Environmental, Health, and Safety Guidelines for Fish 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 Fish Processing include information relevant to fish processing facilities, including the post-harvest processing of fish, crustaceans, gastropods, cephalopods, and bivalves (hereafter referred to as "fish products"), originating from sea or freshwater catch or from farming operations in fresh or salt water. This document does not cover primary fishery activities[2], or the production of fish in aquaculture. The latter is covered in the EHS Guidelines for Aquaculture. 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] Overexploitation of fish stocks is a significant global issue. It is not addressed in this document, however, before a fish processing plant is established, the raw material supply situation should be considered, particularly with respect to the sustainability of the resources that will be the main input. Annex B provides a brief discussion of sustainable fishing principles and good practices.

1.0 Industry-Specific Impacts and Management

The following section provides a summary of EHS issues associated with fish 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

Environmental issues in fish processing projects primarily include the following:

- Solid waste and by-products
- Wastewater
- Water consumption and management
- Emissions to air and energy consumption

Solid Waste and By-products

Fish processing activities generate potentially large quantities of organic waste and by-products from inedible fish parts and endoskeleton shell parts from the crustacean peeling process. The actual proportion depends on the edible fraction of each species being processed. Fish waste is a rich source of essential amino acids, and all inedible fish waste should be converted into by-products (e.g. fishmeal or silage).

Recommended prevention and control techniques to reduce the amount of solid waste include the following:

- Encourage fishing vessels to reduce the capture of "non-target species" to reduce the amount of waste in the by-product line;
- Design fish processing operations to enable the recovery of waste streams in accordance with Good Manufacturing Practice (GMP) and Hazard Analysis and Critical Control Points (HACCP) food safety programs;
- Where feasible, reprocess waste into commercial by-products.[3] Off-cuts and wastes should be recovered and taken to the by-product facility in time to prevent product deterioration. Internal organs, blood, endoskeleton parts, and any by-catch can be reprocessed into fish meal and fish oil. In cases in which reprocessing for fish meal or oil production is not an option, consider the lower-cost option of production of fish silage;[4]
- Wastewater from fish meal plants often contains high levels of proteins and oils, which makes the recovery financially feasible. Consequently, most fish meal factories now have stick-water evaporation plants, where the liquid fraction after the press is evaporated and the proteins recovered.

Sludge Treatment and Disposal

The following measures reduce the volume of disposable waste generated from waste and wastewater treatment processes:

- Sludge dewatering on sludge drying beds for small-scale factories and dewatering using belt presses and decanter centrifuges for medium and large-scale factories;
- Land application (as fertilizer) of wastes from on-site wastewater treatment in agricultural production;
- Pathogens can be destroyed during controlled anaerobic digestion (biogas) or aerobic treatment (composting);
- Disposal of wastes in landfill if not used for biogas production or combustion.

[3] Processing plants often outsource by-product processing to specialized companies that further process the waste into a dedicated fish meal product or produce other feed products for animals (e.g., mink fodder or fish silage).
[4] Fish silage is a product derived from the liquefaction of whole fish or parts of fish through the action of enzymes in the fish and additional acids. Silage can be used for applications similar to those of fishmeal.

Wastewater

Industrial Process Wastewater

Fish processing requires large amounts of water, primarily for washing and cleaning purposes, but also as media for storage and refrigeration of fish products before and during processing. In addition, water is an important lubricant and transport medium in the various handling and processing steps of bulk fish processing. Fish processing wastewater has a high organic content, and subsequently a high biochemical oxygen demand (BOD), because of the presence of blood, tissue, and dissolved protein. It also typically has a high content of nitrogen (especially if blood is present) and phosphorus.

Detergents and disinfectants may also be present in the wastewater stream after application during facility cleaning activities. A range of chemicals is typically used for cleaning, including acid, alkaline, and neutral detergents, as well as disinfectants. The disinfectants commonly used include chlorine compounds, hydrogen peroxide, and formaldehyde. Other compounds also may be used for select activities (e.g. disinfection of fishmeal processing equipment).

The following recommended methods may be used to enhance the removal of solid waste prior to entry into the wastewater stream:

- Collect internal organs and other organic materials separately, for processing into by-products according to the recommendations for solid waste management above;
- Design the production line so that cooling water, storm water, and process effluents can be kept separate to permit appropriate treatment options;
- Conduct a dry precleaning of equipment and production areas before wet cleaning (e.g. rubber scraping of work tables and plant floor before hosing);
- Establish procedures for the dry removal of offal, using dry vacuum systems where feasible;
- Fit and use floor drains and collection channels with grids and screens, and / or traps, to reduce the amount of solids entering the wastewater;
- Equip the outlets of wastewater channels with screens and fat traps to recover and reduce the concentration of coarse material and fat in the combined wastewater stream;
- Avoid submersion of open products (e.g. fillets) in water, as soluble protein may leak out and enter the wastewater effluent stream;
- Ensure that tanks are effectively bunded and provide overfilling protection on bulk storage tanks;[5]
- Choose cleaning agents that do not have adverse impacts on the environment in general, or on wastewater treatment processes and sludge quality for agricultural application. Optimize their use through correct dosage and application. Avoid cleaners that contain active chlorine or prohibited, banned, or restricted chemicals.

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 or settling ponds; 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 contain and neutralize nuisance odors.

[5] Irish EPA (1996).

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

- Use enough ice to secure product quality and match ice production to requirements;
- Improve efficiency by concentrating activities or certain processes on fewer days per week, if the facility or process is not operated at full capacity;
- Improve the process lay out to facilitate cleaning and eliminate wet transport of wastes, thereby minimizing water consumption;
- Dry clean with a scraper or broom before cleaning with water. Use efficient cleaning procedures as mentioned in the section "Industrial Process Wastewater" section above;
- Avoid recycling contact process water. Recycling of cooling water, rinse water, and wastewater for some specific noncritical applications may be feasible as long as hygiene considerations are observed.

Emissions to Air

Odor is often the most significant form of air pollution in fish processing. Major sources include storage sites for processing waste, cooking by-products during fish meal production, fish drying processes, and odor emitted during filling and emptying of bulk tanks and silos. Fish quality may deteriorate under the anaerobic conditions found in onboard storage on fishing vessels and in the raw material silos of fish processing facilities. This deterioration causes the formation of odorous compounds such as ammonia, mercaptans, and hydrogen sulfide gas.

Odor Prevention

The following recommended measures should be undertaken to prevent the generation of odor emissions:

- Avoid processing batches of raw material that are of considerably lower than average quality; this will reduce the odor components;
- Reduce the stock of raw materials, waste, and by-products and store this stock for short periods of time only in a cold, closed, well-ventilated place;
- Seal by-products in covered, leak-proof containers;
- Keep all working and storage areas clean and remove waste products immediately from the production line;
- Empty and clean fat traps on a regular basis;
- Cover all transfer systems, wastewater canals, and waste-water treatment facilities to reduce the escape of foul odors.

Odor Control

The recommended odor control techniques in fish processing include the following:

- Install condensers on all appropriate process equipment (e.g., cookers and evaporators) to treat air emissions for odor, including sulfides and mercaptans;

- Install biofilters as the final method of air treatment and acid scrubbers for ammonia removal ahead of the biofilter;
- Install cyclones and filtration (fabric filters normally are adequate) to remove particulates;
- Reduce fugitive odor sources from open doors, open windows, and general room ventilation through the use of negative pressure-controlled ventilation systems.

Exhaust Gases

Exhaust gas emissions (carbon dioxide [CO_2], nitrogen oxides [NO_X] and carbon monoxide [CO]) in the fish processing sector result from the combustion of gas and fuel oil or diesel in turbines, boilers, compressors and other engines for power and heat generation. Guidance for the management of small combustion source emissions with a capacity of up to 50 megawatt thermal (MWth), including air emission standards for exhaust emissions, is provided in the **General EHS Guidelines**. For combustion source emissions with a capacity of greater than 50 MWth refer to the **EHS Guidelines for Thermal Power**.

Particulates

Particulate emissions are generally not a serious problem in the fish processing sector. The primary process source is the fish smoking process, which is relevant if the gas from this process is not treated effectively in the cleaning process. The recommended control techniques for particulate emissions during fish smoking include the following:

- Consider use of integrated smoking units with incineration and heat recovery;
- Clean the kiln exhaust using filters, incinerators, and / or wet scrubbers;
- Ensure that smoke from the fish processing process is emitted from a stack of sufficient height;
- Transfer air emissions to the boiler house for use as the supply air for the combustion process. This method requires that the boiler house be located parallel to the emission sources and that the capacity (supply air volume) matches the need for combustion process air.

Energy Consumption and Management

Fish processing facilities use energy to produce hot water, steam, and electricity for process and cleaning applications. Electricity is used for electrical equipment, air conditioning, cooling, freezing, and ice production. General recommendations to obtain energy efficiency through reduced heat loss, improved cooling efficiency, heat recovery, and increased utilization of energy efficient equipment are discussed in the **General EHS Guidelines**.

1.2 Occupational Health and Safety

Occupational health and safety issues that occur during the operational phase of fish processing projects primarily include the following:

- Physical hazards
- Biological hazards
- Lifting, carrying, and repetitive work injuries
- Exposure to chemicals
- Exposure to heat and cold
- Confined space
- Exposure to noise and vibrations

Physical hazards

Causes of accidents in fish processing operations include falls caused by slippery floors and stairs; equipment safety issues associated with filleting knives and other sharp tools; and cuts from sharp edges on process equipment (e.g. stainless steel basins). In addition to general recommendations included in the **General EHS Guidelines**, the following are sector-specific recommendations for accident prevention:

- Provide workers with training in the proper use and maintenance of cutting equipment (including the use of machine safety devices, handling / storage and upkeep of knives, and emergency shutoff procedures) and personal protective equipment (e.g. metallic gloves and leather aprons for cutting activities, and protective footwear with rubber soles);
- Design the plant so that different activities and the flow of processes do not cross. In addition, clearly demarcate transport corridors and working areas; ensure that handrails are provided on platforms, ladders, and stairs; and use non-slip floor surfacing;
- Use completely enclosed conveyer belts to protect hands and fingers.

Biological hazards

Workers involved in manual gutting, skinning, and general handling of fish and shellfish may develop infections and or allergic reactions resulting from exposure to the fish itself, or bacteria on the fish. Water spraying processes may result in the formation of aerosols with bacteria that can be inhaled. In addition to general recommendations included in the **General EHS Guidelines**, the following are sector-specific recommendations to prevent exposure to bacteria:

- Consider work rotation strategies to reduce occupational exposure to allergens;
- Wear gloves to protect hands from exposure to products, especially when working with seafood that is known to create allergic reactions (e.g. scallops and shrimp). Provide food-approved shielding hand creams;
- Avoid aerosol-generating activities (e.g. use of compressed air or high-pressure water for cleaning). Where these activities cannot be avoided, provide proper ventilation of enclosed or semi-enclosed areas to reduce or eliminate exposure to aerosols, in addition to adequate distances between workers and aerosol-generating activities;
- Ensure physical segregation of work and personal facilities to maintain worker personal hygiene.

Lifting, Carrying, and Repetitive Work

Fish processing activities may include a variety of situations in which workers can be exposed to lifting, carrying, repetitive work, and work posture injuries. Many of the manual operations in less mechanized fish processing plants include lifting heavy boxes of raw materials. Repetitive strain injuries may result from manual filleting and trimming operations. Poor working postures may result from the design of the workspace, furniture, machinery, and tools. Recommended prevention and control measures for these activities are discussed in the **General EHS Guidelines**.

Chemicals

Exposure to chemicals (including gases and vapors) includes handling chemicals such as chlorine, lye, and acids that are related to cleaning operations and disinfection in process areas. In fish smoking facilities, workers could be exposed to smoke particles that contains potential or confirmed carcinogens such as polycyclic aromatic hydrocarbons (PAHs).

Recommendations to prevent and control exposure to chemicals are presented in the **General EHS Guidelines**. Additional, industry-specific recommendations include:

- Avoid locating smoking kilns in the same rooms as processing workers. Chimney exhaust systems should ensure that smoke is not entering the processing factory. Respiratory protection should be used when cleaning smoke ovens;
- Ensure that employees handling concentrated lye, acid, and chlorine wear protective clothing and eyewear.

Heat and Cold

Exposure to extreme heat and cold is common because fish processing is often conducted in air-conditioned plants under low temperature, even in tropical locations. Improper work clothes in combination with stationary work locations can result, or be an additional factor, in respiratory and musculoskeletal ailments.

Recommendations for the management of exposure to heat and cold include the following:

- Set the temperature in air-conditioned processing facilities, where stationary manual work is conducted, at a level that is appropriate according to temperature stress management procedures as noted in the **General EHS Guidelines**. Products awaiting the next processing step can be kept chilled without lowering the ambient temperature through proper use of ice, slush-ice, or water-ice mixtures;
- Equip cold stores and chill stores with strip curtains to avoid extensive drafts when doors are open. Ensure freezers can be opened from the inside;
- Design air-conditioning systems for processing facilities in conjunction with strip curtain placement to minimize drafts;
- Provide protective clothing in cold environments (e.g. refrigerated storage rooms). Process workers should always be equipped with proper working garments, including dry boots;
- Reduce movement of processing workers between different temperature zones (e.g. when packing frozen products).

Confined Space

Occupational health and safety impacts associated with confined spaces in fish processing operations (e.g. storage areas, boat holds) are common to most industries, and their prevention and control are discussed in the **General EHS Guidelines**.

Noise and Vibrations

Noise and vibration exposure may result from proximity to noisy machinery (e.g. compressors, automatic packing machinery, condensers, ventilation units, and pressurized air). Recommendations for noise management are discussed in the **General EHS Guidelines**.

1.3 Community Health and Safety

Community health and safety impacts during the planning and operation phases of fish processing projects are similar to those of most industrial facilities, and are discussed in the **General EHS Guidelines.**

During the planning phase, the facility should be located at an appropriate distance from neighbors and access roads should be assessed for suitable transport use. Proximity to neighbors is an important issue, especially for the management of odor and waste issues in fish processing operations.

Community health and safety impacts during the operation phase are common to most industry sectors, including those related to noise and traffic safety from the transport of raw materials and finished product. These impacts are discussed in the **General EHS Guidelines**. Industry-specific issues that can impact the community or the public at large may include those associated with the potential presence of pathogens or microbial contaminants as well as other chemical or physical effects from processed fish.

Food Safety Impacts and Management

A food product recall brought about because of contaminated or adulterated food products found in commerce that are attributable to a specific company can damage a viable

business. If a company can trace its products, then recall is a matter of removing all foods associated with specific lot numbers. With a robust food safety program in place, a company can protect itself from product adulteration, contamination, and the impacts of food recalls.

Fish processing should therefore be performed according to internationally recognized food safety standards consistent with the principles and practice of HACCP[6] and *Codex Alimentaria*.[7] Recommended food safety principles include the following:

- Respect "clean" and "dirty" zoning. Design in accordance with veterinary rules (e.g. surfaces are easy to clean and desterilize knives);
- Improve the cooling chain;
- Facilitate tracing parts of processed product;
- Comply with veterinary regulation and precautions for waste and by-products;
- Full institutionalization of HACCP prerequisites including:
  - Sanitation
  - Good Management Practices (GMPs)
  - Implement integrated pest and vector management programs and maximize pest and vector control through mechanical means(e.g. traps), and use mesh on doors and windows to reduce the need for chemical pest and vector control
  - Chemical control
  - Allergen control
  - Customer complaints mechanism
  - Traceability and recall

2.0 Performance Indicators and Monitoring

2.1 Environment

Emissions and Effluent Guidelines

Tables 1 and 2 present emission and 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 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 guidelines are applicable to process emissions. Combustion source emissions guidelines associated with steam- and power-generation activities from sources with a capacity equal to or lower than 50 MWth are addressed in the **General EHS Guidelines** with larger power source emissions addressed in the **EHS Guidelines for Thermal Power**. Guidance on ambient considerations based on the total load of emissions is provided in the **General EHS Guidelines**.

[6] ISO (2005).
[7] FAO and WHO (1962–2005).

Table 1. Effluent levels for fish 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. Air emission levels for fish processing.

Pollutants	Unit	Guideline Value
Ammonia	mg/m^3	1
Amines and amides	mg/m^3	5
Hydrogen sulfide, sulfides, and mercaptans	mg/m^3	2

Resource Use

Table 3 provides examples of energy and water consumption indicators for various aspects of fish processing. Industry benchmark values are provided for comparative purposes only and individual projects should target continual improvement in these areas.

Table 3. Energy and water consumption for common fish production processes

Output per unit of product	Unit	Energy consumption per ton of raw material
Processing of shrimps	MJ	350
Freezing (contact freezer)	MJ	328
Freezer (blast freezer)	MJ	350
Fillet production	MJ	18
Fish-meal production	MJ	2300
Outputs per unit of product	**Units**	**Water consumption per ton raw materials[a]**
Whitefish	m^3/t	5–11
Herring filleting	m^3/t	5–8
Mackerel filleting	m^3/t	5–8

[a] UNEP: Cleaner Production: Fish Processing
http://www.agrifood-forum.net/publications/guide/f_chp0.pdf

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),[8] the Pocket Guide to Chemical Hazards published by the United States National Institute for Occupational Health and Safety (NIOSH),[9] Permissible Exposure Limits (PELs) published by the Occupational Safety and Health Administration of the United States (OSHA),[10] Indicative Occupational Exposure Limit Values published by European Union member states,[11] 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)12.

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[13] 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**.

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

[13] Accredited professionals may include certified industrial hygienists, registered occupational hygienists, or certified safety professionals or their equivalent.

3.0 References

BLS (US Bureau of Labor Statistics). 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/oshwc/osh/os/ostb1479.pdf

BLS (US Bureau of Labor Statistics). 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

DEFRA (Department for Environment, Food and Rural Affairs). Process Guidance Note 6/19 (05) Secretary of State's Guidance for Fish-Meal and Fish-Oil Processes. Scotland: DEFRA.

EC (European Commission). 1996. Council Directive 96/61/EC of 24 September 1996 concerning integrated pollution prevention and control (IPPC). 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

EC (European Commission). 2005. Integrated Pollution Prevention and Control, Draft Reference Document on Best Available Techniques in the Food, Drink and Milk Industries. BREF finalized. Dated January 2006. p vii Typical FDM waste water quality after treatment – the emission levels given are indicators of the emission levels that would be achieved with those techniques normally considered to represent BAT.

EC (European Commission). 2006. Integrated Pollution Prevention and Control, Draft Reference Document on Best Available Techniques in the Food, Drink and Milk Industries. BREF finalized. Dated January 2006. EC. Available at http://eippcb.jrc.es/pages/FActivities.htm

FAO and WHO (Food and Agriculture Organization and World Health Organization).1962–2005. *Codex Alimentaris* is an important link of information on product origin tracking for food safety, input/output indicators for monitoring, including food/feed conversion efficiencies, etc. Maximum Residues Limits for Pesticides in Food. Geneva: FAO and WHO. Available at http://www.codexalimentarius.net/web/index_en.jsp

HSC (Health and Safety Commission). 2005a. United Kingdom. Statistics of Fatal Injuries 2004/05. Fatal injuries to workers in manufacturing (p.7). London: National Statistics. Available at http://www.hse.gov.uk/statistics/overall/fatl0405.pdf

HSC (Health and Safety Commission). 2005b. 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

India EPA (Environmental Protection Agency). 1998. Liquid Effluent Standards – Category: 52.0 Slaughter House, Meat & Sea Food industry. EPA Notification S.O. 64(E), dt. January 18, 1998. Indian EPA. Available at http://www.cpcb.nic.in/standard52.htm

Irish EPA (Environmental Protection Agency). 1996. BATNEEC Guidance Note, Class 7.5, Fish-meal and Fish-oil (Draft 3). Ireland: Irish EPA. Available at http://www.epa.ie/Licensing/IPPCLicensing/BATNEECGuidanceNotes/FileUpload,561,en.DOC

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

Nordic Council of Ministers. 1997. BAT Best Available Technology in the Fishing Industry, TemaNord 1997:579, Copenhagen: Nordic Council of Ministers.

Thailand MOSTE (Ministry of Science, Technology and Environment).1996. Industrial Effluent Standard. Notification by 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). MOSTE. Available at http://www.pcd.go.th/info_serv/en_reg_std_water04.html#s1

World Bank Group. International Finance Corporation Environmental, Health and Safety Guidelines for Fish Processing. Washington, DC: World Bank Group. Available at http://www.ifc.org/ifcext/enviro.nsf/Content/EnvironmentalGuidelines

Annex A: General Description of Industry Activities

The activities that charaterize the fish processing sector depend on the type of fish being processed and the desired final products. Fish processing broadly consists of removing the inedible part of the fish and preserving the edible parts. The main fish processing stocks include cod, tuna, herring, mackerel, anchovy, pilchard, salmon, pollack, hake, and haddock. Products for human consumption range from whole fish to fillets and specialty products, which may be sold frozen, fresh (chilled) or preserved. Wild-caught marine fish processing facilities are typically located at commercial fishing harbors, while factories processing aquaculture products are often located close to the fish farming operation. Fish processing comprises the processing of the main product and associated by-products. Processing activities for fish filleting and preserving, the most common type of production type, are presented in Figure A-1 and described below. Mollusk and crustacean processing activities contain fewer stages and concentrate on the washing, cooking, cooling, processing, and packaging of the product.

Industry Activities

Material Reception and Preparation

Raw materials are typically received at the fish processing facility from a commercial fishing vessel or fish farm. For some fish species, gutting, cleaning, and head removal can take place at sea on board fishing vessels to maintain optimal quality. This is often the case for white fish with a low oil content, which are then kept on ice or frozen until they arrive at the processing facility. Fatty fish fillets may have an oil content of up to 30 percent and are usually not gutted until they arrive at the processing facility. When fish are processed at sea, the offal is typically discarded into the sea. Although this reduces the amount of offal produced at land-based fish processing facilities, if taken ashore, the offal could be turned into a potentially valuable by-product.

During unpacking, fish are subject to quality control (including traceability documentation) and, at this stage, any by-catch and offal can be diverted to the by-product line. Fresh raw fish is washed and graded to separate any material that does not meet standards for quality and uniformity. Frozen raw material has to be thawed (e.g. under running water or with air at controlled temperatures) before washing and grading. The prepared raw material is then chilled for storage, re-iced, or, in the case of live catch, held in holding tan

Product Processing

The product processing phase begins with skinning and cutting to remove the edible parts of the fish and reduce the size to the desired portions. Skinning can be done manually or automatically. In automatic operations, white fish are skinned by pulling the fillet over an automatic knife. Fatty fish, such as herring, are skinned by pulling them over a freezing drum. The fish are then transported to cutting tables where evisceration takes place (e.g. the heads, tails, and inedible parts are removed). The offal is collected and diverted to the by-product line. At this stage, any valuable by-products(e.g. liver and roe), are collected and then sent for separate handling. After evisceration, the cleaned fish products are filleted at the cutting tables and then washed.

Evisceration generates significant amounts of solid waste, most of which ends up in the aqueous waste stream. Facilities processing fatty, ungutted fish such as herring typically generate

the highest levels of aqueous pollutants. However, dry collection and transport of waste can be used to reduce water consumption, increase the amount of saleable offal, and reduce organic discharge in wastewater (e.g. a 60 to 70 percent reduction can be achieved in the herring filleting industry).[14]

Product Finalization

In product finalization, the cut fish and shellfish product is preserved through a variety of processes and may be consumed in their primary form, either raw or cooked. They may also be further processed to produce fish- or shellfish-based foods, such as molded products (fish fingers) or prepared dishes. Preservation methods typically used in fish processing include chilling and freezing, canning, brining and salting, fermenting, drying, and smoking, which may be used in various combinations, such as fermentation with salting and drying.

Chilling and freezing decrease the fish temperature to levels (approximately 0 °C or less than - 18°C, respectively) where metabolic activities, catalyzed by autolytic or microbial enzymes, are reduced or completely stopped. Canning preserves the product by first heating it (usually under pressure) to a temperature that destroys contaminating micro-organisms, and then sealing it in air-tight jars or cans. The remaining preservation techniques, described below, control microbial growth by reducing the water content, adding anti-microbial agents, and / or decreasing the pH of the product.

During brining and salting, a product is treated with common and curing salts (nitrate and / or nitrite) to reduce the water activity beyond the microbial tolerance limits, ensuring that the life of the product is increased and also giving it flavor. Both salt and nitrite are essential for curing to take place. Brining methods include dry, immersion, and tumble / massage brining. Fermentation processes allow the partial decomposition of the fish, which lowers the pH and prevents putrefaction, while giving the final product a strong, distinctive flavor.

Drying decreases the water activity level of the fish to minimize microbial growth. Salted and fermented fish are often further dried to increase shelf life, or fish might be dried without other primary preservation steps. Drying processes can range from solar drying to temperature- and humidity-controlled drying rooms. Dried fish typically has a moisture content of between 38 and 48 percent, depending on the product. Smoking preserves the product through exposure to smoke, which has a bacteriostatic effect. There are two types of smoking, hot and cold both of which add flavor.

By-products

There are two main by-products from the main fish processing process: fish meal and fish oil.

Fish Meal

Fish meal is produced through a cooking and dehydrating process whereby fish oil is separated and water is removed from the product. Fish meal production is a high energy consuming process. Raw material enters the fish meal production line on a feeder system and is then cooked. Cooking temperature and duration depends on the cooker type, but typically the material is cooked for approximately 20 minutes at 90°C. This activity results in significant odor levels. The cooked material is pressed in a screw-press or decanter centrifuge, and the press liquid is diverted into a centrifuge where the fish oil is separated from the stick water. The stick-water flow is then evaporated in a multiple-stage evaporator and the remaining sludge is mixed with the press cake. This combined material is then dried until it has a water content of below 10 percent. After drying, the material is ground to break up any lumps. The fish meal is then sent to packaging and intermediate storage.

[14] Nordic Council of Ministers (1997).

Fish Oil

Fish oil production is typically an integrated part of fish meal production, however, the production of cod liver oil and other specialty products can be established as stand-alone production units. The quality of the fish oil obtained depends largely on the quality of the fish raw material and the equipment used. Today, the extraction of fish oil is conducted exclusively by centrifugal machinery, typically three-phase decanters and separators.

Annex B: Sustainable Fishing Principles and References to Existing Good Practice Materials

Code of Conduct for Responsible Fisheries

Initiated by the United Nations Food and Agricultural Organization (FAO), the Rome Declaration establishes a "Code of Conduct for Responsible Fisheries." The Code is available online at www.fao.org/figis/servlet/static?dom=org&xml=CCRF_prog.xml and outlines the following recommendations:

- Base conservation and management decisions on the best scientific evidence available, taking into account traditional knowledge of the resources and their habitat;
- Develop further selective and environmentally safe fishing gear to maintain biodiversity, minimize waste, catch of nontarget species, and so on;
- Ensure fisheries interests are accommodated in the multiple uses of the coastal zone and are integrated into coastal area management;
- Protect and rehabilitate critical fisheries habitats;
- Ensure compliance with and enforcement of conservation and management measures and establish effective mechanisms to monitor and control activities of fishing vessels and fishing support vessels;
- Exercise effective flag state control to ensure the proper application of the Code;
- Cooperate through subregional, regional, and global fisheries management organizations;
- Conduct fish trade in accordance with the principles, rights, and obligations established in the World Trade Organization Agreement; and
- Promote awareness of responsible fisheries through education and training, as well as involve fishers and fish farmers in the policy formulation and implementation process.

Marine Stewardship Council (MSC)

The MSC provides a set of Principles and Criteria for Sustainable Fishing that are used as the standard in a third party, independent, and voluntary certification program. These principles are based on the Rome Declaration's Code of Conduct for Responsible Fisheries.

Figure A.1: Fish Processing Activities