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ENVIRONMENTAL INITIATIVES IN INDIGENOUS INDUSTRY

Sector Specific Best Practice Guide

FURNITURE MANUFACTURE

Sectors Included:

Furniture manufacture involves the assembly of materials into furniture pieces and subsequent finishing. Materials in use include wood and wood-based products such as MDF, chipboard and plywood, as well as materials like metal, foam, and plastic. Product groups include kitchen furniture, office furniture, dining room furniture, bedroom furniture and upholstered furniture.

Furniture manufacture mainly occurs in small indigenous companies in Ireland with just a handful of larger companies involved. Some of the larger facilities fall under the Integrated Pollution Prevention and Control (IPPC) licensing system as a result of using more than 10 tonnes per annum of solvent in their processes. However, this guide is aimed at the smaller furniture manufacturers and mainly focuses on best practices that are relatively simple and straightforward to implement in an existing facility.

Main Operations:

The main operations that can occur in furniture manufacture are as follows:

- Material preparation/processing: components are sawed, planed, sanded, etc.
- Surface preparation: sanding is used on raw surfaces and between coatings to improve adhesion, and is also used to remove coatings for rework.
- Organic coating: covers powder and liquid coatings, both pigmented and clear. Multiple coating layers are applied, e.g. stain, filler, sealer or base coat, colour coat, and lacquer or topcoat. The type of coating equipment in use in furniture manufacture usually consists of spray equipment. The majority of spray equipment is manually operated. Roller, curtain, and dip coating are also used in a small number of specific applications.
- Curing: the coatings that have been applied are subsequently cured or hardened. This can be by heat/thermal means, while some more recent advances incorporate UV curing (larger facilities).

- Adhesive application: is used in assembly of furniture as well as for attaching other materials such as plastic, foam, or fabric.
- Cleaning: Equipment used in coating is cleaned regularly using solvent. This includes spray guns and lines as well as spray booths. Cleaning is sometimes carried out on the finished product prior to packaging and transport. Solvents are also sometimes used to strip unwanted coatings from product.
- Packaging, storage and transport: the finished articles are packaged and transported to customers.

Main Environmental Considerations:

The main environmental considerations in furniture manufacture are:

- volatile organic compounds (VOCs) from coating,
- particulates and dust,
- hazardous wastes e.g. solvent-containing materials,
- Other environmental considerations including timber resource depletion, noise, energy use, and wash water.
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The main waste streams and environmental impacts from furniture manufacture are:

Waste Stream	Source
Air emissions	Solvents – from coating, glueing, etc. Dust/particulates - from sanding, sawing, etc.
Waste wood	Off-cuts, chips and dust
Waste materials	Any collected waste solvent Rags contaminated with solvent Any collected dried paint (e.g. on dry filters) Solid off-spec. materials out of date coatings Empty coating containers
Wastewaters	From water curtain spray booths (where used) From any general washdown

Current Best Practices:

Current best practices can be broken down into general best practices and those that are specific to particular unit processes involved in furniture manufacture. The following is a list of the areas of furniture manufacture considered in the guide. The best practices in each area are expanded upon within the guide.

1 Choice of raw materials

2 Product design

3 General best practices applicable to furniture manufacturing operations
- 3.1 simple resource tracking
- 3.2 raw material stocks and storage
- 3.3 operating procedures
- 3.4 process control
- 3.5 product handling and storage
- 3.6 reducing finished goods damage rate
- 3.7 housekeeping measures
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- 3.9 waste handling

4 Solvent use in coating
- 4.1 alternative coatings
- 4.2 high transfer efficiency equipment in coating
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- 4.4 use of thinners

5 Solvent use in cleaning
- 5.1 use of enclosed gunwash stations
- 5.2 reducing use of cleaning solvents
- 5.3 spray booth cleaning
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6 Adhesive use
- 6.1 Spraying and manual adhesive application
- 6.2 use of alternative adhesives

7 Material preparation/processing
- 7.1 Operating machines/tools
- 7.2 Setting up machines
- 7.3 Type of cutting machines
- 7.4 Earthing of machines

1 Choice of Raw Materials:

The dimensions of original material available, and the dimensions of the pieces being cut should be looked at to minimise the amount of off-cuts that are generated. While manufacturers may automatically do this for more expensive timbers, this should also be taken into account for cheaper materials like board. Even though they are relatively cheaper to purchase, they still cost money in terms of disposal.

The type and amount of material that is used for each product should be looked at. It may be that an alternative material could be used to either partially or completely replace a particular material. Also a smaller amount of material may be able to achieve the same functionality, e.g. thinner board for the backs of cupboards. Such replacements can be made while maintaining product functionality and quality.

Source of Wood Used

Where available, aim to source wood and wood products such as veneer and board from suppliers that are members of the Pan European Forest Certification (PEFC) Council or of the Forest Stewardship Council (FSC). Such materials would carry logos and guarantee that the materials come from responsibly managed forests. In order to obtain certification under these schemes, suppliers must address various ecological, social and economic aspects of forest management. The use of managed timber sources is an important issue for the furniture sector since it tackles timber resource depletion, protects biological biodiversity and the environment, and ensures the economically viable and socially beneficial management of forests.

2 Product Design:

Where a company has control over the design of furniture, the following should be considered. Such changes do not have to be radical,

- Design to minimise the quantity of materials used.
- Choose materials that are less damaging to human health and/or the environment.
- Design so that the product can be disassembled at the end of its useful life according to component material types. Make sure such disassembled materials are recyclable materials.

3 General Best Practices Applicable to Furniture Manufacturing Operations:

3.1 Simple Resource Tracking

Track usage of raw materials and energy on a regular basis, say monthly or even bi-monthly, and relate it back to product produced.

This tracking can be achieved through looking at energy bills and purchase receipts for different material types, and keeping a tight inventory of materials. Information on products can be obtained from suppliers – for example the solvent and solids content of coatings. Items that are particularly worth tracking include thinners and cleaning solvent. Packaging used on raw materials and on finished product should also be tracked.

These usage figures should be related back to production throughput, e.g. number of units processed, or if possible, estimated square metres of work-surface covered. While the latter is not regularly calculated, it is recommended that the surface area of everything being coated is calculated.

This tracking related back to production could give an idea of typical resource use and highlight operations that are heavy on resources.
In addition to this, tracking of waste production in terms of amount (say number of skips) and costs should also regularly be undertaken. Again these should be related back to production throughput.

If possible, breaking down material usage and waste generation according to individual processes/areas will provide even more information on the efficiency of resource use.

3.2 Raw Material Stocks and Storage

Try to keep stock of raw materials to a minimum, as this will reduce the amount that will eventually become nonusable due to quality problems, obsolete materials, product changes, etc.

Always check that raw materials received fulfil the original order in terms of quantity, dimensions, type, etc., and that they are not unusable or damaged.

Ensure raw materials are stored in a manner that prevents damage and spillage. Indoor storage is recommended for all materials. Especially in the case of coatings, indoor storage, or even a smaller indoor day store for paints and thinners is recommended since outdoor storage or storage in unheated stores will reduce viscosity and require more thinners during application. Follow manufacturers instruction for storage of materials such as adhesives and coatings to maximise their shelf-life. Coatings should be stored in flameproof cabinets, or for larger volumes, in isolated bunded storage.

When stacking wood and wood-based products, separate using small pieces of timber to allow air movement. Make sure such timber separators are aligned in order to prevent warping due to the weight of the wood.

3.3 Operating Procedures

This section sets out improvements that can be made in operating practices. A significant factor in the success or otherwise of these procedural improvements, which cannot be overemphasised, is the training and familiarisation of staff with such practices,

- Ensure coatings are at room temperature before using or before thinning,
- Use mobile pumps rather than pouring for transferring larger amounts of solvent. Such pumps are even available for 25-litre drum size. For smaller amounts, e.g. cleaning, use enclosed piston-type dispensers rather than pouring. This will reduce usage and emissions,
- Only open or mix adhesives immediately before use,
- Just the amount of coating sufficient for a given job should be measured out,
- When using thinners with coatings, or when mixing two component coatings, it is important to follow the correct mix rates as recommended by the supplier/manufacturer. Workers should be trained on this and have correct instructions available to them. Apart from reducing wastage, this will also improve product quality and reduce reject rates. Use of two pack mixing systems or electronic scales can be beneficial,
- If using thinners, use some of the required amount to rinse out the just emptied coating container to help reduce the amount of residue in the container. Always add the thinners to the coating rather than vice versa. Add thinners in small amounts, regularly checking to see if desired consistency has been reached,
- Only carry out spraying within spray booths,
- Keep lids on all containers holding coatings, thinners or wastes. This will also improve product quality since the coating will remain at its designed solvent content. Keep any solvent impregnated wipes in enclosed containers, and when they are used place in a bin with a self-closing lid. Lids should also be kept on part-empty drums and on drums containing solvents waste. Lids can be designed to cover containers during pumping,

3.4 Process Control

Try to maintain a relatively consistent coating shop temperature throughout the year so the viscosity of the coatings is at the recommended levels. This will improve coating finish and reduce the need for thinners.

3.5 Product Handling and Storage

Consider the types of trolleys and handling techniques in use to minimise damage during product and component handling. There are trolleys available that can fit and stack for example, doors, drawers, etc. that can be used for handling of pieces and during drying.

In manual spraying of coatings, a significant portion of the operator's time is spent moving the pieces into and out of the spray booth. An alternative to consider would be the installation of a conveyor from which the parts are suspended on hooks, or a mechanical roller system along which the parts could be moved. The conveyor could pass from the spray booth on into the curing area.

3.6 Reducing Finished Goods Damage Rate

Keep track of the tonnage of finished goods that are damaged during handling on-site or in subsequent distribution and are returned. Work out what percentage of your production tonnage this constitutes. A damaged returns monitoring system should be put in place which, for each damaged piece, identifies the cause of the damage and when it occurs. This can allow improvements to be identified to reduce damages.

There are measures that can be taken to minimise damage rates:

- Train personnel in manual handling techniques to minimise damage,
- Packaging should be stored correctly so that it is not soiled and damage to product such as scratching due to grit and dirt is avoided. This would particularly be important for reusable packaging such as blankets,
- During transit, leave fasteners (e.g. those on wardrobe doors) unlocked to prevent loosening, use string to tie loose items such as drawers, strap down or tie items into place within delivery vans, and do not overload delivery vans,
- Measures such as corner protection packaging can reduce damage. However, this does involve additional packaging, and hence additional expense and resource use,
- Minimise rough surfaces, sharp corners on benches, etc. in process areas to minimise damage to goods while being manufactured and handled.

3.7 Housekeeping Measures

Dust collectors/extractors that filter out chips and dust should be fitted on individual machining tools such as sanders. There are portable dust extraction systems available. The collected dust and chips should be stored in an enclosed container. It may be possible to reuse collected chips and dust in another application (see 3.9 Waste Handling).

Keep workshop areas free from accumulation of dusts by regular vacuuming. This is important also from a health and safety point of view as inhaled wood particulates can be

hazardous to health. Where large amounts of dust are generated, a dust extraction system may be warranted.

All containers of coatings and solvent/thinners should be kept closed when not in use and during handling/transport around the premises. Keep them in areas where they won't get knocked over. Transfer solvent-containing material out of containers that do not seal properly, e.g. are damaged or dented.

Keep a spill kit (i.e. some sort of absorbent material and a closed container or sealable bag in which it can be placed) near to where thinners, solvents and coatings are stored and used. *Note:* don't use sawdust for mopping up spills of any flammable liquids as the resultant mixture could spontaneously combust if stored in a confined space. Similarly, bins containing solvent–laden rags and certain finishes (those with high oils content such as linseed oil based finishes) have the potential to spontaneously combust, and therefore should be regularly emptied.

3.8 Maintenance Procedures

All moving parts should be lubricated frequently so as to extend their life and improve spray equipment performance (specialised lubricants are available from spray gun suppliers). Spray equipment moving parts should be properly adjusted. Certain parts of spray guns, such as the nozzle and valves, should be checked regularly and replaced if worn.

Regularly maintain spray booth filters. For dry booth filters: change the paper filter every few weeks. For water back booths: perform regular dosing, periodic solids removal from the water and periodic disposal of the water.

Drain air compressors of condensate and clean air intake filters on a regular basis. Repair leaks on compressed air lines.

3.9 Waste Handling

Some of your wastes will be classified as hazardous waste. These could include waste solvent as well as solvent containing material such as rags, empty containers, discarded coatings, etc.

Different outlets other than landfill may be possible for your waste streams, by converting them into a product e.g., composting outlets for sawdust or sending them for recovery e.g., energy recovery, plastic or cardboard collection for reuse, collection of solvent containing rags for cleaning, solvent recovery and reuse. You may find that your waste contractor is doing some of this anyway with unsegregated wastes. Costs can

possibly be reduced in this fashion by not relying on a sole contractor to handle all of your waste.

Try to segregate your waste streams, by keeping sawdust separate to larger wood off-cuts, and keeping uncoated wood waste separate from coated wood waste.

Always use reputable firms – under law you are still responsible for your waste even when you hand over control to someone else. Never dispose of any waste, such as timber or waste packaging materials, by open burning.

4 Solvent Use in Coating:

4.1 Alternative Coatings

Using alternative coatings (e.g., low solvent or water based) will help reduce solvent emissions from coating processes and reduce hazardous waste disposal costs.

Conventional coatings typically contain 60 - 80% solvent, which corresponds to 720 – 960 grammes of solvent per litre of coating. Alternative coatings include aqueous coatings, low solvent content coatings, high solids content coatings or other coatings like powder-based coatings.

Do not automatically dismiss trying out alternative coatings as a result of any historical trials that may have been unsuccessful. This is an area under continuous development with both technical and cost improvements regularly being made.

While it may be a significant undertaking to convert all your coatings in one go, you could consider changing one of your coatings or part of your production, for example, using a water-based stain in place of a solvent-based stain. Ask your supplier about potential alternatives and their compatibility with your other coatings.

The solvents Directive (1999/13/EC), a planned "deco paints" Directive and market initiatives such as the B&Q requirement for a “low solvents” label for coatings are likely to eventually force coatings suppliers to reduce solvent content of paints.

It should be remembered also that a reduced usage of solvent will translate to a lower fire risk for your premises. This can in some cases be translated into lower insurance premiums.

Water-based Coatings

There are some water-based products commercially available for coatings such as stains, sealers or base coats (clear and pigmented), primers, waxes, and topcoats. All of the major coatings suppliers now have water-based alternatives for all furniture applications. In many cases they claim equal quality of finish, speed of application and speed of curing to solvent coatings. Some water-based products, when used with very small amounts of additives, pass the British Standard for severe use rating. There is some small amount of solvent in water-based coatings.

This area is constantly evolving. Previous issues with the clarity of water-based coatings have been resolved. Curing or drying facilities may also need to be improved, as drying times will be longer. Some of the more recently available water based coatings have lower curing energy requirements and curing times are being reduced. Aqueous coatings have the added benefit of the ability to mainly use water for gun cleaning. Aqueous coatings can usually be applied with conventional equipment, although the equipment materials should be checked to ensure they are suitably corrosion resistant.

Low Solvent Content Coatings

There are coatings available that have reduced solvent content as compared to conventional solvent-based coatings. Certain low solvent coatings use peroxide to cure the coating and have quick curing times. The solvent content of low solvent coatings that would currently be considered best practice is 100 g/litre (less water) of VOC or solvent content.

High Solids Content Coatings

High solids coatings typically contain more solids than volatile components. High solids content coatings are available for certain coatings such as lacquers. A lower amount of high solids coating is needed to cover a given area. Cleaning solvent use may increase somewhat. High solids coatings that would currently be considered best practice are as follows:

Coating type (spray, curtain or dip application)	**VOC or solvent content g/litre (less water)**
Pigmented coatings	520
Clear coatings	475
Fillers	320

Powder-based Coatings

Powder-based coatings and UV-cured coatings, which are both solvent free, are also alternatives to solvent-based coatings. However, in both cases plant investment is significant and it is usually

more suitable to high volume throughput facilities. Pretreatment with sprays enhances the electrostatic adhesion of particles to the wooden surface.

4.2 High Transfer Efficiency Equipment in Coating

Change to high volume low-pressure (HVLP)) spray equipment that is more efficient in the amount of coating needed to spray a given area, i.e. has a higher transfer efficiency. For conventional high-pressure, air assisted spray equipment only 25% - 40% of coating reaches the surface. For high volume low pressure (HVLP) spray equipment 65% or more of coating reaches the surface. HVLP also offers improved finish quality and reduced coating costs due to overspray reduction. Spray booth cleaning is also reduced due to an increased amount of the coating going onto the product rather than the walls of the spray booth.

At present there has been little take up of such equipment by Irish industry. The typical cost of a high quality spray gun is €400. These spray guns can be connected to the existing conventional pressurised air supply systems. Newer models also have a similar feel in use to conventional guns.

There are also other types of spraying equipment available that offer improved transfer efficiency for specific applications. Air assisted airless spray and airless spray are suitable for coating of large areas.

4.3 Operation of Spray Equipment & Training of Operators

The importance of operator training in the techniques and proper use of spray equipment cannot be emphasised enough. A properly trained person using conventional equipment could possibly have a better transfer efficiency than an untrained person using HVLP equipment.

Operators should be trained on factors such as:

- Holding the spray gun perpendicular to the workpiece surface
- Holding the spray gun 15 to 20 cm (6 to 8 inches) from the workpiece
- Ensuring each stroke overlaps the previous stroke by 50%
- Triggering the gun at the beginning and ending of each pass (i.e. release the trigger just before the stroke ends while the gun is directly over the product)
- Maintaining a consistent gun speed — general recommendation is 1.3 m/s (250 ft/min)
- Maintaining a coating level of 70 – 80 g/m^2
- Maintaining the correct air pressure for spraying and use of the air-cap pressure tester to check this
- Adjusting the spray pattern to suit the item being coated
- The frequency and method of cleaning spray guns.

Proper training and operation will obviously also improve product quality and reduce reject rates.

Spray guns should be cleaned after use or whenever there will be an appreciable interval between uses. Avoid the practice of cleaning by spraying solvent into the water curtain or dry filter. Instead use enclosed units or else spray solvent directly into a container for possible reuse.

Spray training courses are available in Ireland.

4.4 Use of Thinners

Reduction in the use of thinners can be relatively straightforward in most companies and provide savings as well as a reduction in VOC emissions. Measures that can be taken include:

- Keeping lids on coating tins.
- Maintaining ambient temperature. Alternatively, in-line heaters are available for spray equipment to heat the coating just before it is sprayed.
- Keeping control on access to thinners.
- Training operators so that thinners are not always added automatically.
- Purchasing coatings that are already at the correct viscosity and do not require thinning.

5 Solvent use in Cleaning:

5.1 Use of Enclosed Gunwash Stations

Spray guns and lines can be washed in enclosed equipment designed for the purpose. This reduces the release of solvent as well as reducing solvent consumption due to cleaning. Such manually operated or automated equipment is readily available on the market.

5.2 Reducing Use of Cleaning Solvents

Clean spray equipment as soon as possible after coating before the coating hardens and becomes more difficult to remove. Use air to blow back the coating from the lines into the pot.

If not using an enclosed gunwash station, do not spray solvent into the booth as part of cleaning – instead spray it into a container and close the container after use. Solvents usually can be reused for cleaning equipment up to three times. The first wash through could be carried out using ‘dirty’ solvent, with clean solvent being used for the final wash. If parts need to be soaked in solvent for cleaning, this should be carried out in an enclosed container.

Using water-based coatings will eliminate a lot of the solvent needed for cleaning.

If solvent-containing cleaners must be used for a particular application, try to use cleaners that have a lower content of VOCs than conventional solvent-based cleaners. Water-based cleaners such as citrus cleaners are also available.

5.2 Spray Booth Cleaning

Cleaning of spray booths should be carried out on a regular scheduled basis. This will ensure that it does not develop into a large, unmanageable task.

There are coatings that can be applied to the surface of spray booths that can be peeled off after spraying thereby reducing the cleaning task. However, bear in mind that this will generate an additional solid waste that will need disposal.

Try to carry out initial cleaning of the spray booth using non-solvent methods:

- clean flat surfaces by scraping.
- Use hot water under pressure (although this will generate effluent and permission to release to sewer/waters would be needed from your local authority).

When using solvent to clean the spray booth it should be used with a brush or on rags/wipes.

5.3 Reducing Need for Product Cleaning

Careful storage may reduce cleaning requirements. Protective packaging may help reduce the amount of cleaning required. This does need to be considered against the additional resource use as a result of such packaging. Reusable packaging or coverings may be applicable.

All cleaning applications of product should be assessed to see if they are absolutely necessary.

5.5 Alternative Stripping Agents

If stripping agents are to be used, alternatives to those containing methylene chloride should be considered.

6 Adhesive Use:

6.1 Spraying and Manual Adhesive Application

Some of the above best practices for coatings application similarly apply to adhesive application using spray techniques, namely:

- high transfer efficiency equipment
- proper operation of spray equipment & training of operators

Use a spreader after application of the glue to give a consistent layer thickness.

6.2 Use of Alternative Adhesives

Determine the solvent content of the adhesives in use. Alternatives may be available with a lower VOC content. Water based adhesives are available for use with certain applications such as bonding foam with foam, fabric, plywood, etc..

7 Material Preparations/Processing:

7.1 Operating Machines/Tools

Do not use excessive sanding pressure, as this will result in increased nibbing or raising of the wood grain, which will require increased denibbing (sanding) between coats.

Sand wood to a matt surface. Sanding until a gloss surface appears will increase nibbing during finishing. Use the correct grit sequence during sanding.

Only use sanding belts that are unworn and unclogged. This will not compromise the coating finish. Regularly clean sanding belts using steam or commercial sanding belt cleaners.

7.2 Setting up Machines

Use off-cuts to set up machines.

7.3 Type of Cutting Machines

If cutting machines are being replaced or new machines are being purchased, consider a computer numerical controlled (CNC) cutting machine which has much lower wastage compared to conventional machines as it works out the optimum usage of material from given sizes and projected jobs. Such machines can now be used for wood in addition to wood-based products.

7.4 Earthing of Machines

If machines are earthed and anti-static sanding belts are used, apart from the obvious safety benefits, the amount of dust remaining on the product will be reduced. This will reduce the need for cleaning and improve finishing leading to cost and environmental savings in reduced use of cleaners and a reduced need for rework.