TECHNICAL DATASHEET
Cast-A-Form 9600, 9601, 9602

CAST-A-FORM is a water soluble hot melt system suitable for creating mould and mandrel forms which may be used in the manufacture of various composite structures including hollow items such as ducts and tanks or pressure vessels. It is a powder, which only requires melting and subsequent pouring into a heat resistant mould. It solidifies on cooling and may be easily de-moulded without the use of mould release agents.

Handling Properties:

	9600	9601	9602
Heat Resistance, °C	135	177	232
Melting and Pouring Temperature, °C	154-167	204-216	271-288
Mould Preheat Temperature, °C	66-93	79-107	149-177

Physical Properties:

	9600	9601	9602
Colour	Blue	Green	White
Compressive Strength @ 75°F, MPa	117	104	97
Compressive Strength @ 300°F, MPa		16	46
CTE @ 75°F to Operating Temp., m/m/°C	5.0×10^{-5}	5.2×10^{-5}	4.3×10^{-5}
CTE @ Operating Temp. to Melting Temp., m/m/°C	4.3×10^{-5}	5.0×10^{-5}	4.3×10^{-5}
Water Solubility Rate, Water heated to 60°C, mins/450g	5-10	5-10	5-10
Cast Density, g/cm^3	2.07-2.13	2.07-2.13	2.07-2.13

Note:
Always keep CAST-A-FORM dry. Keep containers covered to prevent moisture absorption. Never add anything to CAST-A-FORM in the powder or liquid state.

CAST-A-FORM Moulds:
High Temperature Epoxy Composites may be used for short run situations. For medium to long runs, Aluminium moulds are suggested. Walls of the moulds should be as uniform in thickness as possible. The pouring gate should open into the largest cavity of the mould.

Composite Materials Limited
Unit B, Telford Way, Middlewich, Cheshire. CW10 0GX
Tel: +44(0)1606 738811 Fax: +44(0)1606 738846
www.compositematerialsltd.com info@compositematerialsltd.com

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CAST-A-FORM MOULDS**:**

Moulds for **CAST-A-FORM 9600** and **9601**:

- Short Runs: (9600 only) Use Surface Coat with Laminating Resin and tooling grade only glass cloth.
- Medium Runs: Use Surface Coat with Laminating Resin and tooling grade glass cloth.
- Long Runs: Use Aluminium Castings.

Moulds for **CAST-A-FORM 9602:**

- Short Runs: Use Surface Coat with Laminating Resin and tooling grade glass cloth.
- Medium to Long Runs: Use Aluminium Castings.

Technical data and instructions for the epoxy mould materials appropriate to your application are available upon request.

For the best quality mandrels, the mould should be designed in such a way that it has uniform wall thickness (refer to the discussion in CASTING MOULD DETAILS). Whenever possible, the pouring gate should open into the largest cavity of the mould.

The sections of a mould should be assembled and clamped in place for storage immediately after use to prevent distortion

Melting Procedures:

1. Select the appropriate type of **CAST-A-FORM** so that it corresponds to the cure temperature that will be used on the finished part.
2. Place the selected **CAST-A-FORM** material in a melting pot equipped with a thermostat and set the control for the appropriate melting temperature (see "Physical Properties"). Stir material until melted.
3. Never break through a solid surface crust because molten **CAST-A-FORM** (under pressure) may spurt up. After becoming liquid, **CAST-A-FORM** is a heat transfer material and will heat or cool about as evenly as water.
4. **DO NOT** heat **CAST-A-FORM** materials more than 66°C above their recommended "Melting or Pouring" temperature. Overheating will increase viscosity, shorten mould life and may produce harmful vapours. Overheating will also cause some slight foaming of the melt and, if poured in this state, results in a weaker porous mandrel.
5. At the melting temperature, the viscosity of liquid **CAST-A-FORM 9602** is not noticeably changed when contaminated with water. The other **CAST-A-FORM**'s will thicken or will not melt at all when contaminated with water.
6. **CAST-A-FORM 9602** should be heated at the melting temperature for several hours to drive off any absorbed water before casting. Water cannot be driven from the other **CAST-A-FORM** by heat. However, if the other **CAST-A-FORM**'s have a good pourable viscosity, the water contamination is nil and they can be poured immediately.

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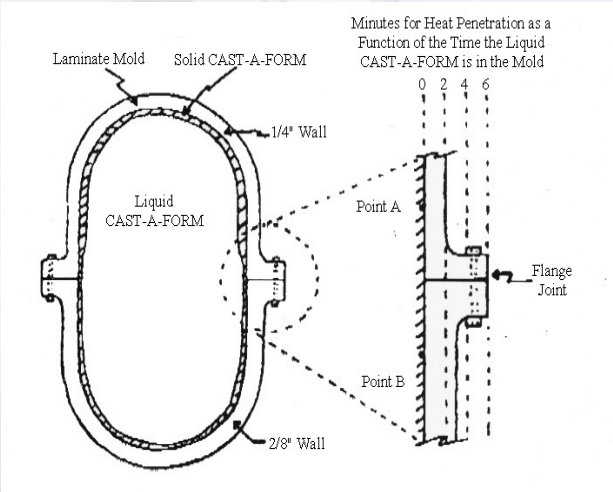
Basic Casting Procedure:

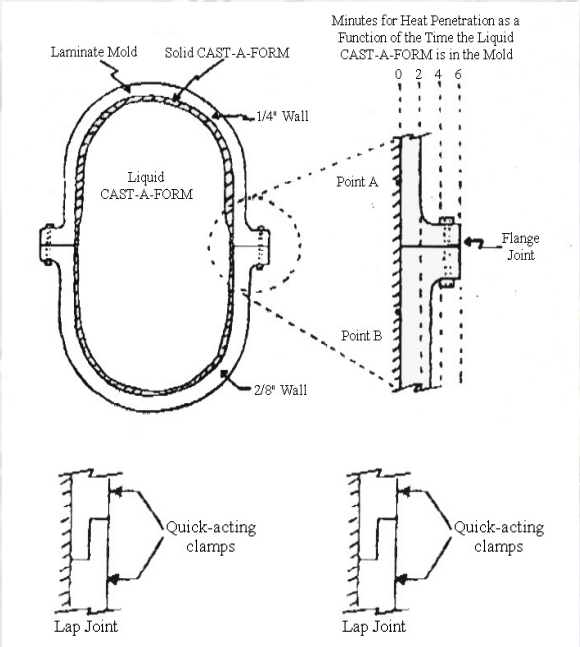
NOTE: Suggested variations on this procedure for certain applications are described in later sections of this bulletin.

1. While stirring, adjust liquid **CAST-A-FORM** to specified pour temperature.
2. Stabilize the mould to be used at the recommended "Mould Pre-Heat" temperature.
3. Pour the liquid **CAST-A-FORM** in the mould fairly rapidly until it is full. No parting agent is necessary.
4. If a hollow mandrel is desired, pour the liquid **CAST-A-FORM** out of the mould as soon as the outside material begins to harden (within three to five minutes after filling).
5. Allow the mould to cool down to near the stabilizing temperature of Step 2.
6. Open the mould. If the shell or mandrel wall is thick enough, remove the mandrel.
7. If the mandrel wall is too thin leave it in the mould and repeat Steps 2-6.

Casting Mould Details:

A graphic illustration of the importance of uniform mould wall thickness is shown on the page. When the mould is filled with hot liquid **CAST-A-FORM**, heat builds up at the inner mould surface and finally penetrates to the outside surface where it is dissipated into the air. The temperature of the inside surface of the mould reaches a maximum in two minutes in places where the mould thickness is the same as at Point A in the illustration. However, heat continues to build up on the inside surface of the mould where the wall is thicker, such as at Point B. In these areas, heat is not dissipated until after three minutes have passed. The inside surface temperature at the joint area is even hotter since heat is not dissipated here until after six minutes have passed. Thus **CAST-A-FORM** solidifies slower at the thicker mould section, resulting in a thinner mandrel wall section. If the flange type joint should create a problem, one solution is to build the mould with lap joints fastened by quick closing clamps as indicated here. In places where the mould cannot be uniform in wall thickness, such as in throat areas, metal inserts can be used to bleed off the heat and enable **CAST-A-FORM** to build up in thickness uniformly with the rest of the mandrel.





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In arriving at the best procedure for complex configurations, the first mandrels cast should be broken and checked against the mould. If thick mandrel wall sections fit against thin mould wall sections and vice versa (thickness variations are opposite between mandrel and mould), the pour temperature and /or cycle time may be wrong and should be reduced to eliminate this problem. Reducing the mould temperature will also help, but pour lines may appear due to sudden cooling of the **CAST-A-FORM.**

In order to get consistent and predictable results, the mould temperature, pouring temperature, and cycle time must all be closely controlled. **CAST-A FORM** should be poured evenly into the mould, which is held at such an angle as to allow air to escape easily. If it is poured too rapidly, air may be trapped inside. If it is poured too slowly, there will be pour lines in the surface due to irregular cooling.

Certain irregular shaped mandrels with long, thin extensions may warp if removed from the mould too fast (while the mandrel is "green"). These mandrels should be left in the mould as long as possible, but not so long as to allow cracking due to thermal contraction of the surrounding mould, to set in.

To minimize thermal contraction (shrinkage) in large diameter (127 mm or more) mandrels, the mandrel wall can be built-up in layers. Repeat Steps 3,4, and 5 of the BASIC CASTING PROCEDURE until the desired wall thickness is obtained.

After removing them from the mould, hot **CAST-A-FORM 9602** mandrels should be slowly cooled in a warm, dry, stress-relieving oven to prevent cracking. The other **CAST-A-FORM** mandrels can be cooled at room temperature if placed on a non-conductive surface. The part fabrication may then commence in the normal way. If handling of the mandrel is necessary, gloves should be worn.

Specific Applications:
A few of the more widely used procedures are mentioned here, but **CAST-A-FORM** can be adapted to a multitude of purposes:

Mandrels for Ducts
Both **CAST-A-FORM 9600** AND **9601** are used extensively for the manufacture of reinforced fibreglass ducts. Shrink-tape or vacuum bag pressure may be used as needed. Complicated mandrels can easily be washed out and result in great saving in labour.

Filament Winding Mandrels
CAST-A-FORM 9602 is used for its strength at elevated temperatures and its casting advantages. During development, **CAST-A-FORM 9601** can be used with a R.T. epoxy mould which allows low-cost rework toward completion of design and size. A predetermined charge of **CAST-A-FORM**, calculated from the surface area and thickness requirements for the mandrel, is poured into the preheated mould (high temp. epoxy or aluminium). The mould is then rotated slowly to distribute the melt uniformly over the mould surface.

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The mandrel is removed from the mould and slowly cooled to the handling temperature over a period of 5 to 8 hours. Some cases require that oversize holes be cast in the mandrel so thermal contraction will allow it to clamp down around a metal shaft without cracking.

Difficulties may occur with certain types of rubber liners that exude or "sweat" at elevated temperatures. If these liners are used, the mandrel should be coated with an impervious film to prevent exuded liquid from lowering the heat resistance and affecting the other physical properties of the mandrel.

Mandrel Removal:
After curing the part, one of the following methods may be used to remove the **CAST-A-FORM**.

- WASH OUT-Place cooled, finished part in a container of hot water, under hot running water tap, or insert a steam jet inside the mandrel.
- MELT OUT- Place the finished part on end over a suitable collecting container in a non-recirculating oven heated to the melting temperature of the **CAST-A-FORM**.
- BREAK OUT- Use ordinary manual methods.

In the latter two methods, the **CAST-A-FORM** may be returned to the melter if not contaminated during use.

Handling Precautions:

FOR INDUSTRIAL USE ONLY. KEEP OUT OF REACH OF CHILDREN.

- **CAST-A-FORM** contains inorganic nitrates, nitrites and oxides. Eye contact with **CAST-A-FORM** powder causes severe irritation and a chemical burn.
- **CAST-A-FORM** is a moderate irritant to all mucous membranes. Avoid breathing dust. If ingested, powdered **CAST-A-FORM** causes burns to any surface contacted.
- In the molten state, **CAST-A-FORM** causes severe burns when contacting the skin. As with any hot, molten material, severe damage to the eyes occurs if in contact.
- **CAST-A-FORM** powder is drying to the skin. Skin contact should be avoided.

Processing Precautions:

- Do not allow any acid to contact **CAST-A-FORM** in any form. Toxic gases will evolve.
- Do not store **CAST-A-FORM** near ammonium or chlorate compounds or combustible materials. While not flammable, **CAST-A-FORM** supplies oxygen to fires. **CAST-A-FORM** can act as a strong oxidizer.
- Do not use **CAST-A-FORM** in melting pots or tanks which formerly contained cyanide compounds.
- Do not allow **CAST-A-FORM** to contact magnesium. Together they may result in explosive conditions.

- Do not heat **CAST-A-FORM** above 66°C higher than the recommended "Melt and Pour Temperature". Explosive decomposition may occur at 530-590°C. Local over-heating of **CAST-A-FORM** or direct flame impingement on melting pot is dangerous.
- Do not add other material to **CAST-A-FORM** -explosive and toxic vapour mixtures may result.
- Do not attempt to melt **CAST-A-FORM** after it has become contaminated with water or other material.
- Use only water as the wash-away liquid. Do not pour water into molten **CAST-A-FORM**- copious amounts of steam will result.

Physical Properties:

Specific Volume (solid cast, g/cm^3)	2.06-2.13
Decomposition Temperature (°C)	Approximately 650
Specific Heat (J/kg °C)	1,380 to 1,550
Heat Conductivity	Approximately equal to water

Thermal Contraction – "SHRINKAGE"

The thermal expansion and contraction of **CAST-A-FORM** may be compensated for in the mould if necessary. Example with **CAST-A-FORM 9600**:

- Subtract the part cure temperature from the **CAST-A-FORM 9600** melting temperature. 154°C - 121°C = 33°C
- Multiply this figure by the coefficient of linear thermal expansion for the type of **CAST-A-FORM** used and also by the part dimensions (such as 254 mm length) 33°C x 4.32 x 10^{-5} x 254 mm = 0.36 mm
- Often this figure is small enough to disregard. In this case it is less than 0.0015 m per m of length.

Guide to Computing Mould Dimensions for the Production of CAST-A-FORM Mandrels

The data presented here shows the dimensional changes needed in designing moulds for **CAST-A-FORM** mandrels where close tolerances are necessary. These figures were obtained by application of the coefficient of linear thermal expansion for **CAST-A-FORM**. They must be considered as a guide only and do not take into account such factors as:

1. The thermal expansion of the mould, which will vary due to differences in mould construction (material used, wall thickness, mould backing, configuration, etc.)
2. Differences in the length of time molten **CAST-A-FORM** remains in the mould before pouring back into the melter (net expansions of the mould and mandrel are affected).
3. Part shrinkage (usually insignificant).
4. Reuse of **CAST-A-FORM** material (contamination will increase the thermal contraction).

The thermal expansion of the mould above its original dimensions may partially compensate for the thermal contraction of **CAST-A-FORM** and result in slightly larger mandrels. In fact, this mould expansion could be made to work for the user. That is, changes in the preheat

temperature of the mould, within practical limits, would allow the user to make minor changes in the mandrel size. This may allow for greater accuracy of the finished part made from the mandrel.

	CAST-A-FORM Pour temp.	Mandrel Contraction When Cooled to 24°C	Part Cure Temp	Mandrel Expansion 24°C to Part Cure Temp	FACTOR* Added to Mould Pattern to 24°C
9600	154-166°C	0.0065 m/m	121°C 107°C 93°C 24°C	0.005 m/m 0.004 0.0035 0.000	0.0015 m/m 0.0025 0.003 0.0065
9601	204-216°C	0.0095 m/m	163°C 149°C 135°C 121°C 107°C 93°C 24°C	0.0075 m/m 0.0065 0.006 0.005 0.0045 0.004 0.000	0.002 m/m 0.003 0.0035 0.0045 0.005 0.0055 0.0095
9602	271-288°C	0.011 m/m	232°C 218°C 204°C 191°C 177°C 163°C 149°C 24°C	0.009 m/m 0.0085 0.008 0.0075 0.0065 0.006 0.0055 0.000	0.002 m/m 0.0025 0.003 0.0035 0.0045 0.005 0.0055 0.011

* A factor is a dimensional difference, reported to the nearest 0.0127mm, resulting from the thermal contraction of **CAST-A-FORM** alone. For extremely close tolerances, mould thermal expansion characteristics and configuration variables should be considered.

NOTE: All of the above data is applicable to virgin **CAST-A-FORM** only.

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