PIA Technical Standard 100

Parachute Industry Association Publications

January 23, 1984 TS-100

Standardized Nomenclature for Ram-Air Inflated Gliding Parachutes

Introduction

This Technical Standard was adopted by the Parachute Industry Association (PIA) on January 23, 1984. In view of the fact that the member companies of the PIA are responsible for the production of approximately 90% of the ram-air parachutes in the world, it is anticipated that this document will become the defacto standard for the rest of the parachute community as well. Provisions have been made for periodic revisions of this document; inputs concerning revisions and additions are welcome and should be submitted to:

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The construction details shown on the accompanying drawing are not intended to imply that the information provided is the only way to manufacture the part.

NOTE: The referenced figures are at: http://WWW.PIA.COM/piapubs/TSDocuments/TS100-AT.pdf

Definitions

Airfoil Section Area: The cross sectional area of a given rib (airfoil) section; must specify which rib and cut and/or finished area. Used for calculations of pack volume and internal volume of canopy. Figure 3a.

Angle of Attack: The angle formed between the flight path and the chord line. The Greek letter alpha (a) is used to denote the angle of attack. See fig. 5.

Angle of Trim: The angle formed between the reference line and the trim line; or also found as the angle formed between the plumb line and the trim line minus 90 is called the

angle of trim or trim angle. The 90 value is used to rotate the plumb line into an orientation that is equivalent to aircraft usage. See fig. 5.

Angle of Incidence: The angle formed between the reference line and the chord line; or also found as the angle formed between the plumb line and the chord line minus 90 is called the angle of incidence. The 90 value is used to rotate the plumb line into an orientation that is equivalent to aircraft usage. See fig. 5.

Aspect Ratio: Standard definition; Span2/area; which for a rectangular planform reduces to span/chord.

Cascade Line: A suspension line that joins another line (usually in the same set) below the canopy surface but above the connector link which results in a shorter total line length for the parachute. Figure 1.

Cell: The compartment formed by the top and bottom surfaces and two adjacent load bearing ribs. Each cell is usually divided by a non-load bearing rib to form two half cells. Cells are numbered from left-to-right by full-cell number; use left (L) and right (R) to designate the appropriate half cell. Figure 1.

Chord: Standard definition: The chord is measured (in a straight line) from the farthest forward point to farthest aft point on the airfoil section. Measured with the canopy laid flat on side with very light tension and as many wrinkles removed as practical. If the chord is not constant, an average chord may be specified or the chord at each loaded rib may be specified; must also specify design (cut dimensions less seam allowance) or finished dimensions. Figure 2.

Control Lines: Control Lines (also known as steering or brake lines) are used to steer and modulate the forward speed of the parachute. Control lines are usually fastened to the trailing edge of the canopy, usually in distinct left and right groups, and are commonly constructed as upper and lower sections; the upper section typically consists of two to five lines per side that converge and join to a single lower control line per side. The lower portion of each set of the control lines is usually routed through a guide ring on the back of the corresponding rear riser and fastened to a control toggle. Control lines are named by left or right sets and numbered sequentially from outside to inside and are usually attached to the trailing edge at the intersection of the rib seams which are also numbered sequentially (at the trailing edge only) from the outside to the inside. Note that the seam number and the control line number attached to it do not necessarily have to match: e.g. control lines 1,2,3,4 may be attached to seams 1, 3, 5, 7. Figure 1, 3a.

Control Line Deflection: Control inputs should be expressed in inches deflected downward from the full up position. Alternately, control deflections may be expressed as a percentage of the full control stroke required to stall (steady state) the parachute: i.e. 100% = stall, 0% = no deflection. Note that full-flight setting, toggle length, riser length and suspension line lengths (and trim) can affect the available control stroke; any

specifications for control stroke should also include the specifications for the above items. Figure 3a.

Construction, Chordwise: This is the most common type of ram-air parachute construction. The top and bottom surfaces are assembled from panels that run from front to rear (chordwise) and are joined to the ribs and each other using a variety of sewn seams. Listed below are several variations on this method.

Construction, Full-Cell Chordwise: Top and bottom surfaces are cut to the full width of the cell (plus seam allowance). There are two basic types of full- cell construction:

I-Beam: Full-cell construction in which the top and bottom surfaces are joined to each other at the seams with the loaded ribs. The non-loaded ribs are typically joined to the top and bottom surfaces between the loaded ribs using a flat rolled seam. Figure 4b.
Interlocking T-Beam: Full-cell construction in which the top surfaces are joined to each other at the seams with the non-loaded ribs and the bottom surfaces are joined to each other at the seams with the loaded ribs. Note that this technique will have a half-cell panel at each end of the top surface. Figure 4c.
Half-Cell Chordwise: Top and bottom surfaces are cut to the width of the half-cells and joined to each other at all rib seams. Figure 4c.

Construction, Spanwise: The top and bottom surfaces are assembled from panels that run from side to side (spanwise) across the full width of the canopy. This usually requires three or four panels each for the top and bottom surfaces. Figure 4d.

Cross-Ports: Small holes (usually 5 to 15" maximum diameter) cut in the rib sections to balance the air pressure within the cells across the full span of the canopy. Cross-ports are not cut in the outboard rib sections on either end. Figure 2.

Deployment Brakes: (D-brakes) Used to prevent canopy surge during opening and to provide more reliable openings. The deployment brakes are usually set by pulling the control lines (and thus the trailing edge of the canopy) down to a predetermined point and temporarily fastening them into place at that point; after opening, the user can either leave the deployment brakes set or release them to allow the canopy to achieve full glide. The deployment brake setting should be referenced to the bottom of the leading edge; such as four inches above the bottom of the leading edge, three inches below, etc. Measurements should be taken from the bottom of the rib seam at the line attachment point to the trailing edge at the control line attachment point, with the trailing edge folded over to the leading edge so that the trailing edge lines lay on top of the leading edge lines. If the upper control lines are not all the same length, the reference line must be specified.

Flares, Suspension Line Attachment: Flares are used on some canopies to eliminate the load tapes on the ribs. The flares usually take the form of a catenary curve between the line attachment locations. Figure 3b.

Full-Flight Setting: The setting of the trailing edge with the control toggles in the full up positions should be given as a distance above or below the bottom of the leading edge (same reference method as deployment brakes). Also note that the reference control line must be specified: e.g. upper control line #3 set to 4" above the bottom of the leading edge. Figure 3a.

Glide Path (Flight Path) Angle: The angle formed between the glide path of the parachute/payload and the horizon. Note that gliding flight has a negative value by convention. The Greek letter gamma ( ) is used to denote the flight path angle.

Pilot Chute Controlled Reefing (PCR): Any of the several types of ram air parachute reefing systems that use the drag of the pilot chute to modulate the opening rate of the canopy. Due to the wide variety of implementations, one should give a brief description of the system and operation when referring to PCR systems.

Planform: Defined as the overall shape of the wing using the top view perpendicular to the chord line with the canopy laid flat.

Planform Area: Defined as the product of the finished chord times the finished span of the canopy.

Plumb Line: The plumb line is the straight line formed by using the quarter chord point and the connector links (all stacked on top of each other) as endpoints. This is equivalent to (but rotated 90) to the centerline used in aircraft as the reference line. The plumb line is used only to locate a reference system that may be quickly and easily determined for any parachute.

Projected Area: The area of the inflated canopy as view from above, perpendicular to the chord line at the centerline of the parachute. Due to canopy curvature and cell inflation bulging the projected area is always smaller than the planform area.

Quarter Chord Point: The quarter chord point is located 25% of the distance from the leading edge to the trailing edge along the chord line, which is the straight line between the farthest forward and farthest aft points on the airfoil section.

Reference Line: The reference line passes through the quarter chord point at a right angle to the plumb line. Usage is equivalent to aircraft practice of using the aircraft centerline as a reference line.

Ribs: The sections of fabric installed between the top and bottom surfaces of the canopy and used to establish the airfoil shaped of the canopy. Most canopies have both loaded and non-loaded ribs. The suspension lines are attached to the loaded ribs at the line attachment points. Loaded ribs are numbered from left- to-right to correspond to the suspension line number; non-loaded ribs are numbered from left-to-right to correspond to full-cell number. Figure 2.

Riser Specifications: Should include overall length (specify finished or cut), type of webbing, type of connector links to be used, stitch patterns, thread, riser release mechanism, etc. The normal position for the control line guide ring is on the back side of the rear risers; the top of the control ring should be located 4" (1/16) from the canopy end of the riser. Risers using Velcro to hold the control toggles in place should use the hook Velcro on the riser and the loop Velcro on the toggle; the hook Velcro should be 1" x 5" and should start 1" below the bottom of the guide ring, centered under the ring. Figure 1.

Slider (Sail Slider): Used as a reefing device on ram-air parachutes. During deployment, the canopy is reefed as the spreading force of the canopy is resisted by the slider which is held up against the lower surface of the canopy by the airflow. Usually consists of a rectangular section of canopy cloth reinforced on the edges with lightweight webbing or tape with a large grommet or D-ring installed at each corner. Suspension lines (and control lines) from the individual riser groups are routed through the corresponding grommet in the slider. During packing, the slider is pulled up against the bottom of the canopy. Figure 1.

Slider Stops: Small pieces of rigid material (plastic, phenolic, etc.) that are installed on the lower edges of the stabilizer panels to prevent the grommets on the slider from riding up over the stabilizer material and damaging the stabilizers or the slider. A corresponding item known as a slider bumper is installed at the lower end of the suspension lines to prevent damage to the slider grommets caused by the slider contacting the connector links.

Stabilizer Panels: Stabilizer panels are installed on the ends of the canopy and act much as an end plate on an aircraft wing; stabilizers typically run from near the leading edge to near the trailing edge of the canopy; on many canopies the stabilizer is rolled into the outside lower rib seam during construction. Figure 2.

Span: Measured parallel to the leading edge of the top surface, 6" behind the leading edge, with minimal tension (5 lb. or less); if the length of the trailing edge is not the same as the length of the leading edge, an average span or separate leading and tailing edge dimensions may be given and must be specified. Measurements shall be made with 10 pounds-force (or less) tension on the area being measured; at standard atmospheric conditions. Figure 2.

Suspension Lines: Carry the load from the canopy surface to the risers. The lines are numbered by set number from left-to-right and by row letter from front to rear. For example, a canopy with seven cells will normally have eight sets of (usually) three or four rows; thus:

- **Line 1A** is the left front suspension line.
- **Line 8A** is the right front suspension line.
- **Line 1D** is the left rear suspension line (with four rows).
- **Line 8B** is in the second row on the right side.

Note that some canopies may have cascaded lines in order to reduce bulk; i.e. B cascade to A; D cascade to C. The names of the lines are the same.

Suspension Line Lengths: May be given as a leading edge line length and trim dimensions or as a complete set of dimensions. Trim dimensions should be given as a difference in length between one row of lines and the next; A to B, B to C, C to D, etc. For canopies that do not have all the lines in a given row set to the same length the trim dimensions should be given as a complete set of lengths for the line set. Normally all the lines in a given row are the same length; thus, a specification giving leading edge line length, trim dimensions, cascade lengths (as required), deployment brake setting, full flight setting, and upper/lower control line lengths is sufficient to determine all the line lengths on the parachute. Specifications for trim/length dimensions should also include a total overall tolerance for the trim dimensions to avoid accumulation of tolerances. Note that the trim measurements should be taken from the bottom of the rib seam at the line attachment point in order to avoid problems due to differences in the length of the line attachment tapes, type or knot, etc. Figures 1, 2, 3a.

Tapes, Reinforcement: Different types of tape may be used in each of the locations described below (all Figure 2):

- **Load Tapes:** Also known as V-tapes on those canopies which place the tapes in a "V" pattern. Found on the loaded ribs only. Used to distribute loads from the line attachment tapes into the canopy.
- **Rib Leading Edge Tapes:** Found in the leading edge of each rib section.
- **Leading Edge Tapes:** Found in the leading edge of the top and bottom surfaces.
- **Trailing Edge Tape:** Found in the trailing edge seam; usually rolled into the seam.
- **Line Attachment Tapes:** Sewn to the bottom edge of the loaded ribs in alignment with the load tapes; used to transfer the load from the lines to the load tapes. Some canopies use line attachment tapes that continue onto the loaded rib thus taking the place of the load tapes.
- **Cross Tapes:** Reinforcing tapes that run spanwise on the top or bottom surface to distribute concentrated loads into the canopy.
- **Bridle Attachment Tapes:** Used to attach the pilot chute bridle to the top (usually) of the canopy. Most often is tied into the other reinforcing tapes in the canopy in order to distribute the loads.

Trim Line: The trim line is the straight line formed using the farthest forward and farthest aft line attachment points (not control line attachment points) as endpoints. Note that this eliminates the effects of a curved bottom surface when specifying trim angle; however, the trim measurements are still required for an accurate specification. The trailing edge may be used as the aft reference point only if it is not used as a control surface or deployment aid.

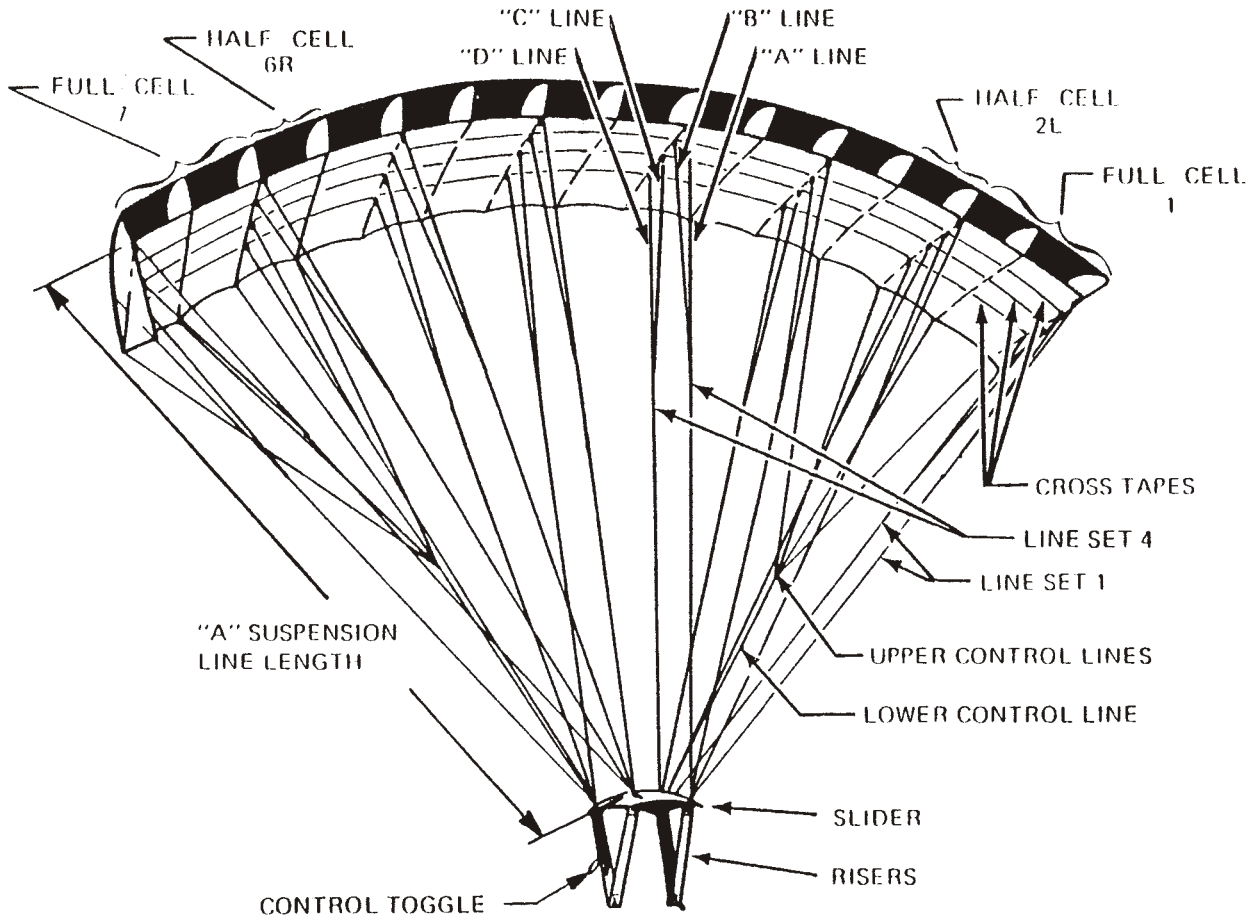
Toggles, Control: Control (steering) toggles are attached to the bottom end of the lower control lines to allow the jumper an adequate handhold on the control lines. May consist

of a wide variety of configurations of webbing or hard plastic T-handles. Where required or critical, a drawing of the control toggle should be supplied. Figure 1.

Trim Measurements: See suspension lines measurements. Figure 3a.

Note: See Figures 1-5 in Attachment I: http://WWW.PIA.COM/piapubs/TSDocuments/TS100-AT.pdf

TS-100: Standardized Nomenclature for Ram-Air Inflated Gliding Parachutes



NOTE: IN THIS VIEW
"B"--LINES ARE CASCADED TO "A" LINES
"D"--LINES ARE CASCADED TO "C" LINES

NOTE: ALL NUMBERING/LETTERING PRECEDENCE IS LEFT TO RIGHT AND FRONT TO REAR (RELATIVE TO DIRECTION OF FLIGHT)

FIGURE 1

Attachment I

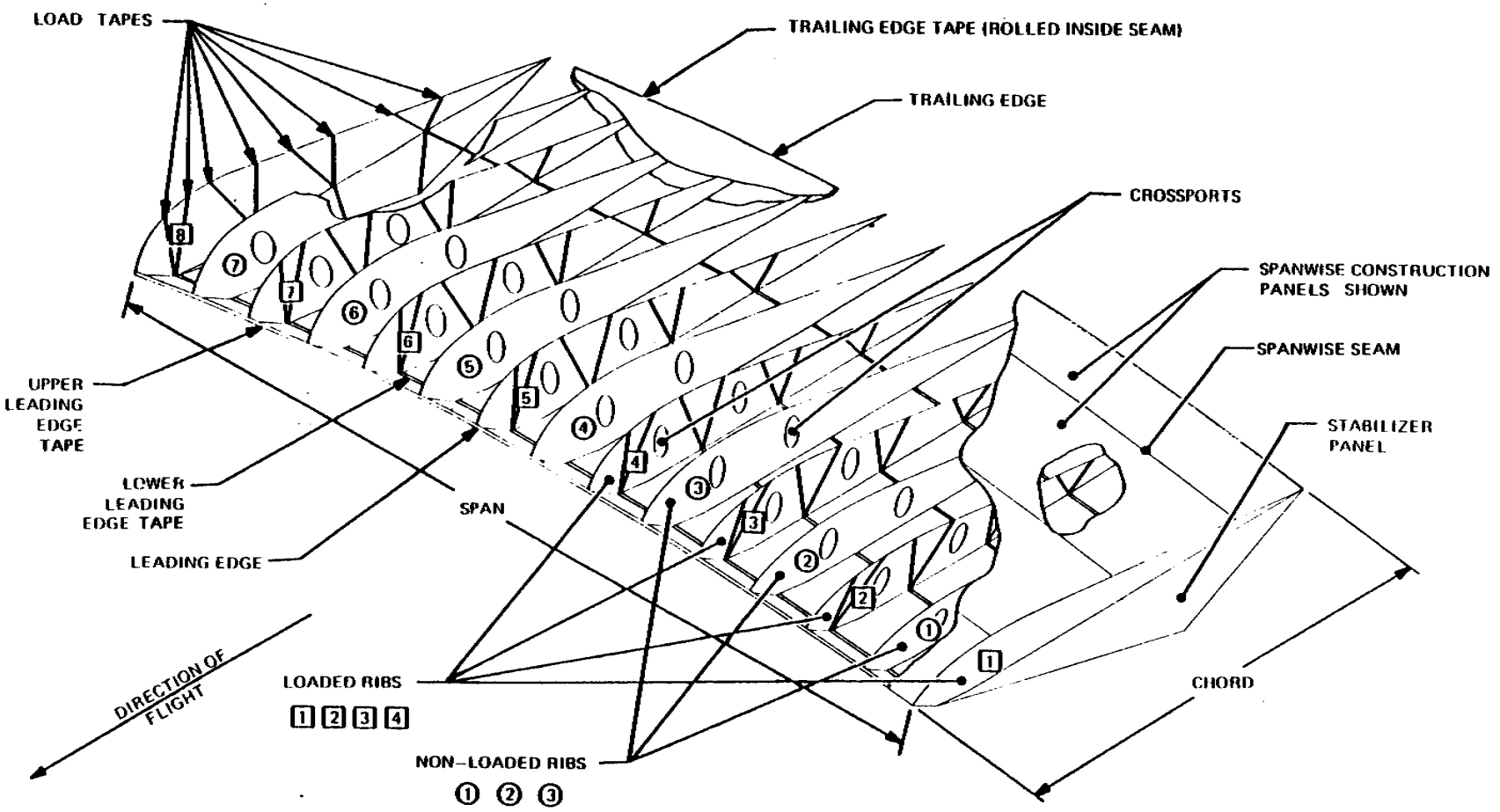
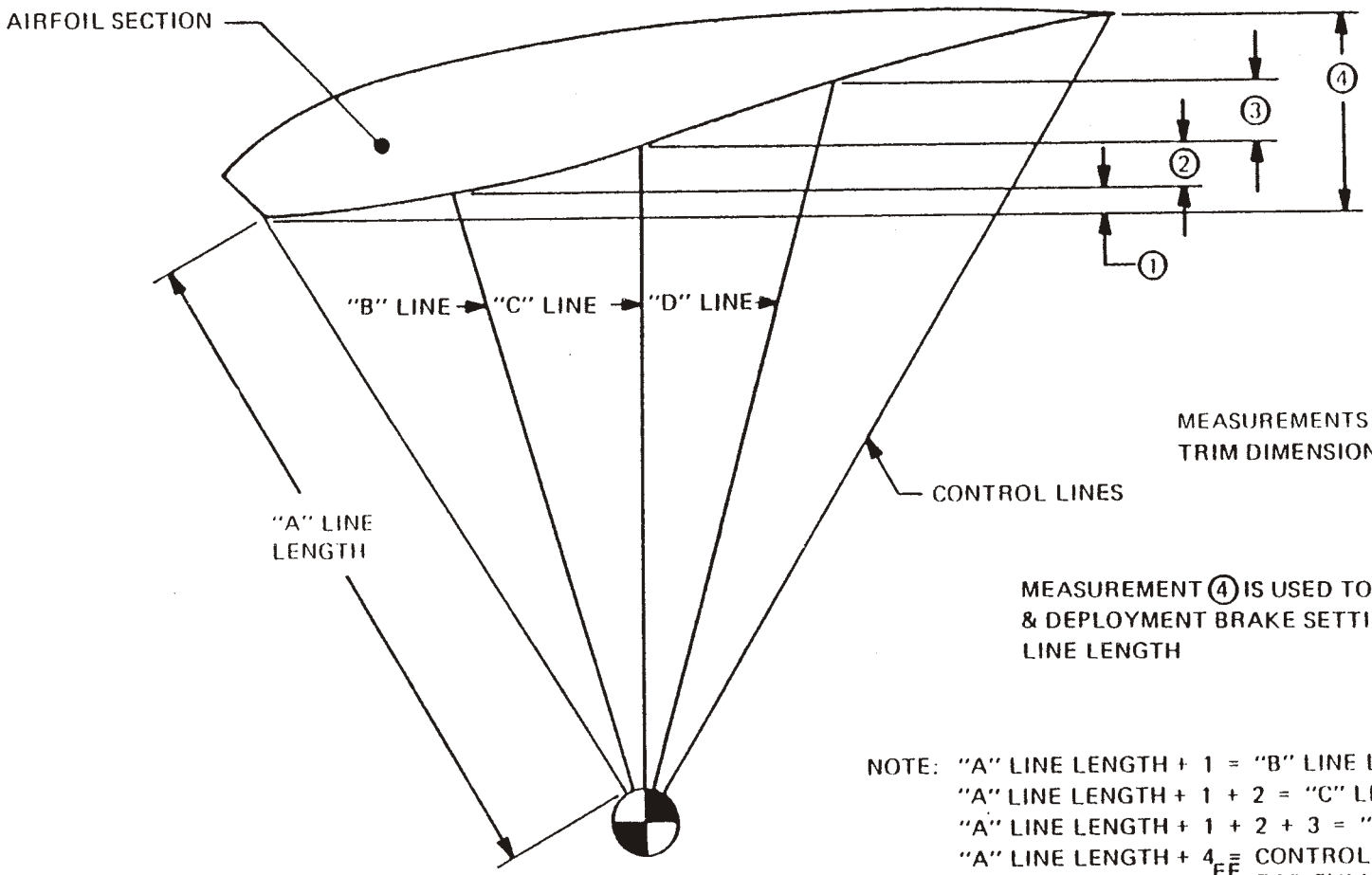

LOAD TAPES
TRAILING EDGE TAPE (ROLLED INSIDE SEAM)
TRAILING EDGE
CROSSPORTS
SPANWISE CONSTRUCTION PANELS SHOWN
SPANWISE SEAM
STABILIZER PANEL
UPPER LEADING EDGE TAPE
LOWER LEADING EDGE TAPE
LEADING EDGE
SPAN
CHORD
DIRECTION OF FLIGHT
LOADED RIBS
1 2 3 4
NON-LOADED RIBS
① ② ③

FIGURE 2

LOADED RIB WITH DIRECTLY ATTACHED SUSPENSION LINES SHOWING
SUSPENSION LINE MEASUREMENTS AND TRIM DIMENSIONS



MEASUREMENTS ① ② ③ ARE TRIM DIMENSIONS

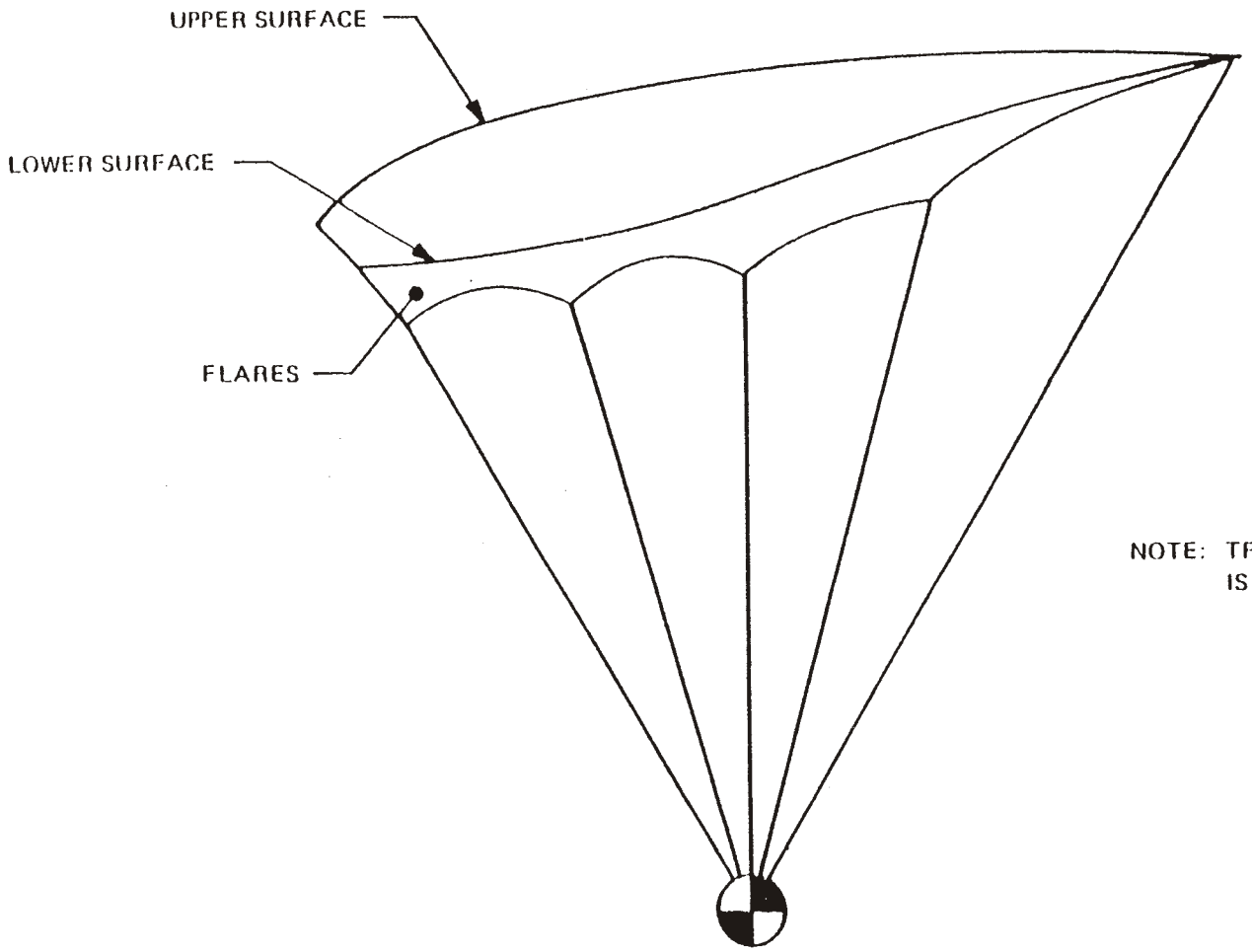
MEASUREMENT ④ IS USED TO SPECIFY FULL FLIGHT & DEPLOYMENT BRAKE SETTING RELATIVE TO "A" LINE LENGTH

NOTE: "A" LINE LENGTH + 1 = "B" LINE LENGTH
"A" LINE LENGTH + 1 + 2 = "C" LINE LENGTH
"A" LINE LENGTH + 1 + 2 + 3 = "D" LINE LENGTH
"A" LINE LENGTH + 4_{FF} = CONTROL LINE LENGTH FOR FULL-FLIGHT SETTING
"A" LINE LENGTH + 4_{DB} = CONTROL LINE LENGTH FOR DEPLOYMENT BRAKE SETTING

NOTE: IN THIS VIEW SUSPENSION LINES ARE NOT CASCADED

FIGURE 3a

LOADED RIB USING FLARES FOR SUSPENSION LINE ATTACHMENTS



NOTE: TRIM AND RIGGING INFORMATION
IS THE SAME AS SHOWN IN FIGURE 3a.

FIGURE 3b

HALF CELL CHORDWISE CONSTRUCTION

SECTION VIEW FROM FRONT

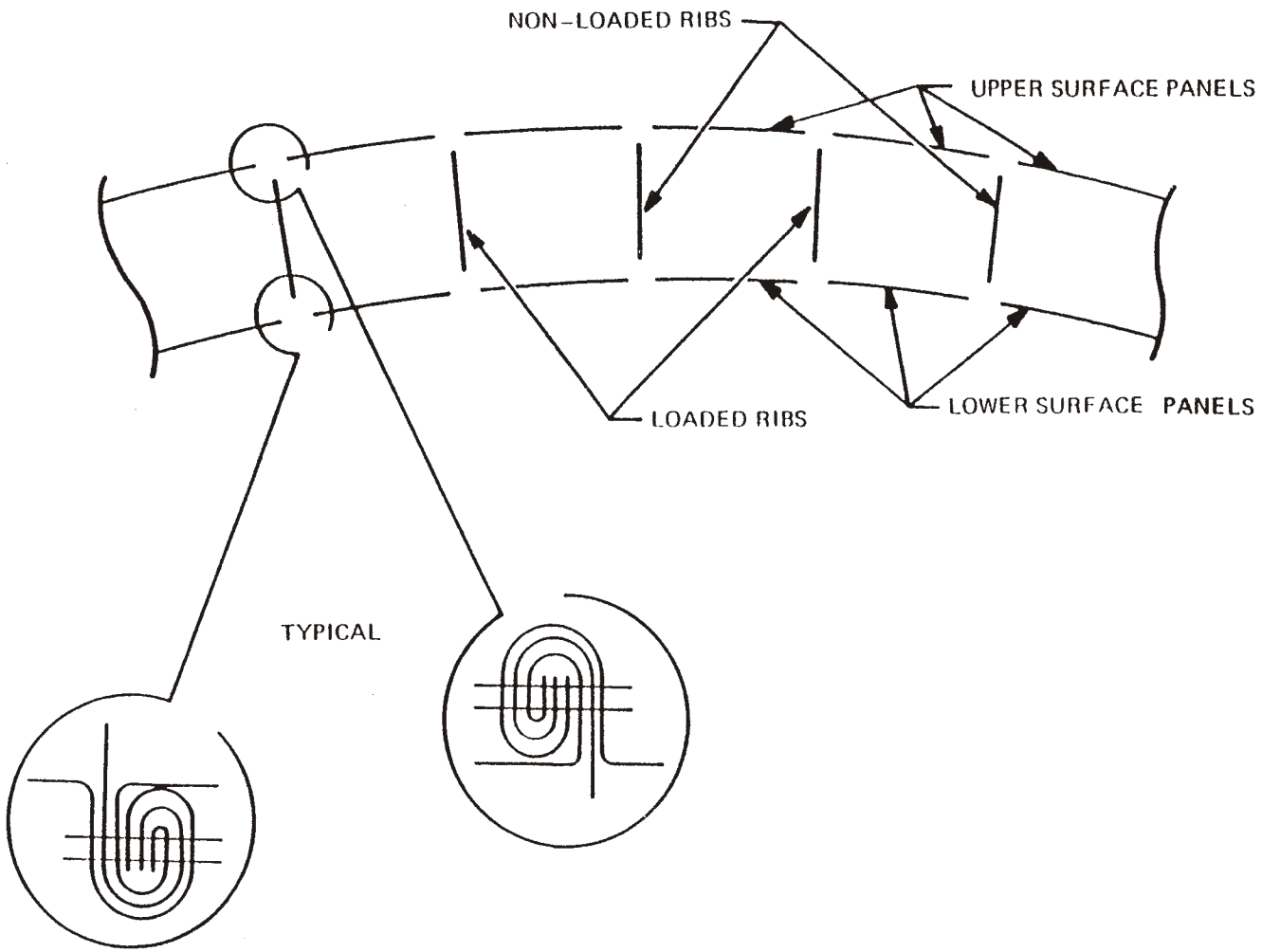


FIGURE 4a

FULL CELL CHORDWISE CONSTRUCTION "I" BEAM"

SECTION VIEW FROM FRONT

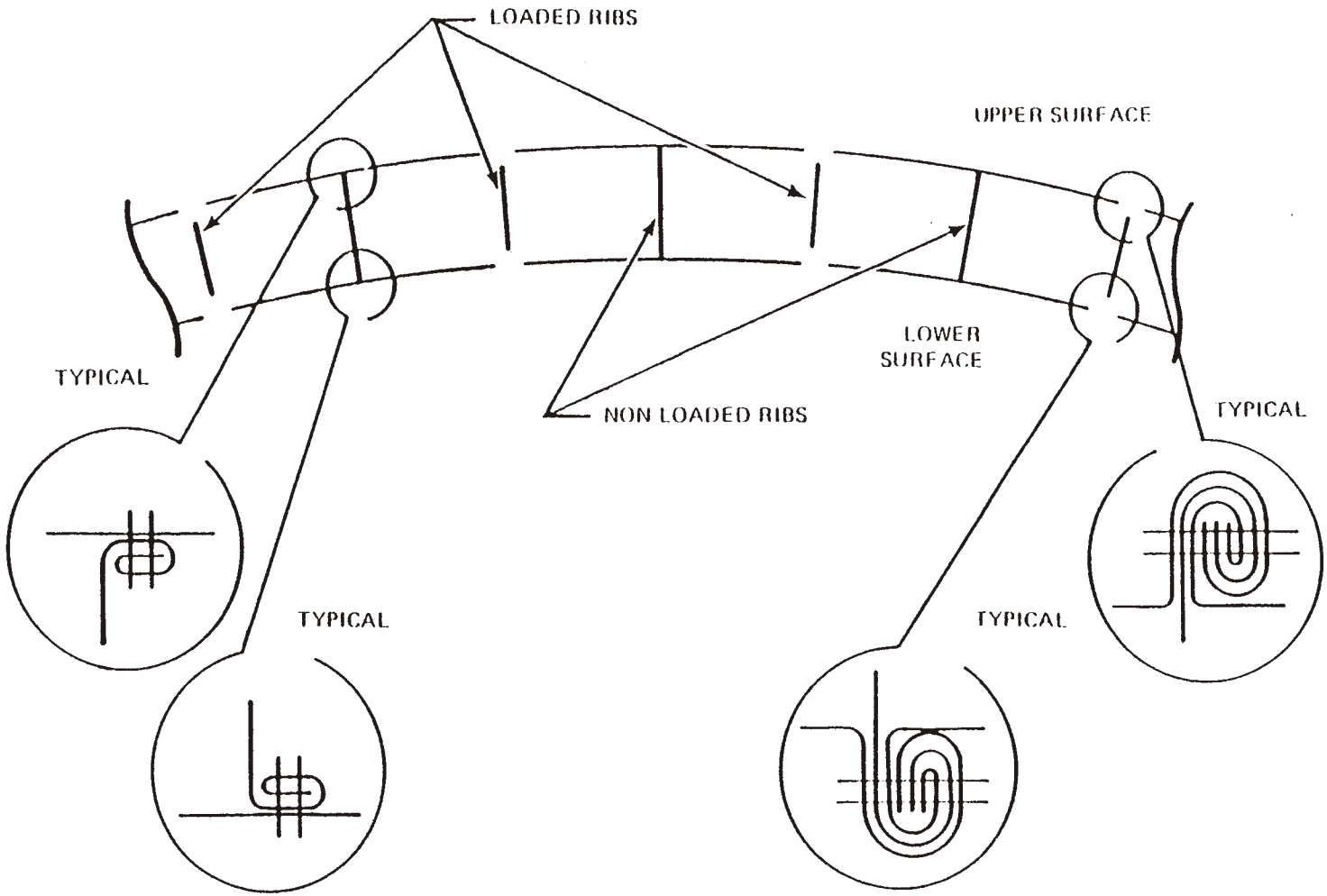


FIGURE 4b

FULL CELL CONSTRUCTION

INTERLOCKING "T" - BEAM

SECTION VIEW FROM FRONT

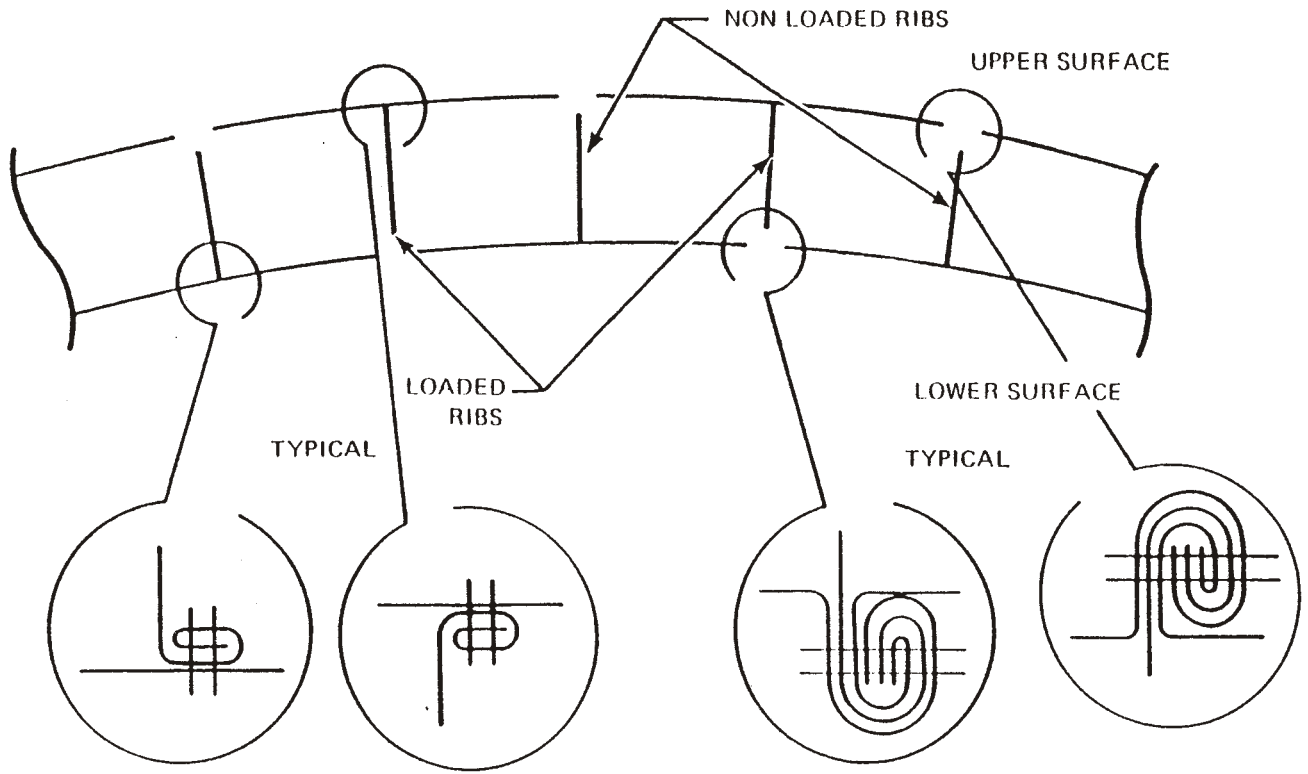


FIGURE 4c

SPANWISE CONSTRUCTION

SECTION VIEW FROM FRONT

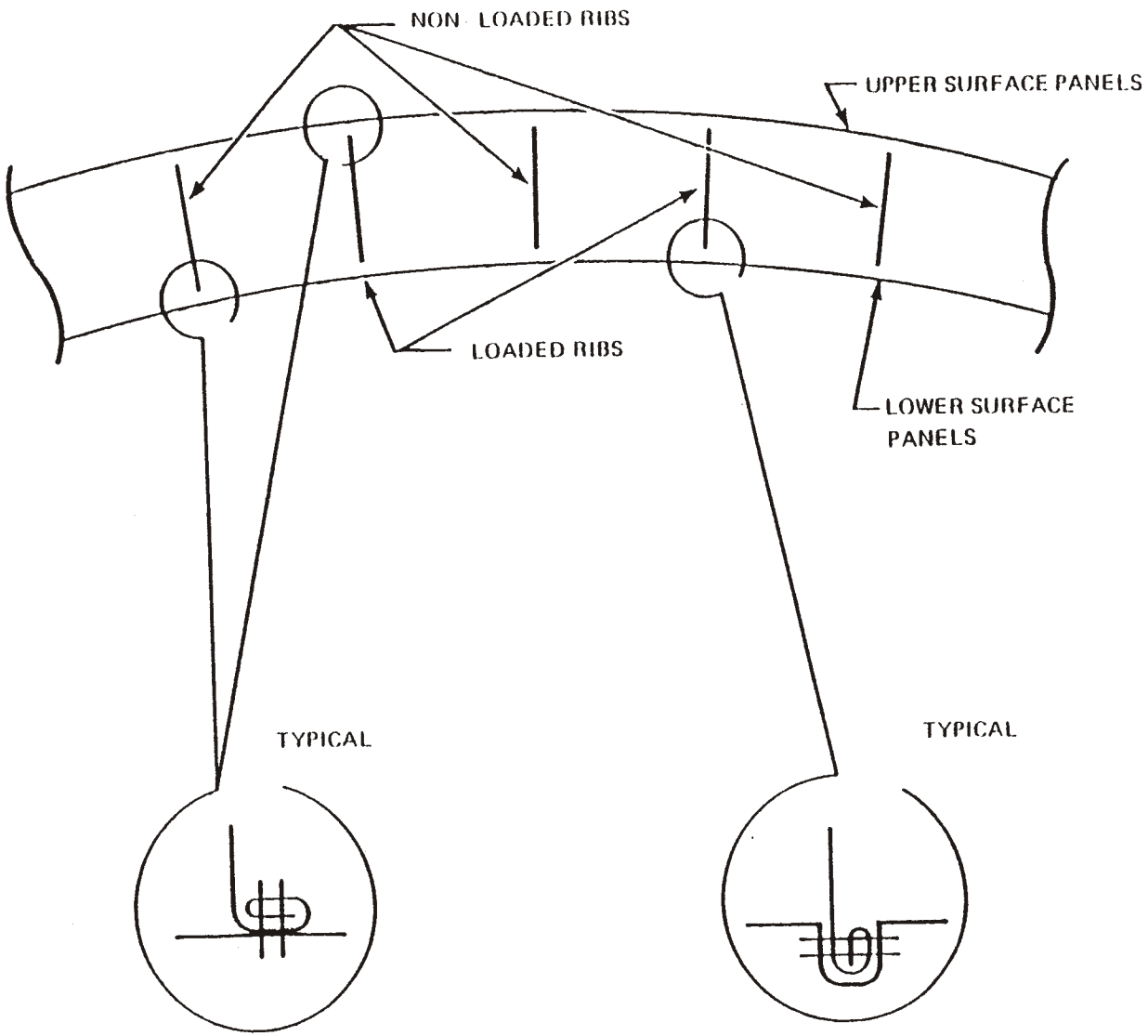
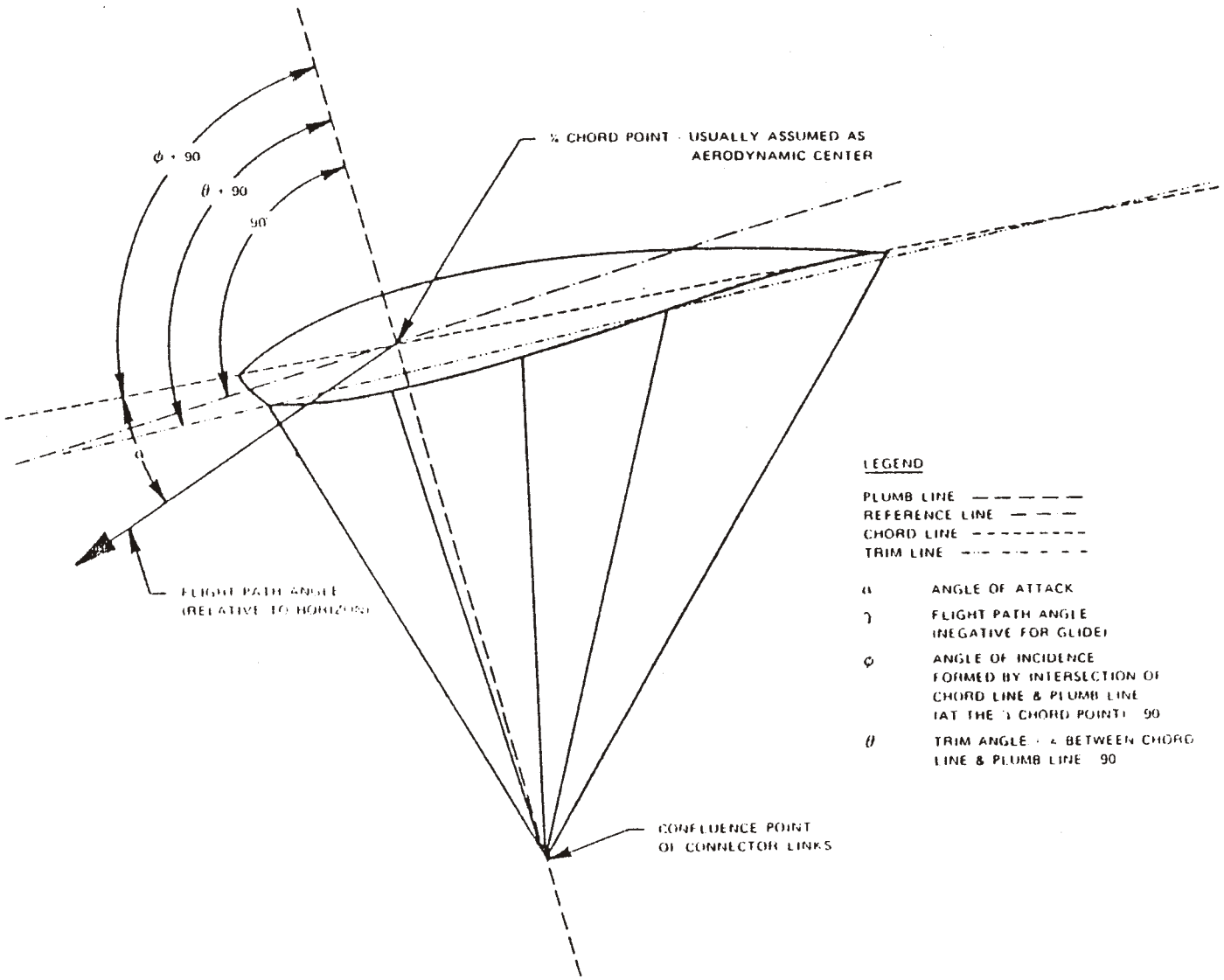


FIGURE 4d



Attachment I
Figure 5