Environmental, Health, and Safety Guidelines for Health Care Facilities

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 Health Care Facilities include information relevant to the management of EHS issues associated with health care facilities (HCF) which includes a diverse range of facilities and activities involving general hospitals and small inpatient primary care hospitals, as well as outpatient, assisted living, and hospice facilities. Ancillary facilities may include medical laboratories and research facilities, mortuary centers, and blood banks and collection services. Annex A provides a description of activities in this sector. 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.

1.0 Industry-Specific Impacts and Management [2]

The following section provides a summary of EHS issues associated with health care facilities (HCF) which occur during the operations phase, along with recommendations for their management. Recommendations for the management of EHS impacts common to most large industrial facilities during the construction and decommissioning phases are provided in the **General EHS Guidelines**.

HCF Design Considerations

The design and functional layout of an HCF should ensure the following: separation of clean / sterilized and dirty / contaminated materials and people flows; development and inclusion of adequate disinfection / sterilization procedures and facilities; adequate space for the storage of recyclable materials (e.g. cardboard and plastic) for pickup; selection of heating, ventilation, and air conditioning (HVAC) systems that provide isolation and protection from airborne infections; design of water systems to provide adequate supplies of *potable* water to reduce risks of exposure to *Legionella* and other waterborne pathogens; provision of hazardous material and waste storage and handling areas; treatment and exhaust systems for hazardous and infectious agents; and selection of easily cleaned building materials that do not support microbiological growth, are slip-resistant, nontoxic, and nonallergenic, and do not include volatile organic compound (VOC)-emitting paints and sealants.

Internationally recognized guidelines for design and construction of hospitals and HCFs include the American Institute of Architects (AIA) and the Facility Guidelines Institute (FGI), the American Society for Healthcare Engineering (ASHE) of the American Hospital Association (AHA), and the Green Guide for Health Care (www.gghc.org). These guidelines should be used to verify the adequacy of planning for new HCFs or renovation of existing facilities.

1.1 Environmental

Environmental issues associated with HCF include the following:

- Waste management
- Emissions to air
- Wastewater discharges

Waste Management

Waste from health care facilities (HCF) can be divided into two separate groups. The first consists of general waste, similar in composition to domestic waste, generated during administrative, housekeeping, and maintenance functions. The second group consists of specific categories of hazardous health care waste, as detailed in Table 1 below.

Health care facilities should establish, operate and maintain a **health care waste management system (HWMS)** adequate for the scale and type of activities and identified hazards. Facility operators should undertake regular assessment of waste generation quantities and categories to facilitate waste management planning, and investigate opportunities for waste minimization on a continuous basis. In addition to the guidance provided on solid and hazardous waste management in the **General EHS Guidelines**, the HWMS should include the following components:

[2] Information in these EHS Guidelines is drawn predominantly from the World Health Organization (WHO), Safe management of wastes from health-care activities, Pruss et al. (1999). This document is currently under review by the WHO, and updated practices will be incorporated into future versions of this these EHS Guidelines, as necessary.

Waste Minimization, Reuse, and Recycling

Facilities should consider practices and procedures to minimize waste generation, *without sacrificing patient hygiene and safety considerations*, including:

- Source reduction measures:
  - Consider options for product / material substitution to avoid products containing hazardous materials that require the product to be disposed as hazardous or special waste (e.g. mercury[3] or aerosol cans), and preferring products with less packaging or products that weigh less than comparable products that perform the same function
  - Use of physical rather than chemical cleaning practices (e.g. using microfiber mops and cloths), where such practices do not affect disinfection and meet relevant standards for hygiene and patient safety[4]
- Waste toxicity reduction measures[5]:
  - Consider options for product / material substitution for equipment containing mercury or other hazardous chemicals; products that may become hazardous waste when disposed; products made of polyvinyl chloride (PVC[6]); halogenated compounds[7]; products that off-gas volatile organic compounds (VOCs), or products that contain persistent, bioaccumulative and toxic (PBT) compounds; products that contain substances which are carcinogenic, mutagenic or reproductive toxins (CMR)
- Use of efficient stock management practices and monitoring (e.g. for chemical and pharmaceutical stocks), including:
  - Small / frequent orders for products that spoil quickly and strict monitoring of expiry dates
  - Complete use of old product before new stock is used
- Maximization of safe equipment reuse practices, including:
  - Reuse of equipment following sterilization and disinfection (e.g. sharps containers)

Waste Segregation Strategies

At the point of generation, waste should be identified and segregated. Non-hazardous waste, such as paper and cardboard, glass, aluminum and plastic, should be collected separately and recycled. Food waste should be segregated and composted. Infectious and / or hazardous wastes should be identified and segregated according to its category using a color-coded system, as detailed in Table 1 below. If different types of waste are mixed accidentally, waste should be treated as hazardous.[8] Other segregation considerations include the following:

- Avoid mixing general health care waste with hazardous health care waste to reduce disposal costs;
- Segregate waste containing mercury for special disposal. Management of mercury containing products and associated waste should be conducted as part of a plan

[3] Use of mercury-based medical devices (e.g. thermometers and blood pressure devices) should be avoided and / or replaced, with preference given to digital and aneroid alternatives. Further information is available from WHO (2005), Mercury in Health Care, available at: www.who.int/water_sanitation_health/medicalwaste/mercurypolpaper.pdf

[4] For more information see Hospitals for a Healthy Environment, available at: www.h2e-online.org/docs/h2emicrofibermops.pdf

[5] For more information on material and product substitution options in healthcare facilities, see Health Care Without Harm http://www.noharm.org/globalsoutheng/

[6] Products made of PVC may include intravenous (IV) bags, blood bags and tubing, basins, hemodialysis equipment, patient identification bracelets, bedpans, inflatable splints, respiratory therapy products, stationary supplies, catheters, lab equipment, drip chambers, medical gloves, thermal blankets, internal feeding devices, and packaging. When burned at certain temperatures, PVC has the potential to release dioxins and furans, and other persistent organic pollutants (POPs).

[7] For example, minimize use of halogenated compounds through work practice modifications including use of citrus-based solvents rather than xylene alternatives (without compromising the quality of the medical service provided); conduct initial cleaning with a used solvent, and use fresh solvents for final cleaning only; adopt calibrated solvent dispensers and unitized test kits; and reduce the variety of solvents used to minimize waste streams.

[8] Staff should not attempt to correct errors of segregation by removing contents of a waste receptacle, or placing one receptacle inside another.

involving specific personnel training in segregation and clean up procedures;

- Segregate waste with a high content of heavy metals (e.g. cadmium, thallium, arsenic, lead) to avoid entry into wastewater streams;
- Separate residual chemicals from containers and remove to proper disposal containers to reduce generation of contaminated wastewater. Different types of hazardous chemicals should not be mixed;
- Establish procedures and mechanisms to provide for separate collection of urine, feces, blood, vomits, and other wastes from patients treated with genotoxic drugs. Such wastes are hazardous and should be treated accordingly (see Table 1);
- Aerosol cans and other gas containers should be segregated to avoid disposal via incineration and related explosion hazard;
- Segregate health care products containing PVC[9] to avoid disposal via incineration (see Air Emissions below) or in landfills.

On-site Handling, Collection, Transport and Storage

- Seal and replace waste bags and containers when they are approximately three quarters full. Full bags and containers should be replaced immediately;
- Identify and label waste bags and containers properly prior to removal (see Table 1);
- Transport waste to storage areas on designated trolleys / carts, which should be cleaned and disinfected regularly;
- Waste storage areas should be located within the facility and sized to the quantities of waste generated, with the following design considerations:
  - Hard, impermeable floor with drainage, and designed for cleaning / disinfection with available water supply
  - Secured by locks with restricted access
  - Designed for access and regular cleaning by authorized cleaning staff and vehicles
  - Protected from sun, and inaccessible to animals / rodents
  - Equipped with appropriate lighting and ventilation
  - Segregated from food supplies and preparation areas
  - Equipped with supplies of protective clothing, and spare bags / containers
- Unless refrigerated storage is possible, storage times between generation and treatment of waste should not exceed the following:
  - Temperate climate: 72 hours in winter, 48 hours in summer
  - Warm climate: 48 hours during cool season, 24 hours during hot season
- Store mercury separately in sealed and impermeable containers in a secure location;
- Store cytotoxic waste separately from other waste in a secure location;
- Store radioactive waste in containers to limit dispersion, and secure behind lead shields.

Transport to External Facilities

- Transport waste destined for off-site facilities according to the guidelines for transport of hazardous wastes / dangerous goods in the **General EHS Guidelines**;
- Transport packaging for infectious waste should include an inner, watertight layer of metal or plastic with a leak-proof seal. Outer packaging should be of adequate strength and capacity for the specific type and volume of waste;
- Packaging containers for sharps should be puncture-proof;
- Waste should be labeled appropriately, noting the substance class, packaging symbol (e.g. infectious waste,

[9] For examples of products containing PVC, see footnote 6.

radioactive waste), waste category, mass / volume, place of origin within hospital, and final destination;

- Transport vehicles should be dedicated to waste and the vehicle compartments carrying waste sealed.

Treatment and Disposal Options

Facilities receiving hazardous health care waste should have all applicable permits and capacity to handle specific types of health care waste. Wastes from each category should be treated according to the treatment methods and technologies described in Table 1. When selecting a waste disposal technology, operators should consider other potential health and environmental issues that may be generated by the treatment. The main types of treatment and disposal technologies and techniques available for health care waste are described below.[10]

Incineration is a high temperature dry oxidation process to reduce organic, combustible waste to significantly smaller quantities of inorganic, incombustible matter. Incineration may produce gaseous air emissions, ash residues, and wastewater. Depending on the amount of waste generated and the other factors, HCFs may operate on-site incinerators, or waste may be transported to an off-site incineration facility[11]. Incinerators should have permits to accept health care waste and be properly operated and maintained.[12] Further guidance on incineration is contained in the 'Emissions to Air' section, below.

Chemical disinfection involves the addition of chemicals to kill pathogens in health care waste. Waste should be mechanically shredded prior to treatment. Treatment involves the use and handling of hazardous chemicals, in addition to disposal of hazardous residues following treatment.

Wet thermal treatment disinfects waste by exposing shredded waste to high temperatures / pressure steam inside an exposure tank. Wastewater discharges and odor may result. Autoclaving is a type of wet thermal disinfection process typically used to sterilize reusable medical equipment. Dry thermal disinfection involves the shredding, heating, and compacting waste in a rotating auger. Air emissions and wastewater may be generated, and residues require disposal.

Microwave irradiation involves the destruction of microorganisms through the microwave heating action of water contained within the waste. Following irradiation, waste is compacted and disposed of as part of the municipal waste stream. Contaminated wastewater may also be generated.

Land disposal involves the disposal of health care waste into landfill facilities. Properly designed and operated sanitary landfills will protect against air and groundwater contamination. Disposal of waste into open dumps is not considered good practice and should be avoided. Pretreatment of waste prior to land disposal may involve encapsulation (filling containers with waste and an immobilizing material and sealing the containers).

Inertization involves mixing waste with substances (e.g. cement) to minimize leaching of toxic waste into ground or surface water.

[10] Further detail on waste management and disposal methods and technologies can be found in Pruess (1999), US EPA (2005b) Sector Notebook on Health care Facilities; and Health Care Without Harm (2007), For Proper Disposal: A Global Inventory of Alternative Medical Waste Technologies.

[11] Further guidance on use of municipal incinerators for disposal of health care waste is addressed in Pruss (1999), page. 84.

[12] Health care waste should be disposed of using pyrolytic or rotary kiln incinerators. Single chamber incinerators should only be used in emergency situations (e.g. acute outbreaks of communicable disease) when other incineration options for infectious waste are not available.

Emissions to Air

Sources of air emissions at HCFs may include exhaust air from heating, ventilation, and air conditioning (HVAC) systems, ventilation of medical gases and fugitive emissions released from sources such as medical waste storage areas, medical technology areas, and isolation wards. Emissions may include exhaust from medical waste incineration if this waste management option is selected by the facility[13]. In addition, air emissions may result from combustion related to power generation. Recommended prevention and control for power generation combustion source emissions are addressed in the **General EHS Guidelines.**

Exhaust air (e.g. from medical technology areas [MTAs], including isolation wards, laboratories, and waste storage and treatment facilities) may be potentially contaminated with biological agents, pathogens, or other toxic materials, and should be treated by conveying the exhaust air to combustion air to render it non-toxic and non-contagious before discharge. Condensate and blowdown liquids should be classified as health care wastewater and treated accordingly (see 'Wastewater' below). A stack sufficiently tall to eliminate odor nuisances and optimize dispersion should be used. Stack heights for all waste treatment facilities should be determined in accordance with guidance provided in the **General EHS Guidelines**.

Incineration

Large general hospitals may be equipped with their own incinerator plant, which is the major source of emissions to air and wastewater. Typically, only a relatively small portion of medical waste should be incinerated[14], and the need for a hospital waste incinerator (HWI) should be carefully evaluated against other technologies and techniques for waste management and disposal discussed above[15]. Pollutants potentially emitted from HWIs include:

- Heavy metals;
- Organics in the flue gas, which can be present in the vapor phase or condensed or absorbed on fine particulates;
- Various organic compounds (e.g. polychlorinated dibenzo-p-dioxins and furans [PCDD/Fs], chlorobenzenes, chloroethylenes, and polycyclic aromatic hydrocarbons [PAHs]), which are generally present in hospital waste or can be generated during combustion and post-combustion processes;
- Hydrogen chloride (HCl) and fluorides, and potentially other halogens-hydrides (e.g. bromine and iodine);
- Typical combustion products such as sulfur oxides (SO_X), nitrogen oxides (NO_X), volatile organic compounds (including non-methane VOCs) and methane (CH_4), carbon monoxide (CO), carbon dioxide (CO_2), and nitrous oxide (N_2O).

Pollution prevention and control measures include:

- Application of waste segregation and selection including removal of the following items from waste destined for incineration: halogenated plastics (e.g. PVC), pressurized gas containers, large amounts of active chemical waste, silver salts and photographic / radiographic waste, waste with high heavy metal content (e.g. broken thermometers, batteries), and sealed ampoules or ampoules containing heavy metals;

[13] Controlled-air incineration (also referred to as pyrolytic, starved-air, two-stage incineration, or modular combustion) is the most widely used HWI technology. Single-chamber and drum / brick incinerators should be used only as a last resort option.

[14] Infectious and pathological waste, selected pharmaceuticals (combustibility to be determined from the manufacturer's specifications) and chemicals, and sharps may be combusted in a pyrolytic incineration facility designed for this purpose. The types of waste incinerated typically include a heterogeneous mix of some, or all, of the following: human and animal infected anatomical waste; absorbents; alcohol, disinfectants; glass; fecal matter; gauze, pads, swabs, garments, paper, and cellulose; plastics, PVC, and syringes; sharps and needles; and fluids and residuals.

[15] Non-incineration Medical Waste Treatment Technologies in Europe, Health Care Without Harm (2004).

Table 1. Treatment and disposal methods for categories of health care waste

Type of waste	Summary of treatment and disposal options / notes
Infectious waste: Includes waste suspected to contain pathogens (e.g. bacteria, viruses, parasites, or fungi) in sufficient concentration or quantity to cause disease in susceptible hosts. Includes pathological and anatomical material (e.g. tissues, organs, body parts, human fetuses, animal carcasses, blood, and other body fluids), clothes, dressings, equipment / instruments, and other items that may have come into contact with infectious materials.	**Waste Segregation Strategy**: Yellow or red colored bag / container, marked "infectious" with international infectious symbol. Strong, leak proof plastic bag, or container capable of being autoclaved. **Treatment**: Chemical disinfection; Wet thermal treatment; Microwave irradiation; Safe burial on hospital premises; Sanitary landfill; Incineration (Rotary kiln; pyrolytic incinerator; single-chamber incinerator; drum or brick incinerator)[e] • Highly infectious waste, such as cultures from lab work, should be sterilized using wet thermal treatment, such as autoclaving. • **Anatomical waste** should be treated using Incineration (Rotary kiln; pyrolytic incinerator; single-chamber incinerator; drum or brick incinerator[e]).
Sharps: Includes needles, scalpels, blades, knives, infusion sets, saws, broken glass, and nails etc.	**Waste Segregation Strategy**: Yellow or red color code, marked "Sharps". Rigid, impermeable, puncture-proof container (e.g. steel or hard plastic) with cover. Sharps containers should be placed in a sealed, yellow bag labeled "infectious waste". **Treatment**: Chemical disinfection; Wet thermal treatment; Microwave irradiation; Encapsulation; Safe burial on hospital premises; Incineration (Rotary kiln; pyrolytic incinerator; single-chamber incinerator; drum or brick incinerator)[e] • Following incineration, residues should be landfilled. • Sharps disinfected with chlorinated solutions should not be incinerated due to risk of generating POPs. • Needles and syringes should undergo mechanical mutilation (e.g. milling or crushing) prior to wet thermal treatment
Pharmaceutical waste: Includes expired, unused, spoiled, and contaminated pharmaceutical products, drugs, vaccines, and sera that are no longer needed, including containers and other potentially contaminated materials (e.g. drug bottles vials, tubing etc.).	**Waste Segregation Strategy**: Brown bag / container. Leak-proof plastic bag or container. **Treatment**: Sanitary landfill[a]; Encapsulation[a]; Discharge to sewer [a]; Return expired drugs to supplier; Incineration (Rotary kiln; pyrolytic incinerator [a]); Safe burial on hospital premises[a] as a last resort. • Small quantities: Landfill disposal acceptable, however cytotoxic and narcotic drugs should not be landfilled. Discharge to sewer only for mild, liquid pharmaceuticals, not antibiotics or cytotoxic drugs, and into a large water flow. Incineration acceptable in pyrolytic or rotary kiln incinerators, provided pharmaceuticals do not exceed 1 percent of total waste to avoid hazardous air emissions. Intravenous fluids (e.g. salts, amino acids) should be landfilled or discharged to sewer. Ampoules should be crushed and disposed of with sharps. • Large quantities: Incineration at temperatures exceeding 1200 °C. Encapsulation in metal drums. Landfilling not recommended unless encapsulated in metal drums and groundwater contamination risk is minimal.
Genotoxic / cytotoxic waste: Genotoxic waste may have mutagenic, teratogenic, or carcinogenic properties, and typically arises from the feces, urine, and vomit of patients receiving cytostatic drugs, and from treatment with chemicals and radioactive materials. Cytotoxic drugs are commonly used in oncology and radiology departments as part of cancer treatments.	**Waste Segregation Strategy:** See above for "infectious waste". Cytotoxic waste should be labeled "Cytotoxic waste". **Treatment**: Return expired drugs to supplier; Chemical degradation; Encapsulation[a]; Inertization; Incineration (Rotary kiln, pyrolytic incinerator); • Cytotoxic waste should not be landfilled or discharged to sewer systems. • Incineration is preferred disposal option. Waste should be returned to supplier where incineration is not an option. Incineration should be undertaken at specific temperatures and time specifications for particular drugs. Most municipal or single chamber incinerators are not adequate for cytotoxic waste disposal. Open burning of waste is not acceptable. • Chemical degradation may be used for certain cytotoxic drugs – See Pruss et al. (1999) Annex 2 for details. • Encapsulation and inertization should be a last resort waste disposal option.

Table 1. Treatment and disposal methods for categories of health care waste

Type of waste	Summary of treatment and disposal options / notes
Chemical waste: Waste may be hazardous depending on the toxic, corrosive, flammable, reactive, and genotoxic properties. Chemical waste may be in solid, liquid, or gaseous form and is generated through use of chemicals during diagnostic / experimental work, cleaning, housekeeping, and disinfection. Chemicals typically include formaldehyde, photographic chemicals, halogenated and nonhalogenated solvents[d], organic chemicals for cleaning / disinfecting, and various inorganic chemicals (e.g. acids and alkalis).	**Waste Segregation Strategy**: Brown bag / container. Leak-proof plastic bag or container resistant to chemical corrosion effects. **Treatment**: Return unused chemicals to supplier; Encapsulation[a]; Safe burial on hospital premises[a]; Incineration (Pyrolytic incinerator[a]; • Facilities should have permits for disposal of general chemical waste (e.g. sugars, amino acids, salts) to sewer systems. • Small hazardous quantities: Pyrolytic incineration, encapsulation, or landfilling. • Large hazardous quantities: Transported to appropriate facilities for disposal, or returned to the original supplier using shipping arrangements that abide by the Basel Convention. Large quantities of chemical waste should not be encapsulated or landfilled.
Radioactive waste: Includes solid, liquid, and gaseous materials that have been contaminated with radionuclides. Radioactive waste originates from activities such as organ imaging, tumor localization, radiotherapy, and research / clinical laboratory procedures, among others, and may include glassware, syringes, solutions, and excreta from treated patients.	**Waste Segregation Strategy:** Lead box, labeled with the radioactive symbol. **Treatment**: Radioactive waste should be managed according to national requirements and current guidelines from the International Atomic Energy Agency. IAEA (2003). Management of Waste from the Use of Radioactive Materials in Medicine, Industry and Research. IAEA Draft Safety Guide DS 160, 7 February 2003.
Waste with high content of heavy metals: Batteries, broken thermometers, blood pressure gauges, (e.g. mercury and cadmium content).	**Waste Segregation Strategy:** Waste containing heavy metals should be separated from general health care waste. **Treatment**: Safe storage site designed for final disposal of hazardous waste. • Waste should not be burned, incinerated, or landfilled. Transport to specialized facilities for metal recovery.
Pressurized containers: Includes containers / cartridges / cylinders for nitrous oxide, ethylene oxide, oxygen, nitrogen, carbon dioxide, compressed air and other gases.	**Waste Segregation Strategy:** Pressurized containers should be separated from general health care waste. **Treatment**: Recycling and reuse; Crushing followed by landfill • Incineration is not an option due to explosion risks • Halogenated agents in liquid form should be disposed of as chemical waste, as above.
General health care waste (including food waste and paper, plastics, cardboard)**:**	**Waste Segregation Strategy**: Black bag / container. Halogenated plastics such as PVC should be separated from general health care facility waste to avoid disposal through incineration and associated hazardous air emissions from exhaust gases (e.g. hydrochloric acids and dioxins). **Treatment:** Disposal as part of domestic waste. Food waste should be segregated and composted. Component wastes (e.g. paper, cardboard, recyclable plastics [PET, PE, PP], glass) should be segregated and sent for recycling.

Source: Safe Management of Wastes from Health-Care Activities. International Labor Organization (ILO), Eds. Pruss, A. Giroult, and P. Rushbrook (1999)

Notes:

a. Small quantities only
b. Low-level infectious waste only
c. Low-level liquid waste only
d. Halogenated and nonhalogenated solvents (e.g. chloroform, TCE, acetone, methanol) are usually a laboratory-related waste stream for fixation and preservation of specimens in histology / pathology and for extractions in labs.
e. Note on incinerators. Pyrolytic and rotary kiln incinerators should be used. Use of single-chamber and drum / brick incinerators are not normally considered good practice, except in emergency situations as a last option.

- Incinerators should have permits issued by authorized regulatory agencies and be operated and maintained by trained employees to ensure proper combustion temperature, time, and turbulence specifications necessary for adequate combustion of waste.[16] This includes implementation of operational controls including combustion and flue gas outlet temperatures (combustion temperatures should be above 850 °C while flue gases need to be quenched very quickly to avoid formation and reformation of POPs) as well as use of flue gas cleaning devices meeting international standards.[17]

Secondary air pollution control measures for hospital waste incinerators include the following:

- Wet scrubbers to control acid gas emissions (e.g. hydrochloric acid [HCl)], sulfur dioxide [SO_2, and fluoride compounds]). A caustic scrubbing solution will increase the efficiency for SO_2 control;
- Control of particulate matter may be achieved through use of cyclones, fabric filters, and / or electrostatic precipitators (ESP). Efficiencies depend on the particle size distribution of the particulate matter from the combustion chamber. Particulate matter from hospital incinerators is commonly between 1.0 to 10 micrometers (μm). ESPs are generally less efficient than baghouses in controlling fine particulates and metals from HWI;
- Control of volatile heavy metals depends on the temperature at which the control device operates. Fabric filters and ESP typically operate at relatively high temperatures and may be less effective than those that operate at lower temperatures. Venturi quenches and venturi scrubbers are also used to control heavy metal emissions. The volatile heavy metals usually condense to form a fume (less than 2 μm) that is only partially collected by pollution control equipment;
- Management of incineration residues such as fly ash, bottom ash and liquid effluents from flue gas cleaning as a hazardous waste (see **General EHS Guidelines**) as they may contain high concentrations of POPs.

Wastewater

Process Wastewater

Wastewater from HCFs often has a quality similar to urban wastewater. Contaminated wastewater may result from discharges from medical wards and operating theaters (e.g. body fluids and excreta, anatomical waste), laboratories (e.g. microbiological cultures, stocks of infectious agents), pharmaceutical and chemical stores; cleaning activities (e.g. waste storage rooms), and x-ray development facilities. Wastewater may also result from treatment disposal technologies and techniques, including autoclaving, microwave irradiation, chemical disinfection, and incineration (e.g. treatment of flue gas using wet scrubbers which may contain suspended solids, mercury, other heavy metals, chlorides, and sulfates).

Depending on the effectiveness of hazardous waste management practices (in particular waste segregation strategies described above), hazardous health care wastes may enter the wastewater stream, including microbiological pathogens (wastewater with a high content of enteric pathogens, including bacteria, viruses, and helminthes / parasitic worms), hazardous chemicals, pharmaceuticals, and radioactive isotopes. Pollution prevention measures to minimize the generation of wastewater include the following:

[16] Technical information on the proper operation and maintenance of hospital waste incinerators may be obtained from WHO (1999) Chapter 8 and the US EPA Handbook on the Operation and Maintenance of Medical Waste Incinerators (2002).

[17] Refer to Guidelines on BAT/BEP practices relevant to Article 5 and Annex C of the Stockholm Convention on Persistent Organic Pollutants, Section V.

- Waste segregation measures should be employed to minimize entry of solid waste into the wastewaster stream, including:
  - Procedures and mechanisms for separate collection of urine, feces, blood, and vomit from patients treated with genotoxic drugs to avoid their entry into the wastewater stream (as described above under waste segregation for hazardous and other wastes);
  - Collection of large quantities of pharmaceuticals for separate treatment or return to manufacturer (see Table 1). Small quantities of mild, liquid pharmaceuticals, excluding antibiotics or cytotoxic drugs, may be discharged to sewer systems with a large water flow.

Municipal Wastewater Treatment [18]

If wastewater is discharged to sanitary sewage treatment systems, the HCF should ensure that wastewater characteristics are in compliance with all applicable permits, and that the municipal facility is capable of handling the type of effluent discharged, as discussed in the **General EHS Guidelines**.

On-site Wastewater Treatment

In cases where wastewater is not discharged to sanitary sewage systems, HCF operators should ensure that wastewater receives on-site primary and secondary treatment, in addition to chlorine disinfection.

Techniques for treating wastewater in this sector include source segregation and pretreatment for removal / recovery of specific contaminants such as radio isotopes, mercury, etc.; skimmers or oil water separators for separation of floatable solids; filtration for separation of filterable solids; flow and load equalization; sedimentation for suspended solids reduction using clarifiers; biological treatment, typically aerobic treatment, for reduction of soluble organic matter (BOD); biological or chemical nutrient removal for reduction in nitrogen and phosphorus; chlorination of effluent when disinfection is required; dewatering and disposal of residuals as hazardous medical / infectious waste. Additional engineering controls may be required for (i) removal of active ingredients (antibiotics and miscellaneous pharmaceutical products, among other hazardous constituents), and (ii) containment and treatment of volatile constituents and aerosols stripped from various unit operations in the wastewater treatment system.

Wastewater generated from use of wet scrubbers to treat air emissions should be treated through chemical neutralization, flocculation, and sludge settling. Sludge should be considered hazardous, and may be treated off-site in a hazardous waste facility, or encapsulated in drums with mortar and landfilled. Sludge treatment should include anaerobic digestion to ensure destruction of helminthes and pathogens. Alternatively, it can be dried in drying beds before incineration with solid infectious wastes.

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**.

1.2 Occupational Health and Safety

Occupational health and safety impacts during the construction and decommissioning of health care facilities (HCF) are

[18] Additional criteria for disposal to municipal systems may be found in WHO (1999).

common to those of most civil construction facilities and their prevention and control is discussed in the **General EHS Guidelines**. General health and safety hazards occurring in HCFs include manual handling injuries, such as sprains and strains from lifting and carrying patients; falls, trips, and slips; injuries caused by moving objects; and mental stress. These and other typical physical hazards are discussed in the **General EHS Guidelines**.

HCF health and safety hazards may affect health care providers, cleaning and maintenance personnel, and workers involved in waste management handling, treatment, and disposal. Industry specific hazards include the following:

- Exposure to infections and diseases
- Exposure to hazardous materials / waste
- Exposure to radiation
- Fire safety

Exposure to Infections / Diseases

Health care providers and personnel may be exposed to general infections, blood-borne pathogens, and other potential infectious materials (OPIM)[19] during care and treatment, as well as during collection, handling, treatment, and disposal of health care waste.

The following measures are recommended to reduce the risk of transferring infectious diseases to health care providers:

- Formulate an exposure control plan for blood-borne pathogens;[20]
- Provide staff members and visitors with information on infection control policies and procedures;[21]
- Establish Universal / Standard Precautions[22] to treat all blood and other potentially infectious materials with appropriate precautions, including:
  - Immunization for staff members as necessary (e.g. vaccination for hepatitis B virus)
  - Use of gloves[23], masks, and gowns
  - Adequate facilities for hand washing[24]. Hand washing is the single most important procedure for preventing infections (e.g. nosocomial and community). Hand washing should involve use of soap / detergent, rubbing to cause friction, and placing hands under running water. Washings of hands should be undertaken before and after direct patient contacts and contact with patient blood, body fluids, secretions, excretions, or contact with equipment or articles contaminated by patients. Washing of hands should also be undertaken before and after work shifts; eating; smoking; use of personal protective equipment (PPE); and use of bathrooms. If hand washing is not possible, appropriate antiseptic hand cleanser and clean cloths / antiseptic towelettes should be provided. Hands should then be washed with soap and running water as soon as practical

[19] According to US OSHA, blood-borne pathogens are pathogenic microorganisms that are present in human blood and can cause disease in humans, including human immunodeficiency virus (HIV), hepatitis B virus (HIB), and hepatitis C virus (HCV). Other potentially infectious materials (OPIM) refers to (1) The following human body fluids: semen, vaginal secretions, cerebrospinal fluid, synovial fluid, pleural fluid, pericardial fluid, peritoneal fluid, amniotic fluid, saliva in dental procedures, any body fluid that is visibly contaminated with blood, and all body fluids in situations where it is difficult or impossible to differentiate between body fluids; (2) Any unfixed tissue or organ (other than intact skin) from a human (living or dead); and (3) HIV-containing cell or tissue cultures, organ cultures, and HIV- or HBV-containing culture medium or other solutions; and blood, organs, or other tissues from experimental animals infected with HIV or HBV.

[20] U.S. Department of Labor Occupational Health and Safety Administration (OSHA). Regulations (Standards - 29 CFR) Bloodborne pathogens. - 1910.1030 for health care facilities.

[21] U.S. Centers for Disease Control (CDC), Guideline for infection control in health care personnel (1998) , Available at: http://www.cdc.gov/ncidod/dhqp/pdf/guidelines/InfectControl98.pdf

[22] Transmission-based precautions include air, droplet, and contact precautions are available from the US Occupational Health and Safety Administration (OSHA) at http://www.osha.gov/SLTC/etools/hospital/hazards/univprec/univ.html

[23] Health care workers may be latex sensitive, resulting in serious allergic reactions. Hypoallergenic gloves, glove liners, powderless gloves, or other similar alternatives should be available to those workers who are allergic.

[24] US CDC Guideline for Hand-Washing in Health Care Facilities (2002). Available at http://www.cdc.gov/mmwr/preview/mmwrhtml/rr5116a1.htm

- Procedures and facilities for handling dirty linen and contaminated clothing, and preparing and handling food
- Appropriate cleaning and waste disposal practices for the health care workplace

- The following recommendations should be implemented when using and handling of needles / sharps:
  - Use safer needle devices and needleless devices to decrease needlestick or other sharps exposures[25]
  - Do not bend, recap, or remove contaminated needles and other sharps unless such an act is required by a specific procedure or has no feasible alternative
  - Do not shear or break contaminated sharps
  - Have needle containers available near areas where needles may be found
  - Discard contaminated sharps immediately or as soon as feasible into appropriate containers
  - Used disposable razors should be considered contaminated waste and disposed of in appropriate sharps containers
- Establish policies to exclude animals from facility property.

In addition to the above recommendations, the following measures are applicable to personnel involved in waste management to reduce the risk of transferring infectious diseases:

- Implement immunization for staff members, as necessary (e.g. vaccination for hepatitis B virus, tetanus immunization);
- Provide adequate supplies of PPE for personnel involved in waste management including: overalls / industrial aprons, leg protectors, boots, heavy duty gloves, helmets, visors / face masks and eye protection (especially for cleaning of hazardous spills), and respirators (for spills or waste involving toxic dust or incinerator residue) as necessary;
- Provide washing facilities for personal hygiene, particularly at waste storage locations.

Exposure to Hazardous Materials and Waste

HCF workers may be exposed to hazardous materials and wastes, including glutaraldehyde (toxic chemical used to sterilize heat sensitive medical equipment), ethylene oxide gas (a sterilant for medical equipment), formaldehyde, mercury (exposure from broken thermometers), chemotherapy and antineoplastic chemicals, solvents, and photographic chemicals, among others. In addition to the guidance provided above, hazardous materials and wastes should be handled according to occupational health and safety guidance provided in the **General EHS Guidelines**.

Waste Anesthetic Gas (WAG) Exposure

Health care workers may be at risk of toxic exposure to nitrous oxide; the halogenated agents halothane (fluothane), enflurane (ethrane), isoflurane (forane); and other substances typically used as inhalation anesthetics.

Recommended measures to control exposure to waste anesthetic gas (WAG used in the operating room for example) include use of a scavenging unit attached to the anesthesia unit. The scavenging unit may have a charcoal filter that absorbs halogenated anesthetic gases, but not nitrous oxide. Spent charcoal filters should be disposed of as hazardous waste. If

[25] OSHA recommends the following safety devices: Needleless connector systems: needleless connectors for IV delivery systems (e.g. blunt cannula for use with prepierced ports and valved connectors that accept tapered or luer ends of IV tubing). Self-Sheathing Safety Feature: Sliding needle shields attached to disposable syringes and vacuum tube holders (e.g. disposable scalpels with safety features such as a sliding blade shield). Retractable Technology: Needles or sharps that retract into a syringe, vacuum tube holder, or back into the device (e.g. syringe with a retractable needle, retractable finger / heel-stick lancets). Self Blunting Technology: Self-blunting phlebotomy and winged-steel "butterfly" needles (a blunt cannula seated inside the phlebotomy needle is advanced beyond the needle tip before the needle is withdrawn from the vein). Add-on Safety Feature: Hinged or sliding shields attached to phlebotomy needles, winged steel needles, and blood gas needles.

there is no scavenging unit, or if the scavenging unit does not have a filter, vacuum lines are used to collect WAGs which are subsequently vented outside and dispersed.

Radiation

Occupational radiation exposure may result from equipment emitting X-rays and gamma rays (e.g. CT scanners), radiotherapy machines, and equipment for nuclear medicine activities. HCF operators should develop a comprehensive plan to control radiation exposure in consultation with the affected workforce. This plan should be refined and revised as soon as practicable on the basis of assessments of actual radiation exposure conditions, and radiation control measures should be designed and implemented accordingly. Recommendations to prevent and control exposure to radiation are discussed in the **General EHS Guidelines**.

Fire Safety

The risk of fire in health care facilities is significant due to the storage, handling, and presence of chemicals, pressurized gases, boards, plastics, and other flammable substrates. Fire safety recommendations applicable to occupational areas are presented under 'Occupational Health and Safety' in the **General EHS Guidelines**. Recommendations applicable to buildings accessible to the public, including health care facilities, are presented under 'Life and Fire Safety' in the **General EHS Guidelines**. Additional recommendations for fire safety include:

- Installation of smoke alarms and sprinkler systems;
- Maintenance of all fire safety systems in proper working order, including self-closing doors in escape routes and ventilation ducts with fire safety flaps;
- Training of staff for operation of fire extinguishers and evacuation procedures;
- Development of facility fire prevention or emergency response and evacuation plans with adequate guest information (this information should be displayed in obvious locations and clearly written in relevant languages).

1.3 Community Health and Safety

Community health and safety issues during the construction, operations, and decommissioning of HCFs are generally common to those of most industrial facilities, and are discussed in the **General EHS Guidelines**. Community hazards associated with health care facility environments, particularly related to hazardous health care waste, necessitate that members of the public receive adequate information regarding potential infection hazards within the facility, and at associated waste disposal sites (e.g. landfills). Guidance on community disease transmission is provided in the **General EHS Guidelines**.

2.0 Performance Indicators and Industry Benchmarks

2.1 Environmental Performance

Emissions and Effluent Guidelines

Tables 2 and 3 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 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. Emissions guidelines are applicable to process emissions. Combustion source emissions guidelines associated with steam- and power-generation activities from sources with a capacity equal to or lower than 50 megawatt thermals (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**.

Effluent guidelines are applicable for direct discharges of treated effluents to surface waters for general use. Site-specific discharge levels may be established based on the availability and conditions in the 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.** 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.

Table 2. Effluent Levels for Health Care Facilities

Pollutants	Units	Guideline Value
pH	S.U	6 - 9
Biochemical oxygen demand (BOD_5)	mg/L	50
Chemical oxygen demand (COD)	mg/L	250
Oil and grease	mg/L	10
Total suspended solid (TSS)	mg/L	50
Cadmium (Cd)	mg/L	0.05
Chromium (Cr)	mg/L	0.5
Lead (Pb)	mg/L	0.1
Mercury (Hg)	mg/L	0.01
Chlorine, total residual	mg/L	0.2
Phenols	mg/L	0.5
Total coliform bateria	MPN[a] / 100ml	400
Polychlorinated dibenzodioxin and dibenzofuran (PCDD/F)	Ng/L	0.1
Temperature increase	°C	<3[b]

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 3. Air Emission Levels for Hospital Waste Incineration Facilities[b]

Pollutants	Units	Guideline Value
Total Particulate matter (PM)	mg/Nm^3	10
Total organic carbon (TOC)	mg/Nm^3	10
Hydrogen Chloride (HCl)	mg/Nm^3	10
Hydrogen Fluoride (HF)	mg/Nm^3	1
Sulfur dioxide (SO_2)	mg/Nm^3	50
Carbon Monoxide (CO)	mg/Nm^3	50
NO_X	mg/Nm^3	200-400[(a)]
Mercury (Hg)	mg/Nm^3	0.05
Cadmium + Thallium (Cd + Tl)	mg/Nm^3	0.05
Sb, As, Pb, Cr, Co, Cu, Mn, Ni and V	mg/Nm^3	0.5
Polychlorinated dibenzodioxin and dibenzofuran (PCDD/F)	ng/Nm^3TEQ	0.1

Notes:
a. 200 mg/m3 for new plants or for existing incinerators with a nominal capacity exceeding 6 tonnes per hour; 400 mg/m3 for existing incinerators with a nominal capacity of 6 tonnes per hour or less
b. Oxygen level for incinerators is 7 percent.

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**.

Resource Consumption, Energy Use, and Waste Generation

Environmental performance of hospital installations should also be evaluated against internationally published benchmarks for resource consumption, energy use and waste generation. If inefficiencies are identified, the comparison with published benchmarks should be followed by a detailed audit or survey to identify potential opportunities for improvement, without compromising the objective of providing quality, safe, health care.[26]

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),[27] the Pocket Guide to Chemical Hazards published by the United States National Institute for Occupational Health and Safety (NIOSH),[28] Permissible Exposure Limits (PELs) published by the Occupational Safety and Health Administration of the United States (OSHA),[29] Indicative Occupational Exposure Limit Values published by European Union member states,[30] 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)[31].

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[32] 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**.

[26] Examples of reference sources include: Energy Consumption: United States Department of Energy, Energy Information Administration (http://www.eia.doe.gov/); Natural Resource Canada, Office of Energy Efficiency (http://oee.nrcan.gc.ca); Water Use: Healthcare Environmental Resource Center (http://www.hercenter.org/); Waste Generation: Hospitals for a Health Environment (http://www.h2e-online.org/)
[27] Available at: http://www.acgih.org/TLV/ and http://www.acgih.org/store/
[28] Available at: http://www.cdc.gov/niosh/npg/
[29] Available at: http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=9992
[30] Available at: http://europe.osha.eu.int/good_practice/risks/ds/oel/
[31] Available at: http://www.bls.gov/iif/ and http://www.hse.gov.uk/statistics/index.htm
[32] Accredited professionals may include Certified Industrial Hygienists, Registered Occupational Hygienists, or Certified Safety Professionals or their equivalent.

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Annex A: General Description of Industry Activities

The Health Care Facilities (HCF) sector includes a diverse range of facilities and activities involving general hospitals, small inpatient primary care hospitals, outpatient facilities, assisted living facilities, and hospice facilities. Ancillary facilities may include medical laboratories and research facilities, mortuary centers, and blood banks and collection services.

The HCF sector involves close contact among patients, health care providers, and support staff; extensive use of sharps and instruments designed for diagnostic and curative (invasive and noninvasive) procedures; and utilization of pharmaceutical, chemical, radiological, and other agents for diagnosis, treatment, cleaning, and disinfection.

The basic infrastructure elements / activities of HCF facilities are to improve the health of patients, prevent transmission of infections among patients and staff, and control impacts to environment, health, and safety including maintenance of sanitary conditions; use of appropriate disinfection and sterilization techniques; provision of potable water and clean air for all operations; and nosocomial infection control.

The medical technology area (MTA) is the central focus of a hospital / clinic. Typically, it is not present in outpatient facilities, assisted living facilities for elderly or handicapped persons, or hospice facilities. Dedicated patient and services areas (P&SA) are of major significance in hospitals and clinics, as well as in assisted living facilities for elderly or handicapped persons, and hospice facilities.

Typically an HCF needs between 60 to 100 square meters (m^2) per bed, in addition to an area of equal or similar size for parking and facility access. With periodic upgrading of technologies, the relevant investment involved ranges from US$175,000 to 500,000 per bed in developed countries, and in developing countries may range from US$175,000- 200,000 per bed.

As part of day-to-day operations, HCFs generate a variety of wastes, including air emissions, wastewater effluents, health care waste (e.g. infectious, pathologic, and chemical wastes), and municipal solid waste. Average electricity consumption for an HCF is influenced by its design criteria, particularly by the availability or need for specific services. These may include a dedicated heating plant or in-house services such as kitchens and laundries, which may require outsourcing if unavailable in the HCF. The energy consumption of a general hospital is almost double that consumed by all other types of buildings, mostly because of MTA energy needs.

Figure A.1: Schematic Diagram of a Health Care Facility