Minimum Standards for Swine Buildings with an Air Filtration System

Engineering and Biosecurity

May 2013

Fact Sheet

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Air filtration is one of the most expensive biosecurity measures and only protects the farm from one part of the infection risk. Before making this investment, the owner of a swine production site should ensure that all biosecurity components are in place to protect animals against risk factors other than airborne infection. The purpose of this document is to list the biosecurity and engineering components that should be implemented on a site with filtered air to maximize the results obtained through an air filtration system (access areas, animal transportation, employees, equipment, airtightness of buildings, etc.). It is also important to ensure that the biosecurity measures, and their compliance, are not only sufficient, but also consistent.

Biosecurity: Minimum Requirements to Implement on a Site Before Contemplating Air Filtration

Controlled Access Zone (CAZ)

- A clearly demarcated perimeter surrounds the building.
- Securely closing and locking gate(s) control all access roads.
- Clear signage is posted, indicating that a biosecurity program is in effect on the site and all unauthorized access is prohibited (Figure 1).
- Signs include a phone contact number of the person in charge.
- The site is organized so there is no unnecessary foot traffic on the road taken by delivery and pig transportation trucks (Figure 2)

Figure 1 Controlled Access Zone sign
Source: Canadian Swine Health Board

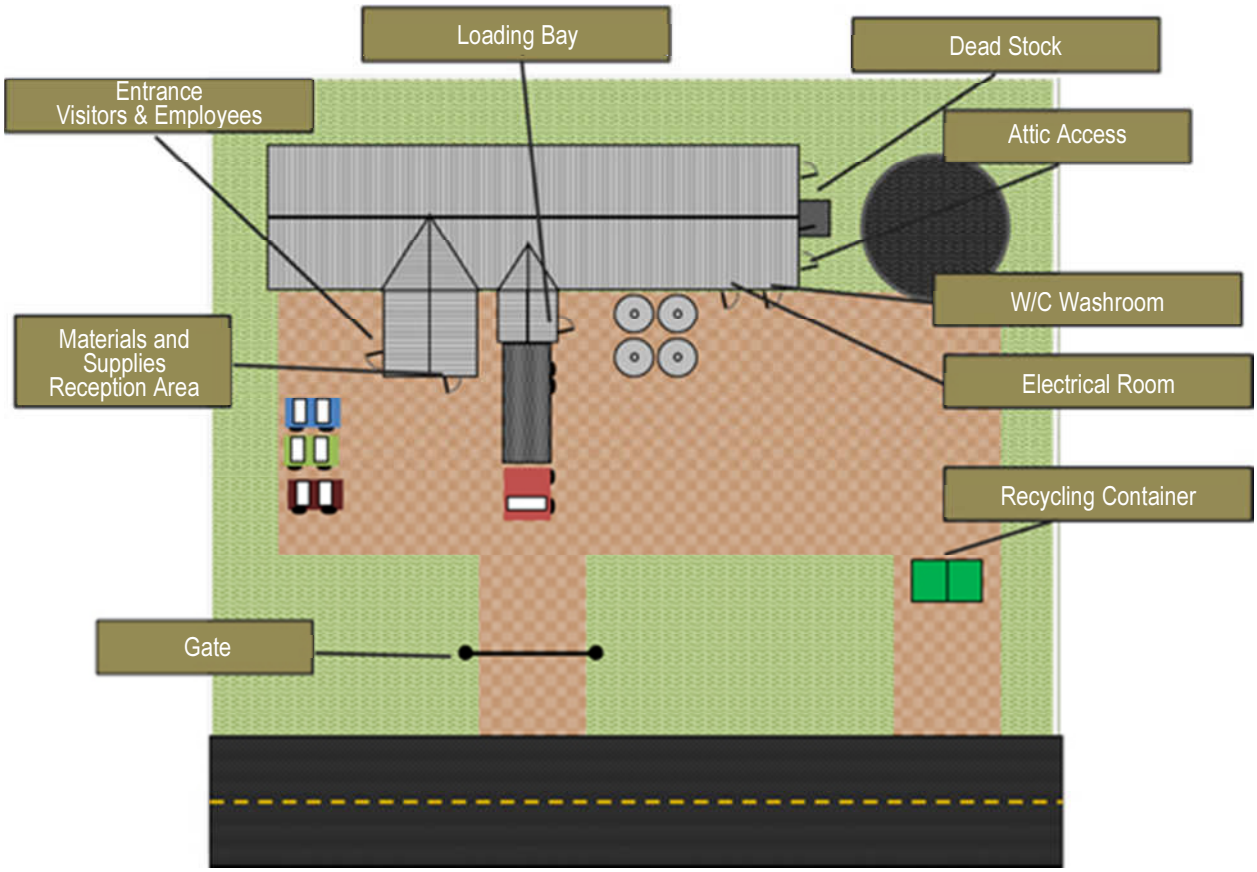

Figure 2 Example of the layout of a swine production site
Source : François Cardinal, D.M.V., M.Sc.,
Les Consultants Avi-Porc SENC, Membre du groupe Maelström

Restricted Access Zone (RAZ)

- Clear signage is posted, indicating that access to the building is prohibited and clearly displaying the procedure for authorized visitors to follow (Figure 3).
- All doors to the building are locked at all times.
- Figure 4 shows an aerial view of a swine building with the CAZ and RAZ zones delineated and Figure 5 shows the activity zones with their corresponding levels of risk.

Figure 3 Restricted Access Zone sing
Source: Canadian Swine Health Board

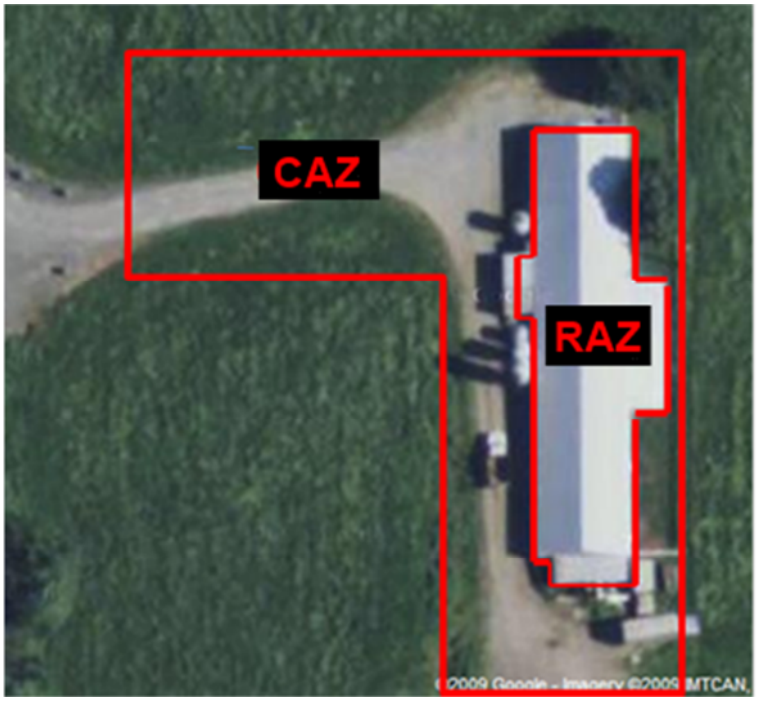

Figure 4 Example deliniating CAZ and RAZ boundaries
Source: BC Pork Biosecurity Program (2009)

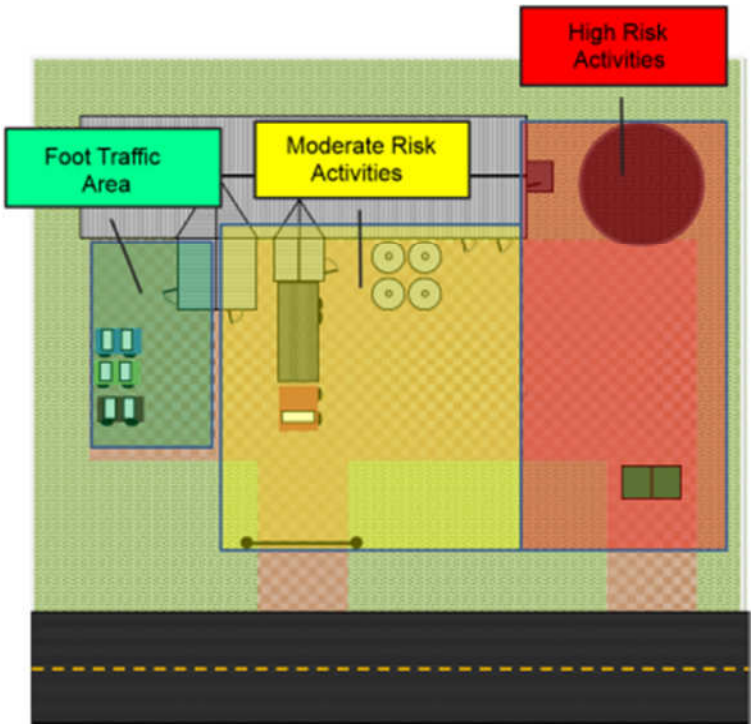

Figure 5 Areas of activity and corresponding levels of risk
Source: François Cardinal, D.M.V., M.Sc., Les Consultants Avi-Porc SENC, Groupe Maelström

Chain of Command and Decision

- The biosecurity protocol is set down in writing.
- The herd veterinarian of the farm is responsible for establishing the biosecurity procedures.
- One person oversees the implementation of biosecurity protocols on the site, ensures their implementation at all times and reports any breaches to the site owner. This same person is also responsible for ensuring that the building is airtight and that the air filtration system is well maintained and functioning properly. The person has followed the necessary training.
- The site conducts a regular biosecurity checklist audit.
- Biosecurity protocols are reviewed periodically with the employees.
- All new employees receive formal training on the biosecurity procedures to be applied and on the particularities of a building with filtered air.
- All employees have a duty to report any equipment malfunction or faulty building airtightness to do with the air filtration system (backdrafting through stopped fans, air leakage, broken filters, clogged prefilters, etc.).
- Special biosecurity response plans have been drawn up in anticipation of events, such as major renovation work or a serious problem (e.g. power outage) occurring on the farm.

Incoming Animals

- The herd veterinarian confirms the health status of incoming animals before each new intake.
- The herd veterinarian of the receiving site is aware of and has approved the biosecurity procedures carried out on the source herd.
- All incoming animals are housed in a separate quarantine unit.
- The health status of the animals is validated before the end of the quarantine period, using diagnostic procedures.
- Employees observe the quarantined animals daily, checking for any sign of disease symptoms.
- The herd veterinarian is notified as soon as any abnormal clinical signs are observed in the quarantine unit.
- The quarantine unit is thoroughly washed down and disinfected between batches.

Incoming Animal Transport

- The truck used to transport incoming animals is always washed, disinfected and dried before the animals are loaded.
- The route taken by the transport truck from the source farm to the delivery site avoids passing near other hog farms or farm-dense areas.
- The truck makes no stops en route.
- A proper loading bay (Figure 6) ensures unloading can proceed without risk of infecting the animals:
  - The loading bay is designed to facilitate access to the trailer without stepping outside the truck.
  - The loading bay can be washed down.
  - The loading bay is heated.
  - The loading bay is designed, or can be modified, to allow unloading of animals while at the same time, blocking any inflow of unfiltered air into the building.
- A procedure is in place to prevent employees or the transport truck driver from infecting animals during the unloading process:
  - Handwashing at entry
  - Footwear and clothing change

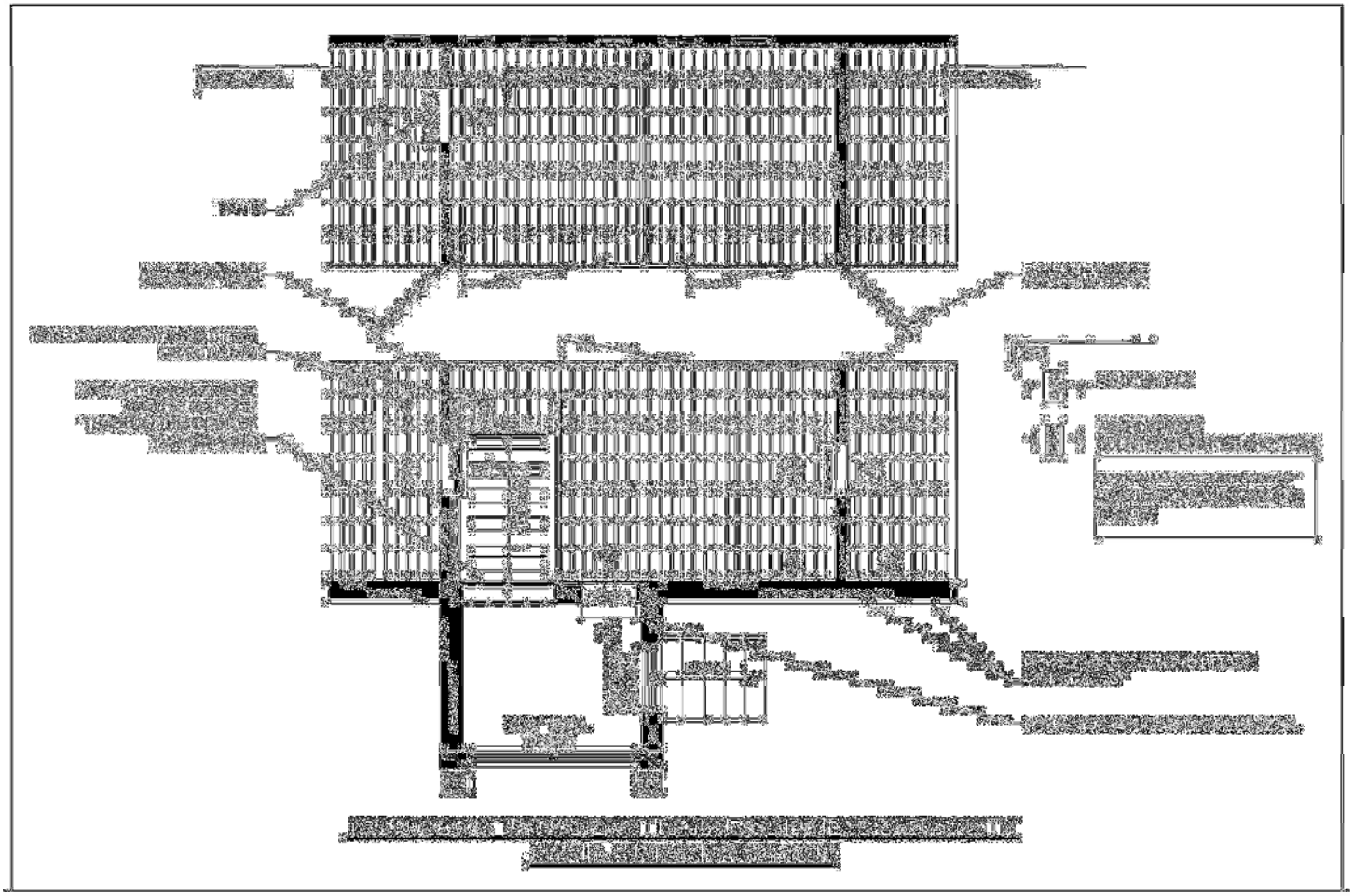

Figure 6 Example of loading bay with positive pressure ventilation
(Translated from the French and taken from: Amélioration et adaptation des installations et des équipements de chargement des porcs en engraissement en fonction des nouveaux paramètres d'élevage québécois, CDPQ, 2012)

Outgoing Animal Transport

- The truck used to transport outgoing animals is thoroughly washed, disinfected and dried before arriving.
- The trailer never contains animals from other sites when the truck arrives.
- The truck makes no stops en route.
- A proper loading bay ensures load-out of animals can proceed without risk of infecting the rest of the herd:
  - The animals to be loaded cannot turn back into the building or loading-out area once they are inside the trailer.
  - The clean zone (interior) and the dirty zone (exterior) areas of the loading bay are clearly demarcated.
  - The loading bay can be washed.
  - The loading bay is heated.
  - The loading bay is designed, or can be modified, to allow loading-out of animals while at the same time not allowing entry of unfiltered air into the building.

Semen

- Semen comes from a CFIA-accredited insemination centre.
- The centre is certified PRRS-negative.
- The herd veterinarian of the receiving site is aware of biosecurity procedures implemented at the insemination centre and deems them appropriate.
- The herd veterinarian of the receiving site knows what diagnostic monitoring procedures are implemented at the insemination centre and deems them appropriate.
- A specially designated drop off point is available, where the courier can leave the semen without entering the building (Figure 7).
- A system is in place that lets the courier drop off the semen without unfiltered air entering the building.
- A special procedure is followed to remove the semen from the packaging without contaminating it and before bringing it into the animal area.

Figure 7 Airtight door for courier to place semen into farm fridge.

Employees and Visitors

- Employees and visitors who have visited another pig farm must observe a period of down time, set by the herd veterinarian, before entering the premises.
- A doorbell outside the building lets visitors signal their arrival.
- Farm employees can speak to visitors via intercom or through a window, without having to go through the Danish entry.
- Visitors are thoroughly briefed (verbally and by well-located and clearly displayed signage) on the biosecurity procedure before they go through the Danish entry.
- The exterior door can be unlocked remotely without staff having to go through the Danish entry to open the door (electric lock).
- There is minimally a clearly demarcated Danish entry that is to be respected before entering the building.
  - Boots and outerwear are left in the outer zone (dirty).
  - Jewelry, glasses, cell phones and other personal items are left in the outer zone.
  - Handwashing takes place in an intermediate zone (gray).
  - Farm-dedicated clothing and boots are provided and put on in the inner zone (clean).
- Each of the three zones (outer, intermediate and inner) of the Danish entry is clearly demarcated.
- Employees and visitors always follow the clean entry procedure to access the facility.
- A visitor log is maintained; all visitors sign-in and record their names, phone numbers and the date when they last visited a farm.
- A procedure is in place for employees who take care of the animals in the quarantine unit:
  - Footwear and clothing change between units
  - Handwashing at entry
  - Wait time period before returning to the herd areas
- Employees who go into the quarantine unit have to follow a disease response plan in the event of stock health problems.

Vermin, Insects, Birds, Other Animals

- No domestic animals other than pigs ever enter the RAZ.
- No piles of scrap and debris are left lying around buildings where vermin can hide.
- Vegetation around the buildings is kept cut short.
- No openings in the building's exterior envelope can provide entry for vermin and birds into the building or the attic.
- All air inlet openings (under the eaves) are covered with a ½" x ½" metal mesh (Figure 8).
- The condition of the mesh (whole, undamaged) is checked regularly.
- A professional exterminator carries out a regular rodent control program.
- Provision is made for the exterminator to have access to the attic by the outside of the building (Figure 9).
- All doors close tightly to prevent entry of vermin and unfiltered (stray) air.

- The walkways and alleys in the building are cleaned daily to prevent build-up of water, manure and food.
- No feed or grain residues/spills are allowed to build up at the base of the silos or elsewhere on the site.
- All feedstuffs not consumed by the animals are removed on a daily basis.
- No manure stockpiled in any zone on the farm.
- No manure stockpiled inside the CAZ.

Figure 8 Example of bird-proof metal mesh

Figure 9 Example of attic access from the outside

Equipment, Materials, Supplies, Tools

- No equipment, materials, tools, or supplies ever goes straight into the building.
- The building includes a dedicated materials and equipment reception area which reduces the risk of the delivery driver infecting the herd (Figure 10).
- All machinery and equipment to be introduced is thoroughly cleaned and disinfected before it goes into the RAZ.
- Materials and equipment to be introduced is left for 24 hours at room temperature (21° C) before it goes into the RAZ.
- No packaging materials go into the RAZ.
- Only the minimum number of necessary tools are kept inside the RAZ.
- Only new and unopened bottles of medicines and vaccines are used.
- Drugs and vaccines must not have come from another farm site.
- Tools used for regular maintenance and repairs are available on the premises.
- Tools used only occasionally (rentals, subcontractors) are cleaned and disinfected before being introduced into the premises (contact time = 24 hrs.).
- Paper and pencils are available for visitors.

Figure 10 Reception area for supplies and materials (zones clearly defined)

Water, Feedstuffs, Bedding

- Feed is stored in bulk bins that are proof against wild animals, vermin and birds.
- Feed delivery invoices are deposited in a drop box outside the RAZ.
- Bags of feed are delivered to the materials receiving area or to another area designed to eliminate the risk of the delivery driver infecting the herd.
- Bagged feed is delivered in such a way that no unfiltered air can enter the building.
- Only the feedstuff that was in the bags enters the RAZ (no bags).
- Water comes from an artesian well and it is treated before being distributed throughout the building.
- Bedding is stored in a place that is inaccessible to birds and rodents.
- No human foodstuffs are taken into the animal areas.
- The animals do not eat any untreated commercial food waste or household table scraps.

Manure

- A separate access route, different from the entranceway taken by employees and visitors, leads to the manure pit.
- Manure spreading equipment is thoroughly cleaned and disinfected before being used at the site.
- All pit drains have pull plugs to prevent outside air infiltration into the building.

Dead Stock and Waste

- A procedure is in place for the removal of carcasses and afterbirths (placentas) from the RAZ without risk of infecting the herd and without causing an inflow of unfiltered air into the building.
- A separate door is used to take out carcasses and afterbirths from the building. This door is not used for the entry of people, for the loading bay or for deliveries of equipment and supplies.
- The carcasses and afterbirths awaiting disposal are kept in a closed container.
- The container is located outside the CAZ.
- The rendering collection truck, if using a rendering plant, never comes into the CAZ.

Washing and Disinfection

- Each room of the premises is thoroughly cleaned and disinfected every time it is emptied, or at least once a year (minimum).
- All demountable equipment is taken apart so it can be washed and disinfected.
- Soap is used during the washing.
- The disinfectant used is known to be effective against PRRS.
- The calibration of the washing equipment and the dilution of the disinfectant are checked periodically.
- The quality of disinfection is checked at regular intervals using agar impressions.
- Water lines are disinfected on a regular basis.

Engineering: Minimum Recommendations for the Design, Installation and Post-Installation Monitoring of a Swine Building with Filtered Air.

Information to Have in Hand to Assist Your Engineer in Designing the Air Filtration System

- Site plan of the premises
- Floor plan showing the location of air inlets and fans, including:
  - Dimensions of each room
  - Quantity, diameter and model of each fan in each room
  - Dimensions of the various openings of the air circuit from the outside towards the inside of the building
  - Number and type of animals including their weight at the beginning and the end of growing period in each unit
- A cross-sectional view showing the type of ventilation system and the air intake

Before Starting the Design

The design points of the air filtration system are intended for competent engineers in this field.

Ensure that:

- Maximum air flow through all rooms during the summer complies with generally accepted standards.
- The total static pressure of the entire air circuit (without filters) is less than 0.05 inches of water when air inlets are open to the maximum.
- When air flows through the attic, sub-roof insulation is installed to prevent preheating the air by the action of sunlight in summer. In addition to promoting growth performance, this will reduce total airflow in the summer and also reduce the clogging rate of the air filtration system.
- The possibility of implementing a ventilation strategy incorporating low-flow cooling techniques, thereby reducing the number of filters, has been evaluated.
- The necessary modifications to bring the building up to biosecurity protocol standards are addressed.
- Before going ahead with implementation of the air filtration system, potentially problematic items must be rectified.

Design of the Air Filtration System

- Determine the number of filters required in order not to exceed a total pressure of 0.15 inches of water (air circuit + filters) when the vents are open to the maximum and all the fans are running. Ideally, aim for an overall design pressure of 0.1 inches of water and make sure the air circuit restricts airflow (eaves and inlets) to a minimum. It is important to have some leeway since static pressure will increase with the clogging of the prefilters and filters. The greater the design pressure, the more frequent the need to replace prefilters and filters.
- Decide on the filter installation method, depending on the type(s) of air inlets and the model of filter.

- Check that it is possible to install the filter model called for, and that they are easily accessible, once installed.
- Check that the air circuit downstream from the filters is to prevent the entry of potentially contaminated air.
- Make sure there is no foul air backdrafting from fans to filters that could prematurely clog the filters.

Handling Inflows of Potentially Contaminated Air

- Caulk all sources of unfiltered air inflow (e.g. door and window surrounds, feed auger, manure removal pipes/drains, etc.). For greater detail, see **Post-Installation Monitoring** section.
- Design the building so that, by using double doors systems (SAS), you reduce inflow of contaminated air through frequently used exterior doors.
  - Note: Ideally, the SAS used in the loading bay should be under positive pressure (Figure 51) so that airflow direction is out of the building when the doors are open. Airflow speed should be at least 100 to 150 ft./min. If the SAS is under negative pressure (Figure 52), there should be at least three programmed changes of filtered air after the exterior door closes and before the inner door opens.
- Ideally, provide an enclosed loading bay under filtered air specifically for holding all or most of the animals during loading/load-out procedures.
- Emergency exit doors must be tight fitting yet offer a safe escape route in case of fire or other emergencies.
- Little used outer doors should be properly tight fitting.
- Fit sealed non-backdrafting dampers on all fans because conventional shutters are not sufficiently airtight, but continue to keep the conventional shutters in place.

Installation of Filters and Retrofitting the Building

Installing the Filters

- Hire a meticulous installer and carpenter who will strive to minimize the risk of leakage.
- Make sure the installer is qualified to install air filtration systems.
- Install a pressure gauge in each room to monitor the clogging of the air filtration system.
- Install filters and boxes over the air inlets tightly (Figure 11).
- Plan on at least three visits from the design engineer to oversee the installation.
  - Note: The filter box must be weatherproofed (water and snow) and must be handled with care so as not to touch or puncture the filter media with fingers. The filter media is fragile.
- Make sure that the filters and prefilters are accessible for maintenance.

Figure 11 It is very important to make sure the filter boxes are installed tightly during setting up because after installation, it is hard to locate leaks. A lot of caulk will be used.
Source: Clarcor Air Filtration

Before Air Filtration System Start-Up

- Inspection of the air filtration system is done by the design engineer to verify compliance of the work.
- Inspection of all buildings is done by the design engineer to ensure that all entries of contaminated air have been sealed.
- An inspection of loading/unloading bays is carried out by the design engineer to prevent entry of potentially contaminated air during reception or shipment of animals or equipment/supplies.
- Inspection of the building's infrastructure with the veterinarian is carried out to make sure it complies with the prescribed biosecurity protocol.

Start-Up and Calibration of the Ventilation and Air Filtration Systems

- Adjust the opening of the air inlets according to the flow rate, to maintain a static pressure of less than 0.10 – 0.15 in. of water in summer, and less than 0.05 in. of water in winter. This is done while still respecting the distribution pattern of air, promoting the well-being of the animals.
- Validate the programming of the electronic controllers.
- Make sure that the static pressure corresponds to what was envisaged in the design.

Training for Operators and Employees

- Train the operators on the functioning of the ventilation-air filtration system, various important adjustments to make, as well as the maintenance and regular checks to be carried out. Training is to be provided by the design engineer
- Train the employees on the biosecurity measures to be implemented. Training is to be provided by the farm's herd veterinarian.

After Installation of the Filters

Maintenance and Repairs to Plan for

- Together with the design engineer decide on the maximum pressure at which the prefilters or filters need to be cleaned or replaced. You are advised to avoid exceeding a total of 0.2 in. of water with clogged prefilters and filters. A pressure that is too high increases the degree of unfiltered air leakage.
  - Take note of the static pressure when the filters are clean, so that you can see the progression of the clogging over time.
    - Note: When the ventilation is at maximum, record the static pressure of each room in a weekly log, to monitor the clogging of the prefilters and filters.
  - Excessive clogging can negatively affect the operation of the ventilation system and result in increased pressure losses thereby facilitating inflow of contaminated air.
- Record the minimum and maximum temperatures in the rooms daily to detect abnormally high temperatures and clogging problems.
- Inspect prefilters and filters monthly to check that they are not damaged or clogged.
  - Note: These inspections are important since rodents may have gnawed holes in the filters.
- Replace the filters and prefilters according to the manufacturer's recommendations.
- Have the design engineer carry out an annual inspection of the ventilation-filtration system.

Post-Installation Follow-Up: Inspections

- Routine and frequency of inspection
  - Inspections of the air filtration system and potential sources of air infiltration should be carried out regularly (ideally, monthly, but minimum of every 6 months).
  - In spring and autumn, before the PRRS season, an outside inspection must be done to check for presence of vermin holes, cracks in concrete, etc.
  - Check that the caulking applied in the past is still tightly in place.
  - Inspection frequency must be complied with.
- The air filtration system (filters, prefilters, filter boxes and filter casings)
  - Prefilters should be held securely in place (clips) (Figure 12).
  - An inspection of filters and filter boxes must be done regularly so that you can plug or quickly repair any places that are letting in unfiltered air.
  - About cleaning or replacing the prefilters:
    - Prefilters should not be damaged (Figure 13): if this is the case, they must be replaced.
    - Dust buildup on the prefilters must be watched closely and the prefilters replaced when they are dust laden (Figure 14).
      - Plan on replacing the prefilters every 6 months approximately.
    - When replacing the prefilters, you must also check the filters for clogging to see if they too need cleaning or replacing.

- About cleaning or replacing the filters:
  - The filters must not be damaged. If damaged, they must be replaced.
  - Cleaning the antimicrobial filter or replacing the mechanical filters is required if dust has built up. (Figure 15).
    - Filter life is estimated at 3 years (check this with the manufacturer); it can vary from case to case.
  - Regardless of the installation of new prefilters, the condition of mechanical filters should be checked whenever static pressure is greater than 0.05 to 0.10 in. of water relative to the initial situation (with new filters and prefilters), and this at maximum airflow. Example: if the initial static pressure was 0.10 in. of water and the pressure with used filters, but with new prefilters, is 0.20 in. of water, then you have to change the filters. If the initial pressure was 0.15 in. of water, at 0.2 in. of water the filters should be replaced.
  - Regardless of the installation of new prefilters, the condition of the antimicrobial filters should be checked whenever the static pressure is greater than 0.05 in. of water relative to the initial situation (with new filters and prefilters) and this at maximum airflow. Example: if the initial static pressure was 0.10 in. of water and the pressure with used filters, but with new prefilters, is 0.15 in. of water, you have to change or clean the antimicrobial filters. It is advisable not to exceed 0.15 in. of water with antimicrobial filters.
    - In the case of antimicrobial filters, their lifespan depends on the lifespan of the antimicrobial/antiviral agents integrated in the filter fiber. Check this with your supplier. With this type of filter, it is advisable not to exceed a static pressure of 0.15 in. of water, even with clogged filters. These filters are washable but you should first check with the manufacturer for the appropriate method.

  NOTE: It is important to confirm with your supplier what the criteria are for determining whether it is time to replace the filters. The frequency of cleaning, washing or replacing the prefilters and filters can vary depending on the building's location (near a road, a wooded area, a source of pollen, etc.).

  - A test bench for testing used filters with regards to viruses and pressure drop is currently under development by CDPQ and Université Laval. It will be possible in the future to run tests on a sample from your used filters on this test bench.

Figure 12 Prefilter not properly held in place by fasteners/clips (prefilter tends to fall when fasteners/clips are located on the sides of the prefilter)

Figure 13 Damaged prefilter that has to be replaced

Figure 14 Dust laden prefilters that have to be replaced

Figure 15 Dust clogged anti-microbial filters that have to be cleaned

- Exterior doors
  - Door frames must be airtight.
  - Unused doors must be properly sealed with:
    - A polythene sheet mounted with slats around the perimeter of the door [1] (Figure 16). In the event that the animals might tear the polythene sheet, additional protection may be added at the bottom of the door (e.g. a hinged plywood sheet, easily removable in emergencies). Any system put into place must allow fast emergency opening of the door.
    - Thick grease could be applied as an alternative sealant to the outside perimeter of the doors, to seal it (solution recommended from a safety point of view).
  - All functioning exterior doors should be good quality and equipped with magnetic weatherstripping.
  - Screw holes in exterior door handles must be sealed since air infiltration is possible here (Figure 17).
  - An inspection of all exterior doors for airtightness should be done regularly (ideally monthly) and any necessary repairs completed quickly.

[1] It is the breeder's responsibility to ensure compliance with the prescribed safety rules concerning fire or other issues relating to access to the doors

Figure 16 Door made airtight using polythene and slats around the perimeter

Figure 17 Smoke test showing air leakage through the screw holes of an exterior door handle

- Exterior windows
  - All exterior windows should be sealed and blocked from being opened (Figure 18)
  - A sheet of Plexiglas should be fixed over the window from the inside and sealed with an appropriate sealant (Flextra) to prevent outside air from entering the building or someone from inadvertently opening the window, as the case may be.
    - This procedure blocks the entry of unfiltered air, should anyone open the window.

Figure 18 Office window that has to be sealed and covered with a Plexiglas panel from the inside

- Various wall or ceiling junctions
  - All wall-ceiling junctions should be appropriately caulked (Flextra).
    - A lath should be fixed along the joints between the wall and ceiling and an appropriate sealant/caulk applied along the edges of the lath (Figure 19).
  - All joints between plywood sheets in the animal areas, office, corridor etc. should be properly caulked (Flextra) (Figure 20 and Figure 21)

- An inspection (at least twice a year) should be done so as to repair the places letting in unfiltered air.
  - Any caulk applied to the surface that is coming away, must be removed and re-applied (Figure 22).

Figure 19 Wall-ceiling and wall-wall junctions sealed with a lath and the appropriate caulk

Figure 20 Joint between two plywood sheets that has to be sealed

Figure 21 Caulk applied along the joints between plywood sheets

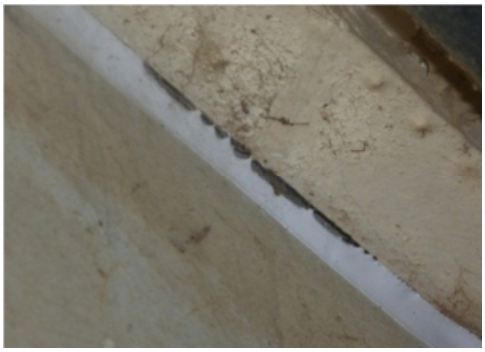

Figure 22 Caulk applied to wall-ceiling junction is coming away from the suface. It has to be removed and reapplied.

- Concrete
  - All broken concrete, cracks and control joints (Figure 23 and Figure 24) should be appropriately repaired and filled in (According to the repair to be done, Sika® products can be used. Visit http://can.sika.com/ to locate your closest distributor)
    - The product used must be freeze-thaw resistant for outdoor usage and resistant to both water (washing facilities) and air contaminants (NH_3 and H_2S).
  - An inspection of foundations and concrete walls must be carried out to identify potential air infiltration points and repair them.

Figure 23 Broken concrete sandwich wall

Figure 24 Sandwich wall with cracked control joint that has to be sealed with an appropriate caulk

- Holes created in the exterior walls
  - The perimeters of all pipes (Figure 25 and Figure 26) and electrical wiring conduits that pass through the exterior walls, together with all other holes made in the outside walls, should be properly sealed with an appropriate caulk, from both the inside and outside of the building.
    - Smoke tests have shown that air infiltration is possible when foam is used to seal the perimeters of feed lines (Figure 28)
  - It is suggested that you remove the foam previously applied and apply an appropriate caulk, either the same type as that used around the edges of the fan housings (Flextra) (Figure 29), or install a flexible rubber collar, long enough to prevent the pipe from pulling out of its position as a result of vibrations caused by the system (best solution).
  - A monthly inspection of the sealant applied around the inside and outside perimeters of these pipes must be carried out, in order to rapidly take care of any necessary repair.

Figure 25 The perimeters of these propane pipes must be sealed with an appropriate caulk (Flextra)

Figure 26 Perimeter of electrical wiring conduit allowing air infiltration that has to be appropriately sealed

Figure 27 Infiltration of air through a hole in the wall created by a PVC conduit body. Hole has to be sealed with an appropriate caulk

Figure 28 Smoke test done on the perimeter of a feed line sealed with foam allowing you to see that air infiltration is possible

Figure 29 Perimeter of a feed line sealed so as to prevent infiltration of cantaminated air. Even so, installation of a flexible rubber collar is recommended.

- Entry of employees and visitors (procedure)
  - The building entrance follows the Danish entry principle or is equipped with a shower (Figure 30).
    - Three well-defined zones: a contaminated zone (where outerwear and footwear are left), a transition zone with a sink or a shower, and a clean zone where farm-dedicated clothing and boots are put on.
  - The entry procedure must be clearly displayed and visible at the entrance (poster)
  - A double door system (SAS) with sealing strips required around the edges of the doorways and thresholds lets one door to be opened at a time, so as to minimize the entry of unfiltered air.
  - Doors upstream and downstream of the shower area or the Danish entry must be airtight to prevent the entry of unfiltered air into the building when the outer door is opened.
  - The ideal procedure for the entry of employees and visitors (scenario with shower) is:
    - Boots, coats and other personal effects are left in the contaminated zone of the main entrance (ideally, this area includes a physical demarcation, for example a bench in the entryway) which is located before the transition zone (the showers). The shower is then obligatory, clothes are left in the place provided for this purpose (lockers) and putting on farm-dedicated clothing is done on the other side of the shower.
  - In the main entry to the farm and in the office area, an air purifier with HEPA filter (Figure 31) could be installed to trap viruses, if any. If the air purifier is strong enough, it would be best to have it run 24 hours a day (check this with the supplier).
  - The tightness of the SAS doors should be checked regularly.

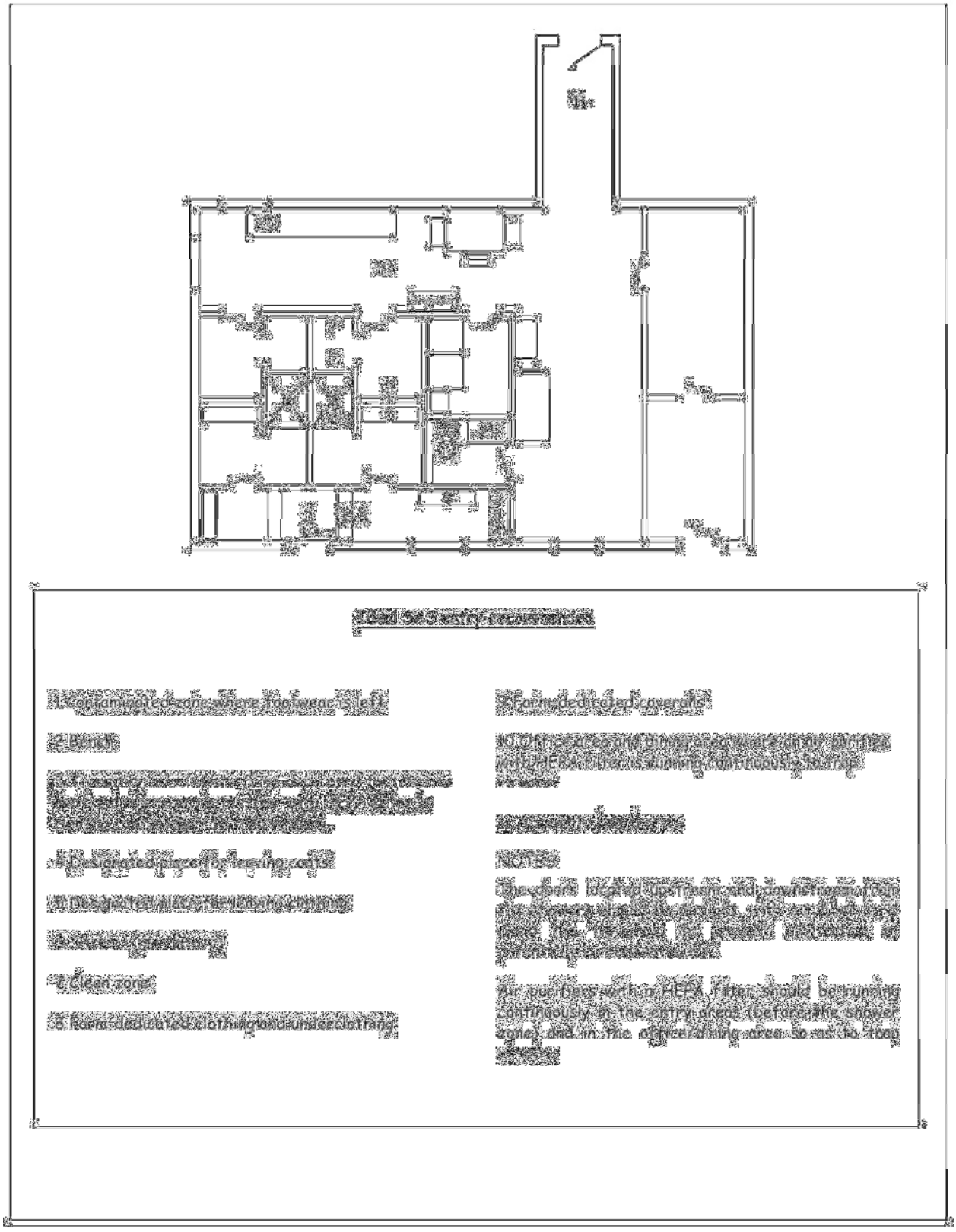

Figure 30 Ideal SAS entry

Figure 31 Air purifier with HEPA filter

- Loading/load-out bay
  - The key point of a loading bay is the double door system (SAS). The two doors should never be opened simultaneously.
  - Animal load-in and load-out procedures must be clear and prominently displayed.
  - An airtight door threshold that is not raised above the floor, as is usually the case, will facilitate the movement of animals (Figure 32).
  - When the threshold of the loading bay outer door is raised above the floor, a wooden ramp (downward slope) should be installed so as to not damage the threshold and affect the airtightness of the door (Figure 33)
  - Installation of a ventilated SAS under positive pressure is recommended. This can be done by setting up a fan to blow filtered air from the barn into the SAS. Ideally the SAS should be maintained under constant positive pressure using a small fan to prevent contaminated air infiltration, since keeping this type of door airtight is difficult. Before opening the door, a larger capacity fan switches on to guarantee an outflow of air with an air velocity of at least 150 ft./min., by the outer door (Figure 34). Appendix A (Figure 51) contains a diagram of a ventilated loading bay under positive pressure.
  - It is also possible to ventilate the loading/load-out bay under negative pressure. The way to proceed is this: when loading in animals or supplies, the inner door must be closed *before* opening the outer one. Once the animals are in, and in order to expel all contaminated air, the fan is turned on in such a way as to ensure a minimum of three changes of filtered air through air inlets equipped with counterweights (Figure 35). Afterwards, the inner door can be opened to bring the animals into the herd. The air change procedure is the same when loading-out animals, that is to say, once the outer door has been closed. Appendix B (Figure 52) contains a diagram of a loading/load-out bay under negative pressure.
    - It is important that the fan used to change the air can remove enough air, i.e. ideally, three (3) changes of air in a period of less than two (2) minutes; this to avoid too long an animal holding period. You calculate the airflow needed for three (3) air changes per two (2) minutes in this way:

$$Necessary\ airflow\ rate\ \left(\frac{ft^3}{min}\right) = \frac{3\ changes\ of\ air\ *Volume\ of\ unit\ area\ (ft^3)}{2\ minutes}$$

- For more detailed information, please refer to the documents concerning the project *Amélioration et adaptation des installations et des équipements de chargement des porcs en engraissement en fonction des nouveaux paramètres d'élevage québécois* available on line at http://www.cdpq.ca/recherche-et-developpement/projets-de-recherche/projet-194.aspx

Figure 32 Threshold facilitating movement of animals

Figure 33 Threshold raised above floor and protected by a temporary wooden ramp

Figure 34 Ventilated bay under positive pressure drawing filtered air from the herd area

Figure 35 Conterweighted air inlets allow entry of filtered air inside a ventilated loading bay under negative pressure

- Fans, shutter frames and backdraft dampers
  - Caulk is applied to the inside perimeter of fan housings from the inside (Figure 36).
  - All shutter frames must be in place.
    - No shutters should be missing or damaged.
    - If this is the case, the shutter frame must be replaced (Figure 37).
    - Keep the conventional shutters in place, for additional security, even if a backdrafting system has been installed.

- A backdrafting system has been put in.
  - The system is operating correctly.
  - The system shows no apparent signs of damage.
  - No obstacles (ice, dirt) are preventing the dampers from closing tightly.
  - In the event of problems, it is important you contact your equipment dealer so that they can help you resolve the issue without delay.
  - As part of the project « Développement de méthodes permettant de réduire les infiltrations d'air parasites dans les bâtiments porcins sous air filtré », the effectiveness of four backdrafting systems was assessed. The two devices recommended so far for their airtightness and restriction of airflow are the homemade air chute (windsock) (Figure 38) and the No BackDraft damper (Figure 39), from Conception Ro-Main inc., a Quebec-based company.
    - Blower door tests on a test bench verified the airtightness of the different anti-backdrafting devices. The tests were based upon the use of an on/off model of fan with a maximum airflow and a static pressure of 0.1 inches of water, in combination with traditional shutters for dual protection. The air chute and the No Backdraft damper showed a reduction in air infiltration of 84% and 96% respectively, compared to traditional shutters alone.
    - For airflow restriction, the combination of air chute and traditional shutters (recommended dual protection) showed the most airflow restriction, i.e. a reduction of 23%, compared to a fan with traditional shutters alone, whereas the No BackDraft damper under identical dual protection conditions showed a reduction of 15%.
    - To obtain further information, please consult the fact sheet available on line at http://www.cdpq.ca/recherche-et-developpement/projets-de-recherche/projet-187.aspx
- In winter, insulated and sealed winterizing louvers or Styrofoam panels are installed to provide extra protection on Stage 3 or higher fans, even if these fans are fitted with an anti-backdrafting system (Figure 40).
  - A relatively flexible sealing strip (foam) can be applied to the perimeter of the panel to make sure there is no air infiltration. The Styrofoam panel may be held in place by an elastic strap during the winter.
- An inspection (at least twice a year) must be done to repair the places allowing infiltration of unfiltered air, as the fan housings represent a potentially important source of contaminated air.

Figure 36 Perimeter of a fan housing that has to be sealed

Figure 37 Damaged shutter frames that have to be replaced

Figure 38 Air chute on vent

Figure 39 No BackDraft damper
Photo: Conception Ro-Main inc.

Figure 40 Laminated foam panel on a wooden frame fitted with rubber weatherstripping and held in place with an elastic strap

- Interior lining
  - Plywood sheathing is generally more airtight than corrugated plastic sheets that are only somewhat airtight. In reality many screw holes perforate the surface and the vapor barrier. In addition, the junction between two sheets of plastic is not watertight and sometimes the plastic warps at the junction, creating a space that allows air infiltration (Figure 41). You should therefore pay special attention to this problem and fix it if necessary.
  - With corrugated plastic, the presence of a windbreak, vapor barrier and fiberglass insulation is essential to create a barrier against the entry of viruses.

Figure 41 Breaks in corrugated plasticManure discharge pipe
Photos : Darwin Reicks

- Manure discharge pipe
  - The discharge pipe or pump must always be completely submerged in the manure in order to avoid backdrafting via the discharge pipe carrying the manure to the pit (Figure 42).

Figure 42 Reception pit submersible pump in gestation unit

- Manure evacuation vent pipe
  - A filter must be installed on the end of these pipes (Figure 43 and Figure 44) together with a prefilter to prevent damage to the filter from UV. The filter has to be protected from weather and sun.

Figure 43 Aeration vent for the manure discharge on which a filter must be installed

Figure 44 Example of a filter installed on an aeration vent for the manure discharge (a prefilter should also be installed). Even so, a weatherproof cover should be installed to protect the filters.

- Manure pump-out port where manure is stored in a deep pit beneath the animals
  - There should be no air movement possible towards the interior of the building.
  - Pump-out port covers should be kept airtight and in good condition; and replaced if need be (Figure 45).
  - You should make sure that no air infiltration is possible when the pump-out port cover is removed.
  - The pump-out port should be opened preferably on sunny and dry summer days (warm temperature), avoiding rainy or foggy days, since cold, cloudy and damp conditions facilitate PRRS virus transmission.
  - A Coroplast box or a curtain can be used to cover the inside four sides of the port and so follow the movement of the manure to prevent air infiltration towards the building interior during pumping out (Figure 46).

Figure 45 Airtight cover on a pump-out port

Figure 46 Canvas curtain hanging down onto the manure surface to minimize air infiltration
Photo: Darwin Reicks

- Air conditioning system
  - The air conditioning system must not take in outside (unfiltered) air. To prevent the entry of potentially contaminated air, the system must recirculate inside air.

Figure 47 Air used by the air conditioning system must not come from outside (unfiltered).The system must recirculate inside air.

- Attic access hatch
  - Interior attic access hatches must be blocked and sealed off appropriately (Figure 48).
  - All access to the attic must be by the exterior of the building (Figure 49).

Figure 48 Attic access hatches blocked off

Figure 49 Attic accesss by the exterior of the building

- Rodent holes
  - These holes must be properly repaired.
- Air vents (office, ventilation, shower)
  - All air entering the ventilation system must be filtered (oversized filters to prevent excessive pressure drop) if it comes from the outside. This is to prevent entry of potentially contaminated air.
- Feed supply lines
  - To avoid backdrafting through these pipes, you have to make sure there is always feed in the feed bins.
  - Should there be an empty feed bin, a bag type antimicrobial filter can be placed over the end of the feed line to prevent infiltration of unfiltered air.

Figure 50 Possible air infiltration through the feed line from an empty feed bin

Conclusion

Buildings equipped with air filtration systems call for regular monitoring that is carried out rigorously and continuously to maximize their performance. If a problem is found, you must act fast to quickly rectify the situation. The extent and observance of biosecurity measures should be sufficient and consistently applied. Upholding a biosecurity program is essential to reducing the risk of infection for the herd, and that, in combination with an air filtration system.

This document does not present the problems and solutions in detail. Therefore you should not limit yourself only to the information presented in this document, since it is based on knowledge available at the time of writing.

It is important that you regularly make inquiries about air filtration in swine buildings, as a lot of research and development is currently underway in North America that can bring about advances in knowledge and technology. In the end, air filtration should be seen as another tool for managing health risk.

Annexe A

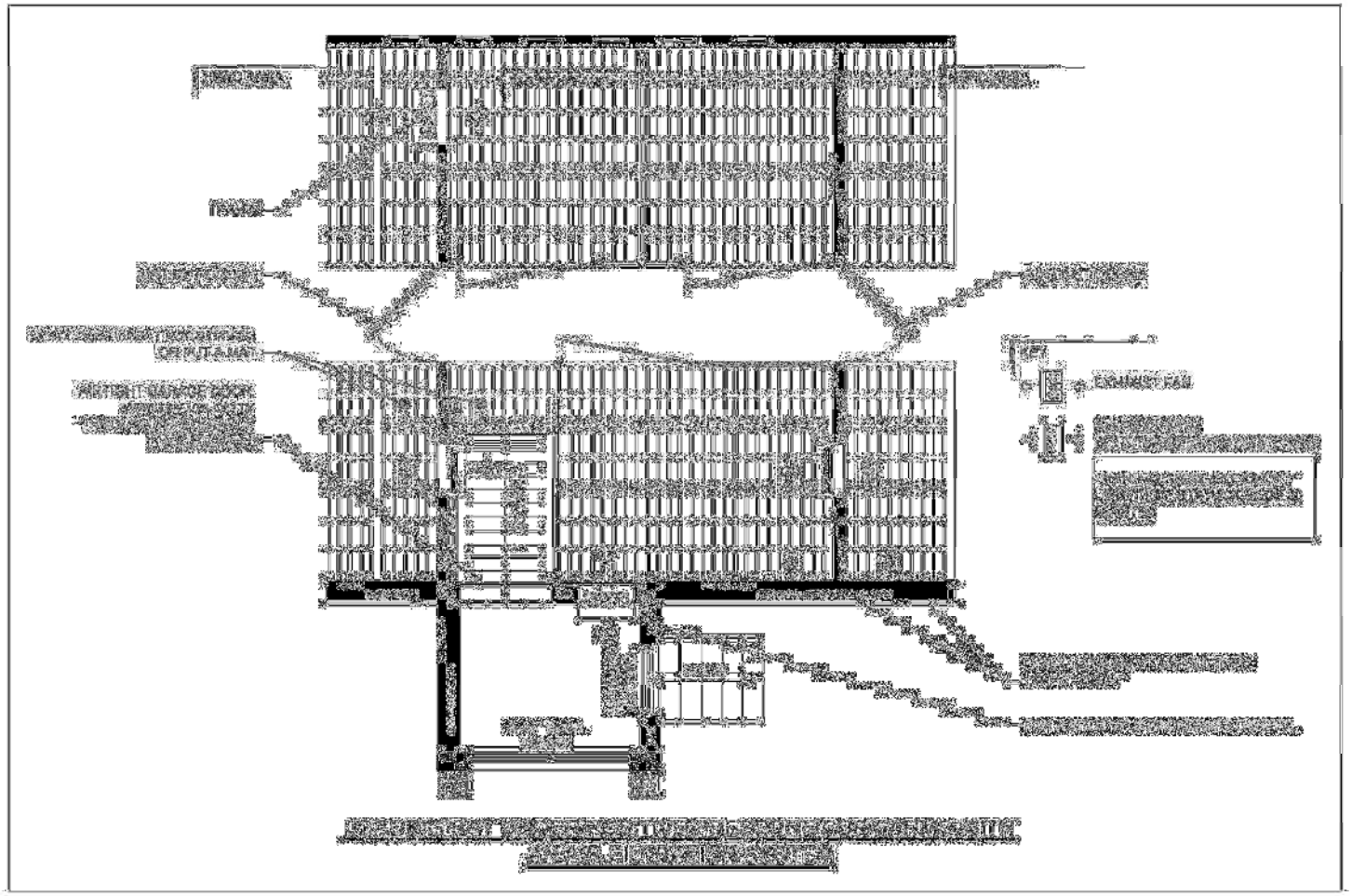

Figure 51 Example of loading bay with positive pressure ventilation
(Translated from the French and taken from: Amélioration et adaptation des installations et des équipements de chargement des porcs en engraissement en fonction des nouveaux paramètres d'élevage québécois, CDPQ, 2012)

Annexe B

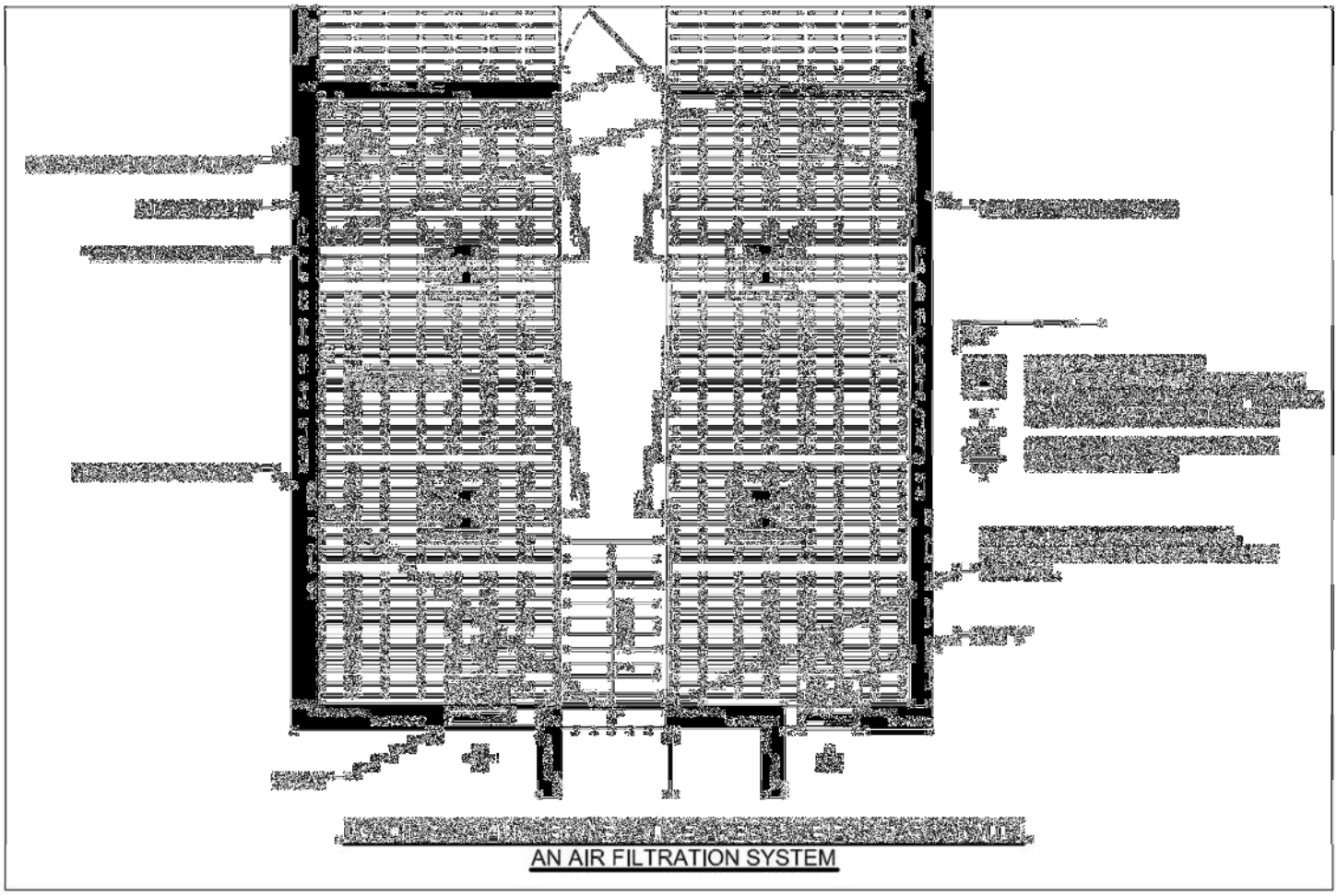

Figure 52 Example of loading bay with negative pressure ventilation
(Translated from the French and taken from: Amélioration et adaptation des installations et des équipements de chargement des porcs en engraissement en fonction des nouveaux paramètres d'élevage québécois, CDPQ, 2012)

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