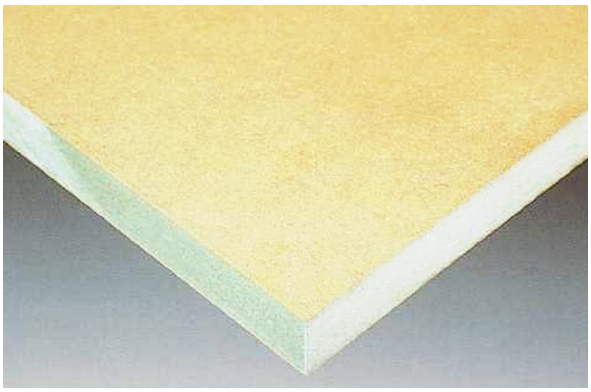
Panel Guide

ANNEX 2E

Dry Process Fibreboards (MDF)



Description

Dry process fibreboards are engineered wood-based sheet materials made by bonding together wood fibres with a synthetic resin adhesive. The term 'dry process fibreboards' is a generic term so called by virtue of the manufacturing process.

Within this description, the most common class of board is Medium Density Fibreboard (MDF) although this in itself is a generic class, which can, for marketing purposes, be sub-divided into panel types differentiated principally by their density, i.e.

High Density MDF (HDF)
Low Density MDF (LDF)
Ultra Low Density MDF (ULDF)

Since 1966 when the first MDF was produced commercially in Deposit, New York State, USA, the market for MDF has increased dramatically world-wide. The first MDF was produced in Europe in 1973 and today European production capacity rivals that in the USA, with 13 million cubic metres per annum produced in 2006.

Because of its availability in a wide range of thicknesses and the ability to be machined and finished to a high standard, dry process fibreboards have been accepted in a wide range of applications both in construction and also furniture, where in both cases it has substituted solid timber and also other wood-based panels in particular applications.

The development of value added variants with enhanced mechanical performance and improved performance in the presence of moisture and fire have further aided the applications available.

MDF can be manufactured with either softwood or hardwood species. The majority of MDF manufactured is composed mainly of softwood although some individual brands may contain a higher percentage of temperate hardwood depending on the location of the factory to the local forest resource.

The constituents of a typical standard MDF manufactured in the United Kingdom or Ireland are 82 virgin wood fibre (wholly or mainly softwood), 10% synthetic resin binder, 7% water, less than 1% paraffin wax solids and less than 0.05% silicon. The most common binder is urea-formaldehyde although depending on the grade and end use of the product other binders may be used, i.e. melamine urea-formaldehyde, phenolic resins and polymeric methylene di-isocyonate (PMDI).

A typical process involves reducing wood down to small chips, which are then thermally softened and mechanically refined into fibres, which are then mixed with a synthetic resin binder. The resinated fibres are dried and then formed into a mattress ready for pressing. The mattress is pressed between heated polished press plates to the desired thickness. For thick boards more than one mattress may be 'piggy backed' together.

Appearance

MDF has smooth sanded surfaces, it has a homogeneous construction and is typically pale straw in colour. For identification purposes the whole panel, i.e. individual layers of the panel may be dyed according to industry practices (e.g. green for panels with enhanced moisture resistance, or red for panels integrally treated with flame-retardant chemicals). Integral colouring is distinct from the voluntary coloured stripe system that may be applied on the outside edge of panels in a pack, at opposite corners to identify particular grades in accordance with EN standards. The presence of an integral colour does not guarantee that enhanced properties are present, and reference should be made to panel markings or manufacturer's literature to verify this.

Density, Mass and Sheet Size

Standard forms of MDF have densities as follows:

Average density: 700 - 800kg/m^3
Core density: 600 - 700kg/m^3
Face density: 1000 - 1100kg/m^3

These are now considered to be part of a wide range of dry-process fibreboards with the following densities.

High Density MDF (HDF): Above 800kg/m^3
Light MDF (LDF): Below 650kg/m^3
Ultra-Light MDF (ULDF): Below 550kg/m^3

Due to variation between brands, the weight of MDF is not constantly proportional to thickness. Typical weights, based on standard MDF with average density 750kg/m^3, are:

Thickness	Mass per Unit Area
6.5mm	5.0kg/m^2
9.0mm	6.3kg/m^2
12.0mm	8.4kg/m^2
16.0mm	11.0kg/m^2
19.0mm	14.0kg/m^2

MDF is available in an extensive range of thicknesses, i.e. 1.8mm to 60mm. The most common sheet sizes are: widths 1220mm, 1525mm and 1850mm and in lengths up to 3660mm.

Other sizes are available or can be produced to order (minimum order conditions exist).

With the exception of the largest users such as volume furniture manufacturers, MDF in common with other wood-based panels would generally not be supplied direct by the manufacturer but instead, depending on the volume and specification, could be supplied through a distributor or merchant.

Applications

Due to the particular machining and finishing attributes combined with good working properties and its availability in a wide range of sheet thicknesses and sizes, MDF finds application in a wide range of construction and furniture applications. It is used increasingly for interior design and building applications such as skirtings and architraves, windowboards, wall linings, and decorative facades, as well as the core material for some floorings.

MDF can be cut without breakout or splintering and it can be profiled on the edges and surfaces. The smooth and relatively dense surface provides an excellent base for painting, veneering and laminating. Consequently MDF is used extensively in furniture production, and with the range of value added variants, its use is being extended into shopfitting and display, interior fitments, exterior application (e.g. signage and shop fronts) as well as components within numerous other products.

Specification

MDF manufactured in Europe for use in construction must be specified in accordance with European Standards. The UK versions of these are EN 622 Part 1 and EN 622 Part 5. As explained in Section 2 of 'PanelGuide', MDF that is used in construction must comply (by law) with the Construction Products Directive, and the most straightforward route to achieving this is by complying with the Harmonised Standard for wood-based panels (EN 13986 – "Wood-based Panels for Use in Construction – Characteristics, Evaluation of Conformity and Markings"; this standard calls up Parts 1 and 5 of EN 622 . These are:

EN 622
Part 1 – General requirements for all fibreboards
Part 5 – Requirements for dry process boards (MDF)

Selection of a particular grade is dependent upon the ambient climatic conditions together with the level of loading that is anticipated.

The requirements given in EN 622-5 are not specific to any particular application and so it is appropriate to refer to Codes of Practice or manufacturers literature when considering a particular application (Refer to Sections 2 and 3 of PanelGuide).

For construction applications some selection guidance is given in DD CEN/TS 12872.

The specifications classify boards according to their intended end use classification.

MDF Type	**Use Classification***
MDF	General Purpose – Dry
MDF.H	General Purpose – Humid
MDF.LA	Load Bearing – Dry
MDF. HLS	Load bearing – Humid**
L-MDF	General Purpose - Light MDF – Dry***
L-MDF.H	General Purpose – Light MDF – Humid***
UL1-MDF	General Purpose – Ultra Light MDF – Dry ***
UL2-MDF	General Purpose – Ultra Light MDF – Dry ***
MDF.RWH	MDF used in rigid underlays***

* Defined in EN 622-5
** These panels are restricted under humid conditions to instantaneous or short periods of loading.
*** Add during latest revision of EN 622-5

EN 622-5 is currently being revised and the new version is likely to include both light and ultra-light grades as well as an underlayment grade of MDF.

EN 622-1 specifies some properties that are common to all uncoated fibreboards, i.e. dimensional tolerance, moisture content and formaldehyde potential.

EN 622-5 specifies properties for each type of MDF grade: swelling in thickness, internal bond, bending strength and modulus of elasticity (not design values). In addition supplementary properties which may be specified are identified although no values are given, i.e. surface soundness, axial withdrawal of screws, surface absorption and dimensional changes. Panel manufacturers generally provide values for these properties.

Physical Properties

a) Climate

Like other wood-based panel products, MDF is hygroscopic and its dimensions change in response to a change in humidity. Typically a 1% change in moisture content increases or decreases the length and width by 0.4mm per metre run.

As a guide, MDF could be expected to attain the following moisture content under the specific conditions.

Relative Humidity at 20°C	**Approximate Equilibrium Moisture Content**
30%	5%
65%	8%
85%	12%

When components are factory produced for installation on site it is essential that the site conditions are suitable to receive the components, with wet trades completed and the building dried out.

Panels with enhanced moisture resistance are not waterproof; the term "moisture resistant'" applies to the adhesive binder which (within limits defined by EN 622-5 will not break down in the presence of moisture). Physical wetting of all grades of MDF should be avoided.

b) Biological attack

MDF will not normally be attacked by wood boring insects common in temperate climates, but is susceptible to fungal attack under prolonged wet conditions.

General guidance on the use of preservative treatments for panel products can be found from the Wood Protection Association manual 'Industrial Wood Preservation – specification and practice Commodity Specification C11. This guidance helps make the right choice of preservatives for the end use and the panel product to be treated as not all panel products need to be treated for particular end uses or are indeed suitable for some treatments. It also stresses that the preservative and/or the panel manufacturer should be consulted before any treatment is carried out as treatment may alter the physical and/or visual properties of the panel product.

c) Water Vapour Permeability

The value of the water vapour resistance factor (μ) for MDF varies from a value of 2 at a density of 250kg/m^3 to 20 at a density of 800kg/m^3, when tested in accordance with EN ISO 12572, using test conditions C (the wet cup method). Dry cup values vary from 5 at a density of 250kg/m^3 to 30 at a density of 800kg/m^3. Values for various densities of fibreboard are given in Table 9 of EN 13986.

d) Thermal Conductivity

The thermal conductivity (λ) of MDF varies from 0.05 W/mK for a panel density of 250kg/m^3 to 0.14 W/mK for a panel density of 800kg/m^3. Values for various densities of fibreboard can be found in Table 11 of EN 13986.

e) Reaction to Fire

Under the new Euroclass system for characterising the reaction to fire performance of materials, an untreated MDF may be assumed to achieve as follows:

Product	EN Product standard	End use condition[6]	Minimum density (kg/m^3)	Minimum thickness (mm)	Class [7] (excluding floorings)	Class [8] (floorings)
MDF[1] [2] [5]	EN 622-5	Without an air gap behind the wood-based panel	600	9	D-s2,d0	D_{fl}-s1
MDF[3] [5]	EN 622-5	With a closed or an open air gap not more than 22mm behind the wood-based panel	600	9	D-s2,d2	-
MDF[4] [5]	EN 622-5	With a closed air gap behind the wood-based panel	600	15	D-s2,d0	D_{fl}-s1
MDF[4] [5]	EN 622-5	With an open air gap behind the wood-based panel	600	18	D-s2,d0	D_{fl}-s1
MDF[5]	EN 622-5	Any	400	3	E	E_{fl}
			250	9	E	E_{fl}

(1) Mounted without an air gap directly against class A1 or A2-s1, d0 products with minimum density 10kg/m^3 or at least class D-s2, d2 products with minimum density 400 kg/m^3.

(2) A substrate of cellulose insulation material of at least class E may be included if mounted directly against the wood-based panel, but not for floorings.

(3) Mounted with an air gap behind. The reverse face of the cavity shall be at least class A2-s1, d0 products with minimum density 10 kg/m^3.

(4) Mounted with an air gap behind. The reverse face of the cavity shall be at least class D-s2, d2 products with minimum density 400 kg/m^3.

(5) Veneered phenol- and melamine-faced panels are included for class excl. floorings.

(6) A vapour barrier with a thickness up to 0,4mm and a mass up to 200 g/m^2 can be mounted in between the wood-based panel and a substrate if there are no air gaps in between.

(7) Class as provided for in Table 1 of the Annex to Decision 2000/147/EC.

(8) Class as provided for in Table 2 of the Annex to Decision 2000/147/EC.

NOTE The classes given in this table are for unjointed panels, T&G jointed panels installed according to DD CEN/TS 12872 and fully supported joints installed according to DD CEN/TS 12872.

If the manufactured product does not satisfy any of these minimum requirements then it must be tested and classified according to EN 13501-1.

Further information on the reaction to fire testing in both the BS and EN systems is provided in Section 2.2.3.

Storage and Handling

MDF should be stored flat and dry, off the ground, with all four edges flush. Storage in an enclosed building is preferable and external storage should be avoided whenever possible.

Stacking on edge should be avoided wherever possible. Panels should be stacked on a close-boarded or slatted pallet, or if this is not possible on battens at no more than 600mm centres. The battens should all be of equal thickness and should be vertically aligned with any others in the same stack, in order to avoid distortion of the panels.

Panels should be protected by a waterproof covering during transport and the edges properly covered. Edges should also be protected against damage by lashings or other banding, this is particularly important for panels with profiled edges e.g. tongued and grooved panels. It is particularly important that panels are protected from wetting during storage and construction. "Humid" panels can tolerate inflated humidity conditions such as can be found in kitchens and bathrooms but direct contact with water should be avoided with the unprotected panel. All panels should be installed at a moisture content as close as possible to that which they will attain in service, in order to minimise any movement problems.

Once on site, it is preferable for individual panels to be "stickered" before installation in order to allow air to circulate and to allow the panels to attain a moisture content as close to their final in-service moisture content as possible.

Further guidance on storage and handling can be found in PanelGuide Section 4.

Working with MDF

Satisfactory results can be achieved using hand tools but quicker and more consistent results can be achieved using either portable or fixed power tools.

Tungsten carbide tipped (TCT) tools will give better cutting performance on power tools.

Where material routing and moulding is required, the cutter type, tool and material feed speed all affect the quality of finish, cutters must be kept sharp, as dull cutters will cause edges to 'bell'. Whilst all MDF generally machines well, the density profile will differ between brands and this may influence the quality of finish.

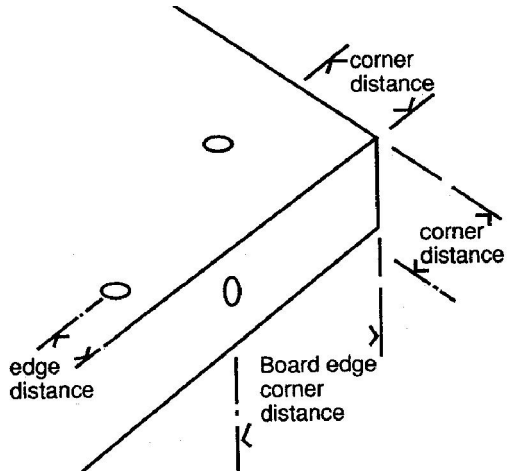
MDF can be drilled using all types of wood working drill bits.

Fixing MDF

MDF can be fixed using all conventional woodworking fixings and techniques. It provides good holding power for screw fixings into board faces and edges. Parallel core screws should be used because they have greater holding power than conventional wood screws. Typical screw withdrawal values tested to EN 320 are:

Face: 1050N
Edge: 850N

A high overall diameter-to-core diameter ratio is desirable. Nails and staples can be used for lightly loaded fixings or to hold glued joints while adhesive sets.



Drill pilot holes for screw fixing. Typically, the holes should be 85 to 90% of the screw core diameter. Fixings into the panel face should not be within 12mm of edges and 25mm of corners. Screws into the panel edge should not be within 70mm of corners.

MDF can be bonded with all types of woodworking adhesive. The appropriate type depends on end use.

Dowel joints can be satisfactorily used with MDF. Multi-grooved dowels are recommended. Dowels and holes should have an interference fit, that is of such size that the dowel can be pushed home by hand but, even without adhesive, is not sufficiently loose that it can fall out. Allow some tolerance on the dowel diameter, typically up to 0.2mm oversize.

Mechanical joints and fixing

Mechanical fittings can be applied to MDF with the following recommendations:

Wherever possible, select fittings that depend upon face fixing. Avoid fittings that depend upon the expansion of a component inserted into the board edge.

When using screws, use recommended pilot hole dimensions.

When fixing MDF as wall panelling or cladding, it is important to leave a small expansion gap between adjacent panels. The gap should be 2.5mm per metre minimum; often a feature gap is used, for example 10 or 12mm, with or without coverstrip.

Adhesive-bonded joints

A wide variety of jointing methods can be used, provided the following simple guidelines are observed:

- The joint parts should be accurately machined.
- Use sharp cutters to avoid tearing or burnishing the surfaces to be bonded.
- Use a high solids content adhesive with low flowing properties (polyvinyl acetate or urea formaldehyde).
- Locate mating pieces accurately and hold them under pressure while the adhesive sets.
- The width of grooves machined in MDF should be limited to about one-third of the thickness of the panel. The depth of groove should be about one-half of the panel thickness.
- Allow adhesive-bonded joints to condition for several days before sanding and finishing; this avoids the appearance of sunken joints and is essential with high-gloss finishes.
- A tongue and groove joint is very efficient, provided the fit of the joints is not too tight to cause a split along the edge.
- When attaching lippings, the tongue should be machined on the solid wood piece.

Finishing

Sanding

The faces of MDF are usually pre-sanded by manufacturers with 120 grit abrasive. This provides a smooth surface ideally suited to the direct application of most veneers and

plastic foils. Scuff sanding with the objective of increasing adhesion may be detrimental. For the economic application of paints or printed effects and for very thin foils a further light sanding with 200 grit abrasive may be advisable. Excessive sanding of the faces should be unnecessary and because it could unbalance some MDF boards it should be avoided.

Silicone carbide based abrasives are generally recommended for sanding MDF, Aluminium oxide abrasives tend to dull rapidly, producing burnishing. A 'modified close coat' abrasive is suggested. High sanding speeds cut the most efficiently; for example, with belt sanders, belt speeds in excess of 1500 metres per minute are recommended.

Sanding after moulding or routing produces a smoother surface, moulded edges can be sanded using a profiled sander. 80/100 grit abrasives should be used to remove cutter marks, 120/150 grit is required for finish sanding.

Surface Coatings

MDF can be finished with a wide range of coatings.

Because the edges of MDF are more absorbent than the surfaces, they may require sealing with shellac, polyurethane, diluted PVAC, or specially formulated, high solid content sealers; these compensate for their greater absorption.

Opaque paints are the easiest finishes to apply as their high solids content allows a high build. A base coat and a finish coat are usually all that is required.

Pigmented systems can produce single colour finishes; more specialised techniques and lacquers can produce metallic, marbled and other finishes.

Conventional oil or water-based paints give good results; better and quicker results can be achieved using lacquers based on nitrocellulose, acid catalysed resins, polyurethane or polyester resins applied by hand spray.

High-gloss finishes can be obtained using a high-build coating based on polyester resins, possibly with a clear lacquer top coat to protect the surface and enhance the gloss effect.

Clear lacquers and varnishes can be used. Application and preparation is similar to that for pigmented finishes. When coloured translucent finishes are required, decorative stain finishes can be used. Solvent-borne stains will wet the surface effectively and ensure an even colour; water-borne stains can be used but the waxes added to MDF to reduce water absorption may result in uneven absorption of stain and consequent colour variation. One or two coats of clear lacquer can protect stained surfaces. As the edges of MDF are more absorbent that the surfaces, stain finishes applied to edges may result in darker colours compared to surfaces.

Depending upon the finishing system used, it may be necessary to sand between coats using a fine-grit paper. Water-based systems in particular tend to raise the fibres.

Health & Safety

In sheet or processed form MDF does not present any health or safety risk. Contact with wood products can cause irritation effects but the most significant risks come from mishandling the material.

Very fine dust is produced when MDF is machined. Just like any other wood dust, this is a potentially hazardous substance and it must be controlled. There is no evidence that exposure produces health effects that are different in nature to those associated with exposure to similar levels of dust from other wood sources.

Dust from cutting operations can be controlled adequately by complying with the Control of Substances Hazardous to Health (COSHH) Regulations 2002. Under these regulations, wood dust has a Workplace Exposure Limit (WEL) of 5mg/m^3, this is the relevant limit for controlling exposure to MDF dust.

Exposure must be reduced as far as possible below this limit, usually with properly designed and maintained dust extraction equipment fitted to woodworking machines.

Extraction equipment is often not practicable or even available when using portable or hand-held tools, so wear a suitable dust mask (for example, Type FFP2 to EN 149). If possible, machine MDF in a well-ventilated place.

Formaldehyde in the workplace atmosphere has an WEL of 2 parts per million (ppm). However, studies indicate that anyone machining MDF in typical situations is exposed to levels of free Formaldehyde significantly below this.

Two formaldehyde classes (determined in accordance with EN 120, EN 717-1 and EN 717-2) are specified in the "Harmonised Standard" (EN 13986) at a moisture content of 6.5%.

Based on EN 120, the limits are set at:

Class E1 $\leq$ 8mg/100g
Class E2 > to $\leq$ 30mg/100g

MDF manufactured in the UK and Ireland has Class E1 formaldehyde content.

Hazards and control

In sheet or processed form, MDF is non-classifiable under the COSHH regulations. However, there may be handling hazards.

COSHH Regulation 6 requires an assessment to be made (and normally recorded) of health risks associated with wood dust or formaldehyde together with any action needed to prevent or control those hazards.

The table below gives the most common hazards and identifies control methods to minimise the risk of harm actually occurring.

Common hazards and methods of control

Activity	Hazard	Control
Manual handling (in full sheet form)	Large sheet sizes present a risk of strain or crush injuries if not handled correctly.	Store carefully in uniform stacks on a flat level base. Use mechanical handling equipment. Adopt correct manual handling procedures
Carpentry work Activities likely to produce high dust levels include: • Sanding by machine & hand • Sawing, routing & turning • Hand assembling machined or sanded components	Wood dust in general (including dust from MDF) may cause dermatitis and allergic respiratory effects. Wood dust is flammable.	Off site: preparation under exhaust ventilated plant. On site: enclose and exhaust ventilation. Dust extraction on portable tools. Good ventilation. Respiratory protection equipment. *Note*: Any health hazards arising from the use of MDF at work can and should be controlled by compliance with the requirements of the Control of Substances Hazardous to Health (COSHH) Regulations 2002

MDF Safety Concerns

In 1997 questions were voiced through the media as to the safety of MDF. In relation to speculation the Health and Safety Executive embarked on an 18 month investigation into the health effects of MDF.

The results of this investigation were reported on the 6 December 1999 and the following is an extract from the HSE Press Release.

"The Hazard Assessment Document for MDF reports on the scientific evidence for the possible health effects of exposures arising from machining MDF and includes information from the HSE commissioned research on the atmosphere created during the machining of MDF,

> "*The Hazard Assessment Document was discussed by the Advisory Committee on Toxic Substances' Scientific Sub-Group, the Working Group on the Assessment of Toxic Chemicals (WATCH). These committees provided a forum where both the trade unions and industry were able to present their views on the work that was taking place.*
>
> *WATCH endorsed the conclusion of the hazard assessment that there is no evidence of any different ill-health effects associated with exposure arising from the machining of MDF to those associated with similar exposure arising from machining other forms of wood.*
>
> *In respect of occupational exposure, WATCH expressed the view that the most appropriate risk management strategy for MDF is the one currently recommended by HSE. This specifies that the level of dust arising from the machining of MDF should be kept to as low as reasonably practicable below the Workplace Exposure Limits (WELs) for softwood dust and hardwood dust and that levels of free formaldehyde should be kept as low as*

reasonably practicable below the WELs for formaldehyde. Softwood and hardwood dusts each have an 8-hour time weighted average WEL of 5mg/m^3 (total inhalable dust, whilst formaldehyde has WELs of 2 ppm, as an 8-hour time weighted average and as a 15 minute short term exposure limit.

Based on current available evidence, the HSE's view is that any health risks that might arise from the use of MDF at work can and should be controlled (in common with many other substances) by compliance with the Control of Substances Hazardous to Health (COSHH) regulations"

In respect of DIY exposure, the Medical Research Council's Institute for Environment and Health (MRC) is on record as saying "Looking at the domestic situation, available evidence suggests that DIY exposure to wood dust (through cutting, sawing, sanding, etc) is unlikely to pose any measurable health risk", and added that "While MDF (because of its composition) is likely to produce more fine dust than solid wood for the same operations, it is – as with wood – considered unlikely to pose any significant hazard".

In respect of actual dust exposure levels in the home arising from DIY activity the MRC opinion is that it seems unlikely that such activities would give rise to total dust exposures remotely approaching those seen in occupational settings.

The MRC recommended that during DIY activities, care should be taken when working on MDF so as not to liberate or inhale dust, an appropriate facemask should be worn.