation for export quarantines:

- The area should be cleared of trees, scrub, and stumps.
- Tree roots should be grubbed to 300 mm below natural ground surface.
- Topsoil should be stripped from the area and stockpiled for later reclamation work.
- All holes should be back-filled with suitable clay or gravel
- If the exposed material is of a suitable quality for pen floor foundations ie clays having low, intermediate and high plasticity, clayey sands and clayey gravels, the area should be ripped, brought to optimum moisture level for compaction, and compacted to 95% of standard maximum laboratory dry density with a suitable roller.
- Cut, fill and grade the foundation to a smooth 3 – 6% slope away from the feeding areas.
- The top 300 mm surface fill should consist of a suitable gravely clay to provide a sufficiently durable pen surface. This should be laid in even layers having a maximum thickness of 200

mm prior to compaction, brought to optimum moisture level for compaction, and compacted to 95% of standard maximum laboratory dry density with a suitable roller.

For export quarantines built on sandy soils the following method is suggested for the construction of the pen floor foundation:

- ❖ The area should be cleared of trees, scrub, and stumps. Tree roots should be grubbed to 300 mm below natural ground surface.
- ❖ All holes should be back-filled with coarse sand.
- ❖ The sand base should be graded, watered and compacted to form a smooth 3 – 6% slope away from the feeding area
- ❖ The top 450 mm surface fill should consist of a suitable gravely clay to provide a sufficiently durable pen surface. This should be laid in even layers having a maximum thickness of 200 mm prior to compaction, brought to optimum moisture level for compaction, and compacted to 95% of standard maximum laboratory dry density with a suitable roller.

6.6.2.4 Pen signage

All pens should have a small sign with the pen number. This sign should be at the top end of the pen along the feed bunk so that feed truck operators can locate the correct pen when delivering feed. It is also useful to be able to identify the pen number from the cattle lane with another sign on the entrance gate from the stock lane to the pen.

6.6.3 Feed troughs

Feed troughs should be designed to allow sufficient space for all livestock to eat without competition.

For cattle, the following points should be considered:

- Feed troughs should always be located along the fence line, never within the pen.
- They should be located along the higher end of the pen with drainage away from the trough on both the feed road and pen sides. This minimizes boggy conditions on the pen side of the bunk and keeps the feed road firm and accessible.

- The bed of the trough should be 17.5 cm above the level of the apron to facilitate a natural feeding stance, particularly after a layer of manure builds up on the apron.
- Feed trough length will depend on the number of livestock to be fed within the pen. Cattle of 600 kg live-weight require a minimum of 30 cm of trough space/head when fed once daily. More frequent feeding will allow the trough space per head to be reduced. An average market size bull with a weight of 250-395 kg may require a minimum of 18 cm trough space and a younger cattle of less than 250 kg body weight may require 15 cm trough space.
- Open troughs should incorporate 2.5 to 3.0 m wide reinforced concrete aprons sloping away from the feed source.
- Feed troughs should be constructed of durable material which is not easily damaged and cannot be moved by animals.
- They should have an internal profile which can be easily cleaned, and the external sides should meet the ground at right angles.
- To prevent manure and spilt feed accumulating beneath the trough and to improve the ease of cleaning, troughs should have vertical external sides.
- The ends should be open, and long runs of troughs should include drainage points to allow drainage after rainfall.
- The inside surfaces of feed troughs should be smooth with well-rounded corners to facilitate easy cleaning.
- To prevent livestock from entering the feed trough and possibly escaping, cables should be strung out over the feed trough.
- The cross-sectional area of the trough determines the amount of feed that can fit into the trough per unit length. If the cross-sectional area is too small frequent filling will be necessary. If the feed trough is too wide, feed pushed to the back of the trough is less accessible and animals are tempted to step into the trough to try to reach it.
- Feed troughs should allow rainwater to drain, preferably by having drain holes or slots at intervals along the length of the trough. These drainage points need to be large enough that they do not get blocked.

Table. 2. Sample feed trough dimensions for cattle

Description	Dimension
The height of the back wall above the feed apron.	500 mm
The height of the front wall above the feed road.	700-750 mm
The height of the livestock restraint rail above the apron	1000–1150 mm
The width of the feed storage area of the trough	715 mm
The thicknesses of the front walls	135 mm
The thicknesses of the back walls	120 mm
The cross-sectional area of feed per meter length of trough	0.196 m^2
The cross-sectional area of concrete for the trough per meter length of trough	0.219 m^2

- Trough space for camels should be managed on the same basis as for cattle.
- For sheep and goat, the following should be done:
    - Troughs can be designed so that sheep and goats have access to one or both sides – it is important that the correct feed space is provided to reduce shy feeding.
    - For double-sided access to feed troughs length of 20cm per adult sheep or goat and 15cm trough length for a kid or lamb of less than one-year of age.
    - For single sided access to a trough, 30cm per lamb or kid and 40cm per adult sheep or goat of trough space should be allowed.
    - Troughs should be raised off the ground to reduce fouling. Lift the top edge up to 40–45cm for lambs and kids and 50–55cm for adults.

Fig 7. Sample cattle feedlot trough

Fig. 8 Sample sheep and goat feed trough.

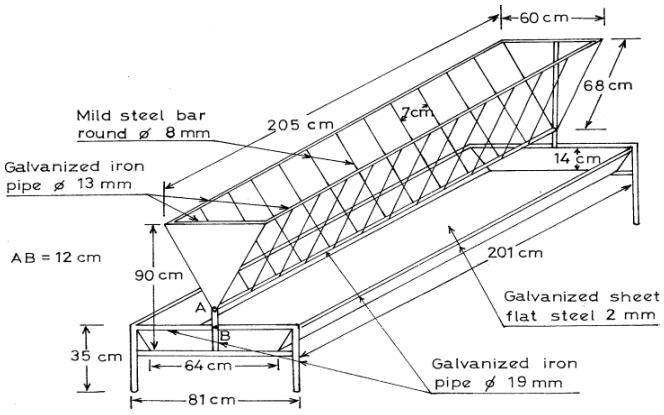

Figure 9 - Sample sheep and goat grain and hay feeder. Hay is placed on the top.

6.6.4 Water troughs

- Access to an adequate supply of good quality water is essential for the survival, welfare and performance of animals.
- Water troughs should be large enough and designed in such a way that all livestock have easy access.
- Each pen should preferably have access to two water troughs so that livestock can have access to water if one trough blocks
- Animals must be prevented from stepping or falling into water troughs by sides extended high enough from the ground and an exclusion bar (steel or timber frames) over the surface of the trough.
- Low volume shallow troughs are preferred to reduce the flushing volume generated during regular cleaning operations. A good quick supply of water is essential for low volume troughs.
- Water troughs should be in the lower half of the pens, with provision for any spillage and water discharged during cleaning to drain directly to the drainage system to avoid creating wet spots.
- Water troughs should have vertical external sides which meet the ground at right angles to prevent manure accumulating beneath the trough.
- Troughs should not be shared between pens to avoid disease transmission.
- The water source should not be close to the feed source, to avoid more feed is deposited in the water trough or vice versa.
- Water troughs should incorporate at least 3.0 m wide reinforced concrete aprons all around the trough sloping away from the trough at 2 to 3%.
- Water troughs may incorporate shade structure as hot water reduces intake. The size of the trough shade structure should be limited to the need to protect the water trough from direct sunlight but not to provide shade for animals standing underneath.
- Water troughs should have a height of 0.9 m for cattle and camel, 0.3 m for sheep and goats.
- A minimum of 25-30 cm of water trough length per head is required for cattle and 30 cm for camel;

- For sheep and goat, at least 30cm of trough for the first animal and 1.5cm for each additional animal is recommended. For example, a trough length of 7.6m is the minimum requirement for a size of 500 sheep and goat.

6.6.5 Pen shade

Shade can have a large impact on the body heat load experienced by animals by reducing solar radiation and slowing the rate of gain of body heat. Shade can improve animals' comfort and productivity. The design of shade structures should ensure that ventilation beneath the structure is maximized and where possible, air temperatures are kept below body temperature.

6.6.5.1 Orientation of shade structures

- ❖ The optimal alignment of shade structures is north-south. This allows the shade to move across the pen throughout the day and assist the drying of the pen floor beneath the structure.
- ❖ A slope of 15^{o} rising to the east provides two extra benefits – the shade roof will create its own passive air movement as air heated beneath the roof rises, and the slope will allow a larger area to be shaded during the mid to late afternoon when the day temperature is usually highest.

6.6.5.2 Size of shade structures

- ❖ The minimum requirement is that the area of shade be sufficient to cover all animals.
- ❖ Recommended shade areas per head range from 1.9 square meters to 6.0 square meters for cattle and camel, 0.55 -$1m^2$ for sheep and goat.
- ❖ Higher shade structures provide more cool air for the animals, and allow the shade to move across the pen faster.
- ❖ Minimum suggested height is 5.0 meters on the western side rising at a slope of 15^{o} towards the eastern side to the maximum height of 8.1 meters.
- ❖ Most shade structures are 12 meters wide.

6.6.5.3 Positioning of shade structures

- ❖ The shade should be positioned in the pen so that animals have access to the shade as it moves across the pen during the day, particularly during the afternoon when daily temperatures are at their maximum.

- shade structure needs to be located towards the western side of the feed pens to ensure the shade remains in the pens during the late afternoon.

6.6.5.4 Shade materials

The most common shade materials are galvanized sheeting or shade cloth due to availability and relatively low cost. Shade cloth has the advantage of allowing air to pass through the material, but shade cloth can be affected by degradation of the material, bird damage, and vermin damage if furled during the rainy season. Galvanized sheets have a longer service life and can allow free flow of air if spaces are left between the sheets. They are generally heavier than shade cloth to erect and support, requiring more substantial structures.

6.6.5.5 Management of shaded areas

The use of shade structures will result in a moist area beneath the shade due to deposition of faeces and urine. This area, if not managed to limit manure accumulation and moisture build up, may result in increased humidity and elevated ammonia levels beneath the shade and in the pen. Repair and maintenance of the pen surface will also be high in this area.

The area should be regularly cleaned of wet manure to limit odour production and ammonia emissions. Shade structures of the dimensions outlined above allow access by sunlight to the pen floor as the shade moves across the pen throughout the day. This will assist in reducing the occurrence of shade related wet pen conditions.

6.6.5.6 Structural design of shade structures

Shade structures need to be designed carefully with attention paid to the loads that the structure must bear. Wind blowing against the structure results in directional loads. Side loading is caused by wind action against walls and posts, while wind action on a sloping roof can cause the roof to act either as a wing or an aerofoil depending on wind direction.

These forces must be taken into account when designing the structure. The mass of material supported by the structure is called the “dead load”. The dead load of galvanized sheeting is higher than for shade cloth, so the support structures need to be more substantial. The dynamic load of the shade structure is a load that varies in character. It typically results from movement of

a structural member or other variable or oscillating force. It is recommended that engineering advice be sought in the design and placement of export quarantine shade structures.

6.6.7 Feed storage

Feed storage should be constructed on the opposite side of the area where the isolation and recovery pens are located. Animal feed store must be vermin proof.

6.6.8 Fences, gates & lanes

Fences, gates and lanes should be designed to enable efficient movement of livestock and cleaning machinery. No single fence type appears better than others and this decision is left to the producer and availability of local materials. Access into the pens may require 1 or 2 gates. Consideration should be given to moving livestock, cleaning of pens and removal of manure.

6.6.8.1 Perimeter fence

The external fence should be fenced with 5 cm diameter wire mesh, woven wire or using masonry walls as may be considered appropriate. The type of fencing needed for livestock confinement depends on several factors including animal species, age, breed, and production system. Factors for selecting fencing type include affordability, maintenance, durability, and effectiveness of containing livestock.

A. Mesh wire fences

Mesh wire fences are strong and provide great safety to animals. Mesh wire fencing is made in 11, 12 ½, 14 and 16 gauges, and fences are available in diamond-mesh and square knot designs. The square knot wire design is formed from single line wires spaced 10 cm apart and stay wires spaced 5 cm apart. The joints are held by a piece of short wire formed into a knot.

The diamond-mesh wire design uses two smooth wires spaced 10 cm apart, which are twisted together for all line wires. Stay wires consist of single smooth wires the same size as the line wires. These stay wires are wrapped around adjacent line wires to form a triangle with a 5 cm base. The diamond shape is formed when two of these triangle bases are fitted together. Both

mesh fence designs are strong and highly safe for animals.

Fig.10 Sample wire mesh fence

- ❖ The metal or wooden stands or poles need to be interconnected by tensile barbed wire strands which may be reinforced with plain wire meshes.
- ❖ The fencing for cattle and camel should be built with metal poles standing at intervals of about 10-15m with wooden poles in between.
- ❖ The spacing of posts for sheep and goats should be 3.7 to 6m apart.
- ❖ The height of the fence may be 1.4 - 1.5 m for cattle (which may be 1.6-1.8 for cattle not accustomed to handling); 1.2 m for sheep; 1.4 – 1.5 m for goats and 1.8 m for camel.

B. **Woven wire fences**

Woven wire fences consist of a number of horizontal lines of smooth wire held apart by vertical wires called stays.

B.1 Cattle

- Barbed and woven wire fences have traditionally been used for cattle. However, barbed wire fences require higher maintenance and have shorter lifespans than woven wire fences.
- 5-strand woven wire fences with one or more strands of barbed wire above the fence are excellent for cattle.
- Fence height should be at least 1.4 - 1.5 m for cattle (which may be 1.6-1.8m for cattle not accustomed to handling) and 1.8 m for camel. Though the initial cost of woven wire fence is

higher than the cost of a 5-strand barbed wire fence, woven wire fences require less maintenance and last longer that barbed wire fences.

- Standard galvanized woven wire with the top and bottom strands of number 12 1/2 gauge or larger are recommended.
- Vertical stay wires shall be 14 ½ gauge or larger and spaced not more than 30 cm apart.
- One or more strands of barb wire spaced approximately 10 – 15 cm apart shall be added at the top.
- Posts spacing should be not more than 4.8m for standard galvanized woven wire.
- Fences for camel can be made with similar materials and specifications with that of cattle by considering the specific height requirement of 1.8 m.

B.2 Sheep and goat

- Several options currently are available that include barbed wire, cable, woven wire, net wire. Factors for selecting a fencing type include affordability, maintenance, durability and effectiveness of containing livestock.
- Woven wire fencing, shown below, are excellent for goats. Depending on the breed types to be confined, fence height should be at least 1.2 m for sheep; 1.4 – 1.5 m for goats high.
- Woven wire fencing consists of smooth horizontal (line) wires held apart by vertical (stay) wires.
- Spacing between line wires may vary from 4 cm at the bottom to 20 cm at the top. Wire spacing generally increases with fence height.
- Stay wires should be spaced 15 cm to 30 cm apart depending the size of the animals.
- Woven wire fencing is excellent for predator control. The fence bottom should be placed on the ground to allow for the use of snares where predators dig under the fence.

Fig.11 Sample woven wire perimeter fence for sheep and goat

7.7.2 Pen fence

Pen fence must be economical to build and maintain; they must contain stock but not hinder pen drainage or cleaning.

A. Cattle

- The height of the fence may be 1.4 to 1.5 m for cattle (which may be 1.6 to 1.8 for cattle not accustomed to handling) and 1.8 m for camel.
- Pen fence posts are generally made from either steel or timber. Wooden posts should be at least 25 cm in diameter with corner and gate posts 30 to35 cm in diameter.
- The posts may be of steel or timber, and should be set into the ground at least 90 cm, and at least 4.5 to 9m for cattle and camel;
- If timber posts are to be concreted into position, the post should protrude below the bottom of the concrete to allow water to drain out and prevent the post from rotting.
- Steel posts need to be set in concrete 90 cm below ground level with the concrete finishing about 20 cm above ground level
- Pen fences constructed with cables are stronger than wire fences.
- Fences should include five rows of cables and rails to allow under-fence cleaning while preventing animals escaping by rolling under the cable.
- Cables should be attached to, or directed through, fence posts so that no sharp edge can deteriorate the cable as it moves constantly back and forth under pressure from the animals.

- ❖ Cables can be run through holes in wooden posts; steel posts require hollow sleeves or external eyelets
- ❖ The bottom cable or wire should be 40 cm above the pen surface to enable under fence cleaning with a push bar.
- ❖ Top rails and belly rails are required to add strength to a fence.
- ❖ Top rails and belly rails and posts can be either wood or steel. Wooden rails should be at least 150 mm in diameter and steel rails at least 100 mm in diameter
- ❖ The parameters indicated above can be adapted to camel by giving consideration the relative height differences

B. Sheep and goats

- Woven wire fencing is the most reliable form of sheep and goat fencing because it provides a strong but flexible barrier.
- Individual knots are tied to the horizontal and vertical wire intersections, creating a mesh that holds tight and won't slip. The knots create a springy texture, so the fence will flex when challenged, rather than snap the way welded wire can.
- Wire fence spacing should be no more than 10 cm high and 10 cm wide to keep goats from breaking free.
- The height of the fence may be 1.2 m for sheep and 1.4 to 1.5 m for goats
- Install H-braces at each corner of the pen and at gate entrances to bolster their strength.
- Brace and corner posts should be made of 15-20 cm diameter treated lumber and set in the ground a minimum of 100 cm to prevent movement.
- Line posts hold the fence in place between the corners and gates and are typically wood (10 cm treated lumber), steel t-posts, or a combination of these.
- Steel t-posts are a good alternative to wooden posts and make for easier installation. Various weights are available to meet different needs for strength and durability.
- Recommended spacing of line posts is between 2.5 - 3.65 m depending on the material that the posts are supporting and the anticipated amount of pressure on the fence.

- To assure stability, line posts should be set at least 60 to 75 cm deep, and tall enough to accommodate a top-line wire if desired.
- Install posts on the outside of the fence line so that pressure from animals pressing against the material is supported.
- The bottom wire of the fence should be as close to the ground as possible. Stake it securely to prevent goat and sheep from trying to go under the fence.
- Woven wire fences consist of smooth horizontal (line) wires held apart by vertical (stay) wires. Spacing between line wires may vary from 4 cm at the bottom to 20 cm at the top. Wire spacing generally increases with fence height.
- It's important to keep the crimps intact on the horizontal line wires. This allows the fence to expand and contract during fluctuating weather conditions. Avoid using too much muscle when stretching the fence.

Fig.12 Sample woven wire pen fence for sheep and goats

6.6.8.3 Gates

- ❖ The size and location of gates are important; they must provide good, safe access to the pens for both pen cleaning equipment and stock
- ❖ Quarantine facilities require a gate at the rear of pens for movement of stock and pen cleaning equipment, and another across the feed trough apron for easy cleaning of aprons
- ❖ Stock movement gates are usually located at the bottom of the pens
- ❖ Gates should be lightweight but strong

- ❖ Gates should not have sharp protrusions that livestock can bump into and be bruised by as they move in and out of the pen.
- ❖ All gates should lay flat against the fence line when open and should be long enough to block the livestock laneway when open.
- ❖ Gateways should be set at an angle so that tight turns into pens are avoided.

6.6.8.4 Laneways

- ❖ A good lane system will promote efficient movement of livestock and pen cleaning equipment
- ❖ Lane widths of between 4 and 5 meters are generally suitable for moving livestock and machinery into and out of pens.
- ❖ Laneway fences should be constructed with cable or plain wire.
- ❖ The use of barbed wire should be avoided.

6.6.9 Isolation pens (sick & recovery)

- ❖ Sick animals can be held in special pens, separated from their congeners, to facilitate veterinary inspection or treatment.
- ❖ Isolation pens should be sited and constructed in such a way that waste and effluent from them cannot contaminate adjacent pens in the facility or passageways.
- ❖ Isolation pens should have separate drainage systems.
- ❖ Isolation pens should be away from the main passageways used by people and animals.
- ❖ The pens should have separate facilities such as water and feed troughs.
- ❖ The distance between an isolation pen and the rest of the facility shall be at least 60 meters.
- ❖ Sick and recovery pens can be constructed adjacent to each other for an easy transfer of convalescent animals.
- ❖ The Isolation pens should have a minimum space allowance of 14 m^2 per head for cattle; 1.0-1.3m^2 for sheep; 4.6 – 5m^2 for goats and 100 m^2 for 1 camel plus 50 m^2 for each additional camel with a minimum width of 6m.

6.6.10 Foot bath

Each export quarantine facility should have 0.5 x 1.5 m foot bath made of 10 cm thick mass concrete along the following alleys:

- At the gate of the entry into the facility compound, offices and feed stores.

- At the end of the crush after animals are received.
- Along the exit alley from the recovery pen.

6.6.11 Effluent management system

- ❖ There should be a sedimentation system where the base should be constructed from compacted gravel to enable cleaning operations to proceed under wet conditions. Basin embankments and beds should be impermeable to prevent seepage of effluent into ground or surface water resources.
- ❖ Holding ponds should be constructed so as to ensure impermeability.
- ❖ A cut-off trench and compacted clay core are generally required beneath and within the embankment respectively.
- ❖ The embankment crest width should be at least 3 m.
- ❖ The upstream and downstream batters should be no steeper than 1 in 3.5 and 1 in 2.5, respectively, if clay construction materials are used.
- ❖ A by-wash should be provided to ensure that the embankment is not overtopped following extreme rainfall events.

6.6.12 Manure management system

- ❖ Manure stockpile areas should incorporate a stable compacted base to enable manure handling operations to proceed under wet weather conditions.
- ❖ Manure stockpile areas should be established within the facilities along the controlled drainage area and with a regular 1-3% slope.
- ❖ The foundation of the area should be prepared to the same specifications as the facility pen foundation, and the surface should be finished with a layer of compacted stones to ensure all weather access.
- ❖ The manure stockpiles should be constructed up and down the slope of the area, not across the slope. This will assist drainage.

6.6.13 Emergency water storage

Animals under quarantine must have an uninterrupted supply of clean water, every export quarantine station should have contingency plans for pump or pipeline failure. Water supply may be interrupted for many hours or even days due to natural disasters (damage to infrastructure), electricity blackouts, pump or pipeline failure.

- A temporary emergency (back-up) water supply and suitably sized water storage close to the export quarantine facility are essential.
- Export quarantine facilities need an onsite water storage to overcome differences in supply and demand and to also provide an emergency storage for temporary supply failures.
- Emergency water storages can be constructed from almost any material as long as they safely store water at a reasonable cost.
- Emergency water storages can be made of steel or concrete above-ground tanks or earthen embankment storages.

Earthen embankment storages: Earthen embankment storages are filled by pumping water from some other source. The ring tank is in the shape of a ring (or square or rectangle) bounded by a compacted earthen embankment and usually located on relatively flat ground. The material required for the embankment is excavated from inside the embankment, hence water can be stored above and below the natural ground level.

As all water is stored above natural surface level it can be gravity fed to the point(s) of usage. Each earthen embankment storage is unique in size, shape, capacity, location, soil and environmental characteristics and hence has to be designed individually.

Above-ground tanks: Above-ground tanks are an alternative to earthen embankment storages. They can be constructed from various materials (e.g. concrete, polyethylene, corrugated iron), are available in various sizes and generally have an enclosed roof. Most steel or concrete tanks can be supplied with a cover. When located on a stand or high point above the export quarantine pens, gravity assists flow of water to the off-take points. The cost per volume of storage of these tanks is much higher than from earthen storages.

Temporary supply: Trucking emergency water is expensive and requires intensive management. It should be considered only as a temporary solution or in extreme emergencies.

Storage size: Emergency or back-up water sources sufficient to meet the basic water requirements of cattle during peak demand days and the anticipated emergency period must be incorporated in the design and planning process. This supply or storage should be of sufficient capacity to supply water to cattle under emergency conditions until breakdowns can be repaired.

- ❖ Emergency supply should be capable of supplying basic water requirements for at least 48 hours. Where some infrastructure (e.g. deep artesian bores) may take much longer than 48 hours to repair, a secondary water supply source or large temporary supply is essential.
- ❖ The number of days of storage required depends on the anticipated time needed for pumping systems to come back online. The following formula can be used to determine the emergency storage volume. Storage Volume (L) = Peak drinking water (L/head/day) × Pen capacity × No. of supply days. For example, an export quarantine with 1000 head on feed needs a two-day emergency supply volume of = 40 L/head/day × 1000 head-on-feed × 2 = 80,000 L.
- ❖ The same formula can be used to calculate emergency water requirements for other species of livestock by considering the daily water requirement for camel = 30-40L/head/day; for sheep = 6L/head/day; for goat =10L/head/day.

6.6.14 Offices and other facilities

A main export quarantine station should have adequate office accommodations for operators and government inspectors.

6.6.14.1 Inspectors' office

- ❖ The inspectors' office should be located in the same general area as company offices.
- ❖ Office amenities and facilities for the protection and storage of clothing, equipment and supplies of inspectors shall be provided.
- ❖ The minimum office space requirement for a private office is 11m² for one inspector and 1.4 m² for each additional inspector.
- ❖ There shall be an adjoining toilet and wash and dressing room facilities.
- ❖ A shower facility is required for inspectors.
- ❖ The room should be furnished with shelves and lockers.

6.6.14.2 Employee welfare rooms: Should have separate washrooms and dressing rooms for both sexes. The lunchroom and cafeteria may be combined.

6.6.14.3 Washrooms toilets and urinals

- The construction of washrooms should be of smooth, hard, impervious material such as glazed tile or smooth, steel, troweled cement plaster, with properly drained floors.
- They shall be of adequate size for the maximum number of employees.

- Urinals can be supplied under condition as above with 1 stall for 40 men.
- In female washrooms, a urinal may be substituted for a toilet.
- Toilets and urinals for male and female should be separately constructed
- The floor of the toilets and urinals should be at least cement tiles.
- The wall, at least 1.5 m high from the floor shall be constructed with ceramic tiles.
- The toilets and urinals ought to be furnished with hand washing facilities
- There shall also be a sufficient number of showers in the quarantine station

6.6.14.4 Dressing rooms

- ❖ Dressing rooms should be separate from but communicate directly with washrooms.
- ❖ The floors need not be drained but the finish should be amenable to thorough cleaning.
- ❖ Individual lockers for the use of employees shall have a 45^{o} slope and should have a floor clearance of not less than 35 cm.
- ❖ The shower(s) should be attached with changing room(s) and should have floor at least cement tiles and wall 2 meters high epoxy paint finishing.
- ❖ There should be separate changing room(s) and shower(s) for male and female workers.

6.6.14.5 Equipment and drug stores

- These rooms should be so constructed as to be readily maintained in a clean and sanitary condition and also to protect against dust, moisture and other undesirable conditions.
- The floor can have cement tile finishing.
- There shall be adequate wall and floor racks and shelves.
- The wall shall be finished at least with light plastic paint.

6.6.14.6 Laboratory

- The floor should be at least cement-tile.
- The wall shall be at least white oil paint finishing and the ceiling can be chip wood.
- Hot and cold-water supply should be available in the laboratory.
- The laboratory should be constructed by dividing a testing room and inspector's office separately.
- The laboratory should be equipped with the necessary instruments, devices and reagents as per the standard of the laboratory guidelines of the MoA and relevant international standards

6.6.14.7 Clothes washing & ironing room: The room should be supplied with hot & cold water and laundry facility.

6.6.14.8 First aid accommodation

- ❖ The first aid accommodation should be available as per the standards and authorization of the Ministry of Health.
- ❖ The first aid accommodation should be kept in appropriate and accessible places.

6.6.14.9 Fire protection equipment

- ❖ Portable cylinder (fire extinguisher) with chemical substance should be available as per the standards and authorization of the Fire Brigade Station.
- ❖ The fire extinguisher(s) should be kept in appropriate and accessible places.

6.6.14.10 Incinerator

- ❖ The incinerator should be built on the leeward of the quarantine.
- ❖ The incinerator could be built either from metal or bricks.
- ❖ Its size should be enough to incinerate whole carcass of cattle or camel at a time and should be at least 50 m away from the livestock pen and service facilities.

6.6.14.11 Waste treatment

- Human waste from toilets, showers and lavatories shall be dealt separately by collecting in a septic tank extended to soak pits.
- Waste water from livestock pens should be led to waste water treatment pond by a piped system.

6.6.14.12 Energy production unit

- ❖ Packaged boiler, refrigeration units and an electric generator or connections to the public supply should be housed in separate rooms.
- ❖ Hot water heaters or heat exchangers for the quarantine supply shall be located in a central boiler room.
- ❖ The diesel engine room should be built separately on the leeward of the quarantine station.

6.6.14.13 Boiler room

- ❖ The boiler room shall be adjacent to the sterilization room.
- ❖ The wall and the floor should be finished with oil paint and cement screed respectively.

6.6.14.14 Sterilization room

- ❖ The room shall be equipped at least with autoclave(s).
- ❖ The wall and floor should be finished with oil paint and cement screed; respectively.

6.6.14.15 Emergency slaughter house

- A quarantine station needs to have well separated area to slaughter accidentally injured or severely sick animals.
- The facility should be fitted with carcass burning pit.
- The cattle and camel unit would be equipped with floor pulling ring, hoist and rail system, cradles and equipment sterilizer and hand washing facilities.
- The sheep and goat unit would be the same except that it would not have a pulling hoist or rail system.
- The units should be equipped with stainless steel table, drain hole, pressurized cold and hot water supply.

7. Border control post construction requirements

A border control post is an inspection post designated for carrying inspections on animals and animal products arriving from third countries or exiting from Ethiopia for export. These checks are carried out to protect animal and public health from diseases that may be introduced in to the country or disseminated from Ethiopia to other countries importing live animal and their products from Ethiopia. Facility requirements of different border control posts may vary depending on the type and volume of work they may perform.

7.1 Facility requirements for land crossing boarder control posts

Border control posts located at major land crossing points along the main trade routes to Djibouti, Somalia, Sudan etc may require facilities that include the following:

- ❖ Office facilities that include dressing room for inspectors
- ❖ Toilets and showers that match the number of inspectors and support personnel
- ❖ Designated area for parking livestock trucks while verifying accompanying documents and international animal health certificates

7.2 Facility requirements for boarder control posts at major international air ports

Apart from the facilities indicated under no 7.1 above, border control posts located at major international air ports such as Bole International Air Port may require additional export animals waiting facility (livestock resting pen) that may include loading and unload ramp and resting pen where animals coming from main export quarantines wait until loaded to the cargo plane to be exported. The construction requirements of livestock resting pen at airport should address the following points:

7.2.1 General requirements

- The location of the facility should be within the premises of the airport terminal suitable for keeping animals until loaded to planes
- The facility should be located more than 50 meters away from areas where imported live animals and animal products are off loaded in the airport.
- The facility should be properly fenced to prevent unauthorized entry of personnel and other animals in to the facility or escape of animals from the resting pen.
- The floor should be compacted with gravel and well drained
- There resting pen should have a shade structure that can accommodate all sheep and goats to be kept at any one time in the pen

7.2.2 Loading & unloading ramp

Loading and unloading ramp is required at resting pen to unload sheep and goats coming from quarantine stations for export and to load the same animals to the transport truck that will transport them to the plane to be loaded by using a loading rump prepared to serve the purpose.

Requirements for loading & unloading ramp at the resting pen:

- Docks of different heights or adjustable ramps should be provided to accommodate vehicles of varying heights.
- The unloading and loading facilities shall be so constructed that unloading and loading can be carried out without having a gap between the vehicle and the dock or ramp.
- The sides of any ramps or dock should be high enough to prevent the escape or injury of animals.
- The loading and unloading ramp should have a slope of no more than 20 -30 degrees with a floor of concrete, steel or timber;

- ❖ Ramp floors should give good grip, be easy to walk on, not flexible and bouncy, and should not resonate or create undue noise
- ❖ Unloading ramp should have a horizontal docking area of 1.5m long to prevent livestock from slipping as they step out of the transporter.
- ❖ Loading height will vary slightly with the type of livestock transport vehicle to be used, but is generally 1.1–1.2 meters for most body trucks and semi-trailers.
- ❖ The loading and unloading dock area should be leveled and non-slippery with a gentle stepped ramp of around six meters in length to reach the 1.2 m loading height.
- ❖ At the top of the ramp, a level platform of about 2–3 m long will allow livestock to balance and gain more confidence to move onto the different flooring material of the trailer.
- ❖ Sheeting the sides of the lead-up race and the loading and unloading ramp should be done to make animals focus on the exit, eliminates baulking from visual distractions and thus improves flow.

7.2.3 Livestock resting pen

The livestock resting pens hold livestock for a relatively short time until they are to be loaded to the cargo plane.

- Sheep and goats should not be exposed to excessive noise of aircraft and other machinery for longer than absolutely necessary.
- When the animals are tired at the time of arrival at the airport, the official veterinarian can decide to give them an adequate rest before loading. This might even imply that the animals cannot be taken on a particular flight.
- The number and size of waiting pens depend on the maximum anticipated number of animals to be exported by cargo planes at any one time.
- Different waiting pens should be available for the different species of animals (cattle, sheep and goats) to be exported
- Space requirement for waiting pen is 0.55 m^2 per head of sheep and goats.
- Reliable and continuous supply of water should be available
- Metallic hayracks should be installed in each resting pen at about 60-100 cm from the floor across the length on the opposite side of the water supply line.
- Metallic hayrack length should not be less than 20 cm per sheep and goat

- Water troughs that will allow access to all animals without competition should be constructed in each one of the pens (allow at least 30cm of trough for the first animal and 1.5cm for each additional animal).

7.2.4 Race

A race to be used for leading livestock from the waiting pen to the loading ram for transporting animals by truck to the cargo plane ready to transport. The race should fulfil the following requirements:

- A race is to be located attached to the resting pen leading to the loading ramp.
- The height should be 1.2 m for sheep and 1.4 to 1.5m for goat
- The race length will depend on the number of livestock to be handled.
- The width of the path (race) shall not be greater than 35 cm for sheep and goats.
- The outer panel of the race needs to be sheeted to aid good livestock flow by overcoming external visual distractions that will frighten them.

7.2.5 Loading ramp conditions to the plane

Table 1. Criteria to be considered satisfactory for loading ramps to the plane

Features	**Description**
Slope	Not more than 30° and possibly less
Height of side gates	Not less than 1.30 m for adult animals
Step from ground to ramp and from top of ramp to aircraft	Not more than 12 cm
Space between top of ramp and aircraft	Not more than 1.5 cm

7.2.6 Sheep and goat containers conditions for air transport

If containers are used to transport sheep and goats by plane, their design and construction should follow the principles laid down for that purpose in the relevant container notes of the current edition of the IATA Live Animals Regulations. They must meet the following specifications:

- ❖ conform to the size of the standard pallet of the aircraft that will be used to transport animals;
- ❖ not be constructed of material that could be harmful to the health or welfare of animals;

- allow observation of the animals and be marked on opposite sides with the International Air Transport Association (IATA) symbols which indicate animals and the upright position;
- allow emergency access to animals;
- allow the animal to stand in its normal position without touching the roof of the container or, in the case of open containers, provide at least 10 cm clearance above the animal's head when standing in its normal position
- ensure doors can be opened and closed easily, but be secured so that they cannot be opened accidentally;
- The container must be strong enough to contain the animals and be free of internal projections likely to cause injury. The materials used for constructing the container may include metal, wood, fibre glass and polyethylene.
- The floor shall be constructed of a material, or so designed, to prevent the animals from slipping. Each floor of the container must be leak-proof and strong enough to withstand the weight of the animals. Sufficient suitable material should be spread on the floor to absorb all excreta.
- The sides of the containers must be close-boarded to a minimum height of 30 cm to prevent spillage of excreta. Containers are normally ventilated through apertures in their side paneling. These apertures should be equivalent to not less than 20% of the floor area for each tier, and preferably not less than 40% of the whole side. Ventilation apertures exceeding 10 cm must be provided with a bar to prevent the sheep or goats forcing their heads or legs outside the container.
- The container shall have a sliding or hinged door that is constructed in such a way as to prevent accidental opening.
- be designed to minimize the risk of any opening or space entrapping any portion of the animals' body;
- ensure faeces and urine cannot escape from the crate; this requires a minimum upturn of 20 cm but it should not block any ventilation openings;
- allow for a facility for provision of water and possibly food during transportation of longer than six hours duration.
- The stocking density in containers should be high enough to prevent injuries at plane take-off, during turbulence or at landing, but still allow individual animals to lie down. In deciding

stocking densities, the total travelling time should be considered, in addition to the breed, size and condition of the animals.

Stocking density can be calculated in two ways:

- the weight of the animal in relation to the available floor area;
- the oxygen or ventilation required per kg/animal in relation to the ventilation capacity.

The following indicative figures are considered to be satisfactory when sheep and goats are being transported:

Average weight	Floor area per sheep/goat
25 kg 50 kg	0.20 m^2 0.30 m^2

Stocking density for sheep and goats in relation to ventilation requirements:

- Aircraft carrying sheep or goats should preferably be equipped with forced ventilation. For aircraft carrying sheep or goats, the ability to supply 0.13 to 0.22 m^3/kg/hr of air is required.

8. Post-entry quarantine construction requirements

Post-entry quarantine refers to inspection of animals and animal products that are imported in to the country in order to prevent introduction and spread of disease-causing agents in to the country. Post-entry quarantine facilities are to be constructed at major border crossing and in cities and towns with international air ports.

8.1 Major construction requirements

- the facility must be located at least 2.5-3km away from any premises holding livestock.
- the facility should have the capacity to receive and house the types and total number of imported animals
- facilities must be adequate to prevent contact between imported animals and other animals of like or susceptible species

- the facility must have a source of clean water, adequate for the consumption of the animals to be quarantined and any necessary cleaning and disinfection
- feed must be stored in a manner that prevents access by susceptible species
- facilities should have adequate space for veterinarians to adequately restrain, conduct examinations and testing of the imported animals.
- The examination space must be equipped with appropriate animal restraining devices for the safe inspection of animals.

8.2 Fencing

- the site must be fenced to prevent the entrance of wildlife and stray persons and contain the quarantined animals should they escape from the quarantine facility
- the fencing should of be of construction (material, mesh type and size) sufficient to prevent susceptible species passing through
- any gates in the fencing must be lockable
- for those animals permitted to be outside, fencing must be adequate to prevent contact between the quarantined animals and other animals of susceptible species. This can be accomplished either by double fencing of the paddocks or by preventing concurrent presence of susceptible species in the neighboring fenced fields

8.3 Waste disposal

- manure from the quarantined animals must be either stored in a manner that prevents access by susceptible species or is disposed of at a site not accessed by susceptible species
- carcasses of animals that die during the quarantine must be disposed burial or burning

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