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Environmental, Health, and Safety Guidelines for Food and Beverage 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

These guidelines cover the processing of meat[2], vegetable, and fruit raw materials into value-added food and beverage[3] products for human consumption. Meat and poultry slaughtering and processing activities, from reception of the animals until the carcasses are ready for sale or further processing, are covered in the EHS Guidelines for Meat Processing and the EHS Guidelines for Poultry Processing. 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

[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] Meat includes beef, pig, and poultry.

[3] Includes only the manufacturing of non-fermented beverages. Beer manufacturing is addressed in the EHS Guidelines for Breweries.

1.0 Industry Specific Impacts and Management

The following section provides a summary of EHS issues associated with food and beverage processing, which occur during the operational phase, 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

Essential tools for managing impacts while optimizing water, energy, and resource use and improving working practices involve the adoption of industry-specific good-manufacturing practice, quality management systems (including ISO 9000 series, ISO 22000), risk management systems (e.g., Hazard Analysis Critical Control Points, HACCP), and environmental management standards (e.g., ISO 14000).[4]

Environmental issues in food and beverage processing facilities primarily include the following:

- Solid waste
- Wastewater
- Energy consumption
- Emissions to air

Solid Waste

Depending on the raw materials, food and beverage processing activities may generate significant volumes of organic, putrescible solid waste in the form of inedible materials and rejected products from sorting, grading and other production processes.[5] Where meat products are the raw material, solid waste generated during processing may include organic materials that have the potential to significantly impact food safety due to the proliferation of pathogenic microorganisms.[6]

Recommended measures to prevent and control solid waste generation include the following:

- Minimize inventory storage time for raw materials to reduce losses from putrefaction;
- Monitor and regulate refrigeration and cooling systems during storage and processing activities to minimize product loss, optimize energy consumption, and prevent odors;
- Consider use of enclosure techniques to minimize damage to raw materials stored outdoors;
- Monitor and optimize process yields, e.g. during manual grading or cutting activities, and encourage the most productive employees to train others in efficient processing.
- Clean, sort, and grade raw foodstuffs at an early stage (e.g. at the farm site), in order to reduce organic waste and substandard products at the processing facility;
- Contain solid waste in dry form and consider disposal through composting and / or use for soil amendment;
- Organic and non-organic debris / soil, solid organic matter, and liquid effluents, including sludge from wastewater

[4] HACCP is for the systematic identification and management of risks associated with the production and distribution of foodstuffs. ISO 22000:2005 covers requirements for a food safety management system in which an organization in the food chain demonstrates its ability to control food safety impacts to ensure that food is safe at the time of human consumption. ISO 9000 series is an international standard for the certification of manufacturing and quality management systems; ISO 14001 is an international standard for the certification of environmental management systems.

[5] For example, mushrooms have a low wastage factor (around 3 – 5 percent) whereas the wastage factor for sweet corn kernel processing is much higher (around 50-60 percent). United Nations Environment Programme (UNEP). 2004. Working Group for Cleaner Production in the Food Industry. Fact Sheet 3: Food Manufacturing Series. Food and Beverage Processing.

[6] The proportion of animal by-products in food processing activities in relation to their carcass weight ranges from approximately 8 to 16.5 percent for pig, 7 to 8 percent for poultry, and 12 percent for beef. European Union (EU) Commission. 2006. Directorate General Joint Research Council (JRC) Institute for Prospective Technological Studies. Integrated Pollution Prevention and Control Reference Document on Best Available Techniques in the Food, Drink and Milk Industries.

treatment, which remain after the implementation of waste prevention strategies should be recycled as a soil amendment (based on an assessment of potential impacts to soil and water resources) or other beneficial uses such as energy production;

- Collect and reuse rejected raw materials for manufacturing other products;[7]
- Provide leak-proof containers for collected solid and liquid waste;
- Segregating individual by-products from each other and from waste to maximize their use and minimize waste.

Wastewater

Industrial Process Wastewater

Effluent streams from food and beverage processing may have a high biochemical and chemical oxygen demand (BOD and COD) resulting from organic wastes entering into the wastewater stream, and from the use of chemicals and detergents in various processes including cleaning (discussed below). In addition, effluent may contain pathogenic bacteria, pesticide residues, suspended and dissolved solids such as fibers and soil particles, nutrients and microbes, and variable pH. The effluent load should be reduced by preventing raw materials, intermediates, product, by-product and wastes from unnecessarily entering the wastewater system, as discussed in the solid waste section above.

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 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 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. Food and beverage processing activities (e.g. washing, internal transport of raw materials using water, cooling of blanched foods, and general equipment cleansing) may consume large quantities of water.[8] In addition to the recommendations on water conservation included in the **General EHS Guidelines**, industry specific measures include the following:

[7] Secondary products may include jams and cut products, such as coleslaws; sauerkraut; orange peels for use in dietary fiber supplements; potato pulp for production of biofuel; onion material for onion oil production, fructooligosaccarides, pectic polysaccharides, and low-lignin dietary fiber; animal waste for production of animal feeds with strict recognition of biosafety considerations; and use of bones, fat, and other by-products from meat as raw material for glue, detergents, gelatin, and other materials.

[8] Water demands in meat processing are diverse and may, depending upon the specific operation, include thawing of frozen materials, continuous equipment, boot, apron and clothing washing and disinfection as well as generation of steam and process heat, and cooling processes.

- Minimize water consumed during production processes:
  - Optimize product conveying systems to reduce contact of raw material and product with water, for example by using dry instead of wet conveying systems. Optimize process line operations to avoid spills of raw materials and water, reducing the need to wastewater treatment and associated energy consumption;
  - Use dry methods, such as air classifiers, magnetic separators and vibration over sieving and screening devices, for the primary cleaning of robust raw materials with low moisture content;
  - Where feasible, use a continuous / batch steam or a dry caustic process for peeling activities, or alternatively, consider dry caustic peeling;
  - Minimize rate of make-up supply to continuously overflowing tanks, flumes etc.
  - Use taps with automatic shut-off valves and use high water pressure and optimized nozzles,
  - Use counter-current wash techniques for primary wash of raw materials;
  - Implement dry clean of equipment with scraper or broom before cleaning with water
  - Minimize wet transport (pumping) of waste
- Reuse water streams in the production processes to the maximum extent possible while avoiding water contamination or compromising food safety:
  - Separate and recirculate cooling water from process and waste water streams. Recirculate and reuse thawing water in a closed circuit provided this practice does not compromise food safety
  - Recirculate fluming water used in vegetable transfer provided this practice does not compromise food safety
  - Return condensate for use as boiler feed water. Alternative uses for condensate include as a sprinkling agent for dust suppression or in general factory wash down (e.g. cleaning the floor)
  - Where feasible, recycle low grade wash water and reusing it for the primary wash of raw materials or for wet transport
  - Explore opportunities collection and use of storm water consistent with food safety requirements
- Review process lines and operations to identify opportunities to reduce the effluent load by minimizing contact with water at every stage of the process, to avoid contamination of the water and the need for consequent treatment, including:
  - Use dry methods (e.g. vibration or air jet) to clean raw materials
  - Install grids to reduce or avoid the introduction of solid materials into the wastewater drainage system. Install trays to catch waste from trimming operations and juice / product on conveyors
  - Ensure regular integrity testing of bulk storage tanks for product and waste
  - Provide secondary containment for storage and process vessels to contain spills
  - Adopt best-practice methods for plant cleaning, which can be manual or automated Clean In Place (CIP)[9] systems, using approved chemicals and (or) detergents with minimal environmental impact and compatibility with subsequent wastewater treatment processes.

[9] Automated CIP systems reduce chemical, water, and energy consumption and facilitate rinse recovery but may not be appropriate for all applications.

Energy Consumption

Food and beverage processing activities may require high levels of thermal energy consumption in process heating, cooling, and refrigeration. In addition to the recommendations on energy conservation included in the **General EHS Guidelines**, industry specific measures include the following[10]:

- Implement operational, maintenance and housekeeping measures:
  - Insulate refrigeration room/areas and use of automatically closing doors and airlocks
  - Insulate refrigeration rooms / areas
- Optimize plant processes for energy efficiency:
  - Use Combined Heat and Power (CHP) particularly in plants which have high heat and power demand for more than 5000 hours/year
  - Reduce the size of refrigeration rooms where feasible, but still taking food safety into consideration
  - Design plant layout to reduce pumping and conveyor belt transportation distances
  - Ensure that fouling on heat transfer surfaces, for example in the sterilization process, is regularly cleaned to ensure optimum efficiency
  - Avoid refrigeration of fruits, vegetables and by-products intended for animal feed by storing outside in clean covered areas or in containers, when climate conditions and plant design allow
  - Use high temperature pre-cooling before refrigerated cooling and freezing, for example, after blanching pre-chill products by passing them cold water before freezing. This is particularly cost –effective when liquid nitrogen freezing is used.
- Recover energy from thermal processes where possible. Heat recovery opportunities may include, for example[11]:
  - Recovering heat from ovens, dryers, evaporators, pasteurizers and sterilizers.
  - Maximizing regeneration efficiency in plate heat exchanger pasteurizers (regeneration efficiency up to 94 percent is possible)
  - Recovering heat from condensed steam for blanching and steam peeling operations before it is discharged
  - Using multi-effect evaporators in large scale evaporator applications.

Emissions to Air

The main air pollutants from food and beverage processing operations consist of particulate matter (PM) and odor. PM may arise from solids handling, solid reduction and drying. Odor may be released by thermal processing steps such as steam peeling, blanching and dehydrating and by microbial action in stored solid waste. In meat processing, odor may also be emitted from cooking and smoking activities. [12]

Management of emissions to air from combustion sources for electricity generation is addressed in the **General EHS Guidelines**.

Particulate Matter

Recommended techniques to prevent and control particulate matter emissions include[13]:

- Cover skips and vessels, and stockpiles, especially outdoors;
- Enclose silos and containers used for bulk storage of powders and fine materials;

[10] EC (2006)

[11] EC (2006)
[12] EC (2006)
[13] Based on Environment Agency. 2003. Environment and Heritage Service. Guidance for the Food and Drink Sector. Sector Guidance Note IPPC S6.20.

- Where enclosure is not feasible, use sprays, windbreaks, sweeping, sprinkling, and other stockpile management techniques to suppress dust ;
- Use closed conveyors equipped with filters to clean transport air prior to release;
- Use cyclones and, if necessary, and fabric filters to remove dust from exhaust air;
- Remove particulate matter from the gas stream using dry cyclones, venturi scrubbers, electrostatic precipitators (ESPs) or dry filter systems, as necessary.

Odor

Recommended techniques to prevent and control point source odor emissions include:

- Use exhaust stack heights that are consistent with Good Engineering Practice (GEP) as described in the **General EHS Guidelines**;
- If the plant is in close proximity to residential areas consider the use of wet scrubbers to remove odor emissions. Wet scrubbers are used to remove odors with a high affinity to water, such as ammonia emitted during the rendering process; and
- During the procurement of air emission systems for smoking units, it is best practice to install integrated systems that combine air cleaning, incineration, and heat recovery. Such systems are highly effective with regard to the reduction of odor emissions, production / energy efficiency;
- Recirculate exhaust gas from frying and other cooking operations to the burner.

Recommended techniques to prevent and control fugitive emissions of odor include:

- Minimize storage duration for solid waste to avoid putrefaction;
- Operate facilities under partial vacuum to prevent fugitive odor emission;
- Regular inspection of chilling and freezing equipment to monitor loss of refrigerants.

1.2 Occupational Health and Safety

Occupational health and safety issues associated with the operation of food and beverage processing during the construction and decommissioning phases are discussed in the **General EHS Guidelines**. Hazards during the operational phase include the following:

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

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, such as 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 are presented below.

- Maintain walking and working surfaces clean and dry by preventing spillages through equipment design and operation, providing workers with anti slip footwear where still necessary;

- Control of occupational risks at their source through implementation of engineering controls. Address residual risks based on hygiene and safety surveys and by providing workers with training in the proper use and maintenance of safety devises (including the proper use of machine safety devises) and personal protective equipment (PPE), such as hearing protection, and gloves, aprons etc. to avoid cuts, amputations, and other sharp instrument traumas;
- Ensure that the process layout reduces opportunities for process activities to cross paths, thus avoiding collisions and falls;
- Demarcate transport corridors and working areas and ensure the proper placement of handrails on platforms, ladders, and stairs;
- Prevent ingress of water;
- Ground all electrical equipment and installations;
- Prepare emergency plans and train staff for emergency situations.

Lifting, Repetitive Work, and Work Posture Injuries

Food and beverage processing activities may include a variety of situations in which workers can be exposed to lifting, carrying, repetitive work, and work-posture injuries. Such injuries may result from heavy manual lifting and repetitive work, including the operation of slicing and vacuum-packing machines and poor working postures caused by inadequate workstation and process activity design. Recommended management approaches to reduce these injuries are discussed in the **General EHS Guidelines**.

Exposure to Noise

A variety of operations in food and beverage processing units generate substantial noise levels, for example the canning plant, bottling machines, conveyors and blanching applications. Recommended measures to prevent and control worker exposure to noise are discussed in the **General EHS Guidelines**.

Biological Hazards

Exposure to biological and microbiological agents may be associated with inhalation and ingestion of dust and aerosols. Dust from the ingredients used in food and beverage processing and high levels of humidity may cause skin irritation or other allergic reactions.

Recommendations for the prevention and control of exposures to biological hazards specific to food and beverage processing include the following:

- Avoid dust- and aerosol-generating activities (such as use of compressed air or high-pressure water for cleaning) and, where they cannot be avoided, provide proper ventilation of enclosed or semi-enclosed areas to reduce or eliminate exposure to dust and aerosols;
- Install exhaust ventilation equipped with filters, cyclones, etc., at sources of dust;
- Provide workers with PPE that is appropriate for the process activity, e.g. masks and gloves;
- Ensure physical segregation of work and welfare facilities to maintain worker personal hygiene.

Chemical Hazards

Exposure to chemicals (including gases and vapors) typically involves chemical-handling activities related to cleaning operations, disinfection of process areas and use of preservatives in long-term food storage, 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**.

Food and beverage processing sites usually have large refrigeration systems, which often use ammonia as a primary refrigerant, and may have secondary refrigerants such as glycols or brines. Ammonia is a toxic substance and can form explosive mixtures with air. Guidance on the safe use of ammonia and other refrigerants is readily available from professional refrigeration institution[14] and should be considered.

Heat and Cold

Food and beverage processing may create changing temperature conditions due to activities such as heat treatment, chilling and freezing. Workers may be exposed to heat from steam peeling, pasteurization, and canning processes and exposed to low temperatures in refrigerated areas / rooms. Irradiation dosing to extend the shelf-life of fruits and vegetables should be monitored for occupational exposure to radiation. Recommended measures to prevent and control exposure to heat, cold, and radiation are discussed in the **General EHS Guidelines**.

1.3 Community Health and Safety

Community health and safety impacts during the construction and decommissioning of food and beverage processing facilities are common to those of most industrial facilities and are discussed in the **General EHS Guidelines.** Industry-specific issues with the potential to impact the community are those associated with hygiene and food safety.

Process, Equipment, and Staff Hygiene

The design of the processing plant should be organized to ensure that products move from "dirty" to "clean" areas to avoid recontamination. Employee movement within the facility should be opposite to the flow direction of products (i.e. from "clean" towards "dirty" zones). Cleaning activities during processing will depend on the particular production and processing systems. Daily cleaning and disinfection should comprise:

- Ensuring proper equipment clearance for cleaning
- Removal of solid waste
- Pre-rinsing with water
- Application of detergent(s)
- Rinsing
- Disinfection
- Post rinsing
- Post treatment

Staff should be trained in food safety issues and should follow established procedures for hand washing, working attire (clothes, shoes, gloves and hair coverage), and how to handle injuries and diseases.

Food Safety Impacts and Management

A food product recall caused by contaminated or adulterated food products can devastate 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 those numbers. With a robust food safety program in place, a company can protect itself from product adulteration, contamination, and the impacts of food recalls.

Food and beverage processing should therefore be performed according to internationally recognized food safety standards consistent with the principles and practices of Hazard Analysis Critical Control Points (HACCP)[15]; and Codex Alimentarius[16].

[14] See the Institute of Refrigeration (IOR) for guidelines on the safe design of ammonia and other refrigeration systems, as well as safe handling of ammonia. Also, the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE).

[15] International Organization for Standardization (ISO) (2005)
[16] Food and Agriculture Organization of the United Nations (FAO) and World Health Organization (WHO) (1962-2005)

The Codex Alimentarius provides Current Official Standards for a range of specific products from the food and beverage processing sector including canned, quick frozen, and whole fresh food products. In addition the Codex Alimentarius provides Current Official Standards for general and specific manufacturing steps in the production process, for example General Principles of Food Hygiene, Recommended International Code of Hygienic Practice for Canned Food and Beverage Products and the Recommended International Code of Practice for the Packaging and Transport of Tropical Fresh Food and beverages. In general, recommended food safety principles include:

- Strictly maintain cold chains and other preservation processes;
- Full institutionalization of HACCP prerequisites as well as Standard Operational Procedures, including:
  - Sanitation
  - Good Manufacturing Practice (GMP)
  - Pest control
  - Chemical control
  - Allergen control
  - Staff hygiene and education
  - Customer complaints mechanism
  - Traceability and reuse

2.0 Performance Indicators and Monitoring

2.1 Environment

Emissions and Effluent Guidelines

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 requirements 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 from food processing activities are principally associated with particulate matter (PM) and odor. PM and odor emissions from point sources such as ventilation exhaust systems and smoking units should be released through GEP-designed stacks. Smoking unit emissions of PM should typically not exceed 50 mg/Nm3. 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 Thermal Power EHS Guidelines. Guidance on ambient considerations based on the total load of emissions is provided in the **General EHS Guidelines**.

Table 1. Effluent levels for food and beverage 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

Table 2: Waste Generation in the Food and Beverage Processing Sector

Solid waste produced per tonne of product	Unit	Industry Benchmark
Maize	Kg	40
Peas	Kg	40
Potatoes	Kg	40
Broccoli	Kg	200
Carrots	Kg	200
Strawberries	Kg	60
Apples	Kg	90
Peaches	Kg	180

Resource Use and Waste Generation

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.

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),[17] the Pocket Guide to Chemical Hazards published by the United States National Institute for Occupational Health and Safety (NIOSH),[18] Permissible Exposure Limits (PELs) published by the Occupational Safety and Health Administration of the United States (OSHA),[19] Indicative Occupational Exposure Limit Values published by European Union member states,[20] 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)[21].

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[22] as part of an occupational health and safety monitoring program.

Table 3: Resource and Energy Consumption in Food and Beverage Processing

Outputs per unit of product	Unit	Industry Benchmark
Electricity Consumption [a]	kWh$_e$/t frozen vegetables	
Sorting of vegetables (carrots)		8
Caustic peeling of vegetables		2
Steam peeling of vegetables		3.5
Washing of vegetables (carrots)		2.5
Mechanical processing prior to freezing (diced carrots)		2.5
Drum blanching in deep freezing of vegetables		0.5 – 1.3
Countercurrent water cooling of vegetable		0.5 – 1.3
Belt blancher with water cooler		2 - 9
Belt blancher with air cooling		7 - 30
Water Consumption	m^3/ton	
Canned fruit		2.5-4.0
Canned vegetables		3.5-6.0
Frozen vegetables		5.0 – 8.5
Fruit juices		6.5
Jams		6.0
Potato processing: [b] Range Well managed		4.5 – 9.0 5.1
Cooked Ham [b]		4 - 18
Cured Ham [b]		2 - 20
Sausages, ham, bacon, etc. [b]		10 - 20

NOTES
[a] Tables 3.31 – 3.39. European Commission. IPPC. Reference Document on BAT in the Food Drink and Milk Industries. P. 169 - 177.
[b] Table 3.20: Water consumption for some processes in the food and beverage sector. European Commission. IPPC. Reference Document on BAT in the Food Drink and Milk Industries. P. 162.

[17] Available at: http://www.acgih.org/TLV/ and http://www.acgih.org/store/
[18] Available at: http://www.cdc.gov/niosh/npg/
[19] Available at: http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=9992
[20] Available at: http://europe.osha.eu.int/good_practice/risks/ds/oel/
[21] Available at: http://www.bls.gov/iif/ and http://www.hse.gov.uk/statistics/index.htm

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

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**.

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Annex A: General Description of Industry Activities

The food and beverage processing sector covers a wide range of products. Many process steps are common to the manufacture activities of different products. Food and beverage processing plants vary in size and location, and are ideally located in close proximity to fresh water resources. Plant operation is often seasonal reflecting the harvesting of the raw materials, however product lines are unaffected by seasonal variations and take place throughout the year.

Figure 1.0 summarizes the major processes for most food and beverage products from fruit and vegetable sources, though the actual process flow will vary depending on the product and the plant set-up. Figure 2.0 summarizes the major steps for processing of meat products, specifically applicable to cooked ham manufacturing.

Fruit and Vegetable Processing[23]

Fruit and vegetable production begins with the preparation of the raw food and beverages thorough a variety of methods including cleaning, trimming and peeling to reduce the product to a uniform size before cooking, canning, drying or freezing, as well as pulping and filtration to make soft drinks. The process culminates with the packaging and transport of the final product.

There are two major sub-sectors including fresh packed products and processed products. Processed products involve other unit operations such as cooking, evaporating and drying to provide product diversity and increase shelf-life. Common examples of processed fruit products are canned peaches and pears, dried fruits, jams and jellies, and fruit purees for use in the food industry. Examples of processed vegetable products include canned beans and frozen peas, as well as vacuum packed beetroot. Typical examples of soft drinks are food and beverage juices and concentrated fruit extracts for dilution with water.

Receipt of Raw Materials

Raw materials are typically delivered in bulk on trucks and are off-loaded directly for processing or for storage (e. g. in silos). Other solid material ingredients may be delivered in bags on pallets. Liquid raw materials and ingredients may be transported in bulk tankers and pumped to storage tanks or delivered in containers on pallets. Solid raw materials are conveyed by belts and elevators.

Primary Grading / Screening

This process stage often covers grading and sorting but its main objective is the assessment of the overall quality of the food using a number of criteria. Solid raw materials should preferably be sorted and graded on the farm in order to minimize the quantity of waste material, organic and non-organic debris, and off-specification product that is transported to the processing plant.

Intermediary Storage

Storage of food and beverages can be required at various stages of the manufacturing process and the storage conditions will be dependent on the product. In general the parameters to be controlled for storage include humidity, temperature, atmospheric conditions, and hygiene.

Primary Cleaning

Primary cleaning removes and separates off-specification material, organic and non-organic debris, metals, and pesticide residues, among other contaminants, from the raw material prior

[23] This section briefly describes the major manufacturing steps in the food and beverage processing sector and has been adapted from text in the British Environment Agency's Guidance for the Food and Drink Sector, Environmental Agency (2003).

to further processing. The method used depends on the type of materials to be removed and may include the use of water although dry methods are favored for water conservations and wastewater prevention reasons.

When water is used, the raw materials may be sprayed, and then immersed for organic and non-organic debris removal using brushes, shaking, and stirring. The spray water may be chlorinated and detergents may be added to the wash water, which may also be heated to increase cleaning efficiency.

Sorting, Grading and Inspection

The washed material may be sorted, graded and inspected prior to further processing to ensure uniformity. Sorting is the separation of materials into categories and the main factors are size, shape, weight, and color. Size sorting is typically done using screens and sieves. Shape sorting may be done manually or mechanically and weight sorting is typically used for valuable material such as tropical fruits. Color sorting is performed manually or by use of computer technology whereby the material passes the control point on conveyor belts at high rates and rejected items are blasted away using compressed air.

Product Preparation

Most raw materials have parts that are inedible and need to be removed in order to make the raw materials uniform and suitable for further processing. In the product preparation phase, the sorted and graded materials are subjected to a variety of processes including trimming (manual or by rotating knives), peeling, and size reduction, as well as mixing, forming, separation and concentration of the food components. Various peeling methods are available including flash steam, flame, knife, abrasion, and caustic.

Product Processing

Food and beverages can be processed as a single operation or in a combination of several operations. The most common processing methods are through heat application and heat removal. The heat application methods include blanching, pasteurization, heat sterilization, evaporation, and dehydration including heat processing by baking or cooking in oils. Heat removal processing includes chilling, controlled or modified storage and packaging (to reduce the rate of respiration), freezing, and freeze-drying. Other preservation and processing methods include the use of sodium chloride and sugar, food additives, and irradiation.

Packaging

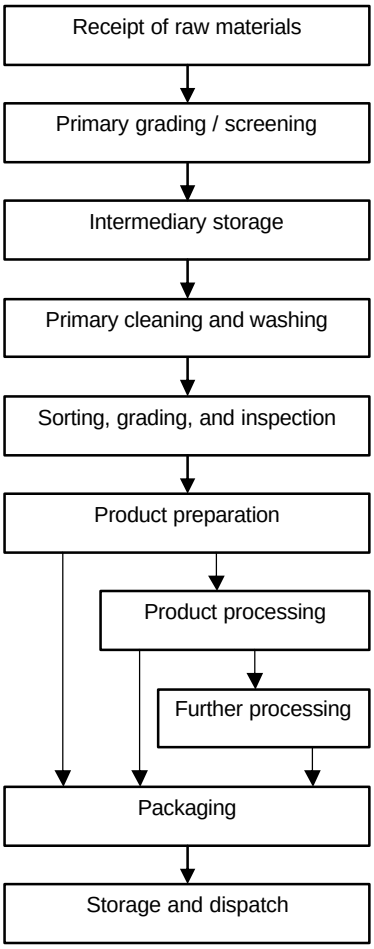
Products are packed to provide containment, protection, communication, and convenience. Packaging materials typically used in the food and beverage processing sector include flexible polymer materials (e.g. single films and laminates), paper, cardboard and corrugated cardboard, glass, cans, and wooden or polymer boxes.

Meat Processing

If beef, poultry and pork are received frozen, processing involves thawing after arrival to the processing plant using air, water showers, or water immersion techniques. The first two techniques generally require less water consumption than immersion thawing methods. Thawed meat is then cut into retail portions using electric cutting systems. Excess fat and bones can be reprocessed into commercial products such as gelatin, glues, etc. Fresh cuts are refrigerated prior to further processing into preserved meat products, such as sausage, ham, and bacon. Cuts may be ground down and reconstituted into different product shapes using various processing machinery. Preservation techniques include heat, such as cooking (e.g. in water bath, shower, steam, and hot air ovens) and smoking,

dehydration, fermentation, brining, curing, pickling, and canning. These activities are performed to increase the shelf life of the product. Brining, curing and pickling typically involve injection of a saline solution, followed by a massaging process to ensure mixing of ingredients and product additives. Meats are then inserted into casings to define their shape and size.

Figure A.1: General Process for Food and Beverage Processing Operations



Source: Adapted from UNEP (2004)

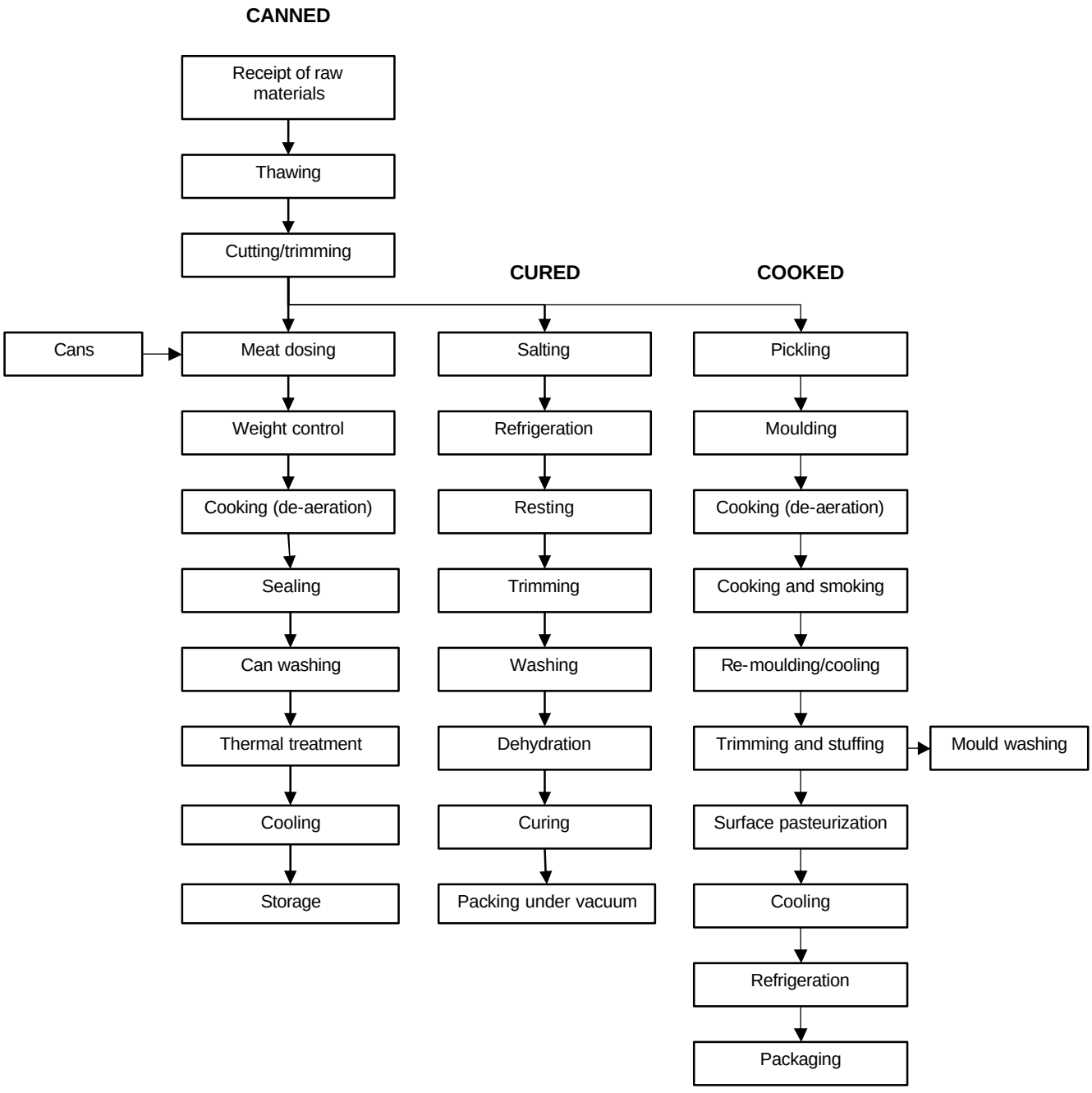



Figure A.2: Canned Meat Production (Including Cured and Cooked Meat)