DE HAVILLAND AIRCRAFT OF CANADA LIMITED

PPS 10.48

PRODUCTION PROCESS STANDARD
PROPRIETARY INFORMATION

Fabrication of 280°F Cure, Phenolic Resin Pre-Impregnated, Fibre Reinforced Composite Parts

Issue 15
- This standard supersedes PPS 10.48, Issue 14.
- Vertical lines in the left hand margin indicate technical changes over the previous issue.
- Direct PPS related questions to christie.chung@dehavilland.com or (416) 375-7641.
- This PPS is effective as of the distribution date.

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Issue 15 - Summary of Changes (over the previous issue)

The following summaries are not detailed and are intended only to assist in alerting PPS users to changes which may affect them; refer to the applicable sections of this PPS for detailed procedure and requirements.

- Replaced throughout PPS where “Bombardier” is specified with “De Havilland Aircraft of Canada Limited” or “De Havilland Canada” as the DASH 8 program is under new ownership.
- Added the option to repair surface scratches and resin starved area according to PPS 10.40 in addition to PPS 34.34.

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1 SCOPE

1.1 This Production Process Standard (PPS) specifies the procedure and requirements for the fabrication of 280°F cure, phenolic resin pre-impregnated, graphite/glass fibre laminate and sandwich panel assemblies.

1.1.1 This PPS complements the engineering drawings that specify its use as an authorized instruction. The procedure specified in this PPS must be followed to ensure compliance with all applicable specifications. In general, if this PPS conflicts with the engineering drawing, follow the engineering drawing. The requirements specified in this PPS are necessary to fulfil the engineering design and reliability objectives.

1.1.2 Refer to PPS 13.26 for the subcontractor provisions applicable to this PPS.

2 HAZARDOUS MATERIALS

2.1 Before receipt at De Havilland Canada, all materials shall be approved and assigned Material Safety Data Sheet (MSDS) numbers by the De Havilland Canada Environment, Health and Safety Department. Refer to the manufacturer's MSDS for specific safety data on any of the materials specified in this PPS. If the MSDS is not available, contact the De Havilland Canada Environment, Health and Safety Department.

3 REFERENCES

3.1 BAERD GEN-018 - Engineering Requirements for Laboratories.

3.2 EO 81104 - Interior Composite Components Finish Appearance Classification.

3.3 Federal Aviation Regulations Part 25 - Para. 25.853 Amdt. 25-83.

3.4 PPS 10.22 - Preparation of Moulds.

3.5 PPS 10.23 - Storage, Handling and Preparation of Pre-Impregnated Materials.

3.6 PPS 10.24 - Preparation of Honeycomb Cores for Lay-Up in Sandwich Panel Assemblies.

3.7 PPS 10.25 - Storage and Application of Film Adhesives Used in Composite Assemblies.

3.8 PPS 10.28 - Assembly of Wire Thermocouples.

3.9 PPS 10.36 - Composite Assembly - Flammability Compliance Test Procedure (DASH 8).

3.10 PPS 10.39 - Machining of Fibre Reinforced Composite Parts.

3.11 PPS 10.40 - Repairs to Laminates & Sandwich Panels.

3.12 PPS 10.51 - Certification of Ovens.

3.13 PPS 13.23 - Preparation & Use of DHMS P1.30 Resin.

3.14 PPS 13.26 - General Subcontractor Provisions.

3.15 PPS 13.28 - Storage Life of Adhesives, Sealants, Paints and Composite Products.

3.16 PPS 13.39 - Bombardier Toronto Engineering Process Manual.

3.17 PPS 31.17 - Solvent Usage.

3.18 PPS 34.08 - Application of Epoxy-Polyamide Primer (F19 & F45).

3.19 PPS 34.34 - Surface Finishing Compounds (F33).

3.20 QAMTR 029 - Testing Requirements, DHC-8 Composites and Laminates.

4 MATERIALS, EQUIPMENT AND FACILITIES

4.1 Materials

4.1.1 Abrasive paper, aluminum oxide, 180 - 240 grit size.

4.1.2 DHMS A6.06 expandable epoxy film adhesive.

4.1.3 DHMS A6.08, Class 3, Type 3 epoxy film adhesive.

4.1.4 DHMS P1.26 phenolic coated aramid fibre base honeycomb core.

4.1.5 DHMS P1.29 fire retardant rigid foam.

4.1.6 DHMS P1.30 honeycomb core filler.

4.1.7 DHMS P1.44 graphite/glass fibre material, 280°F cure, pre-impregnated phenolic.

4.1.8 DHMS P1.59 glass-graphite fabric, fire resistant, phenolic resin impregnated for interior sandwich and laminate panels.

4.1.9 DSC 85-5 pressure sensitive metallized polyester labels.

4.1.10 DSC 234 composite manufacture expendable materials (see Table I).

4.1.11 Edge bleeder cloth, style 181 glass.

TABLE I - LIST OF EXPENDABLE MATERIALS TO DSC 234

MATERIAL DSC 234	MATERIAL TYPE
-1	Nylon Vacuum Bagging Film, 250°F Cure Cycle
-3	Nylon Tubular Vacuum Bagging Film, 250°F Cure Cycle
-5	Perforated (Pin Prick) Release Film
-10	Breather/Bleeder Cloth, Non-Woven Polyester, Max Pressure 100 psi.
-11	Breather/Bleeder Cloth, Non-Woven Polyester, Fire Retardant, Max Pressure 50 psi.
-12	Release Ply, Up to 350°F Cure Cycle (Note 1)
-12-3	Pre-Impregnated Peel-Ply (Note 1)
-15	High Temperature Pressure Sensitive Tape
-17	Vacuum Bag Sealant
-19-48	Non-Perforated Barrier/Release Film
-20	Fiberglass Tape, Pressure Sensitive Adhesive
-21	Elastomeric Intensifier (see Figure 1 and Note 2)

Note 1. DSC 234-12 release ply may be used in place of DSC 234-12-3 pre-impregnated peel-ply and DSC 234-12-3 pre-impregnated peel-ply may be used in place of DSC 234-12 release ply.
Note 2. As an alternate, a 0.032" thick 2024-T3 aluminum intensifier may be used.

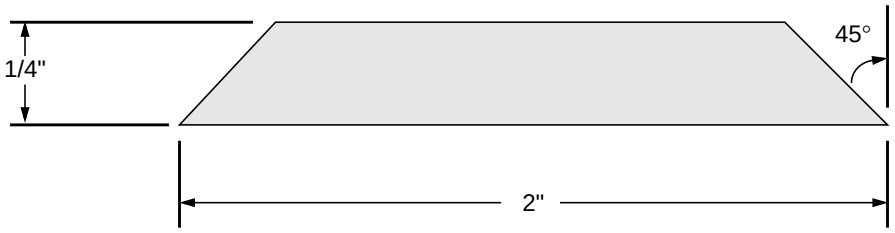


FIGURE 1 - DSC 234-21 ELASTOMERIC INTENSIFIER

4.2 Equipment

4.2.1 Curing oven, certified according to PPS 10.51.

4.2.2 Lint-free cotton gloves (e.g., DSC 422-1).

4.2.3 Leather gloves (e.g., DSC 422-3).

4.2.4 Hot air gun, maximum temperature of 160°F.

4.2.5 Protective gloves, neoprene (e.g., DSC 422-5), latex rubber (e.g., DSC 422-2) or PVC (e.g., DSC 422-6).

4.2.6 Sharpie 30001 felt tip markers.

4.2.7 Shop vacuum source, capable of maintaining and monitoring a minimum vacuum of 24" Hg.

4.2.8 Thermocouples to PPS 10.28.

4.2.9 Vertrod 36PS-1/4-W.C thermal impulse heat sealer.

4.3 Facilities

4.3.1 This PPS has been categorized as a Controlled Critical Process according to PPS 13.39 and as such only facilities specifically approved according to PPS 13.39 are authorized to perform the fabrication of 280°F cure, phenolic resin pre-impregnated, graphite/glass fibre laminate and sandwich panel assemblies according to this PPS.

4.3.2 Subcontractors must direct requests for approval to De Havilland Canada Supplier Quality Management.

4.3.3 Facility approval must be based on a facility report, a facility survey and completion of a qualification test program, if required. The facility report must detail the materials and equipment to be used, the process sequence to be followed and the laboratory facilities used to show compliance with the requirements of this PPS. Any deviation from the procedure or requirements of this PPS must be detailed in the facility report. Based upon the facility report, De Havilland Canada M&P Engineering may identify additional qualification and/or process control test requirements. During the facility survey, the facility requesting qualification must be prepared to demonstrate their capability. Once approved, no changes to subcontractor facilities may be made without prior written approval from De Havilland Canada M&P Engineering.

4.3.3.1 For approval of subcontractor facilities to perform the fabrication of 280°F cure, phenolic resin pre-impregnated, graphite/glass fibre laminate and sandwich panel assemblies according to this PPS, completion of a test program and submission of suitable test samples representative of production parts is required. Test samples must meet the requirements as defined by De Havilland Canada M&P Engineering.

4.3.3.2 All testing and evaluation specified herein must only be performed by De Havilland Canada Materials Laboratory or by laboratories accredited according to BAERD GEN-018.

5 PROCEDURE

5.1 General

5.1.1 For the purposes of this PPS, the term “MRB” (Material Review Board) must be considered to include De Havilland Canada MRB and De Havilland Canada delegated MRB.

5.1.2 Pre-impregnated material consists of woven fabric which has been impregnated with a heat curing phenolic resin and “B” stage cured by the manufacturer. The term “material” used throughout this PPS refers to the pre-impregnated materials listed in section 4.1 unless a particular type is specified.

5.1.3 For the purposes of this PPS, laminates are considered to consist of single or multi-ply layers of material which have been laid up and cured to form a part, part component or test specimen.

5.1.4 For the purposes of this PPS, sandwich panel assemblies consist of a honeycomb core sandwiched between two or more plies laid up and cured to form a part or part component.

5.1.5 Intermixing of material from different vendors covered by a single DHMS is not allowed. Intermixing of material from different vendors covered by different DHMS’s is allowed.

5.1.6 For class 5 parts only, if tab extensions are used, ply by ply inspection is not necessary. Ensure tabs are suitably sized and staggered to allow for the identification of the ply material, verification of orientation of the fabric or fibre and verification of the lay-up sequence as specified on requirements of the engineering drawing. Install tab extensions beyond the trim line.

5.2 Preparation of Materials and Equipment

5.2.1 Prepare core fillers according to PPS 13.23.

5.2.2 Prepare moulds according to PPS 10.22.

5.2.3 Prepare thermocouples according to PPS 10.28.

5.2.4 Store, handle and prepare pre-impregnated materials according to PPS 10.23.

5.2.5 Prepare honeycomb core materials according to PPS 10.24.

5.2.6 Store, handle and prepare DHMS A6.06 and DHMS A6.08 film adhesives according to PPS 10.25.

5.2.7 Solvent clean metal parts and doublers according to PPS 31.17 immediately before lay-up.

5.2.8 Protect all additional materials to be incorporated into the lay-up against contamination by carefully wrapping them in neutral Kraft paper or polyethylene storage bags and storing them in areas free of dust, solvents, release agents, etc.

5.2.9 If DHMS P1.29 fire retardant rigid foam has not been stored in a controlled environment at 60 to 80°F with the relative humidity not exceeding 60%, immediately before machining and lay-up, dry the foam for a minimum of 30 minutes at 275 ± 20°F.

5.3 Lay-Up of Laminates

5.3.1 If bonding or liquid shimming is to occur after fabrication of the part, apply a layer of DSC 234-12 release ply or DSC 234-12-3 peel-ply and an intensifier to the relevant area of the part surface.

5.3.2 Lay-up laminates as follows:

Step 1. To facilitate the lay-up of the first ply next to the tool, it is acceptable to pre-heat the tool to a maximum temperature of 120°F.

Step 2. Lay-up the first ply by orientating it as specified on the engineering drawing. Use radiused nylon or Teflon blocks to work the fabric into the mould contours.

Step 3. Peel the backing film from the laid up ply and continue the lay-up. Orient all plies as specified on the engineering drawing. If necessary, mark the position of the plies on the laid up ply using the applicable template and a Sharpie 30001 felt tip marker. If necessary, tape the plies in position outside of the trim line using DSC 234-15 pressure sensitive tape. Use a hot air gun, as required, to soften the material for forming and to increase ply tack. If required, the edge of the plies may be marked on the mould outside the trim line using a Sharpie 30001 permanent felt tip marker.

Step 4. If the material tack presents difficulties in positioning, lay a sheet of backing film on the laid up ply. Position the next ply over the film and slide the film from the plies while working down. Work each ply into intimate contact with the previously laid up ply. Take particular care on radii, complex curvatures, etc. to ensure complete contact of the material.

5.3.3 Incorporate thermocouple ends under the second last ply outside the trim line. Use DSC 234-15 tape to secure the thermocouple wires to the tool. If the shape of the tooling makes it impossible to incorporate a thermocouple end under the second last ply, use DSC 234-15 tape to secure thermocouple ends (covered with two layers of breather cloth) to the tool after completion of the lay-up.

5.3.3.1 Ensure there is a minimum of 1 thermocouple incorporated for every 10 square feet of part surface. If possible, place thermocouples at opposite ends and sides of each other (i.e., do not place side by side).

5.3.4 If the use of peel-ply is specified, locate peel-ply on the part with an overlap of 1" to 2". Mark the location in which the peel-ply has been applied using coloured peel-ply or a Sharpie 30001 felt tipped marker so that the location of the peel-ply will be evident after curing.

5.3.5 If splices in the plies are permitted by the engineering drawing, overlap the splices by 3/4" to 1 1/4". For DHMS P1.44 or DHMS P1.59 Type 1 material, butt splices are permitted along the base of tight radii. For DHMS P1.44 or DHMS P1.59 Type 2 material, to reduce the severity of tight radii, a maximum of 3 strips of 1/2" wide Type 2 material may be laid up at the base of the radii.

5.3.6 If the engineering drawing allows the cutting of notches in the plies to allow forming over contours, then stagger the notches to prevent local material build-up.

5.3.7 De-Bulking and Temporary Vacuum Bagging

5.3.7.1 If de-bulking is specified on the manufacturing document, then de-bulk parts as follows:

Step 1. Vacuum bag the part according to paragraph 5.3.7.3 or paragraph 5.3.7.4.

Step 2. Apply a minimum vacuum of 24" Hg.

Step 3. Maintain the vacuum for 0.5 to 2 hours at 65 - 75°F (see section 6.8).

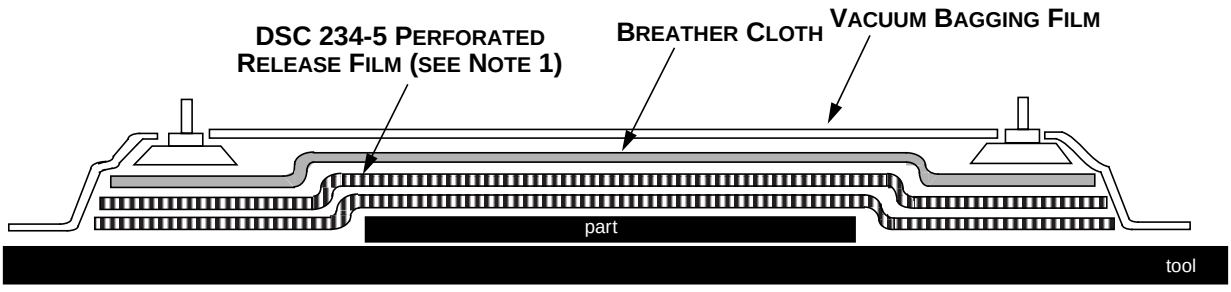
5.3.7.2 If the manufacturing document does not specify de-bulking of the parts, then either de-bulk according to paragraph 5.3.7.1 or temporary vacuum bag the part to facilitate the lay-up procedure as follows:

Step 1. Vacuum bag the part according to paragraph 5.3.7.3 or paragraph 5.3.7.4.

Step 2. Apply a minimum vacuum of 24" Hg.

Step 3. Maintain the vacuum for 5 to 30 minutes at 65 - 75°F (see section 6.8).

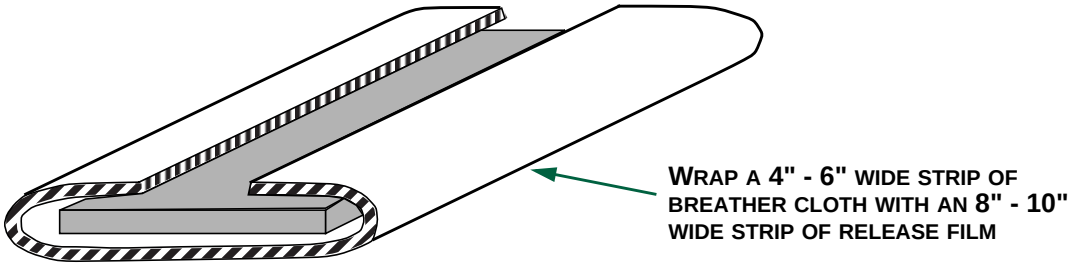
5.3.7.3 Vacuum bag parts for de-bulking or temporary vacuum bagging as follows:



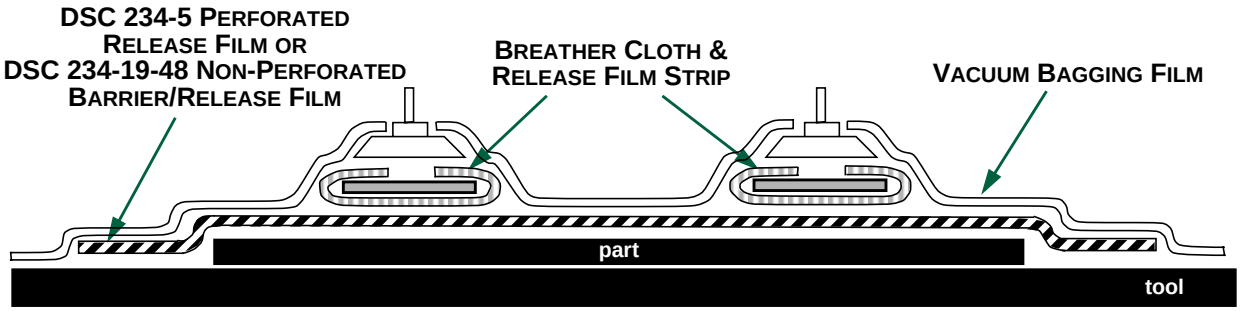
Note 1: In place of two layers of DSC 234-5 perforated release film, it is acceptable to use one layer of DSC 234-19-48 non-perforated barrier/release film.

STANDARD VACUUM BAGGING FOR DE-BULKING OR TEMPORARY BAGGING

5.3.7.4 As an alternate to vacuum bagging for de-bulking or temporary vacuum bagging as shown in paragraph 5.3.7.3, it is acceptable to substitute prepared strips for the second layer of release film and the layer of breather cloth (see following figures).



BREATHER CLOTH & RELEASE FILM STRIPS



ALTERNATE METHOD OF VACUUM BAGGING FOR DE-BULKING OR TEMPORARY VACUUM BAGGING

5.4 Lay-Up of Sandwich Panels

5.4.1 Lay-up sandwich panels as follows:

Step 1. Lay-up the outer laminate of the sandwich panel in the mould according to the procedure specified in section 5.3. If core stabilizing is specified on the work order or engineering drawing, lay-up the outer plies of the sandwich panel according to section 5.4.2. If core stabilizing using DHMS P1.48 flyscreen is specified on the engineering drawing, stabilize honeycomb core according to PPS 10.24.

Step 2. Press the core, prepared according to PPS 10.24, against the ply using just sufficient force to ensure contact of the cells to the fabric. If necessary, use a hot air gun to heat the material and increase its tack. If necessary, use small sections of DHMS A6.08 film adhesive to hold the core in position but limit the amount of adhesive film to 4 square inches per square foot of core.

Step 3. If the core is to be spliced as part of the laid up assembly, process the parts according to section 5.4.3.

Step 4. If potting of cells is specified on the engineering drawing, pot the applicable core cells with the specified core filler according to PPS 13.23.

Step 5. If the use of doublers is specified on the engineering drawing, add doublers to the core according to section 5.4.4.

Step 6. If the use of inserts or edging is specified on the engineering drawing, add inserts and edging to the core according to section 5.4.5.

Step 7. Complete the inner laminate lay-up according to section 5.3.

Step 8. If inserts or edgings have been added to the core, position an intensifier and a layer of DSC 234-12 release ply or DSC 234-12-3 peel-ply over the junction of the core and insert or edging. Position the intensifier and release ply/peel-ply such that they overlap approximately equally over the core and insert or edging (see Figure 2).

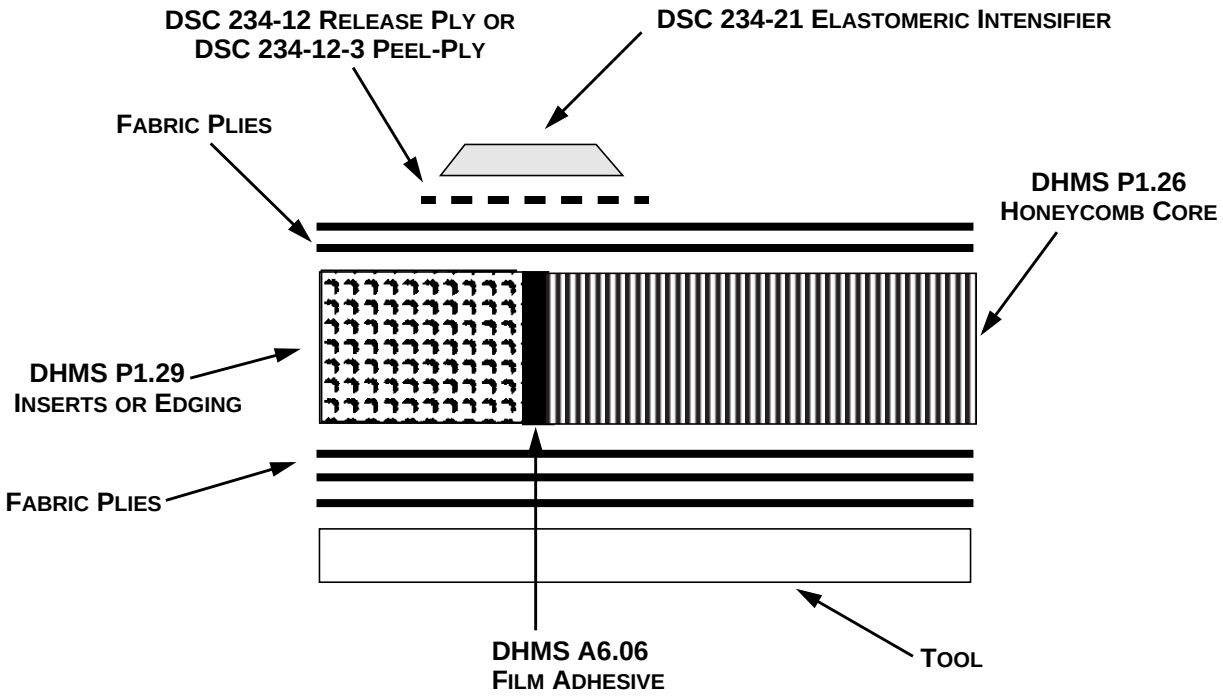


FIGURE 2 - USE OF INTENSIFIERS

5.4.2 Core Stabilization

5.4.2.1 If the tool is equipped with a grit strip, then lay-up the two fabric plies (except if only one ply is specified on the engineering drawing) above and below the core according to Figure 3.

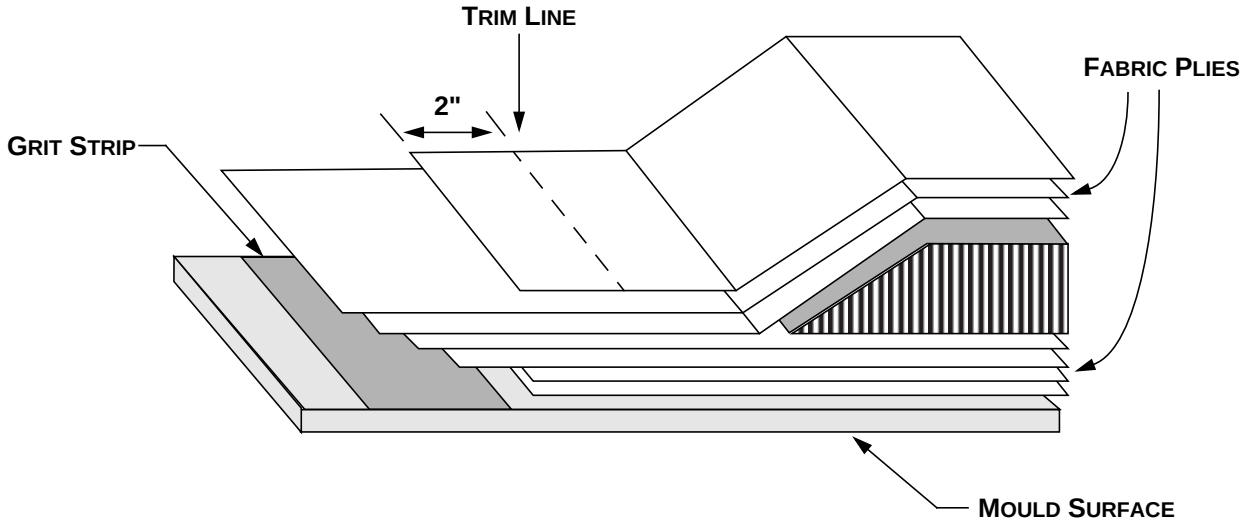


FIGURE 3 - GRIT STRIP METHOD OF CORE STABILIZATION

5.4.2.2 If the tool is not equipped with a grit strip, stabilize the core according to paragraph 5.4.2.3 or paragraph 5.4.2.4.

5.4.2.3 If the tool is not equipped with a grit strip it is acceptable to stabilize the core using the edge bleeder method as shown in Figure 4. As a minimum, the two plies (except if only one ply is specified on the engineering drawing) above and below the core must be tied down. It is acceptable to tie down additional plies with the exception of the first ply next to the tool. Position the plies on the mould and extend the edges 2" beyond the trim line or over the holding pins (if provided). When laying a bordering strip of edge bleeder cloth (style 181 glass), ensure that it will overlap the fabric ply by approximately 1". When applying a strip of DSC 234-15 high temperature pressure sensitive tape or high temperature masking tape, ensure that it will overlap the edge bleeder cloth by approximately 1". Press the tape firmly against the tool and the edge bleeder cloth.

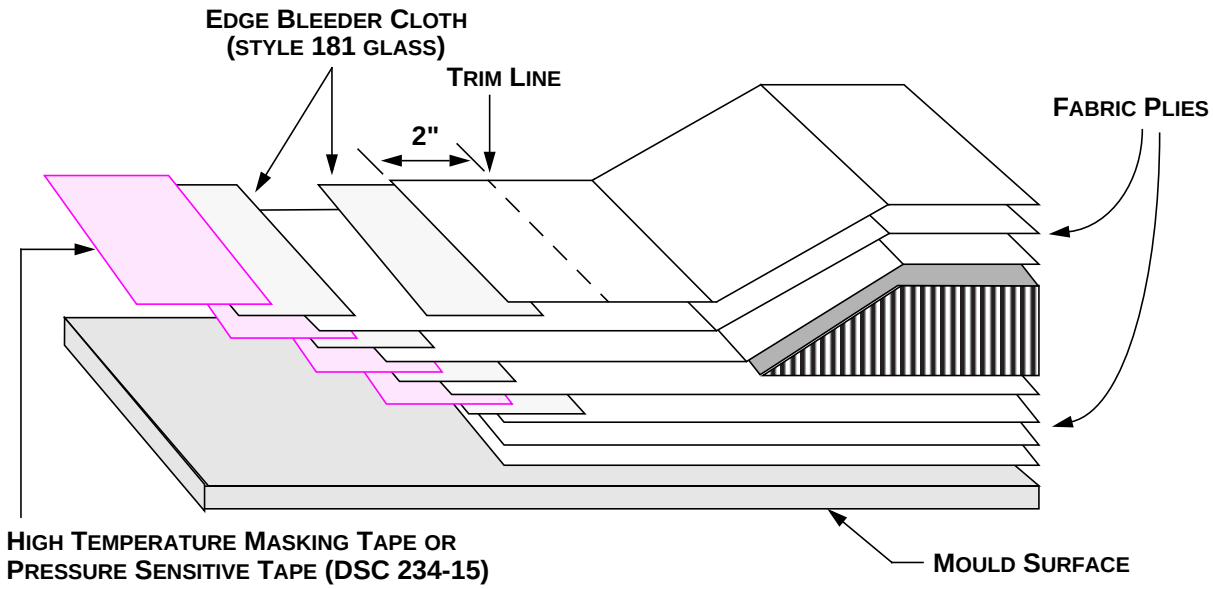


FIGURE 4 - EDGE BLEEDER METHOD OF CORE STABILIZATION

5.4.2.4 If the tool is not equipped with a grit strip it is acceptable to stabilize the core using the fiberglass tape method as shown in Figure 5. As a minimum the two plies (except if only one ply is specified on the engineering drawing) above and below the core must be tied down using fiberglass tape. It is acceptable to tie down additional plies with the exception of the first ply next to the tool. Stagger fabric plies to ensure that bordering strips of DSC 234-20 adhesive backed fiberglass tape extend at least 0.5" onto the mould surface while overlapping approximately 1 1/2" over the fabric plies (see Figure 5). Position the plies on the mould so that the edges extend at least 2" beyond the trim line or over the holding pins (if provided).

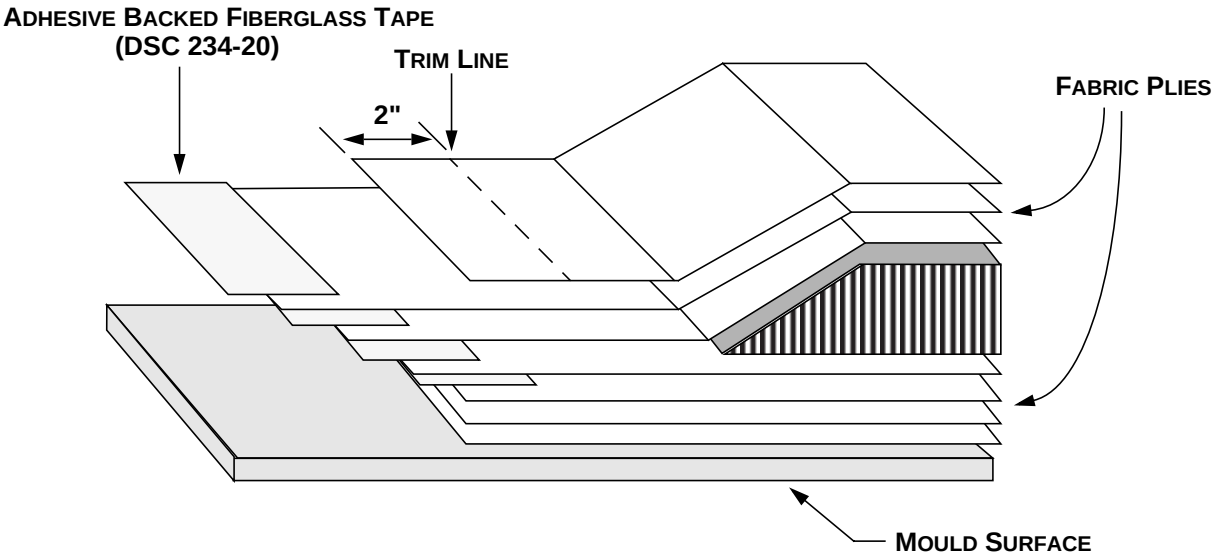


FIGURE 5 - FIBERGLASS TAPE METHOD OF CORE STABILIZATION

5.4.3 Core Splicing

5.4.3.1 Splice cores as follows:

Step 1. Thoroughly clean both splice edges according to PPS 10.24.

Step 2. Cut a strip of DHMS A6.06 expandable film adhesive the same length as the splice edge. Use 0.05" thick sheet to splice 1/8" cell sizes and 0.10" thick sheet (or two layers of 0.05" thick sheet) for splicing of 3/16" and 1/4" cell sizes.

Step 3. As the core sections are laid up in the mould, place the strip of adhesive between the cleaned splice edges and join with light hand pressure.

Step 4. Check to ensure the gap between spliced cores is approximately 0.10" or less.

5.4.4 Adding Doublers

5.4.4.1 Add doublers to the core as follows:

Step 1. Prime doublers with F19 Type 2 primer according to PPS 34.08.

Step 2. Solvent wipe all doubler surfaces according to PPS 31.17.

Step 3. Apply a layer of DHMS A6.08 film adhesive to the top and bottom surfaces according to PPS 10.25.

Step 4. Insert the doubler into the core and press firmly into place. Ensure that the doubler is flush with the surface of the core.

Step 5. Fill voids in the potted areas along the doubler sides flush with core filler.

5.4.5 Addition of Inserts and Edgings

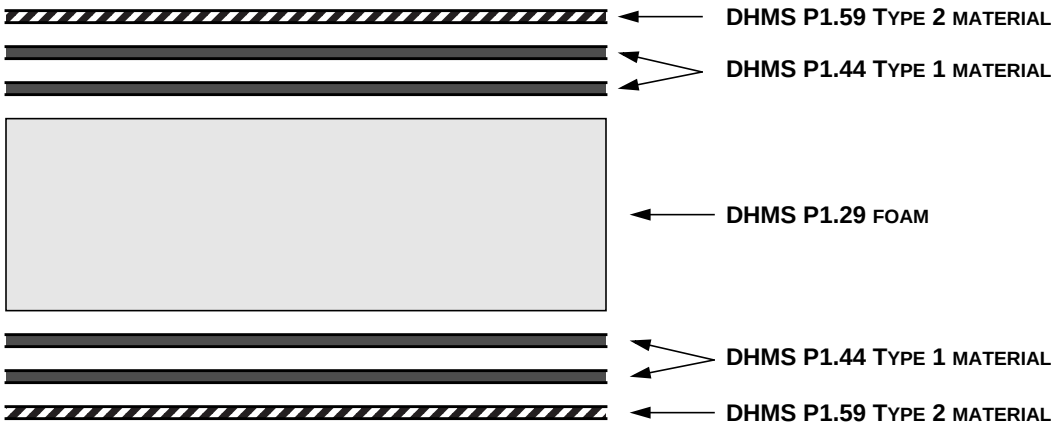
5.4.5.1 Add inserts and edgings as follows:

Step 1. Machine the insert to the required size. Edgings may be machined oversize in width to facilitate machining to the final part trim line after curing. Machine foam material using conventional clean cutting tools.

Step 2. Wipe the surfaces clean of dust and foam particles using a clean cloth.

Step 3. Apply DHMS A6.06 expandable film adhesive (0.05" thick for 1/8" core cells and 0.10" thick for 3/16" or 1/4" core cell sizes) to the sides of the insert according to PPS10.25.

Step 4. Apply DHMS A6.08 film adhesive to the top and bottom surfaces of the insert according to PPS10.25. When laying up plies of DHMS P1.59 Type 2 material over DHMS P1.29 foam, it is acceptable to use 2 plies of DHMS P1.44 Type 1 material in place of DHMS A6.08 adhesive on the top and bottom surfaces of the insert as shown:



Step 5. Install the insert in position by pressing firmly against the surrounding core to ensure contact.

Step 6. If the inner ply is not to be laid up immediately, cover the exposed insert and adhesive surfaces with protective paper to prevent contamination.

5.4.5.2 If it is necessary to bond foam to foam or foam to metal, use 0.050" thick DHMS A6.06 expandable film adhesive.

5.5 Vacuum Bagging

5.5.1 Vacuum bag parts as follows:

Step 1. Apply DSC 234-17 vacuum bag sealant to the mould surface to surround the part's perimeter. Leave a minimum of 1" from the ply ends to the vacuum bag sealant. If DSC 234-3 tubular vacuum bagging film is to be used, the vacuum bag may be sealed using a thermal impulse heat sealer (see paragraph 4.2.9).

Step 2. Cover the lay-up with one layer of DSC 234-5 perforated release film.

Step 3. For light construction parts (i.e., 3 or less plies per skin on sandwich panels, or 5 or less plies on laminates) cover the lay-up with one layer of DSC 234-10 or DSC 234-11 breather cloth.

Step 4. For heavy construction parts (i.e., 4 or more plies per skin on sandwich panels, or 6 or more plies on laminates) cover the lay-up with one layer of DSC 234-10 breather cloth. Place additional layers of the applicable breather cloth over protrusions, sharp edges, etc. to prevent puncturing of the bag.

Step 5. Position vacuum outlets around the part as evenly spaced as possible. Include at least one vacuum outlet for **every** 9 square feet of surface area and an additional vacuum outlet for vacuum monitoring. Add 3 to 4 layers of the applicable breather cloth under each of the vacuum outlets (see Figure 6 or Figure 7, as applicable). Position each of the vacuum outlets as shown in Figure 6. However, if there is insufficient space on the tool outside the part area for positioning of the vacuum outlet, construct a pleat to contain the vacuum outlet as shown in Figure 7. In cases where it is possible that a high flow of resin may clog the vacuum outlet, add a piece of bagging film approximately twice as big as the vacuum outlet under the extra layers of breather cloth. The bagging film should be smaller than the extra layers of breather cloth to ensure a continuous air path.

Step 6. Apply DSC 234-19 barrier film and DSC 234-15 high temperature pressure sensitive tape as shown in Figure 6 or Figure 7, as applicable.

Step 7. Cover the lay-up with DSC 234-1 vacuum bagging film and work the edges firmly into the vacuum bag sealant. Apply additional vacuum bag sealant in areas where the vacuum bagging film has been doubled or pleated. However, if possible, the prepared lay-up may be covered with DSC 234-3 tubular vacuum bagging film.

Step 8. Puncture the vacuum bagging film at the vacuum outlets.

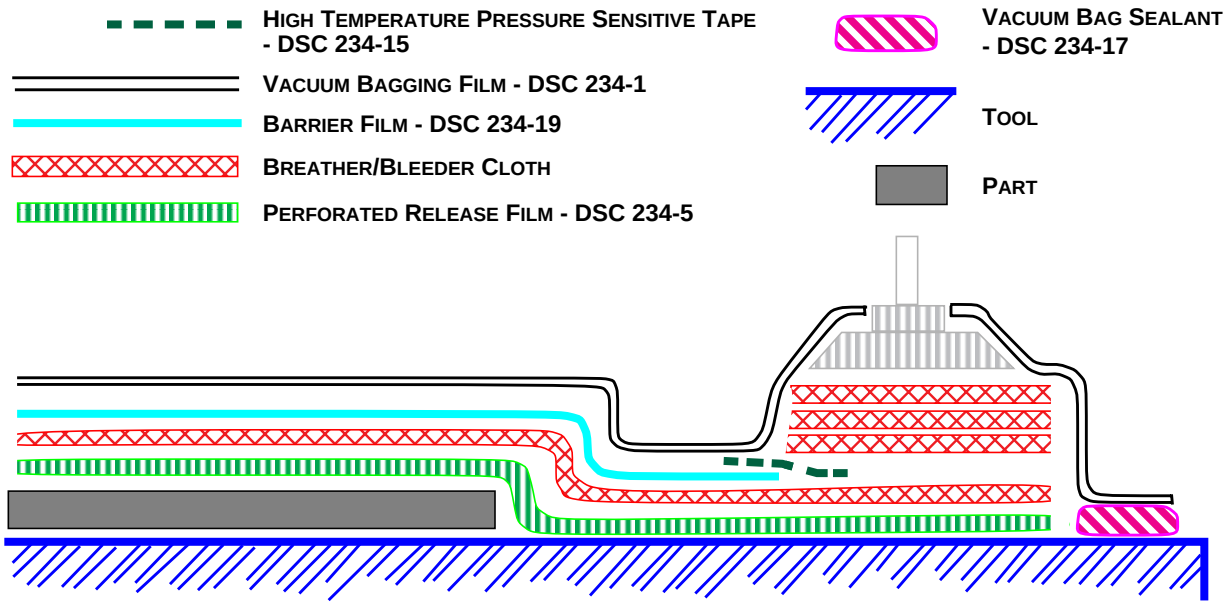


FIGURE 6 - STANDARD PLACEMENT OF VACUUM OUTLETS

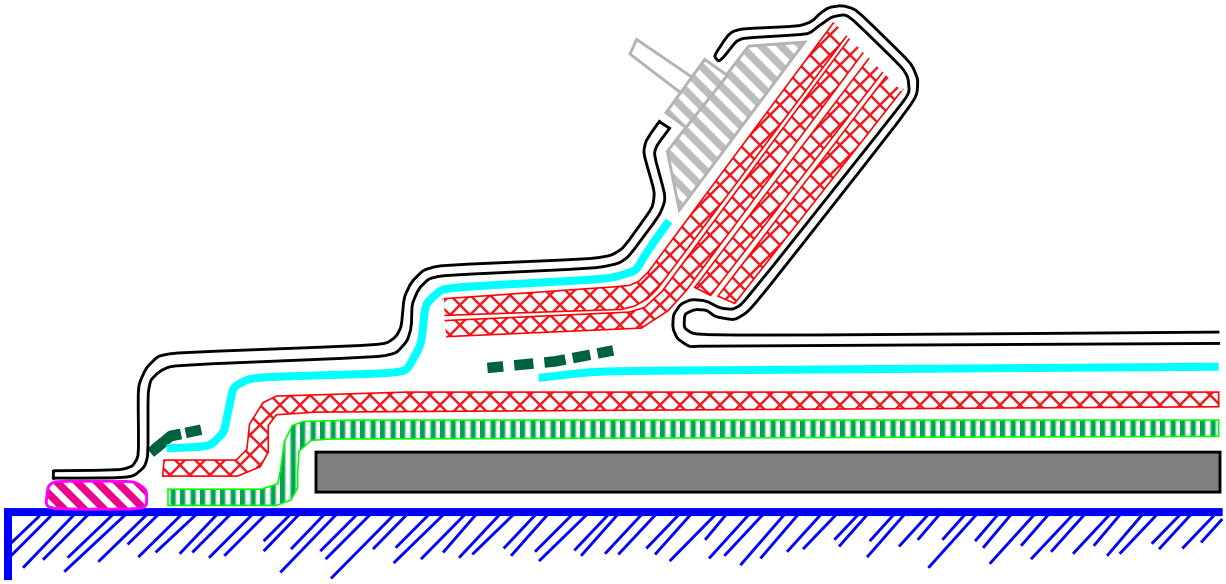


FIGURE 7 - PLEAT PLACEMENT OF VACUUM OUTLETS

5.6 Leak Testing

5.6.1 Perform leak testing of vacuum bagged assemblies as follows:

Step 1. Connect the vacuum outlets to their applicable connectors.

Step 2. Slowly apply a minimum vacuum of 24" Hg to the bagged assembly. Adjust the bag while it is evacuating by pleating and folding to ensure complete contact and even pressure on the lay-up.

Step 3. When the vacuum is achieved, shut off the vacuum supply and check for leaks by observing the pressure gauge. The maximum acceptable leak rate is 1" Hg per minute over a 5 minute period.

Step 4. If the leak rate is greater than 1" Hg per minute over a 5 minute period, repair the leaks (or re-vacuum bag according to section 5.5, if necessary) and re-test for leaks according to this section.

5.7 Curing

5.7.1 Prepare a cure chart and a cure plot, if available, for each oven load. Ensure that the cure chart shows each of the following readings recorded every 5 minutes or less (except for the vacuum line readings).

- Temperature reading of each thermocouple.
- Vessel temperature.
- Vacuum line readings recorded every 10 minutes or less.

5.7.2 Record the heat-up and cool down rates each 5 minute interval.

5.7.3 When curing, verify the following:

- heat-up and cool down rates for each 5 minute interval
- cure duration
- vacuum monitoring

5.7.4 The oven may be opened to correct bag leaks, replace thermocouples, etc. provided that the part temperature has not exceeded 140°F.

5.7.5 Oven cure as follows:

Step 1. Transfer the laid up part, while under vacuum, to the oven.

Step 2. Tape thermocouples, covered with two layers of breather cloth, to the tool outside the vacuum bag area on a minimum of four parts (including the heaviest, largest, lightest and smallest parts).

Step 3. Record on the oven record sheet which thermocouple is attached to each part.

Step 4. Connect all vacuum outlets to the oven vacuum connectors and apply a minimum vacuum of 24" Hg.

Step 5. Ensure all thermocouple and vacuum connections have been made.

Step 6. Turn on the heaters and begin heating the parts. A vacuum reading of less than 24" Hg at any time during the cure cycle is cause for rejection and disposition of the represented parts. However, during heating of the parts to the cure temperature (280 ± 10°F), a vacuum reading on the vacuum line as low as 20" Hg, due to out gassing, is acceptable.

Step 7. As each thermocouple reaches 130°F, maintain the heat up rate for that thermocouple at one of the following options until the cure temperaure is reached.

Option 1: Maintain a heat up rate of 2 to 5°F per minute until 280 ± 10°F is reached.

Option 2: Maintain a heat up rate of 2 to 5°F per minute during heat up at 130 to 250°F followed by a heat up rate of 0.5 to 5°F per minute until 280 ± 10°F is reached.

Step 8. As each thermocouple reaches the cure temperature (280 ± 10°F), maintain that thermocouple at the cure temperature for 60 to 90 minutes. If a thermocouple indication falls below 270°F, consider the cure time for that thermocouple to have stopped and restart the cure time only when the cure temperature (280 ± 10°F) is restored. A thermocouple indication rise above 290°F is cause for rejection and disposition of the represented parts. Exposure to the cure temperature (280 ± 10°F) for greater than 90 minutes is cause for rejection and disposition of those particular parts. Indicate on the recording chart any correction made during the cure cycle.

Step 9. Upon completion of the cure cycle, shut off the heaters and allow the parts to cool at a rate no greater than 5°F per minute.

Step 10. Once the parts have cooled to 140°F or less, release the vacuum, remove the bag and separate the part from the mould.

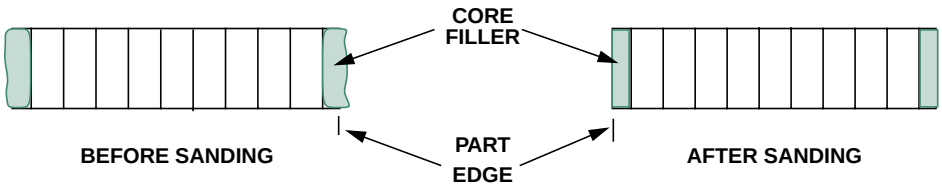
5.8 Finishing

5.8.1 Finish parts as follows:

Step 1. Trim the part to the engineering drawing requirements according to PPS 10.39.

Step 2. Solvent clean all surfaces according to PPS 31.17.

Step 3. If the engineering drawing specifies “Edge Filling” sandwich panel assemblies, use a suitable spatula to fill all open edge cells with the core filler specified. Allow DHMS P1.30 resin to cure according to PPS 13.23. Smooth to the required part profile by lightly sanding the edge with 180-240 grit abrasive paper.



Step 4. If the engineering drawing specifies “Under Cutting”, process sandwich panel assemblies after curing and de-moulding by using a suitable rotary file to remove the core cells to the depth specified on the engineering drawing and fill the cavity and allow the material to cure according to PPS 13.23.

Step 5. Repair structural defects according to the applicable repair procedure specified in Table II. If the defect magnitude exceeds the limits as specified in Table II, refer the part to MRB for disposition.

Step 6. If the part is to be covered with a decorative laminate, repair imperfections as listed in Table III according to PPS 34.34. For parts where the engineering drawing specifies a flammability requirement to FAR 25.853, repair of a surface area up to 9 square inches is allowed. Refer flammability requirement parts exceeding this limit to MRB for disposition.

Step 7. If the engineering drawing specifies “Surface Finish - F33” or “Surface Finish - PPS 34.34”, repair imperfections as listed in Table III and pin holes according to PPS 34.34.

5.8.2 Ensure all vacuum bagging material is removed after curing and before any further processing.

5.8.3 Except as specified in paragraph 5.8.3.1, any details to which release ply, peel-ply and/or parchment paper has been incorporated must have the release ply, peel-ply and parchment paper removed after curing and only immediately before any secondary bonding or lay-up applications.

5.8.3.1 Do not remove release ply, peel-ply and/or parchment paper if details are to be machined or stored, or when details are not laid up within the same work shift.

5.8.4 Minimize the possibility of damaging completed composite parts during handling. Do not leave completed parts unprotected in the work area. Remove completed parts from the work area as soon as possible.

TABLE II - STRUCTURAL DEFECTS (NOTE 1)

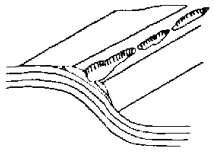
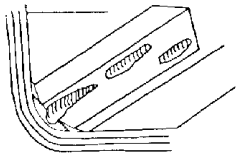
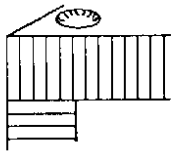
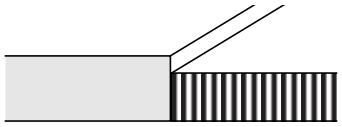
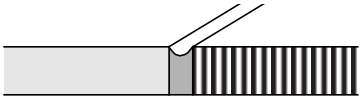
DEFECT	DESCRIPTION (Note 2)	REPAIR PROCEDURE
Surface Scratches (Note 3)	• Fibre damage • First ply only • Maximum depth of 0.005" • Maximum length of 1"	PPS 10.40 or PPS 34.34
Resin Starved Area (Note 4)	• Maximum 10% of surface	
Deep Scratches	• Penetrating through first ply only • Maximum depth of 0.010"	PPS 10.40
Partial Fractures	• Penetrating through first ply only • Maximum depth of 0.010"	

Delamination (Note 5) and Internal Voids	• Class 6 components only
	  • No more than 1 such defect per square foot
	  • Maximum size of 1 square inch
	  • Maximum length of 2"
	• Class 1 through Class 5 components
	  • Refer to MRB	

Small Holes and Punctures	• No more than 1 such defect per square foot • Maximum diameter of 1/4"	
Misplaced Fastener Holes	• Maximum 10% of pattern • Maximum diameter of 1/4"	
Parts Trimmed Too Small	• No fastener holes in area to be built up • Maximum width of 1" • Maximum length 25% of the part's periphery	
Tackiness (i.e., not fully cured)	• MRB authority is required	

Note 1. These defects are structural in nature, affecting the strength or performance of the part. This type of defect must be repaired before placing the part in service.
Note 2. These are the limitation to which these defects may be repaired without MRB authorization. Defects exceeding the stated limits require MRB authorization for repair.
Note 3. Refer surface scratches exceeding 1" in length to MRB for disposition.
Note 4. Not including pin holes - pin holes are not a structural defect.
Note 5. Refer parts with incomplete bonding or delaminations at doublers, edging or core to MRB for disposition.

TABLE III - IMPERFECTIONS (NOTE 1)

IMPERFECTIONS	DESCRIPTION	ILLUSTRATION
Excess Resin	• Air bubbles in resin at corners	
	• Air bubbles in fillets	
Surface irregularities	• Depressions at panel pins • Maximum 0.010" deep	
	• Telegraphing of core inserts, edgings, core splices, etc. • Maximum 0.010"	
	• Depressions at core splices • Maximum 0.010"	
	• Dents and dimples • Maximum 0.010" deep • Maximum 1" diameter	
Surface Scratches (Note 2)	• No fibre damage • Maximum length of 1"	
Wrinkles & Depressions	• Mark-offs from bag folds which do not include a ply in the wrinkle/depression • No fibre damage	
Pin Holes	• Air bubbles between yarns	

Note 1. These defects are confined to the surface of the part and have little or no effect on the strength or performance of the part but will result in an undesirable appearance in the finished part. This type of defect or imperfection does not require repair unless the part is to be covered with a decorative laminate or the engineering drawing specifies "Surface Finish - F33" or "Surface Finish - PPS 34.34". These defects are repairable without MRB authorization. However, for parts where the engineering drawing specifies a flammability requirement to FAR 25.853, repair of a surface area up to 9 square inches is allowed. Refer parts exceeding this limit to MRB for disposition.

Note 2. Refer surface scratches exceeding 1" in length to MRB for disposition.

6 REQUIREMENTS

6.1 In-Process Inspection of Production Parts

6.1.1 In-process inspect all parts according to all applicable facility Quality specifications.

6.1.2 Check all pre-impregnated materials before use to ensure that the remaining shop time and storage life will allow sufficient time for lay-up and cure before the expiry of their shelf life.

6.1.3 Except for class 5 parts, inspect ply by ply to ensure the correct number of plies, ply orientation, lay-up sequence and ply dimensions as specified by the engineering drawing. For class 5 parts only, it is permissible to perform inspection with use of tab extension from each ply laid up in the mold instead of ply by ply inspection. For parts that conform to the engineering drawing, apply an inspection stamp to the manufacturing document.

6.1.4 The splices in the plies, if permitted by notation on the engineering drawing, must overlap by 3/4" - 1 1/4". For DHMS P1.44 or DHMS P1.59 Type 1 material, butt splices are permitted along the base of tight radii.

6.1.5 The edges of contour forming reinforcing plies must have been positioned within ± 0.125" of the location specified by the engineering drawing.

6.1.6 The edges of flat reinforcing plies must have been positioned within ± 0.062" of the location specified by the engineering drawing.

6.1.7 For parts that conform to the engineering drawing, apply an inspection stamp to the manufacturing document. Refer production parts that do not meet the requirements of this PPS to Quarantine Parts Areas (QPA) for disposition.

6.2 Visual Inspection of Finished Components

6.2.1 The parts must be uniform in quality, appearance and condition and free of foreign material and internal or external imperfections that would be detrimental to the appearance or performance of the parts.

6.2.2 The class of finish for the tool side and the bag side of the part must be as specified in EO 81104 (see paragraph 3.2). If EO 81104 does not reference a particular part, the finish on both sides must be at least class C.

6.2.2.1 A class A finish is required on parts which will be in close and constant passenger view and must be virtually blemish free. On a class A surface, only defects of a very minor nature which do not detract from the overall appearance of the component are acceptable.

6.2.2.2 A class B finish is required on components which may be viewed on a casual basis by passengers or are in constant view from a distance greater than 10 feet. On a class B surface, a consistent weave and/or core pattern telegraphing over at least 80% of the surface is acceptable.

6.2.2.3 A class C finish is required on surfaces considered to be of a utilitarian nature which are not appearance sensitive. They represent good industry standard and are a reasonable product result of the process.

6.3 Dimensional Inspection for Finished Components

6.3.1 The parts must meet the dimensional requirements specified on the engineering drawing.

6.3.2 The maximum panel warpage must be less than 0.025" per foot length of panel.

6.3.3 The irregularities in panel facings due to telegraphing of fabric around inserts, edges and core cells must be less than ± 0.010".

6.3.4 Reject parts exceeding the dimensional limits specified herein and refer them to QPA's for deposition.

6.4 Test Panel Requirements

6.4.1 If the engineering drawing specifies that the component or assembly must meet flammability requirements of FAR 25.853, flammability compliance testing must be completed as specified in PPS 10.36 prior to the manufacture of production parts.

6.4.2 Prepare process control test panels, part test coupons, qualification testing for first-off article inspection and periodic production article inspection according to QAMTR 029. Ensure the following data for each component/test panel is recorded on the manufacturing document:

- Identification of component.
- Serial number for traceability.
- Cure batch number.
- Material and core batch numbers.
- Lay-up date and processing information.
- Ambient temperature and humidity during lay-up.
- Testing results.

6.5 Receipt and Storage Life Extension Testing

6.5.1 Subject all batches of pre-impregnated material and film adhesives to acceptance, receipt and storage life extension testing according to PPS 10.23 or PPS 10.25.

6.6 Recording of Processing Information

6.6.1 The temperature measurements from each thermocouple must be recorded during the entire curing cycle. Multi-point recorders may be used, providing that each thermocouple is monitored at least once every 5 minutes.

6.6.2 The recorder must be capable of recording the temperature to within ± 1°F. Calibration of recording equipment against equipment of known accuracy, traceable to the National Institute of Standards and Technology, National Research Council or equivalent must be carried out periodically.

6.6.3 The temperature chart must be related to time so that the heat-up and cure time may be checked and recorded. Record vacuum applied to the assemblies during curing. Alternatively, data may be recorded and inspected on the cure cycle chart.

6.6.4 Ensure that each item on the cure chart and cure plot, if applicable, as specified in paragraph 5.7.1 has been inspection stamped. All temperature charts and vacuum records must be readily available upon De Havilland Canada's requests.

6.7 Part Marking

6.7.1 If the part has been in-process labelled with the part number, it is not necessary to part mark after curing.

6.8 Lay-Up Area Conditions

6.8.1 The work areas must be isolated from machining operations or conditions that will generate dust or other contaminating airborne particles.

6.8.2 The air entering the lay-up area must be filtered and a positive air pressure differential is maintained so that unfiltered air does not enter.

6.8.3 The machines and tools used for cutting raw materials must not deposit internal lubricating fluids onto the work surfaces.

6.8.4 The floors, work surfaces, all tooling and shelvings must be kept clean and free of dust and other contaminants and swept or cleaned at least once a day.

6.8.5 Parting or release agents, uncured silicone bearing material, and solvents must not be used in lay-up areas.

6.8.6 Keep the lay-up area temperature and relative humidity within the limits specified in Figure 8. If the temperature or relative humidity exceeds the limits specified in Figure 8, vacuum bag partially completed parts and store them under a minimum vacuum of 24" Hg.

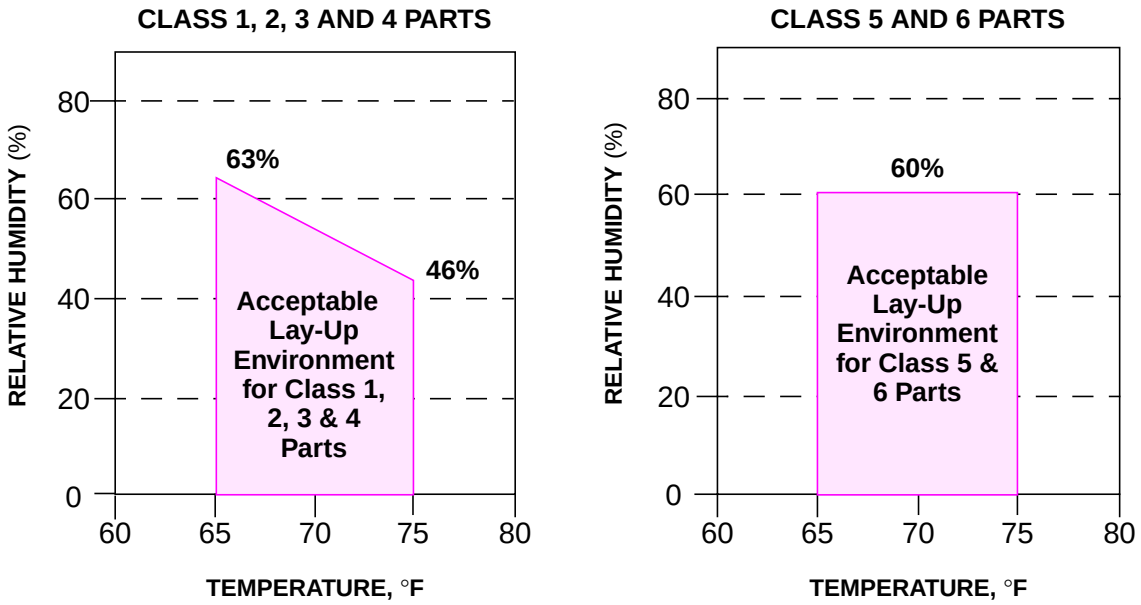


FIGURE 8 - TEMPERATURE AND RELATIVE HUMIDITY LIMITS

7 SAFETY PRECAUTIONS

7.1 Safety precautions applicable to the materials and procedures specified herein shall be defined by the subcontractor performing the work for De Havilland Canada. However, suppliers, subcontractors and partners are responsible for ensuring that their own environmental, health and safety precautions satisfy the appropriate local government regulations.

8 PERSONNEL REQUIREMENTS

8.1 This PPS has been categorized as a Controlled Critical Process according to PPS 13.39. Refer to PPS 13.39 for additional personnel requirements. Certified and/or qualified personnel must have a good working knowledge of the following, as applicable:

8.2 Upon completion of training for laying up composite parts, trainees must have a good working knowledge of the following, as applicable:

- engineering drawing and work order notes regarding the lay-up of composite parts
- sections regarding the lay-up of composite parts in the following PPS's: 10.23, 10.24, 10.25, 10.35, 10.43, 10.48, 13.23, 31.14 and 31.17
- equipment used in the lay-up of composite parts (i.e., cutting tools, radiused Teflon and nylon blocks, etc.)
- benefit of pre-heating the mould before beginning the lay-up
- significance of ply orientation
- why it is necessary to mark splice locations
- why de-bulking is sometimes necessary
- purpose of core edge stabilization and core stabilization
- purpose of potting cells

8.3 Upon completion of training for vacuum bagging composite parts, the trainees must have a good working knowledge of the following, as applicable:

- engineering drawing and work order notes regarding the vacuum bagging of composite parts
- sections regarding the vacuum bagging of composite parts in the following PPS's: 10.23, 10.24, 10.25, 10.35, 10.43, 10.48, 13.23, 31.14 and 31.17
- equipment used in the lay-up of composite parts (i.e., vacuum gauges, leak detector gun, thermal impulse heater, etc.)
- role and purpose of vacuum bagging materials (i.e., release film, vacuum bag, barrier film, vacuum bag sealant, breather cloth, etc.)
- why vacuum outlet placement is important
- significance of leak testing
- why it may be necessary to strip thermocouple wire in the area of the vac-seal
- purpose of pleating the vacuum bag
- purpose of vacuum monitoring

8.4 Upon completion of training for curing composite parts, the trainees must have a good working knowledge of the following, as applicable:

- significance of cure temperature, pressure and time limits
- why the heat-up rate varies between certain parts in the same load
- significance of the heat-up and cooling rates
- effect of temperature and pressure on laid up composite parts
- properties and characteristics of platen press, oven and autoclave curing
- how to prepare a cure chart
- how to set up and operate the platen press, curing oven and autoclave
- know which parts have to be equipped with thermocouples
- cure charts and know which readings must be recorded
- procedure for attaching thermocouple leads to connectors
- when to connect vacuum outlets to vacuum monitors
- limits on the heat-up and cool down rates
- 250°F, 280°F and 350°F cure cycles
- engineering drawing notes, PPS's and manufacturing documents

9 MAINTENANCE OF EQUIPMENT

9.1 Keep tools free from oil, dirt, moisture and other contaminants.

9.2 Calibrate pressure gauges, temperature indicating/recording equipment, etc., according to De Havilland Canada Quality requirements.

10 STORAGE LIFE OF COMPOSITE MATERIALS

10.1 Refer to PPS 13.28 for the storage life of composite materials and products (e.g., DHMS A6.06, DHMS A6.08, DHMS P1.30, DHMS P1.44, etc.).