Blade Area Ratio Defined

A HydroComp Technical Report
Report 135

OVERVIEW

Blade area ratio, or BAR, is a parameter used to relate the size of a propeller blade to its diameter. It is critical to the control of cavitation and changes to BAR affect its efficiency and thrust-making performance.

The generic term or "BAR", however, does not sufficiently describe the blade area ratio. In fact, there are three types of BAR – *Projected*, *Developed* and *Expanded*.

CALCULATION OF AREA RATIO

For all three types, the appropriate total blade **area** outside of the hub is divided by the propeller disk area (e.g., πR^2) to derive the area **ratio**.

DEFINITIONS

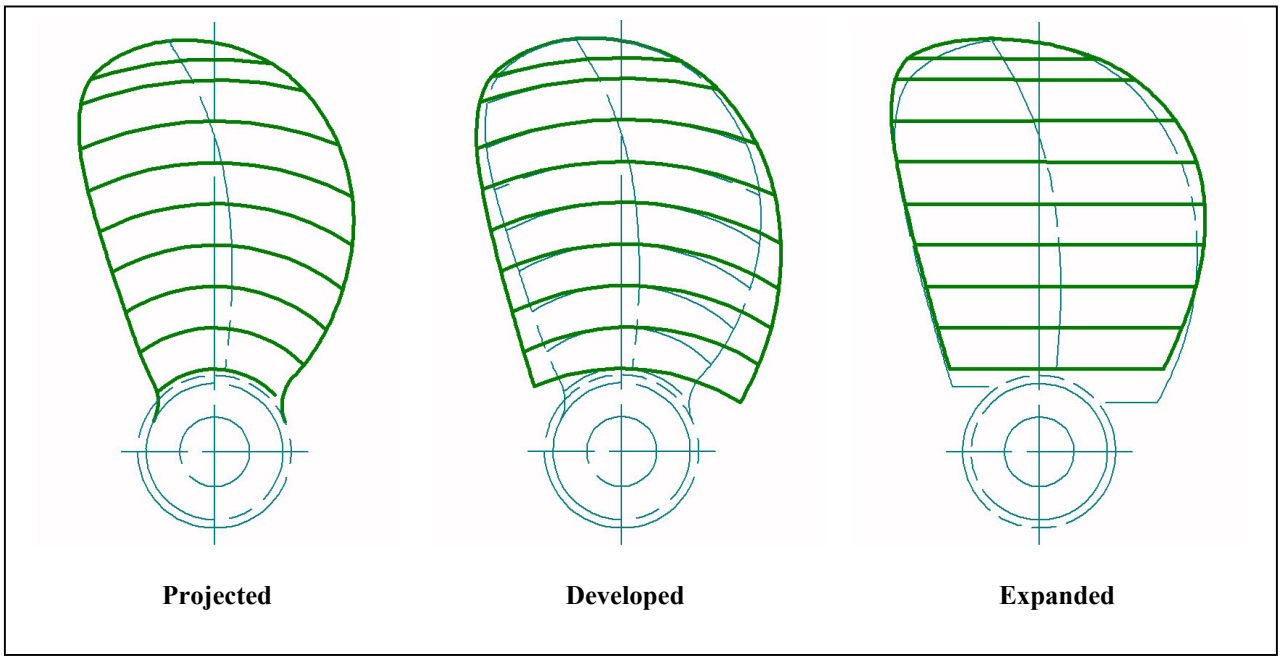
The three graphics shown below illustrate the three different types of BAR for a common propeller.

Projected Area Ratio (PAR)

The *Projected* view is the one you see when you look down on the propeller. The Projected area is the area of the outline as projected onto a surface below. Projected area ratio is the smallest of the three.

Developed Area Ratio (DAR)

Developed area is the area of the blade outline if it could be *untwisted* (i.e., as if the whole blade were unattached from the hub and brought to zero pitch).



Projected **Developed** **Expanded**

Expanded Area Ratio (EAR)

Expanded area is what if found if the Developed area could be flexibly unwrapped on a flat surface so that all sections were parallel. Expanded area is what is important to propeller designers, to treat the propeller blade like a wing. In other words, the Expanded view converts the propeller from its helix to a flat plane.

Expanded area ratio is typically close in magnitude to Developed area ratio, and is often used interchangeably.

CONVERSION

You can use the the following formula to find approximate conversions between the three types of BAR.

D = diameter
P = pitch
Z = number of blades

$$\frac{PAR}{DAR} = 1.067 - 0.229 \times P/D$$

$$\frac{EAR}{DAR} = 0.34\left(2.75 + \frac{DAR}{Z}\right)$$

