Sub-Sectoral Environmental Guidelines PAPER PACKAGING AND PRODUCTS

PROCESS DESCRIPTION

Paper conversion may include converting paper into a wide variety of products, for example, paper boxes and bags and packaging. The main elements of the process may include the delivery and storage of paper and other raw materials; the cutting and gluing of paper and cardboard; the printing of paper and packaging, which may involve heat set web offset, or flexographic printing or gravure/intaglio printing (used for printing food or medicine packaging); surface coating (for example, printing of patterns, PVC coating or adhesive coating); lacquering; laminating; and storage of the finished product.

SUMMARY OF KEY ENVIRONMENTAL RISK/LIABILITY FACTORS

Land contamination

Land may be contaminated by either current or previous operation at or near the site. Contamination may arise from bulk storage or use of fuels, oils, inks or solvents within paper processing operations.

Air emissions

The main atmospheric pollutants may be volatile organic compounds (VOC's), from solvents which may be present in inks and coatings used in impregnating and laminating. These materials may be subject to tight legislative control, requiring either investment in new technology or installation of emissions control equipment (VOC incineration).

- Major sources of air emissions may include:
  - VOC emissions from printing processes arising from inks and solvents;
  - solvent emissions from laminating processes, notably from adhesives;
  - solvent and odour emissions from lacquering processes arising from, for example, use of ethyl acetate and acetone. Drying of the lacquers may be achieved by warm air drying, which may create offensive odour.

- Where solvent emissions are abated using an incinerator, emissions should be regularly monitored to ensure effective operation.

- Other air emissions may arise from on-site boilers or power generation plant.

Product standards

Paper products and packaging may be subject to national and international environmental standards relating to packaging and labelling. These standards may influence customer requirements for the quantity, quality and content of paper based products which in turn will influence the raw materials and processes used to produce them. In particular, where packaging materials are

being produced for export, these may be subject to, for example, requirements of EU packaging legislation.

FINANCIAL IMPLICATIONS

- Contamination of the soil or ground water on or around the site may result in expenditure on site clean up or result in reduced asset value.

- Environmental standards for air emissions control (particularly solvent emissions), waste disposal and effluent control and treatment may require investment in new equipment or an increase in operating costs.

- Customer environmental requirements for packaging of specific design, raw materials content or recyclability may affect costs of raw materials and production.

OTHER POTENTIAL ENVIRONMENTAL ISSUES

Water supply and wastewater management

Sources of water from mains or via direct abstraction should be considered. Some water is likely to be required for cleaning purposes, and for boilers or sprinkler systems.

Leakage or spillage of materials may present a risk of water pollution where this no effective system for containment. Materials which may give rise to water pollution include solvents; printing inks and residues; machine oil; detergents and other cleaning materials; and residual paint in lacquering wastes.

Handling and storage of material

Bulk storage vessels for solvents, lacquers and oil require secondary containment in order to reduce the risk of spills entering drainage systems or groundwater contamination. Appropriate ventilation should be in place and protective equipment used by employees where solvents are mixed or used.

Solid and hazardous waste management

- Solid waste can arise from sub standard products and the production process. Major quantities paper and cardboard waste may be generated

- Hazardous wastes may include waste oil, fuel, solvents and ink residues

Odour

- Odour and noise emissions may constitute a nuisance to the local population.

ENVIRONMENTAL IMPROVEMENTS

- Potential improvements in control of air emissions include:
  - venting of VOC's to a suitable arrestment plant (eg., incinerator) and regular monitoring of emissions;
  - minimising the use of VOC's through use of water based inks and lacquers;
  - regular monitoring of emissions from solvent incinerators;
  - back venting of emissions from road tankers during collection of waste solvents and residues;
  - storage of all potentially odorous waste material enclosed in containers or bulk storage vessels.

- Recycling of waste water to reduce consumption of mains water and save energy costs.

- Effective bunding of bulk storage tanks to prevent spillage of chemicals into watercourses.

- List of all hazardous materials held on site and clear procedures for the handling and treatment of spillages.

- Regular inspection of secondary containment facilities and fitting of alarms.

- Removal of hazardous wastes, such as waste solvents or inks, by licensed contractors.

- Design of chimney and vents of sufficient height and appropriate position to avoid causing a local nuisance.

- Regular review of customers requirements and national and international environmental controls affecting packaging materials.

ENVIRONMENTAL ACTION PLANS

- Develop an Environmental Action Plan (EAP) to include:
  - financial plan or budget for environmental management and performance improvement;
  - clear roles and responsibilities for environmental management;
  - knowledge, information and monitoring of environmental performance;
  - setting of environmental performance targets to meet regulation and best practice;
  - programme for environmental performance improvement to meet targets;
  - plans and procedures for managing environmental issues, including atmospheric emissions, waste management and wastewater discharge.
  - schedule for revising and updating the EAP.

- Review associated systems, such as health and safety and emergency plans.

GUIDE TO INITIAL DUE DILIGENCE SITE VISITS

When visiting the sites of potential borrowers or during loan supervision use the following as a practical guide to due diligence.

- Perform a complete tour of the works.
- Note the presence of any VOC abatement equipment.
- Look for signs of poor house-keeping, such as signs of spillage of ink, piles of waste paper or storage of unmarked drums of chemicals.
- Establish whether drainage systems lead to wastewater treatment systems or discharge directly to water courses and note the colour and appearance of adjacent water courses.
- Enquire about waste disposal options used by the site, particularly for waste chemicals and solvents.
- Review the history of the site and the area, particularly any previous industrial use, in order to access the likelihood of soil and groundwater contamination.
- Review the measures to prevent the escape of volatile organic compounds during storage and use.
- Assess the level of health and safety awareness, for example, the presence of safety notices and the use of protective equipment.
- Note the location and integrity of oil and chemical storage areas. These should be located away from operational areas and have measures to contain spillage.
- Note the levels of noise and odour at works and whether measures are in place to control internal and external levels.

It is also suggested that contact is made with local regulatory agencies to determine compliance record and whether complaints have been made by the public.

Sub-sectoral Environmental Guidelines PRINTING AND PUBLISHING

PROCESS DESCRIPTION

There are several different types of printing process, e.g., heat set web offset, gravure/intaglio, flexigraphic, cold set web offset, etc. These printing processes take one or more prepared inks and apply them to a material, usually paper. The inks may be water or solvent based. For most, but not all, the processes require that the carrier (the water or solvent) is evaporated to leave the dry printed article. Where the carrier is a solvent (e.g., toluene, xylene) this evaporation will give rise to solvent emissions.

SUMMARY OF KEY ENVIRONMENTAL RISK/LIABILITY FACTORS

Air Emissions

Solvents emissions may have to be controlled or minimised at source. Usual control methods include thermal incineration or solvent recovery by condensation. Where condensation is practised, the recovered solvents are either sold as contaminated solvents or are distilled for reuse in the printing process. Solvent abatement technology is expensive and often requires a minimum threshold of solvent throughput in order to operate correctly. Some facilities are replacing solvent based inks with water based inks in order to eliminate the problems of solvent control.

With the advent of newer technologies and materials some inks are being replaced by different formulations, such as uv curing inks and coatings containing isocyanates. These can lead to other issues such as fume/ozone from the uv curing plant and isocyanate emissions.

In older style print works lead may still be used to manufacture monotype or linotype castings.

Chemical Storage and Soil and Groundwater Contamination

When materials such as solvents and oils are stored, either in bulk or in drums, the risk of soil and groundwater contamination will need to be minimised. Oils and solvents should be stored in secure containers, with secondary containment.

Contamination can occur from a spillage or seepage from storage facilities, or from accidental releases during production processes. Organic compounds, such as solvents, can be highly mobile in soil and can permeate concrete and asphalt. Surface and groundwaters may become contaminated if spillages enter drainage systems or migrate through the soil. Depending on local geological conditions, the contamination arising from a spillage may be minor or significant. In general, older printing works with a long history of solvent usage are more likely to be contaminated.

Fire Risk

There is a high potential for fires to occur at printing works due to the heat of the production equipment (during a print run) and the presence of flammable materials. Additional expenditure may be required for fire prevention and protection equipment/systems.

FINANCIAL IMPLICATIONS

- Adapting to increasingly stringent environmental regulations can involve substantial capital expenditure, or in extreme cases force plant closure
- Pollution abatement may be achieved at a moderate cost via management initiatives. Installation of abatement technology may involve significant costs.
- Fees and penalties, particularly in respect of effluent discharges.
- Risk of major spills polluting adjacent watercourses and resulting in fines.
- Contamination of soil and groundwater from leaking storage tanks/loading areas.
- Outstanding claims (health and safety)
- Fire risk and the requirement for expenditure on fire protection and prevention systems.

OTHER POTENTIAL ENVIRONMENTAL ISSUES

Wastewater Discharges

A permit with specific discharge parameters may be required to discharge wastewater. Many facilities may have on-site wastewater treatment plants which may neutralise colour and pH and filter solids (paper/plastics). There are likely to be costs associated with complying with the limits specified in the discharge permit.

ENVIRONMENTAL IMPROVEMENTS

Potential environmental improvements may include:

- move to water based inks to eliminate solvent emissions;
- where solvent based inks cannot be replaced, install emission control/abatement equipment;
- the print rollers/heads should be covered and vented to prevent diffuse solvent emissions into the workplace;
- drying tunnels (if provided) should operate on the lowest possible air throughput to minimise the volume of solvent laden air requiring treatment.
- installation of fire protection/prevention equipment.

GUIDE TO INITIAL DUE DILIGENCE SITE VISITS

When visiting the sites of potential borrowers, or during loan supervision use the following as a practical guide to due diligence.

- Perform a complete tour of the site if possible.
- Assess fire protection/prevention measures.
- The presence and effectiveness of pollution abatement equipment (solvent incineration).
- Inspect the effluent treatment and disposal system.
- Note signs of poor housekeeping.
- Look for localised spills, leaking pipes etc.
- Check use of personal protective equipment.
- Review age and condition of process equipment.
- Check source of electricity, heat and water supply.
- Assess emergency response to fires, major spills etc.
- Review historical and projected environmental fees and fines.

It is also suggested that contact is made with local regulatory agencies to determine compliance record and whether complaints have been made by the public.

Sub-sectoral Environmental Guidelines: PULP AND PAPER

PROCESS DESCRIPTION

The manufacture of paper and allied products is based on preparation of a pulp of cellulose fibre from which paper can then be made. The characteristics of the produced paper can be changed by applying coatings before being cut and prepared for sale. Paper production may be considered to comprise three main activities:

- *Pulping:* Pulp is produced from a variety of cellulose-containing feedstocks (hardwood, softwood and other non-wood sources such as hemp, jute, flax, sisal, and cotton). There are two principal methods - chemical (kraft, sulphite and semi-chemical) and mechanical (stone groundwood, refiner groundwood and thermo-mechanical) pulping. The production of pulp is often practised at a site remote from the actual papermaking facility. Pulp is a traded commodity itself.

- *Papermaking:* The pulp used to produce paper may either be virgin pulp, produced by one of the above processes or, increasingly these days, by the reuse of recycled paper or 'secondary fibre'. Virgin pulp will often be imported rather than produced on the site, whereas secondary fibre will usually be brought onto the site as waste paper and will often require some degree of processing, for example by de-inking, in order for pulp of sufficient quality to be produced. The pulp is diluted to a suitable concentration and continuously spread onto a moving belt (a 'wire'). This is then allowed to dry, producing paper. Various additives may be put into the pulp at this stage to assist in the papermaking process or to give the paper certain characteristics, e.g. wet strength.

- *Coating:* Paper may be subsequently treated and/or coated in order for the desired properties to be imparted to the paper. These coatings may vary from a simple clay coating (e.g. for glossy papers) to a double-sided polythene coating (e.g. for photographic paper). Coating may be undertaken on the same site as the papermaking itself or as a stand-alone off-site process.

SUMMARY OF KEY ENVIRONMENTAL RISK/LIABILITY FACTORS

Wastewaters

Large volumes of wastewater are produced at pulp and paper mills, which are rich in organic matter, and high in suspended solids and dissolved salts. This wastewater is of a highly polluting nature and typically must be treated to an appropriate standard before release into natural waters.

Air emissions

Boilers are often used in the production process and these typically produce gaseous emissions, which will need to be treated prior to discharge to air.

Soil and Groundwater contamination

Soil and groundwater can become contaminated through leaks from chemical storage tanks, and accidental spillages. This is more likely to be an issue at older sites.

Fire/Explosion Hazard

Inadequate storage and production facilities may give rise to an increased risk of fire and explosions.

Occupational Health and Safety

Health and safety issues may be associated with production processes. These could include handling of chemicals such as chloride and occupational noise.

FINANCIAL IMPLICATIONS

- Fees and penalties for emissions and effluents may be significant;
- Accidental releases of untreated wastewaters and run-off from solid waste storage areas, could result in fines and clean-up costs;
- Since these processes are consume a large amount of energy, energy consumption will be a key financial issue;
- Major fires/explosions can be financially ruinous;
- Installation of pollution abatement technology can involve significant costs, in particular, wastewater treatment.

POTENTIAL ENVIRONMENTAL ISSUES

The principal issues of water pollution, air pollution and fire/explosion risk will be dealt with separately for each stage of the paper production process.

Water pollution

Pulping

There are two methods of wood pulping - chemical and mechanical. Of the two methods, chemical pulping is more polluting.

Chemical Pulping
In chemical pulping, the wood or other fibre-containing material is digested in a chemical liquor to liberate the fibre. The used liquor is extremely polluting and the disposal of this liquor (black liquor) is of prime concern. It is often recirculated to an energy recovery facility where colour/organic matter is burned and the pulping solution is regenerated for re-use.

Mechanical Pulping

In mechanical pulping, processed fibres are separated by mechanical shear. This requires a high energy input. With the majority of the lignin remaining in the fibres there is still some dissolution of organic material to generate an effluent. Because the process does not generate liquors containing dissolved wood material which can be burned for energy recovery, large amounts of electricity must be taken either from municipal supplies, or generated on-site by burning auxiliary fuels such as oil, coal or gas. Large amounts of water are used as the transport medium and consequently significant quantities of moderate strength effluent are produced and are a potential source of pollution.

For both chemical and mechanical pulping plants where pulp is to be used for the production of high-quality papers, the pulp is usually bleached by various chemicals, although pulp produced by mechanical pulping is whiter and requires less bleaching than chemically produced pulp. Use of chlorine for bleaching has tended to be discouraged in recent years. Chlorine has been replaced by chlorine dioxide or, preferentially, hydrogen peroxide in more modern mills

Papermaking

Where a papermaking process is using recycled paper it often has to be de-inked prior to obtaining a pulp suitable for papermaking. There are two de-inking processes in common use - flotation and washing. Washing uses significantly larger quantities of water and the yield is usually much lower than that generated by flotation. The main sources of water pollution include rejects from screening and cleaning, sludge from de-inking, excess white water and accidental losses.

Issues to Consider

- It should be noted that the contaminants in these waste streams will reflect contaminants in the waste paper being recycled. Some old carbonless papers contain polychlorinated phenyls (PCPs) and some inks and dyes may contain heavy metals.

- The amount of water used per tonne of paper produced serves as an indicator of the mill's 'water use efficiency'. A paper mill manufacturing very high quality papers (e.g. banknote paper) may have a water use per tonne of paper produced ratio of 30-70:1. A 'white paper' mill producing white paper from imported virgin pulp may have a ratio of 15-25:1 whereas low-grade brown paper may have a ratio of 5-10:1. Typically, the actual figure in the above ranges provides a useful indicator of the mill's efficiency.

- Water pollution from papermaking itself is caused by suspended solids (fibres and fillers, often clay) and dissolved materials (soluble fractions from the pulp, sugars, starches, etc). There will also be traces of additives that are used by the mill which often include biocides for slime control and release agents. The very high concentrations/loads of organic materials are extremely oxygen depleting.

The main problem faced by the paper industry is the minimisation/

treatment and disposal of this effluent. The main sources of water pollution include excess white water, press section, cleaning systems (wire sprays) and rejects vacuum pumps, and cooling and sealing.

A papermaking machine tends to be operated at around 40^{o}C so effluent from a paper mill can be warm and thermal pollution can also result.

It is almost certain that some form of effluent treatment will be required. For discharge to sewer this will normally comprise screening and settlement or flotation (to remove the majority of the solid material). For discharge to river additional biological treatment facilities will be required. It is important to note that most forms of treatment will generate a sludge which will also require disposal.

If full effluent treatment facilities are provided every opportunity should be given to recycling some of the treated effluent back into the mill for reuse.

Air pollution

Pulping

In chemical pulping, particularly kraft pulp mills, large quantities of sulphur containing chemicals are used. If these substances are oxidised (e.g. via incineration) there is the potential for SO_x generation. If they are reduced (e.g. in anaerobic conditions) then highly odorous sulphide containing compounds (e.g. hydrogen sulphide) could be produced. There is a tendency for these malodorous gases to be produced from the process itself so odour elimination/containment systems should be in-place.

In mechanical pulping installations the volatile substances present in wood are often emitted along with excess steam. These substances include turpenes, ethanol, methanol, resin acids, etc.

Where a pulp mill uses chlorine, chlorine dioxide or sodium hypochlorite for bleaching there are risks of chlorine gas emissions. Generally concentrations should not be significant but provisions should be made for detecting and handling chlorine.

Papermaking

Emissions to air are limited; any volatile materials in the wood will have been lost during the pulping process. Specific air pollution that may occur includes formaldehyde from urea or melamine formaldehyde resins used for wet strength, particulates from some finishing operations and sulphides from the anaerobic degradation of sulphates in the water

As paper mills tend to be large installations a significant number have on-site generation of steam and electricity. Any on-site power stations will have SO_x, NO_x and CO_x limits to comply with.

Coating

Generally, any coating is applied to the paper using a carrier material. Water is used for most clay coatings, but for other coatings or printing, particularly the

organic ones, the carrier may be solvent based. Whatever the carrier, it has to be evaporated off the paper (often in a drying tunnel or oven) to leave the coating in place. When solvents are used these evaporate off producing a solvent-laden air stream.

Fire/Explosion risk

Pulping/Papermaking

It is common where large bales of pulp or paper are stored to provide sprinkler systems which become activated in the event of a fire. Because pulp and paper are difficult to extinguish, once alight, any fire where quantities of pulp or paper are stored will invariably require large quantities of water to ensure that the fire is extinguished. Fire water produced will be polluting and will require containment.

There is also an explosion risk where chlorine and other chemicals are improperly stored.

Other environmental issues which may be associated with a pulp or paper mill and a coating process include:

Soil and groundwater contamination

- Stored timber may be contaminated with pesticides and consequently any run-off from the storage area may be contaminated with pesticides.

- Bulk chemicals stored in bulk in a pulp mill can be varied and can include caustic soda, biocides (used to prevent slime growth in the process) and sodium hypochlorite.

- Any spillage or unplanned loss may result in a soil/groundwater or watercourse contamination. A spillage of some products, eg biocides, could also seriously impair the performance of any effluent treatment plant so containment should be considered rather that simple diversion to foul sewer.

Solid waste generation

Significant amounts of solid waste may be generated. The largest volume would probably be sludges from an effluent treatment plant. Other solid wastes will include ash, bark and wood waste, and paper and general cardboard/ packaging waste.

Because many of the solid wastes are organic they can often be utilised for beneficial purposes. Wastewater treatment sludges can be used for soil conditioning. Ash from bark burning boilers (often used on pulp mills where dry debarking is practised) is rich in potash and can be used as a fertiliser.

POTENTIAL ENVIRONMENTAL IMPROVEMENTS/OPPORTUNITIES

Pulping

- water recycling.
- improved (more efficient) washing and screening systems.
- oxygen (rather than chlorine) pre-bleaching and bleaching.
- contaminated condensate treatment.
- energy efficiency.
- air emissions management.

Papermaking

- fibre recovery.
- reuse of water.
- closing-up of vacuum pumps (vacuum pumps may account for >25% of the water use in an inefficiently operated mill).
- provision of storage and balancing facilities in the mill to prevent overflows/loss of pulp.

Coating

- recovery and recycle of excess coating material.
- conversion from solvent-based coatings to water based (it should be noted that often conversion from solvent to water-based coatings enables the machine speed to be increased leading to increased throughput).
- conversion to low-temperature curing materials.
- getting start-up operation correct to minimise or eliminate out-of-spec product.

ENVIRONMENTAL MANAGEMENT/IMPACT MITIGATION

Develop Environmental Management Action Plan (EMAP) to include:

- Regulatory compliance measures;
- Waste management plan (waste minimisation, re-use, recycling, monitoring);
- Health and safety improvements;
- Product standards improvements (especially if export to EU/USA is an option);
- Costs of equipment upgrades/compliance;
- Roles and responsibilities, time frame and bench marks.

Most measures to achieve regulatory compliance and minimise exposure to hazards involve intermediate levels of technology

GUIDE TO INITIAL DUE DILIGENCE SITE VISITS

When visiting the sites of potential borrowers, or during loan supervision use the following as a practical guide to due diligence:

- perform a complete tour of the site compound if possible;
- the quantities and characteristics of atmospheric emissions, wastewater discharges and solid and hazardous waste arisings;
- the current status regarding pollution abatement technology;
- inspect the effluent treatment and disposal system for waste sludges;
- note any effluent discolourisation at the outfall
- note signs of poor housekeeping;
- look for localised spills, leaking pipes etc;
- check use of personal protective equipment for hearing and breathing;
- review age and condition of process equipment;
- check source of electricity, heat and water supply;
- assess emergency response to fires, major spills etc;
- review historical and projected environmental fees and fines.

It is also suggested that contact is made with local regulatory agencies to determine compliance record and whether complaints have been made by the public.