European Bank
for Reconstruction and Development

Sub-sectoral Environmental and Social Guideline: Glass Manufacturing

Introduction

This guideline focuses on the manufacture of glass and glass products.

Reference NACE codes:

23 Manufacture of other non-metallic mineral products
- 23.1 Manufacture of glass and glass products (flat glass, shaping and processing of flat glass, manufacture of hollow glass, glass fibres, processing of other glass, including technical glassware).

Material risks

Below is an overview of the environmental and social (E&S) material risks present in glass manufacturing:

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E&S Risk Category ***Key E&S Risks***[1]	**Environment** Affect the natural environment	**Health and Safety** Affect the health or safety of employees	**Labour** Affect workplace conditions and the treatment of employees	**Community** Affect the health and safety, livelihoods, and environment of the community and wider public	**Page no.**
Air Emissions	√	√		√	5
Noise Emissions	√	√		√	6
Water Use	√			√	7
Wastewater	√				7
Solid Waste	√			√	8
Energy Use	√				8
PCBs/Asbestos		√			9
Hazardous Materials	√	√			10
Machine and Electrical Safety		√			10
Traffic Management		√		√	11
Manual Handling		√			11
Slips, Trips and Falls		√			12
Temperature Exposure		√			12
Confined Spaces		√			12
Labour and Working Conditions		√	√		12
Relations with Local Communities				√	13

[1] Note: this table provides an indicative list of the EHS risks associated with the sub-sector; it is not meant to be an exhaustive list and EHS risks will depend on the specific setting and scale of the operation or facility.

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Contents

1. Process Description

The glass industry produces a wide variety of products, the majority of which are sold to other industries, e.g. food packaging, construction, automotive manufacturing etc. However, there are some specialist small volume sectors producing high-value technical or specialist glass products.

Glass is made by melting together several minerals at very high temperatures. Silica in the form of sand is the main ingredient and this is combined with soda ash and limestone and melted in a furnace at temperatures of 1,700°C.

Other materials can be added to produce different colours or properties. Glass can also be coated, heat-treated, engraved or decorated.

Whilst still molten, glass can be manipulated to form packaging, car windscreens, glazing or numerous other products. Depending on the end use, the composition of the glass and the rate at which it is allowed to cool will vary.

There are six main groups of products covered by this guideline (glass frit, water glass and stone wool are excluded):

- *Container glass:* molten glass is formed by automated machines which press and/or blow the shape. Colouring agents and surface coatings are applied to the finished product;

- *Domestic:* processes are similar to container glass. The products are finished through polishing, etching, engraving, enamelled etc.

- *Flat glass*: comprising float glass and rolled glass:

  - *Float glass*: molten glass is poured onto a bath of molten tin. The glass ribbon is caught by rollers and drawn in length and width. The product then passes through a temperature-controlled tunnel for annealing (i.e. heat treatment to change glass properties). Glass is then cut and surface coatings added as required;

  - *Rolled glass*: molten glass is squeezed through water-cooled double steel rollers prior to annealing.

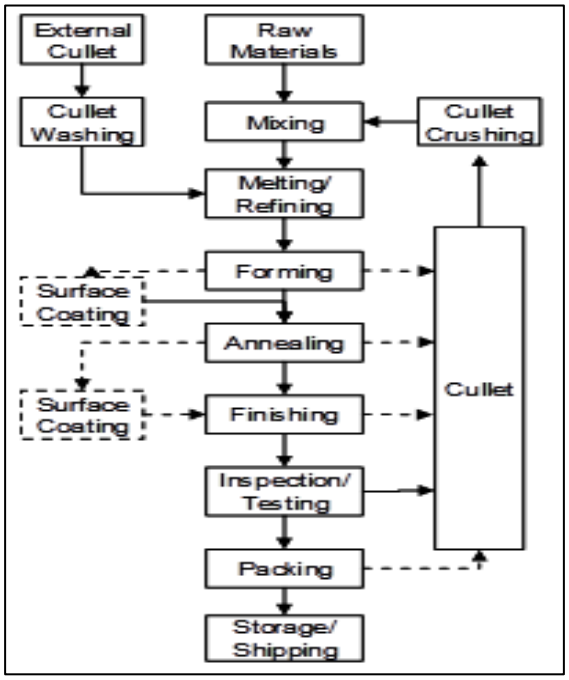
- *Special:* a variety of chemical compositions and forming techniques are used, e.g. pressing, blowing, moulding, spinning, etc.;

- *Continuous filament glass fibre:* molten glass is drawn through bushings which contain over 1,600 calibrated holes at a constant speed of several thousand metres per minute. This is normally an aluminoborosilicate glass with very low sodium oxide content. The product is used to strengthen and stiffen thermosetting plastics, thermoplastics, nylon and polypropylene;

- *Glass wool:* molten glass flows into a rapidly- rotating alloy steel dish (crown) which has several hundred fine holes round the edge through which it is thrown out to form filaments. These are then extended into fine fibres by a high velocity blast of hot gas. The fibres are sprayed with a bonding agent, drawn by suction onto a conveyor and carried

through an oven which cures the bonding agent, then to trimmers and guillotines which cut the product to size.

Glass Manufacturing – Typical Flow diagram



2. Key E&S risks

Below are the material E&S risks associated with this sector and key measures to manage them.

Where gaps are found in the management of key E&S risks, the E&S risk management measures may form part of a corrective E&S action plan agreed with your customer.

Air Emissions

Over 80% of the emissions to air in glass manufacture arise from the melting furnaces. The principal emissions to air are:

- Combustion gases from energy generation;
- Furnace emissions, e.g. dust, nitrogen oxides, sulphur oxides, chlorides, fluorides and metals present as impurities in the raw materials;
- Particulates arising during raw materials storage, weighing and filling, cutting, grinding and polishing operations.

Other emissions include:

- Coating and breakdown products, e.g. acid vapours from etching and cleaning;
- Forming and curing area emissions from glass fibre manufacture;
- Airborne glass filaments and fibres;
- Boiler emissions (depending on the fuel type used);
- Green House Gases (GHGs) such as CO_2 from the decomposition of carbonates;
- Fine airborne particulates including silica sands, feldspar and toxic compounds (for example, lead oxide, boron, arsenic, amongst others).

The emission of dust as a result of the handling and storage of raw materials can impact on neighbouring properties and wider communities.

Glass fibres can cause itching of the skin and eyes and a temporary coughing/sneezing.

Inhalation of silica sands can cause silicosis if inhaled.

How can a business manage this risk?

- Consider air emissions under the requirements of the European Union (EU) air quality and emissions directives (e.g. Directive 2008/50/EC on ambient air quality and the Industrial Emissions Directive (IED) 2010/75/EU), and local environmental regulations and permitting requirements;
- Install/upgrade and maintain abatement technology to minimise exposure to toxic raw materials and products and to control the release of dust emissions, e.g. enclosure of equipment, installation of appropriate ventilation with filters, gas balancing systems etc.;
- Inventory all GHG emissions; this information can be used in the reporting processes where necessary, and to set effective reduction targets/initiatives.
- Undertake regular testing of internal air quality (workspace) and external air emissions;
- Ensure that regular maintenance and monitoring of fuel-burning equipment is undertaken;
- Provide workers with suitable Personal Protective Equipment (PPE) including respirators to avoid the inhalation of airborne glass filaments and fibres;
- Provide First Aid stations and train workers in trauma (associated with glass cuts, fibres or filaments) either through inhalation, skin contact or eye trauma.

Noise Emissions

Public/environmental health and nuisance issues associated with noise can arise from production activities and may have a significant effect on neighbouring locations.

Noise-induced hearing loss is an occupational hazard associated with glass manufacture.

How can a business manage this risk?

- Locate and design facilities to avoid sensitive receptors to noise or to minimise their exposure;
- Enclose noisy machinery to isolate people from noise where practicable and eliminate noise exposure through the hierarchy of controls;
- Identify sources of elevated noise and demarcate these;
- Provide PPE (e.g. hearing protection) where workers and visitors have to enter noisy areas and ensure appropriate use of PPE;
- Rotate tasks to minimise worker's time spent in noisy areas over an eight hour period;
- Conduct regular hearing tests for workers.

Water Use

Water is used primarily for cleaning, cooling and glass finishing processes. The quantities of water required are marginal compared to other industries and can be readily recycled into the process.

Water abstraction volumes are likely to be controlled through permitting conditions. Over-abstraction may impact other water users.

How can a business manage this risk?

- Abstraction from water resources should comply with the EU Water Framework Directive (2000/60/EC) and local environmental regulations and permitting requirements;
- Evaluate water supply and water efficiency measures (e.g. recycling, reuse, run-off reduction, storage etc.) to reduce impacts on surrounding resources and community supplies;
- Reduce water volumes used through the use of high-pressure hoses; reuse and recirculate water and use re-circulated chilled water systems where practicable.

Wastewater

Wastewater is discharged from the glass production process. There are potential pollution issues arising from:

- Use of coating materials during coating preparation, handling, throw off from winding etc.;
- Use of toxic compounds in lead crystal glass and special glass manufacture;
- Organic compounds from the lubricants used in cutting;
- Water treatment chemicals;
- Run-off from contaminated or dirty cullet[2], external stores and spillages.

How can a business manage this risk?

- Discharge into water resources should comply with the EU Water Framework Directive (2000/60/EC) and local environmental regulations and permitting requirements;
- Assess and understand downstream water users to identify and manage and risks and vulnerabilities;
- Use a closed process water system (to minimise uses and losses);
- If wastewater is discharged to a municipal wastewater treatment plant (WWTP) or to an on-site operated WWTP a permit for control is likely to be required;
- Install (or upgrade) on-site WWTP treatment plant to meet permitted effluent discharge standards;
- Install diversion drains to direct surface water

[2] Cullet is a term for recycled glass.

runoff away from waste areas;

- Separate cooling water from process water;
- Install grids to reduce or avoid the introduction of solid materials into the waste water drainage system;
- Adopt equipment cleaning-in-place (CIP)[3] methodologies to reduce chemical, water and energy consumption.
- Monitor effluent to ensure compliance with wastewater discharge standards.

Solid Waste

The glass manufacturing process itself produces very little waste material. Waste is limited to maintenance waste, occasional off-specification raw material that cannot be blended and packaging waste.

Other solid wastes include dust from abatement equipment, acidic residues from coating, and replacement refractory materials from furnace maintenance.

How can a business manage this risk?

- Comply with national and EU regulations (as applicable) for the safe disposal of waste;
- Companies operating within the EU (either as a manufacturer or as a supplier into EU 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 the waste streams;
- All trimmed glass should be recycled back into the melting process;
- Store solid wastes in adequate containers and segregate where possible to encourage recycling;
- Where possible and safe to do so, recycle or re-use benign waste products; maintain an inventory of wastes generated and minimise where possible;
- Glass which cannot be remelted on site can be sent for recycling.

Energy Use

Glass manufacture is a high temperature, energy intensive process, with furnace temperatures up to 1,300°C to 1,650°C and flames up to 2,000°C. Materials may need to be in the furnace between 24 and 72 hours. Typically, these are fired by fossil-fuels although some may be electric. The design of a furnace has a major impact on

[3] CIP is a method of cleaning the interior surfaces of pipes, vessels, process equipment, and associated fittings, without disassembly using approved chemicals and/or detergents with minimal environmental impact and compatible with subsequent wastewater treatment processes.

energy consumption. Cullet (or recycled glass) requires less energy to melt than unprocessed raw materials.

Energy is also required in the form of electricity for machinery operation, lighting and production of compressed air.

How can a business manage this risk?

- Examine options for heat recovery and insulation, to reduce/supplement energy usage;
- Examine options for increasing energy efficiency through modifying work practices and installation of energy efficient devices/equipment;
- Maximise use of cullet to reduce energy and raw material consumption;
- Use low carbon content fuels where possible;
- Recover waste heat from furnace flue gases to preheat materials or for space heating;
- Upgrade insulation techniques and materials;
- Consider a more energy efficient melting technique if appropriate;
- Ensure furnace size and throughput is efficient;
- Conduct regular furnace maintenance and repairs (replace refractory bricks every 6-12 years).

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.

Asbestos has been used on a large scale for many years as a fire proofing and insulation material and may be encountered in a wide range of forms including asbestos cement boards, as fire retardant gaskets in pipe work and as fire retardant insulation around boilers and furnaces.

Neither PCBs nor asbestos are likely to be principal issues of concern in relation to glass manufacture, however either material may be present and may therefore pose some potential for environmental and/or health and safety impacts.

How can a business manage this risk?

- Where the presence of asbestos or PCBs is known or suspected, seek professional advice in order to commission a survey;
- Particular attention should be paid to facilities constructed prior to the 1990s.

Hazardous Materials

Hazardous materials used in the glass manufacturing industry may include fuels, oils, colourants (for specialist glass products), cleaning agents, solvents etc. Incorrect storage or handling of these substances may be a source of contamination risk (to people, habitats, soil or water resources).

How can a business manage this risk?

- Glass manufacturers and producers of glass fibre in the EU producing more than 20 tonnes per day are subject to national regulations under the Industrial Emissions Directive (IED) (2010/75/EU) which replaced the Integrated Pollution Prevention and Control Directive (2008/1/EC). Operations outside the EU will still be subject to local regulations;
- Maintain storage areas to ensure that they are organised, secure, clean and dry;
- Record all hazardous materials held on site in an inventory with Materials Safety Data Sheets (MSDSs) available in the appropriate language. Prepare procedures for their handling and treatment in the event of spillage;
- Provide secondary spill containment for bulk storage and tanks;
- Conduct regular inspection of all bulk containment facilities and effluent holding tanks to ensure integrity of storage;
- Provide PPE that is fit for the task to prevent injury and exposure to hazardous materials;
- Train staff in the correct selection, use and maintenance of PPE. Inspect PPE regularly and maintain or replace as necessary.

Machine and Electrical Safety

In a busy manufacturing environment, it is common to have injuries where people interact with machinery or equipment. This can be owing to moving or falling objects such as, crates and boxes, using equipment such as conveyors, packaging machines and palletisers or operating fork lift trucks and delivery vehicles/trucks, all of which can lead to serious injury or death.

Sharp tools are used to cut glass. Potential eye and other severe cutting injuries can arise from broken and flying glass.

The use of electrical devices during glass manufacturing in proximity to water means that the risk of electrical shock is present during a variety of operations.

How can a business manage this risk?

- Within the EU, machinery purchased after 1 January 1995 must comply with the Machinery Directive 2006/42/EC;
- Assess machine safety in consultation with machine operators, reduce hazards according to the hierarchy of controls and undertake

modifications/install guards and interlocks as required;

- Wear safety glasses at all times, cut-resistant gloves and long aprons provided to workers who handle flat glass;
- Consider flat glass handling automation;
- Assess electrical installations and ensure that appropriate insulation, earthing and Residual Current Devices (RCDs) are in place.

Traffic Management

Accidents involving vehicles and moving machinery are a risk to workers. Accidents can occur within operational or storage areas, or on access roads.

How can a business manage this risk?

- Separate people from vehicle movement to ensure the safety of workers, the community and the public;
- Train vehicle and forklift drivers to properly operate the machinery and equipment.

Manual Handling

Lifting, repetitive work and posture injuries occur as a result of lifting and carrying heavy or awkward shaped items such as crates, products and solid wastes.

Repetitive tasks can lead to musculoskeletal injuries and work-related upper limb disorders (WRULDs).

How can a business manage this risk?

- Assess tasks throughout the process, with particular focus on heavy and repetitive tasks;
- Redesign manual processes to avoid lifting/repetitive activities;
- Install mechanical lifting aids where possible and rotate work tasks to reduce repetitive activities.

Slips, Trips and Falls

Slips trips and falls are regular occurrences in glass manufacturing environments and result in many injuries. Typically these are because of uneven ground, wet/greasy floors from oil and other spillages and poor housekeeping.

Glass manufacturing operations may also involve working at height to access roofing or lighting areas and/or equipment.

How can a business manage this risk?

- Keep walking and working surfaces clean and dry and provide workers with anti-slip footwear;
- Restrict access to areas being cleaned or where spillages have occurred;

- Schedule floor cleaning for a time when work is not in progress or has finished for the day and floors have dried as much as possible;
- Restrict access to working at height;
- Conduct a job risk assessment for all tasks that require working at height;
- Install correct fall arrest systems where necessary (guarding and harnesses etc.).

Temperature Exposure

Furnaces and other hot equipment can increase the temperature of the working environment which can lead to heat stress for those working in the vicinity.

Contact burns can result from contact with hot equipment especially during maintenance activities.

How can a business manage this risk?

- Minimise time needed for staff to access areas with elevated heat levels.

Confined Spaces

Glass manufacturing plants contain vessels such as tanks and pits which may require entry by staff during maintenance and cleaning.

Entry to confined spaces without effective management and control can result in engulfment and asphyxiation.

How can a business manage this risk?

- Implement confined space procedures, training, equipment and control systems if confined space entry is necessary;
- Install covers, fences and fall prevention methods to prevent falls into tanks and other confined spaces.

Labour and Working Conditions

Glass manufacturing operations may use casual and contract labour.

Child labour is a prevalent risk particularly in relation to smaller-scale family run operations.

Worker accommodation standards, particularly for temporary/casual labourers may not reach the standard required for permanent employees.

How can a business manage this risk?

- Comply with International Labour Organisation (ILO) requirements on working hours, pay, overtime, etc.;
- Include all ILO prohibitions on child labour into

contracting agreements;

- Provide appropriate worker accommodation which meets, at a minimum, the basic needs of workers, national legislation and the requirements of EBRD Performance Requirement 2.

Relations with Local Communities

Having good relationships with neighbouring communities reduces the risk of local opposition to the glass manufacturing activities.

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

How can a business manage this risk?

- Review socio-economic baseline conditions to identify local, community-based enterprises and/or use of water resources and to assess any impacts on these;
- Assess opportunities for the involvement of the local community in direct employment or in the provision of goods and services;
- Engage with the local community and other interested and/or affected stakeholders to maintain good social relations;
- For areas of high population density or high community interest, prepare and implement a Stakeholder Engagement Plan (SEP);
- Develop a Traffic Management Plan.

3. Financial Implications

Outlined below are key financial implications of ineffective management of E&S risks related to glass manufacturing.

- Fines, penalties and third party claims may be incurred for non-compliance with environment, health and safety regulations;
- Inadequate health and safety provisions (including risk assessments, training, infection control and provision of PPE, etc.) for workers (permanent, temporary and/or casual) may lead to absenteeism, health care costs or health and safety incidents and claims;
- Where large quantities of energy are used then this can result in high operating costs to the business;
- Injuries may lead to increased payroll costs to replace skilled workers and lost production time;
- Fires and explosions will have a substantial financial impact and insurance should be obtained;
- Capital investment may be required to comply with new environmental, health and safety requirements;

- Financial provisions may need to be set aside to address contamination and retirement of assets.

4. Suggested Due Diligence Questions

Perform a complete tour of the facility, accompanied by someone knowledgeable about all the activities at the site.

When assessing E&S risks, it is important to engage the customer on how these risks are managed.

During the initial site visit, the issues will vary according to the type of glass manufacturing and the level of environment, health and safety and hygiene management already introduced. While visiting the site it is important to discuss and review the following:

General Housekeeping

- Check the standard of housekeeping at the facility, e.g. do areas look clean and tidy, is there build-up of dust on floors and surfaces, is there evidence of any recent spills or releases of raw materials/product;
- Are the walking and working surfaces kept clean and dry?
- Confirm what processes are undertaken and whether any hazardous chemicals are used? How hazardous are the materials and have associated risks been documented and addressed in appropriate systems?
- Check the condition of storage facilities for chemicals;
- Check the age and condition of equipment, look for signs of wear and tear, degradation, leaks and breaks.

Environmental, Health and Safety

- Confirm organisational responsibilities and systems for environment, health, safety and social matters and that these systems cover both employees employed directly and sub-contractors;
- Check the condition and efficiency of any wastewater treatment plant present and location of discharge points. Note the colour and appearance of adjacent watercourses;
- Note whether the plant discharges to a local watercourse or the municipal wastewater treatment works;
- Note the noise and dust levels at the site to determine whether abatement equipment is in use or might be required;
- Check the condition of storage facilities for bulk raw materials;
- Are staff wearing Personal Protective Equipment?
- 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?

- Is fire-fighting and first aid equipment available? Is there a trained and competent fire-fighting resource on site?

- Check the age and condition of equipment, look for signs of wear and tear, degradation, leaks and breaks;

- Check that solid waste storage and disposal (storage equipment) is in a good condition;

- Check that waste disposal takes place on a regular basis;

- 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;

- Have the premises been inspected recently by the regulatory authorities for health, hygiene and environment? What were their findings?

- Check for automatic safeguards on machinery to prevent accidental injury.

- Does the organisation have insurance to cover any significant damage to the environment/community/operations (this may be covered by public liability insurance or the organisation may be party to an industry insurance scheme). Review the terms of the cover.

- Has the organisation been subject to environment & safety or quality audits by customers/insurers? What was the outcome of these audits?

- Does the organisation have insurance in place to cover the recall of products? Have there been any recent product recall incidents? What were the reasons for the product recall?

- Have there been any recent incidents on site such as fatalities, fires/explosions, spills? Is insurance in place to cover such incidents? Is there any legal action pending/likely?

- Does the business plan have line items for Environment, Health and Safety improvements as well as asset management?

- Check the conditions and duration of validity for all permits;

- Does the business plan have line items for Environment, Health and Safety 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.
- 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?
- Establish whether any complaints have been received;

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

Action Plans

As a minimum, any business should be required to have the following in place:

- Operational procedures to manage environmental, health and safety 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;
- Emergency plans for environment, health and safety accidents or hygiene non-compliance;
- Management review/demonstrated involvement in environment, health, safety and hygiene management.

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