Boats: What to Look For

Introduction

We chose the name Marathon because of the strength of the products and the commitment we put into building everything we do. Building a quality product is our number one commitment at Marathon.

More inches of weld. Higher quality alloy materials. More man-hours dedicated to each product. It's what sets Marathon apart from the rest.

We're so committed to making a superior product that our craftsman sign their name on every boat they build as a symbol of superior quality and a personal guarantee.

Then we thoroughly test our boats through a series of vigorous inspections on and off the water to insure they meet our high expectations and exceed yours.

Better Built. Tested Tough. That's A Marathon.

We've been building boats with pride for over 30 years. Come see why a Marathon Boat will be the last boat you'll ever own!

Welded Boats in General:

Having come to the boating business from another industry, it was amazing the BS we found. All the ‘conventional’ wisdom was not necessarily wisdom but opinion. Being in over our heads at the time was doubly frustrating, as we had thought it was straight forward. As we found our bearings we realized that it must be doubly frustrating for the customer. What follows is a distillation of Marathon’s philosophy and approach to boat building. It is not necessarily right, and you the reader should be wary of it as it may just be another sophisticated line of BS.

However, this much we can guarantee. If you are looking for a boat and can form and own your own opinions on the following topics you will likely end up with a boat that is right for you – whether you buy it from Marathon Marine or not. And that is the bottom line to us, as another sale of a heavy gauge welded aluminum boat in the industry creates one more convert to this wonderful product.

Our Bias

Marathon has 30 years experience building the toughest recreational boats around, namely heavy gauge, welded aluminum jet powered riverboats which operate in extreme water conditions. Marathon has a reputation of building not only a durable boat (most 20 –30 year old boats are still out there) but also a hull which is smooth and predictable. Marathon’s philosophy is to get the hull right, and everything important follows namely ride durability and turning.

We build heavy gauge, welded aluminum boats, both prop and jet, but our primary claim to fame is jet boats.

Secondly, our boats tend to be overbuilt for the general user - if there is an option, we tend to overdo it. We build our boats for longevity and all round use. Our reputation is based on a quality, enduring hull that steers where you want and does not fall apart.

If you are looking for speedboats or racers, other firms have more expertise in this area.

Secondly, if you are looking for a heavy duty, offshore boat that can handle storms, gales and breaking seas, then you need a tougher boat than Marathon currently builds and has experience with. If you are the type of person that is going to go out in all conditions offshore or in the Great Lakes then there are some excellent builders, particularly on the Pacific coast.

If however you are the typical adventuresome person who will go just about anywhere, but keeps an eye on the weather and conditions Marathon boats are second to none as an affordable, heavy-duty boat for river, lake and close to shore ocean use. Our boats have handled the odd Arctic Ocean storm and survived on the Great Lakes, Great Bear Lake, Lake Winnipeg and Lesser Slave Lake.

We also build in the North Northwest for customers that take their boats on 10 day trips in remote locations in temperatures that range from -20F to 100+F. A critical requirement for these users is reliability and shelter from the elements - being exposed to sleet at 25F is not much fun if you do not have heat and protection from getting wet.

Shop for a Manufacturer First

Walk into the wrong manufacturer with a naïve attitude and you may end up with the boat the builder wanted to get rid or rather than the boat you need or want. Ask around where people got their boat and why. “Lowest price” is not always the best. It is very easy to build a cheap boat that looks good. Here are some of the tricks to building a cheap boat:

- Fold the boats ‘origami’ style out of 5052. This saves welding and fabrication. However, it eliminates the use of stiffer alloys in gunwales.
- Origami boats have not rub rails. You will bump up against things that will scratch your paint. Extrusions protect that.
- Skimp on stringers. Stringers form the structural basis for your boat and hold everything together. Without a strong base, nothing else works.
- Quality of components. You may not be able to recognize quality in cables, but look at latches, hinges, finished edges etc.
- How is the electrical finished. If you are out on the ocean, it better be salt proof
- Minimize welding quality. Welding takes skill. One manufacturer’s discussion forum had a number of customers discussing how to fix leaks that were clearly welding errors. If you are content buying a boat that has welding like that go for it.

Listen for descriptions of good service, accessible and knowledgeable boat people.
It is worth quoting from an editorial in Hot Boat

> *"These boats (that he was testing) were horrid, compared to comparably priced and powered boats . . . The fit and finish were phenomenal on both. It was just*

> *that a couple of little incidentals, namely ride and handling, had escaped the equation and fallen way way short of the acceptable mark. . . . The arrogance of the builder . . . having realized that it rides and handles like crap, and peddling it anyway is galling. What makes it even worse is that its builder has a good reputation in the industry."*[1]

Amen.

Look in the used boat ads

Are there many or few used boats for sale by that manufacturer? Call some of the sellers. Why are they selling? Are they upgrading with the same manufacturer? Better yet, take a look at some of the used boats. All boats look great new; how do they look after five years? Is the finish worn? Are stringers or transoms cracked? Do you see all one brand or are they evenly spread out across all? If there are a lot of brand X boats on the resale market there is likely a reason.

Judging the Production Staff

Evaluate the shop. Is it humming? Is it worn but neat? Does it smell like grease and expertise? If so you have a winner. What do the welds look like? Do you get the feeling they know what they are doing?

Manufacturer Reputation

Ask around. Check with people you know. Ask the dealer manufacturer who would be their second choice if they do not buy from you. You will not always get a straight answer, but generally you will hear the same names come up. We know whom we are most often compared to.
If you are looking to get in at a very low price, then there will be certain names; if you are into a quality boat you will hear another set of names. In the industry there are those that build quality which shows through resale having a limited number of boats on the market. There are those who make their boats look good, especially to the first time buyer, but take all the short cuts in building. Find out what the short cuts are. Know how the boats are built. Just as you can buy a cheap or expensive fiberglass boat, so too can you buy one or the other in welded. You as the buyer have to decide what to get.

Buying a Welded Boat for the First Time

We love to sell boats. It is good for our business and helps to sell more boats. However, we recognize that for most first time buyers of welded aluminum it can be a scary business. The typical buyer has 1-3 boats before, either glass or riveted but are looking for more. Then they hit the BS wall. Most manufacturers of these products do not have the common names you know in glass or riveted. After all of the some 400,000 boats sold in North America, welded aluminum comprises only 1-2,000. So how do you buy? Following are some suggestions:

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[1] Hot Boat Page 8, May 2002 by Kevin Spaise

Know the Boat you want

We stated our bias up front. You are getting an all round, durable hull. Many of our competitors have a race background and have earned worldwide recognition for that. However, keep in mind racing implies a certain type of construction namely, lightweight, delta pad and limited life as noted in March 2000 Hot Boat Magazine:

> *" The (Brand X) was designed as a throwaway. These boats were extremely light and, with large lifting strakes and delta pads, generate a tremendous amount of hydrodynamic lift. Essentially, you're comparing an apple to an orange. The (Brand Y – like Marathon) was designed to deal with rough water and windy conditions while still delivering a good ride. The (X) on the other hand was designed to strictly with the quarter-mile in mind (running in ideal conditions.)*

Do you want dragster or SUV? If you want the dragster we should not be your supplier.

You are in a different world in buying welded aluminum and jets. It is okay to not know as much as salespeople. A good salesperson will inform you as to your options. You should be able to describe what kind of boating that you need and want. Things such as:

- Where do you want to use it? On lake and some river or all shallow water river use?
- What do you want to carry 2 people or 10?
- Do you want it just for hunting and fishing or for wakeboarding too?
- How dressed up do you want it?

Ask lots of questions. There is a lot of varied opinion out there as to what constitutes the "right' boat. We have our opinions, but we are not the customer – you are. It is your boat and you have to be happy with it.
If the salesperson focuses in on a particular boat make sure it meets your requirements. If you're hit with a wall of technical jargon, ask for explanations. Do not accept jargon. Boats are simple. They float, they have a power source and they have a drive. Oh, and the pointy end should go forward. Your salesperson should be able to explain how this works for the boat you are looking for.

There is no Perfect Boat

The last thing is – there is no free lunch. Most boats are a compromise. Boats that work well in shallow water may not work so well in rough water. Props are good for some things and not others. Wide beam boats are nice, but take more power. Accessories are great, but add weight and cost. Pretty boats with lots of carpet and upholstery are nice at the lake with docks, but not so good when landing on muddy or rocky shores. Paint is nice unless you are going out camping, hunting rough whitewater trips. Head height (camper) tops the full length of the boat sound great in theory, but are you really going to be running out in the rain or sleep on the boat? These are decisions and tradeoffs that you, not the salesperson should feel comfortable with and be able to make informed decisions about.

The same basic hull and power plant can cost $40,000 or $70,000 depending upon accessories. The performance will be the same (well actually the boat with less options will probably perform better because it is lighter) - it is up to you what you want to spend. Questions you need to answer include:

- Will you be comfortable?
- Will you look as good?
- Will you be as dry?
- Do you like the exhaust rumble of the 350 or do you like the lighter weight of the 2 stroke.
- Will you be able to use the boat in all weather conditions?

That depends on you, your budget and what you want to do. We actually like to sell fewer accessories, as it makes for a less complicated boat that is more user friendly.

Take a test ride

We strongly advise a test ride, either in a prospective boat, on a friend's boat or via a dealer. You can almost always test a Marathon boat. To quote Hotboat again:

> *" . . . if you are in a buying mode . . . you not only deserve . . . a pre-purchase ride or drive, you owe it to yourself. If a builder cannot arrange for that to happen either through a factory demo ride or by . . . hooking up with an owner, there's something wrong – if not with the boat, with the service. With due respect to the builders who have proven their product, my advice is to walk at this point."*

Test rides are great, but what do you look for?

Acceleration out of the hole

Pay attention to acceleration out of the hole or 'holeshot'. Lots of builders give you a large beam but at the expense of a narrow bottom that gives you slow acceleration. For example, quite often you will find boats with an 83-85" beam, that only have a 5'6" bottom, as compared to a larger 6' bottom. This translates into slower acceleration and less load carrying capacity. If you just look at beam, you will get fooled. You can visually see this when you look down the boat from the bow or transom (fore and aft, bow and stern). If you see the sides leaning way out, like a "V", that is likely what is going on.

Why do manufacturers do that? One reason is that many buyers just buy based on the specs. So, in the boating reviews etc, you will see beam as a measurement. There is nothing wrong with that, however for a boat, the more important (and generally ignored measurement) is bottom width. The bottom/hull is what interacts with the water. That is the platform which makes up the boat. It is pretty much impossible to make up for a bottom that is wrong for you.

Although not strictly correct, there is a good correlation between acceleration out of the hole and potential weight carrying ability. Generally speaking, faster acceleration means larger weight carrying ability (between two boats of equal engine size).

However, as discussed later, bottom width is not the only factor which affects acceleration. 'The Hook' and bottom shape also have an effect. So, do not make hole shot the only indicator you use – keep watching as there is more going on as the boat accelerates.

Bottom Width and Engine Size and Type

A related issue is the interaction of engine size and bottom width. For general recreational use, the heavier the engine the wider the bottom you want. The reason for this is that when the boat is at rest, that thing at the back is a big lump of dead weight. Some boats have such narrow bottoms that when you put a 350 in them and walk to the back of the boat, the water comes up over the swim grid. While this may or may not be a concern to you, you should be aware of it, particularly if you plan on big trips and corresponding big loads. Then it may become an issue.

Keep in mind this is largely an 'at rest' issue. Once you are planing, the force of the water moving against the hull will largely reduce the issue (although as discussed above, the holeshot with the heavier engine will be a lot less).

In practical terms, what does this mean? Generally speaking we recommend that if you are going to put a 350 or bigger into a boat, get a boat with a 6'6" bottom. That boat will carry the weight of the engine. If you are going Sportjet, stick with a 6' bottom as you do not need the weight carrying capacity of the bottom and the narrow bottom advantages of less drag and resistance add up.

Turning ability

How does the boat turn? Is it a smooth turn, with minimal speed loss? Does it 'chine walk' (rock back and forth) through the turn? If so, that is likely due to reverse chines, which are discussed later. Does the boat lose excessive speed through the turn with the spray line moving progressively forward as you turn? If so, that is likely due to the chine walking and/or a vee bottom shape.

When going forward in straight line do you always have to correct the boat with little adjustments right and left (active steering)? If so, this is likely due to one or more of a hook, reverse chines or a shallow vee or deadrise. Alternatively it could be a problem with loose steering. If you suspect this, get it checked immediately. Ideally, like in your car, you want the boat to sit in the water and have it go where you want it without continual adjustments.

Stability at Speed: Porpoising versus bow down

The more power you put to it, the more the boat should lift out of the water and remain stable. Does yours? A well designed boat will run nose up and stable, through all speed ranges. Often however, two different things can happen – porpoising or the bow is way down with the spray line far forward on the boat.

Porpoising is where the nose lifts and falls as the boat runs through the water. This can be quite pronounced and violent at higher speeds. Essentially this happens when there is too much lift on the bow. As speed builds up, the water pressure on the hull causes the boat to rise out of the water and into the air. This is exactly what you want the boat to do. On a well designed boat, this will happen smoothly and the boat will be steady in a fore/aft motion. Essentially the lifting water pressure on the hull equals the drag/gravity downward pressure of the boat at all points along the hull. However if the trim on the boat or the hull design is such that it generates a disproportionate amount of lift on the bow, the bow will rise out of the water to the point that the lifting forces from the water pressure can no longer support the bow. Then the bow falls into the water. However it overcompensates and falls too low into the water and then is driven back up again by the water pressure on the hull. And thus the cycle (porpoising) continues.

This is the same thing that happens in a prop boat when the motor is trimmed out too far. Any time you see a boat with the bow bouncing up and down it is porpoising. In a prop boat, when trying to maximize speed you will intentionally trim the engine out to lift the bow and reduce the wetted surface of the hull. However there reaches a point when the porpoising becomes quite violent and can literally injure someone in the bow. The difference between prop and jet boat, as discussed later, is that there is no trim (unless you buy trim tabs) on a jet boat.

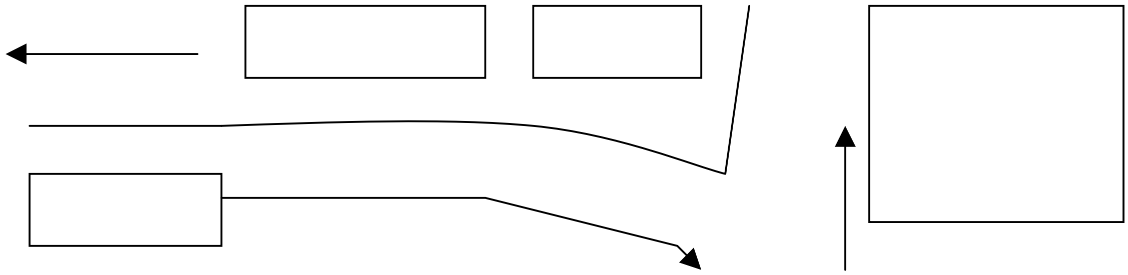
Therefore the hull design is critical. This is discussed later in the trim section. That section also discusses how to fix the problem.

The Hook

The opposite of the porpoise is the hook or where the boat bow is driven down and the boat accelerates. As a result the boat tends to plow through the water with the spray line well forward on the boat – sometimes up at or forward of the driver.

At the start of the discussion we stated our bias. We have a very strong bias with respect to the hook. Whereas pretty everyone will agree that porpoising is bad, not everyone agrees the hook is bad. In fact, many manufacturers intentionally build hooks in. So first we will describe what it is, and then we will guess why some manufacturers intentionally build in hooks.

Hooking is done by making the stern portion of the bottom slightly concave. Everything is fine at slow speed and in fact a hook can actually assist the boat in getting out of the hole and getting the boat up on plane. This occurs as the stern portion of the concave forces the water down and therefore creates upward pressure on the bottom and therefore lift as shown below. The reason it can create faster hole shot, is that typically the heaviest part of the boat is where the engine is – at the stern. So the more lift at the stern, the faster the boat gets on plane.



As most sport boats are built for fishing and skiing, many manufacturers intentionally put a hook in the boat to assist the hole shot. This way the boat can use a smaller motor to get the boat up on plane.

The second reason is it prevents porpoising. The hook prevents porpoising as described below.

As always, however, there is no free lunch. What you gain at one end, you lose at the other. As the hooked boat begins to accelerate the hook begins to force the stern of the boat up and the bow down. The faster you go the more the bow goes down. This limits top end speed and handling. You can see this effect by watching the spray line (the point where the spray stops coming off the boat which is also where the side exits the water) move forward on the boat.

Hence the second reason for putting the hook in – to prevent porpoising. As described above, when the boat is hooked, the faster you go, the more the bow is driven down – it never gets a chance to lift. Therefore it cannot porpoise. From a manufacturer’s perspective, this is great. No customer complaints about porpoising boats.

Now back to the hook. You can see the effect of the hook very readily in a boat with trim tabs or an outboard. Adjust (trim) the tabs or motor downwards while cruising to push the bow is down. Now adjust your trim so the bow begins to rise. By lifting the bow you will pick up speed. Also notice that the spray line moves towards to the stern. At a certain point, it will also feel like a brake has been released. The boat will suddenly handle easier, feel lighter and more maneuverable and it will ‘dance’.

So now comes the bias part. Although hooks are bad in all boats, it is particularly the case in jetboats. In our opinion, the most dreaded of all jet boating phenomenon is the hook. We like a boat that performs. Part of that performance means matching your power to the boat. If you need to hook your boat to get the thing on plane, then either you have hull design issue or not enough power. Our suggestion would be to buy a smaller boat that can plane on the power you can afford or buy a bigger powerplant/engine.

This raises a last reason manufacturers may put hooks in - it limits top end speed. The hook acts as a natural brake – the more power you put to the hull, the more it bow steers – and you also get tired of paying the gas bills associated with the hull drag.

So what is the advantage of getting rid of the hook? You get a boat that continues to rise smoothly as you apply power. A well tuned boat will have the spray line continually moving to the stern as speed increases. This results in a boat that requires less water to run in (a good thing in shallow water), less hull drag and better fuel mileage. As well you get a boat that is more responsive and turns easily. If it is tuned right, it feels like it 'dances' when you turn it.

If your boat is hooked you may have an easy or difficult fix. The easy, lucky fix is by either adjusting the tabs at the end of the hull, if they exist (they are on all Marathon jet boats) or the jet drive ride plate, if there is one such as on the Mercury jet. Lastly you can change the angle of the jet nozzle on non-Mercury drives.

If you have a delta type keel and the bow is driven down while accelerating, you will have a bigger problem. Marathon does not build a delta keel, so we cannot recommend a fix for this problem.

If these adjustments do not work, you may require major changes to the hull. Before doing so, make sure you know what you are doing or take it to someone with a known reputation for such fixes - the fix is as much an art as a science.

Spray Line?

In evaluating a boat, look at where the water is coming off the boat at speed? Is it in the middle or near the transom? Is it a clean line or jagged? Does it move backward as you accelerate or does it move forward?

As we discussed earlier, generally speaking, the farther back the spray line, the more efficient the hull, and therefore the faster and more fuel efficient it will be. If it is coming off at the windshield with a light load, then you have a problem. The spray coming off the sides of the boat should be relatively 'clean' with little turbulence. Turbulance means drag which means decreased performance and fuel economy.

A lot of little things in the boat add up to big differences on the water.

Boat Materials: Aluminum versus Fiberglass

The boats in general section applies to any boat. Why should you buy welded aluminum?

	Aluminum	**Fiberglass**
Stiffness	Pound for pound as stiff as steel	Low. Needs reinforcement

Density	Low. 35% of steel	Medium
Strength to weight Ratio	High	Low
Corrosion resistance in Salt Water	High	High
Osmosis Risk	Nil	High
Impact Resistance	Varies, depending upon grade (see below)	Brittle, very little. Once hit osmosis sets in
UV Resistance	High	Low - needs additives

As can be seen from the above, aluminum is superior as a construction material to fiberglass for structural components as:

- It has high impact resistance
- There is no osmosis risk
- It has high rigidity
- It is lighter.
- It has a high strength to weight ratio.

Cost differences between glass and aluminum

Cost is a misleading comparison. Although pound for pound, aluminum is more expensive than fiberglass, one needs substantially more fiberglass to obtain an equally strong hull. For example, it takes about a 3,000- 4,000 lbs. of fiberglass to equal the strength of a 1,000 pound aluminum hull. There are a few glass boat builders who build this strong a hull. When you check their prices you will find they cost substantially more than the aluminum hull.

Secondly, although the glass hull may initially be as strong, it will not have anywhere near the impact resistance of aluminum.

Thirdly, although they may be able to handle an initial impact, the collision creates stress cracks which allow osmosis to set in and the hull will deteriorate over time. Sun, stress cracks and osmosis will all wreak havoc over time. Therefore, over time fiberglass' strength deteriorates.

Fourth, all the added weight on the glass boat creates a severe performance, fuel consumption and power plant penalty. To push the extra weight of a glass boat a larger, heavier more expensive engine is required. In a bit of negative circle, bigger engines need to be even bigger to push their own weight. Bigger engines burn more fuel which requires even more weight for fuel storage and therefore an even bigger engine. More weight makes for slower planning and more wallowing in big water. Ask any heavy duty glass boat owner about the performance and operating cost of their boat.

Types of Aluminum

All welded aluminum boats are not created equal. Builders used different techniques and different aluminum in their hulls. The following tells you what to look for:

	5052-H32	**5086-H32**	**6061-T6**
Impact resistance	Soft, dents easily	Hard	Hardest
Tensile strength - Ultimate (where the metal breaks)	100%	129%	135%
Tensile strength - Yield (point to which metal bends and will not spring back)	100%	122%	152%
Ducility (ease of bending)	Easy	Care must be taken	Limited bending
Where used in Marathon	Sides, dashes	Bottom	Stringers, side trays

- Based on 1⁄4" thickness
- Figures are minimums. Actual samples will vary. 5052 tends to have the highest variability.

From the chart above one can see why Marathon uses 6061 for the rub rail gunwale joint components and 5086 for bottoms. These are structural components that hold the boat together. As boat powers through the water it flexes. Therefore you want strength, hardness and little bending ability in your structural components. It is the structural components that allow the boat to keep its integrity.

How does this affect you? Ask what is in the boat.. See how it is built. Ask what materials go into it. Why ask? Some boats use 5052 in their bottoms. Others use minimal thicknesses and designs in their stringers. If you are a light duty user, it probably does not make much difference. However if you put your boat through its paces and push it a little, you will see the differences show up over time as one boat will develop cracks and the other will not.

Material Thickness

This paper is talking about heavy gauge welded aluminum boats or what some call plate aluminum. The bottoms in these boats range from 3/16” to 1⁄2”. Although some builders in this class use thinner bottoms in this class, most quality builders do not. Heavy gauge welded boats usually see heavy use and requires the strength.

We are totally excluding boats of the light duty welded aluminum class, which are basically a small step up from riveted boats. These builders use thin bottom material, often 5052 and reinforce their boats completely differently than heavy gauge builders. Secondly, look at the material thickness and listen to the explanations as to what is used and why.

A Word about Welding

You are buying a welded boat. The quality depends on the welding. Welding depends upon proper heat selection, speed of weld, type of material being welded etc. A properly welded and reinforced boat will last for years – an improper one will develop cracks and other problems.

Suck marks, caterpillar tracks

Welding requires the melting and fusion and mixing of the two pieces being welded together with a filler wire. Weld too hot and you burn through and distort the material. Weld too cold and you do not get fusion and melting of the two pieces – you just get melted filler wire sitting on top of the two pieces.
Proper fusion in materials up to 1⁄4” thick shows up on the opposite side of the material as distortion lines and marks. These marks are generally call ‘suck marks’ or ‘caterpillar tracks’. Eliminating these in the welding process requires minimizing heat and therefore fusion. It also minimizes the strength of the joint. In other words, one way to make a cosmetically more appealing boat is to ‘cold weld’ the boat. The cheapest, easiest and weakest weld is a cold weld. Stay away from boats like this unless you are a light duty user, as they will not stand up.

If you are looking at a weld on a side for example, on all the quality boats you will see the weld line running down the side. A certain amount of paint preparation and bodywork can reduce the line, but it generally does not disappear. If you do not see this line where the welds are make sure you are getting a boat that has been properly welded.
If you do see a boat where you cannot see that line it means:

- The boat was cold welded
- Substantiation body work was done to hide the distortion
- The material is thick enough to hide the line
- There is no joint there.

On the flip side, welding weakens aluminum. When heating the aluminum strength is taken out of material. The more heat that is used to weld the boat, the weaker the aluminum becomes. This is one of the reasons that it is important to use higher grades of material for structural components. The initial higher strength or thickness of the material helps compensate for the reduction in strength after welding.

That is why Marathon uses .160 for stringers and .125 for sides, in order to compensate for the welding.

Folded, 'Origami' Construction

There are techniques that rely on folding the boat 'origami' style with minimal welding. In order to fold the boats, softer and generally thinner alloys have to be used. These softer and thinner alloys are much more susceptible to cracking out and failure than what Marathon uses.

If you look at most brands of welded boats, you will find that this technique is rarely used. Besides the drawback of using softer alloys, these boats rarely have rub rails. These protect the sides and paint from abrasion and scratches when rubbing against things like docks and other boats. Secondly they do not have the harder alloys protecting and strengthening the gunwales.

Hull Design

Your hull is probably the single most important factor in your boat selection and enjoyment. All builders have access to the same power, drives and accessories. Pick the wrong hull for what you want to do and your enjoyment may be substantially reduced. Hull design also affects your operating cost and your pocketbook. A poor or inappropriate hull will cost much more to operate than a well designed hull.

Delta Keel

As discussed earlier, delta keels are like hooks in a boat. They generate lift quickly and get the boat out of the water quickly which can lead to higher speeds.
However, delta, flat bottoms have rougher rides at high speeds as the boat is essentially riding on a flat pad – much like a piece of plywood. Delta keels are susceptible to porpoising. The delta keel also leads to 'active steering' as flat surface provides little directional stability. Therefore the driver must continually adjust the boats direction.
A full delta keel that comes to the bow will also slap the waves as this portion of the boat repeatedly hit the flat portion of the keel.
To fairly compare dead rise between a true vee boat and a delta keel, the delta keel dead rise should be cut at least in half or less to compare ride through the water. Thus a 16o delta keel will ride closer to an 8o or less true vee. This is particularly true at higher speeds where the ride will be roughest as only the stern portion (and flattest portion of the delta keel) is in the water when underway.

Deadrise (Vee)

Wave cutting ability and ride is also influenced by the amount of Vee or deadrise of the hull from front to back. Deadrise or Vee is usually measured in degrees.
Deadrise can be continuous or variable. The definition of deep vee generally ranges from 12^o up to 25^o. Once again another compromise arises. The deeper the Vee

- the more effectively the hull will cut through waves,
- the more lateral stability is decreased and
- the power that is required to plane the hull is increased.
- the faster the planing or 'stalling' speed is.
- the less load carrying capacity exists

There is no consistent method of measuring deadrise across the industry. The deadrise measure that really counts is the deadrise at the back of the boat as this is where the boat generally rides once it planes. Many manufacturers build a variable vee hull that tapers to a small vee at the back. Although it may be advertised as a deep vee hull, this measurement may be taken near the front. For example, a deep vee series may have a 35^0 bow entry which transitions to an 18^o vee at the stern.
So how do you decide what degree of hull to get? As in most things in boating, it depends upon what you will be doing. If you are always in big water then go 18^o. If you are going to do mostly river and some lake, then Marathon has found 12^o to be a good compromise. If you are doing mostly lake and some river you still may want to go 12^o if you only go on the lake in good weather. The reality for most boaters, despite all the hype about deep vee boats, is that most boaters rarely see anything over 1-3' chop. These conditions usually exist when it is blowing 15-20 mph. Most boaters do not go out in these conditions, as it is too rough to wake board and water ski. Therefore why go deeper vee and pay the power, speed and load carrying penalty? As well, if you and your family wakeboard, air chair, or you have young kids learning to ski, you will find the planing speed of a deep vee boat is too fast.
Most deep vees need 20-22 mph to plane, which is too fast for novice or intermediate wakeboarders and skiers. A practical example might help. Does this dynamic sound familiar?

- Your spouse is water skiing or wakeboarding
- the boat is struggling to stay on plane at 20 mph
- your spouse signals to go faster
- the boat accelerates, comes up on solid plane and then rockets ahead (because drag is now reduced)
- your spouse frantically signals to slow done
- you pull back on throttle and fall back to your struggling 20 mph semi plane
- the cycle continues and no one has a good time.

This is one of the reasons tournament ski boats are very flat. If you want to go 16.5 mph you can go 16.5. Need another 1 mph? Nudge the throttle ahead. There is no transitioning from slogging along to planing. You get the same thing operating a 12^0 boat. The boat is easy to drive, you are not fighting to stay on plane and the 12^o is more than adequate for a smooth ride in flat and small chop water conditions.
When you do need to run across the lake in 3-5' waves you will find that angling into the waves allows you to make at least as good progress as many supposedly deep vee hulls. A lot of the time, that is because many supposedly deep vees have pretty flat vees/delta keels at the transom for reasons discussed earlier. Therefore, when planning the business end of the bottom is not running on a deep vee but rather on a flat pad. Most customers who run in lakes tell us that the ride on the 12^o hulls is much better than they had expected.

Planing Hull Bottom Types

There are a number of hull choices for river / shallow water service. Each has their own merits and shortcomings depending on the conditions the boat is expected to operate in. Many are completely unacceptable for use in anything but shallow water. However, Marathon's Radius works well in both rivers and inland lakes and waterways.

It also works well with a variety of power choices including outboards and sterndrives. Marathon has built and tested just about every variation of jet boat since 1967. We have learned that there is no one hull design that answers the exact needs of all operators. As a result we incorporate the very best of every feature wherever we can. What follows is a brief summary of what we have experienced with different hull shapes and a brief description of our Radius Bottom.

Excluding racing hulls, there are generally two types of shallow water planning hulls.

- Constant deadrise V (including modified V hulls)
- Flat bottom hulls

In addition to this there may be two different bow type entries incorporated in the design. These include:

- Shallow entry
- Sharp entry

Constant deadrise V (including modified V hulls)

As the centerline profile of a V hull generally forms a point the following applies:

Sharper point = deeper deadrise = more hull in the water = softer ride.

Correspondingly:

The more hull in the water = more wetted surface = more drag = higher fuel consumption

Whether at rest or on plane, a deep V constant deadrise hull will sit / plane deeper in the water. It will also have the tendency to roll at rest. The constant deadrise V certainly has its place and Marathon builds many V hulls - generally with 12 degree deadrise. We have found this to be the optimum deadrise for shallow water operation, stability at rest and rough water handling. However, we have also found that no matter what deadrise is specified a V hull will lose lift in turns - which translates into slower boat speeds when cornering and less responsive hull performance overall.

Flat bottom hulls (8 degrees deadrise or less)

This type of hull generates better lift and makes for an awesome shallow water boat. It is quick to plane and has much less hull in the water to be damaged by underwater obstacles. As is always the case there is a trade off. Flat bottom hulls are extremely rough riding in anything but calm or flat water conditions. This type of hull is also best suited for a seasoned operator that is familiar with its unique handling characteristics. These boats tend to “slide” when cornering and cavitate in rough or white water conditions. Many operators swear by this bottom design. While they do have a place where navigating extremely shallow water, their maneuverability and performance is ill suited for navigation in white water where stability and split second positive direction changes are required.

Bow Entry Types

Shallow Entry

This bow entry type is normally seen on true white water hulls. The stem starts far back on the keel and gradually pulls up to the bow. Its purpose is to generate lift up and over pressure waves, rollers and ledges and also to provide bow floatation when the hull drops into holes and aerated water. This bow configuration generates tremendous lift due to its flat spoon shape. The trade off is pounding in large swells and consistent rough water encountered on lakes and other large inland waters. The Marathon bow entry works well in both these areas.

Sharp Entry

This entry is characterized by the stem rising up far forward along the keel and transitioning abruptly into the bow. This produces a sharp chop / wave cutting bow similar to that seen on many lake or ocean going boats. This bow entry provides more boat in the water and increased static floatation. Because of the aggressive bow profile this type will not provide the lift of the shallow bow entry in white water conditions. It works well in rough water especially when combined with a deeper deadrise or variable deadrise hull. Marathon uses this type of bow entry with a 12 or 18 degree deadrise on most of our all purpose hulls that are used on inland lakes or bays.

Radius Bottom

Regardless of past experience or current preferences, both V type hulls are lacking when compared to the Radius Bottom. Beginning with the bow entry, Marathon's modified shallow bow entry produces an all around smooth ride in rough water yet superb buoyant lift in white water conditions. The ride is unlike anything most operators have experienced. The Radius Hull really shines when the boat is driven hard and fast. When test driving this hull we have noticed experienced operators instinctively bracing themselves when setting up for and initiating a hard turn. They are pleasantly surprised by the solid "no surprises" performance of this hard turning hull type.This solid sensation is generated by the Radius Hull. The following explains why this works.

Lift Forces Explained

There are two lifting forces that come into play on a planing hull: Hydrostatic and Hydrodynamic.
The lift force acting on a stationary (static) hull is known as Hydrostatic.
Lift forces from moving water (under the hull) are known as Hydrodynamic.
A planing hull gets most of its lift from Hydrodynamic forces. Although Hydrostatic force provides some lift, the bulk of it is provided by the Hydrodynamic force.
Hydrostatic and Hydrodynamic force is always applied at right angles to an object - in this case the full surfaces.

The radius of the Marathon keel found on all Spirit models runs the full length of the bottom and spans 28". Think of the radius portion of the bottom like a half pipe or barrel on the bottom.

Under ideal water conditions, the hydrodynamic forces on the bottom, either a radius or V bottom boat, are directed at right angles to the exposed surface. This means that in straight ahead motion, this force is directed to the center of the hull for both the radius and V hulls. The difference is found during times when the water conditions are not ideal - which in the real world is most of the time!

When the boat turns, the water pressure on the side of the hull exposed to the inside of the turn increases. As the boat turns, on a V bottom boat the water pressure pushes/tilts the boat slightly. Why is this? The water pressure is constant along the hull on the inside of the turn but then suddenly stops at the bottom of the V. Therefore, like porpoising one can get a rocking or falling off on a plane.

Lateral Stability During Planing Turns

Because of its large convex surface the Radius Bottom also generates tremendous lift - much like the flat bottom hull but without any of its nasty habits. To hold the hull throughout a turn lateral stability is provided by strakes each of which are specifically sized and placed on the bottom. These strakes contribute to the lateral traction of the hull giving our boat its extreme tight turning performance. More lift translates directly to more payload capacity, less fuel consumption and a faster more nimble hull. Unlike the V hull the Radius Bottom also creates substantial positive lift while in a turning maneuver. This results in a solid stable cornering boat with the attitude of the hull remaining flatter throughout the turn. In addition the combination of the Radius Bottom, high rising chines and aggressive bow entry produces a solid dry riding boat that lifts over chop yet slices through waves. It is truly the best of both worlds.

The ride, lift strength and stability of the hull is such that we have equipped a number of standard 12 degree deadrise Radius Bottom hull's with outboard offshore brackets using 225 HP outboards. These boats are operating in the severe conditions of the offshore and inland waterways of Alaska with superb performance reported by the operators.

Bottom Shape and Jet Intake

Planing hulls have many different shapes or lines. In a water jet powered craft, design errors that would not show themselves with other drive types will become critical. Flow to the jet drive unit is extremely important. One of the most significant advantages of the Radius Bottom is its ability to interface with jet drives. The Radius Bottom transitions perfectly into the pump intake area of the jet drive. This delivers solid water to the eye of the impeller resulting in a dramatic increase on pump efficiency and boat performance. Simply jamming a jet drive into the rear of a V hull will not work. The flow into the pump intake must be a clean, non-aerated flow at all time - in all conditions. Since the V hull is by far cheaper to build than the Radius Bottom hull most builders "transition" a V keel to accommodate the needs of the jet drive. The easiest way to do this on a V hull is to incorporate a Delta pad (flat triangle) into the bottom. Most manufacturers do this the easiest, least costly way by forming the Delta pad from the stem cut out (where the bow begins to rise) all the way back to the stern. This is usually done with a press brake. Many times it is done by splicing and welding the Delta (triangle) into the bottom. Either way they are weakening the bottom in the process.

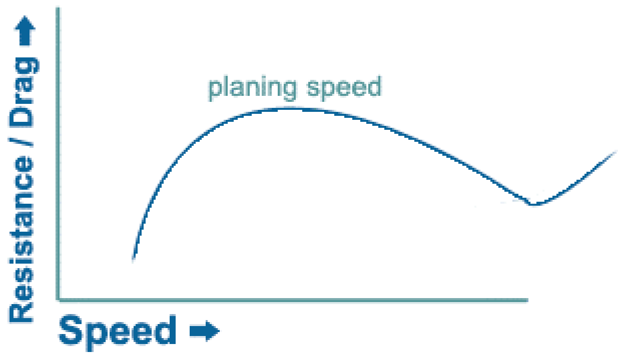
The Delta pad, because it is flat, will generate lift when the hull is planing but it will also exhibit the same bad characteristics of the flat bottom. It will also have the tendency to cavitate (ingest air) in rougher conditions. The Radius transition can best be described as a spoon shape. Whether the boat is on plane or taking off from a standing start the jet drive loads beautifully. Look under a few boats and see the difference for yourself.

Planing Ability

Planing ability and the power required to get a boat on plane are governed by a number of factors, a major one of which is deadrise. Generally speaking, the more the deadrise, the more power is required to get the boat on plane.

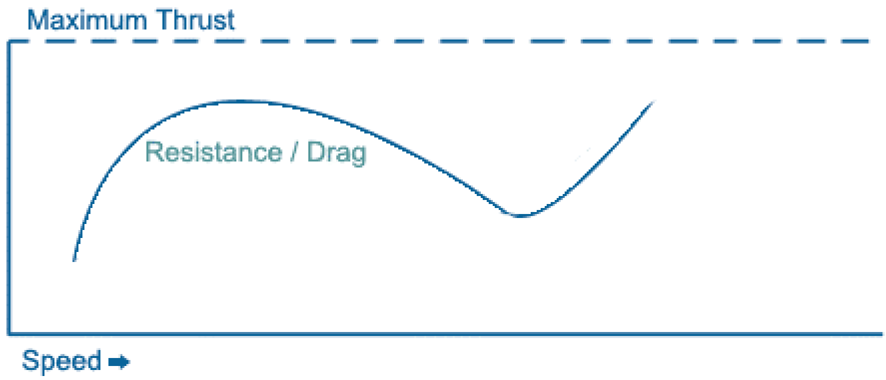
When the boat is at rest, it is sitting deep in the water. As the boat starts to accelerate, the bow is pushed forward and upward by the force of the water against the hull. In order to get on plane, it has to 'climb' over its bow wave. This is the "hole". It takes a tremendous amount of power to escape this wave as the boat makes the transition from a displacement hull to a planing hull. In more technical terms, the hull resistance or drag increases as the boat accelerates from rest to planing speed.

The resistance curve looks something like this:



Note that resistance increases, until the boat planes. At this point the boat has climbed out of the 'hole'/escaped it stern wave and resistance falls. At this point the boat rapidly accelerates.

The boat accelerates, not because of increased horsepower or thrust,(you usually have the boat 'pinned' (maximum power)), but because the hull resistance suddenly falls. This is shown below.



In other words, acceleration or deceleration is the gap or spread between thrust and resistance. This gap, between the resistance and thrust translates into increased speed. At this point, the driver can continue to accelerate or throttle back to a comfortable cruising speed. This is similar to a plane at takeoff. With the landing gear down, there is significant drag. Once the gear is retracted into the plane, drag reduces and the plane speeds up (or the pilot throttles back to maintain constant speed.

Note however, that you cannot increase speed forever. As Newton discovered hundreds of years ago, "for every action, there is an opposite and equal reaction." As the boat continues to accelerate it passes through a point where hull resistance drops to its lowest point and then begins to increase. As the resistance increases, the rate of acceleration begins to slow. Top speed will be reached when the thrust equals the resistance. Resistance increases at a non linear rate so adding 10% more horsepower or thrust does not translate into 10% more speed.
For example, 60 mph is attainable with 240 hp, however hitting 100 may require 600-1000 hp.

All else being equal, the most economical cruising speed would be at the low point of the resistance curve. However, this depends upon how well the engine is matched to your boat. If the low resistance point is at 32 mph, but the engine/impeller combination is not very efficient at that speed (for example the engine is undersized) then the fuel burn will be much higher at that speed (because fuel burn goes up as hp goes up). Therefore, trial and error and matching the proper drive to how you intend to use your boat become important issues.

So what does this mean in practical terms? Planing ability is important, as anyone who has struggled to get a water-skier up in an under powered or poorly designed boat can attest.The flatter the hull, the quicker and easier it will be to get the boat out of this hole on plane, ('on step'). In other words, the resistance curve is not as steep in a shallow vee hull; therefore the boat is able to plane more quickly. Adjusting trim and/or the shape of the bottom can also affect the nature of the 'hole' resistance curve. In an outboard, or IO, trimming the motor in, reduces the curve and thus allows one to get on step more easily.

Reverse Chines

A standard question we get is "What about a reverse chine?" Our answer is "Been there, done that." Reverse chines are designed to trap air and water and therefore generate lift. This is the same principal behind the 'catamaran' style speedboat tunnel hulls. Lift gets the boat out of the water thereby reducing drag and increasing speed.

There is however one important caveat that you probably never heard about – this effect only takes effect a higher speeds. Think about when you were a kid and had your hand out the window and used the wind to 'fly' your hand. It does not work well below 40 mph does it? Similarly, the lift effect on the reverse chine does not really show itself until higher speeds are reached.

So, you may ask, that sounds great, why do you not use it? The downside of the reverse chine is that it only works well at high speed and in a straight line. As soon as you start to turn, it makes the boat rock from side to side, known as chine walking. On turning, the inside chine generates lift, forcing the side to rise up - but the chine cannot support this extra lift, so the side falls and the chine digs in or 'hooks'. This process of lifting and falling or wobbling throughout the turn is called chine walking.

So, going back to our original philosophy, if you want a fast boat and will be doing most of your running at 50+ mph, then a reverse chine boat is probably the one for you. If however, you are like most of us and cruise at 30 mph with occasional bursts to the high 40s and spend time doing lots of turning while wakeboarding, cruising twisty rivers or lakes, then you should question whether you want the reverse chine.

For those who run in gravel rivers and shallow water and are not perfect pilots (most of us) you will find that when you run aground it is difficult to turn the boat to get it out into deep water again as the chine wants to dig in. For example, a common process to get a boat off a bar is to hook up a line to the nose of the boat to another boat and turn it 90^o to get it into the channel. It is very difficult with the turned down chine as the chine keeps digging into the gravel bar.

Lastly, keep in mind the typical production 20' boat with a 310 HP 350 or a Sportjet 200 will be pushing to hit 50 mph, regardless of whose boat it is. So when you hear that the other boat you are looking at will do in the mid 50s with this kind of chine and power take it with a grain of salt or buy it with a guarantee of that top end speed – for it is doing things few other boats will do.

Bottom Width: Flair is not everything

A large part of the stability, capacity and safety in a boat comes from bottom width. Although most boats and specifications cite beam as an important measure, bottom width is a much more important measure. It is easy to make a large beam boat – just flair out the sides. It gives the illusion of a bigger boat, however in terms of effective room there is not really much more. Think of putting a cube in a boat. The size of the cube is governed by the bottom width. Although there is more room at the top between the gunwale and the 'cube' it provides little effective extra capacity. Or think of it another way – when you walk to the side, on a wide flare boat, your feet will hit the sides before your waist does.

Now compare say two boats with an 83" beam, but one has a 5'6" and the other a 6' bottom. Which boat will:

- plane faster?
- be more stable?
- carry a bigger load?
- rest higher in the water?

In all cases, it is the one with the larger bottom. Therefore, when comparing boats do not just look at the beam – bottom width is a much more important feature.
On offshore, big water boats other factors come into play. Although width equals stability, if a boat is too wide it will bob around due to wave action. Stability in these conditions is more related to surface area, which is length times width. A better compromise to go with a little more length and a little less width (beam).

No Trim

What does this mean? When you run a conventional outboard or inboard/outboard (I/O), you can adjust the attitude/angle of the boat up or down depending upon load, water conditions or 'proposing' (up and down bow motion). So for example, when you start out with an I/O and hit the throttle, the nose rears up. You have to compensate with trim - then as the boat comes up on plane, the trim has to be adjusted again. If you forget to trim correctly you can get thrown out of the boat. Trim is adjusted constantly as the boat's speed changes.

In a prop boat you have to learn to drive the trim almost as much as the steering wheel. In a prop boat, you

- trim out to leave shore (if in shallow water),
- trim in to get on plane,
- trim out once underway at speed,

- trim in to make a turn and trim out again once you straighten out
- out to come back into shore.

On most jet boats there is no trim. Regardless of whether you have one or ten people on board, there is little you can do to affect the attitude of the boat. That decision was made long ago by the designer and the manufacturer. If you have a well designed hull it should not make much difference what kind of load you have on board – the boat should perform. You can change attitude of the boat in four ways, three while underway and one on shore.

While you are underway, you can

- shift weight within the boat
- use trim tabs if you have them
- use a 'jetavator'

Generally speaking, a well designed hull under around 25 feet, where the powerplant is well matched to the boat should not require any trim adjustment assuming your load is well balanced on the boat.

You may find that under your normal operating conditions that the hull needs to be tweaked, a little bit – you can do this either by adjusting the tabs at the end of the hull, if they exist (they are on all Marathon jet boats) or the ride plate on the jet, if it exists - such as the Mercury jet.

Hull Construction Standards

An offshoot of the fact that there is no trim on jets means that the standards of construction and design have to be higher, in our opinion, for a good hull. In our experience, if the hull is out 1/16 of an inch the hull does not perform. What is a 1/16" of an inch? Lay a yardstick down the hull - if you see daylight you may have a problem.

Shallow Water Operation

New jet boaters have an aversion to shallow water. They do not believe - in their gut - what the boat will do. The more agile jetboats, with the lighter power plants cannot go everywhere, but just about. However, in order to get there, everyone has to pay their dues. Everyone, sometime, somewhere spends time pushing boats off a gravel bar. Everyone does it. Then you learn to pick your course. However, gone are the concerns about ripping your lower unit off from a deadhead or rock, or wrecking the fiberglass hull from touching bottom. You are running heavy gauge aluminum.

You will find many jet boaters do not know how to tie up at a dock - as you just run it into shore, and tie up to the nearest tree.

No Exposed Drive

Talk about piece of mind. Jump in the boat, turn the key and go. No bottom of the lake to 'rototill', no kids or adults to hurt with the prop, no 4 minute idle out into deeper water before you hit it. During the day you drive the boat up on the beach, rather than docking it or putting it up on the hoist.

Safety

You would be surprised how many people are killed or injured by props. Not many accidents are as publicized as the unfortunate Philadelphia Flyer who was killed when he flew out of the bow, under the boat and into the prop. With a jet drive, he probably would have had a concussion or impact damage from hitting the boat, but the jet would not have hurt him.

Thrust line and Center of Gravity In line

One of the biggest changes you will notice is the jetboat is more controllable when accelerating than a prop boat. When you punch the throttle, the boat goes forward. The bow does not rear up and the stern dive as it does in a prop boat. This is because the thrust line is much closer to the center of gravity of the boat and the forces opposing the thrust. In a prop boat, the thrust is coming from below the boat, leading to more complicated forces which have to be controlled and compensated for, particularly with the bigger engines under high acceleration. A large I/O or outboard can be a vicious thing to handle when under high acceleration. With a jet, you get knocked back in your seat, but the boat goes forward with no twisting and pulling to the left.

Moreover, at high speed, the ‘black art’ of trimming the boat properly begins with a prop boat, whereas on a well tuned jet boat hull, the boat simply climbs more out of the water and the spray line moves to the stern. No fuss, no muss.

Propeller Torque is Different than Impeller Torque

When a customer comes into the showroom and asks why we put the steering wheel on the right hand side, we immediately know that he/she is a jetboater. Why is that? Jets have no torque effect on the operation of the boat so historically welded aluminum boats placed the steering on the left. However, the prop boaters moving to jet are used to the steering on the right as the driver’s weight counteracts the torque effect from the propeller which is most commonly trying to flip the boat to the left.

A well designed jet has no effect as the twisting motion imparted by the impeller is straightened out by the stator behind the impeller.

Propulsion Resistance

Which boat burns more fuel? A jet boat running at 3,000 RPM carrying 2,000 pounds or one operating at 3,000 RPM carrying 200 pounds?

The answer is neither one - they both burn the same amount of fuel. (Some readers will quibble that there are slight differences 1) due to higher ram pressure in the 2,000 pound boat due to the fact it is sitting deeper in the water and 2) a ram effect loading the jet due to the higher speed in the lighter boat.) While these differences do exist, for our purposes, they are negligible. The boats will travel at different speeds but should consume the same amount of fuel.

The reason for this is that the impeller does not have any idea what it is hooked up to, how fast it is moving or what it is pushing. Jets will quite happily spin at 3,000 rpm with

the boat standing still as long as a steady supply of water can replace what is pushed through the jet. (In the real world, a point is reached where the outflow of water exceeds the inflow, at which point the jet cavitates and spins out of control - it has literally starved itself of water. In fact, a standard test for a jet is to find the force exerted just before the jet goes into 'cavitation' - the force at this point is called the static thrust of the jet.
The load on the jet does not vary depending upon weight and speed - which is why jets can reach maximum rpm, regardless of load in the boat. The pitch of the impeller will affect how quickly the engine can accelerate the impeller to maximum rpm but this is totally independent of load (ignoring ram effect).

Power Plants

We quite often have customers who come looking for the big horsepower engines like V8s. Nothing is wrong with that, however the labeling in the market is very misleading. Customers are not getting what they think they are getting.

% of Max RPM	% HP actually produced	Mercury 175 Sportjet Max RPM 5500		350/351 310 HP V8 Max RPM 5500	
		RPM	HP	RPM	HP
10	1	550	2		3
20	4	1100	7		12
30	9	1650	16		28
40	16	2200	28		50
50	25	2750	44		77
60	36	3300	63		112
70	49	3850	86		152
80	64	4400	112		198
90	81	4950	142		252
100	100	5500	175		310

*Horsepower does not increase in a linear fashion, but rather as the square of the percentage of total horsepower. Therefore at 25% of maximum RPM the engine is only generating 6.25% of the rated horsepower.

If you have ever been in both a Sportjet and a V8 boat, you have probably seen the rpm at close to 5500 rpm where the pump was absorbing 175 hp, however it is highly unlikely that you have ever been in a 310 HP boat operating at 5500 rpm and supposedly putting out 310 HP. Furthermore, even if you were, the pump would not be absorbing 310 HP. What does this mean? Well, first of all there are some games being played. Shaft horsepower is not the same as powerhead HP. Mainstream engine manufacturers who sell integrated engine/drive packages must rate their packages power a prop or jet drive. Thus a 200 HP outboard powerhead is typically rated only 140 at the jet. When you buy an integrated unit such as a Mercury Sportjet you get the rated HP at the jet at maximum rpm, whereas the powerhead itself will be generating substantially more HP.

Contrast this to a V8. Typically when you buy a 350/351 V8 and a Berkeley/Legend/Kodiak/American Turbine/Jacuzzi you will hear that a person bought a 350 310 HP engine. This is not a comparable rating to the packaged drives.
The 310 rating is at the powerhead and not the jet nozzle. Moreover, you need to read the fine print as to how the 310 HP is measured. Usually this is on a test bed with no exhaust, load etc on the engine. Secondly, there is a 5 -15% HP loss due to friction, gears etc as power is transmitted to the drive. Powerhead HP is not shaft horsepower. An example of the differences was in 1972 when the auto manufacturers moved to NET ratings of their engines. The previously rated 300 HP engine ended up being 180 HP at the rear wheels. Or look at a Mercury or Volvo V8 stern drive which uses the same powerheads from Detroit as the 310 HP jet drive engines you are looking at purchasing. What are their net ratings? Around 260 HP. These are the same engines – it is just that Mercury and Volvo must NET rate or measure their HP at the prop or jet.
So how do we get to apples and apples rating with a jet rated Mercury Sportjet and a 310HP V8?
In the following section we will build a table of comparisons.

Derived from Impeller Curves

When you are driving your boat, you really do not care what is powering your drive. Whether it is a V8, an elastic band or peddle power – what matters is what is coming out of the jet nozzle or off the propeller blades.
At 2000’ above sea level, most 310 HP 20’ boats run an A2 impeller, in order to get reasonable acceleration out of the hole and a target 50 mph speed (few boats actually hit this). The maximum RPM generally achieved with this type of motor is around 4200 rpm. At this point the engine does not have the power the turn the impeller any faster.
Impeller manufacturers publish power absorption curves. These purportedly show the HP required to turn a specific impeller. Using this example, if you look at the power absorption curve provided by the manufacturer, it suggests that at 4200 rpm the impeller is absorbing 260 hp not 310 HP.
Notice that an A2 impeller was selected as it gave both good hole shot and a reasonable top end. You can reduce the cut of the impeller (the jet equivalent to pitch in a propeller) to an A cut which requires less torque to turn, and get the rpm up which in turn allows the engine to rev higher – which generates more horsepower, which generates more thrust and speed - HOWEVER it may take you forever to get there as you will have very little holeshot or lifting power. Secondly, enjoy it while it lasts. Most V6s and V8s are not designed to run at 4000+ rpm on a continual basis. By way of comparison, where does you car or truck run rpm wise? Typically 2000 -2500 rpm. You usually only hit 4,000 rpm when you kick in passing gear.
Therefore, even though you thought you had a 310 HP motor, you are maxed out at 260 HP (accordingly to the impeller absorption curve) because you have to use an A2. If you

are like most boaters, you will be cruising at around 3200-3400 rpm at which point the engine chart above suggests you are only generating around 110 HP.

RPM Curve Derivation

Referring to the chart above, if the engine redlines at 5500, and you can only get 4200 you get around 237 horsepower. Now the interesting thing is when you compare this to the new inboard jets such as the Mercury Sportjet 175. On a good, cold day at our elevation we can get 5,250 rpm which translates into 167 HP. We have run two identical hulls, one with a 350 and Legend pump and a 175 Mercury jet. They basically run neck and neck. What is happening? The 350 nominally has 77% more horsepower and should blow the 175 out of the water. Several things are happening:

- The weight difference of some 600 - 800 lbs. (the 175 weighs 304 lbs. and the 350 wet, with oil, coolant, and jet is 900 -1100 lbs.). Extra weight increases drag on the hull and slows the 350 boat down
- The calculated difference in HP based on rpm is only 42%
- The calculated difference using the jet manufacturers' power absorption curves is 55%
- There may be a difference in jet efficiency (which we cannot quantify but expect there is some as:
    - The 175 jet's center of effort is 2-3" lower than the Berkeley
    - Pipelines use the trash style (Sportjet) pump to move oil and gas. (We have to believe the engineers are using the most efficient pump)

Just to make things more complicated, let us measure the thrust. This can be done with a draw bar pull test. Hook the boat to a solid object, via a line with a modified version of a spring scale. Accelerate the engine (you will not go anywhere as the boat is tied up and the jet does not 'care' if it is moving) until the engine cavitates. This measures the maximum amount of thrust being developed. Continuing the comparison we have found that the 175 generates approximately 950 lbs. of thrust whereas the 350 generates around 1100 or a 16% difference in thrust.
The discussion above is summarized below:

Measure	**Sportjet**	**350**	**% Difference**
Nominal HP	175	310	77
Impeller HP absorption calculation	167	260	57
Static thrust (lbs.)	950	1100	16
Weight (engine/pump 'wet')	305	1000+	300%
Power to Weight ratio (Static thrust)	3.1	1.1	300%

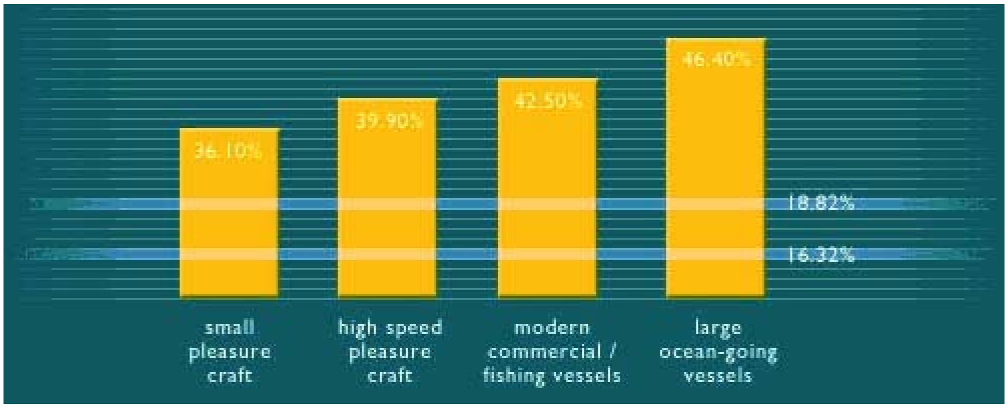
Conclusion

So what happened to that big powerful engine? Where did all the horsepower go? Who cares? You should.
All you care about is speed and fuel economy right? If the answer is no, and you are looking for a high speed, high performance boat so most of the following goes out the window.
In rough terms, where does all that energy go? Basically three areas:

- engine loss,
- hull friction loss and
- jet or drive loss.

Assume you start with 100 units of energy.Immediately on starting, 83% of your gasoline's energy is lost through heat in the exhaust and powerhead. This is because internal combustion engines are generally only 17% efficient. The following illustrates the variations in efficiency for various types of engine/drives and the enormous scope for improvement that exists.

" The table below sets out the efficiency goals for the PDX Marine Drive across a range of marine vessel types. These goals are based on theoretical estimated values. Curtin Consultancy Services have verified that these goals represent reasonable orders of magnitude and estimates. By comparison, the most efficient outboard propeller unit, with its multiple working parts, achieves only 16.32%. And even an inboard petrol-engine waterjet achieves only 18.82%."



Hull friction and resistance is the next big loss at 50% of the remainder. Depending upon hull design, this can range from 45 - 55%.
Finally the jet is only 75% efficient. We do not have comparable data comparing jet to jet, however in our experience there is little measurable difference in efficiency between jets on the market today. There are many claims of this or that but little differences we can see for the average user. There are definitely jets that are more suitable for specific applications such as load carrying or high speed, however that has nothing to do with overall efficiency. If anyone has information showing one jet is superior to another in terms of efficiency we would be glad to hear about it and update our analysis.
Now these are only rules of thumb. But from this, some conclusions can be drawn:

Hull Resistance

Hull resistance is a big loss factor. Two key factors in this are hull stiffness, strength and design flaws such as hooks. Hull stiffness can be seen as factor in those boats that ‘twitch’ and twist as they go through the water. This ties into structural integrity such as stringers and what materials are used. Softer materials allow more flex and therefore more energy loss.
The twisting is absorbing energy which would otherwise go into propulsion. Furthermore, the hull twist makes the boat jump around from side to side, again diverting energy from straight forward propulsion.
Chine walking and porpoising while running absorbs energy and translate into fuel losses.
How much variability is there between boats? This is more an art than a science and we do not pretend to full knowledge and ranking of hulls in terms of efficiency – however neither does anyone else. As an example is the following excerpt from Hotboat April 2003 in Power Talk: High Performance by Bob Brown:

> *“From my experience in racing and doing performance boat tests for the past 30 years, I’ve kind of established my own rating system expressed in a percentage to determine how well a boat is performing. Starting at the top of the ladder, I’ve found a few exceptionally good-running race boats that were capable of achieving a 92-93% performance level, but these are rare. Then we move down a notch to the 90-91% level which only a handful of really dialed-in high performance boats can attain. Next we move into the 87-89% range, where some of the good-running air-entrapment tunnels and really efficient stepvees live. Then it seems that most of the performance boats reside in the 83-86% bracket. And if the efficiency rating is in the 82% and below range, you definitely have some room to improve your setup.*
> *“ So where do these arbitrary percentages come from? Here’s how it works. Remember in the beginning of this column I said you need three accurate pieces of information, propeller pitch, gear ratio and wide-open - throttle engine rpm. Now get your pocket calculator out and follow along.*
> *Start by taking your maximum engine rpm (i.e. 5,000) and dividing it by the gear ratio (1.50:1). Take that number (3,334 which is the number of revolutions your prop makes each minute at WOT), and multiply it by the propeller pitch (24 inches). Then take that number (80,016 inches) and divide it by 12 inches (one foot). That number (6,668 feet) then needs to be divided again by 5.80 (the number of feet in a mile), which gives you 1.263 (rounded off). Then multiply the 1.263 by 60 mph, and you get 75.78 mph, which is the 100% optimum top speed, possible with this prop, gear and rpm combination. As you can see, there’s no way possible (assuming that all three pieces of the original performance data are accurate) that this combination would ever net a top speed even close to 90 mph which one reader was convinced he was doing*
> *Assuming a reasonably efficient setup, an 88% efficiency rating, would equal a speed of around 67 mph. If you are less than that there is room for improvement. However, if you believe you are doing 90 when you can theoretically only go 70, you have more problems than boat setup.”*

This is consistent with Marathon's experience which one test expert noted: "GPS slowed down more boats than any other factor. It got rid of a lot of 55-60 mph 20' 350 310 HP boats" In other words, like the big fish that got away, typically proud boat owners could no longer be under false illusions about how fast their boats were going

Boat attitude

It the boat runs flat, it generates more drag than if it is running clean. Generally, all else being equal, the farther back the spray line is on the boat, the less resistance is generated and the more efficient it is. The more consistent and steady a boat performs the higher efficiency level.
A second factor is weight. All things being equal, less weight means less boat in the water, which means less drag. That is why the better power package, again all things being equal, is the one with the higher power to weight ratio.

Jet Drives

If you thought engines and horsepower were confusing, welcome to the world of jets. Some of the terms you will hear are outboard jets, inboard jets, mixed flow, axial flow, impeller, open blade or vane, closed blade, wear ring, impeller 'cut', clearance, EZ Clean, hard anodized, cavitation, nozzle size, stator, intake.

How jets work

Basically a jet is a pump that takes in water at one end, accelerates it and shoots it out a nozzle. This goes back to Newton's law, that "For every action, there is an opposite and equal reaction." Water jets work on the same principals as airplane jet engines (suck in air, accelerate it and shoot it out the back) or rockets (burn some fuel, create some gas and shoot it out the nozzle.) Just like planes and rockets, there are many variations and versions that work well in one application and not in another. Before getting into detail, we should define some terms.

Impeller

An impeller is basically the jet equivalent of a propeller. It looks like a screw. The impeller is set inside a housing/shaft/tunnel/tube through water passes. The impeller accelerates the water and provides the thrust. Like a propeller, you can change the pitch, however you cannot change the diameter of the impeller as this is governed by the design of the pump and the housing/shaft/tunnel or wear ring within which it sits.

Cut

The cut of an impeller is basically the pitch of the blades of the impeller and is largely equivalent to pitch on a prop. Like a prop, you can get an impeller that will give you high end boat speed but very little pulling or accelerating power (like starting out in fourth gear in a car), or an impeller with good 'hole shot' or acceleration but limited high end boat speed – like starting out in first gear. Unlike a car, you do not have a choice of gears, so once you get into the boat, you are basically stuck with whatever impeller choice you

made.
In axial flow jets the ratings are A, A2, A3 etc. The higher the number, the more torque and or HP is required to turn them. This is the same as in propellers where the higher pitched props require more horsepower to turn them.

The number or rating of each impeller is largely meaningless – it is just a convention. However, what is important is that each impeller has a horsepower absorption curve. Basically each curve is the amount of horsepower it takes to turn a fully loaded (well supplied with water) impeller.
Similarly, you could redraw the curves to show what thrust there is for each rpm level. Each impeller cut will have a different thrust curve.
The trick then is to match the engine you are using with the impeller. However it is more complicated than that, as you also have to decide how fast you want to go, the load you will be carrying and what rpm you want to run.
For example, to take a ridiculous example, if you have an engine that generates 400 HP but only at 10,000 rpm, it will not be a good choice for the impellers listed above – as the impellers above basically require enormous horsepower to turn at 10,000 rpm.
The development and mixing and matching of the whole drive system is a mix of art and science and is beyond this paper but over time various rules of thumb have been developed.
The most common cut impeller installed with a 20' boat and a 310 HP V8 at 2,000 feet above sea level is an A2. This provides good acceleration out of the hole and a top end boat speed of 48-50 mph for a well designed hull. More importantly it provides a cruising speed of 28-32 mph for most boats with the engine working fairly comfortably at 3200 rpm. At this rpm the engine lasts a reasonable period of time, noise levels are not too high and fuel efficiency is maximized.
If you are a 'speed demon' and spend most of the time at the lake on speed runs, then it is not likely the choice for you. You will likely want an impeller that will absorb more horsepower within the range that the engine can produce. This will likely mean a finer cut impeller – and also less thrust generally speaking at the lower end. This in turn means you may need a lighter boat, with a bottom design more attuned to high speed etc, etc, etc.

Cut, Speed and Load

Let's face it. Who really cares about cut and pitch? You just want to get up and go, right? If you have a well matched power plant and drive to your boating needs, you will not have any problems. The difficulty comes when you have conflicting needs. You want a boat that goes 100 mph, but also can pull the kids tubing and then carry the big load when you go on a long trip. The problem comes back to hole shot.
Assume you say, "I want to go faster." Keeping everything else constant – horsepower, boat, weight etc, we would reduce the cut of the impeller. This type of impeller can generate a great deal of thrust – the problem is, it comes at high rpm and requires a great deal of water flow to feed its appetite. At lower speeds it cannot get enough water on the inlet side and therefore it cavitates. For this reason you have to 'feather' or increase slowly rpm so that the impeller does not cavitate.
As the rpm increases, the impeller needs more water to pump through or else it spins

uncontrollably and cavitates. Generally this water supply comes from the boat moving forward, thereby feeding new water to the intake. In other words, if the boat is tied up to a dock or pulling something heavy, 'new' water cannot move into place fast enough to replace what the pump is shooting out the back of the boat. The forward motion of the boat assists this process.
Therefore you have to match impeller, engine, load etc. If you design too much weight and load for engine and impeller all that will happen is that the more you increase rpm, the more the pump cavitates. If you could magically push the boat over the hump point (another boat towing you, a rocket thruster or some such thing) then your boat could go faster than it ever did. However we do not live in the land of magic, so you need to make tradeoffs between load carrying and speed.

Wear ring

The impeller sits inside a housing designed to force all water through the eye of the impeller in a smooth fashion. However, because this is a mechanical device, there has to be a gap between the impeller and the wall of the housing. Typically this part of the housing is called the wear ring. It is called the wear ring, because over time as sand, grit and material passes through the pump, it wears the housing between the impeller and the housing. Therefore most pumps design a sacrificial, easily replaceable part (wear ring) rather than having to replace the whole housing. Replacement life depends upon the type of water running in and how much care the operator takes in operating the boat. In the oil sand laden waters of Ft McMurray, Alberta a wear ring and impeller may only last one season, whereas a jet operating strictly on a lake will rarely have to replace anything. Signs that a wear ring or impeller needs replacing are:

- deteriorating hole shot or acceleration
- the need to increase operating rpm for a given boat speed.
- decreasing fuel efficiency

In any case, it could be the wear ring OR the impeller – only inspection will tell. Some pump designs see faster wear on the wear ring than the impeller or vice versa. In others, one pebble can groove out the wear ring and leave everything else pristine.
In all cases, the deterioration increases the tolerances or distances between the impeller and housing, thereby allowing water to bypass the impeller, reducing pressure and therefore the speed at which water exits the pump.

Nozzle

The nozzle is at the back of the jet and where the water stream exits. It serves a two fold purpose –steering and power. The first is straightforward. By directing the flow of water as it leaves the boat, the nozzles steers the boat. It is this, and basically only this that provides direction. This is one reason extreme caution should be used when cutting power to the boat as all steering is lost. In fact, there are some cases where attempting to avoid an obstacle that more power will provide more steering effect and increase the ability to avoid the obstacle.
Secondly, the nozzle plays and important part in the overall thrust equation, particularly

in mixed flow pumps. By increasing or decreasing the size of the nozzle, the pressure within the water stream (and therefore the exit velocity of the water) can be varied. Thus racing boats have very small nozzles and correspondingly high pressures and exit velocities.

Stator

Hard Anodized

As mentioned previously, running in silty or debris laden waters will cause wear on components. Manufacturers vary in the type of materials and treatment of materials in their jets. Some manufacturers treat the impellers, wear rings and bowls or housing to increase resistance to wear. This is call *hard anodizing.*

Cavitation

This occurs when the pump loses load and the engine and pump increase rpm substantially. It is like taking a car out of gear with the gas pedal still on – the engine revs uncontrollably. Cavitation can be caused by a number of things including:

- Wear ring or impeller damage
- Poor hull design
- Introduction of air to the intake. This can be during spins, running large waves or rapids
- Starving the impeller of from water by plugging up the intake
- Disrupting the impeller itself through a rock or other debris becoming lodged in the impeller itself.

Intake

This is the external portion of the pump on the bottom of the boat where water comes in. The marriage of the intake and hull is one of the most critical aspects of a jet boat, particularly the area 12” around it. Jets require a smooth laminar (unbroken) flow of water to operate effectively. They need it on straight-aways and when turning. A design may work awesome on a straight run, but cavitate in turns. In fact a test of a good design is whether or not the boat cavitates in hard turns. A good design will ensure that the pump does not cavitate through the hardest turns.

The intake itself can be cast aluminum of varying thickness or fabricated out of aluminum. They are all about the same – except beware using a light duty, lake style aluminum casting intake on a boat that is going to be dancing among the rocks – the light duty lake casting is not designed for that kind of use and a rock impact could crack the intake and sink the boat.

Seals

Engine power is transmitted to the impeller by way of a shaft. The front part of the shaft is held in place by seals. The seals have to do two things:

- Allow the shaft to spin with minimal resistance and friction
- Keep water out of the boat (for this is also a barrier between the boat and water in the pump)

There are basically two types of seals:

- Mechanical
- Packing

Generally the mechanical seals are the most popular, if you count total sales, however this may be because the pumps they come on are cheaper as well. The downside of mechanical seals is that they are noisier and if they fail, you can sink your boat, as water will come in. As well, you cannot run them out of the water without risking damage, which means tune-ups done outside the water can be a risky business.
Cost differences are within $300 which is minimal when you are talking a $25 – 50,000 boat.

Mixed flow

A mixed flow pump is essentially one with a closed bladed impeller. The fundamental idea behind a closed bladed impeller is to increase the amount of water in contact with the eye of the impeller thereby generating increased pressure and accelerating it out the nozzle. Increasing pressure increases the exit velocity of the water and therefore the higher the potential speed of the boat – up to 130 mph. Therefore these are the types of pumps one sees on race boats. They are hooked to massive (600 –1200 HP engines). The pressures they generate can be enormous. Whereas a typical production jet drive may have 8 3⁄4” bolts holding it together, a race pump may have 16 – and still strip and blow the bolts apart.
Because a mixed flow pump has a ‘closed bladed’ impeller, even small debris can get trapped in the blades. This disrupts the water flow, creates turbulence and cavitation, essentially disabling the jet. Rocks or debris the size of a thumbnail can cause this to happen.
Similarly, as the blades of the impeller become damaged, this can also disrupt the jet.

Axial flow

These pumps use open bladed impellers and do not generate the types of pressures and exit velocities of mixed flow pumps. For example, the exit speed on a Mercury Sportjet is reported to be around 70 mph, making it impossible to attain higher speeds than this. Because these impellers are wide open, they are not a susceptible to plugging. In other applications, like pipelines and job site pumps, these types of pumps are known as trash pumps. For this reason it is difficult to plug and disable pumps like the Sportjet or Hamilton.

Pump	Type	Seal	Impellers	Ease of Plugging
Sportjet 175	Mixed	None	One	Difficult
American Turbine	Axial	Mechanical	One	Easy
Marine Power	Axial		One	Easy
Legend	Axial		One	Easy
Berkeley	Axial		One	Easy
Hamilton	Mixed			Difficult

Outboard jet:

The bottom drive portion of an outboard prop is replaced with a jet unit. The intake portion of the jet is roughly 2-3” up from the bottom of the boat. The water goes up, is turned roughly 270o before exiting the pump. Because the water must be raised up so high and is rotated 270o there is a significant energy loss (up to 40%) as compared to inboard jets

Inboard jets:

The jet or pump is mounted inside the boat. With the exception of Mercury Marine Sportjets, all pumps are mounted behind the engine.

So, what is the best jet?

That depends on what you want to do. Just as there is no perfect boat, there is no perfect pump. In our experience there are only two generalizations we can make:

- If you want to carry big loads (2000 lbs. or more), some kind of axial flow pump is probably what you need
- If you want to go fast (70 mph+) some sort of mixed flow pump is the only one that will get you there

Outside of this, there are no clear cut answers. In our opinion, they are more or less the same in terms of performance. In our opinion, there are differences in quality and cost effectiveness but little in the way of performance of one pump over another.
It all depends upon what your preference is. There is no institute which generates comparative numbers of efficiencies, thrust, HP absorption etc that one could use to say, “This is the best.” There are no industry standards (outside of the integrated engine/jet package manufacturers) that govern combination. For example if you hook up a Brand X engine to a Brand Y pump there are no standards as to the HP at the nozzle. There is little published data on fuel burns with various combinations. So how do you make a choice? In 30 years of testing we have tested hundreds of permutations and combinations. We have heard all the stories. The introduction of GPS had a very detrimental effect on jet boat owners’ egos and bragging as it somehow brought everyone’s speed down 10-15

mph. We were running one boat with twin Sportjets with 6 people on board that on a good cold day was capable of 55-60 mph was running neck and neck against a lightly loaded boat, known at the fastest boat in the area and capable of 70mph. One of our passengers was super impressed as he said, “Wow, we are doing 70 mph.”
We can almost guarantee that 95% of boaters cannot tell the difference between the performance of one mixed flow pump and another or one type of axial and another. You will hear a lot of talk. Just remember that little of it is independently verifiable. You will have to make up your own mind and whom you trust. It is sad, but the lack of independent standards leaves the game open. This in turn goes back to finding a manufacturer you can trust.

Corrosion

Corrosion is the chemical wearing away of a metal. Rust is a simple example, however in boats the primary concern is in salt water. Here the concern is with two dissimilar metals in the presence of an effective electrolyte. When the metals are connected and electric current (electrolysis) is established and the nobler or more electrically active begins to erode. Examples include stainless steel laminated on aluminum bottoms or stainless steel fittings on aluminum boats. The corrosion, in early stages will appear as surface pitting. Although electrolysis can occur in all water conditions, in practice only salt water causes significant problems.
For this reason, sacrificial anodes are utilized to protect the ‘nobler’ metal. Essentially the anode deteriorates over time and protects the structures on the boat.
Secondary precautions include separating all fittings with non conducting washers, ensuring shore power connections are wired correctly; Additional precautions are required for wood or fiberglass hulls.
Some builders put steel on their bottoms for additional protection. If you go this way, make sure there is a warranty against corrosion and electrolysis.

UHMW

(Abbreviation for Ultra High Molecular Weight plastic.) This is often used on the bottom of boats used in heavy use, shallow water conditions. However, there are several misconceptions about it. Most people think it protects the bottom and provides structural support.
UHMW does nothing of the sort. Basically it acts as grease, and allows the boat to slide over rocks easily. In that sense it protects the boat, as there much less friction when it goes over a rock or gravel than with bare aluminum.
However, upon hitting a rock, the only additional protection is this friction reduction – it does not stiffen up the bottom.
Further, as the UHMW moves it does not form as smooth and flat a surface as the hull, and therefore will have increased drag and reduced fuel economy.
Most applications and manufacturers attach the plastic by drilling holes through the plastic and the hull of the boat. The plastic expands and contracts with varying temperatures and can stress/stretch bolts. Bolts will elongate holes in aluminum and UHMW over time. Any impacts and hitting rocks accelerates the process. Thus any boat

constructed this way is guaranteed to leak over time. In fact some boats are so bad, that you need two bilge pump running overnight, or you have to beach the boat.
Further, UHMW gets brittle and cracks with age and therefore deteriorates.
An alternative to the leaking problem is to tap bolts to a keel plate. These do not penetrate the hull and therefore there is no risk of leaking. This is a more expensive way applying the UHMW but ensures your boat will not sink.

Jet Diagnosis

Rattle at Idle (V8 boats)

Check the alignment and tolerances between the drive shaft and yoke. If the noise disappears above idle the splines engage and lock up eliminate the vibration.

Rattle Follows RPM (V8 boats)

Usually a sign of bearing failure or U joint misalignment.

Speed too low for a Given RPM

- Impeller cut needs to be increased
- Wear ring needs to be replaced/changed
- Impeller may be damaged, particularly the trailing edges
- Obstruction on intake grate or within impeller

Poor acceleration or ‘holeshot’, combined with high top end

- Impeller cut needs to be changed to provide more low end acceleration
- Wear on the impeller and/or wear ring is allowing the pump to cavitate at low boat speeds. One or both may need to be replaced

Definitions

Porpoising

The rhythmic up and down motion the bow of the boat makes as it goes through the water, particularly at high speed. The result of the water pressure generating lift on the forward section of the boat, which cannot be sustained. As a result, the bow drops back into the water. The bow begins to lift . . . etc.

Chine walk:

Where the boat alternates from chine to chine as is goes through the water. This can be particularly noticeable as it turns and does not turn smoothly through the water, but rather rocks from one chine to other throughout the turn

- On Step - the boat is planing

- Out of the hole- getting the boat up on plane. The boat at rest, is sitting deep in the water.

Ram effect

Loading the jet with water by funneling water to it. Basically this is a misnomer for most recreational boats. Ram effect conjures up visions of forcing water into the pump. While it is vitally important that the pump receive a ‘clean’ supply of water (that is no eddies, air bubbles or other turbulence in the water) the distinction we are trying to make is that it is like difference between a passenger airplane jet engine which also requires clean air versus a ramjet which does actually rely on high speed forcing of air into the engine.
In order to achieve full thrust, a jet boat requires boat movement. Basically this is because the water passing through the pump cannot be replaced fast enough when the boat is in a static or fixed position. You will sometimes hear that a pump has a ‘static thrust’ of X. This basically means that that is the point when the pump runs out of ‘clean’ water supply and cavitates when in a fixed position – sort of the jet engine equivalent to a test bed.
As soon as the boat is released, or starts to accelerate, this cavitation level changes as a higher volume of water is now available to the intake and pump will not cavitate.

Static thrust:

The maximum thrust at the point where a jet goes into cavitation.