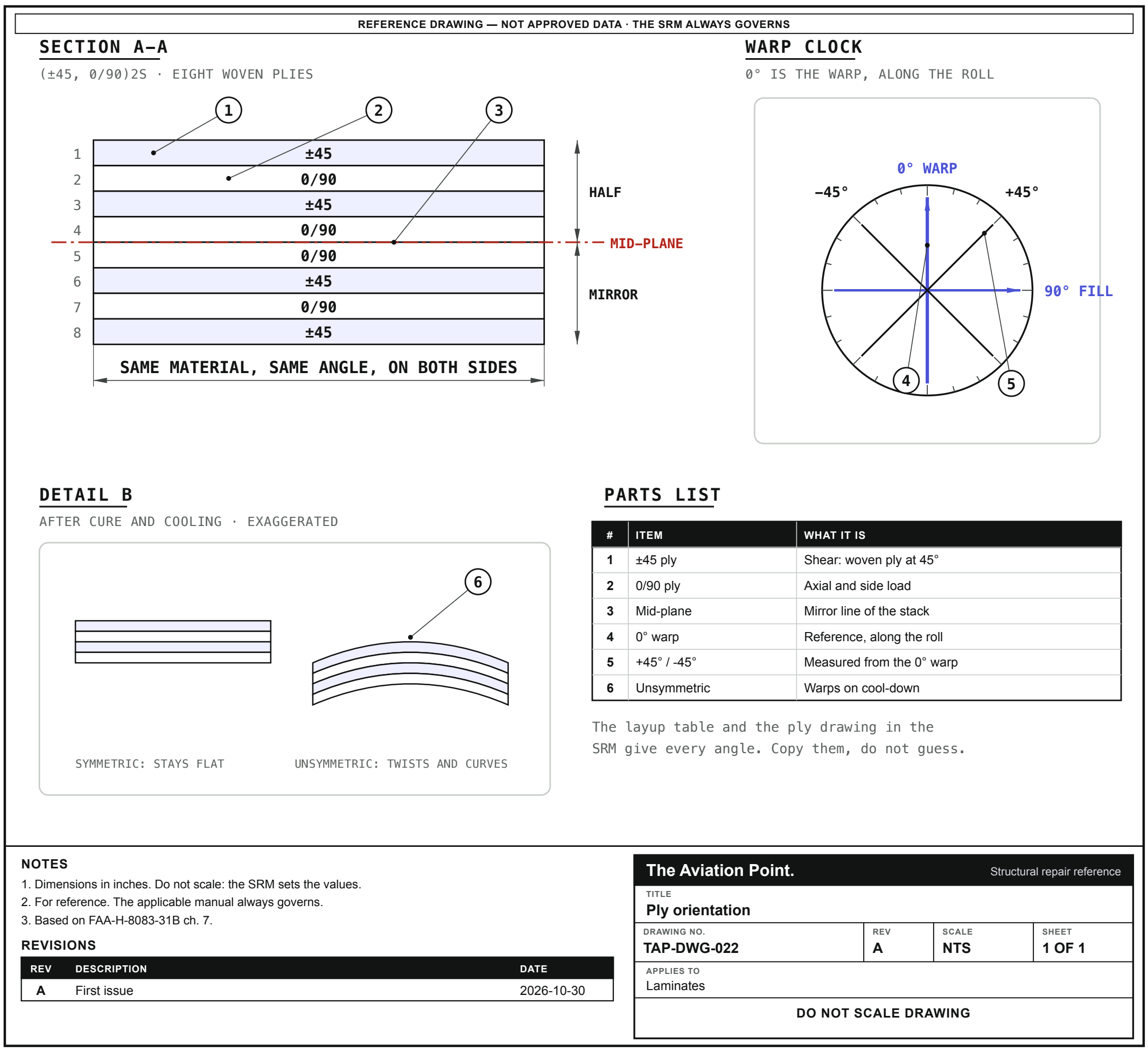
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Ply Orientation and the Warp Clock

Angles · warp clock · layup code · symmetric stacks



Eight-ply stack, warp clock, effect of an unsymmetric stack and parts list, after FAA-H-8083-31B pp. 7-2, 7-3, 7-28 and 7-29 (figures 7-3, 7-49, 7-50).

How a layup is written

Written as	Reads as, outer ply first	Plies	Made from
(+45, −45, 0)S	+45, −45, 0, 0, −45, +45	6	Unidirectional tape
(±45, 0/90)2S	±45, 0/90, ±45, 0/90, 0/90, ±45, 0/90, ±45	8	Woven cloth, quasi-isotropic
([±45]2, 0/90)S	±45, ±45, 0/90, 0/90, ±45, ±45	6	Woven cloth, quasi-isotropic

Symmetric and balanced: what an unsymmetric stack does

Type	Example	Effect when cured
Symmetric, balanced	(+45, −45, 0, 0, −45, +45)	Flat, constant mid-plane stress
Unsymmetric, balanced	(90, +45, 0, 90, −45, 0)	Induces curvature
Symmetric, not balanced	(−45, 0, 0, −45)	Induces twist
Unsymmetric, not balanced	(90, −45, 0, 90, −45, 0)	Induces twist and curvature

Key points

- **0°** axial, **±45°** shear, **90°** side load (Handbook p. 7-2).
- **0° is the warp;** with no clock on the fabric, the direction off the roll.
- **Same material, same orientation** for every repair ply, or an approved substitute.
- **Symmetric stack:** flat after cure; unsymmetric curves or twists.
- **The SRM layup table** governs; mark the part's zero direction.

Step by step

1. Find the layup and the part's zero direction in the SRM.
2. Expand the code; check it mirrors about the mid-plane.
3. Mark the roll direction on the fabric.
4. Cut each ply at its angle; label number and direction.
5. Lay up in SRM order; check each angle before bagging.

SOURCES · FAA-H-8083-31B, AMT Handbook — Airframe, Volume 1, Chapter 7 · AC 43.13-1B, Change 1, Chapter 3, Fiberglass and Plastics

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Educational reference only, not approved data. Always consult the applicable SRM, AMM, or AC 43.13-1B and your certifying authority.