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Sub-sectoral Environmental and Social Guidelines: Metal Surface Engineering

PROCESS DESCRIPTION

Surface engineering refers to a wide range of technologies designed to modify the surface properties of metallic and non-metallic components for decorative and/or functional purposes. There are a wide variety of surface engineering processes; the principal ones are described below:

- **Pre-treatment:** to remove undesirable metallic, metal oxide and other coatings by:
  - Immersion in an acidic or alkali bath or spray cleaning;
  - Abrasive blast cleaning;
  - Degreasing using solvents and acid cleaners.
- **Electroplating:** deposition of a thin layer of metal by passing an electric current through an aqueous solution of metal salt.
- **Anodising:** electrolytic treatment, mainly of aluminium and magnesium, which results in the oxidation of the metal surface to form a protective film of metal oxide.
- **Electroless Deposition:** chemical reduction of certain metals, (copper, nickel, gold and tin).
- **Chemical Conversion:** includes chromating, phosphating, metal colouring, and passivating operations by chemical or electrochemical treatment to form a complex surface layer compound.
- **Organic Coating:** painting, spraying or dipping with solvent, water-based or powdered organic substances.
- **Heat Treatment:** use of heat in salt baths to alter the metallurgical structure and mechanical properties of a component.
- **Hot Dipping:** dipping ferrous articles into molten zinc or zinc alloy (galvanising) or tin or tin alloy (tinning).
- **Metal Spraying:** use of heat, plasma or arc to transfer metals to surfaces of prepared components.
- **Vitreous Enamelling:** application of metallic glass containing liquids by dipping or spraying techniques on to ferrous components.

Many installations operate a mixture of small and large production lines, and a mixture of electrolytic and chemical processes. The majority of processes require pre-treatment, at least one core activity, rinsing, and drying.

KEY ENVIRONMENTAL, HEALTH AND SAFETY RISK/LIABILITY ISSUES

Hazardous Materials Storage

Hazardous chemicals and process gases should be labelled with the appropriate internationally recognised diamond shaped hazard symbol[1]. Chemicals with different hazard symbols should not be stored together - clear guidance on the compatibility of different chemicals can be obtained from the Materials Safety Data Sheet

[1] United Nations 2007

(MSDS) which should be readily available from the manufacturer and on site.

Strong acids, alkalis and solvents will be stored in a variety of containers ranging in size from small e.g. 25l, to intermediate bulk containers (IBCs) up to large bulk storage tanks. Accidental leakages can occur during filling operations and vessels may develop leaks or be overfilled. Pipes and valves connecting containers to the point of use may be damaged or deteriorate. All equipment, associated loading/unloading areas and chemical or waste storage tanks should be completely contained within secondary containment, normally provided by bunding. Repeated spillages can lead to corrosion of the containment if it is not sealed with a substance resistant to the material contained.

Procedures should be in place to ensure that tanks and containment are routinely inspected and repaired and to prevent overfilling and to prevent filling with incompatible materials.

Large-scale solids deliveries may be by bulk tanker, but are more usually in the form of big bags. Powders, pellets and flakes are delivered in 25kg sacks, bags, drums and other containers including disposable packaging. Storage of bulk solids may be in silos. Other solids are stored in their delivery containers.

Metals for deposition are usually delivered as anode bars or anode balls, or as salts but may be in proprietary solutions for chemical treatments.

Disposal of empty drums and packaging of fuel and chemicals may pose both contamination risks to soil and groundwater, and health and safety risks. Wherever possible, packaging should be returned to the supplier for reuse.

Water Supply

Most processes use fresh water for make-up and maintenance of process fluids and for rinsing. Significant quantities of water can be lost by evaporation in processes operating at greater than 60°C.

Much of the water supplied is used for rinsing and quenching after coating and is discharged after treatment. Water use and metal losses can be high if rinsing and treatment techniques are poor. Re-circulatory or low flow systems should be used as appropriate to reduce water consumption. The use of cascade rinsing (counterflow) systems, i.e. rinsing with progressively cleaner water, can reduce water usage. Rinse water can be used to replace evaporative losses.

In some applications, e.g. electronic components, high water quality is required and pre-treatment, e.g. by deionisation or filtration may be necessary.

Wastewater and Liquid Wastes (Effluent)

Effluents usually contain significant pollutants and must be treated prior to discharge to the municipal sewerage system:

- Surface preparation may result in wastewaters contaminated with suspended solids, oils, solvent degreasers, and acid and alkali cleaners.

- Rinse water will contain residues of the solution applied. Acid pickling rinse water may contain pickle agent, iron salts and other dissolved metals. Spent pickle liquors contain dissolved iron and other metals. These metals can normally be recovered by

precipitation. In continuous pickling processes, the acid can be recovered by regeneration.

- Spent electrolytes are normally discharged to an effluent treatment system or consigned to a waste disposal contractor.

- Spent alkali cleaners contain oils, grease and metal particles that may be discharged to the effluent treatment facility or removed by a licensed waste disposal contractor. Sludges will collect at the bottom of the cleaner tank and are dealt with in the same way.

- Discharge from ion-exchange regeneration in the form of acidic or caustic solutions.

Air Emissions

- Venting of strong acid containers to atmosphere takes place to relieve pressure changes.

- Release of acids and chlorine gas during filling.

- Emission of particulates of abrasive materials and abraded metal particles from mechanical surface preparation;

- Volatile organic compounds (VOCs) will be emitted during solvent-based degreasing operations.

- Electroplating can release volatile (and sometimes foul smelling) organic additives to atmosphere; hydrogen gas carrying microdroplets of electrolyte can be released and extracted to atmosphere via the fume collection system.

- Acid based processes, e.g. pickling, anodising, electropolishing, dipping, can release gases (HCl, HF, NOx) and acid mists (sulphuric, nitric, chromic, phosphoric acid) depending on the acid used in the process.

- Heat treatment using cyanide salt bath can release cyanide fumes, which are highly poisonous.

Solid Wastes

Many of the processes including effluent treatment generate a metal sludge. These wastes are hazardous and if recovery of the metals is not possible, they must be consigned for disposal in compliance with national legislation.

Packaging

Large quantities of packaging may be used. Companies operating with the European Union (either as a manufacturer or as a supplier into European Union countries) will be subject to the European Union Packaging and Packaging Waste Directive (94/62/EC), which aims to reduce the amount of packaging that is being introduced into waste.

Permitting

Surface engineering facilities in the EU are subject to national regulations under the Integrated Pollution Prevention and Control Directive (2008/1/EC) and may be subject to the Seveso II (1996/82/EC) which aims to control the major accident hazard from dangerous substances if sufficient quantities of these chemicals are held on site. Operations outside the EU will be subject to local regulation but this will generally set less stringent requirements on the techniques to be adopted.

Energy Consumption

Energy is required to:

- Heat some cleaning, pickling, dipping and plating solutions and salt baths in heat treatment;
- Provide a DC supply to plating, anodising, electropolishing operations;
- Dry after final rinse to prevent corrosion in storage;
- Power fume extraction and abatement scrubbers.

Noise and Vibration

Noise and vibration are significant hazards where mechanical surface preparation is carried out prior to treatment.

Noise may reach levels that are hazardous to health. Hand-arm vibration syndrome from the prolonged use of vibrating tools and machinery causes effects on the body's blood circulation known as 'vibration white finger' (VWF). Other damage may be caused to the nerves and muscles of the fingers and hands causing numbness and tingling, reduced grip strength and sensitivity. Pain and stiffness in the hands, and joints of the wrists, elbows and shoulders are other possible symptoms.

Appropriate PPE should be provided and good occupational health systems are required to monitor and control employee long-term exposure to noise and vibration.

Dermatitis and Respiratory Hazards

- Acid mists from pickling areas can cause skin, eye and respiratory irritation;
- Chromic acid, widely used in electroplating, can cause cancer when inhaled, ingested or in contact with the skin. It can also cause skin irritation, burns and ulceration, asthma and poisoning.

OTHER ENVIRONMENTAL, HEALTH AND SAFETY RISK/LIABILITY ISSUES

Electrical Hazards

Many of the processes use conductive and corrosive fluids resulting in an atmosphere that is humid and laden with corrosive mists. People may therefore be working close to electrical systems and exposed conductors in damp and corrosive conditions.

Polychlorinated Biphenyls (PCBs) & Asbestos

- PCBs are a group of substances which are good electrical insulators. Typically, PCBs may be present as constituents of hydraulic oils or dielectric fluids in electrical switchgear, transformers and fluorescent light starters. PCBs are extremely toxic and become concentrated within the food chain. Any products that may contain PCBs must be disposed of by licensed contractors in accordance with national regulations.
- Asbestos was used on a large scale for many years as a fire proofing and insulation materials and may be encountered in a wide range of forms within the fabric of older

buildings. Asbestos fibres, which are extremely hazardous when inhaled (causing mesothelioma and fibrous thickening in the lungs), may be released when the asbestos containing material is disturbed during maintenance or demolition.

Particular attention should be given to buildings constructed before the 1980s.

Machinery/Product Handling

Moving parts of machinery can result in entanglement and entrapment. Particular attention handling, cutting and grinding activities.

Collision

Heavy loads are lifted and moved at elevated heights using hydraulic platforms and cranes presenting a serious safety hazard. Grinding and cutting activities may eject pieces of scrap metal causing injury.

Manual Handling and Repetitive Work

Lifting, repetitive work, poor posture and carrying heavy or awkwardly shaped objects, such as bags and heavy equipment can result in injuries.

Slips, Trips and Falls

These often occur on the same level and are primarily caused by uneven surfaces, inappropriate footwear, lighting, weather conditions, trailing cables and pipe work especially during unblocking, maintenance and cleaning activities.

KEY SOCIAL, LABOUR AND COMMUNITY RISK/LIABILITY ISSUES

Health Surveillance

Workers in the metal surface engineering industry can be exposed to long-term occupational health hazards, such as asthma, dermatitis, ulcers and cancer. A system of health surveillance should be in place to protect the health of individual employees that may be at risk. Training to recognise harmful effects and symptoms should be provided. It may be appropriate to screen employees prior to employment for certain roles.

OTHER SOCIAL, LABOUR AND COMMUNITY RISK/LIABILITY ISSUES

Odours

Public/environmental health and nuisance issues associated with dust and vented fumes can arise from production activities and may have a significant effect on neighbouring locations. This may be important if there are neighbouring residential and industrial activities in the area;

Transport

Transport of products by either road can be a significant issue. This might lead to road noise and traffic congestion.

Transportation of hazardous materials pose potential nuisance risks, health and safety hazards to staff, and third parties such as neighbours.

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FINANCIAL IMPLICATIONS

- Many countries are signatories to the Kyoto Protocol and have adopted targets for the reduction of CO_2 emissions. Where Governments have set up carbon emission reduction programmes industrial processes have been required to reduce their CO_2 emissions through the setting of targets. This can result in a need for substantial investment in new/clean technologies to achieve the emission targets. These targets may be reflected in environmental permits;
- Under the EU Emissions Trading Scheme (ETS) Member States allocate allowances for carbon emissions to industrial sites, including refineries. The scheme can create both financial assets or liabilities and entities can trade their carbon allowances;
- Injuries may lead to increased payroll costs to replace skilled workers and lost production time;
- Capital investment may be required to comply with new environmental, health and safety requirements;
- Fines, penalties and third party claims may be incurred for non-compliance with environment, health and safety regulations.
- Improvement of the rinsing system will require capital investment but this will be offset by capital savings on a smaller effluent treatment facility, operational savings on water consumption and metal recovery.

IMPROVEMENTS

Environmental, Health and Safety Improvements

General

- Environment, health and safety training for all employees and contractors;
- Good housekeeping should be maintained at all times in all areas to reduce the likelihood of incidents and accidents;
- Systems should be subject to frequent and proper inspection;
- Routine plant maintenance to keep small leaks and spills to a minimum and maintain plant efficiency;
- Controls should be implemented to minimise the exposure to gases, fume, dust, noise and vibration, e.g.
    - Mechanical controls such as enclosures, use of filters and PPE;
    - Administrative controls such as limiting exposure time, health surveillance;
    - Operator behaviour through training and instructions.

Airborne Emissions

- Installation or upgrade of abatement technology to minimise exposure to hazardous substances and to control the release of emissions, e.g. enclosure of equipment, use of appropriate ventilation

with filters, gas balancing systems, baghouses, cyclones, and wet or alkali scrubbers.

Noise & Vibration

- Enclosure of noisy machines to isolate people from the noise where practicable;
- Reduction of exposure times for people working near noisy machinery and provide personal protective equipment where people have to enter noisy areas.

Water and Wastewater

- Consider feasibility of substitution of hazardous chemicals with less hazardous alternatives;
- Segregate rainwater, wastewater and effluent streams to optimise wastewater and effluent treatment;
- Design effluent system to accommodate blending of acid and alkali discharges to reduce need for pH adjustment;
- Consider upgrades to rinsing system to reduce water usage e.g. cascade rinsing, spraying;
- Consider upgrades to wastewater treatment facilities, e.g. ion-exchange treatment;
- Recycle treated wastewater where possible back to the processes or to secondary uses such as for cleaning;
- Emergency storage lagoons may be needed to prevent contaminated firewater reaching controlled waters;
- Maintain on site abatement equipment and wastewater treatment plant.

Energy Efficiency

- Improve insulation to minimise heat loss.

Storage

- Bulk containment must be:
  - inspected regularly to prevent leakage;
  - provided with secondary spill containment;
  - installed with automatic alarms and shut off systems;
- Pave stockyards to prevent pollutant infiltration to soil and groundwater.

Waste

- Implement acid recovery processes to recover metals and reusable acids;
- Return empty containers to the supplier for reuse.

Health & Safety

- Provision of personal protective equipment (PPE) that is fit for the task to prevent injury and maintain hygiene standards. Staff should be trained in the correct selection, use and maintenance of PPE;
- Redesign manual processes to avoid heavy lifting/repetitive activities;

- Install mechanical lifting aids where possible and rotate work tasks to reduce repetitive activities;
- Separate people from vehicles and machinery were practicable;
    - Ensure that the process layout reduces opportunities for process activities to cross paths;
    - Installation of safeguards on moving parts of conveyor belts to reduce risk of entrapment of employees;
    - Install walkways to separate people from vehicle movements to reduce risk of collision.
- Route cables and pipework under walkways to prevent slips, trips and falls;
- Construct walkways of non-slip materials;
- Substitute silica based abrasives with synthetic aluminium oxide based products;
- Provision of panic showers at locations where hazardous chemicals are stored or used;
- Provision of suitable and sufficient washing and changing facilities;
- Cover open tanks to prevent persons accidentally falling into them or becoming overcome with fumes.
- Provide the local fire department with a list and volume of products stored on the premises;
- Introduce accident, fire and explosion precautions and emergency response procedures.

Social Community and Labour Improvements

- Implement a programme of routine worker health surveillance;
- Implement a grievance/dispute resolution mechanism for workers and members of the community to raise issues with the Company.

GUIDE TO INITIAL DUE DILIGENCE SITE VISITS

During the initial site visit, the issues will vary according to the type of process being used and product being produced and depending on the level of environment, health and safety management already introduced.

General

- Confirm organisational responsibilities and systems for environment, health, safety and social issues;
- What process and chemicals are used?
- Note signs of poor housekeeping, such as signs of spillages and high numbers of empty drums. Particularly note any recent spills;
- Check the condition of any assets, facilities, equipment and production areas. Look for wear and tear and poor maintenance.

Air Emissions Management

- Are there any fume control measures? Do these work and are these used? Is the air humid and/or a noticeable odour? Is there any build-up of dust on machinery or other surfaces?

Noise

- Note the noise levels at the site. Is there any evidence of noise abatement measures deployed?

Water Supply & Management

- What amounts and quality of water are required? Where is the water obtained from? Is the water recycled?

Liquid Waste Management

- What liquid effluents are produced? What discharge control measures are employed?
- Is effluent and wastewater treated before discharge? If so, check the condition of the treatment plant and location of discharge points for effluent and wastewater from the facility;
- What does the quality of these discharges look like? Note the colour and appearance of adjacent watercourses;
- Note whether the wastewater treatment plant discharges to ground, a local watercourse or the municipal wastewater treatment works. Higher environmental risks will be associated with facilities discharging to water courses without adequate treatment;
- Is the water quality tested? What are the waters tested for? Where are the samples taken from, how often? Do the discharges have to meet set standards?

Solid Waste Management

- Note nature of solid waste disposal;
- Check that solid waste storage equipment is in a good condition;
- Check that waste storage areas are clear of debris and that skips are covered to prevent waste escaping, for example, check that waste containers have lids or are stored in an area with a roof;
- Check for flora/vegetation zones near storage sites that are not growing very well as this will indicate the possibility of pollution.

Transport of Finished Product from the Site

- Is this by rail, road or water or a combination of these?
- Does road haulage cause excessive traffic through any neighbouring residential areas?

Fuel and Bulk Material Storage Arrangements

- What fuels and materials are stored in bulk on site?
- To gauge the potential for spillages and leaks consider the following:
    - Are there any underground storage tanks?

- Are surface storage tanks and usage areas hard surfaced and bunded? Are these in good condition or are cracks present? Are these regularly tested for leakages?
- Is the size of the bunding adequate for the volume of the materials stored?
- Are the bunds regularly cleaned out to avoid loss of capacity due to holding rainwater etc?

Health & Safety

- Are staff wearing PPE?
- Check signage around the site:
  - Does it convey the health and safety risks?
  - Are fire exits and/or evacuation routes clearly marked?
  - Are there demarcated routes for pedestrians and vehicles?
- Check for automatic safeguards on machinery to prevent accidental injury;
- Check for presence of uncovered tanks/chemical baths;
- Are panic showers provided? Are these tested for legionella?
- Is there worker health monitoring programme? What does it check for?

Incident Management

- Is fire fighting and first aid equipment available?
- Have there been any recent (within the last three years) incidents on site such as fatalities, fires/explosions, spills?
- Assess emergency response to fires, major spills, etc.

Inspections & Regulation

- Check the conditions and duration of validity for all permits;
- What systems are in place to check and maintain assets and infrastructure?
- Has the organisation been subject to environment, health and safety or quality audits by customers/insurers? What was the outcome of these audits?
- Find out what insurances are in place (health, hygiene, fire etc). Identify number and type of claims against insurance. Have insurers made any environment, health and safety audits of the facility? What were there findings and actions taken by management to address these
- Have the premises been inspected recently (within the past 2 years) by the regulatory authorities for health, hygiene and environment? What were their findings?

Investment

- Review budgets for capital expenditure (capex) and operational expenditure to cover

environment, health and safety matters. Does the business plan have line items for environment, health, safety and social improvements as well as asset management and maintenance?

- If investment or refinancing will lead to restructuring of the organisation what will be the potential impacts on health and safety at the operation and wider community? Have these been considered and assessed by the company?

- If the company plans to invest in new technology, what will be the impacts and benefits for human resources?

Social, Labour and Community

- Check that labour standards, contracting and remuneration are in line with national law and are consistent with the average for the sector;

- Check that hours worked, including overtime, are recorded and staff should receive written details of hours worked and payment received;

- Check that wages and working hours are consistent with the average for the sector and national standards;

- Has the Company received inspections from the local labour inspectorate in the previous three years? Have these resulted in any penalties, fines, major recommendations or corrective action plans?

- Does the organisation have a grievance mechanism which allows employees to raise workplace concerns?

- Are employees free to form, or join, a worker's organisation of their choosing?

Take note/ask questions relating to any activities that address the improvements listed in the improvements section of this document

ACTION PLANS

Dependent on the individual business, select appropriate improvements from the list above to include in the action plan. As a minimum, any business should be required to have the following in place:

Environmental, Health and Safety

- Operational procedures to manage environmental, health, safety and social risks;

- Monitoring programmes;

- Improvement objectives, targets and project plans;

- Training for personnel;

- Regular inspections, checks and audits with records to demonstrate achievement of the required level of performance against legal requirements and improvement action;

- Operational procedures to manage environmental, health, safety and social risks;

- Emergency plans for environment, health and safety accidents;

- Waste management plan (waste minimisation, re-use, recycling, monitoring);

- Senior management review/demonstrated involvement in environment, health, safety and hygiene management.

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