Environmental, Health and Safety Guidelines for Meat Processing

Introduction

The Environmental, Health, and Safety (EHS) Guidelines are technical reference documents with general and industry-specific examples of Good International Industry Practice (GIIP)[1]. When one or more members of the World Bank Group are involved in a project, these EHS Guidelines are applied as required by their respective policies and standards. These industry sector EHS guidelines are designed to be used together with the **General EHS Guidelines** document, which provides guidance to users on common EHS issues potentially applicable to all industry sectors. For complex projects, use of multiple industry-sector guidelines may be necessary. A complete list of industry-sector guidelines can be found at: www.ifc.org/ifcext/enviro.nsf/Content/EnvironmentalGuidelines

The EHS Guidelines contain the performance levels and measures that are generally considered to be achievable in new facilities by existing technology at reasonable costs. Application of the EHS Guidelines to existing facilities may involve the establishment of site-specific targets, with an appropriate timetable for achieving them. The applicability of the EHS Guidelines should be tailored to the hazards and risks established for each project on the basis of the results of an environmental assessment in which site-specific variables, such as host country context, assimilative capacity of the environment, and other project factors, are taken into account.

[1] Defined as the exercise of professional skill, diligence, prudence and foresight that would be reasonably expected from skilled and experienced professionals engaged in the same type of undertaking under the same or similar circumstances globally. The circumstances that skilled and experienced professionals may find when evaluating the range of pollution prevention and control techniques available to a project may include, but are not limited to, varying levels of environmental degradation and environmental assimilative capacity as well as varying levels of financial and technical feasibility.

The applicability of specific technical recommendations should be based on the professional opinion of qualified and experienced persons. When host country regulations differ from the levels and measures presented in the EHS Guidelines, projects are expected to achieve whichever is more stringent. If less stringent levels or measures than those provided in these EHS Guidelines are appropriate, in view of specific project circumstances, a full and detailed justification for any proposed alternatives is needed as part of the site-specific environmental assessment. This justification should demonstrate that the choice for any alternate performance levels is protective of human health and the environment.

Applicability

The EHS Guidelines for Meat Processing include information relevant to meat processing, focusing on bovine and porcine slaughtering and processing from reception of the animals until the carcasses are ready for sale or further processing. This document pertains to facilities that provide simple processing of the by-products of meat slaughtering.[2] For guidance on animal welfare, see the IFC Good Practice Note "Animal Welfare in Livestock Operations."[3] This document is organized according to the following sections:

Section 1.0 — Industry-Specific Impacts and Management
Section 2.0 — Performance Indicators and Monitoring
Section 3.0 — References
Annex A — General Description of Industry Activities

[2] Livestock rearing is covered in the EHS Guidelines for Mammalian Livestock Production. Poultry is addressed in the EHS Guidelines for Poultry Production and Poultry Processing.
[3] Available at: http://www.ifc.org/ifcext/enviro.nsf/Content/Publications_GoodPractice. An additional source for animal welfare guidance is the Farm Animal Welfare Council available at www.fawc.org.uk

1.0 Industry-Specific Impacts and Management

The following section provides a summary of EHS issues associated with meat processing operations, along with recommendations for their prevention and abatement. Recommendations for the management of EHS issues common to most large industrial facilities during the construction and decommissioning phases are provided in the **General EHS Guidelines**.

1.1 Environment

Environmental issues specific to meat processing may include the following:

- Solid waste and by-products
- Wastewater
- Emissions to air
- Resource consumption

Solid Waste and by-products

The meat-processing industry slaughters animals to produce primary carcass products, processed cuts, and a variety of by-products. The rendering industry processes the parts not used for human consumption for technical use and for use as animal feed. This activity may generate large quantities of solid waste including the manure and bedding material generated during animal transport and lairage activities, as well as waste from processing steps. Waste products and by-products of slaughtering processes can generally be divided into the following categories: (1) manure, contents of the rumen and intestines; (2) edible products such as blood and liver; (3) inedible products such as hair, bones, feathers; (4) fat (recovered from the wastewater by means of fat-separators); and (5) non-recoverable waste materials that require final disposal. The quantity of by-products from cattle often exceeds 50 percent of the animal's live weight, and 10 to 20 percent for pigs.[4]

Special Risk Materials (SRM)

Special risk materials (SRM)[5] are tissues in cattle that contain the agent that may transmit bovine spongiform encephalopathy (BSE), transmissible spongiform encephalopathy (TSE), or scrapie disease if reprocessed into animal feed. The human disease, Creutzfeldt-Jakob Disease (vCJD), may result from human consumption of products from animals infected with BSE. Although not typically used for food, processing activities may accidentally result in the mixing of SRM tissue with meat products produced for human consumption. Therefore, SRM should be carefully separated from carcasses before their processing into commercially valuable by-products, whether for human or animal consumption.

Separated SRM should be destroyed through incineration with a minimum gas temperature of 850 °C. Prior to incineration, the material should be reduced to an appropriate particle size and heat-treated according to defined combinations of time, temperature and pressure.[6] Incineration should be conducted in specialized facilities whether on or off site, in accordance with government regulations and relevant permits. Additional information on waste incineration is presented in the **EHS Guidelines for Waste Management Facilities**.

[4] Livestock, Environment and Development Initiative (1996)

[5] SRM is defined as the skull, brain, nerves attached to the brain, eyes, tonsils, spinal cord and nerves attached to the spinal cord of cattle aged 30 months or older, and the distal ileum (portion of the small intestine) of cattle of all ages. (Health Canada, 2004). SRM according to Regulation No.1774/2002 of the European Parliament: i) Cattle more than 12 months of age: the skull including the brain and eyes; the tonsils; the spinal cord; and the vertebral column except the vertebrae of the tail and the transverse processes of the lumbar vertebrae, but including dorsal root ganglia. Ii) Cattle of all ages: the intestines from the duodenum to the rectum.

[6] Additional details on pretreatment specifications are provided in Regulation No. 1774/2002 of the European Parliament. European Community (2002).

Sick and Diseased Animals

Animals that die during transport, and sick or dead animals from quarantine pens, should be separated and transported to external facilities in separate containers for treatment and final disposal.[7] Depending on the risk classification of the animal, including whether disease such as BSE is suspected, typical disposal procedures for sick or dead animals include the following:

- Collecting animals not approved by veterinary inspection and segregating them from animal materials sent by the slaughterhouse for off-site rendering.[8] This segregation is necessary because the treatment processes in off-site rendering plants can entail higher pressure, temperature, and duration, in accordance with the risk classifications of the waste materials[9];
- Storing carcasses until collection to prevent putrefaction, odors, and attraction of vectors, using cooling if necessary. Storage times should be minimized to avoid energy intensive cooling requirements;
- Transformation in a bio-gas or composting plant after pressure sterilization;
- Using a reliable collection company approved by local authorities that disposes of carcasses by rendering, with adequate time, temperature and pressure criteria for sanitization, or incineration / co-incineration depending on the cause of fatality;
- Where no authorized collection of carcasses is available, and after approval of the local veterinary authorities, incinerating or burying carcasses on site if allowed. Whether on site or off site, the burial area should be accessible to earth-moving machinery and have stable, low-permeability soils with sufficient physical separation from houses and water resources to avoid contamination by vapors or leachate from buried, decaying materials.

Reprocessable Solid Animal Waste

Reprocessing of solid animal waste into commercial by-products should consider the following:

- Specific control measures should be taken to segregate and manage high-risk tissues according to the recommended SRM management practices discussed above;
- Avoid processing of waste materials for same species feeding;
- Use bones, trim, scraps, hooves, horns and other detritus (not otherwise used beneficially for the production of stable meals, for example, bone meal) in-house or sell to third parties;
- Clean stomach for use as food, feed, or pet food;
- Clean intestines for use as food or sausage casings;
- Recover fat from cut-offs, intestines, and hides for use as animal feed, if collected in relatively pure form. Tallow can alternatively be used as a bio-fuel or for soap among other uses;
- Remove mucosa from small pig casings (the mucous membrane of the small intestine) rather than disposing in the wastewater stream. Environmental breakdown of mucosa has a high biochemical oxygen demand (BOD_5) and has applications in the pharmaceutical industry for manufacturing heparin. Alternatively, mucosa may be digested anaerobically to produce bio-gas;[10]
- Enhance the quality and value of bovine hides for sale to tanneries. Methods include prevention of livestock bruising during transport and handling, maintenance of lairage areas to keep animals clean, use of rounded knives when

[7] European Community (2002).
[8] European Commission (2005).
[9] See footnote 3.
[10] European Commission (2005).

hides are manually removed, and washing / preservation of hides and / or use of refrigeration or proper drying or salting to reduce bacterial degradation during transport to the tannery;

- Curtail animal feeding 12 hours before slaughtering to reduce manure production and reduce the risk of contamination of the carcasses with manure and digestive tract content during slaughter;
- Provide sufficient manure storage capacity until the manure is transported for agricultural and other uses[11];
- Collect and compost stomach and intestinal contents and manure (preferably removed in "dry" form without mixing into the effluent, and provided it does not come from diseased animals) for use as compost or other agricultural application. In the case of bovine slaughter, the cattle's first stomach has a considerable organic material content (approximately 10, 40, and 50 kg for veal calves less than one-year-old, bulls, and cows, respectively).[12]

Sludge from Wastewater Treatment

The following measures should be considered to further reduce the volume of waste generated from wastewater treatment processes:

- Segregate wastewater containing manure and digestive tract content (e.g. from reception of live animals, lairage, cleaning of trucks and specific areas in the casing department). Screened materials from these areas can be used as fertilizers on agricultural land;
- Reuse materials that may be separated from pretreatment processes (e.g. screened materials, suspended solids, and emulsified fats from flotation) in the manufacture of high-quality by-products (e.g. pet food or technical fat for oleochemicals manufacturing);
- Increase the quality of the sludge for possible use as agricultural fertilizer by reducing or eliminating pathogens such as E. coli 0157, campylobacter, and salmonella through controlled aerobic treatment (compost) or anaerobic digestion (bio-gas);
- Treat materials with high organic content (e.g. blood, fat, and manure) anaerobically for the purpose of generating and using bio-gas as an energy source;
- If no other alternatives are feasible, dispose of fat at landfills.

Wastewater

Industrial Process Wastewater

Meat processing wastewater typically has a high content of organic material and consequently a high biochemical oxygen demand (BOD) and chemical oxygen demand (COD) due to the presence of blood, tallow, and mucosa. Wastewater may have a high content of nitrogen (from blood) and phosphorus, in addition to pathogenic and non-pathogenic viruses and bacteria, and parasite eggs. Detergents and disinfectants, including acid, alkaline, and neutral compounds, disinfectants, and liquid paraffin, may enter the wastewater stream after application during facility-cleaning activities.

Recommended management techniques for pollution prevention of wastewater include:

- Prioritize the removal of solid waste before it enters the wastewater stream:
  - Use floor drains and collection channels with grids, screens, and / or traps to reduce the amount of solids entering the wastewater stream

[11] Further information regarding manure storage is available from the Livestock and Poultry Environmental Stewardship Curriculum, at http://www.lpes.org/Lessons/Lesson21/21_2_sizing_storage.pdf

[12] Sorlini in European Commission (2005).

- Collect blood for use in food, feed or in the pharmaceutical industry.[13]
- Manure from the stockyard and from vehicle cleaning should be removed while in solid form;
- Stomach and intestine contents should be removed and transported in a dry state by pumps, screw conveyers or trolleys to outdoor storage and collection points for further recycling. Offal should be transported by vacuum or compressed air systems;
- Prevent direct runoff to water courses, especially from lairage and manure storage areas;

- Apply appropriate tank and equipment cleaning procedures. Clean in Place (CIP) cleaning procedures are useful to reduce chemical, water and energy consumption in cleaning operations;
- Choose cleaning agents that do not have adverse impacts on the environment in general, on wastewater treatment unit processes, or on sludge quality for agricultural application. Prevent the use of agents that contain active chlorine or prohibited, banned or restricted chemicals. Optimize agent use through correct dosage and application (e.g. CIP);
- Implement integrated pest and vector management programs and maximize vector control through mechanical means (e.g. traps, and use of mesh on doors and windows) to avoid or minimize the introduction of chemicals potentially harmful to the wastewater treatment process or the sludge quality.

[13] Blood collection is the single most efficient clean technology measure for wastewater, because liquid blood has a high nitrogen content (30 g/l), COD (400 g/l), and BOD (200 g/l). Blood from slaughtered animals may be collected over a trough. The trough should prevent water from entering the blood tank during cleaning. Sufficient time should be allowed for dripping and drip collection. If the blood is to be used in products for human consumption, a hollow knife with suction can be applied to obtain high-quality blood. This method, however, gives a lower recovery yield and increases the blood volume entering the wastewater stream.

Process Wastewater Treatment

Techniques for treating industrial process wastewater in this sector include grease traps, skimmers or oil water separators for separation of floatable solids; sedimentation for suspended solids reduction using clarifiers; biological treatment, typically anaerobic followed by aerobic treatment, for reduction of soluble organic matter (BOD); biological nutrient removal for reduction in nitrogen and phosphorus; chlorination of effluent when disinfection is required; dewatering and disposal of residuals; in some instances composting or land application of wastewater treatment residuals of acceptable quality may be possible. Additional engineering controls may be required to (i) remove parasitic eggs or spores from influent that may pass through treatment system untreated, and (ii) contain and neutralize nuisance odors. Management of industrial wastewater and examples of treatment approaches are discussed in the **General EHS Guidelines**. Through use of these technologies and good practice techniques for wastewater management, facilities should meet the Guideline Values for wastewater discharge as indicated in the relevant table of Section 2 of this industry sector document.

Other Wastewater Streams & Water Consumption

Guidance on the management of non-contaminated wastewater from utility operations, non-contaminated stormwater, and sanitary sewage is provided in the **General EHS Guidelines**. Contaminated streams should be routed to the treatment system for industrial process wastewater. Elevated consumption of high-quality water, which is an important element of food safety, is often characteristic of the meat processing industry. Water is used for watering and washing livestock, cleaning vehicles, de-hairing and rind treatment of pigs, rinsing carcasses and by-products, and cleaning and disinfecting equipment and process areas. Recommendations to reduce water consumption,

especially where it may be a limited natural resource, are provided in the **General EHS Guidelines**.

Emissions to Air

Odor may often be the most significant form of air pollution in meat processing. Major process odor sources include singeing, scalding, lairage, wastewater treatment and rendering. The latter is an evaporative process that produces condensate with a foul odor. Particulate emissions are typically not significant, although they may be emitted during singeing and meat-smoking processes. Livestock handling areas also may be a source of organic dust depending on the management of fugitive dust.

Odor Prevention

- Consider the location of new facilities, taking into account proper distances to neighbors and the propagation of odors;
- Pasteurize organic material before processing it to halt biological processes that generate odor;
- Install rendering equipment in closed spaces and operate under negative pressure compared to ambient air conditions;
- Minimize the inventory of raw carcasses, waste and by-products and store it for short periods of time in a cold, closed, well-ventilated place;
- Seal off animal by-products (e.g. in covered leak-proof containers or vehicles) during transport, loading unloading, and storage activities. Transport blood in insulated containers to reduce temperature increase;
- Clean pens and livestock yards on a timely basis;
- Empty and clean fat traps frequently;
- Add oxidants such as nitrates to stored waste and effluent, (e.g. in settling ponds). The nitrates are added in powder or granulate form and the resulting chemical reaction reduces odor levels;
- Unload containers containing animal by-products within an enclosed building that is equipped with extraction ventilation connected to odor abatement devices.

Odor Control

Odor abatement may include one or more of the following techniques depending on the location of the facility and proximity of other industrial, commercial or residential areas:

- Post-combustion of flue gases from the singeing and meat-smoking processes;
- Use of exhaust stack heights from rendering and smoking processes that are consistent with practices as described in the **General EHS Guidelines**;
- Use of wet scrubbers to remove odors with a high affinity to water, such as ammonia emitted during the rendering process;
- Condensation of vapors from rendering process combined with scrubbers
- Convey non-condensable gases to the boiler, and pass the low intensity / high volume odors through a biofilter;
- Burn whole vapor gases in a thermal oxidizer and pass the low intensity / high volume odours trough a biofilter

Dust / Particulates

Dust and particulates are mainly associated with livestock handling and singeing activities. The recommended prevention and control techniques include the following:

- Clean and maintain a sufficient level of humidity in pens and livestock yards;
- Reduce fugitive dust by minimizing surface areas with exposed soil surfaces, and by planting hedges or erecting fences to minimize wind turbulence;

- Use liquefied petroleum gas or natural gas instead of fuel oil in the singeing process.

Energy Consumption

Meat processing facilities use energy to heat water and produce steam for process applications and for cleaning purposes, as well as for operation of miscellaneous electrical equipment, refrigeration, and air compressors. In addition to the energy efficiency recommendations presented in the **General EHS Guidelines,** recommended improvements in the meat processing sector may include:

- Generating bio-gas in anaerobic wastewater digestion and utilizing this fuel for boilers or for electric power generation;
- Covering and insulating scalding tanks, controlling water levels, re-circulating water, using steam instead of scalding for pig processing, and using insulated sterilizers to sterilize knives;
- Improving cooling efficiency by insulating refrigeration room / areas and doors, installing an automatic door-closing mechanism (e.g. micro switches), applying airlocks, and setting alarms to go off when chill room doors and external loading doors are left open;
- Recovering evaporative energy in the rendering process through the use of multi-effect evaporators[14];
- Using automated systems that ensure that the singeing flame is on only when an animal carcass is present.

1.2 Occupational Health and Safety

Occupational health and safety hazards for meat processing are similar to those of other industrial facilities. Recommendations for the management of these issues can be found in the **General EHS Guidelines**. In addition, occupational health and safety issues that may be specifically associated with meat processing operations include the following:

- Physical hazards
- Biological hazards
- Chemical hazards
- Exposure to heat, cold and radiation
- Exposure to sources of noise

Physical Hazards[15]

Physical hazards include exposure to same-level fall hazards due to slippery conditions, the use of machines and tools, principally for cutting purposes, and the potential for strains from the handling of live animals and carcasses.[16] Guidance on general workplace conditions, including design and maintenance of working and walking surfaces to prevent slips and falls, are presented in the **General EHS Guidelines**. Additional industry-specific recommendations are presented below.

Machine / Tool Safety

Equipment safety issues are mainly associated with the use of knives, mechanical saws, packaging equipment, and mincers. Cuts may be caused by sharp bones and edges on process equipment (e.g. stainless steel basins). Recommendations for accident prevention from equipment use include:

- Providing workers with training in the proper use of cutting equipment (including the proper use of machine safety devices) and personal protective equipment (PPE) such as metallic gloves and leather aprons for cutting activities;

[14] UNEP (2000).

[15] Further detailed information regarding physical hazards of meat processing, and recommended prevention and control guidance, is available from SafeWork SA, Government of South Australia, at: http://www.safework.sa.gov.au/contentPages/Industry/MeatProcessing/default.htm

[16] These injuries account for 80 percent of reported occupational illnesses in Danish pig and cattle slaughterhouses measured over a five-year period from 1999–2004. Arbejdstilsynet (2005).

- Ensuring that ritual slaughter is carried out by individuals who have received the correct training and have subsequently been approved to slaughter animals;
- Designing a proper slaughterhouse floor that is slip-proof when wet.

Lifting, Carrying, Repetitive Work, and Work Postures

Meat processing activities may include a variety of situations in which workers can be exposed to lifting, carrying, and repetitive work and work posture injuries. Such situations include manual handling of live animals in the stables, removal and handling of manure and other solid wastes, handling of carcasses including pushing, pulling, hanging up, and taking down from the sliding rails, and manually lifting boxes with meat or bones. Additional situations of repetitive work may include the boning process, operation of machinery like slicing machines or vacuum packing machines, packing work, and cleaning of intestines. Recommendations for the management of these hazards include:

- Training workers in proper live animal handling methods including the use of structures and equipment for handling and restraining animals;
- Designing appropriate pen / lairage / livestock yards such that the animals can be calmly moved into the facility, and which allows for escape routes for the workers;
- Conducting stunning of cattle in a controlled setting (e.g. stun-box).

Biological Hazards

Exposure to biological and microbiological agents (e.g. Brucellosis[17]) may be associated with inhalation and ingestion of dust and aerosols during manure handling in the lairage, pens and livestock yards, as well as through incidental ingestion and dermal contact during carcass handling, intestine cleaning, handling of stomach contents, and waste and wastewater management operations. Exposure to dust from the spices used in meat processing may also act as an irritant or as an allergen.

Recommended techniques to manage exposure to dust in general, as well as biological and microbiological agents, are addressed in the **General EHS Guidelines**. Recommendations specific to meat processing and rendering include:

- Avoiding dust and aerosol generating activities (e.g. use of compressed air or high pressure water for cleaning) and where they cannot be avoided providing proper ventilation of enclosed or semi-enclosed areas to reduce or eliminate exposure to dust and aerosols;
- Providing workers with PPE that is appropriate for the activity (e.g. protective clothing, gloves and masks) for workers in intestine and stomach cleaning operations;
- Ensuring physical segregation of work and welfare facilities to maintain worker personal hygiene;
- Designing holding areas for detained animals and high-risk materials to avoid direct contact with workers and ensuring that all waste materials, including those from rejected animals, are removed daily.

Chemicals

Exposure to chemicals (including gases and vapors) may occur during handling of chemicals related to cleaning and disinfecting process areas and lairage / livestock yards. In addition to the recommendations for the management of chemical hazards presented in the **General EHS Guidelines**, the following recommendations should be considered in the context of meat processing:

[17] Brucellosis is an infectious disease caused by bacteria. *Brucella* bacteria may be passed by animals. Humans may become infected by eating or drinking something that is contaminated with *Brucella*, breathing in the organism (inhalation), or having the bacteria enter the body through skin wounds. Contamination of skin wounds and inhalation may pathways for contamination for persons working in slaughterhouses and / or meat packing plants.

- Take precautions (as described in the **General EHS Guidelines**) when handling and storing detergents and disinfectants. Chemicals should not be stored or transported with food or beverages, and should be secured in a locked and clearly identified area;
- Prevent seasonal and other temporary workers from working with chemicals until they have been fully trained;
- Provide respiratory protection and impermeable clothing for use during disinfection of pens and lairage areas.

Heat, Cold, and Radiation

Workers may be exposed to fluctuating internal climatic conditions, including heat and radiation from scalding, singers, brushing, black scrapers, and flame off, and cold from refrigerated rooms. Recommendations for the management of these hazards can be found in the **General EHS Guidelines**.

Noise and Vibrations

Occupational noise and vibration exposure sources include electrical stunning of pigs, electric saws, steam, condensers, ventilation, banging of equipment, and pressurized air equipment. Recommendations for the management of noise and vibration hazards can be found in the **General EHS Guidelines**.

1.3 Community Health and Safety

Community health and safety impacts during the construction and decommissioning of slaughterhouses are common to those during the construction of other industrial facilities, and are discussed in the **General EHS Guidelines**.

Community health and safety impacts during the operation phase common to most industry sectors, including those related to traffic safety from transport of raw materials and finished product, are discussed in the **General EHS Guidelines**. Industry-specific issues with the potential to impact the community or the public at large may include those associated with the potential presence of pathogens or microbes (e.g. Brucellosis) in processed meat.

Food Safety Impacts and Management

A food product recall brought about because of contaminated or adulterated food products found in commerce that are attributable to a specific company can damage a viable business. If a company can trace its products to specific lot numbers then recall is a matter of removing all foods associated with specific lot numbers. Without this ability the business may be destroyed. With a robust food safety program in place a company can protect itself from product adulteration, contamination and the impacts of food recalls.

Meat processing should therefore be performed according to internationally recognized food safety standards consistent with the principles and practice of Hazard Analysis Critical Control Points (HACCP)[18] and Codex Alimentarius.[19] Recommended food safety principles include:

- Respect "clean" and "dirty" zoning, designed in accordance with HACCP prerequisites (e.g. sanitary standard operating procedures) as discussed below;
- Ensure the cooling chain is unbroken for sensitive products requiring refrigeration;
- Facilitate tracing of like animal parts, so that all materials from carcasses detained by veterinary inspection can be removed;
- Ensure animal traceability systems continue to track products once released into commerce;
- Ensure efficient veterinary inspection, including examination of medical certificates (e.g. verification markings, tagging) for the animals;

[18] International Standards Organization (2005).
[19] Food and Agriculture Organization and World Health Organization (1962–2005).

- Comply with veterinary and local environmental regulation and precautions for waste, sludge, manure, and by-products;
- Full institutionalization of HACCP prerequisites including:
  - Sanitation
  - Good management practices
  - Pest control
  - Chemical control
  - Allergen control
  - Customer complaints mechanism
  - Traceability and recall.

2.0 Performance Indicators and Monitoring

2.1 Environment

Table 1 presents effluent guidelines for this sector. Guideline values for process emissions and effluents in this sector are indicative of good international industry practice as reflected in relevant standards of countries with recognized regulatory frameworks. These guidelines are achievable under normal operating conditions in appropriately designed and operated facilities through the application of pollution prevention and control techniques discussed in the preceding sections of this document. These levels should be achieved, without dilution, at least 95 percent of the time that the plant or unit is operating, to be calculated as a proportion of annual operating hours. Deviation from these levels in consideration of specific, local project conditions should be justified in the environmental assessment.

Effluent guidelines are applicable for direct discharges of treated effluents to surface waters for general use. Site-specific discharge levels may be established based on the availability and conditions in use of publicly operated sewage collection and treatment systems or, if discharged directly to surface waters, on the receiving water use classification as described in the **General EHS Guidelines**.

Emissions guidelines are applicable to process emissions. Combustion source emissions guidelines associated with steam- and power-generation activities from sources with a capacity equal to or lower than 50 MWth are addressed in the **General EHS Guidelines** with larger power source emissions addressed in the **EHS Guidelines for Thermal Power**. Guidance on ambient considerations based on the total load of emissions is provided in the **General EHS Guidelines**.

Table 1. Effluent levels for meat processing

Pollutants	Units	Guideline Value
pH	pH	6 – 9
BOD_5	mg/l	50
COD	mg/l	250
Total nitrogen	mg/l	10
Total phosphorus	mg/l	2
Oil and grease	mg/l	10
Total suspended solids	mg/l	50
Temperature increase	°C	<3[b]
Total coliform bacteria	MPN[a] / 100 ml	400
Active Ingredients / Antibiotics	To be determined on a case specific basis	

Notes:
[a] MPN = Most Probable Number
[b] At the edge of a scientifically established mixing zone which takes into account ambient water quality, receiving water use, potential receptors and assimilative capacity

Resource Use and Waste

The following Tables 2 and 3 provide examples of resource consumption indicators for energy and water, in addition to waste generation in this sector. Industry benchmark values are provided for comparative purposes only and individual projects should target continual improvement in these areas.

Table 2. Waste generation.		
Outputs per unit of product	**Mass load unit**	**Industry benchmark**
Solid organic waste	kg/ head cattle	58[a]
By-products for rendering	kg/ head cattle	110[a]
Solid organic waste	kg/ head pig	2.2[a]
By-products for rendering	kg/ head pig	20.8[a]
Blood collection	L/head cattle	10–20[b]
Blood collection	L/head pig	2–4[b]

NOTES:
[a] From Nordic Council of Ministers (2001).
[b] European Commission (2005).

Table 3. Resource and energy consumption.		
Inputs per unit of product	**Mass load unit**	**Industry benchmark[a]**
Energy (fuel and electricity) consumption	kWh/t cattle carcass kWh/t pig carcass	90–1094 (cattle) 110 – 760 (pig)
	kWh/t raw materials	400–650 (dry rendering) 570 (wet rendering)
Water consumption per unit of production[a]	m^3/t carcass	1.62–9 (cattle) 1.6–8.3 (pig)
	m^3/t raw materials	0.5–1 (rendering)
Materials	Detergent consumption kg/t cattle carcass	0.2

Source: European Commission. 2005.
[a] Water consumption m^3/t of slaughtered animal: 1.74 registered in case study in Bolivia (CPTS, 2005)

Environmental Monitoring

Environmental monitoring programs for this sector should be implemented to address all activities that have been identified to have potentially significant impacts on the environment, during normal operations and upset conditions. Environmental monitoring activities should be based on direct or indirect indicators of emissions, effluents, and resource use applicable to the particular project.

Monitoring frequency should be sufficient to provide representative data for the parameter being monitored. Monitoring should be conducted by trained individuals following monitoring and record-keeping procedures, and using properly calibrated and maintained equipment. Monitoring data should be analyzed and reviewed at regular intervals and compared with the operating standards so that any necessary corrective actions can be taken. Additional guidance on applicable sampling and analytical methods for emissions and effluents is provided in the **General EHS Guidelines**.

2.2 Occupational Health and Safety

Occupational Health and Safety Guidelines

Occupational health and safety performance should be evaluated against internationally published exposure guidelines, of which examples include the Threshold Limit Value (TLV®) occupational exposure guidelines and Biological Exposure Indices (BEIs®) published by American Conference of Governmental Industrial Hygienists (ACGIH),[20] the Pocket Guide to Chemical Hazards published by the United States National Institute for Occupational Health and Safety (NIOSH),[21] Permissible Exposure Limits (PELs) published by the Occupational Safety and Health Administration of the United

[20] Available at: http://www.acgih.org/TLV/ and http://www.acgih.org/store/
[21] Available at: http://www.cdc.gov/niosh/npg/

States (OSHA),[22] Indicative Occupational Exposure Limit Values published by European Union member states,[23] or other similar sources.

Accident and Fatality Rates

Projects should try to reduce the number of accidents among project workers (whether directly employed or subcontracted) to a rate of zero, especially accidents that could result in lost work time, different levels of disability, or even fatalities. Facility rates may be benchmarked against the performance of facilities in this sector in developed countries through consultation with published sources (e.g. US Bureau of Labor Statistics and UK Health and Safety Executive)[24].

Occupational Health and Safety Monitoring

The working environment should be monitored for occupational hazards relevant to the specific project. Monitoring should be designed and implemented by accredited professionals[25] as part of an occupational health and safety monitoring program. Facilities should also maintain a record of occupational accidents and diseases and dangerous occurrences and accidents. Additional guidance on occupational health and safety monitoring programs is provided in the **General EHS Guidelines**.

[22] Available at: http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=9992
[23] Available at: http://europe.osha.eu.int/good_practice/risks/ds/oel/
[24] Available at: http://www.bls.gov/iif/ and http://www.hse.gov.uk/statistics/index.htm
[25] Accredited professionals may include certified industrial hygienists, registered occupational hygienists, or certified safety professionals or their equivalent.

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Annex A: General Description of Industry Activities

Meat processing facilities slaughter cattle and pigs and sell the carcasses directly or for further processing into meat products. In some slaughterhouses, inedible and discarded remains are rendered into by-products. Meat processing facilities are typically located outside of, or on the outskirts of, urban centers, allowing proximity to markets while reducing potential disturbance to neighbors. The trends in the sector and market are toward larger units, increased focus on product safety and animal welfare, improved food quality, increased levels of processing, and improved working conditions. Bovine and porcine slaughter differs mainly in the treatment of the animal hides or skin. While the hides are typically removed from the cattle carcasses and sold to tanneries, pig carcasses are normally processed with their skin. Slaughterhouses usually have separate bovine and porcine production lines. As the simplified process diagram illustrates, various operations are performed in bovine and porcine slaughter.

Stunning, Sticking, and Bleeding

Cattle are individually led into the stunning box where they are stunned (e.g. with a bolt pistol or other method. The immobilized cattle are unloaded from the box and hung from an overhead rail by the hind legs. They are then stuck to bleed over a collection trough. The blood may be stored in a refrigerated storage tank and / or processed on location. Pigs are stunned with either CO_2 anesthetization or with electric stunning (a captive bolt pistol might alternatively be applied). The immobilized pigs are hung from an overhead rail by the hind leg / rear toe and then stuck to bleed over a collection trough.

Hide Removal / Decapitation (Bovine) and Scalding / Dehairing (Pigs)

Following bleeding of the bovine animal, the hooves, tail, udder / testicles, head, and (sometimes) forelegs are removed. Cattle hide is removed from the animal either manually or mechanically. The hides are washed and preserved by cooling or adding salt or other bacteriostatic compounds before transport to the tannery.

Following bleeding of pig carcasses, they are immersed in the scalding tank (60°C) for about 3 to 6 minutes to facilitate the removal of the bristles and to loosen the toenails. In the dehairing machine, the bristles, outer skin layer, and toenails are removed by a number of rotating rollers that brush or scrape the surface of the carcasses. The pig carcass is then transferred to the singeing oven where it is exposed to temperatures of 900°C to 1,000°C for 5 to 15 seconds to eliminate residual hair and micro-organisms and to induce a firmer skin texture. After singeing, the carcass is cooled by showering with cold water. If pig meat is used to produce bacon, a heavier singe is applied and the rind is passed through a black-scraping machine to clean / polish the skin. Slaughterhouses may employ a flaying process to skin the pig carcasses after they are washed (with the minimum amount of water without compromising food hygiene safety) and dried, instead of using the scalding and dehairing procedure described above. Cleaning methods which utilize water should consider the potential for carcass contamination if the water quality is not carefully monitored as well as potential for significant water consumption if water conservation precautions are not incorporated. Food safety should be the overriding concern when considering issues of water consumption and conservation.

Evisceration and preparation

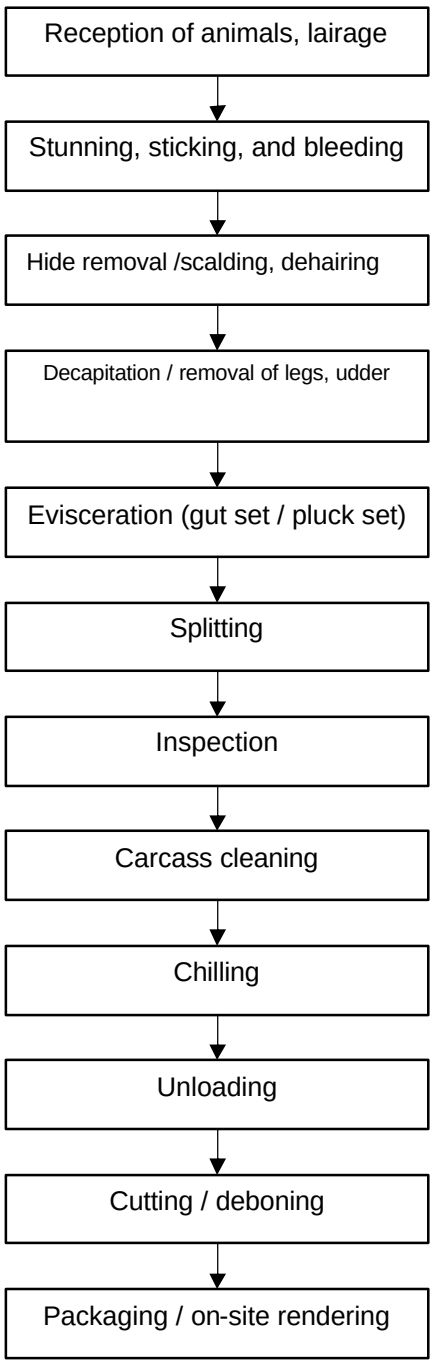
The pig carcasses enter the 'clean slaughter line' for evisceration, during which the stomach, intestines, and pluck set (e.g. heart, lungs and trachea) are removed and transported to separate rooms for further treatment. The carcass is split, cleaned, weighed, inspected, and classified. The evisceration of the cattle carcass includes opening of the carcass at the belly

and removing the bladder, uterus, liver, stomachs, and intestines and then, after cutting through the diaphragm, removing the pluck set. Green offal (e.g. the digestive tract and associated organs) and red offal (e.g. the liver, kidney and heart) undergo further cleaning in separate departments. Following evisceration, the spinal cords are cut free and removed, and the cattle carcass is split with an electric saw. After inspection, the carcass is rinsed before chilling / freezing and maturation. Some slaughterhouses also perform on-site processing (e.g. cutting, deboning, and further meat processing activities including grinding, mixing with additives, pickling, smoking, cooking, and canning) to produce retail cuts.

Rendering

Although rendering is usually conducted at off-site facilities, some meat processing facilities have special, isolated areas of the slaughterhouse designated for on-site rendering of the by-products from slaughter (e.g. blood and fat). Rendering typically includes evaporative processes that generate a foul odor. Specialized off-site rendering plants receive animal by-products and waste from a variety of sectors including meat processing plants, poultry rearing and processing, butchers shops, supermarkets, and livestock-rearing facilities. Methods used for fat melting include batch wet fat melting; batch dry fat melting; and continuous wet fat melting. Batch wet fat melting is the most common method and includes the use of an autoclave to heat materials under pressure with steam. Afterward the free fat is drained to an intermediary tank and the moist grease is pressed and then dried. If the raw materials are clean and fresh, the fat can be used for food production. Blood can be processed to use the plasma in meat products, (e.g. cooked sausages), and for pet food and livestock feed. [26]

Figure A.1: Bovine / Porcine Slaughter Process



[26] The collected blood is filtered and centrifuged to remove gross particles. The plasma contains approximately 8 percent solids and is concentrated by reverse osmosis or nanofiltration, machine hom ogenized, and pressurized before spray drying. Alternatively, the plasma may be concentrated by vacuum evaporation. The red cell fraction can be spray dried after the centrifugation and used for natural pigment in the meat industry, as fertilizer, or in pet food / animal feed.