



TECHNICAL DATA SHEET (TDS)

P1 PAPER BAKELITE

PRODUCT IDENTIFICATION

- **Product Name:** P1 Paper Bakelite
- **Material Type:** Paper-reinforced phenolic thermoset composite
- **Details:**
 - **Company:** MISCO Australia
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- **TDS Number:** MISCO – TDS - 004
- **TDS Date:** 01/01/2025
- TDS Version: 1

PRODUCT DESCRIPTION

P1 Paper Bakelite is a rigid thermoset composite manufactured from layers of electrical-grade cellulose paper impregnated with phenolic resin, hot-pressed under controlled heat and pressure.

The resulting laminate offers a smooth surface, uniform density, and reliable electrical insulation, making it suitable for low-voltage switchboards, transformer supports, and mechanical fabrication.

It provides a strong balance of mechanical strength, dielectric performance, and machinability, while remaining lightweight and cost-efficient. P1 Paper Bakelite is primarily intended for dry, indoor electrical and mechanical applications where moderate temperature and load conditions exist.

NEMA GRADE

NEMA Grade:

- **NEMA Grade:** X
- **NEMA Designation:** NEMA LI-1 Grade X – Phenolic Paper Laminate

CLASS

- **Thermal Class:** Class E
- **Continuous Operating Temperature:** 120 °C
- **Short-Term Temperature Limit:** 140 – 150 °C

MILITARY SPECIFICATIONS AND TYPE

- **Military Specification:** MIL-I-24768/11
- **Type:** PBM (Paper Base Modified)
- **Description:**
 - Defines a paper-reinforced phenolic laminate engineered for dry electrical insulation and light mechanical service.
 - Corresponds to NEMA Grade X and IEC 60893 PF CP 201/206.
 - Designed for Class E (120 °C) continuous operation in low-voltage electrical systems.
 - Provides dependable dielectric strength (~12 kV/mm dry) and moderate mechanical performance for switchboards, transformers, and general industrial use.

KEY PROPERTIES

- Excellent dry electrical insulation performance
- Good mechanical strength and rigidity for light-duty applications
- Cost-effective general-purpose phenolic composite
- Easily machinable with standard or CNC tooling
- Stable under normal service conditions
- Low water absorption (suitable for dry indoor environments)
- Lightweight and easy to handle during fabrication.
- Smooth surface finish for electrical back panels and mechanical fittings
- Thermally rated to Class E (120 °C) continuous operation
- Available in multiple forms: sheet, rod, and tube

APPLICATIONS

- Terminal boards and support panels
- Low-voltage insulation components
- Spacers, shims, and backup strips
- Motor insulation and transformer blocks
- Structural components for switchgear
- Bushings and sleeves in rod/tube form

SPECIFICATIONS

- **Product Form:** Sheet, Rod, Tube
- **Standard Colour:** Brown
- **Sheet Sizes:** 1220 × 1020 mm, 2440 × 1220 mm
- **Rod Diameters:** Ø 10 mm to Ø 100 mm (standard range)
- **Tube Dimensions:** ID 10 mm to 80 mm; wall thickness 3–10 mm.
- **Thickness Range (sheets):** 0.5 mm to 50 mm.
- **Compliance:** GHS, WHS, and HCIS aligned
- **Manufactured to:** IEC 60893, NEMA LI-1, MIL-I-24768
- **UL File:** Available on request

TOLERANCES ON SHEET THICKNESS

- **Sheet Thickness Tolerance:** $\pm 10\%$ standard, tighter tolerances on request
- **Rod Tolerance:** ISO h10/h11 depending on size.
- **Tube Tolerance:** ISO ± 0.3 mm wall thickness standard.

MECHANICAL PROPERTIES

All values are typical and represent material performance under standard laboratory test conditions (23°C, 50% RH). Properties may vary slightly depending on material form (sheet, rod, tube), direction (machine vs. cross), and processing conditions.

Property	Typical Value	Test Method
Flexural Strength	≥ 125 MPa	ASTM D790
Compressive Strength	≥ 200 MPa	ASTM D695
Tensile Strength	≥ 70 MPa	ASTM D638
Shear Strength	~ 60 MPa	ASTM D732
Impact Strength (Charpy unnotched)	≥ 10 kJ/m ²	ISO 179
Hardness (Rockwell M scale)	100–110	ASTM D785
Modulus of Elasticity (Flexural)	8,000–10,000 MPa	ASTM D790
Poisson's Ratio	~ 0.35	Estimated
Density	~ 1.35 g/cm ³	ASTM D792
Elongation at Break	$< 2\%$	ASTM D638
Creep Resistance	Good	Internal Testing
Fatigue Resistance	Moderate	Internal Testing

Additional Notes:

- All mechanical properties assume dry conditions. Performance will degrade if exposed to continuous high humidity or moisture ingress.
- Rods and tubes show slightly improved compressive strength due to fibre orientation and curing profile.
- For tight tolerance machining and structural components, preconditioning in a dry environment is recommended.
- Thermal cycling may cause minor dimensional shift — especially in thicker sections.

ELECTRICAL PROPERTIES

All values below are typical of P1 Paper Bakelite under dry conditions (23°C, 50% RH). Electrical performance is highly dependent on humidity, temperature, and contamination levels. Users must consider environmental exposure when designing with this material.

Property	Typical Value	Test Method
Dielectric Strength (perpendicular to laminate)	≥ 12 kV/mm	ASTM D149
Dielectric Strength (parallel to laminate)	~6–8 kV/mm	ASTM D149
Volume Resistivity	≥ 10 ¹² Ω·cm	ASTM D257
Surface Resistivity	≥ 10 ¹² Ω	ASTM D257
Dielectric Constant (1 MHz)	4.0 – 5.5	ASTM D150
Dissipation Factor (1 MHz)	≤ 0.04	ASTM D150
Arc Resistance	> 100 seconds	ASTM D495
Comparative Tracking Index (CTI)	> 200	IEC 60112
Insulation Resistance (after 24 hr at 50% RH)	≥ 10 ¹¹ Ω	ASTM D257
Breakdown Voltage (AC 60 Hz)	> 35 kV (across 3 mm)	ASTM D149
Creepage Resistance	Moderate	IEC 60112 (qualitative)

Performance Notes:

- P1 Paper Bakelite is an excellent dry-condition insulator; however, phenolic-paper laminates absorb moisture, which can significantly degrade insulation resistance and dielectric strength.
- Not suitable for immersion or outdoor use unless fully sealed.
- For elevated voltages, maintain air and creepage distances per IEC 60664 and AS/NZS 3000 guidelines.
- Arc and tracking resistance are sufficient for indoor switchboards, panels, and terminal boards operating under 600 V.

THERMAL PROPERTIES

These values represent typical performance of P1 Paper Bakelite under standard laboratory conditions (23°C, dry). While the material offers stable thermal behaviour at moderate temperatures, it should not be used for continuous high-heat applications or environments with significant thermal cycling unless protected.

Property	Typical Value	Test Method
Thermal Class	Class E (120°C)	IEC 60085
Short-Term Heat Resistance	Up to 140°C	Internal Testing
Thermal Conductivity	~0.25 W/m·K	ASTM E1530
Glass Transition Temperature (T_g)	~130–140°C	Differential Scanning Calorimetry (DSC)
Coefficient of Thermal Expansion (CTE)	30–50 × 10 ⁻⁶ /°C	ASTM E831
Specific Heat Capacity (C_p)	~1.1 kJ/kg·K	Calculated
Flammability Rating	HB (Horizontal Burn)	UL 94

Ignition Temperature (self-ignition)	~375°C	ISO 871
Heat Deflection Temperature (HDT)	~115°C (1.8 MPa load)	ASTM D648
Thermal Aging Resistance	Good (up to Class E)	IEC 60216

Additional Notes:

- Under thermal stress, phenolic resin systems become brittle and may crack if mechanically loaded.
- P1 is not recommended for applications involving frequent heating/cooling cycles above 100°C without thermal compensation.
- Excess heat can cause surface carbonisation, particularly near electrical arcing points — always maintain safe creepage and clearance.

CHEMICAL RESISTANCE

P1 Paper Bakelite provides moderate chemical resistance due to the thermoset phenolic matrix. Its cellulose paper reinforcement, however, makes it vulnerable to moisture and prolonged exposure to aggressive media. It is suitable for dry environments with incidental contact from oils and mild chemicals.

Chemical Type	Resistance	Remarks
Water (Distilled/Tap)	Poor	Absorbs moisture over time; degrades electrical and mechanical properties.
Mineral Oils	Good	Stable for use in oil-filled transformers and equipment.
Transformer Oils	Good	Compatible with most hydrocarbon-based insulating oils.
Aliphatic Hydrocarbons	Good	Resists fuels such as kerosene, diesel, and paraffin.

Aromatic Solvents	Poor– Moderate	Toluene, xylene may cause softening or surface swelling.
Alcohols (Methanol, Ethanol)	Moderate	Surface may soften or haze over prolonged contact.
Ketones (Acetone, MEK)	Poor	Rapid degradation and softening. Not recommended.
Strong Acids (HCl, H₂SO₄)	Poor	Causes breakdown of both resin and cellulose; avoid.
Weak Acids (Citric, Acetic)	Moderate	Short-term resistance only; rinse thoroughly.
Strong Alkalis (NaOH, KOH)	Very Poor	Immediate degradation: phenolic resins are alkali sensitive.
Salt Spray / Mild Brine	Moderate	Limited resistance; not suitable for marine environments without coating.
Ozone / UV Exposure	Poor	Will darken and become brittle with exposure. For indoor use only.

Key Notes:

- **Moisture absorption is the most significant risk** for this material. Even short-term water exposure can affect dielectric properties and dimensional stability.
- Protective coating or enclosure is recommended when used in humid or chemically active environments.
- **Do not use** in applications involving caustics, aggressive solvents, or immersion.
- In transformer and switchgear environments, ensure the chemical compatibility of cleaning agents and oils used.

PROCESSING AND MACHINING CONSIDERATIONS

P1 Paper Bakelite machines well using conventional tools and equipment, but due to its thermoset resin matrix and paper-based reinforcement, specific care must be taken to avoid chipping, delamination, or heat degradation. Proper handling and workshop control will result in clean, accurate components suitable for electrical and mechanical assembly.

General Machining Guidelines:

Operation	Recommendation
Sawing	Use carbide-tipped or diamond-grit circular saws with moderate feed rates. Maintain high blade speed (~3000 RPM) to avoid edge tearing.
Milling	Use solid carbide tools with high clearance angles. Climb milling reduces surface tear. Moderate feed rates prevent delamination.
Turning (Rod/Tube)	Use carbide tools with a sharp nose radius. Steady rest or tailstock support required for longer rods or tubes.
Drilling	Use brad-point or spade drills; peck drilling technique reduces heat buildup and blowout. Always support material from behind.
Tapping & Threading	Use coarse threads. Pre-drill oversized holes. Phenolic is brittle; consider thread inserts for strength.
Surface Finishing	Sanding or light grinding with dust extraction is acceptable. Avoid heat build-up that could char the surface.
Bonding	Can be bonded using epoxy or phenolic-based adhesives. Light surface abrasion improves adhesion. Not suitable for solvent-based bonding systems.

Tooling and Cutting Considerations

- **Tool Material:** Solid carbide or PCD tooling recommended for high wear resistance.
- **Tool Geometry:** Sharp edges and high rake angles reduce stress and improve cut quality.

- **Feed Rate:** Moderate; excessive feed or speed causes overheating and edge burning.
- **Coolant Use:** Dry machining preferred. If coolant is essential, use misting systems or air blow to avoid moisture absorption.
- **Dust Control:** Phenolic machining produces fine dust; always use dust extraction and appropriate PPE.

Pre-Machining Conditioning

- **Acclimatisation:** Allow material to stabilise at workshop temperature (15–25°C) for at least 24 hours before machining.
- **Drying:** If sheets or rods have been exposed to humidity, pre-dry at 60°C for 6–8 hours to reduce moisture content.

Dimensional Stability Tips

- For tight tolerance parts, avoid high-humidity environments.
- Post-machining heat treatment (light bake at 60°C for 4 hours) can help stabilise dimensions in precision components.
- Use fixturing that supports the entire workpiece to prevent warping during machining.

Note:

P1 Paper Bakelite is a machinable thermoset composite that must be handled and processed with care to maintain its structural and electrical integrity. While it is forgiving under standard workshop conditions, improper machining practices—such as excessive speed, lack of dust extraction, or wet cutting—can compromise material performance and lead to chipping, delamination, or reduced insulation properties.

MISCO Australia strongly recommends:

- Using dedicated tooling for phenolic materials to ensure cut quality and prevent tool wear.

- Implementing a clean, dry work environment to avoid moisture ingress during processing.
- Conducting a test run on scrap material if tolerances are critical or if bonding/post-finishing is required.

Always follow best practice industrial machining safety standards.

SHEET HANDLING BEFORE MACHINING

Proper storage and handling of P1 Paper Bakelite sheets, rods, and tubes is essential to preserve dimensional accuracy, machining quality, and material integrity. Paper-based phenolic composites are hygroscopic and can absorb ambient moisture, which affects flatness, strength, and electrical performance.

Storage Recommendations:

- **Store Flat:** Sheets must be stored on a flat, rigid surface with no overhang to prevent warping. Avoid vertical or unsupported stacking.
- **Environmental Conditions:** Ideal storage temperature is **15–25°C** with **relative humidity below 50%**.
- **Protect from Moisture:** Keep material away from water sources, condensation, and unsealed concrete floors.
- **Covering:** Use plastic sheeting or a sealed plastic wrap to prevent moisture ingress, especially for long-term storage.
- **First In, First Out:** Use older stock first to reduce the risk of distortion or surface oxidation from extended exposure.

Pre-Machining Handling:

- **Acclimatise Material:** Allow sheets, rods, and tubes to stabilise to workshop temperature and humidity for at least **24 hours** before machining.
- **Pre-Dry If Necessary:** If material shows signs of warping or dimensional change (especially in humid environments), dry in a convection oven at **60–70°C for 6–8 hours** prior to processing.
- **Avoid UV Exposure:** Extended exposure to direct sunlight may darken the surface and lead to surface embrittlement.
- **Inspect Before Use:** Check for signs of delamination, edge chipping, or contamination before loading into machines.

ENVIRONMENTAL COMPLIANCE

P1 Paper Bakelite complies with major international environmental, health, and material safety regulations for industrial insulating materials. While the product itself is not biodegradable, it poses minimal risk under normal use and is safe for handling and machining when proper precautions are followed.

Regulatory Compliance:

- **RoHS Compliant** – Free from restricted substances including lead, mercury, cadmium, hexavalent chromium, PBB, and PBDE, per EU Directive 2011/65/EU.
- **REACH Compliant** – Does not contain Substances of Very High Concern (SVHC) as listed in Regulation (EC) No 1907/2006.
- **HCIS Aligned** – Chemical hazard classification references comply with Safe Work Australia’s Hazardous Chemicals Information System (HCIS).
- **WHS Aligned** – Material classification, labelling, and SDS structure in accordance with the Australian Model Work Health and Safety Regulations.
- **Asbestos-Free** – No asbestos or asbestos-containing materials are used in any form.
- **Halogen-Free** – No halogenated flame retardants present.

Material Safety Status:

- Non-toxic in solid form
- Non-reactive under standard storage and usage conditions
- Dust generated during machining may contain trace phenol and formaldehyde residues—use appropriate dust extraction and PPE.
- No known ozone-depleting substances used in manufacture.

SUSTAINABILITY AND ENVIRONMENTAL IMPACT

P1 Paper Bakelite is a long-established industrial insulation material designed for durability and long service life. While not biodegradable or recyclable through conventional means, its stability, low replacement frequency, and non-hazardous composition contribute to a lower overall environmental footprint when used appropriately.

Environmental Characteristics:

- **Not Biodegradable** – Phenolic resins are chemically cross-linked and do not break down naturally in landfill.
- **Not Recyclable** – Cannot be reprocessed or remelted; must be disposed of as industrial waste.
- **Long Service Life** – Reduces frequency of replacement and associated waste.
- **Low Emissions in Use** – Inert in solid form; does not off-gas under standard operating conditions.
- **Energy Efficient Insulator** – Reduces thermal and electrical losses in end-use equipment.

End-of-Life Disposal:

- Dispose of in accordance with local environmental and industrial waste regulations.
- Landfill or high-temperature industrial incineration is recommended.

- Avoid open burning; combustion may release small quantities of phenol, carbon monoxide, and formaldehyde vapours.

Product Stewardship:

- MISCO Australia supports responsible handling, use, and disposal of composite insulating materials.

SAFETY INFORMATION

P1 Paper Bakelite is safe to handle in its solid form under normal conditions of use. However, machining, sanding, or thermal degradation can generate airborne dust and vapours that require appropriate control measures.

General Handling:

- Solid sheets, rods, and tubes are non-toxic and inert in standard workshop environments.
- Edges may be sharp – use gloves when handling large or heavy pieces.
- Avoid striking or dropping rods and tubes, as phenolic composites may fracture under impact.

Machining Safety:

- **Dust Hazard:** Fine particulate dust generated during cutting or sanding may cause irritation to skin, eyes, and respiratory tract.
- **Respiratory Protection:** Use an approved dust mask or P2/P3 respirator when machining.
- **Ventilation:** Operate in well-ventilated areas with local extraction or HEPA-filtered dust collection systems.
- **Skin and Eye Protection:** Safety glasses and gloves are recommended during all processing operations.

- **Thermal Decomposition:** Overheating (above 200°C) may release low levels of formaldehyde, phenol, and carbon monoxide vapours. Avoid prolonged high-speed grinding or thermal exposure.

First Aid Measures:

- **Inhalation of Dust:** Move to fresh air. Seek medical attention if irritation persists.
- **Eye Contact:** Rinse with water for several minutes. Remove contact lenses if present.
- **Skin Contact:** Wash with soap and water. Seek attention for persistent irritation.
- **Ingestion:** Not intended for consumption. Seek medical advice if swallowed.

Safety Data Sheet (SDS):

Refer to Safety Data Sheet (SDS) for full details before handling.

WARRANTY

MISCO Australia warrants that P1 Paper Bakelite products are free from defects in material and workmanship at the time of dispatch. This warranty is limited to the replacement or refund of the defective material, at MISCO Australia's discretion, and applies only when the product is used under normal service conditions and in accordance with recommended storage, handling, and machining guidelines.

This warranty does not extend to performance issues resulting from improper use, modification, or processing outside of standard industrial practices. The end user is responsible for determining the suitability of this product for their specific application, including conducting all necessary performance testing and validation prior to use. MISCO Australia does not accept liability for incidental, indirect, or consequential damages arising from the use or misuse of this material.

This warranty is provided in addition to, and does not exclude, any statutory rights available to the purchaser under Australian Consumer Law.

DISCLAIMER

The information provided in this data sheet is intended as a general guide for the use and handling of material. It is based on current knowledge, testing, and is believed to be accurate and reliable as of the date of publication. However, **MISCO Australia** makes no warranties, express or implied, regarding the material's performance, suitability, or fitness for any specific application.

Users are responsible for determining the material's suitability for their intended purpose, including conducting independent tests and evaluations as necessary. MISCO Australia does not accept any liability for any loss, damage, or injury resulting from the use of this information, the products described, or reliance on the provided recommendations.

Specifications are subject to change without notice as part of MISCO Australia's ongoing product improvement initiatives.

Always refer to the latest version of this data sheet before proceeding with critical applications.

All sales are subject to MISCO Australia's standard terms and conditions of sale.

Revision	Date Issued	Prepared / Reviewed By	Description of Change	Approved By
1.0	January 2025	MISCO Australia –	Initial release of Safety Data Sheet for P1 Paper Bakelite	Director, MISCO Australia

Document Control:

- **Document Title:** P1 Paper Bakelite
- **Document ID:** MISCO – TDS - 004
- **Revision:** 1.0
- **Review Cycle:** 24 months or upon regulatory update (whichever occurs first)

End of Technical Data Sheet.