Boat shafting,

Let’s Do the Job Right the first time

I snapped my shaft what's with all the various type of material and do I need to increase the size of the shaft diameter.
There are a myriad of shaft material to select form Monel , Carbon steel, Brass to Naval Bronze. The vast majority of modern shafting utilized today is of the specialty heat treated stainless steel. Not only is it used for boat shafting but in many industrial applications such as pump shafting. It is known by the various trade names Aqualloy 17, 19, 22 Aquamet 17, 19, 22 Nitonic etc.. Lets understand how stainless steel is made. It is a carbon steel base with chromium and nickel added to produce a durable highly corrosion resistant material our typical grade are rated numerically base on there content of chromium and nickel, various grades are 304 , 316, 404 and 416. 316 SS is utilize in many marine application as it is the most corrosion resistant but it is also one of the more expensive 416 is magnetic and is likely to be used for knife blades because it's properties enable it to hold an edge. Most boat shafting is made of a specially treated class 304 SS it is nitride or heat treated with nitrogen ruggedizing it properties giving it better tensional properties

Determining your shaft size is highly important as to heavy and you are wasting resources such as monetary and mass, to small and there is the risk of snapping your shaft leaving you dead in the water. Some prop twisters with years of experience judge the size of the required shaft shearly on the wheel or propeller size. They in turn look at the diameter and pitch and judge approximately the proper shaft size based on years of experience. This is a very seat of the pants calculation and I am sure it has worked for many years but with today's many different material grades there is a more technical arrival at proper shaft diameter. The following formula is used by most machinist’s, mechanic and engineers alike and is relatively easy to compute knowing the shaft horse power transmission gear ratio and wide open throttle speed. Generally, safety factors of 2 are considered adequate for boats intended for light pleasure service. For more severe service-such as racing craft, workboats, diesel powered and gas turbine powered boats – higher design coefficient should be based on experience. The safety factor has always been curious to me but let use trust in the powers that be and say the rule of thumb or acceptable practice or good engineer practice is a value of 5 (five).

With that said let use run through a calculation using the most wildly used shafting used for work boats being Aqualoy 17, as it is with all matters a of machining manufacturing and construction there are always trade off's Aqualloy 17 is a superb selection it is one of the most durable cost effective materials with the trade off of corrosion resistance. Corrosion tends to be a factor when boats sitting idle for a long time hence work boats are not concerned with this draw back of Aqualloy 17 as they have to keep moving in order to survive.

$$\textbf{S.F.} = \frac{D3 \times St \times N}{321{,}000 \times P}$$

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D = Shaft Diameter, Inches
P = Shaft Horsepower
S = Safety Factor
St = Yield Strength, tensional shear, PSIG
N = Shaft Speed

Example for a recent repower:

$$\textbf{S.F.} = \frac{1.5 \times 135{,}000 \times 3200}{321{,}000 \times 420}$$

$$\textbf{S.F.} = \frac{648{,}000{,}000}{134{,}820{,}000}$$

S.F. = 4.81

One Fourteenth rule:

Propeller Diameter 20”

20/14 = 1.43” Diameter shaft

The One – Fourteenth Diameter Rule

The oldest rule of thumb for determining propeller shaft diameter is simply that it be one–fourteenth of the propeller diameter. In spite of its simplicity, this rule works surprisingly well. A 36 inch diameter propeller would require a 2.57 inch shaft, by this method.

The one-fourteenth does not take into account many of the variables in selecting the best propeller shaft and propeller combination. As it does not reflect differences in shaft materials (St: Yield strength)

Surprisingly both the calculation and the rule of thumb method came out with the same results 1.5 inch diameter shaft so for this repower we were able to save significant dollars by not have to upgrade the shaft size and therefore struts and stuffing boxes during this repower!

By Captain Jim Mahoney

Capt. Jim Mahoney is a licensed Marine Engineer of unlimited tonnage and horsepower and served his apprenticeship with the Calhoon Marine Engineering Beneficial Assoc. Graduating form their highly respected school located in Easton Md.