T34C Tech Articles & photos

By

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# Choosing an Engine and Propeller for the T34C

*See Appendix G for enhanced Engine and Propeller detail*

**References:**

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One beautifully sunny afternoon, as Susan and I brought "Temujin" towards St. John's Creek in Solomon's Island, I saw a beautiful wooden yawl anchored just to the starboard side of the thoroughfare.

I said to Susan, "I know that boat; but, can't exactly place it. I've seen it before." Susan is used to hearing this kind of thing; but, humored me, as we motored over towards it and seeing someone coming from the companionway, I called over, "Is that an S&S?"

"It's Santa Maria." came the reply.

"You built her?"

"Yes, from the book!"

"Amazing, she's beautiful, congratulations!"

Some other pleasantries passed between us, and, then I motored on as we were headed to the Holiday Inn pier and a wedding reception.

As we motored along, I explained to my wife, Susan, that the boat we had just seen was designed by Francis Kinney. But, what made it so interesting is that the design is only contained in the book: "Skene's Elements of Yacht Design", an updating by Francis Kinney of principles of yacht design developed many years earlier by Norman Skene.

The fellow took the information in the pages of this book and turned it into a beautiful replica of Francis Kinney's 43' Yawl, "Santa Maria". It is an outstanding and astounding achievement.

Now, for choosing an engine and a propeller, we are going to open the pages of that very same book that was the well spring for a beautiful yawl. And, we are going to see that choosing an engine and propeller, while not as astounding, is rewarding and straight forward.

## Equations for Horsepower:

There are a number of equations that are useful in trying to determine the size and type of engine you select for your boat. We will use them in the discussion which follows to determine what size engine and propeller are desirable for the Tartan 34C.

The first step is to determine the theoretical hull speed of the Tartan 34C. This equation is based on an assessment of the hull's wave making characteristics as a displacement hull. Therefore, the equation is Hull Speed (in knots) = 1.30 x the Square root of the waterline length, or 1.30 x the square root of 25' (5) = 6.50 knots. This is adjusted to mph by multiplying 6.50 x 1.15 = 7.47 (7.5) mph. This adjustment allows use of a number of charts designed to ease the calculation and selection of propellers and pitch.

So, now that we know the hull speed, we must now determine the required shaft horsepower to achieve that hull speed given the overall resistance the hull makes as it goes through the water.

**Chart 1** (See appendix G) shows the short method for determining the resistance for displacement type hulls.

Calculating the displacement of the Tartan 34C, I used a loaded displacement of 12,000 lbs. This allows for the stated mean-loaded displacement of 11,200 lbs., plus 800 lbs. for provisions, and equipment needed for extended passagemaking. It is, maybe, a bit high; but, rather a bit high than too low. So, the displacement measured in long tons = 12,000/ 2240 = 5.35 long tons. That is the amount of water the hull displaces and must, in effect, move aside as it goes forward.

Now, given 5.35 long tons, we must determine the speed/length ratio of the hull which is through the formula: Hull speed/ square root of the lwl or 6.50 / 5 = 1.30. Going to the scale, we can select the resistance in pounds for every 2240 lbs. of displacement. The chart shows the number, using the upper end of the scale, to be 45 lbs. Therefore, the total amount of resistance is 45 x 5.35 long tons = 240.75 lbs.

The next thing is to calculate to Effective Horse Power required to move 240.75 lbs. This is done by the calculation: EHP = R x S x .003, where R = Resistance, S = speed, in knots, .003. The resultant EHP = 240.75 x 6.50 x 003 = 4.7 EHP

Applying a propulsive coefficient of 35% for a propeller hidden behind a large keel, the resultant shaft hp = 4.7/.35 = 13.43 shaft hp.

Further adjustments: it is important and sensible to keep in mind that the numbers represent theoretical numbers based on assumptions relative to the water being flat, the boat being on her lines, a clean bottom and absent all other resistance producing elements like barnacles, etc. If one changed the propulsive coefficient for example by a small amount to, say, 25%, then the EHP would be 18.84. This would be a reasonable thing to do.

For safety and seamanship sake, it is therefore, likely that the ongoing or continuous horsepower requirement for the Tartan 34C is at least 13.5 shaft horsepower and more than likely a continuous 18.84 shaft horsepower.

In selecting an engine, therefore, it is essential that this horsepower output be found using not more than 2/3rds of the engine's power output curve so that the total available horsepower should be at least 27 h.p. and, better, 30, at 3,000 rpms. It is also significant at what rpms the engine puts out the required horsepower. If the engine doesn't reach 18 of so horsepower until its running at 2500 rpms, then it is wearing itself out. It is also important to observe on the power curve, where the torque outputs lie. These data will show at what point the engine is actually loosing power as the rpms increase.

Your application should not overburden your motor but fit somewhere on the engine's curve to allow for easy and smooth running with the most efficient levels of fuel consumption.

# Propellers:

Selecting a propeller is not akin to witchcraft. In spite of the fact that marina hands' eyes glaze over into a kind of Zen trance when the subject of propeller diameter and pitch arises, determining prop size and pitch is a relatively straightforward exercise and follows directly from the data you have assembled when you selected your engine.

It is important to keep in mind that:

AXIOM: Propeller revolutions may vary as the size of the propeller may vary for the same net result. Thus: a 12" propeller of a given pitch will have the same forward thrust at X rpms as a 15" propeller of a given pitch will have at X – Y rpms. So, the selection of a reduction gear can be a critical choice only in so far as it will require hull modifications and other modification when it comes to the Tartan 34C. This may not be true in the case of other boats. So, it is important to understand that, if you are using a reduction gear, your shaft rpms will be lower than if you are using a direct drive 1:1 transmission. So that. typically the following is so:

Maximum engine rpms: 3000

Direct drive: 3000 shaft rpms

1:65:1 reduction gear = 1818 rpms.

2:00:1 reduction gear = 1500 rpms.

So you must make your propeller selection in terms of rpms at the shaft and not rpms in the engine. The higher the gear ratio, the larger the propeller needs to be to turn out the same forward movement as the smaller propeller driven off a direct drive at a higher shaft rpms. (Your tach will read rpms in the engine. If you have a reduction gear you must mentally adjust this number for shaft rpms, or your tach will have to show rpms at the shaft, so if your shaft is turning at 1500 rpms, your engine is flat out if you are sporting a 2:00:1 reduction gear.)

**Chart #2** (see appendix G)shows a short method for selecting a propeller diameter.

The chart is for 3 bladed propellers and, for two bladed, must be, as Frank Kinney points out, modified by experience, say 5% or so.

But, if you look along the chart, you will see shaft horsepower on one side, propeller diameter in inches in the middle and shaft rpms on the right hand side. By drawing a line through the scale, you will find the approximate diameter for the prop you'll require based on the shaft horsepower in relationship to the rpms you choose to operate your engine. So, for example, if you are turning out 2300 rpms to produce 20 hp; from your engine power curve your prop will be 12" in diameter. If you are turning out 20 hp at 1200 rpms at the shaft because of a reduction gear, your prop will be ~ 15" or 16". Remember you are still churning out the same shaft horsepower.

Now, we come to pitch. The next chart, **Chart 3** (see appendix G), shows the short method for determining pitch. Pitch is the distance your boat will advance per revolution and therefore is directly related to the number of revolutions per minute required to achieve the desired speed. Now this chart uses statute miles so we can refer to the adjustment for statute miles we made earlier: 7.5 mph. You will need to assume certain efficiencies for your propeller, and the manufacturer should be able to provide this data; but for our example 40% seems reasonable. So, walking along the chart, to go 7.5 mph, a 12" prop @ 2300 rpms will require a 9" pitch. Pitch is not related to propeller diameter but only to the distance traveled through the water.

The relative efficiency of propellers varies widely. So, it is important to consider the efficiency difference between one type of prop and another. There are a lot of propeller manufacturers making all sorts of claims for their props. They should be able to provide test data which you can then compare from one propeller to another and make your selection based on imperical data and not boat yard bunkum.

It is also important to consider the nature of the work you are trying to do. Some propellers promise excellent efficiency while producing unacceptable drag. Three bladed propellers afford better efficiency than two bladed, yet the drag is considerable, especially in view of the fact that the fixed blades cannot be hidden behind the keel and only offer marginal improvement.

Lastly, in selecting an engine and propeller keep in mind that most of you will be adding a variety of power take-offs from your engine in the form of higher output alternators etc. so it is best to err on the side of larger output engines rather than one that may directly replace the Atomic 4.

The selection of an engine and propeller is a very important one. One that may make the difference between a successful and unsuccessful ocean passage or retirement journey. It also has a significant impact on the overall value of your investment. I have, in my career, seen too many boats essentially ruined by engine choices that looked more to the short-term outlay than the long term utility and worth of the motor and the boat.

So, good luck and smooth sailing.

## Notes:

Source: Kinney, Francis S., "Skene's Elements of Yacht Design, G.P.

Putnam & Sons, New York, 1988

Francis S. Kinney was a highly respected designer. He divided his time between his own assignments and the firm of Sparkman & Stephens where he worked on designs like Yankee Girl and the Tartan 34C. He was a highly successful sailor and author including his continual revisions of "Skene's Elements" and his book, "The Best of The Best". His boats all possess a beauty all their own as pictures of his "Santa Maria" and "Pipe Dream" illustrate.

# Appendix G - Engine and Propeller detail

**CHART 1: Short Method for Determining Resistance of Displacement Hulls**

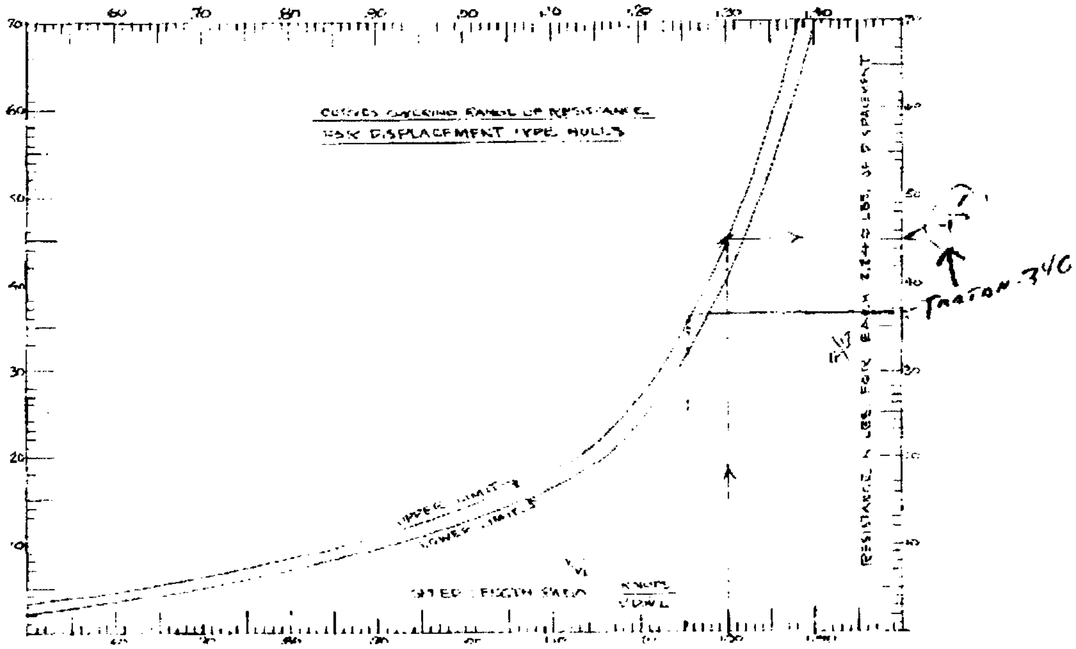

**CHART 2: Short Method for Determining Propeller Diameter**

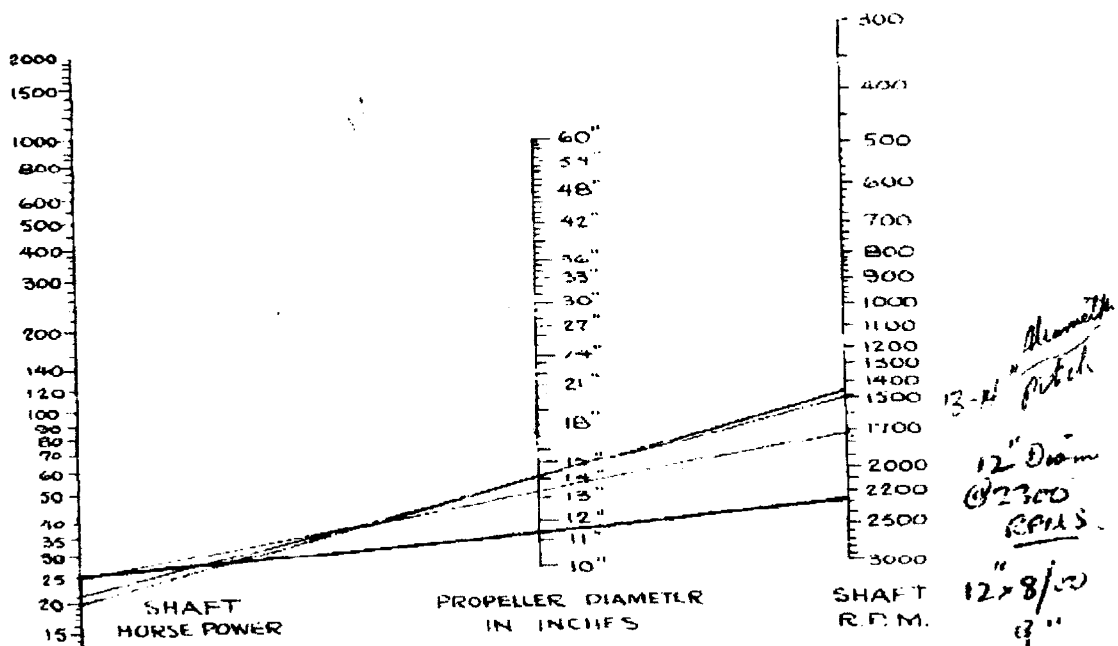

**CHART 3: Short Method for Determining Propeller Pitch**