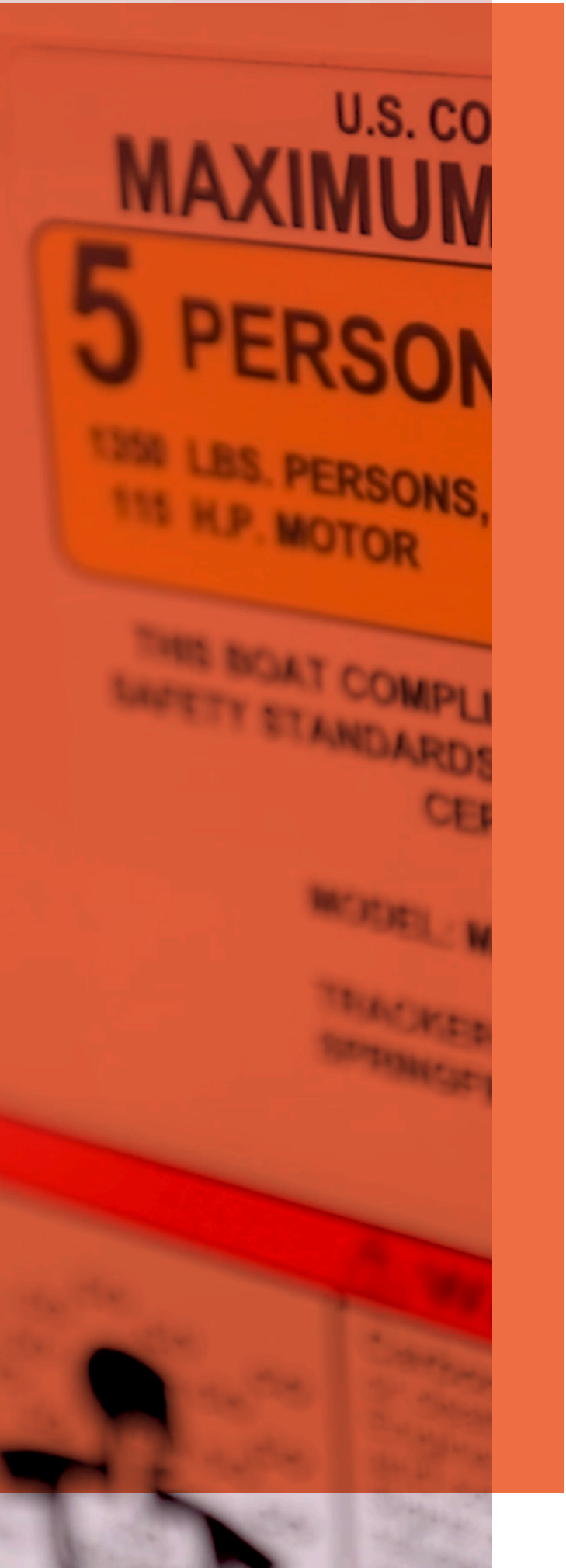


BOAT BUILDER'S HANDBOOK

2021

SAFE POWERING

33 CFR 183 SUBPART D

Produced Under A Grant From Sport Fish Restoration and Boating Trust Fund Administered By The U.S. Coast Guard.

CONTENTS

INTRODUCTION

Boatbuilders are responsible to determine the capacity figures placed on their monohull boats of less than 20 feet in length. A previous guideline (Display of Capacity Information) has covered the manner in which the capacity and powering figures are to be shown on the USCG capacity label. The previous 'Safe Loading' guideline covered the maximum capacity and persons capacity lines on the USCG capacity label. This 'Powering' guideline covers the way to establish an upper powering limit for outboard powered boats.

The format of this guideline is to provide a plain language description of a regulation section and then provide a discussion of the requirements and to provide an example powering calculation.

The determination of an upper limit for the powering for the vast majority of the applicable outboard powered boats is really a simple matter:

- A calculation using two boat characteristics (length & transom width) to determine a factor.
- Plugging that factor into the appropriate formula depending on steering type (remote steering or tiller steering) to establish a powering limit.

That is simple if the boat has a straight, full width transom. Boat designs with a myriad of transom configurations present a problem with determining a transom width. The USCG may need to be consulted on a case-by-case basis to determine safe powering for unique boat designs.

The additional issue of the safe powering of a flat bottom / hard chine jon boat is discussed.

An additional test course method to determine the power limit for a unique boat type is discussed.

The calculation method in the regulation for maximum horsepower was formulated many years ago from a voluntary industry standard used in the USA. This calculation was derived from the experience of testing common boats of the time, driven by average drivers. It eventually developed into a formula based strictly on length and width at the transom, disregarding boat performance characteristics. Later, while the Boat Safety Act of 1971 was taking form, the industry came up with another voluntary standard, this time taking into consideration the boat performance characteristics. This was a test-course method and was adopted as an option for small outboard runabouts of less than 13 feet in length.

It is very common that the powering limit determined by the calculation steps discussed in this guideline will give a builder a larger HP number than desired. This number is just an upper limit – builders frequently down-rate the posted powering limit significantly. As discussed in the 'Flotation' guideline – boatbuilders must provide flotation to support the powering limit placed on the capacity label. Smaller, lighter engine = less flotation material needed.

The full text of the CFR safe powering regulation is attached as Appendix 1.

TAKE HEED: Boatbuilder compliance means fully meeting all applicable regulations. The Boatbuilder's Handbook provides a basic introduction and summary of the regulations. Builders need to refer to the actual regulations for the complete text of the regulation to ensure full compliance. It is the boat manufacturer's responsibility to review, understand, and comply with all applicable regulations.

1.0 APPLICABILITY

Per 183.51: The safe powering regulation applies to outboard powered monohull boat less than 20 feet in length

Except for the "outboard" part, this is the same applicability statement as seen for Safe Loading, Display of Capacity, and Flotation. And all of these regulations, including Safe Powering, make the exception for sailboats, canoes, kayaks, and inflatables. Those boat types have been discussed in the Display of Capacity guideline.

This regulation applies only to monohull outboard powered boats of less than 20 feet, the size range where the Coast Guard has found the largest number of accidents.

2. DEFINITIONS

Flat Bottom, Hard Chine Boat – For the purpose of calculating maximum horsepower capacity under subpart D, a boat is not considered "flat bottom, hard chine" if the bottom of the hull contains any compound curvature or dead rise at the midship section. A rounded chine, or dead rise of at least 2 degrees is sufficient to qualify the boat for the higher horsepower rating. See Figures 4-6. Both conditions must be satisfied for the boat to be considered 'flat bottom, hard chine'.

The regulation intends to place restrictions on boats known as 'jon boats," which have flat bottom and hard chines. Any rounded or modified chine, or any dead rise or transversely curved bottom shape is sufficient to qualify a boat for the higher horsepower rating found in Table 183.53 under "other boats."

Length – Means the straight-line horizontal measurement of the overall length from the foremost part of the boat to the aftermost part of the boat, measured from end to end over the deck, and measured parallel to the centerline, and to the waterline. Bowsprits, bumpkins, swim platforms, outboard motor brackets, handles, and other similar fittings that are only attached to the hull are not included in the measurement. Integrally molded in and welded on structures are part of boat length.

Issues of length where there appears to be an attempt to avoid regulations will be evaluated by the USCG. An example is the addition of a welded on transom structure that takes a boat from under 20 feet in length to over 20 feet in length – and thus no longer subject to the display of capacity, safe loading, safe powering, and flotation regulations. Even if the boat with the welded on extension is still under 20 feet in length, the added structure (and boat length) will have a significant impact on the powering calculation.

Maneuvering Speed – The maximum speed at which the boat is capable of completing the maneuvers required by this standard.

Monohull Boat – a boat on which the line of intersection of the water surface and the boat at any operating draft, forms a single closed perimeter shape. For example, a catamaran, trimaran, or a pontoon boat in which the connecting structure between the hulls remains out of the water at any operating draft is not a monohull boat.

Some boats, e.g., power catamarans, are considered monohull boats for the purpose of this regulation if the line of intersection of the surface of the water with the hull forms a single closed perimeter shape or "footprint" when the boat is carrying its maximum rated horsepower and maximum weight capacity. This means the connecting structure between the hulls gets submerged, therefore forming a single footprint. This issue gets more complicated when a builder assumes the boat to be a multi-hull, and thus, does not establish a maximum capacity and maximum powering limit. The USCG needs to be consulted in such a case.

Motorwell – Any volume defined by a bulkhead or structure that prevents water from entering the passenger-carrying area of the boat through any cutout area in the transom including a cutout where an outboard engine would be mounted.

Motorwell Height – The vertical distance from the lowest point of water ingress along the top of the motorwell to a line representing a longitudinal extension of the centerline of the boat's bottom surface excluding keels. This distance is measured as a projection on the centerline plane of the boat (see figs. 2 & 3).

Transom – Means the surface at the stern of a boat projecting or facing aft. The transom is the flat surface on which the outboard engine would be mounted. The upper boundary of the transom is the line defined by a series of points of contact with the boat structure by straight lines at 45 degree angles to the horizontal.

Transom Beam – Means the maximum transom width, excluding handles, and similar fittings, and extensions, but including permanently installed rub-rails. The transom beam includes the width of the radii at the intersections wit the hull sides and chamfers, and angles of greater than 45 degrees to the centerline plane of the hull. For different transom configurations, the measurement of the Transom Beam follows:

- Full Width Transoms: The transom beam is the width of the boat measured at the widest point of the transom. Measurement is to the intersection of the transom and the sides of the boat, including rub-rails (see fig 1A).

- Transom widths greater than 50% of the boat's maximum beam but less than full width: If the transom surface does not intersect with the sides of the boat, and the transom surface is more than 50% of the maximum beam, then the transom width is the distance between the intersection of the outermost surface of the hull sides, including the rub-rails, with the projection of the transom plane (see figs. 1B,C and D).

- Transom widths less than 50% of the boat's maximum beam: If the transom surface does not intersect with the sides of the boat, and the transom width is less than 50% of the boat's maximum beam, then the transom beam is measured at the widest point on the aft quarter length of the boat including the rub-rails (see fig. 1E).

Transom Height – The vertical distance from the lowest point of water ingress along the top of the transom to a line representing the longitudinal extension of the centerline of the boat's bottom surfaces, excluding keels (see fig. 2).

Nominal Transom Height – The transom height as defined above, plus or minus a tolerance allowed in the test procedures. A nominal 20-inch transom is one that measures 20 inches plus or minus one inch.

It is important, in order to understand the requirements of this regulation, to fully comprehend these definitions, and the USCG interpretation of the manner in which these items must be measured. Boats' shapes have evolved tremendously since boats had square, full transoms and no attachments or fittings that would alter their main dimensions. Today, we have rounded, chamfered, sweeping-down transoms, with or without swim platforms, sheers that almost touch the water aft, and other designs never imagined when these standards were originally written. Depending on the shape of the stern, these measurements may become a matter of interpretation, and consultation with the U.S. Coast Guard may be required.

FIGURE 1 Determination of Transom Type

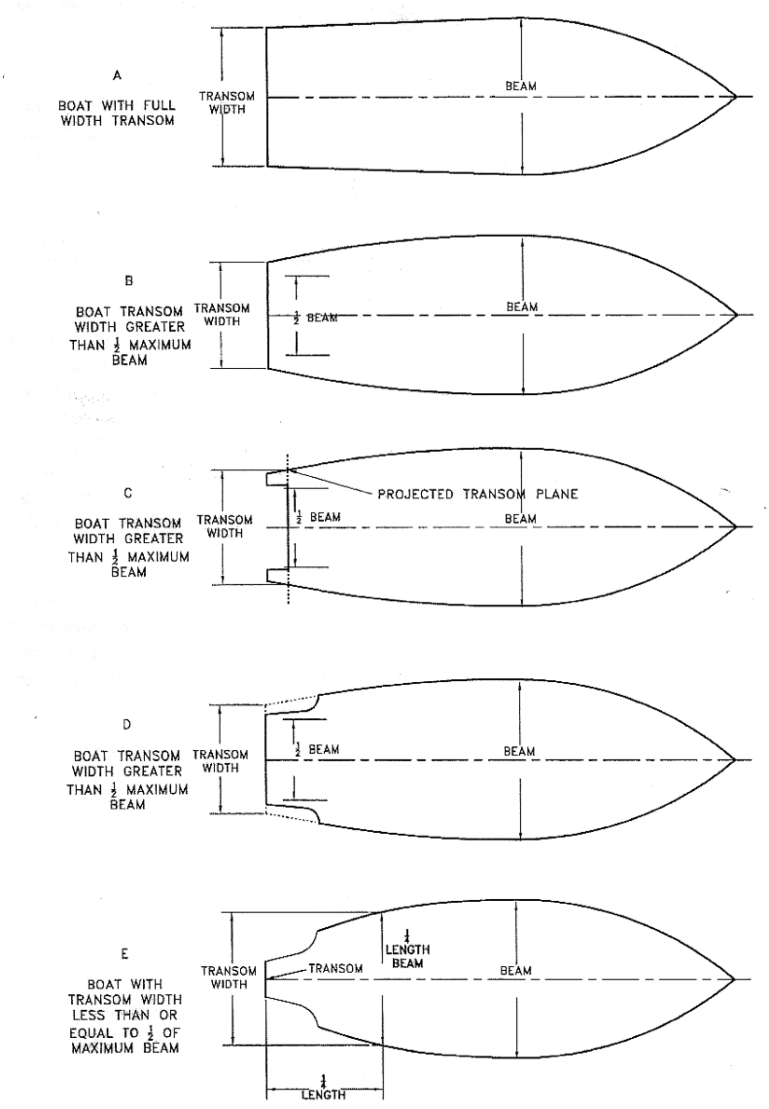


FIGURE 2 Transom Height

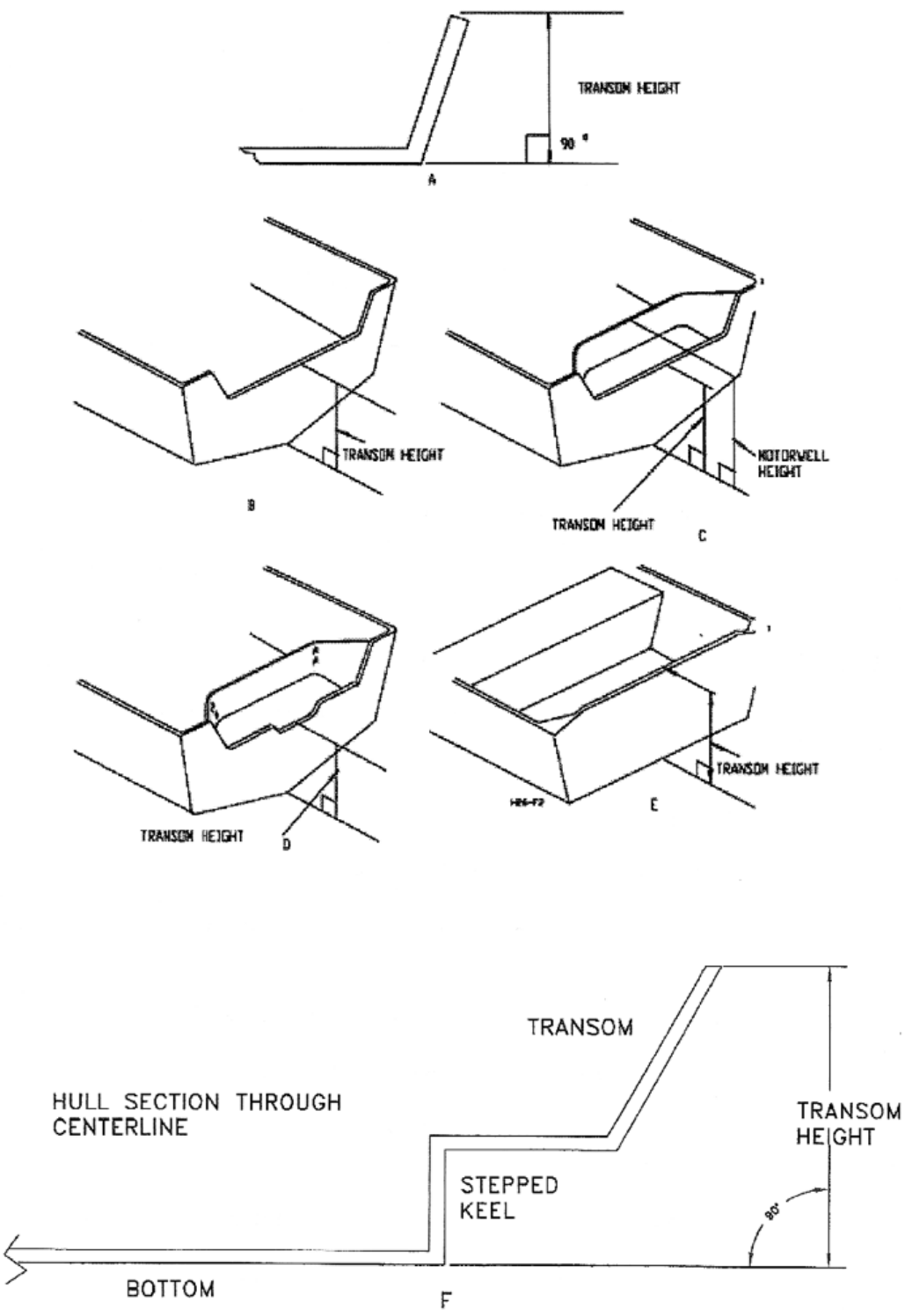


FIGURE 3 Motorwell vs Transom Height

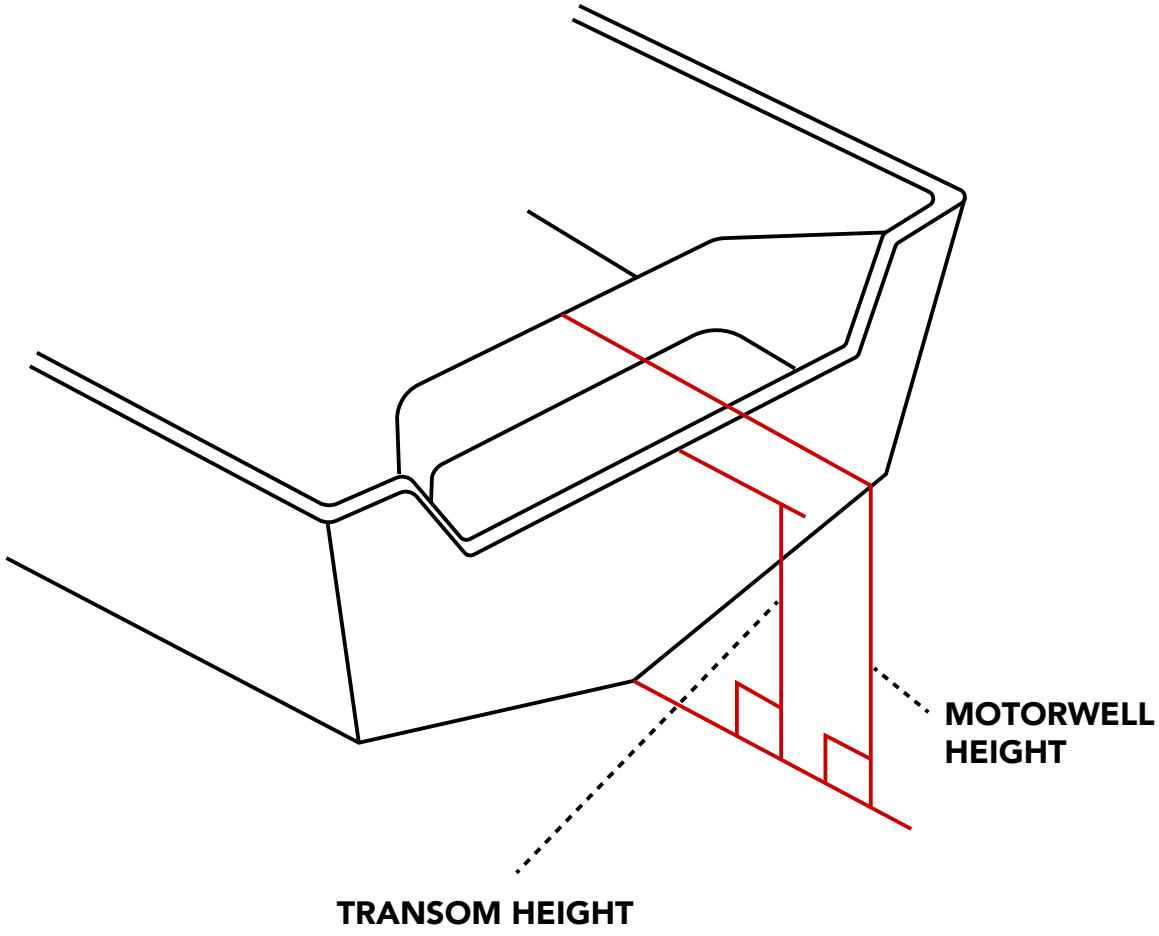


FIGURE 4 Chine Radius - Dead Rise Angle

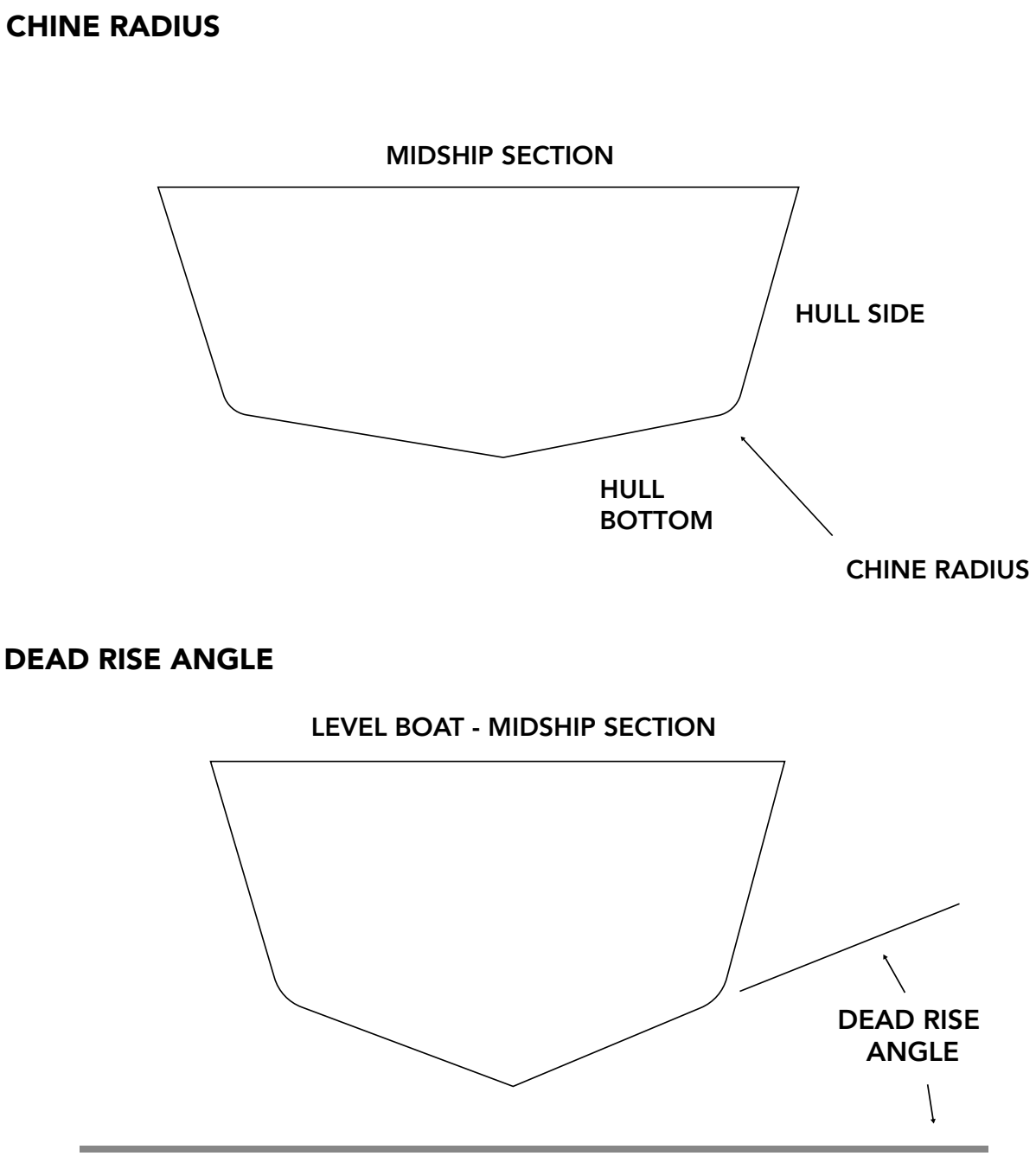
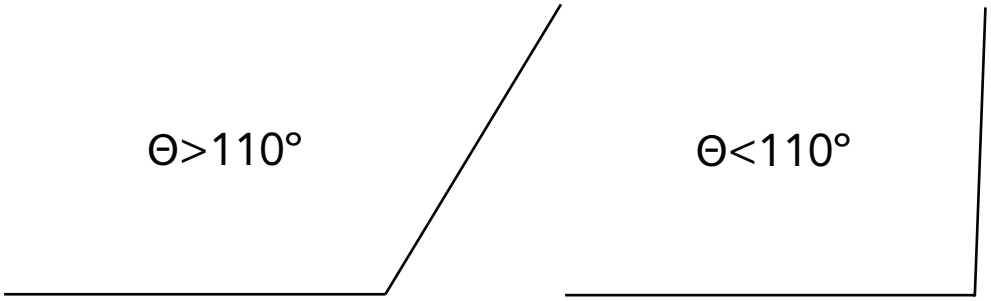
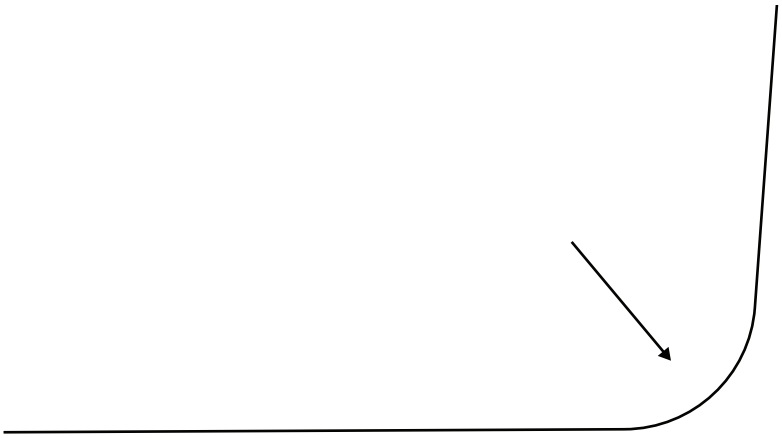


FIGURE 5 Hard Chine Determination

The exact angle between the side and the bottom does not matter – as long as it is less than 110° in the aft quarter. Steering control is established in the aft quarter; the greater the angle, the better the control.



It is primarily about the radius of curvature at the side / bottom joint.



The definition of hard chine, has a small limit of a radius of curvature of ½"

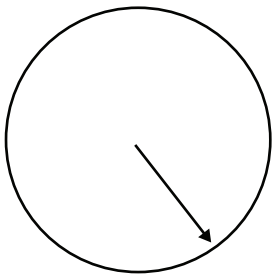
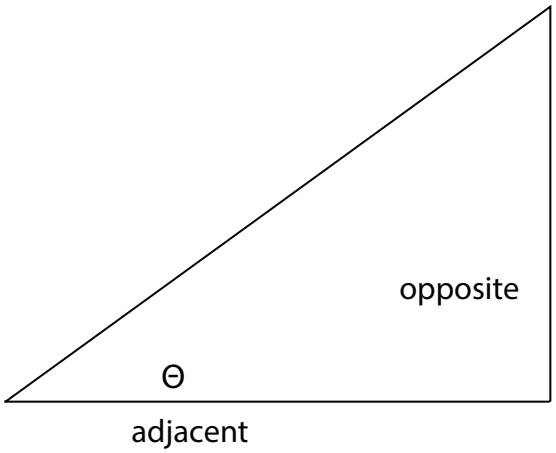


FIGURE 6 Flat Bottom Determination

An alternative approach to the use of an angle indicator … trigonometry.



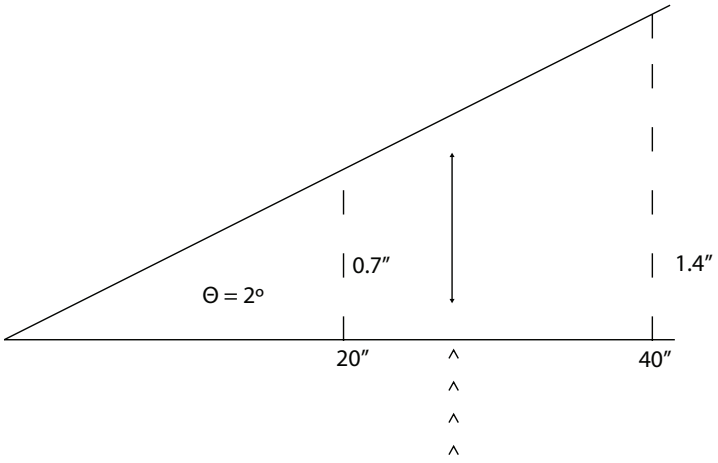
Θ = deadrise angle

tan Θ = opposite/adjacent

tan 2° = 0.0349

Measure out a distance (along the deck) from the centerline of the (transversely level) centerline of the boat. Then measure the vertical distance from the deck to the boat bottom.

The following (not to scale with respect to the 2° angle) shows the cut-off of the vertical distance to determine whether a boat is 'flat bottom'.



Example: the half beam is measured as 26″.
Opposite (vertical distance) = adjacent (half beam) x tan 2° = 26″ x (0.0349) = 0.9″
If vertical distance > 0.9″, the boat is not 'flat bottom'
If vertical distance is equal to or < 0.9, the boat is 'flat bottom'

3.0 MAXIMUM HORSEPOWER CAPACITY

Per 183.53: The regulations specify the manner to calculate the powering limit.

3.1 CALCULATION METHOD

The determination of maximum horsepower capacity by the calculation method is a simple two-step process:

1. Multiply the boat length (in feet) by the transom width (in feet) to get a factor.
2. If the factor is 52 or less read the horsepower capacity from the top of Table 183.75 / if the factor is 52.5 or greater plug the factor into the appropriate equation for steering type.

If factor (nearest integer) is...	0-35	36-39	40-42	43-45	46-52
Horsepower Capacity is....	3	5	7-1/2	10	15

NOTE: For flat bottom hard chine boats, with factor of 52 or less, reduce one capacity increment (e.g. 5 to 3).

		No remote steering, or less than 20" transom:	
If factor is over 52.5 and the boat has:	Remote steering and at least 20" transom height	For flat bottom hard chine boats	For other boats
Horsepower Capacity is....	(2 x factor) – 90	(0.5 x factor) – 15	(0.8 x factor) – 25

Note: calculated capacity may be raised to nearest multiple of 5. (example: calculated HP of 33 may be raised to 35)

The 'factor' has no real meaning – but is the number to enter into the Table 183.53 top chart or bottom equations.

Smaller boats will likely have a factor of 52 or less – and the HP rating can be read directly from the table on top.

Example: an 8.75 ft dinghy with a 4.0 ft transom width will have a factor of 35 [8.75 x 4 = 35]. The powering limit for the dinghy will be 3 HP.

Larger boats will have a factor of 52.5 or greater. Then, the steering system and transom height come into play.

Plus, flat bottom / hard chine jon boats will need to have the powering limits decreased as such boats are not as maneuverable and less stable in a turn.

Boats with remote steering and at least a 20 inch transom height will be more secure in a turn and the operator will be in a safer location – thus, the equation [2 x factor – 90] results a larger powering limit.

Tiller steering boats or those with less than a 20 inch transom will not be as secure in a turn and the operator will be in a more precarious position – so the equation [(0.8 x factor) – 25] results a lower powering limit.

Example: Determine the powering limit for an outboard powered runabout:

Length:	18 feet – 5 inches, or 18.4 feet
Transom Width:	7 feet – 5 inches, or 7.4 feet
Factor:	18.4 X 7.4 = 136.2
Transom height:	20 inches

The boat is sold in two configurations:

1. with a small center console and remote steering, and
2. as an open boat for manually steered tiller engine.

For the first configuration (remote steering configuration / 20 inch transom height):

HP = (2 x factor) – 90

HP = (2 x 136.2) – 90 = 182.4 → rounded up to 185 HP.

For the second configuration (tiller steering):

HP = (0.8 x factor) – 25

HP = (0.8 x 136.2) – 25 = 84.0 → rounded up to 85 HP

The difference is significant (185 with remote steering / 85 HP without remote steering).

As discussed in the 'Display of Capacity Information' guideline, boatbuilders are allowed to post powering limits in the following format:

XXX HP, MOTOR WITH REMOTE STEERING
XXX HP, MOTOR WITHOUT REMOTE STEERING

Example: Determine the powering limit for a flat bottom / hard chine jon boat.

For a jon boat with the same length and transom width, the factor is the same 136.4.

HP = (0.5 x factor) – 15

HP = (0.5 x 136.2) – 15 = 53.1 → rounded up to 55 HP.

Thus, another significantly lower powering limit is found for a flat bottom / hard chine jon boat.

Even though the boats have the same basic boat dimensions, three different HP ratings were found. These ratings make sense: a remotely steered boat has far more control than the same boat with a manual tiller on the engine. Both have better handling characteristics that a manually steered lightweight boat with a completely flat bottom and hard chine side.

3.2 TEST METHOD TO DETERMINE SAFE POWERING

Per 183.53: The regulations also specify a test method to establish the powering limit for boats of less than 13 feet in length.

The regulation acknowledges that some small boats with certain characteristics may handle more horsepower than the formula and table allow. For this purpose, the regulation includes an optional method to clarify the maximum horsepower capacity. This method is a performance one; in other words, the boat must be tested with different horsepower engines to determine which maximum horsepower the boat may safely handle.

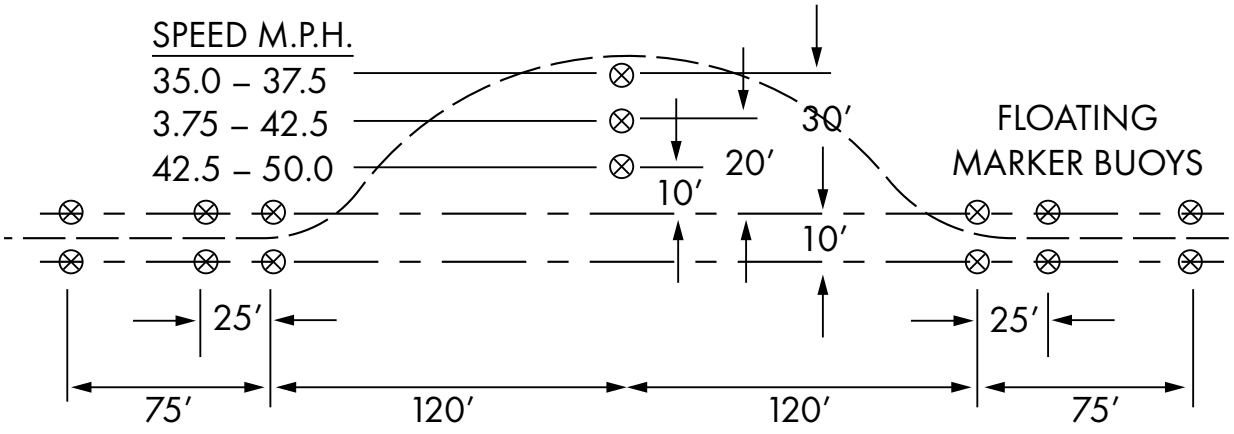
This test course option applies to boats with:

- A nominal 20-inch transom height or motorwell height
- Maximum horsepower not to exceed 40 HP
- Maximum Persons Capacity of two or fewer people, and
- Remote wheel steering
- Length of 13 feet or less

Builders of other types of outboard powered boats (such as low transom height 'flats boats') may make a special appeal to have a boat powering limit established by the test method.

33 CFR 183.53 (b) lists the above qualifying criteria, explains the process for boat preparation, establishes test conditions, explains the quick turn test procedure for boats capable of less than 35 MPH, and explains the test course method for boats capable of speeds of 35 MPH or more. CFR Figure 183.53 showing the test course dimensions is recreated as Powering Figure 7. The boatbuilder who wants to consider this method to establish safe powering should consult with the Coast Guard to confirm the procedures to complete and document the test procedure.

FIGURE 7 Boat Horsepower Capacity Test Course – 35 MPH or More



APPENDIX 1.33 CFR 183 SUBPART D – SAFE POWERING

§ 183.51 APPLICABILITY.

This subpart applies to monohull boats less than 20 feet in length, except sailboats, canoes, kayaks, and inflatable boats, that are designed or intended to use one or more outboard motors for propulsion.

§ 183.53 HORSEPOWER CAPACITY.

The maximum horsepower capacity marked on a boat must not exceed the horsepower capacity determined by the computation method discussed in paragraph (a) of this section, or for certain qualifying boats, the performance test method discussed in paragraph (b) of this section.

(a) The maximum horsepower capacity must be computed as follows:

(1) Compute a factor by multiplying the boat length in feet by the maximum transom width in feet excluding handles and other similar fittings, attachments, and extensions. If the boat does not have a full transom, the transom width is the broadest beam in the aftermost quarter length of the boat.

(2) Locate horsepower capacity corresponding to the factor in Table 183.53.

(3) For a boat with a factor over 52.5, if the horsepower capacity calculated in Table 183.53 is not an exact multiple of 5, it may be raised to the next exact multiple of 5.

(4) For flat bottom hard chine boats with a factor of 52 or less, the horsepower capacity must be reduced by one horsepower capacity increment in Table 183.53.

TABLE 183.53 Outboard Boat Horsepower Capacity

[Compute: Factor = Boat Length × Transom Width]

If factor (nearest integer) is...	0-35	36-39	40-42	43-45	46-52
Horsepower Capacity is....	3	5	7-1/2	10	15

NOTE: For flat bottom hard chine boats, with factor of 52 or less, reduce one capacity increment (e.g. 5 to 3).

		No remote steering, or less than 20" transom:	
If factor is over 52.5 and the boat has:	Remote steering and at least 20" transom height	For flat bottom hard chine boats	For other boats
Horsepower Capacity is....	(2 x factor) – 90	(0.5 x factor) – 15	(0.8 x factor) – 25

(b) For boats qualifying under this paragraph, the performance test method described in this paragraph may be used to determine the horsepower capacity.

(1) Qualifying criteria.

(i) Thirteen feet or less in length;

(ii) Remote wheel steering;

(iii) Transom height

(A) Minimum 19 inch transom height; or,

(B) For boats with at least a 19 inch motorwell height, a minimum 15 inch transom height;

(iv) Maximum persons capacity not over two persons;

(2) Boat preparation.

(i) The boat must be rigged with equipment recommended or provided by the boat and motor manufacturer and tested with the highest horsepower production powerplant for which the boat is to be rated, not to exceed 40 horsepower.

(ii) Standard equipment must be installed in accordance with manufacturers' instructions.

(iii) The lowest ratio (quickest) steering system offered on the boat model being tested must be installed.

(iv) The outboard motor must be fitted with the manufacturer's recommended propeller providing maximum speed.

(v) Standard permanently installed fuel tanks must be no more than one-half full. Boats without permanent tanks must be tested with one full portable tank.

(vi) Portable tanks must be in their designated location or placed as far aft as possible.

(vii) The outboard motor must be placed in the lowest vertical position on the transom or, if mounting instructions are provided with the boat, at the height recommended.

(viii) Boat bottom, motor and propeller must be in new or almost new condition.

Note:
The use of the following special equipment should be considered because of the potential for exceeding the capabilities of the boat while performing the test:
Racing Type Personal Flotation Device
Helmet.

(3) Test conditions. Testing must be conducted on smooth, calm water with the wind speed below 10 knots. The test must be conducted with no load other than a driver who must weigh no more than 200 pounds. The motor trim angle must be adjusted to provide maximum full throttle speed short of excessive porpoising or propeller ventilation or “cavitation”, so that there is no loss of directional control.

(4) Quick turn test procedure. Set throttle at a low maneuvering speed and steer the boat straight ahead. Turn the steering wheel 180° in the direction of least resistance in 1/2 second or less and hold it at that position without changing the throttle or trim settings during or after the wheel change. The boat completes the maneuver successfully if it is capable of completing a 90° turn without the driver losing control of the boat or reducing the throttle setting. Gradually increase the boat's turn entry speed incrementally until the boat does not complete the Quick Turn Test successfully or successfully completes it at maximum throttle.

Note:

It is recognized that operator skill and familiarity with a particular boat and motor combination will affect the test results. It is permissible to make a number of practice runs through the quick turn test at any throttle setting.

(5) Test course method. Set throttle for 30 miles per hour boat speed and run the test course set up in accordance with Figure 183.53, passing outside the designated avoidance marker for 35 to 37.5 miles per hour without contacting any of the course markers. If the boat successfully completes this run of the test course, increase the throttle setting to 35 to 37.5 miles per hour boat speed and run the course passing outside the designated avoidance marker for that speed without contacting any of the course markers. If the boat successfully completes this run of the test course and the motor was not at full throttle, increase the throttle setting to 37.5 to 42.5 miles per hour boat speed and run the course passing outside the designated avoidance marker for that speed without contacting any of the course markers. If the boat successfully completes this run of the test course and the motor was not at full throttle, increase the throttle setting to 42.5 miles per hour or more and run the course passing outside the designated avoidance marker for that speed without contacting any of the course markers. If the boat successfully completes this run of the test course and the motor was not at full throttle, continue to increase the throttle setting and run the test course passing outside the designated avoidance marker for 42.5 miles per hour or more until the boat fails to complete the test successfully or the boat completes the test course maneuvers successfully at full throttle. The boat successfully completes the test course if the driver is able to maneuver it between the designated avoidance markers without striking the markers and without losing control of the boat or reducing the throttle setting. There must be no change in position of any equipment on board and there must be no change of position of personnel in order to influence the test results. There must be no instability evidenced by oscillating motion in the roll or yaw axes exhibited while negotiating the course.

Note:

It is recognized that operator skill and familiarity with a particular boat and motor combination will affect the test results. It is therefore considered permissible to make a number of practice runs through the test course at any throttle setting.

(6) Maximum horsepower capacity.

(i) For boats capable of less than 35 miles per hour, the maximum horsepower capacity must be the maximum horsepower with which the boat was able to successfully complete the Quick Turn Test Procedure in § 183.53(b)(4) at full throttle or the maximum horsepower determined under the calculations in § 183.53(a) of this section.

(ii) For boats capable of 35 miles per hour or more, the maximum horsepower capacity must be the maximum horsepower with which the boat was able to successfully complete both the Quick Turn Test Procedure in § 183.53(b)(4) and the Test Course Method in § 183.53(b)(5) at full throttle or the calculations in § 183.53(a) of this section.

(iii) The maximum horsepower capacity determined in accordance with § 183.53(b) must not exceed 40 horsepower.

Figure 183.53 - Boat Horsepower Capacity Test Course - 35 MPH or More

If factor (nearest integer) is...	0-35	36-39	40-42	43-45	46-52
Horsepower Capacity is....	3	5	7-1/2	10	15