Environmental, Health, and Safety Guidelines for Sawmilling & Manufactured Wood Products

Introduction

The Environmental, Health, and Safety (EHS) Guidelines are reference documents designed to provide project developers, financiers, facility managers, and other decision makers with relevant industry background and technical information. This information supports actions aimed at avoiding, minimizing, and controlling EHS impacts during the construction, operation, and decommissioning phases of a project or facility. [*]

How to Use This Document

The EHS Guidelines for Sawmilling and Manufactured Wood Products provide information that is specific to facilities in this industry sector. They are organized according to the following sections.

These guidelines are designed to be used jointly with the **General EHS Guidelines** document, which provides the user with guidance on common EHS issues potentially applicable to all industry sectors. For complex projects, multiple industry-sector guidelines may be useful. 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 may need to be 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.

Applicability

The EHS Guidelines for Sawmilling and Manufactured Wood Products include information relevant to projects and facilities such as furniture manufacturing, as well as plants manufacturing glue laminated boards and beams. It includes preservative treatment of timber and timber products. Plywood or other wood-derived board products are described in the EHS Guidelines for Board and Particle-Based Products, while growing, harvesting and transport of timber are included in the EHS Guidelines for Forest Management. **Annex A** contains a description of industry activities.

[*] **Note:** Attribution of all references, including verification for completeness and accuracy, to be completed for final draft.

1.0 Industry-Specific Impacts and Management

The following section provides a summary of EHS issues associated with sawmilling and manufactured wood products, 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 associated with sawmilling and wood products manufacturing primarily include the following:

- Sustainable forestry practices
- Solid waste generation
- Emissions to air
- Wastewater effluents
- Noise
- Fire

Sustainable forestry practices

The major environmental impact of sawmilling and wood products manufacturing concerns the management of forest resources. Issues related to sustainable forestry practices are addressed in the **EHS Guidelines for Forest Management.** In sawmilling and manufacturing of wood products, forestry impacts are minimized by maximizing wood conversion efficiency as described below.

Solid waste generation

Conversion Efficiency

Solid waste generation is directly related to the conversion efficiency of roundwood to sawn lumber or other final products. Conversion efficiencies from roundwood to sawn lumber are often below 40 percent. The use of modern equipment and trained staff may increase efficiencies to 70 percent. Technical and operational measures to increase wood conversion efficiency and minimize wood waste include:

- Optimize primary log breakdown technology and techniques, e.g. consideration of bandsaw or framesaw use and use of cross cut before rip cut to increase usable wood volume;
- Use of log scanning equipment to establish the optimum cutting pattern, based on the raw log dimensions and the product mix required for the log. Computerized real time sawing algorithms are available for this purpose;
- Use of scanning technology to maximize utilization of sawn boards and cutting according to predetermined algorithms;
- Use of finger-jointing in downstream operations to combine scrap or low value wood into products. Use of large-dimension waste products in glued laminated boards (glulam);
- Operator training and monitoring to ensure awareness and implementation of measures to improve conversion, such as:
    - Log measurement and categorization by diameter, with framesaws blades spaced to appropriately maximize conversion efficiency
    - Logs fed perpendicularly into framesaw blades
    - Minimization of the use of hooks for movement of logs or boards, to avoid damage to the product

Recycling and Disposal

Opportunities for recycling of wood waste may exist through use of waste as inputs for secondary products in other industries or as a source of fuel for heat and power generation. The optimal recycling options depend upon local market conditions and the size (e.g. sawmill chips or sanding dust) and dryness of the material, however the larger-dimensioned wastes are usually more profitably utilized as fibre "by-products" than fuels. The value and disposal options for sawmill waste are usually enhanced if the waste is bark-free, which necessitates debarking logs before primary breakdown.

Wood waste containing preservative chemicals should be treated as hazardous waste and disposed of in a landfill facility capable of handling wastes that may have chemical leaching properties or by high temperature incineration in an incinerator with effective air pollution control devices. Use of wood waste as an input for secondary products should consider potential contamination caused by residues of preservative chemicals.

Wood waste utilization and disposal options include[1]:

- Use of bark-free wood chips and other wood waste as a raw material input for the pulp and paper or board-making industries. Particleboard manufacturers may also accept sawdust and chips with bark;
- Use of wood and bark chips as mulch for gardens, highway verges, and agriculture. Use of sawdust and wood shavings for animal bedding;
- Use of wood waste as fuel to generate heat / power for the facility's space heating and process needs, and / or for export;
- Production of fuel briquettes;
- Manufacture of charcoal.

If all other feasible, beneficial uses have been considered, wood waste should be disposed of through controlled incineration, as described below. Accumulation of waste in a dump or landfill at the sawmill is not acceptable as these options present a serious fire hazard, which once started can be very difficult to control, in addition to potential for ground water contamination.

Emissions to Air

Air emissions from sawmill operations are generated from a number of sources. Combustion emissions associated with boilers may include carbon monoxide (CO), nitrogen oxides (NO_X), sulfur oxides (SO_x) particulate matter (PM), and volatile organic compounds (VOCs) from bark and wood depending upon fuel selection. VOCs may also be emitted during kiln drying of wood and application of solvents, coatings, and lacquers. Wood dust and larger particulates are generated during sawing, machining and sanding operations.

Sawmill operations may use controlled incineration to dispose of wood waste, which may result in emissions of carbon monoxide (CO), nitrogen oxides (NO_X), particulate matter (PM), and volatile organic compounds (VOCs) from bark and wood.

Management of combustion source emissions (including from biomass fuel) associated with heat- and power-generation activities, or from waste incineration, from sources with a heat input capacity up to 50 Megawatts is addressed in the **General EHS Guidelines.** Larger 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**.

[1] The environmental and occupational health issues associated with wood use in byproduct manufacturing can be complex and should be considered in the selection of wood waste recycling alternatives.

Recommended techniques to ensure proper combustion during wood residue incineration to control associated air emissions include the following:

- Wood waste fuel should be of constant moisture content. Separate storage of wet (e.g. sawmill chips) and dry (e.g. planer shavings) wastes should be maintained and stockpiles protected from the elements. Fuel feeding to the boiler/ incinerator should maintain a constant proportion of wet and dry fuel;
- Maintain an optimal air: fuel ratio appropriate for different fuel mixtures. Install capability for independent adjustment of both the supply of wood waste and combustion air to the boiler / incinerator;
- Where fly ash reinjection is used to improve furnace efficiency, the incoming ash stream should be presorted using sand classifiers. Small ash particles and sand should be sent to the ash pile;
- Ash from incineration of wood waste should be stored in a contained, wind resistant area until it has fully cooled. Ash may be returned to the forest or other sites for use as a fertilizer and soil improver;
- Use of cyclones, baghouse filters and / or electrostatic precipitators, and / or scrubbers to control particulate emissions to the site-specific requirements.

Recommendations to prevent, minimize, and control emissions of VOCs during kiln drying of wood and application of solvents, coatings, and lacquers include:

- Solvents used for cleaning should be collected and recovered through distillation;
- Coatings should be reformulated to reduce VOC content including, where a high-gloss finish is not required, the use of waterborne coatings;
- Dip baths should be enclosed to the extent possible and controlled solvent extraction provided;
- Use of High Volume Low Pressure (HVLP) spraying or electrostatic spray systems to improve spray transfer efficiency;
- Use of enclosed booths for spraying activities. Air recirculation into the spray booth should be used to reduce the volume of air that needs to be treated before release;
- VOCs should be removed from the air stream either by combustion or absorption onto carbon filters. Combustion can be either thermal or catalytic. Absorption onto carbon filters is efficient but may not be feasible in areas where there is no system for recovering the solvents;
- Wood dust and larger particulates are generated during sawing, machining and sanding operations. Local extraction systems should be provided for locations at which these particulates are formed, including saws, sanding, shaping, and routing machines[2]. Cyclones or bag filters are typically employed to remove particulates from the air stream before release. Filtered air may be returned to the workplace which reduces space heating requirements where applicable. Good housekeeping practices should also be employed to minimize dust generation.

Wastewater Effluents

Wastewater effluent from sawmills is generated from runoff from irrigated storage areas known as log yards and log ponds. Wastewater is also generated from chemical coating of wood. Toxic wood preservation chemicals may include polynuclear aromatic hydrocarbons, pentachlorophenol, other pesticides,

[2] Specific local exhaust ventilation controls for various machines and equipment can be found at US Department of Labor, Occupational Safety and Health Administration (OSHA), Wood Products: Sawmills e-Tool: Plant Wide Hazards, 2003, available at: http://www.osha-slc.gov/SLTC/etools/sawmills/dust.html

and compounds of chrome, copper and arsenic. Process wastewater containing chemical preservatives should be contained as part of a closed loop application system.

The runoff from log yards and log ponds may contain toxic chemicals (such as tannins, phenols, resins, and fatty acids) leached from the timber, and soil and other materials washed out of the bark. The leachate typically has a high BOD (150 - 5000 mg/l) and COD (750 – 7500 mg/l).

Recommendations to prevent, minimize, and control effluents from stored timber include:

- Runoff from log yards should be properly contained with impervious surfaces, sealed joints, and spill containment curbs to prevent leaching of contaminated waters into the soil and groundwater;
- Log ponds also should be contained to prevent contaminants leaching into the soil and groundwater;
- Irrigation water should be recycled to limit effluent releases to ground and surface waters;
- Stormwater from process areas should be segregated from stormwater in non-process areas and managed as described in the **General EHS Guidelines**.

Wastewater treatment

Effluent water should be treated to reduce BOD_5 and COD. Since this effluent should not typically contain pathogens, treatment can be achieved by passing the water through constructed wetlands or aerated treatment ponds with a retention time of approximately 14 days or until an acceptable BOD and COD level is achieved. Highly concentrated effluents (for example following evaporation), or effluents which may contain wood preservative chemicals will require an additional level of treatment, such as detoxification (using ultraviolet oxidation) and precipitation or stabilization of heavy metals, depending on the nature of contamination. Additional information on wastewater treatment techniques and appropriate consideration for discharge levels depending on the receiving water body use are discussed in the **General EHS Guidelines**.

Hazardous Materials Management

Facilities involved in application of wood preservative treatments or the coating of products may store large volumes of hazardous chemicals such as wood preservatives, paints, lacquers, and solvents. Wood preservation typically involves dipping or pressurized treatment processes utilizing pesticide-based preservatives diluted in water or oil.[3] Chromated copper arsenate (CCA) is a common wood preservation chemical, however its use is being limited in some countries due to reported toxic effects on the environment. A variety of alternatives are available on the market including ACQ (containing copper oxide and quaternary ammonium), Copper Azole and Borates for use in dry situations, in addition to alternative building materials.[4]

In addition to the recommendations for the safe storage and handling of hazardous materials provided in the **General EHS Guidelines**, the following measures, specific to wood preservative treatment facilities, should be adopted where appropriate:

- Storage tanks and components should meet international standards for structural design integrity and operational performance;
- Chemical storage and treatment sites and tanks should be situated in containment areas for example, a covered,

[3] See the occupational health and safety section of this document for health hazards associated with wood preservatives.
[4] US EPA Advisory, available at: http://www.epa.gov/oppad001/reregistration/cca/alternativestocca.htm

walled, concrete area beneath which there is an impermeable membrane. Any spills into this area should drain into a tank / sump, located in a contained area from which leaks can be detected;

- Level gauges, alarms, and cutoff systems on storage tanks should be installed to decrease the risk of overfilling;
- Tankers delivering bulk shipments of treatment chemicals should employ spill prevention measures, as discussed in the **General EHS Guidelines**;
- A contained and impermeable post treatment dripping zone should be located within the total containment area. Residue from dripping timber should be collected for reuse;
- Treatment chemicals which can be heat-cured onto wood should be adopted to prevent leaching properties. The curing machine should be located within the containment area;
- Treated wood that is cured may be stored in the open. If not cured, wood should be covered and storm water should be collected and treated, as described above in the 'Wastewater Effluents' section.

1.2 Occupational Health and Safety

Occupational health and safety issues during the construction and decommissioning of sawmills and manufactured wood products manufacturing plants are common to those of most large industrial facilities, and their prevention and control is discussed in the **General EHS Guidelines**.

Occupational health and safety issues associated with sawmilling and wood products manufacturing primarily include:

- Physical hazards
- Noise
- Dust
- Chemicals
- Explosions
- Confined spaces

Physical Hazards

The most severe injuries in this sector are usually attributable to the failure of Lockout -Tagout systems. Robust Lockout - Tagout procedures as described in the **General EHS Guidelines** should be devised and practiced regularly.

Machine Safety

Wood processing plants employ various kinds of cutting equipment, for example saws, routers, chippers, planers, sanders, slicers, peelers, etc. Debarkers may also expose workers to injury. Cutting and debarking equipment is often in rapid motion. Accidents often happen when machines are inadvertently switched on during maintenance and cleaning.

Recommendations to prevent, minimize, and control injuries from cutting and debarking[5] equipment include:

- All cutting and debarking equipment, such as circular saws and rotary debarkers, should be fitted with safety guards or interlocks capable of preventing access to moving parts;
- Workers should be trained in the safe use of cutting and debarking equipment, such as the use of push-sticks and other means to move timber past a blade while keeping all parts of the body away from the blade;
- Work stations should be aligned to minimize human danger from fragments which could arise from breakage;
- Saws and debarking equipment should be regularly inspected and maintained to prevent equipment failure;
- All personnel operating cutting equipment should use protective eyewear, and other PPE as necessary. Saws

[5] Specific techniques for minimizing injuries associated with cutting and debarking equipment can be found at US OSHA (2003), available at: http://www.osha-slc.gov/SLTC/etools/sawmills/log_breakdown.html

should be equipped with screens or other devices to protect the worker from log kick-back.

Log Handling Activities

Logs are generally unloaded from railroad cars or heavy trucks and stacked by machines before being moved to log conveyors and log decks for processing in the sawmill. Injuries due to vehicle movement in log yards are common, in addition to injuries from logs that roll off or are dropped by handling equipment or are dislodged from log stacks. Logs may also be stored in log ponds prior to conveyance to the sawmill.

Recommendations to prevent, minimize, and control injury in log yards and log ponds include[6]:

- Complete mechanization of log yard activities should be considered to reduce human contact with logs during handling and stacking activities;
- Transport routes within log yards should be clearly demarcated and vehicle movement should be closely controlled;
- Log stacks should not be higher than a safe height defined by risk assessment which should take account of site-specific circumstances including stacking methodology;[7]
- Access to log yards should be restricted to authorized personnel;
- Log decks should have stops, chains, or other guards to prevent logs from rolling down and off the deck;
- Workers should be trained in safe working procedures in log stack and deck areas, including avoidance of falling logs and planning of escape routes;
- Workers should be provided with protective steel capped boots, hardhats, and high visibility jackets;
- All mobile equipment should have audible reversing alarms;
- Workers should be trained in procedures to minimize injury during movement of logs to log ponds;
- Guardrails and handrails should be installed to prevent accidental falls in log ponds. Walkways and floats should be properly anchored;
- Pond boat operators should be trained in safety measures, and boats should have adequate lifesaving equipment. Facilities to provide warmth should be available in case pond workers fall into the water in cold climates;

Conveyor Systems

Sawmills typically transport wood using electric, movable, multi-route conveyor systems. Conveyors under high tension may break, resulting in injury. Clothing or limbs can also become entangled in conveyors.

Recommendations to prevent, minimize, and control injury from conveyor systems include:

- Plant design should emphasize simple conveyor routes that are clearly demarcated, with use of skirt boards to prevent access as necessary;
- Moving gears, chains, and rollers should be fully enclosed;
- Hard hats should be worn in areas where elevated conveyors are in use;
- Conveyor belt arrestors should be installed to stop the conveyor in the event of a belt failure;
- Belts should be inspected on a daily basis by trained personnel to ensure that they are in good working order. Lockout - Tagout systems for maintenance activities are addressed in the **General EHS Guidelines**.

[6] Specific techniques for log receiving and handling can be found at US OSHA (2003), available at: http://www.osha-slc.gov/SLTC/etools/sawmills/receive.html and http://www.osha-slc.gov/SLTC/etools/sawmills/convey.html
[7] Manual stacking operations may typically limit stacking height to 2 meters while mechanical stacking operations may safely work with greater stacking heights.

Lifting, Repetitive Work, and Work Posture

Sawmill and wood manufacturing activities may involve movement of heavy pieces of equipment or timber, resulting in injuries to the back if lifting is not done correctly. In addition, many of the process tasks are repetitive and can lead to strains / injuries to hands and arms. Recommended management approaches to reduce these types of injuries are discussed in the **General EHS Guidelines**.

Noise

Sawmill and wood manufacturing operations may result in elevated noise levels. In addition to occupational noise management recommendations in the **General EHS Guidelines**, industry specific measures to prevent, minimize, and control injury due to noise include:

- Enclose machines and equipment with elevated noise emissions (e.g. in excess of 85dB(A)) in noise reduction housings;
- Conduct regular maintenance, including water lubrication of machines and cutting blades, and resin build-up removal;
- Adjust circular saw parameters (e.g. bite depth, blade angle, blade speed) in relation to the timber being cut and the machinery used;
- Consider use of low noise sawblades, in addition to other less noisy equipment, e.g. frame saws;
- Provide workers with appropriate PPE including hearing protection.

Dust

Wood dust inhalation may cause irritation, asthma, allergic reaction, and nasopharyngeal cancer amongst wood processing workers. The potential hazard to human health depends on the type of wood being processed with the wood from some tree species having a more serious potential impact than others (e.g. hardwoods, such as oak, beech, teak, mahogany, walnut, mahogany, and birch). Dust exposure should be prevented and controlled through the adoption and maintenance of effective extraction and filtration systems[8] as described in the 'Environment' section above and supplemented by the use of Personal Protection Equipment (PPE) such as masks and respirators, as necessary.

Chemicals

Workers may be exposed to elevated levels of hazardous chemicals, including solvents[9], during application of preservative treatments, painting or varnishing.

Recommended techniques to prevent and control chemical exposure include[10]:

- Substitution of solvent-based coatings and adhesives with less toxic alternatives;
- Use of automated techniques for coating and adhesive application;
- Use of local exhaust ventilation in areas with high chemical vapor concentrations, such as manual spray, rolling, and brushing, in addition dip coating and other automated coating processes. Manual spraying and dip coating should be undertaken in separate, ventilated areas using enclosures or capture hoods supplemented by the use of PPE such as masks and respirators, as necessary;

[8] Specific local exhaust ventilation controls for various machines and equipment can be found at US OSHA 2003. Available at: http://www.osha-slc.gov/SLTC/etools/sawmills/dust.html

[9] The solvents most commonly used in these coatings include toluene, xylenes, methyl ethyl ketone (MEK), methyl isobutyl ketone (MIBK), and methanol. The acid-catalyzed coatings contain formaldehyde. All of these solvents have short-term effects such as irritation of the eyes, nose, and throat, and headaches, dizziness, confusion, fatigue, and nausea. The longer-term effects include reproductive problems, central nervous system disorders, and damage to the lungs, liver, and kidneys. US OSHA (2003)

[10] US OSHA (2003).

- When necessary, workers should have adequate protective clothing to prevent chemical contact with the skin, eyes, or via inhalation.

Further recommendations for the implementation of occupational health and safety management programs and measures are described in the **General EHS Guidelines** as applicable to hazardous materials management and chemical occupational health and safety hazards.

Explosion

Wood products manufacturing, particularly when machining dried wood, may produce fine combustible dust which can be explosive in air. Where solvents are used for the application of coatings by spraying there is a high risk of solvent explosions. Explosion risk can be minimized by application of the prevention and control of dust accumulation as described in the 'Environmental' section of this guideline.

In addition, recommendations to prevent and control the explosion hazard related to dust and solvents include:

- Regular housekeeping to ensure that dust is removed from the facility, including a biannual blow down or vacuuming of the entire facility (e.g. roof rafters);
- Eliminating all sources of ignition from the working environment, including:
    - Use of electrical equipment of at least IP64 rating
    - Elimination of naked flames, such as burner flames, welding or cutting torches, matches, cigarette lighters, and heaters
    - Control of hot surfaces, such as operating internal combustion engines, frictional sparks, heated wires, glowing metals, and overheated bearings
    - Control of portable, battery powered equipment e.g. radios, mobile phones etc.
    - Safe use of certain chemicals, for example peroxide hardening products which can be self-heating or result in spontaneous combustion
    - Installation of spark detection and dousing systems in dust control equipment
    - Electrical grounding of conveyors and dust control systems to prevent discharge of static electricity
- Use of explosion relief panels on all dust moving equipment and in buildings;
- Mills and plants should be equipped with adequate and accessible firefighting equipment including automatic sprinkler systems;
- Workers should be trained in emergency evacuation procedures and first line of attack fire fighting techniques.

1.3 Community Health and Safety

Community health and safety issues during the construction and decommissioning of sawmills and wood based products manufacturing plants are common to those of most large industrial facilities, and their prevention and control is discussed in the **General EHS Guidelines**.

Community health and safety issues associated with sawmilling and wood products manufacturing primarily include exposure to dust and smoke. Dust generation from process activities and smoke resulting from waste wood disposal incinerators may result in impacts to the air quality of local communities. Operators should ensure that the techniques to mitigate impacts described in the 'Environment' section ensure that local communities are not adversely affected.

2.0 Performance Indicators and Monitoring

2.1 Environment

Emissions and Effluent Guidelines

Table 1 presents emission guidelines for process operations in the sawmilling and manufactured wood products sector. 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 in table 2 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**.

Combustion source emissions guidelines associated with steam- and power-generation activities, and waste wood incineration, from sources with a heat capacity equal to or lower than 50 Megawatts 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: Emission levels for sawmill facilities

Pollutants	Units	Guideline Value
Wood dust	mg/Nm^3	50
VOCs	mg/Nm^3	20

Table 2: Effluent Levels for wood treatment and preservation effluent[a]

Pollutants	Units	Guideline Value
BOD	mg/l	50
COD	mg/l	150
TSS	mg/l	50
Oil & Grease	mg/l	10
Phenol	mg/l	0.5
Arsenic	mg/l	0.1
Chromium	mg/l	
- Total		0.5
- Hexavalent		0.1
Copper	mg/l	0.5
Fluorides	mg/l	20
PAHs (each)	mg/l	0.05
Dioxins/ Furans	mg/l	0.0005
Pesticides (each)	mg/l	0.05
pH		6 – 9

[a] Process wastewater containing chemical preservatives should be contained as part of a closed loop application system. Guideline value applies to process water if it is discharged to surface water.

Resource Use

Table 3 provides 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

Table 3: Resource and Energy Consumption

Inputs per unit of product	Units	Industry Benchmark
Sawmills		
Electricity consumption per unit of production	kWh/m3	TBD.
Water used per unit of production	l/m3	290
Raw materials consumption per unit of production	Conversion efficiency, i.e. useful output (m3) divided by round logs (m3) input	56%
Processing Plant		
Electricity consumption per unit of production	kWh/m3	255
Heat consumption per unit of production		
Water used per unit of production	l/m3	290
Ex. Raw materials consumption per unit of production	Conversion efficiency, i.e. useful output (m3) divided by sawn timber (m3) input	40%

Notes:
Source: Chamberlain et al (2005), Crown and Building Research Establishment (1999), Suttie (2004.)

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),[11] the United States National Institute for Occupational Health and Safety (NIOSH),[12] Permissible Exposure Limits (PELs) published by the Occupational Safety and Health Administration of the United States (OSHA),[13] Indicative Occupational Exposure Limit Values published by European Union member states,[14] 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)[15].

Occupational Health and Safety Monitoring

The working environment should be occupational hazards relevant to the specific project. Monitoring should be designed and implemented by credentialed professionals[16] 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**.

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

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

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Annex A: General Description of Industry Activities

The sawmilling and wood products manufacturing sector can be divided into two subsectors consisting of the basic sawmilling that produces inputs into the manufacturing processes and the final products manufacture and assembly. In some plants the entire process is integrated with inputs of roundwood at one end leading to finished assembled products at the other. More often sawmills produce sawn timber for input to other plants or for sale directly into the market. Manufacturing plants purchase sawn timber and board products to build final products such as furniture.

Sawmills

Sawmills typically require forest inputs from 10,000 to 300,000 m^3 per year. Sawmills are generally located in areas close (<100 km) to the forest on which they depend due to the high cost of transporting round timber. Transport links for large volume cargo are essential to bring products to market. Sawmills typically take in roundwood and produce sawn and dried dimensioned lumber as outputs. Input logs are commonly stored in a logyard where they may be irrigated, or, more rarely, they are stored in logponds. From the logyard they are sorted by size and other criteria before transport into the mill on conveyor systems. Logs are often debarked as they enter the mill and are then wet sawn into a variety of lumber sizes.

Timber shaping and cutting activities in mills are typically complex with multiple passes through the mill before a piece is ready for the next process stage. Sawn dimensioned lumber is then dried either naturally or in drying kilns, prior to being exported directly to market or resawn and finished in a dry mill to provide a smooth input for another process.

The sawing process produces large amounts of waste in the form of chips, sawdust, slabs and flawed lumber. These wastes may be processed for input into board or paper mills or they may be burnt on site as waste disposal, or to generate heat for kilns or electricity for the facility. Minimization and disposal of solid waste is the major environmental challenge for this industry.

Lumber intended for outdoor use is commonly treated with a chemical preservative, typically applied in a pressurized vessel that ensures the penetration of the chemicals into the timber. The chemical solution is recycled for further use and is pumped into a storage tank whenever the pressure vessel is emptied. A wide variety of chemicals have been used in the past for wood preservation, some of which are now restricted in developed countries. Three main types of preservatives are used: water based (for example, sodium phenylphenoxide, benzalconium chloride, guazatin, and copper chrome arsenate); organic solvent based (for example, pentachlorophenol and such substitutes as propiconazol, tebuconazol, lindane, permethrin, triazoles, tributyltin compounds, and copper and zinc naphthenates); borates; and tar oils (such as creosote).

Some of the preservatives mentioned here (for example, lindane, tributyltin, and pentachlorophenol) are banned in some countries. Chromated Copper Arsenate (CCA), the most common preservative chemical used in the United States, has been withdrawn from use in domestic human contact situations pending a complete risk assessment. A variety of alternatives are available on the market including ACQ (containing copper oxide and quaternary ammonium), Copper Azole and Borates for use in dry situations, in addition to alternative building materials.[17]

[17] http://www.epa.gov/oppad001/reregistration/cca/alternativestocca.htm

In facilities where wood preservation has been carried out, surplus chemicals may need to be removed and contaminated sites rehabilitated.

Manufactured Wood-based Products

The wood manufacturing sector utilizes a mixture of boards and lumber products to produce final products either in assembled form or in knock down form as flat packs for assembly elsewhere. Manufacturing plants handle inputs in the range of 1,000-30,000m^3 per year. The processes typically involve a mixture of sawing, planning, and routing, and use of adhesives, pins, and screws to produce and assemble the necessary components. The assembled or dimensioned products are commonly treated with a finish of lacquer or paint. The finishing processes of sanding and treating may be repeated so that wood is treated chemically and then sanded before receiving further coats of variety of chemicals. These chemicals include solvents for removing resin from the timber, water for raising the grain, stains, dyes, lacquers and varnishes for coloring and protecting the timber, and paints for providing an opaque covering. The chemicals are commonly dissolved in solvents which have both quick drying and slow drying components. Chemicals are applied using rollers or by spraying to account for both flat and non flat components. In some cases coating is carried out prior to the final machining and assembly. Solvents commonly used in these processes include Toluene, Methanol, Xylene, Methyl Ethyl Ketone, Acetone and N-Butyl Alcohol.

In some sawmills and manufacturing plants, small waste timber is recovered and reprocessed in finger jointing plants to make longer boards which may then also be glued edge to edge to provide wide 'glulam' products. These reconstituted boards may be used to create large scale wooden engineering beams, by gluing together thousands of pieces and often by bending them in presses and moulds.

Figure A.1: Typical Sawmill and Wood Products Manufacturing Processes