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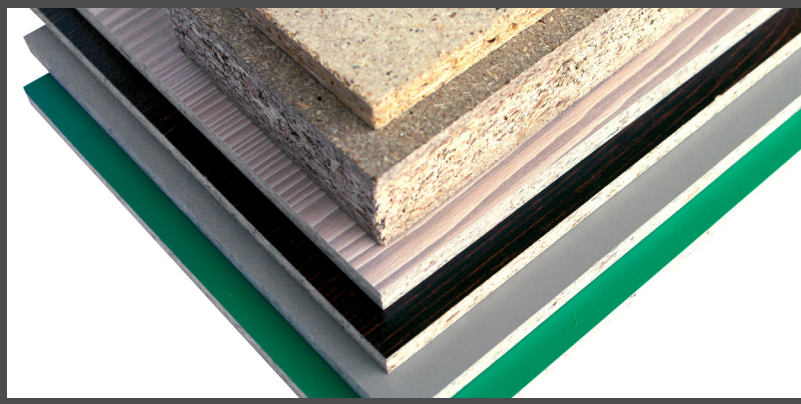
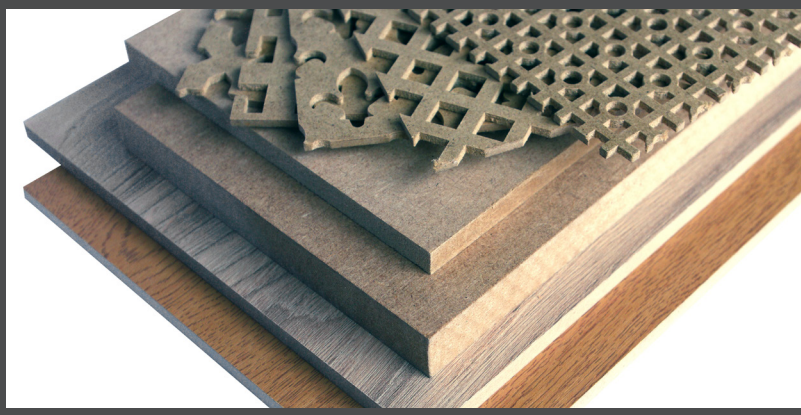
Panel Guide

Version 4







Annex 2E: Dry process fibreboards (MDF)

Description

Dry process fibreboards (MDF) are engineered wood-based panel materials made by bonding together wood fibres with a synthetic resin adhesive.

Since 1966 when the first MDF was produced commercially in Deposit, New York State, USA, the market for MDF has increased dramatically worldwide. MDF was first produced in Europe in 1973.

Because of its availability in a wide range of thicknesses and the ability to be machined and finished to a high standard, MDF has 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.

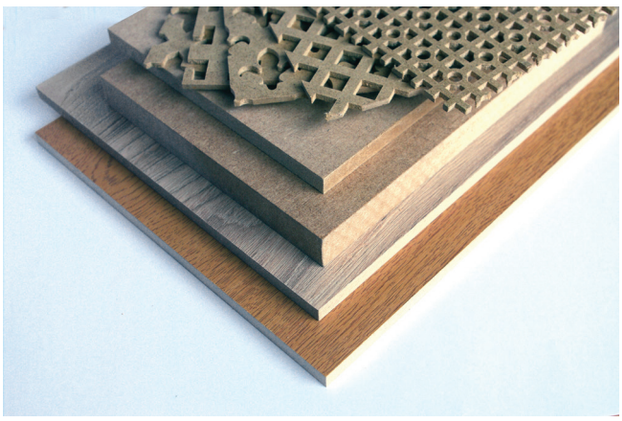


Figure A2.5: Dry process fibreboard (MDF)

MDF can be manufactured with either softwood or hardwood species. Most MDF is composed primarily 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
- 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, such as 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. These 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. Historically, MDF was manufactured in multi-daylight presses, but most modern plants now use continuous presses, where the mat is compressed to the finished thickness between two converging steel belts.

Appearance

MDF has smooth sanded surfaces; it has a homogeneous construction and is typically pale straw in colour. For identification purposes the whole panel, ie individual layers of the panel, may be dyed according to industry practices (for example green for panels with enhanced moisture resistance, or red for panels integrally treated with flame-retardant chemicals), however this is not a requirement of the standard and is becoming less common practice. 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 panel size

Standard forms of MDF typically have densities as follows:

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

MDFs can have densities that range from below 550 kg/m^3 up to 800 kg/m^3 and above.

Due to variation between brands, the weight of MDF is not constantly proportional to thickness.

Table A2.24: Typical weights, based on standard MDF with average density 750 kg/m^3

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

MDF is available in an extensive range of thicknesses, 1.8mm to 60mm. The most common panel sizes are: widths 1220mm, 1525mm and 1850mm and lengths up to 3660mm with the most common being 2400mm.

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 panel thicknesses and sizes, MDF is used in a wide range of construction and furniture applications. It is used increasingly for interior design and building applications such as skirting panels 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 (such as 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 *BS EN 622-1 Fibreboards. Specifications. General requirements*[1] and *BS EN 622-5 Fibreboards. Specifications. Requirements for dry process boards (MDF)*[2]. As explained in PanelGuide *Section 2*, MDF that is used in construction must comply (by law) with the Construction Products Regulation (CPR) by compliance with the harmonised European standard for wood-based panels (*BS EN 13986*); in relation to MDF, this standard calls up Parts 1 and 5 of *BS EN 622*.

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

Table A2.25: Grades of MDF as described in BS EN 622-5

Grade	Use and climatic condition
MDF	General purpose boards for dry conditions
MDF.H	General purpose boards for humid conditions
MDF.LA	Load-bearing boards for dry conditions
MDF.HLS	Load-bearing boards for humid conditions (These panels are restricted under humid conditions to instantaneous or short periods of loading)
L-MDF	Light MDF boards for dry conditions
L.MDF.H	Light MDF boards for humid conditions
UL1-MDF	Ultra-light MDF boards for dry conditions
UL2-MDF	Ultra-light MDF boards for dry conditions
MDF.RWH	MDF for rigid underlays in roofs and walls

The requirements given in *BS EN 622-5* are not specific to any particular application and so it is appropriate to refer to Codes of Practice or the manufacturer's literature when considering a particular application (refer to PanelGuide *Section 2* and *Section 3*).

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

BS 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, ie surface soundness, axial withdrawal of screws, surface absorption and dimensional changes. Panel manufacturers generally provide values for these properties.

Physical properties

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.

Table A2.26: Expected moisture content of MDF

Relative humidity at 20ºC	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 *BS EN 622-5*) will not break down in the presence of moisture. Physical wetting of all grades of MDF should be avoided.

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 WPA Manual *Industrial wood preservation specification and practice. Commodity Specification C11*. This guidance assists with making 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 MDF.

Water vapour permeability

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

Thermal conductivity

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

Reaction to fire

Under the Euroclass system for characterising the reaction to fire performance of materials, as taken from *European Commission Decision 2007/348/EC*, an untreated MDF may be assumed to achieve the performance in *Table A2:27*.

If the manufactured product does not satisfy any of these minimum requirements and a reaction to fire claim is to be made in a DoP for CE marking purposes, then it must be tested and classified according to *BS EN 13501-1*. However if no claim is made in the DoP for CE marking purposes it is still possible to use the British standard system to make a separate claim.

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

Storage and handling

Careful storage and handling is important to maintain panels in their correct condition for use; it is therefore imperative that particleboard is protected from rain and accidental soaking. During transport, it is particularly important to keep edges well covered. Panels should be stored flat in an enclosed, dry building. When handling panels, the edges and corners should be protected against damage.

'Humid' MDF panels can tolerate inflated humidity conditions such as can be found in kitchens and bathrooms but direct contact between the unprotected panel and water should be avoided.

Detailed guidance on the storage and handling of wood-based panel materials is given in *DD CEN/TS 12872* and 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. When using power tools, tungsten carbide tipped (TCT) tools will give better cutting performance.

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

Table A2.27: Reaction to fire classification without further testing of untreated MDF

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]	BS EN 622-5	Without an air gap behind the wood-based panel	600	9	D-s2,d0	D_{fl}-s1
MDF[3],[5]	BS 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]	BS EN 622-5	With a closed air gap behind the wood-based panel	600	15	D-s2,d0	D_{fl}-s1
MDF[4],[5]	BS EN 622-5	With an open air gap behind the wood-based panel	600	18	D-s2,d0	D_{fl}-s1
MDF[5]	BS 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 10 kg/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

dull cutters will cause edges to 'bell'. While all MDF generally machines well, the density profile through the thickness of the panel will differ between brands and this may influence the quality of finish.

MDF can be drilled using all types of woodworking drill bits.

Mechanical joints and fixings

MDF can be fixed using all conventional woodworking fixings and techniques. It provides good holding power for screw fixings into panel 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 *BS EN 320 Particleboards and fibreboards. Determination of resistance to axial withdrawal of screws*[3] 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.

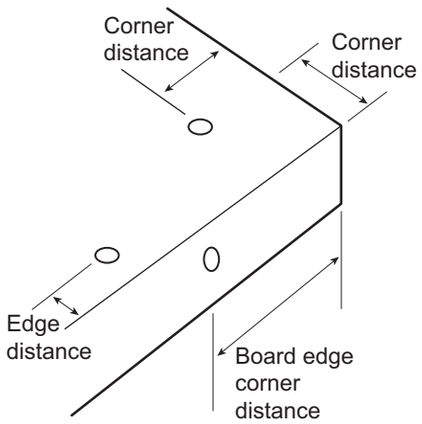


Figure A2.6: Edge distances for fixings

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.

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 panel 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 10mm or 12mm, with or without coverstrip.

Adhesive-bonded joints

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

Dowel joints can be used satisfactorily 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.

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

- Ensure that the joint parts are 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 such as polyvinyl acetate or urea-formaldehyde.
- Locate mating pieces accurately and hold them under pressure while the adhesive sets.
- Ensure the the width of grooves machined in MDF are limited to about one-third of the thickness of the panel. The depth of groove is typically 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.
- For an efficient tongued and grooved joint, ensure the fit of the joints is not too tight, as this may cause a split along the edge.
- For tongued and grooved flooring, apply the glue liberally to both the tongue and the groove to ensure the entire joint is bonded.
- When attaching lipping, ensure the tongue is 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 panels, 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.

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-based 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 than 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 and safety

In panel 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.

Dust

Very fine dust is produced when MDF is machined. Just like any other wood dust, this is classified as 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 5 mg/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 a suitable dust mask should be worn. If possible, work in a well-ventilated place.

Further information on dust and dust masks is given in PanelGuide *Section 6.3*.

Formaldehyde

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

Two classes of 'in service' formaldehyde potential are specified in *BS EN 13986*, Class E1 and Class E2, E2 being the higher of the two. The test methods available for

Table A2.28: MDF – common hazards and methods of control

Activity	Hazard	Control
Manual handling (in full panel form)	Large panel 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 and hand • Sawing, routing and turning • Hand assembling machined or sanded components	• Wood dust in general (including dust from MDF) has health risks – it may cause dermatitis and allergic respiratory effects • Wood dust is flammable	• Off site: preparation under exhaust ventilated plant • On site: enclosure and exhaust ventilation • Dust extraction on portable tools • Good ventilation • Respiratory protection equipment (RPE) 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

determining the formaldehyde potential are *BS EN 717-1*, *BS EN 120* and for coated MDF, *BS EN 717-2*.

Manufacturers in the UK and Ireland do not offer standard grades of MDF with Class E2 formaldehyde content. Further information on formaldehyde is given in PanelGuide *Section 6.4*.

Hazards and control

In panel 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.

Table A2.28 gives the most common hazards and identifies control methods to minimise the risk of harm actually occurring. More detailed information is given in PanelGuide *Section 6.3* and by the Health and Safety Executive.

References

1 BS EN 622-1. Fibreboards. Specifications. General requirements, BSI

2 BS EN 622-5. Fibreboards. Specifications. Requirements for dry process boards (MDF), BSI

3 BS EN 320. Particleboards and fibreboards. Determination of resistance to axial withdrawal of screws, BSI

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Contact details for the PanelGuide project partners are:

Wood Panel Industries Federation
Autumn Business Park
Dysart Road
Grantham
Lincs
NG31 7EU
Tel: 01476 512 381
Email: enquiries@wpif.org.uk
Website: www.wpif.org.uk

Timber Research and Development Association
Chiltern House
Stocking Lane
Hughenden Valley
High Wycombe
Bucks
HP14 4ND
Tel: 01494 569 603
Email: information@trada.co.uk
Website: www.trada.co.uk

National Panel Products Division
Timber Trades Federation
The Building Centre
26 Store Street
London
WC1E 7BT
Tel: 020 3205 0067
Email: ttf@ttf.co.uk
Website: www.ttf.co.uk

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Email: publications@bmtrada.com
Website: www.bmtradagroup.com