Environmental, Health, and Safety Guidelines for Poultry 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. 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 poultry processing include information relevant to processing of chickens, but can be applied to other similar types of poultry processing, such as turkey and ducks. These Guidelines cover process steps from the reception of live birds, slaughter, evisceration, and simple rendering. Poultry rearing is addressed in the EHS Guidelines for Poultry Production. For guidance on animal welfare, see the IFC Good Practice Note "Animal Welfare in Livestock Operations."[2] 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 and Additional Sources
Annex A — General Description of Industry Activities

[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.

[2] 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 the operations phase of poultry processing, along with recommendations for their management. 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

EHS issues in poultry processing projects include:

- Solid organic wastes and by-products
- Wastewater
- Emissions to air
- Energy consumption

Solid Organic Wastes and By-products

Slaughtering and rendering activities may generate significant quantities of organic waste. The carcass yield is, on average, 75 percent of the live bird weight. The resulting solid waste depends on the conversion rate of reprocessing the waste from slaughtering into saleable by-products.

Solid waste can be divided in to two groups: (1) low-risk material originating from healthy birds and, (2) high-risk material that has the potential to transfer disease to humans and animals. Examples of high-risk material include birds that died from causes other than slaughtering, birds or bird parts condemned as unfit for human consumption, and birds suspected of carrying a disease that can be transferred to animals (e.g. Newcastle Disease).[3] Due to potential impacts to humans, birds suspected of being infected with Highly Pathogenic Avian Inluenza (HPIA), or birds that are confirmed to be infected with HPIA, should also be treated as high risk material. Specific guidance on the handling of these birds is provided below.

Recommended management methods to prevent and control generation of organic solid waste include the following:

- Halting feeding 6 to 10 hours[4] before transport to reduce the volume of excreta to be removed after transport or slaughter. Provision of adequate slurry storage capacity for excreta until it is transported for disposal or for use as agricultural fertilizer;
- Reprocessing as much of the low-risk and high-risk material as possible. Recommended guidance on handling of risk materials includes:
  - Since disposal of high-risk material is typically conducted through off-site rendering in an energy intensive process, avoiding mixing low-risk and high-risk materials is recommended. A mixture of low-risk and high-risk materials should be classified as high-risk material and treated accordingly
  - Examples of reprocessing opportunities for low-risk material include use of feathers and down from waterfowl in garments and household items; use of heat treated products as animal feed for pigs, fish and shrimp production; and use of poultry feet for human consumption
- For low-risk material that cannot be reprocessed into by-products, alternative treatments such as acidification, biogas production, use as agricultural fertilizers, and incineration should be considered. Incineration should only

[3] A complete of the most relevant poultry disease can be found on the World Organization for Animal Health (OIE) website: http://www.oie.int/eng/en_index.htm.

[4] UK Environment Agency (2001).

be conducted in permitted facilities operating under international recognized standards for pollution prevention and control.[5]

Highly Pathogenic Avian Influenza (HPAI)

If a batch of birds delivered to the slaughterhouse is suspected of infection with Highly Pathogenic Avian Influenza (HPAI), the birds must be stored separately to avoid contact with healthy birds. HPAI should be suspected when the dead-on-arrival (DOA) frequency is abnormally high, and in connection with other symptoms (e.g. discoloring of the head and tail regions and respiratory problems). The presence of HPAI should be considered when heat stress and other poultry diseases can be excluded as the cause of high DOA frequency.

In general, birds suspected of HPAI infection are killed. Suspected dead birds, as well as all birds which have arrived at the slaughterhouse at a later time than the suspected birds, are kept isolated until testing has established their HPAI status.

If HPAI is confirmed, the entire carcass of the dead birds should be handled as high risk material and transported safely to a rendering facility. Trucks and equipment (e.g. crates and racks) used for transport, as well as personnel, should be thoroughly cleaned and disinfected to prevent disease transmission from one farm to another. The transport route should avoid areas with high density of poultry to reduce the risk of spreading the virus. The slaughterhouse should be cleaned and disinfected, and a minimum operational shutdown of 24 hours should be applied. Personnel working in close proximity should take necessary protective measures as detailed in the Occupational Health and Safety section (see below).[6]

Sludge Treatment and Disposal

Poultry processing operators should consider the following measures to minimize sludge generated from wastewater treatment processes:

- Reuse of high-quality, low risk by-products (e.g. screened materials), and suspended solids and emulsified fats from flotation that are separated during pretreatment processes (e.g. for pet food manufacturing);
- Use of aerobic stabilization or anaerobic digestion. If biogas is produced, blood, fat, and manure are good sources of organic materials. Anaerobic stabilization improves the sludge applicability for agricultural use. Pathogens present in the sludge can be destroyed during controlled anaerobic digestion (biogas) or aerobic treatment (composting);
- Disposal of fat at landfills if it can not be used for biogas production.

Wastewater

Industrial Process Wastewater

Poultry processing activities require large amounts of high quality water for process cleaning and cooling. Process wastewater generated during these activities typically has high biochemical and chemical oxygen demand (BOD and COD) due to the presence of organic material such as blood, fat, flesh, and excreta. In addition, process wastewater may contain high levels of nitrogen, phosphorus, residues of chemicals such as chlorine used for washing and disinfection, as well as various pathogens including salmonella and campylobacter.

Recommended techniques to minimize generation of wastewater include:

[5] Examples of key environmental issues associated with incinerations facilities are available in the IFC EHS Guidelines for Waste Management Facilities.
[6] Based on guidelines provided in articles 36-39 of Council Directive 2005/94/EC, and recommendations by the Danish Veterinary and Food Administration.

- Removal of solid organic waste from transport equipment before rinsing and washing. Organic materials should be collected separately for recycling;
- Use of grids and screens in the factory floor to prevent solid organic material from entering the wastewater collection channels;
- Ensuring that leakage from animal by-product storage containers is avoided (e.g. preventive maintenance, corrosion inspection);
- Use of dripping trays to collect blood and ensure that it is transported to the blood tank rather than into the wastewater stream;
- Consider use of steam scalding of birds to avoid excessive wastewater generation from scalding tanks;
- Where scalding tanks are used, ensuring the entry of birds to the scalding tank does not cause overflow of the tank liquid. Drippings from birds leaving the scalding tank and from overflows should be collected and reused in the scalding tank;
- Regular adjustment of evisceration machinery to reduce accidental release of fecal matter due to the rupture of birds' intestinal tract (resulting in the need for frequent rinsing);
- Where feasible, transportation of organic material using vacuum pumps instead of water transport;
- Application of appropriate tank and equipment cleaning procedures. Cleaning-in-Place (CIP) procedures are useful to reduce chemical, water, and energy consumption in cleaning operations;
- Choosing cleaning agents and application rates that do not have adverse impacts on the environment, or on wastewater treatment processes and sludge quality for agricultural application.

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; flow and load equalization; sedimentation for suspended solids reduction using clarifiers; biological treatment, typically anaerobic (if high in organic content) 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 is characteristic of poultry processing. Water is used for cleaning vehicles, rinsing carcasses and by-products, cooling, transporting the product during production processes, and cleaning and sterilizing equipment and process areas. Recommended techniques to reduce and manage water

consumption, especially where it may be a limited natural resource, are provided in the **General EHS Guidelines.** Specific water consumption recommendations for poultry processing operations include:

- Optimizing water consumption for rinsing and cooling without jeopardizing food safety;
- Where hygiene regulations permit, replacing transport of products and by-products that use water as a media (e.g. feathers after the plucking operation has taken place) with mechanical transport;
- Dry cleaning process areas with a scraper, broom, or specially designed vacuum cleaner before cleaning with water;
- Considering the use of an ice-water mixture in the counter flow water chiller to reduce the required volume of cooling water. (Note that this will likely increase energy consumption.)
- If feasible, replacing counter flow water chiller by air cooling to reduce water consumption. (Note that this will likely increase energy consumption.)

Emissions to Air

Air emissions from combustion sources, such as boiler houses and generators for electric power, are addressed in the **General EHS Guidelines.** Air emission issues of concern in this sector are mainly associated with odor.

Odor Prevention and Control

Major process odor sources include scalding, live bird handling, wastewater treatment, and rendering. Other sources of odors include by-products, blood collection tanks, manure piles, and fat traps.

Recommended measures to prevent the generation of odor emissions include:

- Maintenance of clean live bird handling areas by removing fecal matter and dead birds on a daily basis;
- Emptying and cleaning fat traps frequently;
- Reducing the inventory of raw carcasses, waste, and by-products and minimizing any storage to short periods of time in a cold, closed, well-ventilated area. Dead birds, waste, and byproducts should not be stored in open spaces, where possible;
- Sealing off animal by-products during transport and transporting blood in insulated containers to reduce temperature increase;
- Where feasible, installation of rendering equipment in enclosed buildings operated under negative air pressure.

Recommended measures to control odor emissions include:

- Use of exhaust stack heights from rendering and smoking processes that are consistent with Good Engineering Practice (GEP) as described in the **General EHS Guidelines**;
- If the facility is in close proximity to residential areas, the use of wet scrubbers to remove odor emissions should be considered. Wet scrubbers are used to remove odors with a high affinity to water, such as ammonia emitted during the rendering process.

Energy Consumption

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

- Coverage and insulation of scalding tanks; control of water levels and recirculation of water; use of steam rather than scalding for poultry processing; and use of insulated sterilizers to sterilize knives and other equipment;
- Improvement in cooling efficiency by insulating refrigeration room / areas and doors; installation of an automatic door-closing mechanism (e.g. micro-switches); use of airlocks; and setting alarms to alert operators when chill room doors and external loading doors are left open;
- Recovery of evaporative energy in the rendering process through the use of multi-effect evaporators.[7]

1.2 Occupational Health and Safety

Occupational health and safety issues during the operation of poultry processing facilities primarily include the following:

- Physical hazards
- Biological hazards
- Chemical hazards
- Exposure to heat and cold
- Exposure to noise and vibrations

Physical Hazards

Physical hazards include exposure to same-level fall hazards due to slippery conditions, the use of machines and tools, and collisions with internal transport equipment (e.g. forklift trucks and containers). Guidance on general workplace conditions, including design and maintenance of working and walking surfaces to prevent slips and falls, is presented in the **General EHS Guidelines**. Additional, industry-specific recommendations include[8]:

- Implementation of proper design and management of floor and equipment by:
  - Ensuring that the process layout reduces opportunities for process activities to cross paths, thus avoiding collisions and falls
  - Demarcating transport corridors and working areas, and installing handrails on platforms, ladders, and stairs
  - Grounding all electrical equipment and installations in wet rooms
  - Avoiding spillage and leakage of product or wastes, and implementing cleaning procedures, including drying wet floors after cleaning
  - Avoiding uneven floor surfaces
  - Ensuring adequate lighting in all work areas
  - Optimizing the temperature or providing appropriate personal protective equipment (PPE) at workstations, as the risk of injury is greater when working in a cold environment
  - Training workers in the use of cutting equipment, including the proper use of machine safety devices, and PPE for cutting activities (e.g. metallic gloves and leather aprons) , and protective footwear with rubber soles
  - Ensuring that moving parts on conveyor belts, packaging and skinning machinery, and gizzard peelers are properly safeguarded

Lifting, Carrying, and Repetitive Work

Poultry processing activities may give rise to a variety of situations in which workers can be exposed to lifting, carrying, and repetitive work, and work posture injuries.[9] Such situations include heavy lifting involved in live catch and shackling birds;

[7] UNEP (2000).

[8] Further industry specific guidance for the prevention and control of accidents in this sector is available from U.S. Department of Labor, Occupational Safety and Health Administration (OSHA) Poultry Processing Industry e-Tool available at: http://www.osha.gov/SLTC/etools/poultry/index.html

[9] Ibid.

manual lifting of boxes; and pushing or pulling carts and manually operated fork lifts used for internal transport of poultry.

Examples of repetitive work include boning and operating machinery (e.g. slicing and vacuum packing machines). Poor working postures may result from the design of the workspace, furniture, machinery, and tools. Recommended prevention and control measures for repetitive work are discussed in the **General EHS Guidelines**. Industry-specific measures for poultry processing include the following:

- Reducing repetitive work operation by job rotation (e.g. live bird handling activities);
- Installation of gas stunning machines to facilitate bird shackling;
- Mechanizing manual processes (e.g. slaughtering and boning) if possible, including the use of electric cutting equipment.

Biological Hazards

Workers involved in operations requiring bird handling may be exposed to dust, biological, and microbiological agents. This may result in eye and skin irritations, allergic reactions, and Newcastle Disease or ornithosis. Pathogens including salmonella and campylobacter may cause skin and respiratory tract infections. Specific precautions need to be taken by workers that come into contact with birds that are suspected or confirmed of contamination with HPAI. Recommended industry-specific measures to control worker exposure to biological hazards include:

- Installation of exhaust ventilation at the source of dust and gases (e.g. the live bird handling area);
- Work rotation strategies to reduce occupational exposure to biological hazards;
- Avoiding dust and aerosol generating activities (e.g. use of compressed air or high pressure water for cleaning) and, where this is not possible, providing proper ventilation of enclosed or semi-enclosed areas to reduce or eliminate exposure to dust and aerosols;
- Providing workers with PPE appropriate for the activity (e.g. gloves, ventilated helmets, and other equipment in high-risk operations, such as live bird handling);
- Ensuring physical segregation of work and welfare facilities to maintain worker personal hygiene;
- Prohibition of smoking or eating in the workplace;
- Provision of washing facilities for workers.

Personnel working in close contact with birds that are suspected or confirmed of contamination with HPAI should protect themselves by:

- Use of appropriate PPE including face masks approved for virus protection, protective eyewear, rubber gloves, and disposable protective clothing that covers the entire body;
- Regular handwashing with soap and alcohol;
- Use of antivirus drugs (e.g. Tamiflu) for personnel working with birds and products suspected of infection with HPAI. In general, personnel should be vaccinated every year against human influenza to minimize the risk of recombination of human and avian influenza strains.

Chemical Hazards

Exposure to chemicals (including gases and vapors) typically involves chemical-handling activities related to cleaning operations and disinfection of process areas, in addition to the maintenance of heating (thermal oils) and cooling systems (ammonia). Recommended measures to prevent and control exposure to chemicals are discussed in the **General EHS Guidelines**.

Heat and Cold

Potential occupational impacts from exposure to heat and cold include heat from scalding and other operations, and cold in refrigeration areas and rooms. Recommendations for the management of exposure to heat and cold are presented in the **General EHS Guidelines**.

Noise and Vibration

Noise and vibration exposure may result from proximity to noisy machinery such as compressors, automatic packing machinery, condensers, ventilation units, and pressurized air, among other sources. Recommendations for noise management are addressed in the **General EHS Guidelines.**

1.3 Community Health and Safety

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

Food Safety Impacts and Management

A robust food safety program can protect a company from product adulteration, contamination, and the impacts of food recalls that can damage a viable business. If products can be traced to specific lot numbers, recall is a matter of tracking and removing all foods associated with specific lot numbers.

Poultry processing should be performed according to internationally recognized food safety standards consistent with the principles and practice of Hazard Analysis and Critical Control Point System (HACCP)[10] and Codex Alimentaria.[11] In addition, recommended food safety principles and measures include:

- Respecting "clean" and "dirty" zoning, designed in accordance with HACCP prerequisites (e.g. sanitary standard operating procedures as discussed below);
- Ensuring the cooling chain is unbroken for sensitive products requiring refrigeration;
- As far as possible, ensuring full traceability of all materials and products throughout the supply chain;
- Adequate veterinary inspection, including examination of vaccination certificates for the animals in the supply chain;
- Compliance with veterinary regulations and precautions to be taken for waste, sludge, excreta, and by-products;
- Establishment of appropriate laboratory facilities to undertake testing of swabs, products, and processes;
- Regular testing of staff for salmonella (and other diseases)
- Full institutionalization of HACCP prerequisites throughout the supply / production chain including:
    - Sanitation
    - Good Management Practices (GMPs)
    - Pest control
    - Chemical control
    - Allergen control
    - Customer complaints mechanism
    - Traceability and recall

In addition, the HACCP program should consider industry-specific issues for poultry processing such as the risk of pathogens (e.g. salmonella, campylobacter, and listeria monocytogenes); drug and chemical residues; and metal fragments from processing machinery.

[10] ISO (2005).
[11] FAO and WHO (1962–2005).

2.0 Performance Indicators and Monitoring

2.1 Environment

Emissions and Effluent Guidelines

Table 1 presents effluent guidelines for the poultry processing 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.

Table 1. Effluent levels for poultry processing

Pollutant	Unit	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

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 Megawatt thermal (MWth) are addressed in the **General EHS Guidelines. L**arger power source emissions are 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**.

Resource Use

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

Table 2. Byproduct and Waste Generation

Outputs per Unit of Product	Unit	Industry [a]	Denmark [b]
Waste			
Solid organic waste	g/head		3–8 *
Byproduct for rendering			510
Packaging waste			15
Yield Process Figures			
Blood	% of whole bird live weight	3	3.5
Feathers		5.5	8.8
Head		3	3
Feet		3	3.9
Hocks		5	
Shank		2	
Intestine		6	8 **
Neck skin		1.5	
Neck		2	
Gizzard		1.5	
Liver		2	
Heart		0.5	
Other offal [c]		2	

[a] Meyn Poultry Processing Solutions. 2004. Yield Process Figures. Percentages are based on a live weight of 2000 gr. Percentages are indicative and can vary depending on age, race, feed etc. Meyn Food Processing Technology B.V., Oostzaan:Meyn. The Netherlands.

[b] Danish EPA. 2000. Miljøprojekt Nr. 573 Renere teknologi på fjerkræslagterier – Projektrapport. Ole Pontoppidan and Poul-Ivar Hansen, Slagteriernes Forskningsinstitut. P. 13-14. Data derived fom a survey of 10 poultry slaughterhouses with an average capacity of 12 million chickens per year

[c] (lungs, gall bladder, wind pipe, gizzard content, pro-stomach)

* Less flocculation sludge (15-30 g dry matter per chicken)

** Intestines and other material

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),[12] the Pocket Guide to Chemical Hazards published by the United States National Institute for Occupational Health and Safety (NIOSH),[13] Permissible Exposure Limits (PELs) published by the Occupational Safety and Health Administration of the United States (OSHA),[14] Indicative Occupational Exposure Limit Values published by European Union member states,[15] or other similar sources.

[12] Available at: http://www.acgih.org/TLV/ and http://www.acgih.org/store/
[13] Available at: http://www.cdc.gov/niosh/npg/
[14] Available at: http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=9992
[15] Available at: http://europe.osha.eu.int/good_practice/risks/ds/oel/

Table 3. Resource and Energy Consumption

Outputs per Unit of Product	Units	Finland [a]	Nordic [b]	EU [c]	Denmark [d]	
Energy / Fuel					*Chicken*	*Duck*
Electricity	kWh/head	0.67	---	---	0.37	0.93
	kWh/kg slaughtered animal	0.49	0.16-0.86	---	0.21	0.24
Heat	kWh/head	0.69	---	---	0.22	0.97
	kWh/kg slaughtered animal	0.50	0.03-0.16	---	0.12	0.25
Total energy consumption	kWh/head	---	---	---	0.59	1.87
	kWh/kg slaughtered animal	---	---	0.152-0.86	0.33	0.49
Water Consumption						
	l/head	17.9-18.7	---	---	16.1	43
	l/kg slaughtered animal	12.8-14.0	---	5.07-67.4	8.6	10.1

[a] Finnish Environment Institute. 2002. Finnish Expert Report on Best Available Techniques in Slaughterhouses and Installations for the Disposal or Recycling of Animal Carcasses and Animal Waste. The Finnish Environment. 539. Helsinki. 2002. Table 3, p. 19. Energy consumption by Finnish slaughterhouses (including stand alone slaughterhouses as well as plants with integrated meat cutting, deboning, and further processing). (The number of installations where data was obtained varies from 1 to 5); and Table 5. p. 20. Water consumption by Finnish slaughterhouses (including stand alone slaughterhouses as well as plants with integrated meat cutting, deboning, and further processing). (The number of installations where data was obtained varies from 1 to 4).

[b] Nordic Council of Ministers, BAT report, TemaNord 2001.553, p.72, Main key figures for the poultry slaughter process based on averages of data supplied by 8 slaughterhouses in Denmark in 1998.

[c] European Commission. 2005. Integrated Pollution Prevention and Control. Reference Document on Best Available Techniques in the Slaughterhouse and Animal By-products Industries. Seville: EC. P. 107. Table heading "Consumption and emission data for poultry slaughter". http://eippcb.jrc.es (accessed on 20-10-2005).

[d] Danish EPA. 2000. Miljøprojekt Nr. 573 Renere teknologi på fjerkræslagterier – Projektrapport. Ole Pontoppidan and Poul-Ivar Hansen, Slagteriernes Forskningsinstitut. P. 10-14. Data derived fom a survey of 10 poultry slaughterhouses with an average capacity of 12 million chickens per year and 1duck slaughterhouse with an average capacity of 0.5 million ducks per year.

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)[16].

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[17] 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**.

[16] Available at: http://www.bls.gov/iif/ and http://www.hse.gov.uk/statistics/index.htm

[17] Accredited professionals may include Certified Industrial Hygienists, Registered Occupational Hygienists, or Certified Safety Professionals or their equivalent.

3.0 References and Additional Sources

Arbejdstilsynet. 1998. Arbejdsmiljøvejviser 38. Fjerkræslagterier, fiske- og foderfabrikker. Copenhagen: Arbejdstilsynet. Available at: http://www.arbejdstilsynet.dk/graphics/at/pdf/arbejdsmiljoevejvisere/amv-38.pdf (accessed on 20-10-2005).

Arbejdstilsynet. 2005. Anmeldte arbejdsbetingede lidelser 1999–2000. Årsopgørelse 2004. Copenhagen: Arbejdstilsynet. (Reported accumulated occupational disease 1999–2004. Annual report 2004). Available at: http://www.at.dk/graphics/at/07-Arbejdsmiljoe-i-tal/02-Arbejdsskader/Aarsopgoerelser/Anmeldte-arbejdsbetingede-lidelser-2004.pdf (accessed on 20-10-2005).

U.S. Bureau of Labor Statistics (BLS). 2004a. Industry Injury and Illness Data – 2004. Supplemental News Release Tables. Table SNR05: Incident rate and number of nonfatal occupational injuries by industry, 2004. Washington, DC: BLS. Available at: http://www.bls.gov/iif/home.htm and http://www.bls.gov/iif/oshwc/osh/os/ostb1479.pdf (accessed on 20-10-2005).

BLS. 2004b. Census of Fatal Occupational Injuries Charts, 1992–2004. Number and rate of fatal occupational injuries by private industry sector, 2004. (Table page 10). Washington, DC: BLS. Available at http://www.bls.gov/iif/oshwc/cfoi/cfch0003.pdf (accessed on 20-10-2005).

Centro de Promoción de Tecnologías Sostenibles (CPTS). 2005. Guía Técnica de Producción Más Limpia para Mataderos de Bovinos. (Cleaner technology guidelines for slaughterhouses). Bolivia: CPTS. Available at: www.cpts.org (accessed on 05-04-2006).

European Commission (EC). 2005. Integrated Pollution Prevention and Control, Reference Document on Best Available Techniques in the Slaughterhouses and Animal by-product industries. BREF, European Commission, May 2005. Adopted final BREF. Seville: EC. Available at: http://eippcb.jrc.es/pages/FActivities.htm (accessed on 20-10-2005).

EC. 2003. Integrated Pollution Prevention and Control, Reference Document on Best Available Techniques in the Slaughterhouses and Animal by-product industries. BREF, European Commission, November 2003. Not final document. Seville: EC. Available at: http://www.bvt.umweltbundesamt.de/archiv-e/esslaughterhouses and http://www.bvt.umweltbundesamt.de/kurzue.htm (accessed on 20-10-2005).

EC. 1996. Council Directive 96/61/EC of 24 September 1996 concerning integrated pollution prevention and control (IPPC). Brussels: EC. Available at: http://europa.eu.int/comm/environment/ippc/index.htm Consolidated: http://europa.eu.int/eur-lex/en/consleg/pdf/1996/en_1996L0061_do_001.pdf (accessed on 05-04-2006).

European Economic Communities (EEC). 2006. Council Directive 2005/94(EC of 20 December 2005 on Community measures for the control of avian influenza and repealing Directive 92/40/EEC. Official Journal of the European Union. 14.1.2006. Brussels:EC. Available at: http://www.defra.gov.uk/animalh/diseases/notifiable/disease/ai/pdf/ai-directive-oj.pdf#search=%22EC%20Directive%202005%2F94%22 (accessed on 07-09-2006).

EEC. 2002. Regulation (EC) no 1774/2002 of the European Parliament and of the Council of 3 October 2002 laying down health rules concerning animal by-products not intended for human consumption. Brussels: EEC. Available at: www.europa.eu.int/eur-lex/en/consleg/pdf/2002/en_2002R1774_do_001.pdf (accessed on 05-04-2006).

EEC. 1991. European Council Directive 91/497/EEC of 29 July 1991 amending and consolidating Directive 64/433/EEC on health problems affecting intra Community trade in fresh meat to extend it to the production and marketing of fresh meat. Brussels: EEC. Available at: www.europa.eu.int/eur-lex/en/consleg/pdf/1991/en_1991L0497_do_001.pdf (accessed on 05-04-2006).

Food and Agriculture Organization and World Health Organization (FAO and WHO).1962–2005. "Codex Alimentarius." Geneva: FAO and WHO. Available at: http://www.codexalimentarius.net/web/index_en.jsp (accessed on 20-10-2005).

Health and Safety Commission (HSC). 2005a. United Kingdom. Rates of reported fatal injury to workers, non fatal injuries to employees and LFS rates of reportable injury to workers in manufacturing. London: National Statistics. Available at: http://www.hse.gov.uk/statistics/industry/manufacturing-ld1.htm#notes (accessed on 20-10-2005).

HSC. 2005b. Health and Safety Statistics 2004/05.London: National Statistics. Available on Page 21 at: http://www.hse.gov.uk/statistics/overall/hssh0405.pdf (accessed on 20-10-2005).

HSC. 2005c. United Kingdom. Statistics of fatal injuries 2004/05. Fatal injuries to workers in manufacturing (p.7). London: National Statistics. Available at www.hse.gov.uk/statistics/overall/fatl0405.pdf (accessed on 20-10-2005).

Health & Safety Executive (HSE). 1997. HSE Information Sheet. Priorities for Health and Safety in the Poultry Processing Industry. Food Sheet No. 11. Sheffield: HSE. Available at: http://www.hse.gov.uk/pubns/fis11.pdf (accessed on 20-10-2005).

Irish Environmental Protection Agency (EPA). 1996a. BATNEEC Guidance Note for the Slaughter of Animals. Wexford: Irish EPA. Available at: http://www.epa.ie/Licensing/IPPCLicensing/BATNEECGuidanceNotes/FileUploaded,585,en.DOC (accessed on 20-10-2005).

Irish EPA. 1996b. BATNEEC Guidance Note for the Rendering of Animal By-products. Wexford: Irish EPA. Available at: http://www.epa.ie/Licensing/IPPCLicensing/BATNEECGuidanceNotes/ (accessed on 20-10-2005).

Irish EPA. 1996c. BATNEEC Guidance Note for the Poultry Production Sector. Wexford: Irish EPA. Available at: http://www.epa.ie/Licensing/IPPCLicensing/BATNEECGuidanceNotes/ (accessed on 20-10-2005).

Irish EPA. 2004. IPC Guidance Note on Storage and Transfer of Materials for Scheduled Activities. Wexford: Irish EPA. Available at: www.epa.ie (accessed on 20-10-2005).

India Environmental Protection Agency. 1998. LIQUID EFFLUENT STANDARDS - Category: 52.0 SLAUGHTER HOUSE, MEAT & SEA FOOD INDUSTRY. EPA Notification S.O. 64(E), dt. 18 January 1998. Delhi: India EPA. Available at: http://www.cpcb.nic.in/standard52.htm (accessed on 05-04-2006).

International Standards Organization (ISO). 2005. ISO 20000: 2005: Food safety management systems - Requirements for any organization in the food chain. Geneva: ISO. Available at: http://www.iso.org/iso/en/CatalogueDetailPage.CatalogueDetail?CSNUMBER=35466&ICS1=67&ICS2=20&ICS3= (accessed on 05-04-2006).

Livestock, Environment and Development Initiative (LEAD). 1996. Management of Waste from Animal Product Processing. L.A.H.M. Verheijen, D. Wiersema,

L.W. Hulshoff Pol, J. De Wit. International Agriculture Centre, Wageningen, The Netherlands. Study Coordination by FAO, U.S. Agency for International Development, World Bank and LEAD. Available at: http://www.virtualcentre.org/en/library/CDlibrary/PUBS/X6114E/x6114e00.htm#Contents or www.fao.org/WAIRDOCS/LEAD/X6114E/X6114E00.HTM (accessed on 05-04-2006).

Mexico [Secretaría de Medio Ambiente, Recursos Naturales y Pesca]. 1997. NORMA OFICIAL MEXICANA NOM-001-ECOL-1996, QUE ESTABLECE LOS LIMITES MAXIMOS PERMISIBLES DE CONTAMINANTES EN LAS DESCARGAS RESIDUALES EN AGUAS Y BIENES NACIONALES. Publicada en Diario Oficial de la Federación de fecha 6 de enero de 1997. (Mexican official norm -001- ECOL- 1996, which establish the maximum permissible limits for contaminants in effluents). [Mexico City]: [Secretaría de Medio Ambiente, Recursos Naturales y Pesca]. Available at: http://www.rolac.unep.mx/deramb/compendio_legislacion/LegislacionNacionalMexicana/Normas/Areas/NormasSEMARNAT/LIMITES%20MAXIMOS%20PERMISIBLES%20DE%20CONTAMINANTES%20EN%20LAS%20DESCARGA.pdf (accessed on [05-04-2006).

Nordic Council of Ministers. 2001. TemaNord 2001:553, Best Available Techniques (BAT) in Nordic Slaughterhouses. Copenhagen: Nordic Council of Ministers.

Thailand Ministry of Science, Technology and Environment (MOSTE).1996. Industrial effluent Standard. Source: Notification the Ministry of Science, Technology and Environment, No. 3, B.E.2539 (1996) issued under the Enhancement and Conservation of the National Environmental Quality Act B.E.2535 (1992). Bangkok: MOSTE. Available at: http://www.pcd.go.th/info_serv/en_reg_std_water04.html#s1 (accessed on January 2006).

UK Environment Agency. 2001. Sector Guidance Note IPPC S6.11. Guidance for the Poultry Processing Sector. Integrated Pollution and Control (IPPC). Bristol, UK: UK Environment Agency. Available at http://www.environment-agency.gov .uk/business/444304/444364/577703/?version=1&lang=_e (accessed on 05-04-2006).

United Nations Environment Programme (UNEP). 2000. Cleaner Production Assessment in Meat Processing. COWI for UNEP and Danish Environmental Protection Agency. Paris: UNEP. Available at: http://www.agrifood-forum.net/publications/guide/index.htm and http://www.agrifood-forum.net/publications/guide/meatguide.zip (accessed on 05-04-2006).

US EPA (Environmental Protection Agency). 2004a. Effluent Limitations Guidelines and New Source Performance Standards for the Meat and Poultry Products Point Source Category. ENVIRONMENTAL PROTECTION AGENCY 40 CFR Part 432, Federal Register: September 8, 2004. Washington, DC: US EPA. Available at: http://www.epa.gov/fedrgstr/EPA-WATER/2004/September/Day-08/w12017.htm (Introduction to Clean Water Act: http://www.epa.gov/region5/water/cwa.htm) (accessed on 20-10-2005).

US Environmental Protection Agency. 2004b. Technical Development Document for the Final Effluent Limitations Guidelines and Standards for the Meat and Poultry Products Point Source Category (40 CFR 432) Volume 2 of 4. EPA – 821-R-04-011. Washington: US Environmental Protection Agency. Washington, DC: US EPA. Available at: http://www.epa.gov/waterscience/guide/mpp/tdd/vol2.pdf http://www.epa.gov/waterscience/guide/mpp/ (Volume 1: http://www.epa.gov/waterscience/guide/mpp/tdd/vol1.pdf) (accessed on 20-10-2005).

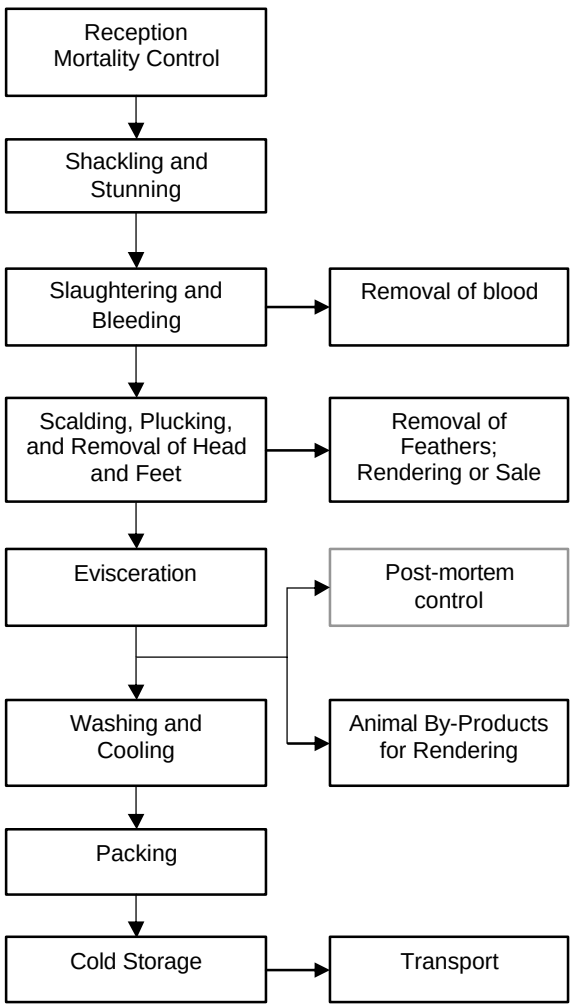
Water Environment Federation. 2005. Standard Methods for the Examination of Water and Wastewater, 21st Edition. American Public Health Association (APHA), American Water Works Association (AWWA) & Water Environment Federation (WEF). Available at: www.standardmethods.org (accessed on 05-04-2006).

Waste Reduction Resource Center. 2005. The Meat Processing Topic Hub™. Raleigh: Waste Reduction Resource Center. Available at: http://wrrc.p2pays.org/p2rx/subsection.cfm?hub=449&subsec=15&nav=15&CFID=128311&CFTOKEN=14135054 and http://wrrc.p2pays.org/p2rx/toc.cfm?hub=449&subsec=7&nav=7 (accessed on 05-04-2006).

Annex A: General Description of Industry Activities

The most common product produced in poultry slaughterhouses is the whole bird. However, poultry meat can be further processed into various products based on the type of poultry meat (e.g. from simple cuts to ready-to-eat meals). Figure A-1 provides a simplified diagram of the various operations performed in poultry processing.

Figure A.1: Poultry Processing Operations



Source: Adapted from the Danish Poultry Meat Association

Preprocessing

The birds are transported by truck to the poultry slaughterhouse, usually in specially designed crates that are stacked on racks and then loaded onto the vehicle. Consideration should be given to prevent heat stress during transport, which may jeopardize animal welfare and cause bird fatalities.

Upon arrival at the poultry slaughterhouse, the birds are held in the reception area in the transport crates, pending veterinarian inspection. The reception area should be designed to avoid heat stress. The official veterinarian then inspects each transport crate of live birds to approve them for human consumption. Sick birds are killed and disposed of. Birds that may be infected with Highly Pathogenic Avian Influenza (HPAI), are segregated to avoid contact with healthy birds, slaughtered, and their remains transported off-site for final disposal. Trucks and equipment (e.g. crates and racks) used for transport, as well as personnel, should be thoroughly cleaned and disinfected to prevent disease transmission from one farm to another.

After inspection, the birds are removed from the crates in the reception area and put on the killing line. The birds are hung upside down by their feet by shackles on a conveyor, which moves them to the stunning area. Once the birds are shackled, stunning is carried out using one of three possible methods that include: (i) an electrically-charged water bath; (ii) gas inhalation; or (iii) a blow to the head using a blunt object.

Slaughtering, Bleeding, and Scalding

Slaughtering can be performed manually or by using an automatic circular knife system. The equipment should be kept sharp at all times, and mechanical slaughtering should be supervised at all times to ensure that all birds are cut correctly. The birds should bleed for at least two minutes to ensure a total

bleed-out. The blood is collected in a tank and handled as an animal by-product for further processing.

After bleeding, the birds are exposed to either steam or hot water as part of the scalding procedures. Scalding loosens the feathers and facilitates plucking. If high-temperature scalding is used, the epidermis will be removed during the plucking process. The scalding process is controlled by regulating temperature and time. Birds prepared for subsequent freezing are scalded at approximately 65 degrees Celsius (^{o}C) and birds prepared for chilled distribution are scalded at approximately 60^{o}C. During low-temperature scalding, water should be continuously added to the scalding tank because the birds absorb water. Cross-contamination of the birds can be reduced during the scalding process by applying a counter-current flow where clean make-up water is added near the point where scalded birds are removed (at the opposite end of the tank from where birds are introduced). Steam scalding can reduce energy consumption and improve hygiene, but this technique is still in the developmental phase.

Further Processing and Evisceration

Feathers are removed in a specially designed plucking machine or by hand. All rotating parts of the machine must be in good working order to avoid damaging the skin of the bird. Feathers are collected and treated as an animal by-product. The birds are showered with water during the automated plucking operation and the feathers are collected in a trough under the plucking machine. The feathers are then transported with recirculated water through a screen and into a container.

If possible, waterfowl feathers are collected and sold. Plucking of waterfowl is difficult, and an extra process is necessary to remove all feathers and downs. Waterfowl may either be plucked manually or by using a process in which the birds are dipped in a bath of hot liquid wax. The hardened wax with the feathers attached is hand stripped after cooling, removing the feathers that were not removed in the first plucking process.

Following scalding and plucking activities, the head and feet are removed. The heads from birds are treated as animal by-products. The feet are treated as animal by-products or, if they are going to be used for human consumption, are further processed using heat and mechanical treatment to remove inedible parts, followed by a visual quality inspection. The neck is broken off and residues present in the windpipe are removed from the neck cavity.

Evisceration is carried out mechanically or manually to remove the internal organs. Care must be taken to prevent contamination with material from the intestinal tract. The open bird and the organs are presented for inspection by a trained individual. Birds unfit for human consumption are removed. Inedible organs including the intestinal tract and lungs are removed and treated as animal by-products. The eviscerated carcass should be rinsed internally and externally with potable water before further processing.

Storing and Packaging

After rinsing, the carcass should be cooled as quickly as possible to at or below 4°C. Several methods are used for chilling including air chilling, which takes place in either a chill room or by continuous air blast; spray chilling, where water aerosols are added to the air; and immersion chilling, which involves moving carcasses through a counter-flow current in a water bath. If this last process is used, the maximum amount of water uptake must be considered.

Birds are weighed individually and sorted according to their weight. After weighing, the birds are inspected visually and categorized. Whole birds are typically packed in plastic bags or in containers wrapped in film. All packing material should be approved according to current national regulation or other

internationally accepted approaches.[18] Birds are stored before sale at or below 4°C. Birds intended to be sold as quick-frozen poultry are frozen in a blast freezer or similar equipment that enable rapid freezing.

Cleaning

Cleaning is one of the most important processes in a poultry processing plant. Some rinsing and cleaning should occur during working hours. After working hours, a total cleaning and disinfection of the plant is carried out, normally on a daily basis. The cleaning process involves these major steps, including disassembling of machinery and equipment, as necessary; physical removal of solid material; rinsing and washing cycles; disinfection; drying; and application of lubricants.

Rendering

Rendering is a heat treatment of animal by-products to eliminate the risk of spreading disease to animals and humans, and to produce usable products such as proteins and fat. Rendering includes evaporative processes that may generate a foul odor. Although rendering is usually conducted at off-site facilities, some poultry slaughterhouses have special, isolated areas of the slaughterhouse designated for on-site rendering.

Low-Risk Material

Low-risk by-products are by-products obtained from animals that have been approved as fit for human consumption (e.g. blood, heads, and feet). Blood is collected in a separate tank. Depending on the storage time before further processing, the need for cooling and chemicals that can prevent coagulation should be considered. Blood is filtered and spray dried to produce blood meal. Blood meal can be used for feeding of fish, pets, and other animals.

Feathers are collected in a separate container. Before transfer to the container, water from the scalding process has to be pressed out of the feathers. Because the plucking process can remove portions of the heads as well, some heads may be present with the feathers. Feathers can be burned to produce heat, or processed with heat to hydrolyze the proteins. The low-value proteins from feathers can be used in pet food or animal feed.

Heads and feet that are not destined for human consumption are collected in a separate container. When these by products are to be used for human consumption they should be approved during the inspection process. Typically, feet used for human consumption are heat treated in order to remove skin and nails before packing. Heads are normally not used for human consumption, although duck tongues are consumed in some countries.

High-Risk Material

High-risk by-products include birds that have died from reasons other than slaughtering, condemned birds, and condemned parts of birds, as well as all other by-products not intended for human consumption. Solid organic material that is captured in the wastewater treatment system screens with a particle size of 6 millimeters (mm) or more should also be treated as high-risk by-products and sent for rendering. Grids used in the slaughterhouse and pre-filtering of waste streams should be designed so that these kinds of animal by-products can be recovered and sent for rendering.

Processing By-products

By-products should be collected in separate containers, which are isolated in such a way that food safety is not jeopardized. The container should be covered to prevent wild birds and animals from coming into contact with the material. The material

[18] For an example refer to the US Food and Drug Administration's (FDA) Inventory of Effective Food Contact Substances (http://www.cfsan.fda.gov/)

must be transported on a regular basis to the rendering plant in sealed containers.

At the rendering plant, the materials are chopped up and then heated under pressure (e.g. in the conventional batch dry rendering method) to kill microorganisms and remove moisture. The liquefied fat and solid protein are separated by centrifugation or pressing. The solid product can then be ground into various animal protein powders for animal feed or pet food. The effectiveness of the heat process used for rendering depends on various factors, including the holding time, the core temperature, and the particle size of the products treated in the process. The rendering process should produce final products that are free from salmonella and clostridium and contain only a limited number of enterobacteriaceae.