

# Benefits of ACDR (Air Cavity Drag Reduction) for Vessels

## Equations and Definitions:

(Ref: "A Generalized Engineering Design Procedure" by Thomas G. Lang, Ph.D.)

$$W = W_o + W_s + W_p + W_f = \text{Vessel Displacement}$$

$W_o$  = payload and outfitting;  $W_s$  = structure and ship systems;  $W_p$  = propulsion system;  $W_f$  = fuel+ system

$W_s = W_s' * W$  where  $W_s'$  = Structural weight ratio

$W_p = K_1 * D * V$  ( $K_1$  = Propulsion system weight constant;  $D$  = Drag;  $V$  = Vessel speed)

$W_f = K_2 * D * R$  ( $K_2$  = Fuel and fuel system weight constant;  $D$  = Drag;  $R$  = Range)

$DRF = (D/W)/(D_1/W_1)$  = Drag reduction factor that provides the calculated results. Model tests are needed to determine actual DRF values.

## Assumptions:

Payload, speed, and range are constant for each type of vessel.

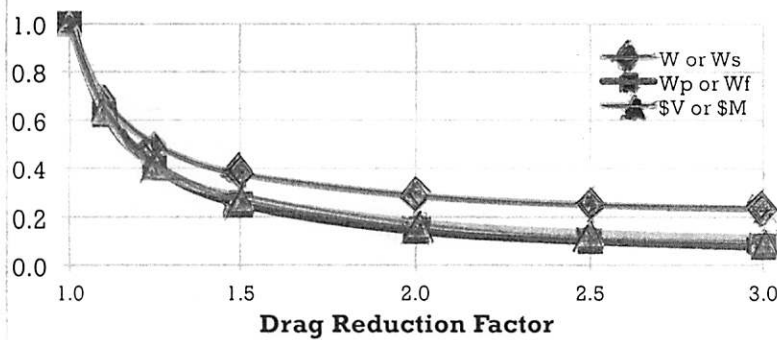
Vessel cost  $\sim W_s + 3W_p$ ; Fuel cost  $\sim$  Fuel used; Maintenance cost  $\sim$  Vessel cost

## Results:

1. ACDR is of greatest benefit for very high speed, high speed vessels, and long range vessels.
2. Cargo vessels benefit most by fuel and propulsion system savings.
3. Limited private model tests indicate that DRF values of around 2.0 are achievable; values up to 3.0 are possible.

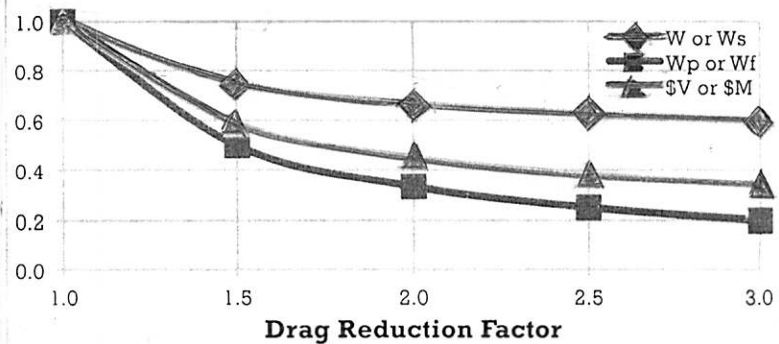
**Very High Speed Vessels (Same V, R, P)**

Original Vessel:  $W_o'=0.10$   $W_p'=0.40$   $W_f'=0.10$   $W_s'=0.40$



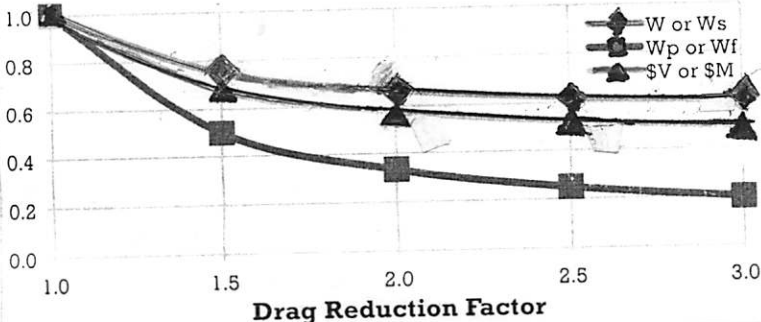
**High Speed Vessels (same V, R, P)**

Original Vessel:  $W_o'=0.30$   $W_p'=0.25$   $W_f'=0.05$   $W_s'=0.40$



**Long Range Vessels (Same V, R, P)**

Original Vessel:  $W_o'=0.30$   $W_p'=0.05$   $W_f'=0.25$   $W_s'=0.40$



**Cargo Vessels (Same V, R, P)**

Original Vessel:  $W_o'=0.75$   $W_p'=0.01$   $W_f'=0.02$   $W_s'=0.22$

