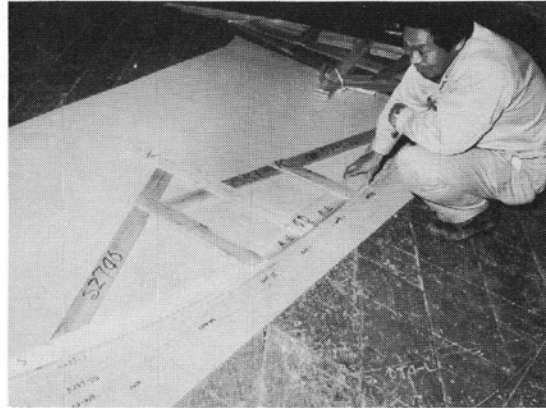
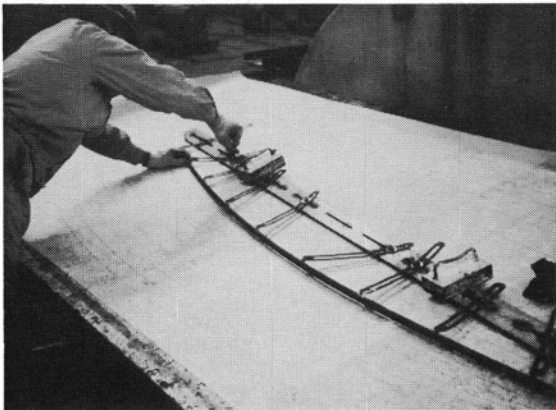


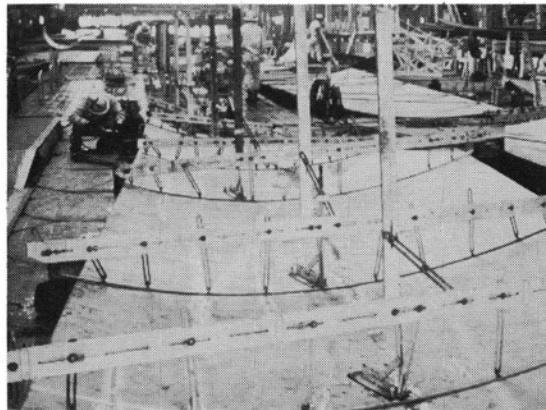
A.



B.



C.



D.

FIGURE 6-7: A. Semi-automatic (shown) and manual line heating methods are applied as controlled work processes for forming curved plates. Similar techniques are also used after rolling or bending to refine the curvature achieved. Line heating is not limited by furnace size, as for forming by a blacksmith, nor limited by press and roller capacities. Thus, line heating is being applied to increasingly wider and longer plates as a means for reducing the lineal footage of welding required and associated shrinkage which complicates A/C.

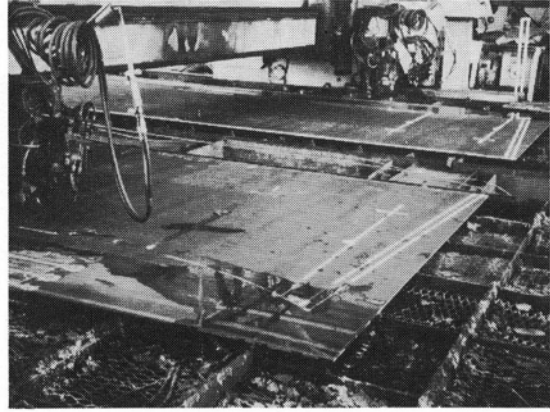
B. Loftsmen prepare for each part, a family of sight-line templates on a single Mylar sheet and thereafter, as one option, reproduce the templates in wood. A sight-line mark, within the “<” mark near the top of the vertical member, coincides with a reference line for the finished part. Match marks near the template ends coincide with plate edges. A station number and an angle of inclination relative to the finished-part surface are noted on each template.

C. Some part-fabrication shops directly employ a “Mylar” for setting a family of adjustable sight-line templates.

D. The accuracy of transverse curvature is checked by measuring distances between curved template edges and a plate surface at specific check points. Longitudinal curvature is checked by measuring the distance between each sight-line mark and a taut string rigged to represent a reference line.



A.



B.



C.

FIGURE 6-8: A/C engineers establish requirements for reference lines 50 millimeters back from cutting lines. Samples of such measurements are recorded in order to determine their standard deviations as the accuracy of reference lines contribute to merged variation.

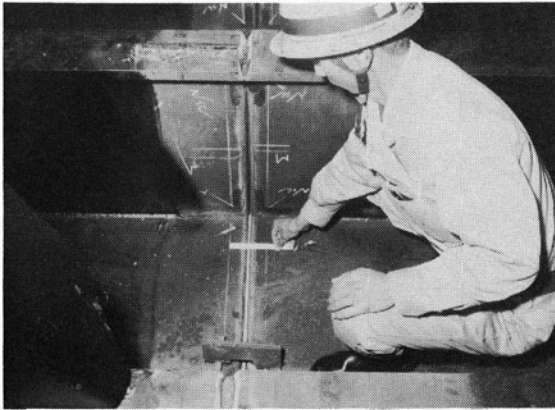
A. A reference line is self-checked to verify that it is 50 millimeters from the marked cutting-line. The jig in the foreground was developed specifically to enhance accuracy for marking reference lines on flat-bar ends.

B. Reference lines are also included in N/C marking instructions so they appear parallel to edges which will be cut and that contribute to merged variation. Measurements of the distance between a cut line and its reference line are used to monitor accuracy of the machine.

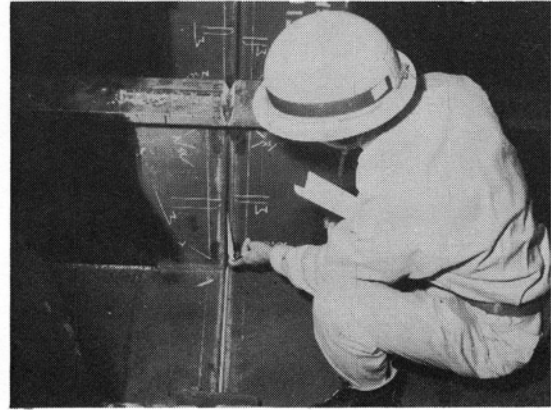
C. After cutting, measurements between a cut edge and its reference line are made and recorded (not shown). Since reference lines exist for such purposes, they are used as shown for setting an adjustable mono-rail for semi-automatic cutting a long "slow" curve.



A.



B.



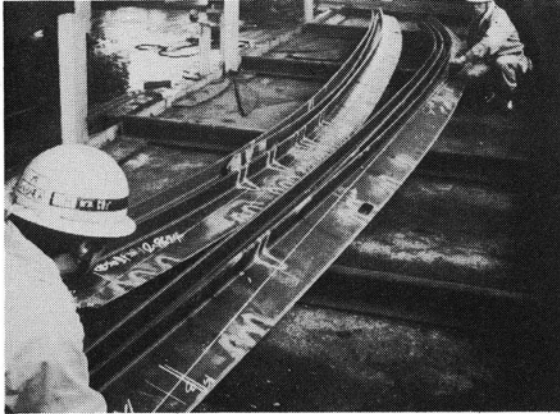
C.

FIGURE 6-9: During sub-block assembly, block assembly and hull erection, measurements of the distances between reference lines, and from reference lines to parts, are obtained and recorded just before and after welding. Analyses of such data advises A/C engineers of fitting accuracies and shrinkages actually being experienced.

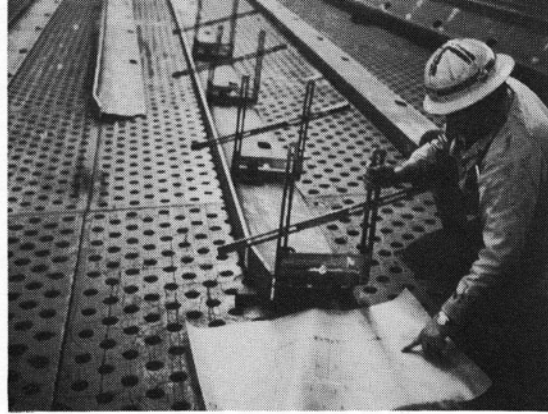
A. Measuring between reference lines after welding plates to create a panel during block assembly.

B. An A/C engineer demonstrates measuring between reference lines just before an erection-joint gap is to be welded. The scale being used is sized and graduated just for this purpose and is attached by a key ring to a graduated, thin wedge used to measure gap widths.

C. Demonstrating how to measure gap width in a bottom longitudinal. The butt-joint gaps for the two longitudinals which can be seen do not require rework. The gap in the bottom shell is already prepared for rework by back-strip welding.



A.

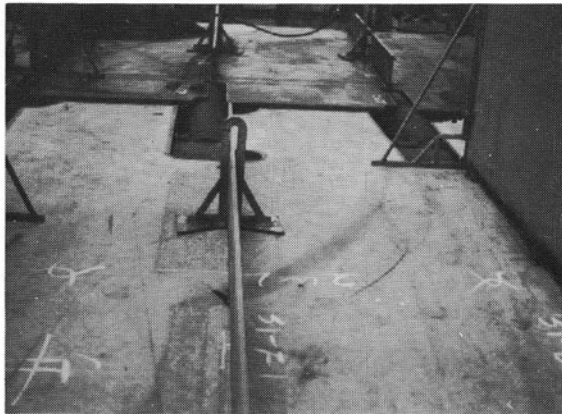


B.

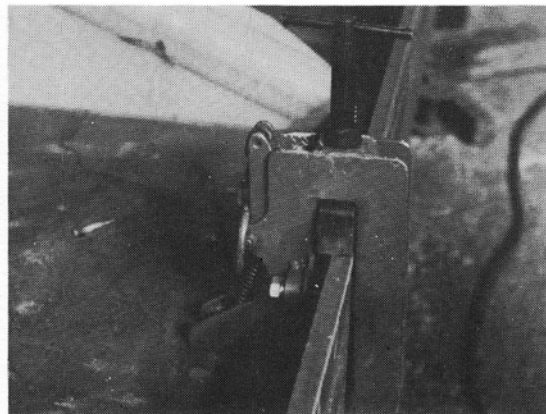
FIGURE 6-10: Loftsmen calculate vital dimensions and provide for vital points, reference lines and check points as specified by A/C engineers and incorporated in work instructions.

A. Inverse curves which were marked on straight members become straight lines when specified bending is achieved. After self checks, part-fabrication shop supervisors measure and record deviations using a taut string as a reference.

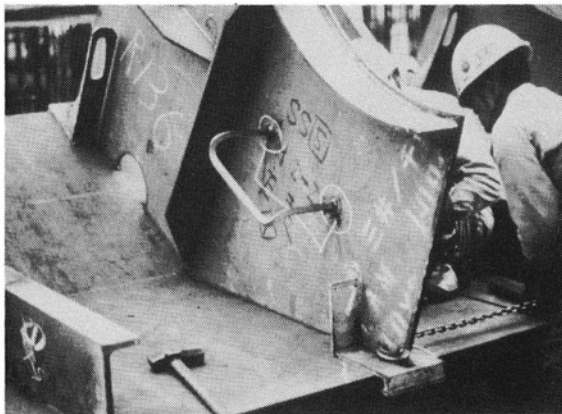
B. For twisting a longitudinal that is already curved, loftsmen prepare a family of sight-line templates on a single Mylar sheet. This is used by part-fabrication worker for adjusting special templates to be set at specific stations on the longitudinal. A white sight-line mark appears on the adjustable bar of each template. Twisting is performed by line heating until all sight-line marks match a taut string. Subsequent measuring to establish the accuracy being achieved for combined bending and twisting employs the same sight-line method.



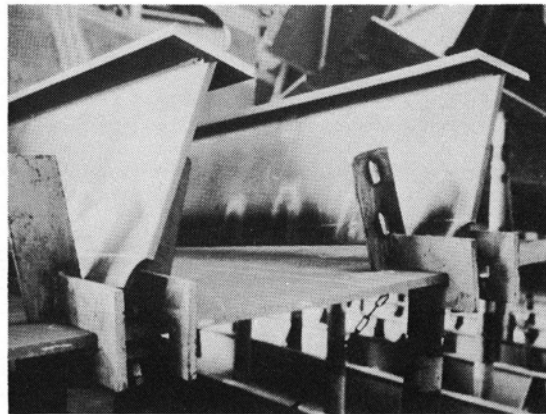
A.



B.



C.



D.

FIGURE 6-11: Prudent A/C engineers assigned within a hull construction department maintain good rapport with supervisors and their workers. When variation merging equations identify a particular work process which needs to be improved such rapport leads to effective innovations; e.g., numerous simple jigs which significantly reduce ranges of variation.

A. Simple jigs support flat bars during the fitting process.

B. A jig which supports a flange during fitting to a web, is equipped with a screw for making fine adjustments.

C. Two relatively easy to make jigs align a small sub-block vertically and simultaneously fix the sub-block at the prescribed distance from the panel edge.

D. Jigs are used to fit longitudinals at prescribed angles during curved-block assembly. The jigs are designed so that they are suitable for use on both forward or aft panel edges, and also on both port and starboard blocks.