DESCRIPTION
Toray’s TC250 offers an excellent balance of toughness, mechanical properties, and hot/wet performance. It is easily processed via vacuum bag/oven, autoclave, or press curing operations. Although TC250 is a 130°C (265°F) cure system, it can be post cured for a higher dry and wet $T_g$, which enhance the product’s elevated temperature performance. TC250 can also be cured or freestanding post cured to 177°C (350°F) to increase its high temperature performance. TC250 is available with virtually all fiber reinforcements in uni-directional tape, slit unidirectional tape, woven, and non-woven prepreg forms.

FEATURES
- Excellent mechanical properties
- Can be initially cured at 82°C (180°F) and post cured freestanding to 130°C (265°F) or 177°C (350°F)
- Good toughness
- Good surfacing properties
- Low laminate void content under low-pressure vacuum curing
- NCAMP qualified on a woven fabric
- Self-adhesive to core

PRODUCT TYPE
130°C (265°F) Cure, Toughened Epoxy Resin System

TYPICAL APPLICATIONS
- Aircraft structures
- Space structures
- Radomes and antennae
- Reflectors

SHELF LIFE
- **Out Life:** Up to 30 days at ambient
- **Frozen Storage Life:** 12 months at -18°C (< 0°F)

Out life is the maximum time allowed at ambient temperature before cure. *Ambient is 18–22°C (65–72°F)

*TOut life tested by SBS on 8-ply 15 x 15 cm (6 x 6") fabric laminate, cured in an out-of-autoclave/vacuum bag only (ODA/VBO) environment with 914–948 mbar (27–28 in Hg). Users may need to separately evaluate out life limits on thicker, larger, and more complex parts.

TYPICAL NEAT RESIN PROPERTIES

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density</td>
<td>1.21 g/cc</td>
</tr>
<tr>
<td>Dry $T_g$</td>
<td>140°C (285°F) cured at 130°C (265°F)</td>
</tr>
<tr>
<td>Wet $T_g$</td>
<td>125°C (257°F) cured at 130°C (265°F)</td>
</tr>
<tr>
<td>Dry $T_g$</td>
<td>180°C (356°F) post cured at 177°C (350°F)</td>
</tr>
<tr>
<td>Gel Time</td>
<td>6–10 minutes at 130°C (265°F)</td>
</tr>
</tbody>
</table>
## ELECTRICAL PROPERTIES OF COMPOSITE LAMINATES

<table>
<thead>
<tr>
<th></th>
<th>TC250 (4581 Quartz)</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Dielectric Constant</td>
<td>3.47</td>
<td>3.43</td>
<td>3.42</td>
<td>3.40</td>
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<tr>
<td>Loss Tangent</td>
<td>0.015</td>
<td>0.015</td>
<td>0.011</td>
<td>0.012</td>
</tr>
</tbody>
</table>

|                        | TC250 (7781 Fg)     |                  |                  |                  |
| Dielectric Constant    | 4.73                | 4.63             | 4.64             | 4.59             |
| Loss Tangent           | 0.026               | 0.023            | 0.016            | 0.019            |

## MECHANICAL PROPERTIES

<table>
<thead>
<tr>
<th>Property</th>
<th>Condition</th>
<th>Methods</th>
<th>UD Tape (a)</th>
<th>2x2 Twill Carbon Fabric (b)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tensile Strength 0°</td>
<td>RTD</td>
<td>ASTM D 3039</td>
<td>2103 MPa</td>
<td>305 ksi</td>
</tr>
<tr>
<td>Tensile Modulus 0°</td>
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<td>ASTM D 3039</td>
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<td>20.3 Msi</td>
</tr>
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</tr>
<tr>
<td>Tensile Modulus 0°</td>
<td>ETW</td>
<td>ASTM D 3039</td>
<td>134.4 GPa</td>
<td>19.5 Msi</td>
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<tr>
<td>Tensile Strength 0°</td>
<td>CTD</td>
<td>ASTM D 3039</td>
<td>2018 MPa</td>
<td>293 ksi</td>
</tr>
<tr>
<td>Tensile Modulus 0°</td>
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<td>ASTM D 3039</td>
<td>138 GPa</td>
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</tr>
<tr>
<td>Poisson’s Ratio</td>
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</tr>
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<td>Poisson’s Ratio</td>
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<td>0.35</td>
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</tr>
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<td>RTD</td>
<td>ASTM D 3039</td>
<td>56.5 MPa</td>
<td>8.2 ksi</td>
</tr>
<tr>
<td>Tensile Modulus 90°</td>
<td>RTD</td>
<td>ASTM D 3039</td>
<td>9.8 GPa</td>
<td>1.42 Msi</td>
</tr>
<tr>
<td>Tensile Strength 90°</td>
<td>ETW</td>
<td>ASTM D 3039</td>
<td>33.8 MPa</td>
<td>4.9 ksi</td>
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<tr>
<td>Tensile Modulus 90°</td>
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<td>ASTM D 3039</td>
<td>8.1 GPa</td>
<td>1.18 Msi</td>
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<tr>
<td>Tensile Modulus 90°</td>
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<td>ASTM D 3039</td>
<td>11.7 GPa</td>
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<td>RTD</td>
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<td>1731 MPa</td>
<td>251 ksi</td>
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<tr>
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<td>ASTM D 6641</td>
<td>133 GPa</td>
<td>19.3 Msi</td>
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<tr>
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<td>123.8 GPa</td>
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<tr>
<td>Compressive Strength 0°</td>
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<td>2011 MPa</td>
<td>292 ksi</td>
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<tr>
<td>Compressive Modulus 0°</td>
<td>CTD</td>
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<td>133.7 GPa</td>
<td>19.4 Msi</td>
</tr>
<tr>
<td>Compressive Strength 90°</td>
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<td>ASTM D 6641</td>
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<td>Compressive Strength 90°</td>
<td>CTD</td>
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<tr>
<td>Compressive Modulus 90°</td>
<td>CTD</td>
<td>ASTM D 6641</td>
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*Continued on page 3*
### MECHANICAL PROPERTIES

<table>
<thead>
<tr>
<th>Property</th>
<th>Condition</th>
<th>Methods</th>
<th>UD Tape (a)</th>
<th>2x2 Twill Carbon Fabric (b)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interlaminar Shear Strength</td>
<td>RTD</td>
<td>ASTM D 2344</td>
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<tr>
<td>Interlaminar Shear Strength</td>
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<td>59.4 MPa</td>
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<tr>
<td>Interlaminar Shear Strength</td>
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<td>ASTM D 2344</td>
<td>88.4 MPa</td>
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<td>Open-Hole Tensile Strength</td>
<td>RTD</td>
<td>ASTM D 5766</td>
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<tr>
<td>Open-Hole Tensile Strength</td>
<td>ETW</td>
<td>ASTM D 5766</td>
<td>438 MPa</td>
<td>63.5 ksi</td>
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<td>Open-Hole Tensile Strength</td>
<td>CTD</td>
<td>ASTM D 5766</td>
<td>387 MPa</td>
<td>56.1 ksi</td>
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<tr>
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<td>RTD</td>
<td>ASTM D 6484</td>
<td>278 MPa</td>
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<tr>
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<td>ASTM D 6484</td>
<td>295 MPa</td>
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<tr>
<td>Filled-Hole Tensile Strength</td>
<td>RTD</td>
<td>ASTM D 6742</td>
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<td>68.3 ksi</td>
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<td>ETW</td>
<td>ASTM D 6742</td>
<td>476 MPa</td>
<td>69 ksi</td>
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<tr>
<td>Filled-Hole Comp. Strength</td>
<td>CTD</td>
<td>ASTM D 6742</td>
<td>437 MPa</td>
<td>63.4 ksi</td>
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<tr>
<td>Filled-Hole Comp. Strength</td>
<td>ETW</td>
<td>ASTM D 6742</td>
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<td>-</td>
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<tr>
<td>In-Plane Shear Str. (+45)</td>
<td>RTD</td>
<td>ASTM D 3518</td>
<td>102 Msi</td>
<td>14.9 ksi</td>
</tr>
<tr>
<td>In-Plane Shear Mod. (+45)</td>
<td>RTD</td>
<td>ASTM D 3518</td>
<td>9.9 GPa</td>
<td>1.44 Msi</td>
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<tr>
<td>In-Plane Shear Str. (+45)</td>
<td>ETW</td>
<td>ASTM D 3518</td>
<td>92.5 MPa</td>
<td>13.4 ksi</td>
</tr>
<tr>
<td>In-Plane Shear Mod. (+45)</td>
<td>ETW</td>
<td>ASTM D 3518</td>
<td>6.3 GPa</td>
<td>0.92 Msi</td>
</tr>
<tr>
<td>In-Plane Shear Str. (-45)</td>
<td>CTD</td>
<td>ASTM D 3518</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>In-Plane Shear Mod. (-45)</td>
<td>CTD</td>
<td>ASTM D 3518</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Single Shear Bearing Str.</td>
<td>RTD</td>
<td>ASTM D 5961</td>
<td>1060 MPa</td>
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<tr>
<td>Single Shear Bearing Str.</td>
<td>ETW</td>
<td>ASTM D 5961</td>
<td>733 MPa</td>
<td>106 ksi</td>
</tr>
</tbody>
</table>

**STANDARD MODULUS UD TAPE LAMINATE PROPERTIES**

(a) Laminate data used UD Tape Prepreg Laminate - HTS-40 12K Carbon Fiber, 150gsm FAW

Vacuum bag oven cure at 14.5 psi, normalized to 60% fiber volume, ETW: 82°C (180°F) Wet, CTD: -55°C (-65°F)

*Wet conditioning done at 83°C (145°F) and 85% RH until complete saturation

**CARBON FABRIC LAMINATE PROPERTIES**

(b) Laminate data used Fabric Prepreg Laminate - HTS 12K PW Spread Fabric, 193gsm FAW. This data represents limited lot data.

Vacuum bag oven cure at 14.5 psi, normalized to 60% fiber volume, ETW: 82°C (180°F) Wet, CTD: -55°C (-65°F)

*Wet conditioning done at 83°C (145°F) and 85% RH until complete saturation
## Toray TC250

**PRODUCT DATA SHEET**

### MECHANICAL PROPERTIES

<table>
<thead>
<tr>
<th>Property</th>
<th>Condition</th>
<th>Methods</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tensile Strength 0°</td>
<td>RTD</td>
<td>ASTM D 3039</td>
<td>545 MPa</td>
</tr>
<tr>
<td>Tensile Modulus 0°</td>
<td>RTD</td>
<td>ASTM D 3039</td>
<td>26.2 GPa</td>
</tr>
<tr>
<td>Compressive Strength 0°</td>
<td>RTD</td>
<td>ASTM D 6641</td>
<td>536 MPa</td>
</tr>
<tr>
<td>Compressive Modulus 0°</td>
<td>RTD</td>
<td>ASTM D 6641</td>
<td>26.5 GPa</td>
</tr>
<tr>
<td>Flexural Strength 90°</td>
<td>RTD</td>
<td>ASTM D 7264</td>
<td>626 MPa</td>
</tr>
<tr>
<td>Flexural Modulus 90°</td>
<td>RTD</td>
<td>ASTM D 7264</td>
<td>25.4 GPa</td>
</tr>
<tr>
<td>Short Beam Shear Strength</td>
<td>RTD</td>
<td>ASTM D 2344</td>
<td>60 MPa</td>
</tr>
</tbody>
</table>

### GLASS FABRIC LAMINATE PROPERTIES

Laminate data used 7781 Fg/TC250 OSI, 39% RC, 294gsm FAW. This data represents limited lot data. Normalized to 50% fiber volume

<table>
<thead>
<tr>
<th>Property</th>
<th>Condition</th>
<th>Methods</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tensile Strength 0°</td>
<td>RTD</td>
<td>ASTM D 3039</td>
<td>520 MPa</td>
</tr>
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<td>Tensile Modulus 0°</td>
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<td>ASTM D 3039</td>
<td>28.1 GPa</td>
</tr>
<tr>
<td>Tensile Strength 0°</td>
<td>ETW</td>
<td>ASTM D 3039</td>
<td>183 MPa</td>
</tr>
<tr>
<td>Tensile Modulus 0°</td>
<td>ETW</td>
<td>ASTM D 3039</td>
<td>26.1 GPa</td>
</tr>
<tr>
<td>Compressive Strength 0°</td>
<td>RTD</td>
<td>ASTM D 6641</td>
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<tr>
<td>Compressive Modulus 0°</td>
<td>RTD</td>
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<td>32 GPa</td>
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<td>Compressive Strength 0°</td>
<td>ETW</td>
<td>ASTM D 6641</td>
<td>323 MPa</td>
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<td>Compressive Modulus 0°</td>
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<tr>
<td>Flexural Strength 0°</td>
<td>RTD</td>
<td>ASTM D 7264</td>
<td>660 Msi</td>
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<tr>
<td>Flexural Modulus 0°</td>
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<tr>
<td>Flexural Modulus 0°</td>
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<td>16.2 GPa</td>
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<tr>
<td>In-Plane Shear Str. 0°</td>
<td>RTD</td>
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<tr>
<td>In-Plane Shear Mod. 0°</td>
<td>RTD</td>
<td>ASTM D 3518</td>
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<tr>
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<tr>
<td>Short Beam Shear Strength</td>
<td>RTD</td>
<td>ASTM D 2344</td>
<td>71 MPa</td>
</tr>
<tr>
<td>Short Beam Shear Strength</td>
<td>ETW</td>
<td>ASTM D 2344</td>
<td>60 MPa</td>
</tr>
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</table>

### QUARTZ FABRIC LAMINATE PROPERTIES

(a) Laminate data used 4503 AQIII/TC250, 43% RC, 108.5gsm FAW. This data represents limited lot data. Normalized to 50% fiber volume

Dielectric Constant at 10GHz - 3.28

Loss Tangent at 10 GHz - 0.0081

(b) Laminate data used 4581 AQIII/TC250, 36% RC, 284.5gsm FAW. This data represents limited lot data

<table>
<thead>
<tr>
<th>Property</th>
<th>Methods</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Short Beam Shear Strength</td>
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<td>60 MPa</td>
</tr>
<tr>
<td>Dielectric Constant at 10GHz</td>
<td>3.28</td>
<td>26.4 Mpa</td>
</tr>
</tbody>
</table>
TC250 Tough Epoxy Resin System: Cure cycle

- Hold at 88±5°C (190±10°F) for 30–60 minutes.
- Heat up at 1–3°C (2–5°F/minute).
- Hold at 130±3°C (265±5°F) for 2 hours minimum.
- Below 71°C (160°F), release pressure and remove. (Temperature based on lagging thermocouple).
- Part must be dwell at this temp. Oven temp. may not reflect actual part temperature.
- Apply 847 mbar (25 inches) Hg vacuum minimum.
- Apply 30–100 psi pressure to autoclave (optional).

**EPOXY PREPREG, ADHESIVE, AND RESIN GUIDELINES AND HANDLING PROCEDURES**

The following guidelines are provided to our customer to assure that all customers are aware of the procedures to attain the best possible results from Toray Advanced Composites epoxy products. These resin systems will provide sound composite hardware and structures if some simple procedures are followed. Keep in mind that these procedures are good practice for all composite prepreg and adhesive materials and should be used whenever possible.

**FREEZER STORAGE**

Epoxy resin materials have good shelf life at room temperature; however, the life and performance of the material is best preserved with the following basic guidelines. Refer to the shelf life included in the product certificates. The epoxy material should be sealed in an airtight bag and kept frozen below -18°C (0°F) when not being used for longest life and most consistent performance. A good safety measure is to have a bag of desiccant (silica moisture absorber) in the core of the prepreg roll just in case a pinhole in the bag or other problem occurs.

**MOISTURE ABSORPTION AND SENSITIVITY**

While very resistant to moisture absorption after cure, epoxies can be adversely affected by moisture uptake prior to cure. For this reason, all materials must be “thoroughly thawed” to room temperature prior to opening the sealed bag to avoid condensation on the material. Also, it is good practice to keep prepreg and in-process hardware in a sealed bag or vacuum bag if to be exposed to the atmosphere for long periods of time.

**HANDLING OF MATERIALS**

When handling any prepreg materials, one should always be wearing clean, powder-free latex gloves. This will assure that no hand oils are transferred to the prepreg and/or composite during processing. The presence of oils in the part could lead to problems in both mechanical and electrical performance of the part. This also guards against any dermatitis that could occur with certain users.
NONMETALLIC HONEYCOMB AND FOAM CORE USE
When using nonmetallic honeycomb and foam core materials for sandwich structures, the materials should always be dried in an oven prior to lay-up to drive off any moisture that may be in the core. The material should then be cooled in the presence of a desiccant, to avoid any moisture uptake. Following this procedure, it is always a good idea to use the material as soon as possible to avoid rehydration.

Recommended Core Dry Time/Temp: 121°C (250°F) for 3–4 Hours

SELF-ADHESIVE PROPERTIES AND FILM ADHESIVE USE
Toray Advanced Composites epoxy resins have been formulated to have good self-adhesive properties to core materials. However, this should not be taken as a green light to eliminate a film adhesive from a cored, structural piece of hardware. This option has been given by Toray Advanced Composites for customers who are looking for the best electrical properties available by not using a film adhesive. Toray Advanced Composites recommends that the structural integrity be verified to your specification prior to end item usage and takes no responsibility otherwise. If this option is exercised, the following modified cure cycle has been found to work well.

1. Ramp the part to 66°C–71°C (150°F– 60°F) (keep pressure < 15 psi)
2. Dwell for approximately 1 hour
3. Ramp the part to the dictated cure temperature for the resin and cure per the provided standard cure cycle

PROCESSING METHODOLOGY
Epoxy resins can be processed using an autoclave, press, pressclave, or oven cure/vacuum bag. For any application where the optimum properties are needed, Toray Advanced Composites recommends the use of an autoclave.

LAY-UP AREA ENVIRONMENTAL CONTROLS
Toray Advanced Composites recommends that any composite or adhesive lay-up be performed in a clean area visibly free from dust. Any work surfaces should likewise be free of residue, dust, or debris. No eating or smoking shall be allowed in the shop area. For radome materials, conductive materials shall not be allowed in the process area. The processing shop area should be maintained between 16–32°C (60–90°F) with a relative humidity of no greater than 70% RH.

BAGGING FOR CURE
Toray Advanced Composites recommends that cyanate ester composite parts bagged for cure should be performed as follows:
1. Release the tool surface
2. Lay-up part using standard debulking procedures
3. Dame the edges of the part for cure
4. Place one ply of porous Teflon® or perforated Teflon® onto the bag surface of the part
5. Place bleeder layers over the porous Teflon® material and trim to the part periphery
6. Place a non-porous layer of Teflon® over the part
7. Utilize a breather cloth to facilitate vacuum draw
8. Install vacuum bag on the tool for cure
9. Follow the provided Toray Advanced Composites cure cycle for the particular resin system
TYPICAL COMPOSITE LAMINATE STACKING SEQUENCE

List of Materials
1. Tool—aluminum, steel, Invar, composite (tool plates must be release coated or film covered). See the list below
2. Release coat or film—Frekote 700NC or 770NC, FEP, TEDLAR
   Lay-up part using standard debulking procedures
3. Silicone edge dams for cure—slightly thicker than laminate
4. Laminate
5. Release coat or film—Frekote 700NC or 770NC, FEP, TEDLAR
6. Caul plate—aluminum, steel, Invar, silicone rubber sheet (metal caul plates must be release coated or wrapped)
7. 2.2 oz/yd² polyester breather, 1 or more
8. Vacuum bag
9. Vacuum sealant
10. Glass yarn string (alternatively or additionally breather may wrap over top of dam to contact edge)

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Figure 1